Jurnal Perikanan

Fisheries Journal, 16 (2), 669-679 (2026)
http://doi.org/10.29303/jp.v16i2.1844

RESOURCE UTILIZATION LEVEL'S ANALYSIS OF YELLOWFIN TUNA (*Thunnus albacares*) FISHERIES IN THE MENTAWAI WATERS OF WEST SUMATRA

Analisis Tingkat Pemanfaatan Sumberdaya Perikanan Tuna Sirip Kuning *(Thunnus albacares)* pada Wilayah Penangkapan Perairan Mentawai Sumatera Barat

Muhammad Dede S.*, Abdullah Munzir, Junaidi

Department of Aquatic, Coastal and Marine Resources, Faculty of Fisheries and Marine Sciences, Bung Hatta University

Jl. Sumatera Ulak Karang Padang, West Sumatra 25133

*Coresponding author: muahammaddede0101@gmail.com

(Received September 4th 2025; Accepted January 8th 2026)

ABSTRACT

The high economic dependence of fishing communities on yellowfin tuna makes them vulnerable to fluctuations in catch and market prices. This study aims to analyze the level of fishery resource utilization, which is crucial for ensuring the sustainability of yellowfin tuna fisheries in Mentawai waters. This study used a quantitative descriptive approach to analyze the level of utilization of yellowfin tuna (Thunnus albacares) fishery resources in Mentawai waters landed at the Bungus Ocean Fisheries Port (PPS), West Sumatra. The CPUE (Customer Equity Index) of yellowfin tuna in the Indonesian Fisheries Authority (WPPNRI) 572 decreased from 2019 to 2024, indicating a decline in stock abundance and increasing fishing pressure, while the utilization rate shifted from underfishing to overfishing (2019–2024). MSY analysis using the Schaefer and Fox model indicates a sustainable utilization limit of 400–487 trips per year, but actual efforts have exceeded this limit, necessitating data-driven adaptive management to maintain stock sustainability. It is recommended to limit the number of trips, establish a minimum catch size, and conduct regular monitoring of CPUE and length distribution to support science-based policymaking.

Keywords: CPUE Value, Overfishing, Utilization Rate, Yellowfin Tuna

ABSTRAK

Tingginya ketergantungan ekonomi masyarakat nelayan terhadap tuna sirip kuning menjadikan mereka rentan terhadap fluktuasi hasil tangkapan dan harga pasar. Penelitian ini bertujuan menganalisis tingkat pemanfaatan sumber daya ikan menjadi sangat penting untuk memastikan keberlanjutan perikanan tuna sirip kuning di perairan Mentawai. Penelitian ini menggunakan pendekatan deskriptif kuantitatif untuk menganalisis tingkat pemanfaatan sumber daya perikanan tuna sirip kuning (*Thunnus albacares*) di perairan Mentawai yang didaratkan di Pelabuhan Perikanan Samudera (PPS) Bungus, Sumatera Barat. Nilai CPUE tuna sirip kuning di WPPNRI 572 menurun dari 2019 hingga 2024, menunjukkan penurunan kelimpahan stok dan meningkatnya tekanan penangkapan, sementara tingkat pemanfaatan bergerak dari *underfishing* menuju *overfishing* (2019–2024). Analisis MSY dengan model Schaefer dan Fox menunjukkan batas pemanfaatan lestari pada 400–487 trip per tahun, namun upaya aktual telah melampaui batas ini, sehingga pengelolaan adaptif berbasis data diperlukan untuk menjaga keberlanjutan stok. Disarankan membatasi jumlah trip, menetapkan ukuran minimum tangkapan, dan melakukan pemantauan rutin CPUE serta distribusi panjang untuk mendukung pengambilan kebijakan *science-based*.

Kata Kunci: Tuna Sirip Kuning, Tingkat Pemanfaatan, Nilai CPUE, *Overfishing*

INTRODUCTION

Indonesia is one of the countries with the highest potential for fisheries production in the world. Two-thirds of Indonesia's territory consists of oceans, with abundant, open-access fish resources. Various economically valuable fish species, both small and large pelagic, are widely distributed throughout the archipelago's waters. One leading commodity is tuna, which plays a significant role in meeting domestic demand and as an export commodity (Primyastanto et al., 2021; Rahmah et al., 2021a). Tuna is a high-value fish species, along with skipjack tuna and mackerel (TTC). Of the various tuna species, yellowfin tuna (Thunnus albacares) is the most commonly caught and has high economic value. Its widespread distribution throughout the Indonesian State Fisheries Management Area (WPPNRI) makes yellowfin tuna a key capture fishery commodity (Masrizal & Naufal, 2019). In addition to its high-quality meat, almost all parts of this fish can be utilized, increasing its market value.

One area with significant potential as a fishing ground for yellowfin tuna is the Indonesian Fisheries Authority (WPPNI) 572, particularly in the waters of West Sumatra. This area is supported by the Bungus Ocean Fishing Port (PPS), which serves as a landing center for catches, including those from Mentawai waters. In 2024, yellowfin tuna production landed at the Bungus PPS reached 528.3 tons with a production value of IDR 23.17 billion (Bungus PPS Statistical Report, 2024). This data demonstrates the strategic role of the Bungus PPS in supporting the industrialization of capture fisheries in West Sumatra (Ikhsan et al., 2017). Over the past five years, the trend in yellowfin tuna production in Mentawai waters has shown a significant increase. This is in line with the increase in the number of tuna handline vessels from 25 units in 2019 to 65 units in 2024 (BPS, 2024). Increased fleet capacity, modernization of fishing gear, and government policy support in the form of fuel subsidies and training in fishing technology are driving factors for the increased catch. However, this trend also raises concerns regarding the potential for overexploitation, fish stock degradation, and socio-economic impacts on coastal communities (Jamilah & Mawardi, 2018).

The high economic dependence of fishing communities on yellowfin tuna makes them vulnerable to fluctuations in catches and market prices. Limited access to capital, technology, and education also weakens the bargaining position of small-scale fishers in the production and distribution chain. Furthermore, weak fishing oversight poses a significant challenge to maintaining the sustainability of tuna resources. Given these conditions, analyzing the level of fish resource utilization is crucial to ensuring the sustainability of yellowfin tuna fisheries in Mentawai waters. Indicators such as catch per unit of effort (CPUE), maximum sustainable yield (MSY), and the level of fish stock utilization require comprehensive assessment.

METHODS

Research Materials

The research was conducted at the Bungus Ocean Fishing Port (PPS), West Sumatra Province. The research was conducted from January to June 2025. The tools used in this study were a computer or laptop, stationery, data recording forms, and a digital camera. The materials used in this study were data on yellowfin tuna (*Thunnus albacares*) catches.

Methods

This study used a quantitative descriptive approach to analyze the utilization level of yellowfin tuna (*Thunnus albacares*) fishery resources in Mentawai waters landed at the Bungus Ocean Fishing Port (PPS), West Sumatra. The data used consisted of secondary data, including yellowfin tuna catch production, number of vessels, and number of fishing trips for the 2019–2024 period, obtained from official reports of the Bungus PPS, and primary data, including the weight of individual tuna caught during January–June 2025, which served as a comparison against data from the previous period.

Data Analysis

The data obtained during the study were then analyzed to assess the potential for sustainable resources. The results of this analysis are expected to provide information regarding the Maximum Sustainable Yield (MSY) value for yellowfin tuna and its utilization level. The analysis was conducted to describe general field conditions and the characteristics of the research object. The surplus production method, based on the Schaefer & Fox (1970) model, was used to estimate yellowfin tuna stocks, with variables X (number of fishing gear units) and Y (Catch Per Unit Effort/CPUE).

CPUE Analysis

Analysis of fishery abundance and utilization levels was conducted by calculating Catch Per Unit Effort (CPUE), which is the division of the total catch by the fishing effort. Data used in this analysis included catch (weight of fish per species) and effort data, such as number of trips, number of vessels, number of fishing gear units, and operating time.

$$\mathrm{CPUE} = \frac{\mathrm{Catch(Y)}}{\mathrm{Effort(X)}}$$

Where:
Catch = Total catch production
Effort = Total fishing effort per fishing unit
CPUE = Catch per fishing effort (tons/trip)

Analysis of Sustainable Fishery Resource Condition (MSY) Value

1. Analysis of Sustainable Fishery Resource Condition (MSY) Value using the Schaefer Model

Tuna fishery potential is estimated by analyzing the relationship between catch and fishing effort using the Schaefer surplus production method (Sparre & Venema, 1990). This relationship is expressed in a linear regression equation:

$$y = a + bx$$

Where:
y = dependent variable (CPUE) in kg/trip
x = independent variable (effort) in trip
a and b= regression parameters

The aaa and bbb values are obtained through linear regression analysis. Next, the maximum sustainable catch potential (CMSY) and optimum effort (EMSY) are determined using the formulas:

$$\mathrm{EMSY} = -\frac{a}{2b} \quad \mathrm{CMSY} = -\frac{a2}{4b}$$

The Schaefer model is only valid if the bbb value is negative, indicating that increasing fishing effort will decrease CPUE. If the bbb value is positive, the CMSY and EMSY calculations cannot be performed.

2. Analysis of the Sustainable Condition of Fishery Resources (MSY) Value using the Fox 1970 Model

Analysis of sustainable potential using the Fox (1970) model was conducted using yellowfin tuna production data and standardized trip data for the 2019–2024 period, then the annual CPUE value was calculated. Linear regression analysis was performed using the variables x (total trips) and y (LnCPUE) to obtain the parameters a and b, which were then used in the CMSY and EMSY calculations. The Fox model depicts an exponential relationship between fishing effort and catches with an asymmetric curve, unlike the Schaefer (1954) model, which assumes a symmetric relationship and allows CPUE to be zero. To determine the CMSY (sustainable potential) and EMSY values in the 1970 Fox model, the following formula is used:

$$MSY = -\left(\frac{1}{d}\right) * \exp(c - 1)$$

$$E_{MSY} = -\frac{1}{d}$$

Where:
c = Fox model intercept result
d = Fox model slope result

3. Yellowfin Tuna Utilization Rate

The yellowfin tuna utilization rate is calculated to assess the extent to which the resource has been exploited compared to the sustainable limit. This analysis is crucial to ensure that the catch rate does not exceed the maximum capacity that nature can recover. The utilization rate calculation is performed using data on the total annual yellowfin tuna catch at the Bungus Fishing Port (PPS) and the Maximum Sustainable Yield (MSY) values obtained through the Schaefer and Fox models.

$$\text{TPC} = \frac{\text{Ci}}{\text{CMSY}} \text{ X } 100\%$$

Where:
TPC = utilization rate (%)
Ci = catch in the first year (kg)
CMSY = sustainable catch (kg)

RESULTS

Yellowfin Tuna Catch per Fishing Effort (CPUE)

The utilization rate of yellowfin tuna is calculated to assess the extent to which the resource has been exploited compared to sustainable limits. This analysis is crucial to ensure that fishing rates do not exceed the maximum recoverable capacity of the resource. The utilization rate calculation was performed using data on the total annual catch of yellowfin tuna at the Bungus Fishing Port (PPS) and the Maximum Sustainable Yield (MSY) values obtained using the Schaefer and Fox models. The catch results are shown in Table 1.

Table 1. Catch Production, Effort (Trip), and Catch Value per Unit Effort (CPUE) of Yellowfin Tuna (*Thunnus albacares*) at the Bungus Ocean Fishing Port, 2019-2024

Year	Catch (kg)	Catch (ton)	Effort (trip)	CPUE (ton/trip)
2019	438873	438,873	139	3,157
2020	240812	240,812	142	1,696
2021	470644	470,644	336	1,401
2022	594308	594,308	550	1,081
2023	512394	512,394	497	1,031
2024	528300	528,300	499	1,059

A high CPUE value can indicate relatively abundant fish stocks, while a low CPUE value can indicate high fishing pressure or a decline in fish stocks in the waters. The results of this CPUE analysis are presented in Figure 1 and Table 1 to provide a clearer picture of the trends and fluctuations in catch productivity during the study period.

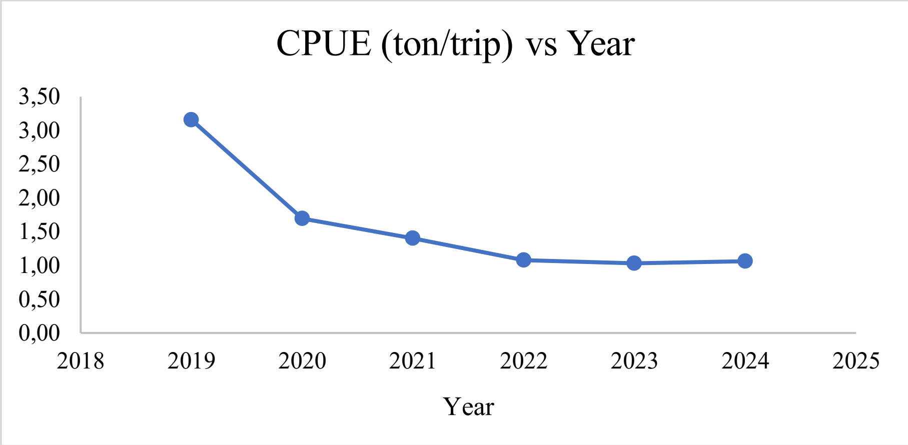

Figure 1. Graph of CPUE (Catch per Unit Effort) of Yellowfin Tuna (*Thunnus albacares*) Landed at the Bungus Ocean Fishing Port, 2019-2024

Sustainable Condition of Fishery Resources (MSY) Analysis

Maximum Sustainable Yield (MSY) analysis is crucial for sustainable fisheries management (Hilborn & Walters, 1992; FAO, 2011). Monthly fluctuations in yellowfin tuna (*Thunnus albacares*) catches at the Bungus Fishing Port for the 2019–2024 period show varying patterns, influenced by seasonal factors, the environment, and fishing activities. The highest production was recorded in May 2019 (59,632 kg), while a significant decline occurred in early 2020, likely due to environmental conditions and socioeconomic factors among fishermen.

Table 2. Distribution of Monthly Catch Weight of Yellowfin Tuna (*Thunnus albacares*) at the Bungus Ocean Fishing Port, 2019–2024 (kg)

Month	Year					
	2019	2020	2021	2022	2023	2024
January	40,036	5,834	21,395	52,144	46,304	967
February	28,253	2,132	38,101	41,622	36,440	200
March	26,028	14,083	42,092	64,887	95,546	1,761
April	59,621	34,546	32,949	64,115	29,835	3,100
May	59,632	14,171	30,567	22,480	35,437	34,795
June	24,307	27,330	39,448	35,261	51,803	62,177
July	34,215	36,281	43,733	27,912	117,213	84,397
August	44,379	13,628	38,643	44,327	71,062	51,155
September	39,959	9,262	30,891	88,478	23,219	94,734
October	29,616	29,855	63,038	62,358	957	95,573
November	18,190	30,866	55,245	54,240	3,697	66,274
December	34,637	22,824	34,542	36,484	881	33,167

MSY indicates the maximum level of exploitation that can be achieved without disrupting the balance of fish stocks in nature (FAO, 2001). In this study, the MSY value of Yellowfin Tuna (*Thunnus albacares*) was analyzed using the Schaefer and Fox surplus production model to determine safe exploitation limits that can be applied to maintain the sustainability of fish stocks in the waters around Mentawai. The following presents the results of the MSY calculation analysis to provide an overview of the ideal sustainable utilization level for these fish stocks.

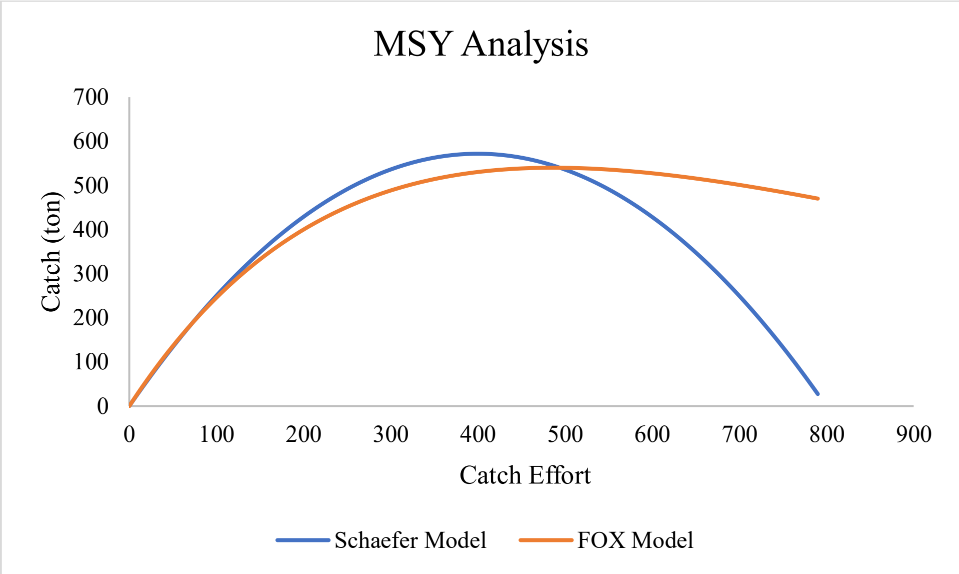

Figure 2. Maximum Sustainable Yield (MSY) Analysis of Yellowfin Tuna (*Thunnus albacares*) Using the Schaefer and Fox Model at the Bungus Ocean Fishing Port

The Schaefer surplus production model is widely used to determine the maximum sustainable utilization level (MSY) of a fishery resource. This model assumes a linear relationship between fishing effort and fish stock, where catches increase with effort until they reach a maximum point (MSY), then decline due to overfishing (Sparre & Venema, 1998; King, 2007). The following graph presents the results of the Schaefer model analysis of the relationship between effort and catch of yellowfin tuna (*Thunnus albacares*) at the Bungus Fishing Port (PPS).

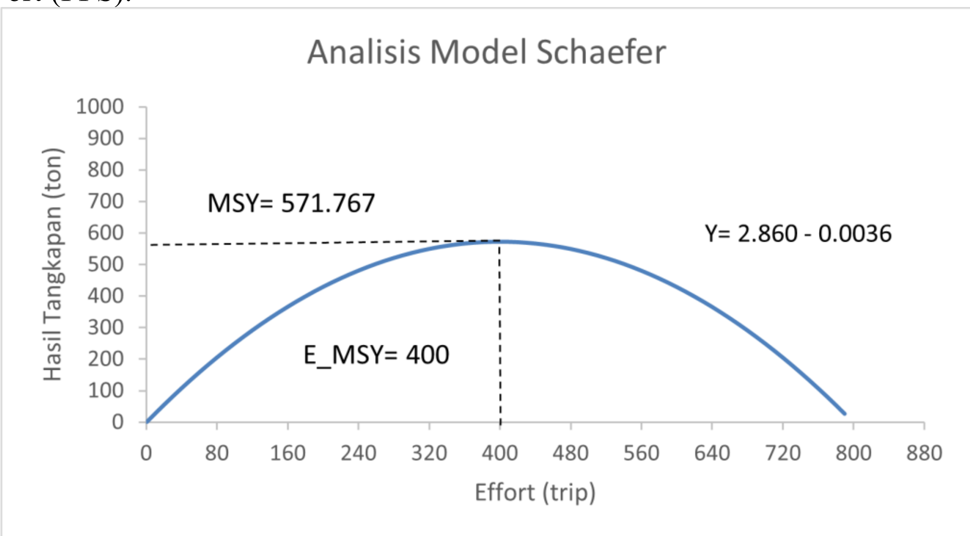

Figure 3. Schaefer Model Analysis Graph

The Fox model (1970) is a surplus production model widely used in sustainable fisheries management. Unlike the Schaefer model, this model uses a logarithmic approach, resulting in a gentler and more realistic curve for stocks experiencing fishing pressure (Prajneshu, 2003; Rouf et al., 2021). The Fox model effectively describes conditions where increased effort does not necessarily decrease catch yields sharply (Purwanti et al., 2024). The following graph shows the relationship between fishing trips and catches of yellowfin tuna (*Thunnus albacares*) landed at the Bungus Fishing Port (PPS) in Mentawai waters.

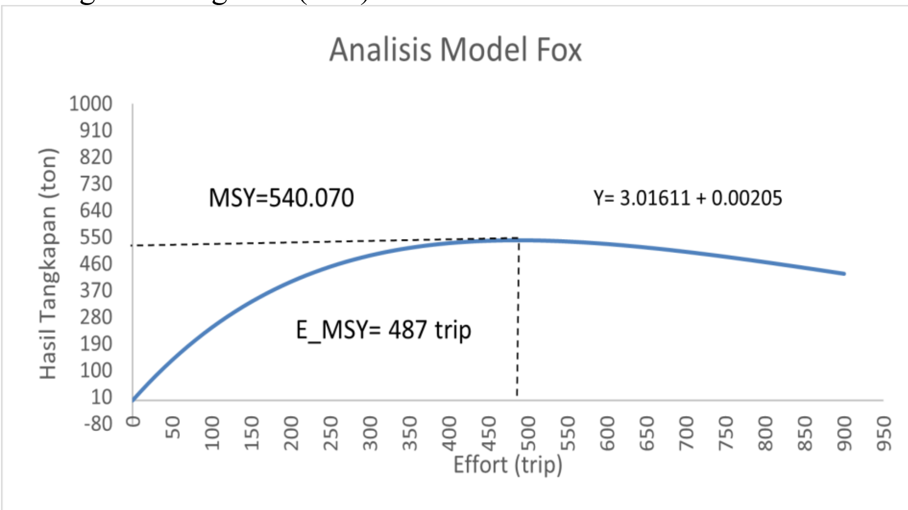

Figure 4. Graph of Fox Model Analysis Results

Utilization Level Analysis

Utilization level analysis using the Schaefer and Fox models is used to assess whether a fishery resource is being optimally utilized, underutilized, or overexploited. This information is crucial for controlling fishing efforts and maintaining stock sustainability. Table 3 presents the results of calculations of the utilization rate of yellowfin tuna (*Thunnus albacares*) landed at Bungus Ocean Fishing Port (PPS) in Mentawai waters.

Table 3. Interpretation and Utilization Rate of the Schaefer and Fox Model Analysis Results for Yellowfin Tuna (*Thunnus albacares*) at Bungus Ocean Fishing Port, 2019–2024

Year	Catch (C actual)	C_MSY Schafer	C_MSY Fox	Schaefer Interpretation	Fox Interpretation	Schaefer | Fox Utilization Rate
2019	438,873	571,767	540,070	Moderately exploited	Fully Exploited	77% | 81%
2020	240,812	571,767	540,070	Moderately exploited	Moderately exploited	42% | 45%
2021	470,644	571,767	540,070	Fully Exploited	Fully Exploited	82% | 87%
2022	594,308	571,767	540,070	Over exploited	Over exploited	104% |110%
2023	512,394	571,767	540,070	Fully Exploited	Fully Exploited	90% | 95%
2024	528,300	571,767	540,070	Fully Exploited	Fully Exploited	92% | 98%

Using the MSY approach and annual evaluations, policymakers can establish control measures such as vessel restrictions, regulated fishing seasons, and protected spawning areas. The combination of biological data and utilization indicators is crucial to support the creation of a productive and sustainable fisheries system. This combination is evident in the tuna weight range data presented in Tables 4 and 5.

Table 4. Weight Range of Yellowfin Tuna (*Thunnus albacares*) at the Bungus Ocean Fishing Port in 2024

Weight of Fish Caught in the Year 2024			
No.	Weight Range	Number of Fish	Total Catch
1	1-10	15	140
2	11-20	1072	16828
3	21-30	1853	53739
4	31-40	2324	108124
5	41-50	2501	152603
6	51-60	1206	88122
7	61-70	834	69149
8	71-80	428	34915
9	81-90	44	4497
10	91-100	2	183
	Total	10279	528300

Table 5. Weight Range of Yellowfin Tuna (*Thunnus albacares*) at Bungus Ocean Fishing Port in 2025

Weight of Fish Caught in the Year 2025			
No.	Weight Range	Number of Fish	Total Catch
1	1-10	234	2018
2	11-20	1819	28686
3	21-30	1848	47879
4	31-40	2634	92878
5	41-50	2560	109403
6	51-60	1887	101452
7	61-70	622	39686
8	71-80	237	18404
9	81-90	24	1885
10	91-100	0	0
	Total	11865	442291

DISCUSSION

Yellowfin Tuna Catch Per Fishing Effort (CPUE)

Table 1 shows that yellowfin tuna production increased from 438,873 tons in 2019 to 594,308 tons in 2022. However, a significant increase in the number of trips caused the CPUE to decrease from 3,157 tons/trip to 1,081 tons/trip. This decrease in CPUE indicates excessive fishing pressure and the possibility of a drastic stock decline, influenced by environmental factors and fish migration patterns (Hilborn & Walters, 1992; FAO, 2011). In 2023–2024, production and effort remained relatively stable, with CPUE around 1 ton/trip, indicating the achievement of a new equilibrium, albeit at a lower level than at the beginning of the period. This trend confirms that fishing intensification does not increase efficiency but rather indicates a serious risk of overfishing (Sparre & Venema, 1998; King, 2007).

Figure 1 shows the CPUE trend for yellowfin tuna (*Thunnus albacares*) at Bungus Fishing Port (PPS) during the 2019–2024 period. The highest CPUE value was recorded in 2019 at 3.2 tons/trip, then dropped sharply to 1.6 tons/trip in 2020, indicating intensive fishing pressure or changing environmental conditions (Armana, 2020). The CPUE decline continued until 2023 (1,031 tons/trip), before stabilizing at around 1 ton/trip in 2022–2024, indicating the achievement of a new equilibrium point. This trend aligns with literature indicating that increases in vessel numbers are often accompanied by decreases in CPUE (Mounder et al., 2006), and underscores the need for intensive monitoring and data-driven management to prevent overfishing. Environmental factors such as changes in sea temperature, currents, and food availability also play a significant role in influencing stock abundance (Wiryawan et al., 2020).

Analysis of Sustainable Fishery Resource Condition (MSY) Value

In 2021, yellowfin tuna production increased with significant monthly fluctuations, with peaks occurring in October (63,038 kg) and November (55,245 kg), likely influenced by water conditions favorable for fish migration. The peak catch in 2022 was recorded in September (88,478 kg), indicating optimal environmental conditions and food availability (Sun et al., 2013). The year 2023 again showed extreme fluctuations, with a peak in July (117,213 kg) and a drastic decline in October and December (<1,000 kg), likely due to changes in fish migration or technical/weather disruptions. In 2024, monthly catches increased again, particularly in September (94,734 kg) and October (95,573 kg), indicating that the end of the year is an optimal fishing period for fishermen.

Figure 2 shows the Maximum Sustainable Yield (MSY) analysis for yellowfin tuna (*Thunnus albacares*) using the Schaefer and Fox models. The Schaefer model yields a higher MSY (~550 tonnes over 400–450 trips) with a clear production peak, while the Fox model shows a gentler curve (~500 tonnes) reflecting a gradual peak in production (King, 2007). These results indicate that actual fishing effort (≥500 trips) has approached or exceeded sustainable capacity, potentially leading to overfishing. The differences in the characteristics of the two models reflect the assumptions used: the Schaefer model is linear, while the Fox model is exponential and more conservative in its MSY estimation.

Figure 3 shows the relationship between fishing effort (trips) and yellowfin tuna catch using the Schaefer model, which assumes a linear relationship between effort and fish stock growth (Atmaja et al., 2017). The maximum production point was reached at 400 trips with a catch of approximately 571.77 tonnes, indicating optimal utilization. Increasing effort beyond this point causes a sharp decline in production to near zero (~800 trips), indicating the risk of overfishing. This situation underscores the need for strict regulation of trip numbers and fishing intensity, as well as the implementation of ecosystem-based management, to maintain the sustainability of yellowfin tuna stocks in Mentawai waters (Guggisberg, 2019).

Figure 4 shows the relationship between fishing effort (trips) and yellowfin tuna catch using the Fox (1970) model, which is based on a logarithmic approach, resulting in an asymptotically convex curve (Sparre & Venema, 1998). Catches increased to a maximum of 540.07 tonnes in 487 trips, after which effort increased insignificantly, indicating a decline in efficiency without the risk of drastic stock collapse. The Fox model is more conservative and realistic than the Schaefer model because it considers the natural catch capacity of the fish stock, making it suitable for tropical fisheries with fluctuating fishing pressure (King, 2007). Management strategies should establish maximum effort limits based on the MSY points from both models, taking into account Fox's conservative values, and implement fleet controls, fishing bans during the spawning season, and no-take zones to maintain stock sustainability in Mentawai waters.

Utilization Level Analysis

According to Table 3, the utilization level of yellowfin tuna (*Thunnus albacares*) in Mentawai waters (2019–2024) shows significant fluctuations. The C_MSY value was recorded at 571,767 tons for the Schaefer model and 540,070 tons for the Fox model. In 2019, the actual catch (438,873 kg) was below C_MSY, with utilization levels of 77% (Schaefer, moderately exploited) and 81% (Fox, fully exploited). In 2020, this decreased to 42–45%, in line with low CPUE due to environmental and external factors (Elleby et al., 2025; FAO, 2020). Starting in 2021, catches increased sharply (470,644 kg) with a utilization rate of 82–87%, approaching the C_MSY, requiring careful management to avoid overfishing (Purwanto, 2016). In 2022, catches exceeded C_MSY (594,308 kg), with a utilization rate of 104–110%, categorized as overexploited (Hilborn & Walters, 1992), indicating excessive fishing pressure. In 2023–2024, catches stabilized (512,394–528,300 kg) with a utilization rate of 90–98%, still in the fully exploited category, but approaching the limit of sustainable capacity (Hampton et al., 2005; Sibert et al., 2012). The overall trend indicates fluctuations and the risk of overfishing, emphasizing the importance of science-based management, regular monitoring, and control efforts to maintain a balance between catch yield and stock sustainability (King, 2007).

Table 4 shows that the majority of Yellowfin Tuna (*Thunnus albacares*) caught at the Bungus Ocean Fishing Port in 2024 were in the 31-40 weight range, with 2,324 fish, and in the 41-50 weight range, with 2,501 fish. Meanwhile, the smallest number of catches was in the 90-100 weight range, with two fish. Therefore, the average weight per catch was 51.40 kg. Based on Table 5, it can be seen that most of the Yellowfin Tuna (*Thunnus albacares*) in the Bungus Ocean Fishing Port in 2025 are in the weight range of 31-40 with a total of 2634 fish and a weight range of 41-50 with a total of 2560 fish. Meanwhile, fish with a range of 90-100 are no longer present in 2025. So, if averaged, the average weight of fish per fish caught in 2025 is 37.28. In 2025, there was a decrease in the average weight per fish caught which is feared to cause overfishing due to quite high fishing pressure. This data is in line with the analysis of the utilization level of Yellowfin Tuna Fish Resources.

CONCLUSION

We would like to express our gratitude to all staff and crew at the Bungus Oceanic Fisheries Port for their support, cooperation, and assistance throughout the research process. We extend our deepest appreciation for the facilitation of data access, field assistance, and technical and administrative support that significantly facilitated the smooth data collection and research process. The contributions of all parties at the Bungus Oceanic Fisheries Port played a crucial role in the success of this research.

ACKNOWLEDGEMENT

The author would like to thank the rain managers of the Pattimura Ambon Meteorological Station and the Maluku Climatology Station who have facilitated the data so that this research can be carried out well.

REFERENCES

Aryani. N. T., Yusrudin., Sumaryam. (2025). Tingkat Pemanfaatan Ikan Tuna (*Thunnus albacares*) di WPP-NRI 573 yang Didaratkan di Pelabuhan Perikanan Samudera. *Jurnal Ilmiah Perikanan dan Peternakan*, 3(1), 305-321

Atmaja, S. B., Sadhotomo, B., & Nugroho, D. (2011). Overfishing pada perikanan pukat cincin semi industri di Laut Jawa dan implikasi pengelolaannya. *Jurnal Kebijakan Perikanan Indonesia*, 3(1), 51–60.

Elleby, C., Pérez Domínguez, I., Nielsen, R., Nielsen, M., & Hoff, A. (2025). Introducing maximum sustainable yield targets in fisheries could enhance global food security. *Communications Earth & Environment*, *6*(1),1-12

FAO. (2001). Report of the Second Technical Consultation on the Suitability of the CITES Criteria for Listing Commercially-exploited Aquatic Species. FAO Fisheries Report No. 667.

FAO. (2011). Review of the state of world marine fishery resources. Food and Agriculture Organization of the United Nations.

Hampton, J., Sibert, J. R., Kleiber, P., Maunder, M. N., & Harley, S. J. (2005). Decline of Pacific tuna populations exaggerated? Nature, 434(7037), 280–283.

Hilborn, R., & Walters, C. J. (1992). Quantitative fisheries stock assessment: Choice, dynamics and uncertainty. New York: Chapman and Hall.

Jamilah & Mawardati. (2018). Minapolitan Perikanan Tangkap dan Kemiskinan Rumah Tangga Nelayan. Repository Universitas Malikussaleh. Diakses dari repository.unimal.ac.id

King, M. (2007). Fisheries biology, assessment and management (2nd ed.). Oxford: Wiley-Blackwell.

Masrizal, M., & Naufal, A. (2019). Tingkat Degradasi dan Depresiasi Ikan Tuna Madidihang di Pesisir Utara Aceh -UNAYA. *Prosiding SEMDI UDAYANA*, 6(1), 141–150.

Maunder, M. N., Sibert, J. R., Fonteneau, A., Hampton, J., Kleiber, P., & Harley, S. J. (2006). Interpreting catch per unit effort data to assess the status of individual stocks and communities. *ICES Journal of Marine Science*, 63(8), 1373–1385.

Prajneshu, S. (2003). A method for fitting of nonlinear Fox model in fisheries. *Indian Journal of Animal Sciences*, 73(3), 329–331.

Primyastanto, M., Lestariadi, R. A., & Haris, A. K. (2021). Sustainable operational analysis of the cultivation of Indonesian Thunnus albacares by bioeconomic approach. Ribarstvo, Croatian Journal of Fisheries, 79(2), 61–70.

Purwanti, P., Sofiati, D., Intyas, C. A., Fattah, M., Qurrata, V. A., & Saputra, J. (2024). Assessment of the resource's sustainability using resource utilisation and catch projection approach: case of prigi gulf indonesia. *Journal of Sustainability Science and Management*, 19(7), 57-69

Rahmah, A., Mardhatillah, I., Damora, A., Muhammad, M., & Nurfadillah, N. (2021a). Application of Surplus Production Model to the Yellowfin Tuna Thunnus albacares in the northern and western parts of Aceh waters. *IOP Conference Series: Earth and Environmental Science*, 869(1), 1–9.

Rouf, M. A., Shahriar, S. I. M., Rahman, H., Hasan, M., Antu, A. H., & Siddiqui, N. (2021). Maximum Sustainable Yield for the Passur river fishery of Bangladesh by using Surplus-production model. *Bangladesh Journal of Zoology*, 48(2), 301–312.

Schaefer, K. M., & Fuller, D. W. (2022). Spatiotemporal variability in the reproductive biology of yellowfin tuna (*Thunnus albacares*) in the eastern Pacific Ocean. *Fisheries Research*, 248, 1-10.

Schaefer, M. B. (1954). Some aspects of the dynamics of populations important to the management of commercial marine fisheries. *Inter-American Tropical Tuna Commission Bulletin*, 1(2), 27–56.

Sparre, P., & Venema, S. C. (1998). Introduction to tropical fish stock assessment. Part 1: Manual. FAO Fisheries Technical Paper No. 306/1 Rev. 2. Rome: FAO.

Sun, C. L., Yeh, S. Z., & Su, N. J. (2013). Modelling the habitat preference of yellowfin tuna with environmental variables. *Fisheries Oceanography*, 22(5), 404–416.

Wiryawan, B., Loneragan, N., Mardhiah, U., Kleinertz, S., Wahyuningrum, P. I., Pingkan, J., Wildan, Timur, P. S., Duggan, D., & Yulianto, I. (2020). Catch per unit effort dynamic of yellowfin tuna related to sea surface temperature and chlorophyll in Southern Indonesia. *Fishes*, 5(3), 1–16.