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ANALYSIS OF CATCH PER UNIT EFFORT (CPUE) AND MAXIMUM SUSTAINABLE YIELD (MSY) OF SKIPJACK TUNA (Katsuwonus pelamis) LANDED AT THE PORT OF OCEAN FISHERIES KENDARI

Analisis Catch Per Unit Effort (CPUE) dan Maximmum Sustainable Yield (MSY) Ikan Cakalang (Katsuwonus pelamis) Yang Didaratkan di Pelabuhan Perikanan Samudera (PPS) Kendari

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ABSTRACT

Skipjack tuna is one of the large pelagic fish landed at the Kendari Ocean Fisheries Port (PPS Kendari). The objective of this research is to analyze the Catch per Unit Effort (CPUE) and Maximum Sustainable Yield (MSY) of skipjack tuna (Katsuwonus pelamis) landed at PPS Kendari. The study was conducted in November-December 2023 at PPS Kendari. Data obtained from PPS Kendari for the years 2016-2022 include the catch of landed skipjack tuna, types of fishing gear used, and the quantity of catch for each type of gear. The research method employed is the surplus production Scheafer method. Fishing gear used to catch skipjack tuna landed at PPS Kendari includes gillnets, hand lines, pole and line, purse seines, boat seine, lift net, and others. The standard fishing gear used is the pole and line. The analysis of CPUE values for landed skipjack tuna at PPS Kendari tends to fluctuate, with the highest CPUE occurring in 2020 at 3,670 kg/trip and the lowest CPUE occurring in 2018 at 1,578 kg/trip. Based on the MSY analysis, the optimal fishing effort is determined to be 2126 trips per year, with an optimal catch quantity of 6,130,516 kg per year. The utilization of skipjack tuna at PPS Kendari has not reached the level of overfishing. It can be concluded that the fishing effort for skipjack tuna has not exceeded the limits of sustainable stocks in the Banda Sea, allowing for an increase in fishing effort to achieve maximum results while still adhering to the calculated MSY limits.

Keywords: Skipjack Tuna, PPS Kendari, CPUE, MSY

ABSTRAK

Ikan cakalang merupakan salah satu ikan pelagis besar yang didaratkan di Pelabuhan Perikanan Samudera (PPS) Kendari. Tujuan dari penelitian ini adalah untuk menganalisis *Catch per Unit Effort* (CPUE) dan *Maximmum Sustainable Yield* (MSY*)* ikan cakalang *Katsuwonus pelamis*) yang didaratkan di PPS Kendari. Penelitian dilaksanakan pada bulan November-Desember 2023 di PPS Kendari. Data yang diperoleh di PPS Kendari tahun 2016-2022 antara lain hasil tangkapan ikan cakalang yang didaratkan, jenis alat tangkap yang digunakan, dan jumlah

hasil tangkapan setiap alat tangkapnya. Metode yang digunakan dalam penelitian ini adalah metode surplus produksi Scheafer. Alat tangkap yang digunakan untuk menangkap ikan cakalang yang didaratkan di PPS Kendari yaitu *gillnet*, *hand line*, *pole and line*, *purse seine*, bagan perahu, penganggkut dan lain-lain. Alat tangkap yang dijadikan sebagai alat tangkap standar yaitu *pole and line.* Hasil analisis nilai *CPUE* ikan cakalang yang didaratkan di PPS Kendari cenderung berfluktuasi *CPUE* tertinggi terjadi tahun 2020 yaitu sebesar 3.670 kg/trip dan nilai CPUE terendah terjadi pada tahun 2018 yaitu sebesar1.578 kg/trip. Berdasarkan Hasil analisis MSY diperoleh nilai upaya penangkapan optimum sebesar 2126 trip/tahun dan nilai jumlah tangkapan optimal sebesar 6.130.516 kg/tahun. Pemanfaatan ikan cakalang di PPS Kendari belum mencapai (*overfishing*) maka dapat disimpulkan bahwa upaya penangkapan ikan cakalang belum melebihi batas stok lestari yang ada pada perairan laut banda, sehingga upaya penangkapan dapat ditingkatkan untuk mendapatkan hasil yang maksimal tetapi tetap berdasar pada batas MSY yang telah diperhitungkan.

Kata Kunci: Cakalang, PPS Kendari, CPUE, MSY.

INTRODUCTION

The Banda Sea is a fishing area that has important economic resources and is the target of fishing fleets ranging from small to large scales (Waileruny, 2014). The fish stock in the Banda Sea region itself consists of various types of fish, molluscs and shellfish. The waters of the Banda Sea, especially in the eastern part of Southeast Sulawesi, are located in the Republic of Indonesia State Fisheries Management Area (WPPNRI) 714, which is a potential fishing area, one of which is skipjack tuna (*Katsuwonus pelamis*) (Picaulima, 2022).

Skipjack tuna is one of the fish that is often landed at the Kendari Ocean Fisheries Port (PPS). PPS Kendari is one of the ports that actively produces fish resources (Nurmayana, 2022). Classified as a large pelagic fishery resource, skipjack tuna (*Katsuwonus pelamis*) is a high-value export commodity in the waters of Eastern Indonesia (Diningurm, 2019). Eastern Indonesian waters, skipjack tuna fishing activities have had a significant economic impact since the early 1970s, and are widely used by the community to sell fresh and consume after processing (Sipahutar, 2019). There are several fishing tools at PPS Kendari that are used to catch skipjack tuna, including gillnet, hand line, pole and line, purse seine, and boat charts with boat sizes ranging from 10-30 GT.

Catch per Unit Effort (CPUE) is a simple way to estimate the biomass status of fish in waters by comparing catches with fishing efforts (Nur, 2011). There will be an increase or decrease in fisheries production in an area, this can be seen from the results of fishing efforts. According to Marinding (2023), the value produced in this analysis can be explained by the availability of fish stock at the fishing location and the opportunity for additional production.

Maximum Sustainable Yield (MSY) is the largest amount of fish stock that can be harvested continuously using existing potential without affecting the sustainability of fish stocks. By understanding the sustainable potential value, it is hoped that the level of utilization of fish resources will not exceed the sustainable potential value, so that resource sustainability can continue to be maintained (Taher et al., 2020).

The aim of this study was to analyze CPUE, MSY and utilization levels of skipjack tuna. The benefit of this research is to obtain CPUE, MSY results and the level of utilization of skipjack tuna in Banda sea waters.

METHODS

Place and Time

The research was carried out in November-December 2023 at PPS Kendari. The data used in this research is secondary data. Data obtained at the Kendari PPS for 2016-2022 include

the catches of skipjack tuna landed, the type of fishing gear used, and the number of catches per fishing gear.

Research Location Map

The fishing location was carried out in the Republic of Indonesia State Fisheries Management Area (WPPNRI) 714, namely the Banda Sea at a position around 07º26.160' S to 05º 23.280'. The sampling location was carried out at PPS Kendari, Puday Village, Abeli District, Kendari, Southeast Sulawesi.

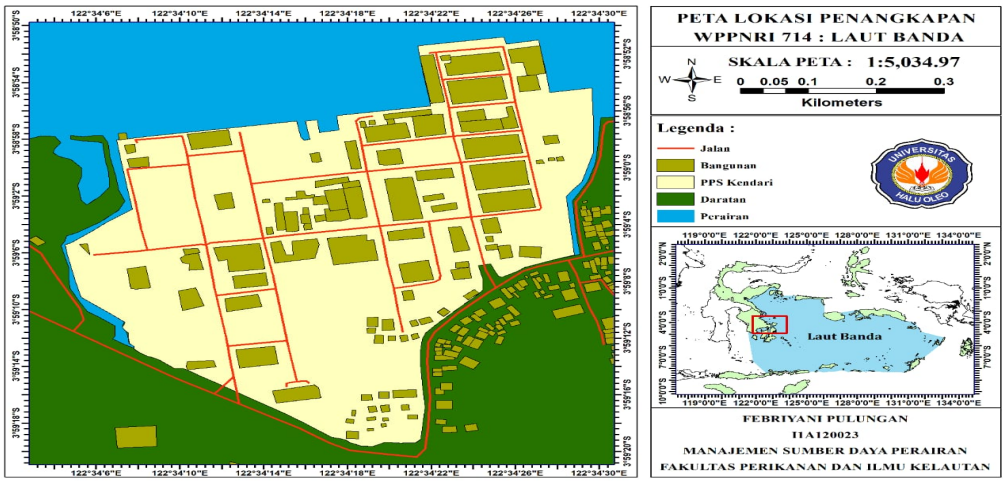

Figure 1. Map of research and fishing locations for skipjack tuna (Katsuwonus pelamis) in the waters of the Banda Sea WPPNRI 714

Fish Data Collection

Data collection took place at the Kendari Ocean Fishing Port. The data source comes from logbooks collected over 7 years (2016-2022). The data collection stage is the process of obtaining research data in the form of raw data. The data extraction process begins with selecting the type of fish based on research data. Data taken from the logbook includes date, ship name, ship GT, number of fishing gear and total catch (Kg). Catches are then sorted by fishing gear per year, then total catch per fishing gear. The logbook has been verified by the harbormaster officer at PPS Kendari.

Data Sorting

The data sorting process is obtained from logbook data. This logbook is the captain's written daily report regarding fishing activities. The logbook is a statement from the captain regarding fishing activities for fish resources (catch) at sea which will be landed at the Kendari Ocean Fisheries Port. The data extraction procedure begins with selecting the type of fish based on research data.

Data analysis

Standardization of Efforts

Standardization of fishing effort is carried out by calculating the Fishing Power Index (FPI). The FPI value for standard fishing gear is 1, and the FPI value for other fishing gear is calculated by dividing the catch of the fishing gear by the catch effort of the standard fishing gear. The fishing capacity index determines the most efficient (standard) fishing gear based on the Sparre & Venema (1999) equation:

$$\mathrm{FPI} = \mathrm{CPUEr}/\mathrm{CPUEs} \quad (1)$$

$$Effort\ Std = FPI\ x\ E \quad (2)$$

Information:
FPI : Fishing gear fishing power index
CPUEr : Catch per fishing effort from other fishing gear (kg/trip)
CPUEs : Catch per fishing effort with standard fishing gear (kg/trip)
Effort Std : effort to catch fishing gear after standardization
E : fishing effort (trip)

Catches per unit effort (CPUE)

After standardizing the effort, an analysis was carried out (Catch per unit effort) based on Sparre & Venema (1999):

$$\text{CPUE} = \frac{Catch(\text{c})}{Effort(\text{f})} \quad \text{.....(3)}$$

Information:
CPUE : catch per attempt to catch skipjack in the year t-th (kg/trip)
Catch : skipjack tuna catch in year t (kg)
Effort : efforts to catch skipjack in the t year (trip)

Maximum Sustainable Yield (MSY)

The potential of skipjack tuna can be estimated by analyzing catches and fishing effort. According to Sparre and Venema (1999), the relationship between catch and fishing effort can be modeled using Scheafer's production surplus method. The data processing stages are as follows:

1. Plot the f value as a function of c/f and estimate the intercept value (a) and slope value (b) using linear regression.
2. Calculation of Estimated Sustainable Potential (CMSY) and Optimum Effort (EMSY) Linear regression equation using the formula:

$$y = a - bx \quad \text{.....(4)}$$

Information:
y : dependent variable (CPUE) in kg/trip
x : free variable (effort) in the trip
a and b : regression parameters

Next, parameters a and b can be searched using the formula:

$$a = \Sigma \frac{Xi}{n} - \Sigma \frac{Yi}{n} \quad b = \frac{n.\Sigma((xi)\ (yi)) - (\sum Yi)}{n.\sum(xi^2) - (\sum xi)^2} \quad \text{.....(5)}$$

Information:
a
b : slope (slope)
xi : fishing effort in period i, and
yi : catch per unit effort in period i

Determination of optimal catch value (CMSY) and optimal fishing effort (EMSY) using Schaefer is as follows:

a. The model equation can be written $\text{CPUE} = a - b(\text{f})$
b. The relationship between C and f can be written $\text{C} = af - b(\text{f})^2$ .....(6)

Information:
CPUE/C : number of catches per unit of fishing effort (kg/trip)
a : intercept
b : regression coefficient/variable f
f : fishing effort (trip) in period-i

If the slope parameter (b or d) is negative, it means that an increase in the number of fishing attempts will result in a decrease in the catch per attempt. If the calculated slope parameter (b or d) is positive, then it is not possible to estimate the optimal stock or effort, but can only conclude that increasing fishing effort will still increase catches (Sparre & Venema, 1999):

1. Schaefer's Model

a) Maximum effort can be calculated using the formula:

$$E_{MSY} = -\frac{a}{2b} \quad \text{.....(7)}$$

b) Maximum sustainable potential value:

$$C_{MSY} = -\frac{a^2}{4b} \quad \text{.....(8)}$$

2. Fox Model

a) The optimum effort value is:

$$F_{msy} = -\frac{1}{d} \quad \text{.....(9)}$$

b) The maximum sustainable potential value is:

$$C_{msy} = -\left(\frac{1}{d}\right) * exp\,(c - 1) \quad \text{.....(10)}$$

Information :
a : Schaefer model intercept
b : slope of the Schaefer model
c : Fox model intercept
d : Fox model slope
F_{MSY} : sustainable fishing efforts (trip)
C_{MSY} : maximum sustainable catch (kg)

RESULT

Standardization of Efforts

Standardization is carried out by determining standard values for the type of fishing gear. The fishing gear used in catching skipjack tuna is gillnet, hand line, pole and line, purse seine, carrier, boat chart, etc. The highest catch in 2017 was from purse seine fishing gear of 3,903,042 kg/year and the lowest catch in 2020 was from gillnet fishing gear of 300 kg/year.

Table.1 Catch and effort of catching skipjack tuna per fishing gear (2016-2022)

Years	FISHING GEAR							
	Gillnet		Hand Line		Pole and Line		Purse Seine	
	C	E	C	E	C	E	C	E
2016	1.680	1	198.629	197	346.586	145	2.566.303	1924
2017			349.906	493	310.948	168	3.903.042	2878
2018			237.681	381	337.791	214	3.716.817	3794
2019			284.134	426	187.116	52	3.117.038	2866

2020	300	1	238.547	354	278.942	76	2.938.814	2017
2021	330	2	113.568	236	217.226	75	2.000.992	1479
2022			121.105	211	329.314	104	3.147.578	2002

Years	FISHING GEAR					
	Boat Chart		Carrier		Etc	
	C	E	C	E	C	E
2016			1.319.202	334	176.544	114
2017			1.818.046	435	172.831	113
2018	2.840	2	2.145.489	484		
2019			1.189.214	297		
2020			1.077.413	229		
2021			669.215	217		
2022			345.698	92		

Source: Analysis Results, 2023

The productivity value of each fishing gear seems to be the highest, namely pole and line. After obtaining the productivity value for each skipjack tuna fishery, standardization of each fishing gear is then carried out starting with selecting the fishing gear to be the standard fishing gear.

Table 2. Productivity of skipjack tuna fishing gear

Years	PRODUCTIVITY						
	GL	HL	PL	PS	BP	PG	Etc
2016	1680	1008	2390	1334		3950	1549
2017		710	1851	1356		4179	1529
2018		624	1578	980	1420	4433	
2019		667	3598	1088		4004	
2020	300	674	3670	1457		4705	
2021	165	481	2896	1353		3084	
2022		574	3166	1572		3758	

Source: Analysis Results, 2023

Information:

GL: Gillnet
HL: Hand line
PL: Pole and line
PS: Purse Seine
BP: Boat chart
PG: Carrier
Etc: Unidentified fishing gear

This type of fishing gear has different abilities in catching skipjack tuna types, so it is necessary to calculate the fishing power index. Based on Table 5, the results of the calculation of the fishing power index and fishing effort show that the standard fishing gear is pole and line. The FPI value of pole and line every year has a value of 1 because pole and line has the

highest fishing effort value every year so that it is used as standard fishing gear for skipjack tuna. It can be seen in Table 3, which is as follows:

Table 3. FPI value for each skipjack tuna fishing gear

Years	FPI						
	Gillnet	Hand Line	Pole and Line	Purse Seine	Boat Chart	Carrier	Etc
2016	0,703	0,422	1	0,558		1,652	0,648
2017		0,383	1	0,733		2,258	0,826
2018		0,395	1	0,621	0,900	2,808	
2019		0,185	1	0,302		1,113	
2020	0,082	0,184	1	0,397		1,282	
2021	0,057	0,166	1	0,467		1,065	
2022		0,181	1	0,497		1,187	

Source: Analysis Results, 2023

The FPI value above is then used to calculate standard effort. From the results of the analysis of standard effort values for the skipjack tuna type, the highest value was obtained in 2018 for the purse seine fishing gear type, around 2355 kg/trip and the lowest value in 2020 for the gillnet fishing gear type was around 0.08 kg/trip, which can be seen in Table 4. namely as follows:

Table 4. Standard effort of skipjack tuna

Years	EFFORT STANDARD						
	Gillnet	Hand Line	Pole and Line	Purse Seine	Boat Chart	Carrier	Etc
2016	0,70	83	145	1074		552	74
2017		189	168	2109		982	93
2018		151	214	2355	1,80	1359	
2019		79	52	866		330	
2020	0,08	65	76	801		294	
2021	0,11	39	75	691		231	
2022		38	104	994		109	

Source: Analysis Results, 2023

Catch per Unit CPUE (CPUE)

Based on data obtained during the 2016-2022 period, the average CPUE value for 7 years was 2,736 kg/trip. The highest CPUE value occurred in 2020, namely 3,670 kg/trip and the lowest CPUE value occurred in 2018, namely 1,578 kg/trip, as seen in Table 5 below.

Table 5. Calculation of CPUE for skipjack tuna (2016-2022)

No	Years	Total Catch (Kg)	Catch Effort	Number of Ships	CPUE (Kg/trip)
1	2016	4.608.944	1928	445	2390
2	2017	6.554.773	3541	506	1851

3	2018	6.440.618	4080	470	1578
4	2019	4.777.502	1328	434	3598
5	2020	4.534.016	1235	349	3670
6	2021	3.001.331	1036	272	2896
7	2022	3.943.695	1245	277	3166
Amount		33.860.879	14395	2753	19151
Average		4.837.268	2056	393	2736

Source: Analysis Results, 2023

The linear equation for the effort of catching skipjack tuna with the equation Y= 46.6787-232.44x and obtained a constant value (a) of 46.6787 and a regression coefficient (b) of -232.44x. According to the equation, it can be explained that for every additional fishing effort of 1 unit of effort, there will be a reduction in the effort of catching skipjack tuna by 232.44 units of catching effort (kg/trip). If there is no effort, then the potential for skipjack tuna available in nature is still 46,6787 kg/trip.

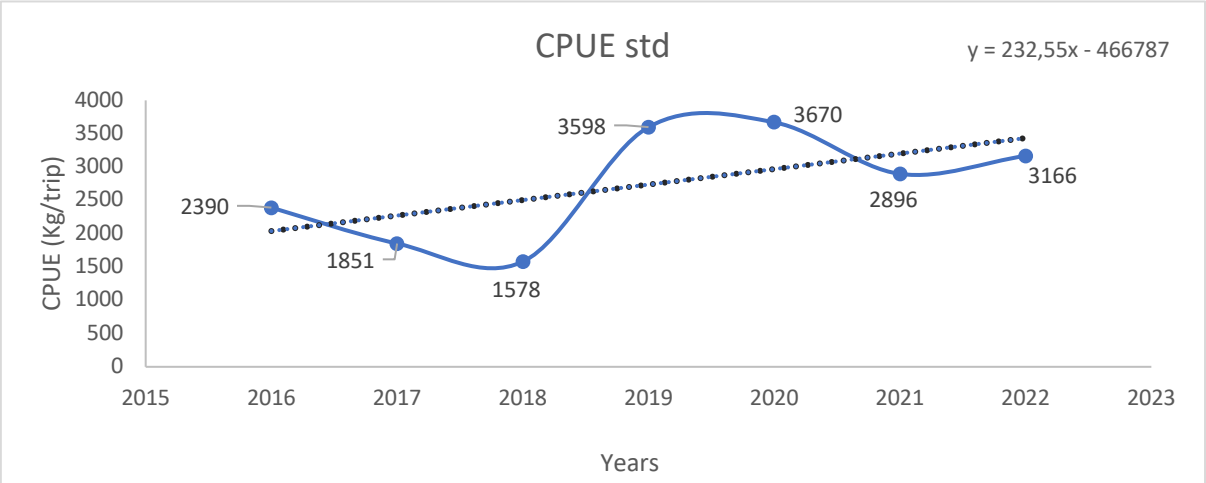

Figure 2. CPUE trend of skipjack tuna (*Katsuwonus pelamis*)

Maximum Sustainable Yield (MSY)

Based on data on skipjack tuna production over the last seven years, namely from 2016-2022, MSY can be calculated using the Schaefer model, we can find out the MSY value and the optimum effort of skipjack tuna landed at the Kendari PPS. Based on the Schaefer model, the maximum catch effort (FMSY) value of 2126 trips/year and the maximum catch yield (CMSY) of 6,130,516 kg/year can be seen in Figure 3 as follows:

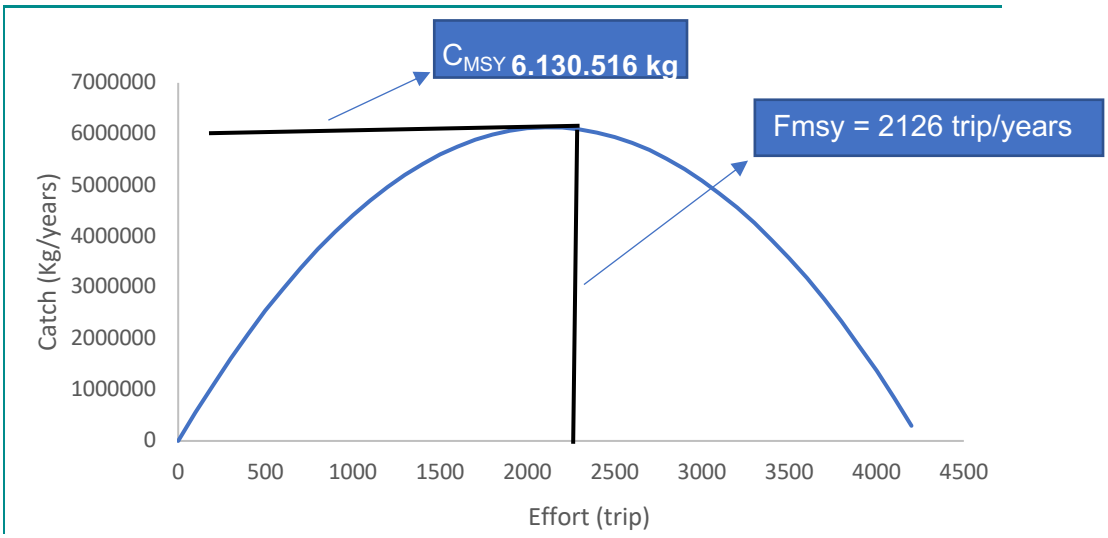

Figure 3. MSY graph for skipjack tuna (*Katsuwonus pelamis*)

Based on skipjack tuna production data for the last 7 years, namely from 2016-2022, using the Fox model, the maximum catch value (CMSY) = 6. 460,769 kg/ year and maximum catch effort (FMSY) = 4,020 trips/ year, can be seen in the following picture:

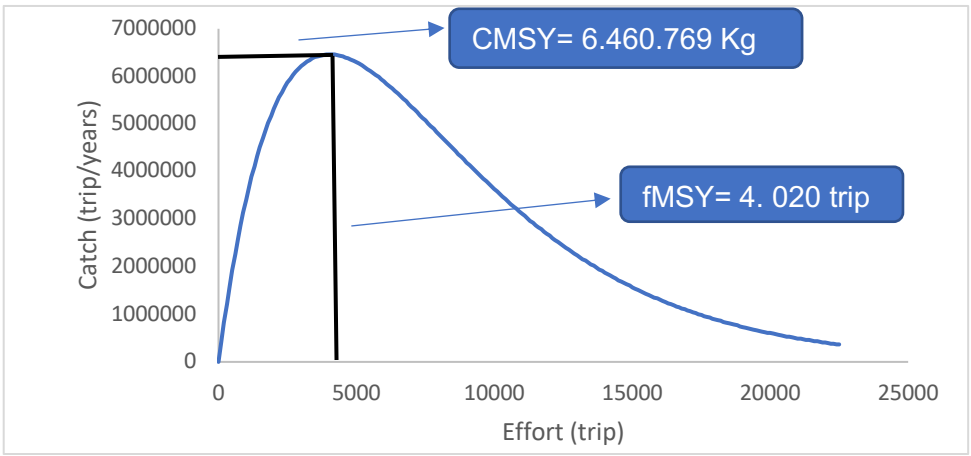

Figure 4. MSY graph of the Fox model of skipjack tuna (*Katsuwonus pelamis*)

DISCUSSION

Standardization

Skipjack tuna fishing in Banda waters mostly uses fishing gear such as gillnets, hand lines, pole and line, purse seines, boat charts, haulers, etc. Based on catches from 7 types of fishing gear, the highest value was obtained in 2017 from purse seine fishing gear of 3,903,042 kg/year and the lowest catch in 2020 from gillnet fishing gear of 300 kg/year.

Based on the results of the productivity analysis, pole and line fishing gear has a much different ability to catch skipjack tuna compared to other fishing gear. Pole and line have a higher chance of catching skipjack tuna compared to other fishing gear such as gillnets, hand lines, purse seines, boat charts, carriers, etc. However, the possibility of catching skipjack tuna using pole and line fishing gear does not show a significant difference compared to purse seine fishing gear (Tuli, 2019).

Standardization of fishing gear requires unification of fishing efforts, namely choosing one type of fishing gear as the standard fishing gear based on the superiority of the type being caught (Lelono, 2012). The fishing gear used as standard is the fishing gear with the highest

productivity (dominant) and an FPI value of 1 compared to other fishing gear. Gulland (1983), states that when different types of fishing gear are used in a body of water, one of the dominant fishing gears can be used as standard fishing gear.

From the results of the analysis of standard effort values for fishing gear for the skipjack tuna species for 7 years (2016-2022), the highest value was obtained in 2018 for the purse seine fishing gear type, around 2355 kg/trip and the lowest value in 2020 for the gillnet fishing gear type was around 0 .08 kg/trip. Capture fisheries in Indonesia tend to be catch-oriented, with the hope that catches will increase over time. This situation causes fishermen to continue to increase their business when the catch is low to make a profit, likewise, when the catch is high, fishermen continue to increase their business because the conditions are profitable. However, increasing effort does not always result in increased catches (Nababan, 2023).

Cacth Per Unit Effort (CPUE)

Based on the catch and effort, the value of the fishing effort for each fishing gear can be calculated using the catch formula for each fishing gear divided by trips (Budiasih, 2015). It can be seen from the data in Figure 3 above, the highest CPUE value in 2020 was 3670 kg/trip and the lowest CPUE value was 1578 kg/trip with a total of 470 ships in 2018. This is in accordance with the statement (Tomangoko, 2022), which means efforts used by the fleet or fishing gear, especially the number of vessels decreased that year in the process of catching skipjack tuna in Banda sea waters. Meanwhile, according to (Tuli, 2019), the high and low values of fishing effort occurred because during that period there were additions and reductions in both the use of fishing gear and trips during that period (effort).

The graph of fluctuations in fishing effort above shows an increase in catches in 2020 and a decrease in catches in 2021. Fluctuations in catches of skipjack tuna in Banda sea waters are not always caused by changes in environmental conditions. The impact of changes in environmental conditions on a particular type of fish can be direct or indirect. This is in accordance with Suhaeti (2002) who states that fluctuations in catch are influenced by various factors, including the presence of fish, the number of fishing attempts, and the success of fishing operations.

Maximum Sustainable Yield (MSY)

The actual catch results obtained for skipjack tuna for 7 years were 4,837,268 kg/year and the value of fishing effort was 2,056 tips/year, this shows that skipjack tuna landed in PPS are still experiencing underfishing, so catches need to be increased in order to get optimal results. Based on the Schaefer model, the maximum fishing effort (fMSY) value was 2126 trips/year and the maximum fishing quantity (CMSY) was 6,130,516 kg/year. The results of skipjack tuna production data for the last 7 years, namely from 2016-2022, using the Fox model, obtained a maximum catch value (CMSY) of 6,460,769 kg/year and a maximum catch effort (FMSY) of 4,020 trips/year, if viewed based on maximum sustainable catch value, the number of catches produced from 2016-2022 has not yet reached the optimal catch. Therefore, based on the data, actual fishing results and actual fishing effort can be compared with the results (CMSY) and (FMSY) for the Schaefer and Fox models, which do not yet show overfishing, which means that fishing for the Schaefer model can be increased by adding the maximum fishing amount (CMSY) is 2,000,000 kg/year and reduces the maximum fishing effort (FMSY) by 70 trips/year. Based on the Fox model, it shows that skipjack tuna fishing is not optimal, in order to get optimal results by increasing the maximum number of catches (CMSY) of = 1,600,000 kg/year, by reducing fishing effort (FMSY) by 1,964 trips/year. This shows that in order to get optimal fishing results, it must not exceed the MSY value (Hutagaol, 2023).

CONCLUSION

Based on the results and discussion, it can be concluded that the CPUE results for 7 years (2016-2022) obtained the lowest CPUE value in 2018 of 1578 kg/trip and the highest value in 2020 of 3670 kg/trip. Results from the Schaefer model with maximum fishing effort (FMSY) of 2126 trips/year and maximum catch (CMSY) of 6,130,516 kg/year. Fox model results obtained maximum catch value (CMSY)=6. 460,769 kg/ year and maximum catch effort (FMSY) = 4,020 trips/ year. The use of skipjack tuna in the Kendari PPS has not yet reached (overfishing), so it can be concluded that the skipjack tuna fishing effort has not exceeded the sustainable stock limit in Banda sea waters, so that fishing results can be increased to obtain optimal results but still based on the MSY limit that has been calculated.

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