

## Data-Driven Approach: A Critical Analysis of Biological, Ecological and Economic Trends in Muara Kintap's Ponyfish Fishery

Ahmadi<sup>1</sup>, Sara F. Ghanem<sup>2\*</sup>

<sup>1</sup>Faculty of Fisheries and Marine Science, Lambung Mangkurat University Banjarbaru, South Kalimantan, Indonesia

<sup>2</sup>National Institute of Oceanography and Fisheries, NIOF, Egypt

\*Corresponding Author: [saraghanem16@gmail.com](mailto:saraghanem16@gmail.com)

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### ABSTRACT

This study analyzed the catch of the ponyfish (*Leiognathus equulus*) landed at Muara Kintap Fishing Port in South Kalimantan, Indonesia. Local fishermen used various gear types especially bottom trawls, beach seines, drift gillnets, and encircling gillnets within Indonesia's Fisheries Management Area (FMA) 712. While bottom trawls displayed the highest efficiency, peaking at 65,956kg, representing 98.26% of the annual total catch. Moreover, they also indicated potential overfishing, particularly in 2022. The ponyfish catches were dominated by individuals measuring between 130- 134mm and weighing 35- 39g. Length-weight relationship data revealed an isometric growth pattern ( $b = 2.98$ ) for the ponyfish, suggesting good overall health ( $K = 1.68 \pm 0.17$ ). However, CPUE (Catch per Unit Effort) data from 2022 raised concerns. The peak CPUE of 89.13kg/ trip, alongside a substantial total catch of 67,122kg across 753.1 trips, significantly surpassed the catch-maximum sustainable yield ( $C_{MSY}$ ) of 28,748kg/ trip and the optimal effort ( $F_{opt}$ ) of 882 trips/year. This suggests overfishing and a potential decline in the ponyfish stock by 2023, representing a substantial loss of USD 3,934. Monthly catch data for 2022 further supported this, highlighting a fishing season from August to October, peaking in October (16,376kg) and continuing into December. To ensure the sustainability of the ponyfish population and fish processing industry, the fishing port authority should prioritize addressing the impact of overfishing practices, particularly trawling. Furthermore, continuous monitoring efforts are crucial to establish data-driven fisheries management practices.

### INTRODUCTION

The Muara Kintap Fishing Port serves as one of the key landing sites for both pelagic and demersal fish in South Kalimantan Province. This port holds significant strategic importance due to its proximity to fishing grounds, facilitating easy access for fishermen to venture out to sea. Among the variety of fish landed at this port is the ponyfish (*Leiognathus equulus*), locally called 'Peperek, Pepetek or Petek', belonging to the Leiognathidae family, which is a demersal species valued for its economic

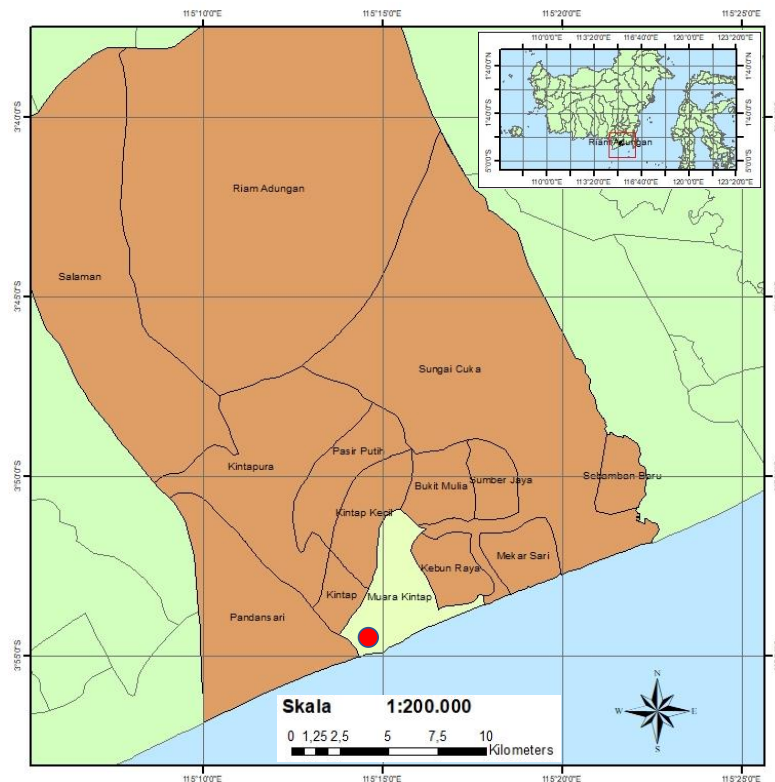
importance and affordable price, catering to all segments of society. They are commonly sold fresh or as dried salted fish. The ponyfish (*Leiognathus equulus*) are first utilized as bait or livestock feed (Sarjana *et al.*, 2001) and are later processed into crispy fried fish (Rosita *et al.*, 2018). Various active and passive fishing gears are employed by fishermen to catch the ponyfish, including fixed lift nets, floating lift nets, seine nets, boat seine, Danish seine, beach net, rampus net, and purse seine (Permatachani *et al.*, 2016; Yusfiandayani *et al.*, 2023).

The ponyfish are typically found in large schools at depths of 40- 60m. They have a flattened and broad body shape with a silvery-white coloration. Moreover, they have high fecundity, with a range of 4,880 and 13,650 eggs and varying egg diameters (0.1 - 0.814mm), contributing to its reproductive success and population dynamics. The ponyfish are considered a typical partial spawner, with a relatively short lifespan and small size, leading to rapid growth and recruitment rates (Sharif *et al.*, 2018). In several areas in Indonesia, such as the Banten Strait and Sunda Strait, utilization rate of the ponyfish can be considered to be in an over-exploited condition (Permatachani *et al.*, 2016; Yusfiandayani *et al.*, 2023). The exploitation rate of the common ponyfish has surpassed the optimum level. Uncontrolled fishing efforts have led to an annual increase in fishing efforts for the ponyfish, but the catch has been declining. Continuous harvesting will lead to further depletion of fisheries resources. Therefore, it is necessary to implement fishing effort restrictions while considering the sustainable catch obtained from fisheries resources. According to Dahuri and Nugroho (2012), there are four indicators of overfishing conditions for a fishery resource stock: (1) the total volume of catch exceeds the maximum sustainable yield (MSY) of the fishery resource, (2) the catch tends to decrease, (3) the average size of caught fish decreases, and (4) fishing areas move further away from the coast or deeper towards the seabed. Therefore, it is recommended to maintain demersal fishing efforts with strict monitoring.

Apart from its economic significance, ponyfish also play a crucial role ecologically. Serving as prey for carnivorous fish, their population dynamics significantly influence the food chain within the ecosystem. A decline in the ponyfish population can indirectly lead to a decrease in predator fish populations as well. Additionally, the ponyfish serve as indicator species in aquatic environments; their frequent and abundant presence can signal overfishing in the area (Sharif *et al.*, 2018). Beyond economic and ecological considerations, the biological aspects of the ponyfish deserve attention as part of efforts toward sustainable fisheries management. Currently, research primarily focuses on growth patterns, condition factors, annual catch (CPUE and MSY), and the utilization rate of the ponyfish population in FMA 712.

## MATERIALS AND METHODS

The study was conducted in Muara Kintap Village, South Kalimantan Province (Fig. 1), situated at coordinates 03°00'45" S and 115°25'02" E, as determined by the GPS-60 Garmin, Taiwan. The ponyfish landed at Muara Kintap Coastal Fishing Port, were captured by local fishermen using bottom trawls, beach seines, drift gillnets, and encircling gillnets within Indonesia's Fisheries Management Area (FMA) 712. A total of 138 individuals of the ponyfish with varying sizes  $133.25 \pm 6.89$  mm (TL), and  $40.09 \pm 7.31$  (g) were examined.



**Fig. 1.** The map showing the location of Muara Kintap Fishing Port in Indonesia

According to **Kühlmorgan-Hille (1974)**, ponyfish are demersal species with flattened bodies, typically small, with lengths usually not exceeding 150mm. They have a silvery coloration with irregular yellow vermiculation on the dorsal side extending to the middle of the dorsal fin, colorless pectoral fins, black membrane on the dorsal fin, and yellow anterior anal fins, often featuring a nuchal spine on the nape. **Pauly (1977)** highlighted that ponyfish possess a distinctive characteristic of emitting silvery white light, commonly referred to as bioluminescence. They have gill filter bones on the first gill arch numbering between 45 and 51. The dorsal fin spines consist of 8 hard rays and 15- 17 soft rays. The anal fin spines comprise 3 hard rays and 13- 14 soft rays. Pectoral fins typically have 16- 17 soft rays.

Fish samples were categorized by sex and measured for total length (TL) and weight (W). Total length was measured from the tip of the snout to the extended tip of the caudal fin, using a ruler to the nearest mm, while the whole-body weight was determined with a digital scale accurate to 0.01g (CE, SF-400, China). Ratios of W/TL and BD/TL were determined using non-dimensional numbers based on empirical methods. The size distribution of the fish sampled was classified into 10-interval classes for length and weight.

### 1-Length-weight relationship

The length-weight relationship (LWR) of fish was expressed using the following equation (Froese, 2006):

$$W = aL^b$$

Where,  $W$  is the total weight (g),  $L$  is the total length (mm),  $a$  is the constant showing the initial growth index and  $b$  is the slope representing the growth coefficient. The  $b$  exponent is used to describe a fish's growth pattern and typically ranges between 2.5 and 3.5 (Bagenal, 1978). The statistical significance of the isometric exponent ( $b$ ) was analyzed using a function proposed by Pauly (1984):

$$t = \left( \frac{SD(x)}{SD(y)} \right) \left( \frac{|b-3|}{\sqrt{1-R^2}} \right) (\sqrt{n-2})$$

Where,  $t$  is the  $t$ -value from the student  $t$ -test,  $SD(x)$  is the standard deviation of  $\log L$ ,  $SD(y)$  is the standard deviation of  $\log W$ ,  $b$  is the slope of the curve,  $R^2$  is the coefficient of determination, and  $n$  is the number of samples. The  $t$ -value was then compared with the  $t$ -table value (0.05) for degrees of freedom at a 95% significance level. If the  $t$ -value was less than the  $t$ -table value, the fish exhibited an isometric growth ( $b = 3$ ), meaning that the length-weight relationship retains the same shape. If the  $t$ -value was greater than the  $t$ -table value, the fish exhibited an allometric growth ( $b \neq 3$ ). If weight increased more than length ( $b > 3$ ), it indicated a positive allometric growth. Conversely, if length increased more than weight ( $b < 3$ ), it indicated a negative allometric growth. The coefficient of determination ( $R^2$ ) and the regression coefficient ( $r$ ) of morphological variables between the sexes were also calculated.

### 2- Condition factor

The condition factor ( $K$ ) of the fish was assessed using the formula provided by Weatherley and Gill (1987):

$$K = 100(W/L^3)$$

Where,  $K$  is the Fulton's condition factor;  $L$  is the total length (cm), and  $W$  is the weight (g). The factor of 100 is used to bring  $K$  close to a value of one. The  $K$  value was used to

estimate the health condition of fish across different sexes, seasons, and localities. The relative condition factor (Kn) was further estimated using **Le Cren's (1951)** formula:

$$Kn = W/^W$$

Where, Kn is the relative condition factor, reflecting the 'condition,' 'fatness,' or well-being of the fish; W is the observed weight, and ^W is the calculated weight derived from the length-weight relationship. A Kn value less than one indicates that the fish is not in good condition, whereas a Kn value greater than one indicates that the fish is in good condition.

### **3- CPUE and MSY**

CPUE is a metric used to assess fishing efficiency. It's calculated as the total catch divided by the number of fishing trips (**Gulland, 1983**).

$$CPUE = \frac{C}{f}$$

A higher CPUE suggests more efficient fishing or a higher abundance of fish, while a lower CPUE indicates less efficiency or lower fish availability. Due to the varying catching abilities of different fishing gears, standardization is essential before assessing fishing power. The fishing gear with the highest CPUE serves as the standard gear for determining the fishing power index (FPI) for each gear type. To calculate the standard effort (trip), the FPI value is multiplied by the corresponding fishing effort. Whereas standard CPUE (kg/trip) was obtained by dividing the catch number by standard effort. Standard CPUE provides a more accurate picture of fishing efficiency by removing the influence of external factors and allowing for a more precise comparison of catch rates across different periods or fishing practices.

By employing a simple regression analysis on the available time series data, the intercept (a) and the slope (b) values were determined to estimate the catch-maximum sustainable yield (C<sub>MSY</sub>) and optimal fishing effort (F<sub>opt</sub>) levels within the framework of the Surplus Production Model (**Schaefer, 1957**).

$$y = a - bx$$

The parameters *a* and *b* values were calculated using the following formulas:

$$a = \sum \frac{Xi}{n} - \sum \frac{Yi}{n} \quad \text{and} \quad b = \frac{\sum((xi)(yi)) - (\sum yi)}{n.(\sum xi)^2 - (\sum yi)^2}$$

while, C<sub>MSY</sub> and F<sub>opt</sub> were estimated using these formulas:

$$C_{MSY} = -\frac{a^2}{4b} \quad \text{and} \quad F_{opt} = -\frac{a}{2b}$$

Where,  $y$  is the CPUE (kg/trip),  $x$  is fishing effort (trip),  $a$  is the intercept,  $b$  is slope of the curve,  $C_{MSY}$  is catch-maximum sustainable yield and  $F_{opt}$  is optimal fishing effort.

#### 4- Utilization rate of fishery resources

The Indonesian **National Commission of Marine Fish Stock Assessment (1998)** defined four levels of fishery resource utilization as follows:

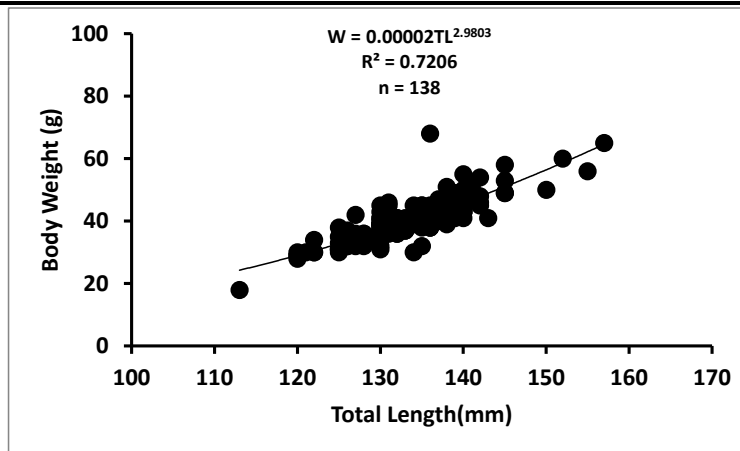
1. Low level: when the catch is still far below the potential MSY level (0-33.3%), indicating that fishing efforts need to be increased.
2. Moderate level: when the catch has become a significant portion of the potential MSY (33.3- 66.6%), but the addition of effort can still be done to optimize the yield.
3. Optimal level: when the catch has reached a portion of the MSY level (66.6- 99.9%) and further effort cannot increase the yield.
4. Overfishing level: when the catch has exceeded the MSY level (>100%) and further effort could jeopardize the sustainability of fishery resources.

## RESULTS AND DISCUSSION

### 1- Growth pattern

The body shape of the ponyfish exhibited an isometric growth pattern ( $b = 2.98$ ), indicating that their length and body weight increased proportionally. The estimated  $t$ -value for the  $b$  exponent was found to be less than the  $t$ -table value. The length-weight relationship for the ponyfish was expressed as  $W = 0.00002TL^{2.9803}$  (Fig. 2). The  $R^2$  value obtained was 0.7206, indicating that more than 72% of the variability in weight was explained by length. The length-weight relationship was positively correlated ( $r = 0.8489$ ). The estimated ratio of weight to total length ranged from 0.16 to 0.41, with a mean of  $0.30 \pm 0.04$ . A similar isometric growth pattern was also observed in *Eublekeeria splendens* (Fadillah, 2015). In contrast, *Leiognathus klunzingeri* and *Leiognathus splendens* exhibited a positive allometric growth (Sangun *et al.*, 2007; Simanjuntak, 2010), while *Leiognathus* sp. and *Leiognathus equulus* were reported to have a negative growth pattern (Hazrina, 2010; Permatachani *et al.*, 2016) (Table 1).

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**Fig. 2.** The relationship between length and weight in the ponyfish suggests an isometric growth. Their bodies maintain a balanced proportion as they grow, potentially indicating a healthy population

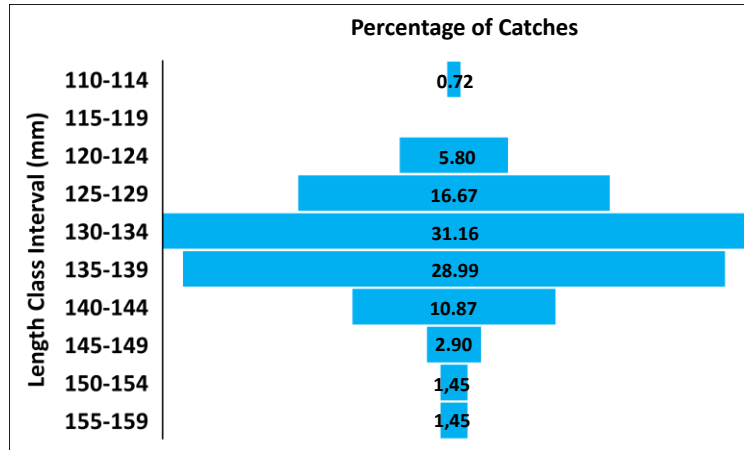
**Table 1.** Comparative growth pattern of the ponyfish species from different geographical areas

Species	Sex	b	Growth pattern	Location	Reference
<i>Leiognathus equulus</i>	-	2.98	I	Muara Kintap	Present study
<i>Leiognathus equulus</i>	M	2.24	A-	Labuan, Banten	Permatachani <i>et al.</i> (2016)
	F	2.06	A-	Labuan, Banten	
<i>Eublekeeria splendens</i>	M	3.01	I	Labuan, Banten	Fadillah (2015)
	F	2.99	I		
<i>Leiognathus splendens</i>	-	3.12	A+	Labuan, Banten	Simanjuntak (2010)
<i>Leiognathus</i> sp.	-	2.83	A-	Palabuhan Ratu	Hazrina (2010)
<i>Leiognathus klunzingeri</i>	-	3.22	A+	North-Eastern Mediterranean	Sangun <i>et al.</i> (2007)

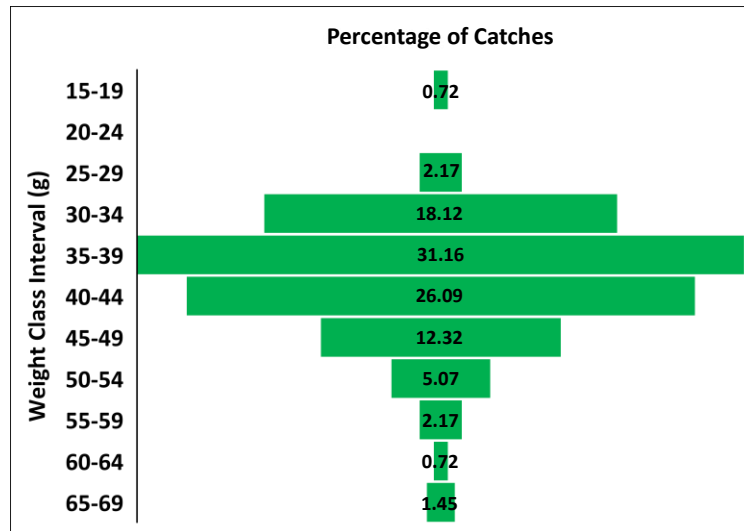
Noted: b = slope, I = isometric, A- = negative allometric, A+ = positive allometric.

The ponyfish observed in this study were primarily distributed within the middle size class. The majority of individuals were caught between 130 and 134mm (TL), comprising approximately 31.16% of the total catch (Fig. 3). This was followed by fish

measuring 135- 139mm (28.99%) and 125- 129mm (16.67%). Less than 10% of the catch consisted of smaller individuals (<12 mm) or larger individuals (>145mm). In terms of weight, the highest percentage of catch was between 35 and 39g, representing about 31.16% of the total catch, followed by fish weighing 40- 44g (26.09%) and 30- 34g (18.12%) (Fig. 4).



**Fig. 3.** The distribution of the ponyfish lengths across various size categories



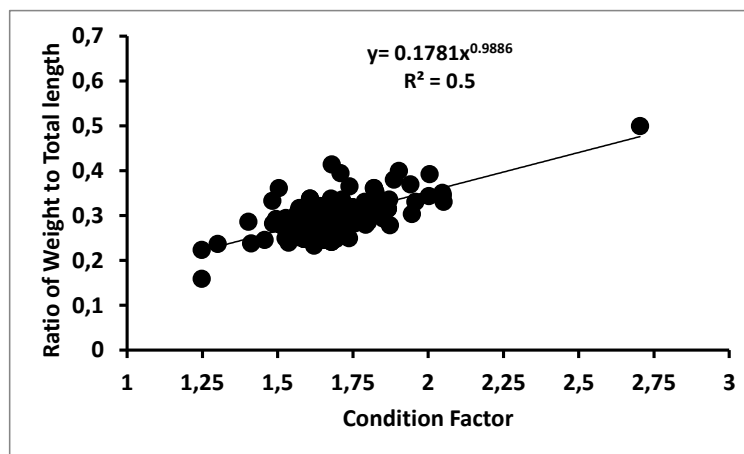
**Fig. 4.** Breakdown of the ponyfish weights to show the distribution of fish sampled across different length sizes



## 2- Condition factor

Based on our calculations, the mean value of Fulton's condition factor ( $1.68 \pm 0.17$ ) was significantly higher than the relative condition factor ( $0.93 \pm 0.09$ ), indicating that the fish were in good health. **Le Cren (1951)** recommended using the relative condition factor (Kn) over Fulton's condition factor (K), as Kn accounts for variations related to food, feeding, and sexual maturity, while K only does this if the exponent value is equal to 3, as we found. Thus, the K factor measures deviations from an ideal fish that follows the cube law, whereas Kn measures individual deviations from the expected weight based on the length-weight relationship. **Stevenson and Woods (2006)** noted that the morphometric condition factor actually measures a fish's shape, such as girth, rather than directly assessing fat reserves. This relative condition factor is widely used as it reflects fish growth and environmental suitability (**Manorama & Ramanujam, 2014; Aditriawan & Runtuboy, 2017; Fadel et al., 2024**).

The relative condition factor of the common ponyfish in Pabean Bay Indramayu of West Java ranged from 0.67 to 1.42, aligning with our study. Fluctuations in the condition factor of fish are likely caused by several factors, including gonadal maturity, spawning season, food availability, and environmental factors (**Novitriana et al., 2004; Sarkar et al., 2013; Prihatiningsih et al., 2014; Abdelmeguid et al., 2024**). Additionally, the relationship between the condition factor and the ratio of body weight to total length is expressed as  $W/TL = 0.1781K^{0.9886}$  (Fig. 5). An increase in the K value corresponds to a higher W/TL ratio, indicating a healthier condition of the fish.



**Fig. 5.** The ponyfish's condition factor based on weight-to-length ratio

The ponyfish catch in Muara Kintap is available year-round due to favorable water conditions, which include abundant mangrove forests and estuaries that support their growth and survival. Similar conditions are found in the waters of Palabuhanratu Bay and Banten Bay (**Sharif et al., 2018; Yusfiandayani et al., 2023**). Despite the naturally high growth and recruitment rate of the ponyfish, it is recommended that the

utilization rate should not exceed the growth coefficient (K) of 0.3 per year and the optimum exploitation rate of 0.5 per year (Gulland, 1983; Froese *et al.*, 2000). This precaution is necessary to prevent growth overfishing, as has occurred to the ponyfish in the Sunda Strait (Permatachani *et al.*, 2016). Therefore, it is essential to implement fishing restrictions and regulate fishing areas.

### 3- Annual catch

Table (2) presents a comprehensive overview of the annual ponyfish catch data from 2019 to 2023, highlighting the contributions of various fishing gears and boat sizes to the total catch at Muara Kintap Fishing Port. The bottom trawl method, particularly with < 5 GT boats, appears to have consistently high catch volumes, especially in 2022 with a significant spike to 61,038kg or about 92.5% of the total catch. This indicates that smaller trawlers are heavily utilized and are highly effective in capturing the ponyfish schooling that inhabits coastal waters. On the other hand, the 5 - 10 GT trawlers have a relatively lower contribution, with only 4,918kg, and none of fish were caught by 10- 20 GT, indicating that larger trawlers may not be as effective or are less frequently used for this type of fishing method. Due to the schooling behavior of fish near the shore, using beach seine methods with boats under 5 GT is more effective than larger ones with wider fishing areas, despite the catch volumes being significantly lower than those of the bottom trawls.

Unlike drift gillnets, the catch volume of encircling gillnets increased proportionally with the number of trips. This is ascribed to the encircling gillnets that can be quickly adjusted and redeployed based on the movement and behavior of fish schools, optimizing catch volume. Fishermen can also use encircling gillnets in various water conditions and depths, making them versatile and effective in different fishing environments.

In 2022, the standardized CPUE reached its peak at 89.13kg/ trip, with a substantial total catch of 67,122kg and 753.1 trips (Table 3). This year represents the highest fishing efficiency and catch volume, suggesting exceptionally favorable conditions for the ponyfish. Meanwhile, in 2023, the CPUE drastically dropped to 0.16kg/ trip, with only 66kg caught over 417.4 trips. The sharp decline in CPUE in 2023 is concerning. It is crucial to investigate the causes, which could include overfishing, environmental changes, or shifts in fish population dynamics. Implementing measures to address these issues is vital for sustainable fishing practices. The exceptionally high CPUE in 2020 and 2022 needs further investigation. Understanding the specific conditions, fishing methods, or environmental factors that led to such high efficiencies could provide valuable insights for future fishing strategies. The significant variations in CPUE across the years suggest the need for an adaptive management approach. Regularly updating management strategies based on the latest data and trends can help in

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responding effectively to changes in fish populations and environmental conditions. Moreover, improved and more detailed data collection, including monthly or seasonal catch data, can help in better understanding the factors influencing CPUE and fish population dynamics. This can lead to more informed decision-making and better management of the ponyfish fishery.

**Table 2.** Descriptive statistic of annual catch data for the Ponyfish that landed in Muara Kintap Fishing Port based on type of fishing gears and the sizes of fishing boats

Type of fishing gears	Fishing boat	2019			2020			2021			2022			2023		
		No.of trips	Vol (kg)	Value (USD)	No.of trips	Vol (kg)	Value (USD)	No.of trips	Vol (kg)	Value (USD)	No.of trips	Vol (kg)	Value (USD)	No.of trips	Vol (kg)	Value (USD)
Bottom trawl	< 5 GT	739	7,204	508	19	1,570	97	606	6,712	425	483	61,038	3,556	165	11	2
	5 - 10 GT	-	-	-	-	-	-	-	-	-	257	4,918	319	69	26	3
	10-20 GT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Sub Total</b>		<b>739</b>	<b>7,204</b>	<b>508</b>	<b>19</b>	<b>1,570</b>	<b>97</b>	<b>606</b>	<b>6,712</b>	<b>425</b>	<b>740</b>	<b>65,956</b>	<b>3,875</b>	<b>234</b>	<b>37</b>	<b>5</b>
Beach seine	< 5 GT	29	1,992	123	-	-	-	26	252	16	15	1,141	67	-	-	-
	5 - 10 GT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-20 GT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Sub Total</b>		<b>29</b>	<b>1,992</b>	<b>123</b>				<b>26</b>	<b>252</b>	<b>16</b>	<b>15</b>	<b>1,141</b>	<b>67</b>	<b>-</b>	<b>-</b>	<b>-</b>
Drift gillnet	< 5 GT	-	-	-	-	-	-	327	90	6	-	-	-	-	-	-
	5 - 10 GT	-	-	-	-	-	-	-	-	-	301	25	2	207	9	2
	10-20 GT	-	-	-	-	-	-	-	-	-	-	-	-	145	20	2
<b>Sub Total</b>		<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>327</b>	<b>90</b>	<b>6</b>	<b>301</b>	<b>25</b>	<b>2</b>	<b>352</b>	<b>29</b>	<b>5</b>
Encircling gillnet	< 5 GT	-	-	-	-	-	-	219	280	17	-	-	-	-	-	-
	5 - 10 GT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10-20 GT	-	-	-	-	-	-	189	280	17	-	-	-	-	-	-
<b>Sub Total</b>		<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>408</b>	<b>560</b>	<b>35</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
Overall	< 5 GT	768	9,196	631	19	1,570	97	1,178	7,334	463	486	62,179	3,623	165	11	2
	5 - 10 GT	-	-	-	-	-	-	-	-	-	558	4,943	321	276	35	5
	10-20 GT	-	-	-	-	-	-	189	280	17	-	-	-	145	20	2
<b>Total</b>		<b>768</b>	<b>9,196</b>	<b>631</b>	<b>19</b>	<b>1,570</b>	<b>97</b>	<b>1,367</b>	<b>7,614</b>	<b>481</b>	<b>1,044</b>	<b>67,122</b>	<b>3,944</b>	<b>586</b>	<b>66</b>	<b>10</b>

**Table 3.** The annual standardized CPUE of Ponyfish landed in Muara Kintap Fishing Port

Year	Catch volume (kg)	Standardized effort (trip)	Standardized CPUE (kg/trip)
2019	9,196	133.9	68.69
2020	1,570	19.0	82.63
2021	7,614	687.4	11.08
2022	67,122	753.1	89.13
2023	66	417.4	0.16

#### 4- Utilization rate

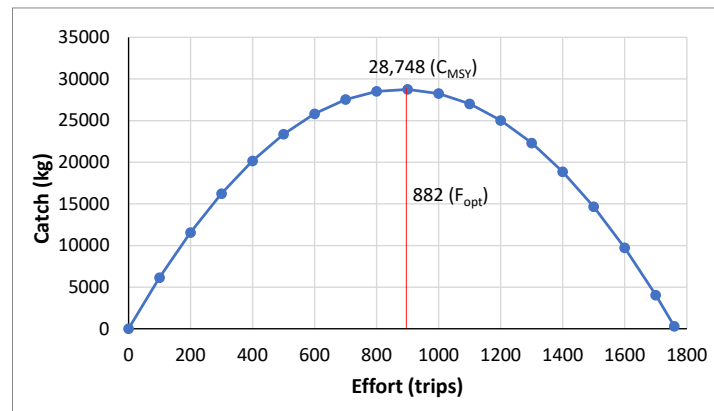
The concept of fishery resource utilization rate is crucial for sustainable fisheries management. By assessing the current utilization rate, fisheries managers can determine whether fishing efforts are appropriate, excessive, or insufficient. This information is essential for implementing effective management strategies to ensure the long-term viability of fish stocks and the health of marine ecosystems. The utilization rate can be calculated by comparing the actual catch to the  $C_{MSY}$ . Given that the  $C_{MSY}$  level was 28,748kg/ trip (Table 4), we can calculate the utilization rate for each year and gear type. For example, the trawls showed the highest fishing efficiency among fishing gears used, especially in 2022, but it also indicates potential overfishing given utilization rate that exceeds 100%. In contrast, the ponyfish utilization rate in 2023 was extremely lower as compared to the previous year.

**Table 4.** The annual utilization rate (%) and fishing status of the ponyfish that was caught by various fishing gears operating at 712 fishing area

Year	Catch (kg)	Utilization rate (%)	$C_{MSY}$ (kg/trip)	Fishing status <sup>^</sup>
2019	9,196	31.99	28,748	Moderate
2020	1,570	5.46	28,748	Low
2021	7,614	26.49	28,748	Moderate
2022	67,122	233.48	28,748	Overfishing
2023	66	0.23	28,748	Low

<sup>^</sup> Refer to the **National Commission of Marine Fish Stock Assessment (1998)**.

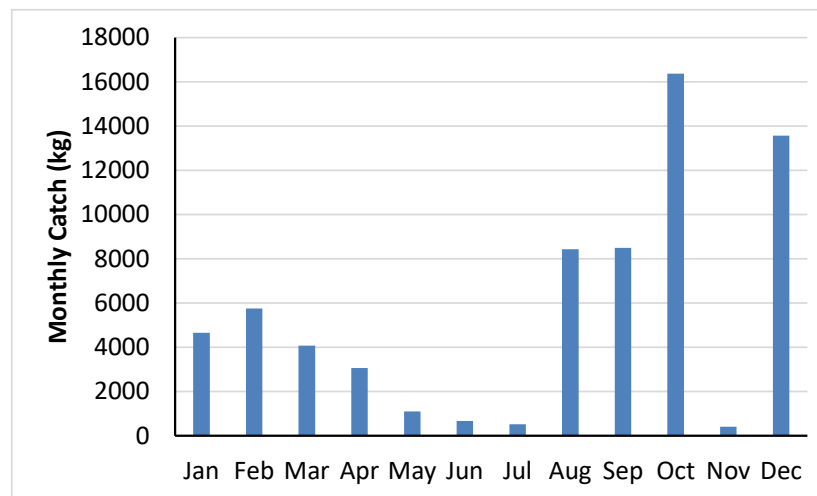
Fig. (6) illustrates the relationship between the actual catch and fishing effort of the ponyfish, aiming to show the  $C_{MSY}$  level, which is the maximum catch that can be sustainably harvested. 28,748kg/ trip indicates the theoretical  $C_{MSY}$  based on standardized catch and effort data with the intercept (a) = 65.1965 and the slope (b) = -0.0369 of the Schaefer model. The annual data points are plotted to visualize how close or far the actual catches are from the  $C_{MSY}$ . The catch levels in 2019 and 2021 were moderate with the utilization rates of 31.99 and 26.49%, respectively, indicating sustainable fishing practices within the  $C_{MSY}$  range. Despite low overall catch in 2020, the high CPUE suggests efficient fishing but with limited effort (Table 3). Catch in 2022 significantly surpassed the  $C_{MSY}$  level, suggesting an overfishing and a potential decline in the ponyfish stock. Although the actual fishing effort (753.1 trips) in 2022 was less than the recommended  $F_{opt}$  level of 882 trips/year, it still raising concerns about potential overfishing. This decline is evidenced by the sharp decrease in catch volume observed in 2023, which fell considerably below the recommended level.



**Fig. 6.** The relationship between the actual catch and fishing effort to determine the recommended  $C_{MSY}$  and  $F_{opt}$  levels for the ponyfish population

Overfishing can reduce the reproductive capacity, leading to fewer offspring in subsequent years. It can also disrupt predator-prey relationships, leading to imbalances that affect other species, including those that prey on or compete with the ponyfish. Continued low catches can lead to reduced income for fishermen and fish processing industries. These impacts of overfishing practices have been widely reported in the previous studies (Colloca *et al.*, 2017; Ding *et al.*, 2017; Sumaila & Tai, 2020). It is necessary to implement stricter regulations and sustainable fishing practices, particularly for trawls that show high efficiency but risk overfishing, possibly through temporary fishing bans during critical breeding seasons to protect spawning stock or reduced quotas to prevent further depletion and allow the population to recover. Empowering local fishing communities through data collection, ecosystem research, and shared decision-making will also promote compliance and encourage sustainable fishing practices.

Fig. (7) illustrates the monthly catch of the ponyfish landed in Muara Kintap Fishing Port in 2022. These data suggest a potential occurrence of overfishing, resulting in a significant decline in catch numbers in 2023. Throughout 2022, the catch numbers seem to fluctuate; the catches were relatively low from January to July. The ponyfish fishing seasons runs from August to October, peaking in October (16,376kg) and continuing in December. Several factors might influence the catch numbers: (a) environmental factors: water temperature, salinity, and currents can affect the ponyfish distribution and abundance. These factors fluctuate throughout the year, impacting fish availability in fishing grounds; (b) The fishing effort comprising the number of fishing vessels, fishing gear used, and fishing duration directly affect catch numbers; (c) market demand: fishermen may adjust their efforts based on market demand, especially from fish processing industries.

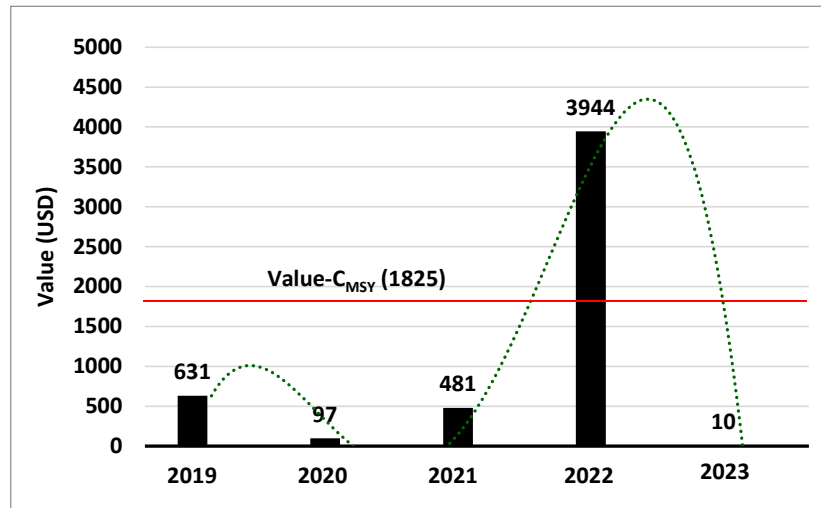


**Fig. 7.** The monthly catch of the ponyfish that landed in Muara Kintap Fishing Port

The economic value of the ponyfish landings at Muara Kintap Fishing Port in 2022 exhibited a dramatic surge of 719.96% compared to 2021 (Fig. 8). This significant increase, reaching USD 3,944 from USD 481, exceeded the estimated value at the catch-maximum sustainable yield (C<sub>MSY</sub>) by 116.11% (USD 1825). However, this trend proved unsustainable, as the value in 2023 witnessed a precipitous decline of 99.75%, dropping to a mere USD 10. This represents a substantial loss of USD 3,934 compared to the previous year.

To ensure the long-term sustainability of the ponyfish fishery at Muara Kintap Fishing Port and prevent the economic instability highlighted earlier, several solutions can be considered: (a) Establish catch quotas based on the recommended maximum sustainable yield (MSY) to prevent overfishing and ensure long-term economic viability;

(b) Strengthen monitoring efforts to track catch data and ensure compliance with regulations; (c) Explore alternative fishing gear or techniques that minimize pressure on the ponyfish population while maintaining economic benefits for fishers; (d) Investigate ways for fishers to supplement their income by engaging in other sustainable fishing activities.



**Fig. 8.** Economic value of the ponyfish landed at Muara Kintap Fishing Port

## CONCLUSION

While length-weight and condition factor analysis indicate the current healthy ponyfish populations, an immediate action is needed to prevent any ecological collapse and economic losses for the fishing community. Fishing port authority should prioritize addressing the impact of overfishing practices, particularly trawling. Continuous monitoring is crucial to establish data-driven fisheries management practices. This would ensure the sustainability of the ponyfish stocks and the long-term profitability of fish processing industries.

## REFERENCES

- Abdelmeguid, N.E.; Ghanem, S.F.; Assem, S.S.; Abou Shabana, N.M.; Ismail, R.F. and Sultan, A.S.** (2024). Ameliorative effects of Chitosan in water remediation, endocrine disruption and reproductive impairment of *Solea solea* after exposure to Benzo (a) pyrene. *Inter. Aqua. Res.* 16(1): 71-90. <https://doi.org/10.22034/IAR.2024.2005296.1584>
- Aditriawan, R. and Runtuboy, N.** (2017). Length-weight relationship and condition factor of common ponyfish, *Leiognathus equulus* (Forsskål, 1775) in Pabean Bay, Indramayu, West Java. *J. Iktiologi Indonesia*, 17(3):311-316.
- Bagenal, T.** (1978). *Methods for assessment of fish production in fresh waters*-3.



- Colloca, F.; Scarcella, G. and Libralato, S. (2017).** Recent trends and impacts of fisheries exploitation on Mediterranean stocks and ecosystems. *Front. Mari. Sci.* 4: 244. DOI: 10.3389/fmars.2017.00244
- Dahuri, R. and Nugroho, I. (2012).** Pembangunan Wilayah: Perspektif Ekonomi, Sosial dan Lingkungan, LP3ES. Jakarta.
- Ding, Q.; Chen, X.; Chen, Y. and Tian, S. (2017).** Estimation of catch losses resulting from overexploitation in the global marine fisheries. *Acta Ocean. Sinica* 36(12):37-44. DOI: 10.1007/s13131-017-1096-x
- Fadel, K.A.; El-Sayed, H.S.; Barakat, K.M.; El-Bermawi, N.; Massoud, R.G.; Abouelkheir, S.S. and Ghanem, S.F. (2024).** Effect of Different Intensities of Magnetized Water on Histological Characteristics and Growth Performance of the Sea Bream (*Sparus aurata*) Juveniles. *Egypt. J. Aquat. Biol. Fish.* 28(1): 281-300. DOI: 10.21608/EJABF.2024.337883
- Fadillah, R. (2015).** Dynamics of fish resource management factors of Peperek *Eubleekeria splendens* (Cuvier, 1829) in Strait Sunda. Institut Pertanian Bogor.
- Froese, R. (2006).** Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *J. Appl. Ichthyol.* 22(4):241-253. <https://doi.org/10.1111/j.1439-0426.2006.00805.x>
- Froese, R.; Palomares, M.L.D. and Pauly, D. (2000).** Estimation of life history key facts of fishes. p. 167-175. In R. Froese and D. Pauly (eds.) *Fishbase 2000: concepts, designs and data source*. ICLARM, Manila, Philippines.
- Gulland, J.A. (1983).** *Fish Stock Assessment: A Manual of Basic Methods*. New York: Wiley and Sons Interscience. Vol. 1, FAO/Wiley Series on Food and Agricultural.
- Hazrina, A. (2010).** Dynamics of fish stocks of Ponyfish (*Leiognathus* spp.) in Palabuhanratu Bay, Sukabumi District, West Java Province. Institut Pertanian Bogor.
- Kühlmorger-Hille, G. (1974).** Leiognathidae. In W. Fischer and P.J.P. Whitehead (eds.). *FAO species identification sheets for fishery purposes. Eastern Indian Ocean (Fishing Area 57) and Western Central Pacific (Fishing Area 71)*. Rome, FAO. Vol. II, pag. Var.
- Le Cren, E.D. (1951).** The length-weight relationship and seasonal cycle in gonadal weight and condition in the perch, *Perca fluviatilis*. *J. Anim. Ecol.* 20:201-219. <https://doi.org/10.2307/1540>
- Manorama, M. and Ramanujam, S.N. (2014).** Condition factor and relative condition factor of an ornamental fish, *Puntius shalynius* Yazdani and Talukdar in Meghalaya, India. *Inter. J. Res. in Fish. Aquac.* 4(2):77-81.
- National Commission of Marine Fish Stock Assessment (1998).** Potential and distribution of marine fish resources in Indonesian waters. Ed: W. Johanes, A.A. Kiagus, E.P. Bambang, H.T. Gomal, N. Nurzali, Asikin. LIPI, Jakarta.
- Novitriana, R.; Ernawati, Y. and Rahardjo, M.F. (2004).** Gonadal development, fecundity, and spawning seasons of Sliymouth, *Leiognathus equulus*, Forsskal 1775

- (Fam. Leiognathidae) in Mayangan Coastal, Subang, West Java. J. Iktiologi Indo. 4(1):7-13. <https://doi.org/10.32491/jii.v4i1.253>
- Pauly, D.** (1984). Fish population dynamics in tropical waters: a manual for use with programmable calculators (Vol. 8). WorldFish.
- Pauly, D.** (1977). The Leiognathidae (Teleostei): Their species, stocks, and fisheries in Indonesia, with Notes on the Biology of *Leiognathus splendens* (Cuv.). Mar. Res. Indon. 19:73-93. <https://doi.org/10.14203/mri.v19i0.373>.
- Permatachani, A.; Boer, M. and Kamal, M.M.** (2016). Fish stock assesment of fish resources common Ponyfish (*Leiognathus equulus*) caught by Rampus net in Sunda Strait. J. Teknol. Perik. dan Kelau. 7(2):107-116.
- Prihatiningsih, W.R.; Ratnawati, P. and Taufik, M.** (2014). Reproductive biology and feeding habits of Ponyfish (*Leiognathus splendens*) in Banten waters and surrounding areas. Bawal, 7(1):1-8.
- Rosita, M.; Hidayat, K. and Maflahah, I.** (2018). Value added analysis of Peperek fish (*Leiognathus equulus*) being Peperek crispy fish using value engineering method. JIPK, 10(1):15-25.
- Sangun, L., Akamca, E. and Akar, M.** (2007). Weight-length relationships for 39 fish species from the North-Eastern Medditeranean coast of Turkey. Turk. J. Fish. Aquat. Sci. 7:37-40.
- Sarjana, S.; Hermawan, A. and Subiharta, S.** (2001). Survival strategies of duck farmer's on feed crisis (Case of duck farmers in Central Java north coast area). In International Seminar on Tropical Animal Production (ISTAP) 2:528-535).
- Sarkar, U.K.; Khan, G.E.; Dabas, A.; Pathak, A.K.; Mir, J.I.; Rebello, S.C.; Pal, A. and Singh, S.P.** (2013). Length weight relationship and condition factor of selected freshwater fish species found in River Ganga, Gomti and Rapti, India. J. Env. Biol. 34(5):951-956.
- Schaefer, M.B.** (1957). Some consideration of the population dynamic and economic in relation to the management of marine fisheries. J. Fish. Res. Board Cana. 14:669-681. <https://doi.org/10.4324/9781315193182-3>
- Sharif, T.A.; Yonvitner, Y. and Fahrudin, A.** (2018). Reproductive biology of Toothed Ponyfish (*Gazza minuta* Bloch, 1795) landed in PPN Palabuhanratu, Sukabumi, West Java. J. Pengelo. Perik. Trop. 2(2):1-12.
- Simanjuntak, R.J.** (2010). The relationship of the rate of exploitation with growth and reproduction of Petek fish *Leiognathus equulus* (Forskal, 1775) Family Leiognatidae. Institut Pertanian Bogor.
- Stevenson, R.D. and Woods, W.A.** (2006). Condition indices for conservation: new uses for evolving tools. Integr. Comp. Biol. 46:1169-1190. DOI: 10.1111/j.1439-0426.2006.00805.x

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- Sumaila, U.R. and Tai, T.C.** (2020). End overfishing and increase the resilience of the ocean to climate change. *Front. Mar. Sci.* 7:523. <https://doi.org/10.3389/fmars.2020.00523>
- Weatherley, A.H. and Gill, H.S.** (1987). The biology of fish growth.
- Yusfiandayani, R.; Purbayanto, A. and Nuraini, B.** (2023). Productivity and seasonal pattern of Ponyfishes (*Leiognathus* spp.) in Banten Bay. *Jurnal Ilmu Pert. Indon. (JIPI)*, 28(3):457-464.