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Analysis of the potential and level of utilization of skipjack tuna (*Katsuwonus pelamis*) landed at Sadeng Coastal Fishery Port (PPP), Gunungkidul Yogyakarta, Indonesia

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Abstract

Sadeng waters are one of the distribution areas for skipjack tuna (*Katsuwonus pelamis*), which can be found almost every month and can even be found every day if the fishing season is right, namely February to March or September to October. Sadeng coastal Fishery Port (PPP) has a role as a center of economic activity and plays a role in developing fishing technology. Capture fisheries businesses, and other activities related to the fisheries and marine sectors. The aim of this research is to examine the potential aspects of *K. pelamis* resources and analyze the optimal use of *K. pelamis* resources. By assessing the potential of fisheries resources to determine the Maximum Sustainable Yield (MSY) value, information can be obtained on the level of utilization and level of effort. This research was carried out from February to May 2023 on a purse seiner. Sadeng Waters, Yogyakarta, Indonesia. Tools and materials used include cameras, stationery and questionnaire sheets. Primary data and secondary data collection methods use 4 (four) methods, namely observation, interview, documentation and literature study. The research results show that the level of utilization of *K. pelamis* in Gunungkidul Regency is experiencing overfishing conditions. The highest utilization rate occurred in 2020 at 132%. The potential fish resources in Gunungkidul Regency are the average production of *K. pelamis* in 2018 to 2022 of 18,122 tons. Based on analysis (MSY) and (F_{opt}), *K. pelamis* resources from 2018 to 2022 have reached over fishing. The high level of utilization of *K. pelamis* occurs due to a lack of supervision from the relevant agencies regarding the recording of production results from fishing vessels based at PPP Sadeng.

Keywords: Purse seine; *K. pelamis*; CPUE; MSY; Fish Power Index (FPI); Total Allowable Catch (TAC)

1. Introduction

The potential for fish resources in Indonesian waters is 9.931 million tons per year with the highest potential found in FMA RI 718 (Arafura Sea) at 1,992 million tons/year (20%), at FMA RI 573 (Indian Ocean west of Sumatra and the Sunda Strait) at 1.228 million/year (12%) and in FMA RI 711 (Karimata Strait, Natuna Sea and South China Sea) amounting to 1.143 million tons/year (12%) [1].

Fish resources are shared resources and is open access, so that it cannot be managed individually and all levels of society have the right to use it. This can give rise to various kinds of competition and will also trigger large-scale and uncontrolled exploitation of fish resources so that it will lead to more economic conditions for fishing [2].

Sadeng waters are one of the distribution areas for skipjack tuna (*Katsuwonus pelamis*), whose presence can be found almost every month and can even be found every day if it is right in the fishing season, namely from February to March or from September to October [3]. Based on the data of fish caught including *K. pelamis*), yellowfin tuna (*Thunnus*

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albacares), Bonito (*Euthynnus affinis*), Spanish mackerels (*Scromberomorus* sp.), short mackerel (*Rastregiller kanagurta*), shortfin scad (*Decapterus macrosoma*), Largehead hairtail (*Triciurus lepturus*), and other economical fish [4].

Sadeng Beach Fishing Harbor has a role as a center of economic activity and plays a role in developing fishing technology. Capture fisheries businesses, and other activities related to the fisheries and marine sectors [5]. Over time, fishing effort continues to increase in line with increasing demand for commodities *K. pelamis* both from local and international markets. This encourages increased exploitation efforts which have the potential to affect biological conditions and the sustainability of fishing efforts.

The aim of this research is to examine aspects of resource potential *K. pelamis* and analyzing optimal utilization of resources *K. pelamis*. By assessing the potential of fisheries resources to determine their value Maximum Sustainable Yield (MSY), in order to obtain information on the level of utilization and level of effort. It is hoped that this research can provide knowledge to the community or fishermen regarding potential and utilization as well as provide insight into the level of utilization and potential of resources *K. pelamis* regarding fishing activities and provide insight into the risks that may occur.

2. Material and methods

This research Activity will be carried out from February 20 to May 20 2023 on a purse seiner at Coastal Fishery Port (PPP) Sadeng, Songbanyu District, Gunungkidul Regency, Yogyakarta Special Region. The tools and materials used in the research are as follows: Camera, stationery, and questionnaire sheets.

2.1. Method of collecting data

The method for collecting primary data and secondary data in this final practice uses 4 (four) methods, namely observation, interview, documentation and literature study. Secondary data is obtained from indirect data, including literature studies in the form of scientific journals, books, reports and documents. The secondary data that the author collected includes data on fishing fleets, fisheries production and production values obtained from PPP Sadeng in 2018-2022.

2.2. Data analysis method

The data that the author has collected in the field will then be analyzed and studied in more depth. The data analysis aims to achieve the predetermined indicators. The method for analyzing the data and information that has been collected is in the form of descriptive analysis, namely systematically describing facts from observations or final practices in a comprehensive and factual manner regarding the operation of purse seine fishing gear. And quantitative analysis is using statistics in the form of indicator analysis to calculate Catch per Unit Effort (CPUE), Fishing Power Index (FPI) and Maximum Sustainable Yield (MSY), level of utilization and efforts to catch fish using purse seines.

2.2.1. Analysis of Potential and Level of Utilization of Fish Resources

Fisheries resources are resources that are limited and can be recovered *(renewable),* which means that any reduction due to death or capture will be able to restore these resources to their original productivity level [6].

1. *Catch per unit effort* (CPUE)
   CPUE value Higher levels reflect a better level of efficiency in the use of fishing effort. The results of fishing in principle are: *output* from fishing activities, meanwhile *effort* which is required is*input* from fishing activities. Hence the magnitude of CPUE can be used as an indicator of the level of efficiency of the use technique *effort* better [7].
   CPUE calculation aims to determine the abundance and level of utilization based on the division between the total catch*(catch)* with arrest efforts *(effort)* [8]. The formula used is as follows:

$$\boldsymbol{CPUE = \frac{Catch}{Effort}}$$

   Information:
   Catch (C) : Total catch (kg)
   Effort (E) : Total arrest attempts (trips)
   CPUE : Catch per fishing effort (kg/trip)

CPUE Analysis used to determine abundance *K. pelamis*of total production *(catch)* per number of boats discharging the catch *(effort)* at PPP Sadeng in the 2018–2022 period. CPUE can be calculated using the formula:

$$CPUEi = \frac{Catch\ i}{Effort\ i}$$

Information:
CPUE i : Catch per fishing effort in year i (tons/trip)
Catch i : Production of purse seine catches in year i
Effort i : Number of ships dismantling in year i
Before the CPUE calculation is carried out, a standardization calculation of the fishing gear used at the PPP Sadeng is first carried out for fishing *K. pelamis*. Fishing activities using two fishing gears, namely purse seines and hand lines [9]. Capture of fishing using purse seines and hand lines are not the same, therefore it is necessary to standardize fishing efforts. The formula used by [10] to standardize fishing efforts are as follows:

$$PI = \frac{CPUEi}{CPUEs}$$

Information :
FPI : *Fishing power index*
CPUEi : CPUE fishing gear to be standardized (tons per unit/trip)
CPUEs : CPUE standard fishing gear (tons per unit/trip)

Calculate Standard Effort using the following formula:

$$Fs = FPI\ x\ Fi$$

Information :
fs : standardized fishing effort (units/trip)
be : fishing effort to be standardized (unit/trip)

2. Maximum Sustainable Yield (MSY) Analysis
   Analysis to calculate *MSY* and *FMSY* You can use the Schaefer model according to [11], as follows:

$$MSY = -\frac{a^2}{4b} \qquad F\ opt = -\frac{a}{2b}$$

Information :
a : *intercept*
b : *slope*

3. Utilization Level Analysis
   The utilization rate is the fish resources that have been utilized calculated per year. The percentage value of fish resources that have been utilized can be determined using the following formula:

$$T = \frac{Ci}{MSY} x\ 100\%$$

Information :
Ci : Catch results of the i year
MSY : *Maximum Sustainable Yield (*MSY)
T : Utilization Level

3. Results and discussion

3.1. Fishing Ground

The fishing area is determined based on the season or wind direction. If the west season occurs, the weather is very unfriendly which causes high waves in outer waters [12]. Fishing area for purse seines is open wide area, the bottom must be free of rocks and corals or shipwrecks. Generally, the fishing area is in the form of a sea whose nature is wateroceanisin open areas with water depths of around 50 meters [13]. The fishing area has been marked with Fish Aggregating device (FADs) and each FAD point has been recorded on GPS.

The distribution of fishing areas is 10 points using FADs owned by the collective group. When approaching a FAD, the captain looks at the water conditions to look for schools of fish around the FAD using various observation parameters including current, waves and wind [14]. The following is a map of the fishing ground where the research was carried out:

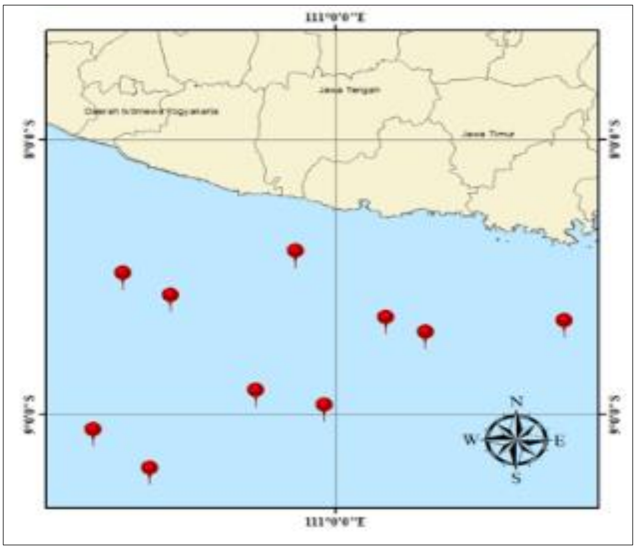

Figure 1 Map of Fishing Grounds

3.2. Fish production

Fish production and production value at PPP Sadeng can be seen in the following table:

Table 1 Fish production at PPP Sadeng from 2018 to 2022

No.	Year	Production (Kg)
1.	2018	2,990,104
2.	2019	2,232,941
3.	2020	2,597,083
4.	2021	3,183,862
5.	2022	3,318,458
Minimum		2,232,941
Maximum		3,318,458
Average		2,864,490

Source: DJPT PPP Sadeng Production Data (2018-2022).

Based on table 1, it can be seen that capture fisheries production in PPP Sadeng based on the Director General of Capture Fisheries (DJPT) has experienced fluctuations from 2018 to 2022. The highest production amount occurred in 2022, namely 3,318,485 tons. The lowest production amount occurred in 2019, namely 2,232,941 tons. Fluctuation The amount of capture fisheries production in PPP Sadeng is influenced by several factors such as natural factors, biological factors and the fishing unit used. According to [15] fisheries production has increased due to market demand and high purchasing power.

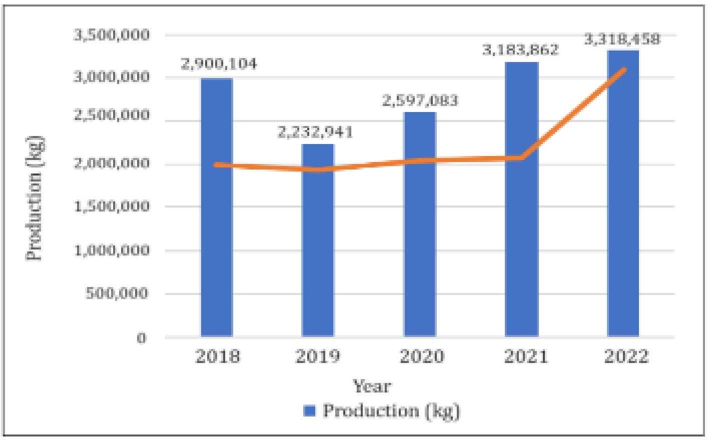

Figure 2 Data of Fish Production at PPP Sadeng in 2018 to 2022.

3.3. Production of *K. Pelamis*

Production and production value of capture fisheries, especially *K. pelamis* in PPP Sadeng from 2018 to 2022 can be seen in the following table:

Table 2 Production of *K. pelamis* in PPP Sadeng.

No	Year	Production (kg)
1.	2018	1,165,371
2.	2019	739,338
3.	2020	1,395,534
4.	2021	873,526
5.	2022	853,423
Minimum		739,338
Maximum		1,395,534
Average		1,005,438

Based on the table 2, it can be seen that production *K. Pelamis* PPP Sadeng has experienced fluctuations in the last 5 years. The highest production occurred in 2020, namely 1,395,534 Kg, while the lowest production occurred in 2019, namely 739,338 Kg.

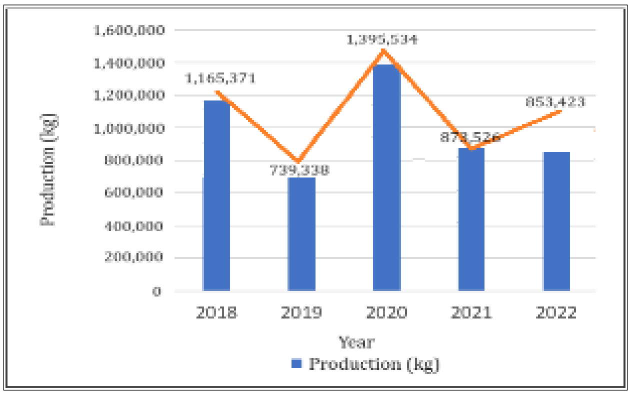

Figure 3 Production of *K. pelamis.*

3.4. Number of fishing boats

The fishing boats is one of the main factors in fishing operations [16]. The number of fishing boat at PPP Sadeng from 2018 to 2022 is as follows:

Table 3 Number of Fishing Fleets in 2018 to 2022.

No.	Year	<10 GT	15-30 GT	>30GT
1.	2018	261	83	8
2.	2019	315	39	8
3.	2020	315	39	8
4.	2021	320	39	5
5.	2022	318	37	6
Average		306	47	7

Source: PPP Sadeng Maritime Affairs and Fisheries Service (2018-2022)

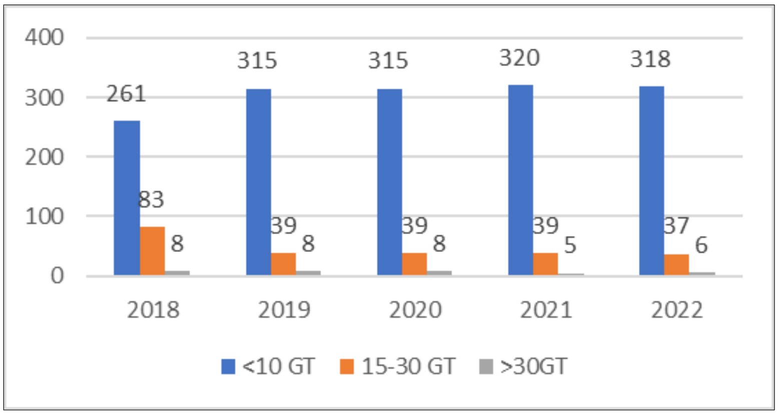

Figure 4 Number of fishing boats.

Based on the diagram above, it can be seen that the number of fishing boats in PPP Sadeng from 2018 to 2022 experienced fluctuations. The highest number from 2018 to 2022 was on boats measuring <10 GT. The average number of boats measuring <10 GT is 305.8.

3.5. Catch Per Unit Effort (CPUE)

The CPUE value is a comparison value between the amount of production and the number of fishing efforts. According to [17], the CPUE value is calculated to determine the abundance and level of utilization of fishery resources in certain waters [18]. By knowing the data on the number of fishing equipment and the number of trips carried out each year as well as the amount of *K. pelamis* production, then the CPUE value of the purse seines can be calculated and hand lines which can be seen in the table as follows.

The analysis results show the highest CPUE value *K. pelamis* using purse seiner there are fluctuations from year to year, the highest CPUE value occurs in 2022, namely 600,914 tons/trip. This is thought to be because the caught attempts that occurred that year were the highest. Meanwhile, CPUE was the highest in caught of *K. pelamis* using hand lines occurred in 2020 with the same value, namely 1,021,712 tons/year.

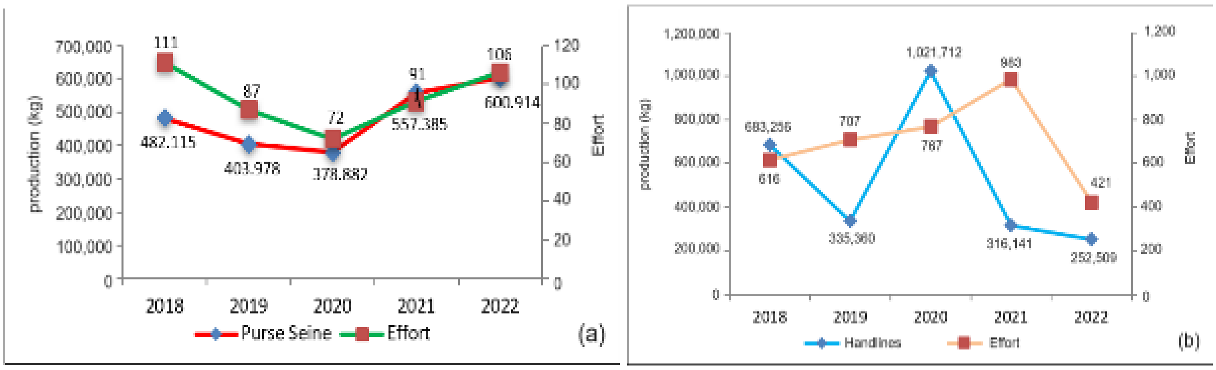

Figure 5 CPUE development *of K. pelamis* on purse seine (a), and hand line (b).

3.6. Standardization of Fishing Gear

Of the two fishing gears, namely purse seines and hand lines must be standardized first to determine effort standard and standard CPUE so that MSY and utilization level analysis can be carried out. The fishing power factor or FPI value of the standard fishing gear is 1, while the FPI of other fishing gear varies with the standard fishing gear used as a comparison. From the analysis results, the CPUE value of the purse seine is the highest value every year so that on FPI has a value of 1. The FPI value of the purse seine and hand lines can be seen in the table.

Table 4 FPI and standard Effort of *K. pelamis* fishing gear, Gunungkidul Regency

Year	**Purse seine**		**Hand line**	
	FPI	Standard Effort	FPI	Effort Standard
2018	1	111	0.26	616
2019	1	87	0.10	707
2020	1	72	0.25	767
2021	1	91	0.05	983
2022	1	106	0.11	421

The standard effort value is then used to calculate the standard CPUE for each year in the period 2018 to 2022.

Table 5 Standard Effort and Standard CPUE values.

Year	**Fish Production Skipjack tuna (kg)**	**E. Standard**	**Standard CPUE**
2018	1,165,371	727	1,602
2019	739,338	794	931
2020	1,400,534	839	1,668
2021	873,526	1,074	813
2022	853,423	527	1,619

CPUE is influenced by the numbereffort carried out throughout the year to produce production. The table below illustrates the standard CPUE results obtained from production comparisons *K. pelamis* with standard effort, then the standard effort and standard CPUE are analyzed with the program microsoft excel to find out the correlation value between the two.

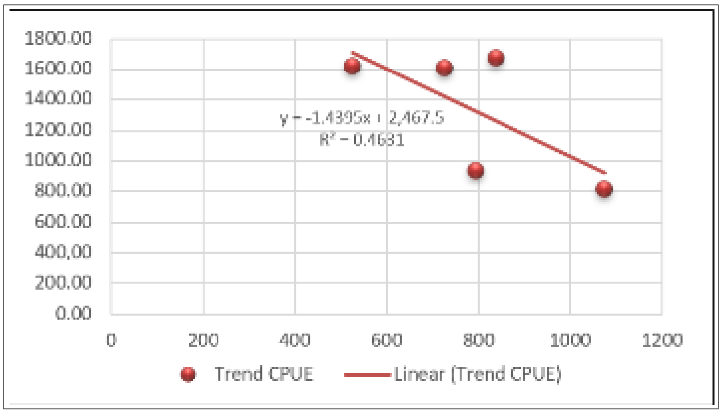

Figure 6 Graph of the relationship between standard CPUE and standard effort

CPUE relationship with effort *K. pelamis* produces a linear regression equation y = -1.4395x + 2467.5 with values a = 2467.4 and b = -1.4394, if one trip is increased, it will reduce CPUE by 1.4394 tons/trip and the R value2 = 0.4631, meaning that 46% of the decrease in catch production (y) was caused by fishing effort (x) while 54% of the decrease in catch production (y) was caused by natural and biological factors.

3.7. Maximum Sustainable Yield (MSY)

Analysis of estimating sustainable potential (MSY) and optimum efforts (F_{opt}) fish resources are determined using a suitable model for use in subsequent analysis. The model determination is based on the Production Surplus Model of Schaefer and Gordon Schaefer [19]. Estimation of sustainable potential (MSY) and optimum efforts (F_{opt}) from *K. pelamis.*

3.7.1. MSY value of the Gordon Schaefer model for skipjack tuna

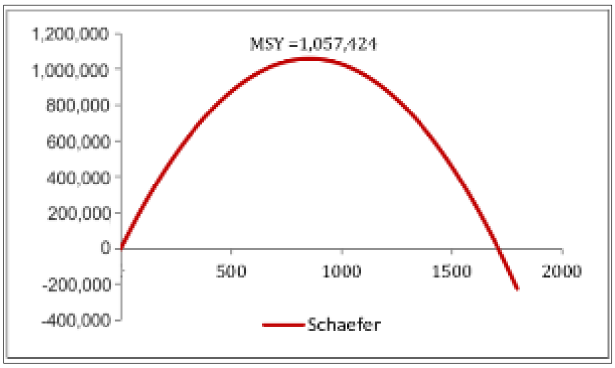

Figure 7 MSY Potential Gordon Schaefer Model *K. Pelamis*.

Based on the Schaefer model estimation, it shows the estimated value of sustainable potential (MSY) *K. pelamis* amounting to 1,057,424 tons/year with optimum effort (F_{opt}) amounting to 857 trips/year. Figure 7 shows that production and fishing effort *K. pelamis* within a period of five years (2018 to 2022) the fishing area of Gunungkidul Regency has reached over fishing. This is based on the opinion [11] stating that over fishing will occur when the level of fishing effort in a particular fishery exceeds the level required to produce MSY. So it is necessary to increase supervision and control of managed fishing so that available resources can continue to be balanced and this does not be over fishing.

3.8. Level of Utilization of *K. Pelamis* Resources

According to [20] the level of fish resource utilization can be seen from the amount of fish production in a particular year compared to the Total Allowable Catch (TAC) or the number of catches allowed. TAC value obtained from 80% of maximum sustainable potential.

Table 6 Level of use of *K. pelamis* resources in Sadeng waters.

Year	Production *K. pelamis*	TAC = 80% MSY	Level Utilization (%)
2018	1,165,371	845.939	110.21
2019	739,338		69.92
2020	1,400,534		132.45
2021	873,526		82.61
2022	853,423		80.71
Average			95.18

TAC is 845,939 tons/year and the average utilization rate is 95.18%, which is caused by the large utilization rates in 2018 to 2020 of 110.21% and 132.45% respectively. Utilization rate fluctuations *K. pelamis* can be seen in the graphic below.

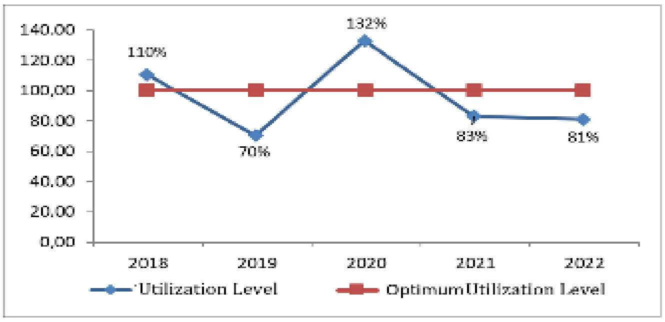

Figure 8 Graph of Resource Utilization Level of *K. pelamis* in Sadeng waters.

From the results of the analysis above, it shows that the level of utilization *K. pelamis* in Sadeng experiencing conditions overfishing. The highest utilization rate occurred in 2020 at 132%. The high utilization rate value of *K. pelamis*. This may be due to a lack of supervision from the relevant agencies regarding the recording of production results from fishing boats based at the PPP Sadeng, so this could be one of the evaluations for supervision from the relevant agencies so that fisheries in Sadeng waters remain preserved. and sustainable for future generations.

4. Conclusion

Based on the results of observations and calculations carried out during the final practice, the following conclusions can be drawn:

1. Potential fish resources in Sadeng waters are average production *K. pelamis* in 2018 to 2022 amounting to 18,122 tons. Based on the analysis of MSY and F_{opt} *K. pelamis* resources during 2018 to 2022 have reached overfishing.
2. Level of resource utilization *K. pelamis* in Sadeng waters experienced fluctuations. Average utilization rate *K. Pelamis* 2018 to 2022 is 95%, meaning there is an excessive level, meaning it can be concluded that fishing operations *K. pelamis* has reached the category over fishing.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclose.

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