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Bioeconomic analysis of Savalai Hairtail (*Lepturacanthus savala*) catches that landed at coastal fishing port (PPP) Sadeng, Indonesia

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Abstract

Savalai hairtail (*Lepturacanthus savala*) is one of the quite important commodities and has been widely utilized. In the peak season, *L. savala* is very abundant. *L. savala* becomes an export commodity, with demand from several Asian countries, including Korea, Japan and other neighboring countries. Export demand reaches 100-500 tons/month. This condition causes *L. savala* fisheries to have quite large opportunities in the international market. The research was conducted from March 20 to May 30, 2024, which took place at the Coastal Fishery Port (PPP) Sadeng. The method used was convenience sampling of fishermen with approximately 10 *L. savala* fishing vessels at PPP Sadeng. The purpose of the study was to analyze the Maximum Sustainable Yield (MSY) and Analyze the Maximum Economic Yield (MEY), Open Access Equilibrium (OAE), and determine the level of utilization status of *L. savala* resources at PPP Sadeng Port. Based on the CPUE analysis, the average standard CPUE value of *L. savala* is 1.612 kg/unit. The CPUE value from 2015 to 2020 fluctuated. From the results of the Gordon-Schaefer bioeconomic analysis model, the MSY value achieved by the *L. savala* capture fishery business was 4.073 kg/year with an EMSY of 299 units/year. The CMEY value achieved by the *L. savala* fishing business was 3.660 kg/year with an EMEY of 204 units/year and a MEY profit of IDR 75,389,065 per year. The COAE value achieved by the *L. savala* fishing business was 3537.431494 kg/year with an EOAE of 407.2252349 units per year. And the advantage of the OAE Analysis value of IDR 0 indicates that the level of effort on *L. savala* resources in Sadeng is on average less than 100% or still safe in terms of resources and fishing economy in fishing areas in Sadeng waters. This happens because fishing efforts carried out by fishermen are still considered less than maximizing the potential in the field of *L. savala* fishing every year.

Keywords: *Lepturacanthus Savala*; Maximum Sustainable Yield (MSY); Maximum Economic Yield (MEY); Open Access Equilibrium (OAE)

1. Introduction

Sadeng waters which are included in FMARI 573 have the potential as a habitat for economically important fish [1] such as Savalai hairtail (*Lepturacanthus savala*), the fish commodity has contributed to increasing the country's foreign exchange [2]. In addition to meeting the need for animal protein for domestic consumption, export demand reaches 100-500 tons/month. This condition causes *L. savala* fisheries to have quite large opportunities in the international market [3]. The large marine potential found in Sadeng waters opens huge opportunities for the development of marine and fisheries businesses [4]. *L. savala* is a demersal fish that is widely found in the Java and Sumatera Seas. The distribution area of *L. savala* covers the sea waters of all of Indonesia. *L. savala* is a carnivorous fish that has strong sharp teeth or fangs on its jaws. *L. savala* is caught with many fishing gears, including purse seine, longline, lift net and mini trawl [5]. The following is the form of *L. savala*

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Source: ppptamperan.dkp.jatimprov.go.id.

Figure 1 Savalai hairtail (*Lepturacanthus savala*)

- *L. savala* is one of the quite important commodities and has been widely utilized [6]. Export demand from several Asian countries, including Korea, Japan and other neighboring countries, reaches 100-500 tons/month. This condition causes *L. savala* fisheries to have quite large opportunities in the international market.

This research was conducted based on background and related Problem Formulation. The objectives of the research are to analyze the Maximum Sustainable Yield (MSY) and Analyze the Maximum Economic Yield (MEY), Open Access Equilibrium (OAE), and determine the level of utilization status of *L. savala* resources in the Sadeng PPP Port at a sustainable level [7]. By knowing the potential aspects of *L. savala* resources MSY and MEY, it is hoped that *L. savala* fishing efforts in Sadeng can be developed.

2. Material and methods

This study was conducted from March 20 to May 30, 2024, which took place at the Sadeng Coastal Fisheries Port (PPP), Yogyakarta. The tools and materials used in this study included boats, fishing gear, meters, cameras, and stationery.

2.1. Sampling and Data Collection Methods

The sampling method used was convenience sampling [8]. In this study, the samples were fishermen catching *L. savala.* The number of samples eligible for the study was approximately 10 fleets of *L. savala* catching vessels at PPP Sadeng.

2.2. Data Analysis Methods

2.2.1. Catch Per Unit Effort (CPUE) Analysis

CPUE is calculated with the aim of determining the level of abundance and utilization of fishery resources in a water area. CPUE calculations are carried out by collecting production data (Catch) and fishing trips (Effort) in a certain year according to the type of Fishing Gear used [9].

2.2.2. Maximum Sustainable Production Analysis (MSY)

Maximum Sustainable Yield (MSY) is a theoretical concept that is widely used in fisheries science and management. MSY fisheries are defined as the optimum catch (in quantity or mass) that can be taken from a population in an unlimited period [10].

2.2.3. Maximum Economic Yield Analysis (MEY)

MEY is the optimum catch that can be obtained continuously (on sustained basis). If the actual catch is less or less than MSY due to insufficient fishing effort, then biologically the fishery is said to be underfishing and further development is possible [11][12].

2.2.4. MSY, MEY Formula Using the Gordon-Schaefer Analysis Model

The Gordon-Schaefer bioeconomic study model is a fisheries monitoring method that can obtain ideal monetary benefits by focusing on the relationship between fishing effort and utilization which must be viewed from a natural and financial perspective by utilizing the following conditions [13]

Table 1 MSY, MEY Formula Using the Gordon-Schaefer Analysis Model

Kete Rangan	MSY	MEY	OAE
Catch (C)	$\alpha / 4\beta$	$\alpha E_{MEY} - \beta(E_{MEY})^2$	$\alpha E_{OAE} - \beta(E_{OAE})^2$
Fishing effort (E)	$\alpha / 2\beta$	$(p\alpha - c) / (2p\beta)$	$(p\alpha - c) / (p\beta)$
Total revenue (TR)	CMSY. P	CMEY. P	COAE. P
Total expenditure (TC)	c. EMSY	c. EMEY	c. EOAE
Profit (π)	TRMSY - TCMSY	TRMEY - TCMEY	TROAE – TCOAE

Description

- α : intercept (Schaefer model)
- β : slope (Schaefer model)
- p : price
- c : cost
- MSY : Maximum Sustainable Yield
- EMSY : Sustainable Fishing Effort

2.2.5. Direction of Capture Management

Fish resource management is how to utilize resources so that they produce high economic benefits for users, but their sustainability is maintained [14].

One of the problems faced by capture fisheries is overfishing and underfishing. Overfishing is largely caused by excessive fishing expansion triggered by an open access regime. The absence of control causes fisheries to escalate and there is excessive extraction of fish resources. Although later several arrangements were made, substitution of inputs in the form of more sophisticated technology caused effective fishing efforts to continue to increase [15].

2.3. Analysis of Effort Level

The level of effort is the final analysis of the results of the MSY, MEY and OAE calculations. By calculating the level of effort Emsy After knowing the level of utilization Cmsy. The level of effort of Fishing Gear is obtained after knowing the optimum level of effort [16]

$$\boldsymbol{EL} = \left(\frac{\boldsymbol{Ei}}{\boldsymbol{EMSY}}\right)\mathbf{100}\%$$

Description

- EL = Effort level (%)
- Ei = fishing effort in year i (trip)
- E = sustainable fishing effort (trip)

In this analysis, we can find out the sustainable and economic potential in the PPP Sadeng by taking samples or recording data from research results by conducting interviews with approximately 10% sampling. With the information that will be obtained by researchers by conducting several analyzes, the following provisions will be produced [17].

Description Utilization level (E)

- $E < 0.5$ = Underfishing, Moderate, fishing effort can be increased.
- $0.5 \leq E < 1$ = Fully exploited, fishing effort is maintained with strict monitoring.
- $E \geq 1$ = Overfishing, Over-exploited, fishing effort must be reduced.

3. Results and discussion

3.1. Ship

The *L. savala* fishing vessel is often called an outrigger boat (*jukung*) by local fishermen. Generally, the trip duration of the ship is 1 day in one trip. The main fishing gear used by this ship is a rawe fishing rod. The shape of the ship can be seen in the following picture 2

Figure 2 Fishing Vessel for *L. savala* in Sadeng

The fishing area is carried out in FMARI 573 which is a potential area with the main commodity of *L. savala*. The distribution of fishing areas is 6 points as in Figure 3 below.

Figure 3 Fishing Areas

3.2. Production and Production Value of *L. savala*

The amount of production and production value of capture fisheries, especially L. savala in Sadeng from 2015 to 2021 are presented in Table 2 and Figure 4 below

Table 2 Production and Production Value of *L. savala* [18]

Year	Production (Kg)	Production Value (IDR)
2015	1,996	49,475,000
2016	429,503	7,991,796,587
2017	16,218	614,355,000
2018	185,012	7,400,480,000
2019	515,905	21,922,650,000
2020	359,117	15,562,370,000
2021	563,527	23,720,890,000
Min.	1,996	49,475,000
Max.	563,527	23,720,890,000
Average	295,897	11,037,430,941

Note: 1 USD = IDR 15.581,50

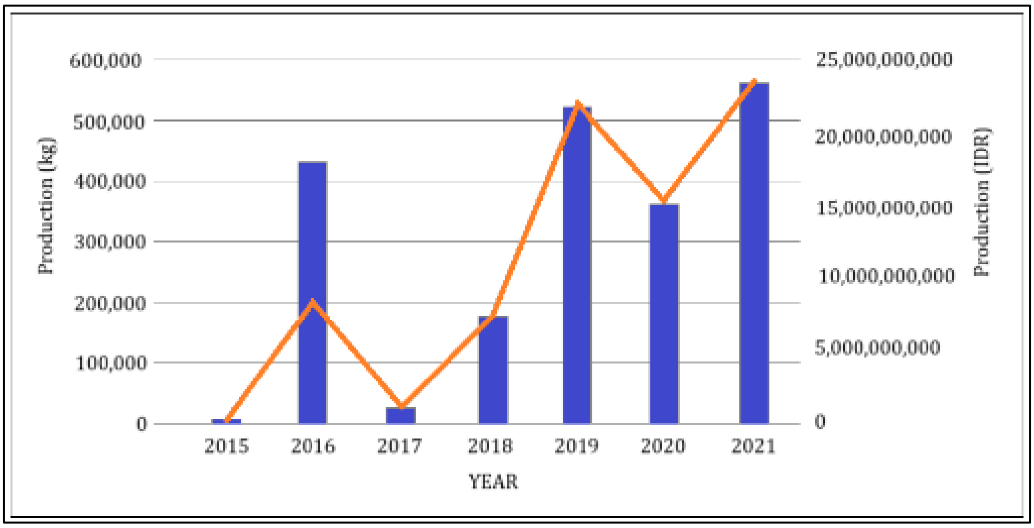

Figure 4 Production (Kg) and Production Value (IDR) of *L. savala*

It is known that the production of *L. savala* in Sadeng has fluctuated over the past 7 years. The highest production occurred in 2021, which was 563,527 Kg, while the lowest production occurred in 2015, which was 49,475,000 Kg. The highest production value occurred in 2021, which was IDR 23,720,890,000, while the lowest production value occurred in 2015, which was IDR 49,475,000. The decrease in production value in 2015 was inversely proportional to the amount of production that increased in that year, while the highest production value occurred in 2021, which was also inversely proportional to the amount of production that decreased.

Fluctuations in the amount of *L. savala* production in Sadeng over the past 7 years have been influenced by the selling power and purchasing power of the surrounding community, because this fish is caught in large quantities in certain seasons, so it becomes a value and is also an economical fish, therefore its selling value is high. If the utilization of *L. savala* resources exceeds stock regeneration, then the stock of these fish resources will become extinct, that efforts to optimize the availability of fish resources with fishing efforts are very important efforts to create a profitable capture fisheries business.

3.3. Fishing Units at PPP Sadeng.

The types of fishing gear used vary, the number of *L. savala* fishing gear used in 2015 to 2021 can be seen in Table 3 and Figure 4 below

Table 3 Number of Fishing Units at PPP Sadeng

Type of Fishing gear	Year						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Purse seine	5	8	8	8	8	8	8
Gillnet	501	408	367	1,167	1,415	2,100	2,150
Lift net	160	-	-	108	116	116	120
Longline	49	46	128	98	112	130	125
Squid jigging	60	-	117	-	112	-	-
Lobster trap	330	-	91	48	83	5	11
Pot/trap	576	685	19	692	411	832	587

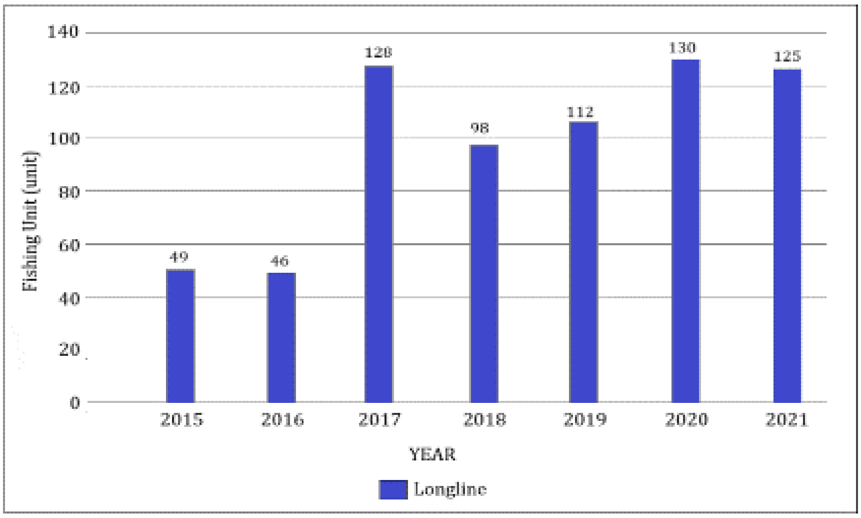

Figure 5 Fishing Unit in PPP Sadeng

Based on Figure 5, the fishing gear used by fishermen varies. The dominant fishing gear is gillnets and longlines and traps. These fishing gears tend to increase every year, but traps have decreased due to the lack of enthusiasts who use them.

3.4. Economic Aspects of *L. savala* Fisheries

3.4.1. Costs

Costs are the total costs that must be incurred by fishermen in fishing business activities. Total costs include fixed costs and variable costs. Fixed costs consist of investment costs which include ship depreciation and engine depreciation plus maintenance costs, while variable costs are operational costs which include fuel costs, food and drink costs. The total cost of the *L. savala* Fishing Business at PPP Sadeng is presented in Table 4 as follows.

Table 4 Total Cost Value

No	Min./Max.	Cost (IDR/Trip)			
		Operational	**Invest cost**	**Maintenance**	**Total**
1	Min.	795,000	54,650,000	100,901	55,462,901
2	Max.	995,000	75,050,000	300,091	76,079,091
3	Average	846,000	64,725,000	225,951	65,597,951

Longline fishing in its operation is one day fishing. This fishing gear operates according to the season. If the season is lean, fishermen will not go to sea and operate fishing gear, because the results that will be obtained later are few or even none. If the normal season is for 1 month this longline fishing operates up to 28 times. While during the peak season it operates up to 30 times almost every day because fishermen will seek profit by taking advantage of the peak season and can get quite a lot of *L. savala* so they will get a lot of profit. In 1 year the longline can operate up to 180 times or even more.

Based on the table above, this cost is taken from longline fishermen. The average total cost incurred for the *L. savala* fishing effort per trip is IDR 65,597,951. The minimum total cost that must be incurred is IDR 55,462,901; the maximum pair of total costs that must be incurred is IDR 76,079,091. The costs that must be incurred by each fisherman vary, the results are adjusted to the needs required.

3.4.2. Income

Income from the *L. savala* fishing business is the result of selling the catch obtained on each trip. This income is gross because it has not been reduced by the operational costs incurred on each trip. Fishermen's income varies, many factors influence it, namely the difference in the amount of catch. The catch obtained by *L. savala* fishermen during the peak season can reach 360 kg.

The price per kilogram of *L. savala* reaches IDR 30,000 to IDR 35,000. The price of *L. savala* can vary because it is influenced by the fishing season. In addition, the season also affects income. This is reinforced by the statement that fluctuations in income from fishermen's catches are caused by seasonal factors, especially during the lean season which is usually marked by a decrease in the amount of catch. This results in price fluctuations which have an impact on decreasing fishermen's income. The productivity of fishermen's businesses during the fishing season is very dependent on the selling price of fish from each collector or boss, so it greatly affects changes in fishermen's income. Details of the catch for each season can be seen in Table 5 below

Table 5 Income/Production Value

No.	**Name of Ship**	**Catch Number per season (Kg)**		
		Peak	Normal	Dry Season
1	Permata Hati	27,200	6,800	3,400
2	Gama Putra	24,500	10,850	3,850
3	Sido Maju	20,700	11,730	3,450
4	Rancah Indah	24,500	12,600	3,500
5	Sido Maju 05	20,700	12,075	4,140
6	Damai Coy	29,200	18,980	5,037
7	Putra Banten	24,500	19,600	4,200
8	Abimanyu 2	19,500	11,050	4,550
9	Arung Samudera	27,200	10,880	5,780
10	Mitra Ratu 07	31,500	10,850	7,000
	Average	24,950	12,542	4,491

3.4.3. Catch Per Unit Effort (CPUE)

By knowing the data on the number of fishing gear and how many trips are made each year and the amount of *L. savala* production [19] (Sobari et al., 2008), the CPUE value can be calculated, which can be seen in Table 6 as follows

Table 6 Catch Per Unit Effort (CPUE) Value

Year	Number Of Trips Total Effort (X)	Production (Kg) Total Catch (Y)	CPUE (Y)
2015	282	46,442	164.69
2016	1,000	212,065	212.07
2017	300	46,500	155.00
2018	2,000	410,720	205.36
2019	2,700	568,418	210.53
2020	2,300	1,400,603	608.96
2021	2,703	1,323,007	489.46
Average	1,612	572,536	292

In Table 6, the development of the amount of production from each known year, then the productivity of *L. savala* itself increases and decreases every year. The increase and decrease in the known CPUE figures can be caused by the arrival of the *L. savala* season itself and result in many longline fishing vessels that in data from other areas because the Sadeng area has great potential for catching *L. savala* itself, however, the decrease in CPUE figures from year to year has resulted in immigrant fishermen moving to other places. Efforts in the relationship between fishing and CPUE describe the level of productivity value of longline fishing that catches *L. savala*, the average catch per unit of fishing effort during the 2015-2021 period was 572,536 tons/trip and there were fluctuations in increases and decreases from year to year. The highest CPUE value during the 2015-2021 period occurred in 2020 at 608.96 tons/trip, meaning that the catch in that year was high, but the fishing effort was low [20].

Meanwhile, the lowest CPUE value occurred in 2015, which was 164.69, indicating that in that year the catch was low, but the fishing effort was relatively high. The correlation between CPUE and fishing effort of *L. savala* showed a negative relationship, namely the higher the fishing effort, the lower the CPUE value. The negative correlation between CPUE and fishing effort indicates that the productivity of longline fishing in PPP Sadeng will decrease if fishing effort increases.

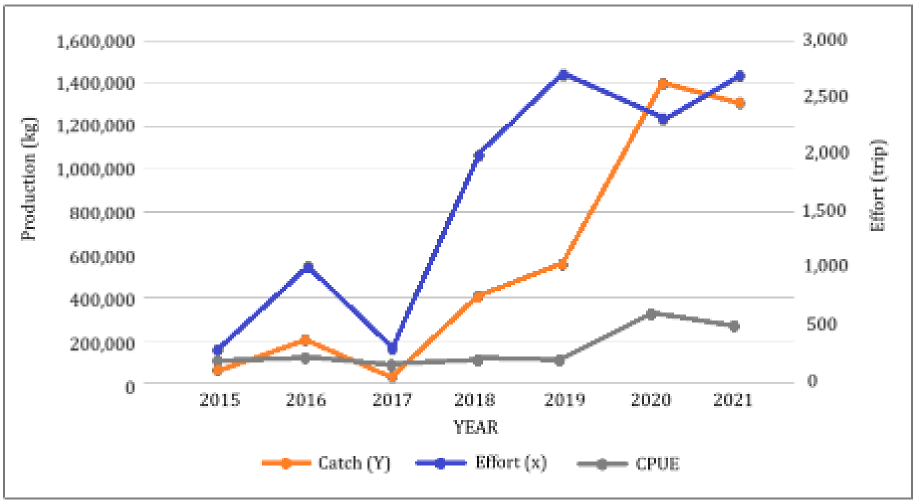

Figure 6 Production value (y), number of trips (x) CPUE *L. savala*

The catch per unit of fishing effort or we can understand it as CPUE reflects the comparison between the catch and the effort expended. The catch is in principle the output of fishing activities, while the effort required is the input of the fishing activities. In terms of production economics, the comparison between output and input reflects the level of technical efficiency of each use of input. Therefore, the amount of CPUE can also be used as an indicator of the level of technical efficiency of better use of effort.

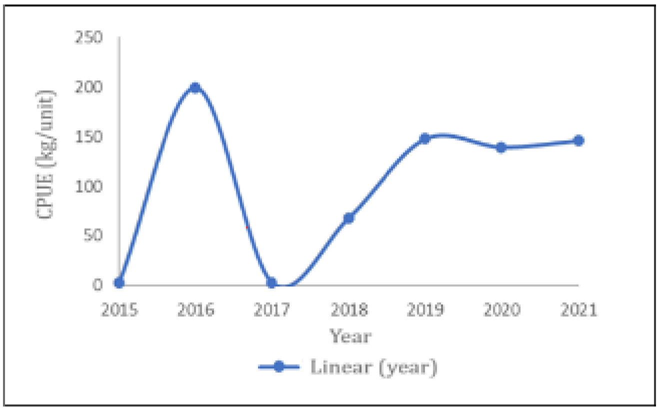

Figure 7 CPUE per year

Based on Figure 7, the highest CPUE value occurred in 2021, which was 1,400,603 kg/unit, meaning that in 2020 the catch of *L. savala* was the highest but the fishing effort was low. The lowest CPUE occurred in 2015 at 46,442 kg/unit, meaning that in that year the catch of *L. savala* was low but the fishing effort was high. The high and low CPUE can be caused by the addition or reduction of Fishing Gear. The CPUE value, which tends to decrease, begins to indicate overfishing. This is in accordance with the statement that the characteristics of a capture fishery are heading towards a condition of overfishing, including longer sea time, fishing locations tend to be further away, productivity/catch rate (CPUE) tends to decrease, the size of the target fish is getting smaller, and the cost of fishing operations is increasing. [21].

The decrease in the CPUE value indicates that the amount of fish production produced is decreasing. This is because the condition of the waters in Sadeng has experienced overfishing. Water that is open access makes it difficult to predict fish stocks, so that fish stocks cannot be controlled. that excessive fishing activities are a form of exploitation of fish populations [22]. If fish resources are reduced, the growth rate of fish will slow down. This condition certainly requires proper management of fishing efforts, so that it has the potential for optimal catch results.

Based on the results of the CPUE calculation above, a graph of the relationship between CPUE and trips is obtained as shown in the following Figure.

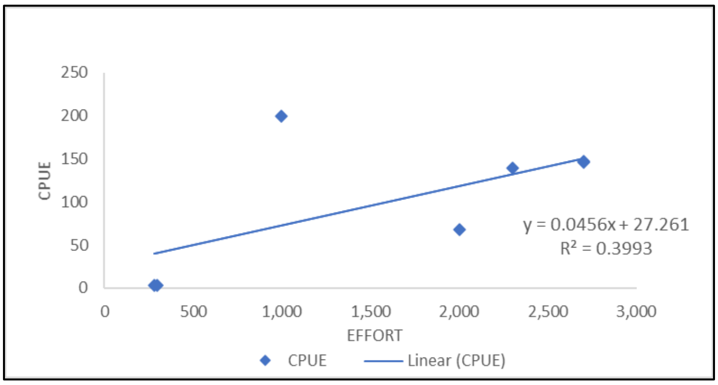

Figure 8 Figure of the Relationship between Effort and CPUE

- Based on Figure 8, the figure shows a graph of the relationship between effort and CPUE which produces a linear equation CPUE = 0.0456 + 27.261 with R^2 = 0.3993, the equation shows that:
- The regression constant (b) = 27.261 states a positive relationship between CPUE and effort that every additional 1 unit of effort will cause CPUE to increase by 0.0456 kg/unit of Fishing Gear. However, if the effort increases by 1 unit, CPUE will decrease by 0.0456 kg/unit. states a relationship where an increase in variable X will result in a decrease in variable Y and vice versa.
- The coefficient of determination R^2 = 0.3993 or 39% This shows that the variation or increase or decrease in CPUE by 39% is influenced by the increase or decrease in the effort value while the remaining 61% is caused by other factors.

3.4.4. Bioeconomic Analysis with the Gorde-Scheper Model

Bioeconomic analysis is an analysis to measure the level of utilization of fishery resources from biological and economic aspects. This analysis uses time series data of production and effort. The Gordon-Schaefer model bioeconomic analysis is one of the bioeconomic analyses that combine economic factors that affect capturing fisheries efforts and biological factors that determine fish production and stocks in nature.

The Gordon Schaefer model bioeconomic analysis is used to determine the condition of *L. savala* resources at the MSY, MEY and OAE levels. Based on the Gordon Schaefer model bioeconomic analysis on *L. savala* resources at the PPP Sadeng, it can be seen in Table 7 as follows

Table 7 Bioeconomic Value with the Grde-Scheper Model

	MSY	MEY	OAE
C (Kg/year)	4,073	3,660	3,537,431,494
E (Unit/year)	299	204	407,225,2349
TR (IDR/year)	162,392,588	145,903,731	141,029,331.8
TC (IDR/year)	103,492,380	70,514,666	141,029,331.8
π (Profit IDR/year)	58,900,208	75,389,065	0

Bioeconomic analysis of *L. savala* in Sadeng with the Gordon-Schaefer model reached the MSY condition at a catch (C_{MSY}) of 4,073 kg/year and an Effort value (E_{MSY}) of 299 units of Fishing Gear/year with a profit of IDR 58,900,208. The MEY condition was obtained when the Catch value (C_{MEY}) was 3,600 kg/year and an Effort value (E_{MEY}) of 204 units of Fishing Gear/year with a profit of IDR 75,389,065. The OAE condition at catch condition (C_{OAE}) is 3537.431494 kg/year and the Effort value (E_{OAE}) is 407.2252349 units of Fishing Gear/year with a profit of 0.

Based on bioeconomic calculations, the effort at MSY conditions is greater than the effort at MEY conditions, so the total cost (TC) incurred at MEY is smaller than at MSY conditions. The profit obtained is 0, which is the break-even point or not profitable but also not detrimental to the *L. savala* fishing effort. The Gordon-Schaefer model bioeconomic equilibrium point graph is presented in the Figure below

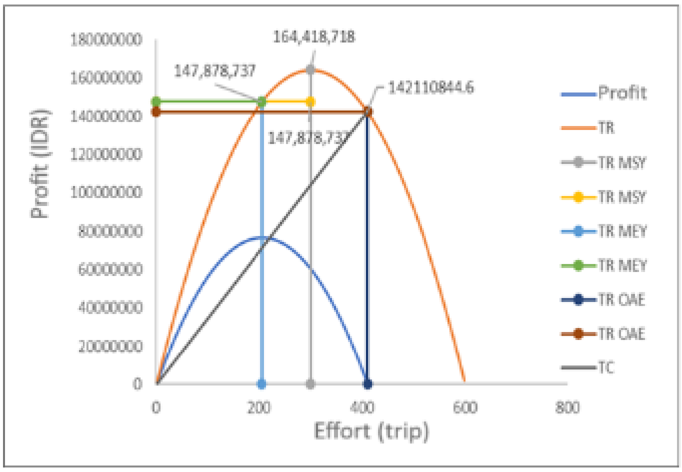

Figure 9 *L. savala* bioeconomic equilibrium point

Figure 9 Gordon Schaefer Model Bioeconomic Equilibrium Based on the Figure, the TR_{MSY} condition is greater than TR_{MEY} and TC_{MSY} is greater than TC_{MEY}. The MEY point is the optimal point when the MEY condition produces a lot of production, but the fishing effort is less than the MSY condition so that it can get a large income and the profits obtained are greater. The profit obtained in MEY condition is IDR 75,389,065 while the profit in MSY condition is IDR 58,900,208.

This shows that when the MEY condition is the profit from the L. savala fishing effort is at its maximum point. The graph of the *L. savala* bioeconomic equilibrium point of the Gordon-Schaefer model with the MSY peak point, *L. savala* production will increase to the MSY peak point. If the effort has exceeded the MSY effort value, then the production of *L. savala* will decrease to point 0. The peak profit obtained is at the peak MEY point, but if the effort value exceeds the MEY effort value, the profit will decrease.

3.4.5. Maximum Sustainable Yield (MSY)

Based on the results of the MSY analysis using the Gordon-Schaefer model, the catch results in CMSY conditions of 4,073 kg/year can be obtained. while the EMSY value is 299 units of Fishing Gear/year. The CMSY value shows the maximum sustainable production level, namely the highest *L. savala* yield, while the EMSY value shows the optimum level of effort. *L. savala* fishing efforts that exceed EMSY can threaten the sustainability of *L. savala* resources in the Sadeng Waters. The MSY graph can be used as a guideline to see whether a fishing activity has underfishing, full exploited or overfishing status.

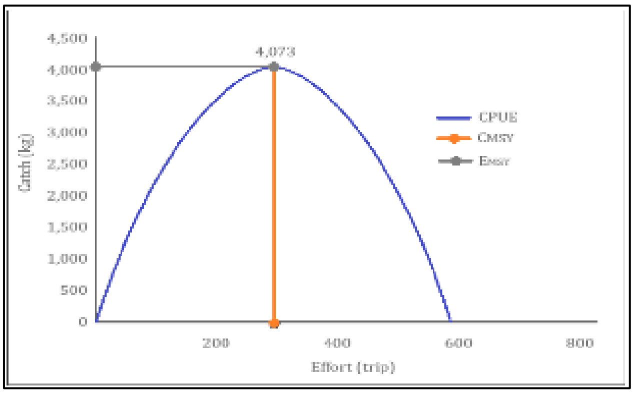

Figure 10 MSY

It is known in Figure 10 above that there are values that have been known during the calculation using the Gordon-Schaefer model, namely the value of TR of IDR 162,392,588 and TC of IDR 103,492,380, only that from this analysis we can predict that the profit can reach IDR 58,900,208 by looking at the picture above and we can see the balance in all events that can be predicted to occur excessive fishing or are still being attempted again and can be as usual.

3.4.6. Maximum Economic Yield (MEY)

MEY is a condition of utilization of catches that prioritizes economic benefits but still maintains the sustainability of fish resources and the environment. Based on the results of the MEY analysis of *L. savala* resources using the Gordon-Schaefer model, the MEY condition occurs when the utilization of *L. savala* resources reaches 3,660 kg/year. Fishing effort will reach CMEY if the Fishing Gear units are 204 Fishing Gear units/year. The results of the MEY analysis obtained a total income (TR) of IDR 145,903,731 and a fishing cost (TC) of IDR 70,514,666 so that a profit of IDR 75,389,065 was obtained.

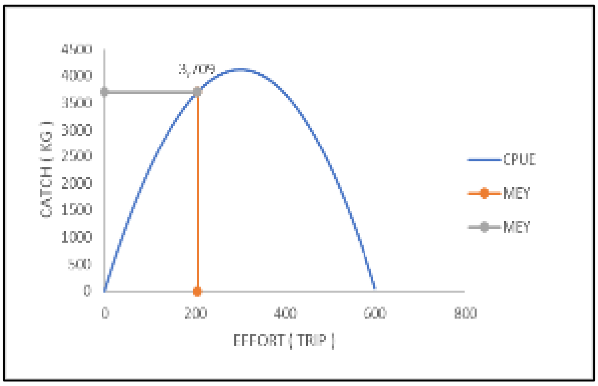

Figure 11 MEY

In Figure 11 we can conclude that the amount of TR Analysis is IDR 145,903,731 and the TC value is IDR 70,514,666 and gets a profit value of IDR 75,389,065 which is stated above, if MEY will look for the lowest point of capture or we can call it garch by trying as optimally as possible to capture greater profits in MSY and OAE Analysis.

3.4.7. Open Access Equilibrium (OAE)

OAE is an open equilibrium that occurs during open access fisheries activities. Based on the results of the OAE analysis using the Gordon-Schaefer model, it is known that the OAE value is close to zero, meaning that the fishing unit is in a condition where the L. savala fishing effort is not economically profitable if the utilization of resources is in the OAE condition.

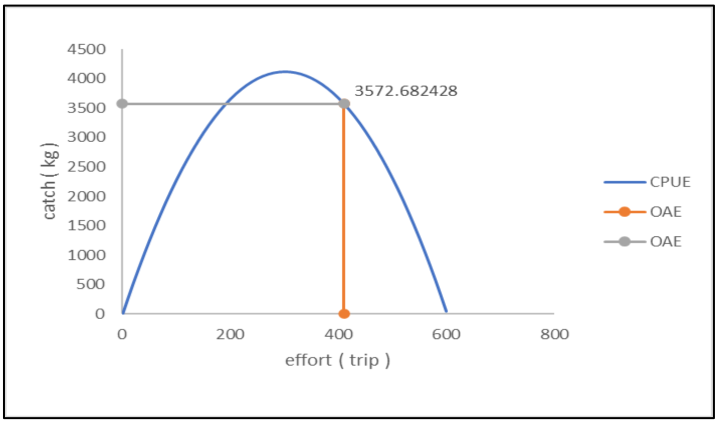

Figure 12 OAE

Figure 12 above emphasizes that the OAE point will produce a value where the OAE analysis has a TR value of IDR 641,029,331 and also a TC value of IDR 641,029,331 and gets a profit of IDR 0, then there will be a loss if the fishing effort is added to the fishing effort that has been explained above and will get minimal income or there could be a loss that will occur at that time.

3.4.8. Level of Utilization and Effort

The level of utilization is the utilization of fishery resources carried out by continuous fishing. The level of utilization is calculated by presenting the number of catches in a certain year to the Total Allowable Catch (TAC) value or the number of catches allowed at 80% of its C_{MSY}. The level of utilization and level of effort of *L. savala* resources in Sadeng are presented in Table 8.

Table 8 Level of Utilization and Effort

Year	Actual Production	Cmsy	Emsy	Actual Effort	Utilization Level (%)	Effort Level (%)	TAC
2015	775	4,124	301	282	2	9	3,299
2016	199,324	4,124	301	1,000	48	33	
2017	855	4,124	301	300	2	10	
2018	136,260	4,124	301	2,000	33	66	
2019	398,676	4,124	301	2,700	97	90	
2020	320,474	4,124	301	2,300	78	76	
2021	394,214	4,124	301	2,703	96	90	
Average	207,225			1,612	51	54	

Based on Table 8, the highest utilization rate of *L. savala* resources occurred in 2019 at 97%, while the lowest utilization rate occurred in 2015 and 2017 at 2%. The utilization rate is influenced by the amount of production per year, the greater the amount of production, the greater the utilization rate.

Description Utilization rate (E)

- E < 0.5 = Moderate fishing efforts can be increased.
- 0.5 ≤ E < 1 = Fully exploited, fishing efforts are maintained with strict monitoring.
- E ≥ 1 = Over-exploited, fishing efforts must be reduced.

The results of the average utilization rate of *L. savala* resources show that the utilization of L. savala resources is experiencing underfishing. This is in accordance with the results of the Analysis at the utilization level which reached an average value of 51% and it was stated that the research conducted by Nikijuluw in [23], that if based on the international agreement contained in the Code of Conduct for Responsible Fisheries (CCRF), then the resources that may be caught are only around 80% of the existing potential.

The measurements in this analysis method cover a lot of the sustainability and economic fields in the Sadeng waters, with results that we can say are not constant in these results, such as there were several years that experienced overfishing such as in 2019 which reached a value of 97% and in 2021 which experienced a decrease of one percent from 2019 which was 96% this states that in that year there were several factors that experienced an increase in capture in the Sadeng waters.

The average level of effort of *L. savala* resources in the Sadeng waters is 54%. The level of effort is influenced by the number of fishing gear used, the more fishing gear the greater the level of effort. The level of effort on *L. savala* resources in Sadeng has been on average less than 100% or is still safe in terms of resources and fishing economy in fishing areas in Sadeng waters. This is because the fishing efforts carried out by fishermen are still considered less than maximizing the potential in the field of fishing *L. savala* itself every year. This is in accordance with the statement [24, 25], the level of utilization that is still lacking for the sustainable potential level (MSY) is very lacking in the economic progress section which can be developed again to obtain more optimal benefits.

4. Conclusion

The conclusions that can be drawn based on the research are as follows

- The productivity of *L. savala* fisheries in PPP Sadeng itself is still experiencing underfishing where in this condition fishermen can still catch as optimally as possible and can add more fishing gear units and fishing fleets. because the utilization rate (effort) is still below 0.5. does not worry about reducing or threatening the population of *L. savala.*
- The level of utilization of *L. savala* resources is still lacking in the level of utilization such as CMSY with an average of 51%, and the level of effort can also still be utilized as optimally as possible EMSY with an average of 54% which means that there have been efforts to catch *L. savala* but it has not been optimized with evidence at the level of utilization E <0.5 produced and attempted by local fishermen in efforts to catch *L. savala* is still less than optimal.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclose.

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