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POTENTIAL AND LEVEL UTILIZATION OF SKIPJACK (*Katsuwonus pelamis*) IN THE BUNGUS OCEAN FISHING PORT WEST SUMATERA PROVINCE

Arthur Brown[1*], Rina Ade Citra Purba[1]
[1]Department of Utilization of Fishery Resource, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru, 28293 Indonesia
*Arthur_psp@yahoo.co.id

ABSTRACT

The skipjack (*Katsuwonus pelamis*) in Bungus Ocean Fishing Port has been evaluated for its sustainable potential using the surplus production approach method. The findings indicate a strong alignment with the Fox approach model. The estimated sustainable potential for skipjack is 471 tonnes per year, with an ideal effort of 45 trips annually. The analysis indicates a moderate utilization status, with an average skipjack utilization rate of 62.76%. It is evident that around 37.24% of its maximum sustainable potential, equivalent to 154.74 tonnes per year, is still unexplored. In addition, the catch rate of skipjack is relatively high at 96.14%, indicating that there is still some untapped potential, with 3.86% of the optimal fishing effort or two trips per year remaining unused. As a result, it is recommended that a total allowable catch of 341 tons be set in order to ensure the long-term sustainability of skipjack harvesting in the area.

Keywords: Skipjack, Utilization, West Sumatera Province

1. INTRODUCTION

The assessment of fish stocks in Indonesian waters states that the Indian Ocean has a high fisheries potential of 6,409 million tons per year with a utilized potential of 5,127 million tons per year. The Indian Ocean has a potential pelagic with a production of 188,280 tons per year and a utilization rate of 48.74%. This exploitation rate also varies according to the number of fishermen available and the equipment owned[1].

Fisheries resources are generally referred to or categorized as recoverable. However, nature's ability to renew is limited. If humans exploit resources beyond their ability to recover, resources will decline, deplete, and even cause extinction[2]. Sustainable utilization of fish resources is vital so that the sustainability of fish resources can be maintained. Utilization of potential fish resources must be controlled so that the sustainability of fish resources in each water area can always be maintained and productivity is optimum. Therefore, every area used for fishing needs to know the level of utilization[3].

Fish resources are recoverable, but if fisheries are not monitored, they can lead to overfishing, which can damage the potential of fish resources. It is a good step if the condition of fish resources in a body of water can be estimated and how far the level of utilization has been volunteered, so that it is known whether the exploitation exceeds its sustainable potential.

Therefore, it is necessary to limit the fishing fleet through strict licensing so that efforts to utilize fish resources can run continuously and use a bio-economic approach in conducting fishing business. Initially, these resources were managed based on biological factors alone, with an approach called Maximum Sustainable Yield (MSY). It aims to determine the

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sustainable potential of sizeable pelagic fish resources and the optimum fishing effort[4].

Bungus Ocean Fishing Port is a port located in Bungus Teluk Kabung Sub-district. Bungus Teluk Kabung Sub-district is a sub-district in Padang City, West Sumatra Province. Geographically Bungus Teluk Kabung Sub-district is bordered to the north by Lubuk Begalung Sub-district, to the south by Pesisir Selatan Regency, to the west by Pesisir Selatan Regency and Lubuk Kilangan Sub-district, and the east by the Indonesian Ocean Bungus Teluk Kabung Sub-district is located at the coordinates between 00°54-1'80'LS to 100'34 00 East. With an area of about 100, 78 km², Bungus Teluk Kabung Sub-district has six sub-districts, namely Teluk Kabung Selatan, Bungus Selatan, Teluk Kabung Tengah, Telung Kabung Utara, and Bungus Barat[5].

PPS Bungus is a place for fishermen to land their catch after completing fishing activities. From 2007-2018 there were many marine fisheries products landed at PPS Bungus. The overall production of marine fisheries catches landed at PPS Bungus in fishing resources is 14,863.38 tons with a fishing productivity value of around IDR 213,060 263 583. One of the marine fisheries products in PPS Bungus is Skipjack Fish which is one of the large pelagic fish caught in PPS Bungus.

Large pelagic fish is a fishery commodity with a relatively high economic value compared to other types of fish. The development of production of significant pelagic primary commodities nationally shows that the type of tuna experienced production growth in 2007-2011 of 4.77%, where skipjack was 3.63%, while the type of tuna decreased by -1.08%. The data shows that as the primary commodity with high economic value, the production rate within five years is the primary indicator for the utilization rate of large pelagic fish species (frigate tuna, skipjack, and tuna)[6].

Skipjack is a type of marine fish commonly consumed by the community. It has a high protein content that is good for the human body. Skipjack can contain much histamine because its red meat tissue contains high histidine amino acids. Histamine levels are one of the factors determining the quality of skipjack[7]. Skipjack is the most dominant catch at PPS Bungus and has an economic value so that the community widely consumes it. This results in high consumer demand in the market, so fishermen conduct large-scale fishing, which can later disrupt the growth cycle and decrease the population.

The number of skipjacks caught yearly increases with various fishing gear such as purse seine, lift net, and fishing rod. The great potential of fisheries in PPS Bungus, so it is important to analyze the stock of skipjack for the development and processing of the capture fisheries sector. Seeing these problems, studies are needed to understand the status of fish stocks. Research on the potential and level of utilization is the primary basis for developing management strategies for sustainable resource use.

2. RESEARCH METHOD

Time and Place

The research was conducted for two months, from July to August 2023, at Bungus Ocean Fishing Port, West Sumatra Province.

Procedures

The data collected is derived from existing sources. Data were collected from the Bungus Ocean Fishing Port. The available data consists of catch and trip data of skipjack fishing gear spanning five years (2016-2020).

Data Analysis

The study of the potential and level of utilization of skipjack resources in Bungus Ocean Fishing Port uses quantitative analysis and descriptive analysis. The quantitative analysis calculates the maximum sustainable yield potential value using the surplus production approach with the Shaefer and Fox model. Descriptive analysis is used to explain the condition of sustainable potential and the level of utilization of skipjack resources in the Bungus Ocean Fishing Port.

Analysis of Standardized Fishing Effort

The fishing effort is the multiplication between the number of fleets (fishing boats) and the number of trips to sea. The calculation of FPI is as follows:

$$CPUE(s) = \frac{Catch\ (s)}{Effort\ (s)}$$

Description:

Catch (s) : Total catch

Effort (s) : Total capture effort

$$FPI(s) = \frac{Catch\ (s)}{CPUE}$$

Description:

Catch (s) : Total catch

CPUE : Catch per unit effort

Analysis of Maximum Sustainable Yield (MSY)

The Schaefer and Fox model estimates the amount of MSY of fishery resources and optimal fishing effort. The amount of parameters a and b can be mathematically found by using a simple regression equation with the formula:

$$Y = a + bx$$

Description:

a : intercept

b : slope

Furthermore, parameters a and b can be found with the formula :

$$a = \frac{\sum yi \sum xi - \sum xi(\sum xiyi)}{n \sum xi2 - (\sum xi)^2}$$

$$b = \frac{n \sum xiyi - \sum xi(\sum yi)}{n(\sum xi^2) - (\sum xi)^2}$$

Description:

X : Capture effort in the period

y : Catch per unit effort in the period.

n : Number of samples

The magnitude of parameters a and b can be found mathematically using a simple regression equation[8].

Schaefer Model (Linear Model)

Relationship between fishing effort and catch per unit effort: CPUE = a + bf

a and b are the intercept and slope, respectively, and the relationship is linear. Thus, the equation for the relationship between catch and fishing effort is:

$C = af + bf^2$

Optimum fishing effort (fopt) is obtained by equating the first derivative of the catch of fishing effort equal to zero.

$$C = af + bf^2$$

$$C = a + 2bf = 0$$

$$f_{opt} = -(a/2b)$$

a and b are the intercept and slope, respectively. The maximum sustainable yield (MSY) is obtained by substituting the optimum fishing effort value, thus obtaining:

$$C_{max} = a(-a/2b) + b(a^2/4b^2)$$

$$MSY = C_{max} = -(a^2/4b)$$

Fox (Exponential Model)

Relationship between fishing effort and catch per unit effort: CPUE = exp (c + df)

c and d are, respectively, the natural logarithm (Ln) of the intercept or regression coefficient of the relationship between Ln CPUE and fishing effort, which is linear. The relationship between effort and catch is: $C = f^{\exp(c + df)}$

Optimum fishing effort (fopt) is obtained by equating the first derivative of catch to fishing effort equal to zero: Fopt= -(1/d)

d is the anti-Ln regression coefficient of the relationship between Ln CPUE and fishing effort. The maximum sustainable yield (MSY) is obtained by substituting the optimum fishing effort value, thus obtained: MSY = - (1/d) exp (c-1)

Analysis of Level Utilization

In calculating the level of fishing gear utilization, the first thing to do is to determine the optimum fishing effort. The level of effort is calculated by sharing the number of fishing trips with the value of the optimum fishing effort. The equation used is as follows:

$$TP(i) = (Ci/MSY) \times 100\%$$

Description:

TP(i) = Utilization rate of year i
Ci = Catch of the year i
MSY = Maximum sustainable yield.

Analysis of Level Ability

In calculating the level of fishing gear utilization, the first thing to do is to determine the optimum fishing effort. The level of effort is calculated by sharing the number of fishing trips with the value of the optimum fishing effort. The equation used is as follows:

$$T_{pu} = \frac{fi}{fopt}$$

Description:

Tpu : Effort level
Fi : Catch effort in year i
Fopt : Optimum fishing effort

3. RESULT AND DISCUSSION

Production of Skipjack (*Katsuwonus pelamis*)

Skipjack production tends to decrease, the highest catch of skipjack caught by purse seine fishing gear occurred in 2017 at 216.41 tons allegedly in that year the catch was overfished so that in the following year the catch decreased while in the boat bagan and tonda fishing gear the catch tends to increase. The decline in purse seine fishing gear in 2022 amounted to 35.82 tons, the decline was due to pressure in the form of indications of decreased water quality (physical, chemical, biological), overfishing activities, and destructive fishing patterns.

Table 1. Production (tons) of Skipjack in the PPS Bungus

Year	Purse Seine	Lift Net	Fishing Rod
2016	66	1,29	7,21
2017	216,41	0	2,22
2018	78,31	116,24	43,18
2019	65,56	108,11	186,47
2020	35,82	130,72	281,01
Amount	462,09	356,36	520,10
Average	92,42	71,27	104,02

Data on the catch of mackerel landed at PPS Bungus in 2016-2020 cannot be used as the only measure that can explain or reflect the abundance of these resources. This is because many factors, such as fishing effort, season, weather, gear technology, fishing techniques, and the success rate of fishing operations, influence fluctuations (changes) in catches. Therefore, one of the appropriate approaches to estimate the abundance of krai tuna resources is the calculation of catch per unit effort (CPUE).

Table 2. CPUE of Skipjack (*Katsuwonus pelamis*)

CPUE (tons/trip)			
Year	Purse Seine	Lift Net	Fishing Rod
2016	33	0,65	0,80
2017	19,67	0	2,22
2018	4,12	2,24	1,49
2019	3,64	1,57	1,65
2020	1,99	1,57	1,42
Amount	68	6,02	7,58
Average	13,6	1,20	1,52

Table 2 shows that changes in CPUE values over five years tend to decrease. The highest CPUE occurred in 2017 and 2018, amounting to 19.67 tons/trip and 4.12 tons/trip produced by purse seine fishing gear, while the lowest CPUE was produced by boat trawl fishing at 0.65 tons/trip in 2016.

The Schaefer model is holistic in the surplus production method, which means that this method rules out many of the details of analytical models. It does not use age or length structure to describe the stock but considers it a homogeneous biomass. This method uses catch-per-unit effort as input. It is usually an annual time series based on commercial fisheries' sampling. The model assumes that fish biomass in the ocean is proportional to the catch per unit effort. The estimated catch is obtained by multiplying the effort by the catch per unit effort. The Schaefer model assumes catch per unit effort U is a negative linear function of effort E. The following figure shows the trend of CPUE value against skipjack fishing efforts at PPS Bungus over five years (2016-2020) in the Schaefer Model.

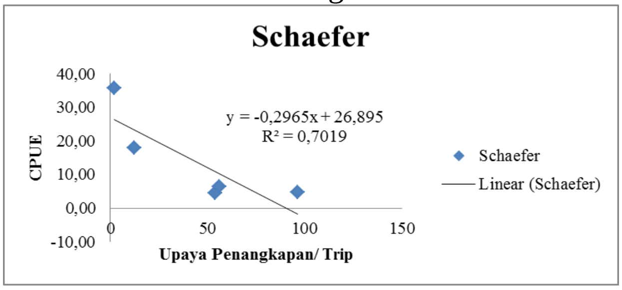

Figure 1. Relationship between CPUE and Effort

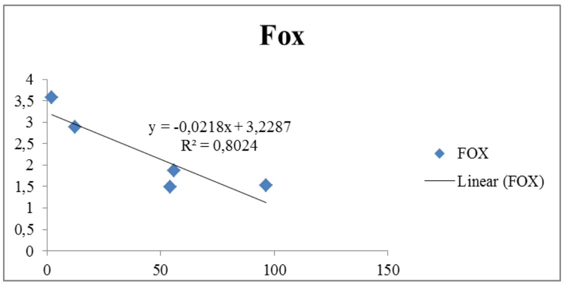

Figure 2. Relationship between CPUE and Effort

Figures 1 and 2 show the relationship between effort and CPUE of Skipjack at PPS Bungus for five years (2016-2020) in the Schaefer and Fox Models. The Schaefer model equation obtained linear results y =-0.2965x+26.895 with R^2 = 0.7019. The regression coefficient (b) of 0.2965 states that the negative relationship between production and effort is that any reduction (due to the negative sign) of 1 trip effort will cause CPUE to increase by 0.2965 tons/trip. However, if effort increases by one trip, CPUE is also predicted to decrease production by 0.2965 tons/trip. If the negative sign (-) states that the direction of the relationship is reversed, an increase in variable X will decrease variable Y and vice versa.

The coefficient of determination (R2) is 0.7019 or 70.19%. This means that the variation or rise and fall of CPUE by 70.19% is caused by the rise and fall of effort values, while the remaining 29.81% is caused by other variables not discussed in this study. The correlation coefficient (R) of 0.83 indicates that CPUE and effort have a strong relationship. Vice versa for the Fox Model, the linear equation y = -0.0218x + 3.2278 is obtained with an R^2 value or coefficient of determination of 0.8024, which means that the variation or ups and downs of CPUE is 80.24% caused by the ups and downs of effort values.

The remaining 19.76% is caused by other variables not discussed in this study. The correlation coefficient (R) of 0.89 indicates that CPUE and effort have a solid relationship. From the two models, it is concluded that the most suitable model is the model that has the highest R-value, namely the Fox model R-value or correlation coefficient value of 0.89 or 89%. In contrast, the Schaefer model's R-value is 0.8024 or 80.24%.

Utilization and Ability Level of Skipjack (*Katsuwonus pelamis*)

By knowing the value of optimum fishing effort (fopt) and optimum catch (MSY) of skipjack, the level of utilization and enrichment in the last five years can be seen in Table 3.

Table 3. Utilization and Ability Level of Skipjack

Year	Total catch (tons)	Total Std.Effort	CPUE standard	Fopt	MSY	Utilization level (%)	Ability level (%)
2016	74,51	2	35,69			17,46	4,54
2017	218,63	12	17,86			51,25	26,65
2018	237,73	54	4,40	46	427	55,25	117,72
2019	360,14	56	6,45			84,43	121,59
2020	447,55	97	4,64			104,93	210,18
Amount	1338,55	221	69,03			313,83	480,71
Average	267,71	44	13,81			62,76	96,14

The average utilization rate of skipjack is 62.76%, with a utilization status in the moderate category. This means that skipjack can still be utilized by 36.24% of its maximum sustainable potential or 154.74 tons. The average utilization level of krai tuna is 96.14%, meaning skipjack can still be pursued by 3.86% of its optimum fishing effort or by two trips/per year. Fisheries resources that are not used to the maximum by fishermen cause losses to existing resources[9]. Conversely, the level of utilization that is used to the maximum and even exceeds the limit will have an impact on fish resources in the waters of PPS Bungus. Based on the data that has been processed, the results show that in 2016, 2018, 2019, and 2020, the utilization rate was 113.497%, 103.691%, 131.491%, and 144.859%. This shows that in that year, there was an over-exploited effort.

Although in some years there is over-exploited which can be a factor in overfishing, in the last five years, namely in 2016-2020, the average utilization rate of skipjack at PPS Bungus has almost reached the optimum level of potential sustainable resources (MSY) of skipjack, which is 62.76% in the moderate status category.

The optimum utilization rate is when the catch has reached part of the sustainable potential (66.6-99.9%). Additional effort cannot increase the yield if the percentage value of the utilization rate (>100%) indicates that the catch exceeds the existing MSY value and is included in the overfishing category[10]. This is following the opinion of Ali[11], which states that the reduction and increase in effort depends on the previous year's sustainable potential and utilization rate.

To overcome overfishing conditions that exceed the environment's carrying capacity, it is necessary to take a precautionary approach through Total Allowable Catch (TAC), which is the amount of catch allowed (JTB) that can be applied. JTB or TAC is 80% of the maximum sustainable catch. Therefore, the JTB for skipjack fisheries in PPS Bungus is 341 tons. This JTB will be sufficient to prevent over-estimation. This is expected to ensure the sustainability and availability of tuna resources throughout the year.

The data above is supported by analyzing the results of research based on annual production data at PPS Bungus by implementing the use of the Schaefer model formula. The Schaefer model graph shows the sustainable potential value is 610 tons, with an optimum fishing effort of 45 yearly trips.

In 2016, the catch was 74.51 tons; in 2017, the catch was 218.63 tons; in 2018, the catch was 237.73 tons. In 2019, the catch was 360.14 tons. In 2020, the catch was 447.55 tons. The catch in 2020 has left the MSY reflection line, which means that the catch in that year has exceeded the maximum sustainable potential (MSY) value, while in 2016, 2017, 2018, and 2019, the catches in the four years were still within the MSY line, which means that the catch has not exceeded the maximum sustainable potential value and is still within safe limits so that it still has the potential to be developed. The amount of catch allowed in the Schaefer model is 488 tons.

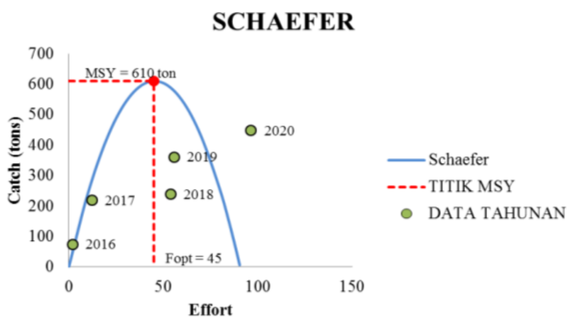

Figure 3. MSY and Fopt of Scahefer Model

The Fox model's sustainable potential value is 427 tons, with an optimum fishing effort of 46 trips. In 2016, 2017, 2018, and 2019, the catch is still in the MSY reflection, which means that the catch is still below the estimated value of the sustainable potential, while in 2020, the catch is outside the MSY reflection, which means that the catch has exceeded the value of the sustainable potential even though the fishing effort made has exceeded the optimum effort value. The amount of catch allowed for the Fox model is 341 tons.

Table 4. Comparison of Schaefer and Fox Models in Determining the Best Model

Mark	Schaefer	Fox
Sign Conformity	Retrieved	Retrieved
Coefficient of Determination	0,7018	0,8024
MSY	610 ton	427 ton
Fopt	45 trip	46 trip
JTB	488 ton	341 ton

In the 2019 fish stock assessment book, it is explained that the determination of criteria in selecting the best model is a model that has the lowest average value of estimation validation, and according to Passingi[12], the best model to use is a model that has a high R-value or the highest coefficient value and the lowest JTB. So

The following are the different images of the graphical results of MSY and Fopt values in the Schaefer and Fox models.

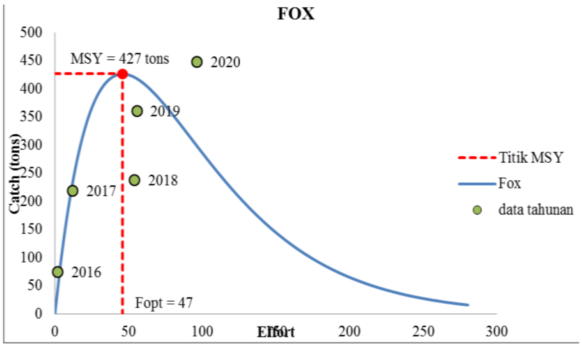

Figure 4. MSY and Fopt of Fox Model

that in both models, the most suitable model used to estimate the potential of skipjack fisheries in Bungus Ocean Fishing Port is the Fox Model where this model has the highest coefficient of determination of 0.8024 and the lowest value of Total Allowable Catch (JTB) of 341 tons.

4. CONCLUSION

From the results of the study, it was concluded that the sustainable potential of skipjack in the Bungus Ocean Fishing Port with the production surplus approach method is more suitable using the Fox approach model. The sustainable potential value of skipjack is 427 tons per year, and the optimum effort is 46 trips per year. The average value of the skipjack utilization rate is 62.76% with moderate utilization status, which means that the level of skipjack utilization can still be utilized by 37.24% of its maximum sustainable potential, or 154.74 tons. The average level of utilization of skipjack is 96.14%, which means that the level of utilization of skipjack is almost close to its optimum fishing effort of 46 trips/year. The Total Allowable Catch is 341 tons. From the results of this study, it was found that the utilization of krai tuna resources was in the moderate category. The utilization of skipjack in PPS Bungus can still be developed again. However, it is necessary to pay attention to the limits of exploitation of existing fisheries and marine resources

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so that the catch remains and stock availability is maintained.

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