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ANALYSIS CATH PER UNIT EFFOR (CPUE) AND MAXIMUM SUSTAINABLE YIELD (MSY) OF INDIAN SCAD (Decapterus sp) LANDED AT OCEANIC FISHING PORT (PPS) OF KENDARI

Analisis Catch Per Unit Effort (CPUE) dan Maximum Sustainable Yield (MSY) Ikan Layang (Decapterus sp) Yang Didaratkan di Pelabuhan Perikanan Samudera (PPS) Kendari

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ABSTRACT

The Banda Sea is one of the most fertile and potential waters in the field of fisheries and the largest fishing area in Indonesia. This study aims to analyze the CPUE and MSY of indian scad from 2016-2022 (last 7 years). The value of Catch per Unit Effort (CPUE) fluctuated from 2016-2022. The highest purse seine equivalent CPUE value in 2018 was 4,562 kg/trip and the lowest in 2021 was 2,573 kg/trip. Based on the Schaefer model, the optimum fishing effort value is 3,382 trips per year and the maximum sustainable catch value is 7,936,016 kg per year. From this value, it indicates that the indian scad landed at PPS Kendari is underfished because it has not reached its sustainable potential.

Key words: Banda Sea CPUE, Indian Scad, MSY

ABSTRAK

Laut Banda merupakan salah satu perairan yang subur serta berpotensi dalam bidang perikanan dan daerah penangkapan ikan yang terbesar di Indonesia. Penelitian ini bertujuan untuk menganalisis CPUE dan MSY ikan layang dari tahun 2016–2022 (7 tahun terakhir). Nilai *Catch per Unit Effort* (CPUE) mengalami fluktuatif dari tahun 2016–2022. Nilai CPUE setara *purse seine* tertinggi pada tahun 2018 yaitu sebesar 4.562 kg/trip dan terendah pada tahun 2021 yaitu sebesar 2.573 kg/trip. Berdasarkan model Schaefer, didapatkan nilai upaya penangkapan optimum sebesar 3.382 trip per tahun dan nilai jumlah tangkapan maksimum lestarinya sebesar 7.936.016 kg per tahun. Dari nilai tersebut menandakan bahwa ikan layang yang didaratkan di PPS Kendari, mengealami *underfishing* karna dikarenakan belum mencapai potensi lestari.

Kata Kunci: CPUE, Ikan Layang, Laut Banda, MSY

INTRODUCTION

The Banda Sea is one of the fertile waters and has the potential for fisheries and is the largest fishing area in Indonesia. This can be seen from the large fish catch and it is the largest

fishing area in Indonesia (Yulia, 2013). Kendari coastal waters (and its surroundings) in the Southeast Sulawesi region are part of the western Banda Sea, in the Eastern Region of Indonesia. Fish resources found in Kendari waters consist of coral, pelagic, demersal and other marine biota (Hartati & Pralampita, 1993; (Linting *et al*., 1994).

Flying fish are one of the main catches of fishermen in WPP 714 Banda Sea, uncontrolled fishing can threaten the ecosystem and its economic potential. Due to the public's fondness for flying fish, demand for flying fish is likely to increase, which encourages fishermen to increase their catch. Although flying fish are a marine resource that can be recovered, their capture can disrupt the balance of the aquatic biological environment and the fish's recovery capacity, making stock recovery more difficult and time consuming (Hasrun et al., 2021).

The utilization rate is the fish resources that have been utilized calculated per year. The aim of calculating the level of utilization is to determine the percentage of fish resources in a body of water that are utilized. Utilization levels that exceed the Maximum Sustainable Yield (MSY) can threaten the sustainability of fish resources, the availability and continuity of their life cycle will be disrupted and have an impact on fish stocks which will decrease (Simbolon et al., 2011).

Until now, flying fish fishing in the Banda Sea is still open access (open to every fisherman) or the amount of effort has not been controlled and the licensing system regulations are not yet optimal. One of the factors that needs to be monitored is the catch per unit effort or CPUE and the level of utilization or MSY of flying fish (Decapterus sp) resources in the waters of the Banda Sea, where this information is very much needed in sustainable fisheries management. Therefore, CPUE and MSY analysis was carried out, which are the average catch rate values for the type of fishing gear. It can also be said to be a method used to determine the annual average of marine fisheries production to assess the stock status and number of catches of flying fish.

This research aims to analyze CPUE and MSY of flying fish from 2016-2022 (last 7 years). It is hoped that the results of this research can be used as consideration in the sustainable management of flying fish (Decapterus sp) in WPP 714 of the Banda Sea, and can be used as information for further research.

METHODS

Map of Research and Capture Locations

The fishing location was carried out in the Fisheries Management Area of the Republic of Indonesia (WWP NRI) 714, namely the Banda Sea with coordinates around 07026.160' S/ 128058.647' E to 05023.280' S/ 133053.650' E. Sampling was carried out at PPS Kendari located in Puday Village, Abeli District, Kendari City, Southeast Sulawesi.

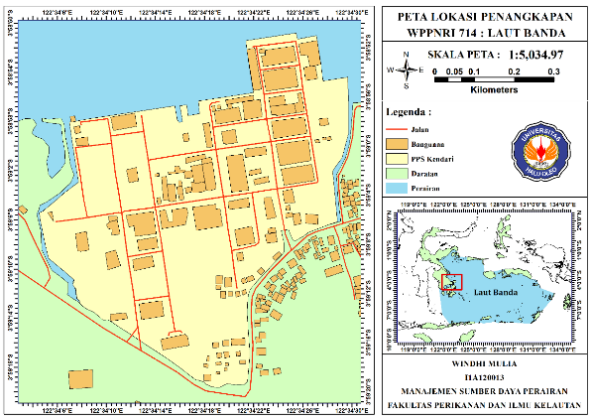

Figure 1. Map of WPPNRI 714 Banda Sea research and fishing locations

Data retrieval

Data source

Data collection was carried out at the Kendari Ocean Fisheries Port (PPS). The data source is logbook data collected over 7 years, namely 2016 - 2022. The logbook contains data on number, time of capture, name of vessel, GT, type of fishing gear, and fish catch for flying fish species.

Data Sorting

The extra data process starts from selecting the type of fish, data on fishing time, fish catch, ship name, and type of fishing gear for flying fish. Next, the catches are tabulated, then analyzed using Microsoft Excel software.

The steps taken are as follows: (1) Compile production data in units of weight (kg) and fishing effort (effort) in trip units based on the type of fishing gear from the logbook, (2) Standardize effort, standardization of effort needs to be done because in The research area has a lot of fishing gear used to catch gliders, so an equivalent unit of measurement is needed, (3) Make a table for fishing gear, a productivity table, and an FPI table according to the fishing gear obtained each year, (4) Next make a table effort by dividing the fishing effort of each fishing gear by the FPI of each fishing gear (5) then calculating the standard trip and standard CPUE.

Data analysis

Standardization of Efforts

Before the CPUE calculation is carried out, first carry out a standardization calculation of fishing gear. The fishing gear standardization process is carried out by calculating the Fishing Power Index (FPI). The FPI value for standard fishing gear is 1.0 and the FPI value for other types of fishing gear is calculated by dividing the CPUE of the fishing gear by the CPUE of the standard fishing gear. The formula used is as follows according to Sparre & Venema (1998):

$$\text{FPI} = {CPUEr}/{CPUEs}$$

$$Effort\ Std = FPI\ x\ E$$

Information :

FPI	: fishing gear performance index
CPUEi	: annual catch per fishing effort by other fishing gear (kg/trip)
CPUEt	: annual catch per standard fishing effort (kg/trip)
Effort Std	: effort to catch fishing gear after standardization
E	: fishing effort (trip)

Standard CPUE Analysis

After carrying out the fishing gear standardization process, the next step is to calculate the CPUE value using the formula according to Sparre & Venema (1998) which is as follows:

$$\text{CPUE} = \frac{Cath\ (C)}{Effort\ (F)}$$

Information:

CPUE : catch of flying fish per fishing effort in year t (kg/trip)
Catch : catch of flying fish in the t-th year (kg)
Effort : effort to catch flying fish in the t-th year (trip)

Maximum Sustainable Yield (MSY) Analysis

Estimation of the potential of flying fish can be estimated by analyzing catch and effort. According to Sparre & Venema (1998), the relationship between catch and effort can be used using the Schaefer production surplus method.

The data processing steps are:

1. Plot the f value against c/f and estimate the intercept value (a) and slope value (b) using linear regression.
2. Calculate estimates of sustainable potential (C_{MSY}) and optimum effort (E_{MSY}) Linear regression equation with the formula:

$$y = a - bx$$

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:

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

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

The determination of optimum catch value (C_{MSY}) and optimum effort (E_{MSY}) is:

a. The model equation can be written CPUE = a – b (f)
   The relationship between C and f can be written $C = af - b(f)^2$

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

By using simple regression analysis from existing times series data, intercept (a or c) and slope (b or d) values can be calculated so that maximum catch results and optimal effort can be estimated (Sparre & Venema, 1999).

Optimal fishing effort (C_{MSY})

$$E_{MSY} = \frac{a}{2b}$$

Sustainable potential (C_{MSY}) or optimal catch

$$C_{MSY} = \frac{a^2}{4b}$$

Information :
a : intercept
b : regression coefficient/variable f
EMSY : optimal fishing effort
CMSY : optimal catch

RESULT

Standardization of Efforts

Table 1. Annual fishing gear productivity (2016-2022 period).

YEARS	PRODUCTIVITY						
	Chart Boat	Gillnet	Handline	Fishing rod Tonda	Purse Seine	Carrier	AND OTHERS
2016		1500	2490		2.300	710,37	883,92
2017					1.937	852,50	823,64
2018				650	1.559	795,61	
2019					2.308	20,95	
2020			2007,57	1717	2.188	4855,91	
2021	1740	1865	2700		1.533	1027,00	
2022	680				1.899	1199,79	

Source: research results 2023

Table 2. FPI (Fishing Power Index) of fishing gear per year (2016-2022 period)

YEARS	FPI						
	Chart Boat	Gillnet	Handline	Fishing rod Tonda	Purse Seine	Carrier	AND OTHERS
2016		0,652	1,082		1,00	0,3088	0,384
2017					1,00	0,4401	0,425
2018				0,417	1,00	0,5105	
2019					1,00	0,0091	
2020			0,918	0,785	1,00	2,22	
2021	1,13	1,216	1,761		1,00	0,670	
2022	0,36				1,00	0,632	

Source: research results 2023

Based on the analysis results in Table 1, it shows that the dominant fishing gear productivity is purse seine fishing gear, which can be seen from its productivity which is quite high from 2016-2022B. Meanwhile, Table 2 shows that the results of the Fishing Power Index (FPI) calculation produce purse seine fishing gear as the standard fishing gear for catching flying fish in the waters of the Banda Sea with an FPI value = 1.0. Differences in fishing methods and fishing abilities are thought to cause differences in the number of types and catches between small pelagic fishing gear in the waters of Lut Banda. The differences in fishing methods cause differences in fishing ability, fishing time and fishing location can make differences in the fishing efficiency of each fishing gear.

Standard Effort

Table 3. Standard fishing gear effort per year (2016-2022 period)

YEARS	EFFORT STANDARD						
	Chart Boat	Gillnet	Handline	Fishing rod Tonda	Purse Seine	Carrier	AND OTHERS
2016		1	2		2.300	35	14
2017					1.937	18	14
2018				0	1.559	36	
2019					2.308	1	
2020			19	3	2.188	122	
2021	1	2	2		1.533	60	
2022	17				1.899	61	

Source: research results 2023

Based on Table 3, it can be seen that the results of calculating the standard effort for catching flying fish in the waters of the Banda Sea have been adjusted to use purse seine fishing gear as the standard. It can be seen that the total effort to catch flying fish in 2016 was 2,300 units, and likewise every year until 2022 with a total of 1,899 units. This shows that every year there is a decrease in total fishing effort. The results of this total effort calculation can then be used to calculate CPUE.

Catch per Unit Effort (CPUE)

Table 4. Results of Catch Effort

Years	The catch (kg)	Effort (Trip)	CPUE (Kg/ Trip)
2016	6.341.670	2.352	2.696
2017	6.646.499	1.969	3.375
2018	7.277.928	1.595	4.562
2019	8.090.139	2.308	3.505
2020	7.111.579	2.332	3.049
2021	4.113.684	1.599	2.573
2022	6.494.937	1.976	3.286
Amount	**46.076.436**	**14.133**	**23.046**
Average	**6.582.348**	**2.019**	**3.292**

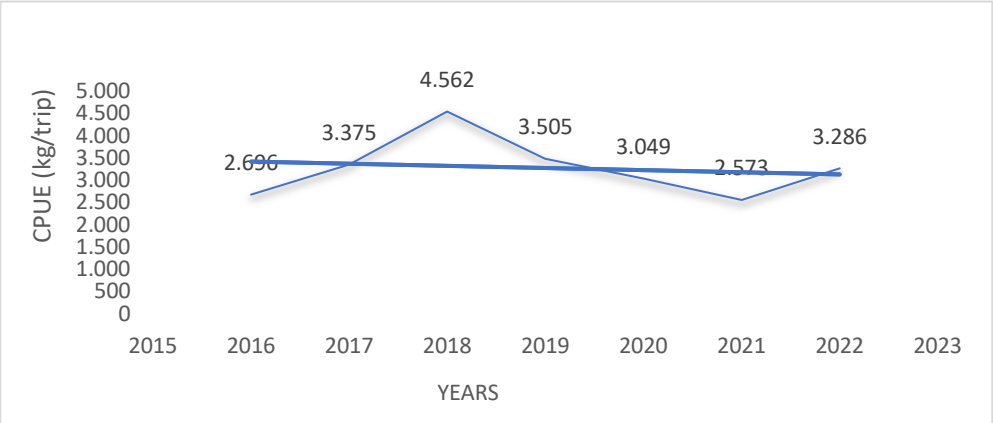

Figure 2. Catch per Unit Effort (CPUE) Trend Graph

Maximum Sustainable Yield (MSY)

MSY is a reference in fisheries resource management that still allows exploitation without reducing the population, this aims to ensure that fishery resource stocks are still at a safe level. According to Widodo & Suadi (2006).

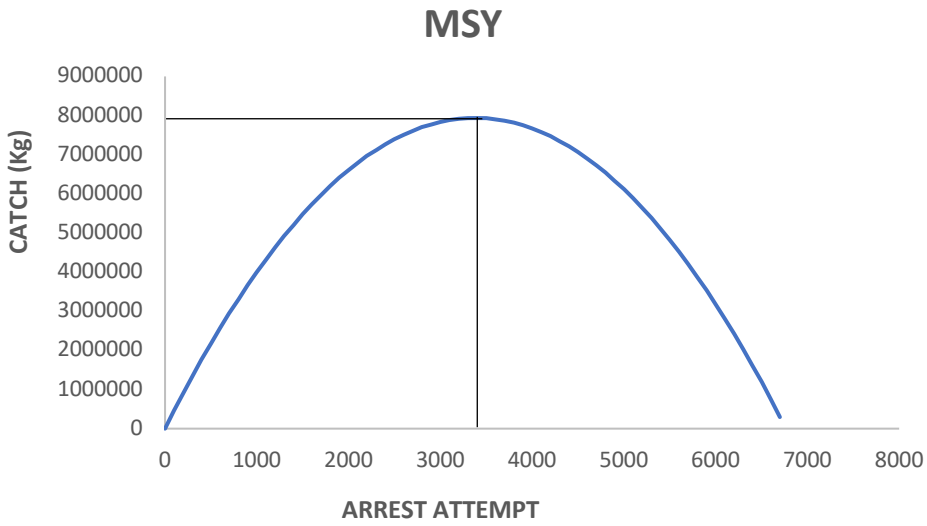

Figure 4. Maximum Sustainable Yield (MSY) graph

DISCUSSION

Standardization of Efforts

- **Productivity of Fishing Gear**

Based on the research results, using specific fishing gear is expected to avoid high by-catch yields which can reduce the stock of other marine resources that are not the target of fishing. In order to optimize the utilization of flying fish (*Decapterus* sp) resources in the waters of the Banda Sea and ensure its sustainability, it is necessary to determine several types of fishing gear that are suitable for each type of fish. The expected benefit is that fishermen get the catch as expected, and fish resources do not experience pressure from various unproductive fishing gear. Prisantoso & Sadiyah (2017), stated below, the level of productivity of the main fishing gear used must be in accordance with the catch from the fishing gear, by looking at the factors that influence the catch, whether in the form of production factors or resource factors themselves.

- **FPI (Fishing Power Index)**

Based on the results of research data on flying fish catching which has the greatest productivity value is the purse seine so that the purse seine fishing gear is the standard fishing gear which has an FPI value equal to one, while the FPI value of other fishing gear is obtained from the CPUE value of other fishing gear divided by the CPUE value of the gear. capture is used as standard. Each fishing gear (purse seine, gill net, hand line bag and P. tonda) has different abilities in catching flying fish. So a process of standardizing fishing effort is needed first before finding the CPUE value. In standardizing fishing gear, the Fishing Power Index (FPI) value is calculated, starting with determining standard fishing gear. In accordance with the statement of Fauzi & Anna (2005), that calculating FPI is carried out to standardize the fishing gear used to catch fish. This is done because each tool has a different fishing capability, so standardization is carried out to calculate the aggregate effort input. If standardization is not carried out, it will not be possible to add up the total aggregate input (total effort) from the analyzed fisheries. Latuconsina (2010), states that standardization of fishing gear in order to

calculate potential fish resources is important considering that in tropical regions each type of fish can be caught using more than one type of fishing gear. The fishing gear designated as standard fishing gear is selected from the fishing gear that has the highest productivity value (CPUE).

Effort standard

Based on the research results, the highest arrest effort was in 2019 at 2,308 units and the lowest arrest effort was in 2021 at 1,533 units. The decrease in fishing effort is due to the influence of uncertain changes in natural conditions on populations and resource communities. In accordance with the statement by Batubara et al. (2021), that the operation of the ship fleet is influenced by the weather and fishing season, so ships that only have one fishing gear have to wait for the fishing season to go to sea. According to Wurlianty et al. (2015), if fishing effort continues to be increased, it will affect the productivity of existing fishery resources and will ultimately experience a very significant decline.

Catch per Unit Effort (CPUE)

Based on the CPUE (Catch per Unit Effort) value, it fluctuates from 2016 – 2022. The highest CPUE value was in 2018, namely 4,562 kg/trip and the lowest was in 2021, namely 2,573 kg/trip. The high and low CPUE values occurred because during this period there were additions and reductions in both the use of fishing gear and fishing trips (effort). In 2021, the CPUE value experienced depletion because the fishing effort in the previous year was very high so that the fish resources obtained decreased. However, in the following years the CPUE value increased, which resulted in the recovery of fish resources. In accordance with the statement (Nugraha et al., 2012), that the decrease in CPUE value could be caused by an increase in fishing effort not followed by an increase in the quantity of fish caught by fishermen. The decrease in the CPUE value is an indicator that the utilization of fishery resources in a particular body of water is quite high. The high level of fish resource utilization by fishermen will result in a decline in the sustainability of the fish resource population. Sparre & Venema (1999), also said that an increase in fishing effort which was not followed by an increase in the number of catches resulted in a decrease in CPUE. The decrease in CPUE is an indicator that the utilization of fish resources in these waters is high. In overfishing conditions, an increase in the number of fishing efforts can cause a decrease in catches in subsequent years. This is because stock biomass is a limited resource that is shared by vessels in a fishery so that the share of catch for each vessel increases in line with the increasing number of vessels entering the fishery.

Maximum Sustainable Yield (MSY)

Based on data on the production of flying fish in the last 7 years (2016 - 2022), the sustainable production of fisheries or Maximum Sustainable Yield (MSY) can be calculated using the Schaefer production surplus method. The sustainable potential value and optimum efforts of flying fish in the Banda Sea can be determined, so that it can be determined when overfishing occurs by comparing efforts and catches each year. Based on the Schaefer model, the optimum fishing effort (fMSY) value was 3,382 trips per year and the maximum sustainable catch value (CMSY) was 7,936,016 kg per year (Figure 4). The number of catches produced from 2016–2022 reached its highest point in 2019, with 8,090,139 kg/year, the catch value has reached the maximum catch value (CMSY) and has exceeded the optimum fishing effort (fMSY). If this is not immediately followed up, fisheries resources are threatened with overfishing, and fishery resources could even decline very drastically due to uncontrolled and poorly managed levels of exploitation. (Kusumaningrum et al., 2021)stated that fish resource stocks have been exploited approaching and exceeding the MSY value, so increasing the number of fishing efforts is not recommended, even though catches can still increase.

Increasing fishing effort will disrupt the sustainability of fish resources, and the catch per unit effort will definitely decrease. In accordance with the statement (Simbolon et al., 2011) that overfishing conditions can occur if fishing efforts are carried out that exceed the optimum effort value and excess catches will reduce the carrying capacity of the fishery resource.

The actual value obtained for these fish over a period of 7 years was 6,582,348 kg. This value indicates that the flying fish landed at PPS Kendari are experiencing underfishing because they have not yet reached their sustainable potential, namely CMSY of 7,936,016 kg/year and fMSY of 3,382 trips/year. This is in accordance with the statement Nasution (2018), stating that catches that have not exceeded the MSY value are still said to be underfishing, but if they exceed the MSY value then they are said to be overfishing. Based on this, additional fishing efforts for these fish still need to be added. Utami & Gumilar (2011), stated that the effort that can be made if there is a lack of fishing (underfishing) is by increasing the number of fishing vessels to produce optimal catch value. Therefore, based on this data, it has not shown overfishing, which means that catch results need to be increased by adding a maximum catch of 1,353,668 kg/year and additional effort of 1,363 trips.

Through growth and recruitment, fisheries resources actually have the ability to recover which is greatly influenced by the surrounding environment, such as food availability, inter- and intra-species competition, the presence of predators, and a healthy environment. Listiani (2017), also stated that limiting the level of effort is important to implement, this is because if the level of effort and level of utilization exceeds the MSY value, it can threaten the sustainability of fish in nature. According to (Fisheries and Marine Technology et al., 2014) the utilization of fisheries resources is quite potential and has the opportunity to be developed to improve the community's economy if the level of utilization is still low (below the MSY value). However, if the results of the utilization level are already relatively high, efforts should not be increased because it has the potential to become overfishing.

CONCLUSION

Based on the research results, the conclusion that can be seen is that the CPUE value trend experienced a slight decrease between 2016 - 2022 with an average value of 3,292 kg/trip. The amount of sustainable potential (MSY) for the last 7 years (2016 – 2022), the value of optimum fishing effort (fMSY) is 3,382 trips per year and the value of maximum sustainable catch (CMSY) is 7,936,016 kg per year. The resource utilization status of flying fish (Decapterus sp) landed at PPS Kendari can be said to be experiencing underfishing because the actual value of 6,582,348 kg has not exceeded the MSY value.

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