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UTILIZATION OF MANTIS SHRIMP *(Harpiosquilla raphidea)* RESOURCES IN LABUHANBATU WATERS, NORTH SUMATRA PROVINCE

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ABSTRACT

Mantis shrimp (*Harpiosquilla raphidea)* can be found in the waters of Labuhanbatu, North Sumatra Province. The significant economic value and fishing effort of this shrimp species are believed to affect the decline in population numbers in the Labuhanbatu aquatic ecosystem, which has the potential to threaten the sustainability of its natural habitat. This study aimed to analyze the resource utilization of mantis shrimp in Labuhanbatu waters. The research methodology used was secondary data analysis. The research was conducted from November 2024 to April 2025, specifically in the waters of Labuhanbatu, North Sumatra Province. The dataset analyzed includes time series data from 2017 to 2024, including information on mantis shrimp catches and the number of fishing trips obtained from the Labuhanbatu Regency Marine and Fisheries Service. Data analysis was carried out using the Gordon-Schaefer bioeconomic model, along with calculations of utilization rates and effort rates. The results of the resource utilization analysis showed that mantis shrimp in Labuhanbatu have been overexploited. In catch rate optimization and cost reduction, scenarios that produce maximum economic yield (MEY) show higher profitability than scenarios based on maximum sustainable yield (MSY). This highlights the unsustainability of open-access mantis shrimp fishing practices in Labuhanbatu waters and the potential for mantis shrimp resource depletion. Furthermore, the utilization rate estimated at 93% indicates overexploitation, where the exploitation rate exceeds the MSY threshold. In addition, the effort rate reached 91%, indicating that the production capacity is almost at the maximum limit.

Keywords: Mantis Shrimp, Bioeconomic, MSY, MEY, OA

1. INTRODUCTION

Mantis shrimp is one of the captured fisheries, and shrimp has high economic value. Some species of mantis shrimp are known as exotic food ingredients and have become export commodities because of their premium quality taste. The types of mantis shrimp with high economic value include those from the Harpiosquillidae and Squillidae families, such as *Harpiosquilla harpax, Lysiosquillina maculata, Squilla empusa*, and *Squilla mantis*[1]. Mantis shrimp have other names: dadah shrimp, ronggeng shrimp, centipede shrimp, eiko shrimp, and mantis shrimp. It is also called mantis shrimp or praying shrimp[2].

Mantis shrimps are not widely consumed domestically but are very popular with foreign communities. This popularity, combined with high market demand and a very high monetary value, makes them one type of shrimp often caught in Indonesian waters[3].

The price of mantis shrimp in the international market is $3,5 per tail, measuring 17,5-22,5 cm[4]. Meanwhile, the traditional market price in Labuhanbatu ranges from IDR 40.000 to 150.000 per tail,

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depending on the size[3]. Murni & Dimenta[5] stated that the Labuhanbatu water area is a shrimp fishing location, one of which is *H. raphidea* and contributes as a provider of Indonesian export mantis shrimp stocks from the Sumatra region. The high economic value and business of catching this shrimp is thought to have an impact on reducing the quantity of its population in the Labuhanbatu aquatic ecosystem and will threaten the sustainability of its population in natural ecosystems.

The following studies related to *H. raphidea* mantis shrimp have been conducted in Indonesia. Astuti & Ariestyani[6] associated with the potential and economic prospects of mantis shrimp in Indonesia, Situmeang et al.[7] which examines the identification of mantis shrimp species (stomatapoda) in the waters of Bengkulu City, a study of the spatial distribution of *H. raphidea* mantis shrimp in Kuala Tungkal, West Tanjung Jabung Regency, Jambi Province[8]. Dimenta et al.[9] examined the reproductive biology of mantis shrimp Cloridopsis scorpio in the mangrove ecosystem of Belawan, North Sumatra Province, Hasibuan & Dimenta[3] examined the Reproductive Aspects of Mantis Shrimp Harpiosquilla raphidea in the Mangrove Ecosystem of Labuhanbatu Regency, North Sumatra, and Suman et al.[10], examined the Management of mantis shrimp in the Waters of West Tanjung Jabung and surrounding areas, Jambi.

In particular, research examining the bioeconomics of mantis shrimp resource utilisation in Labuhanbatu, North Sumatra Province, still lacks information. Given the increasing number of mantis shrimp caught due to its high economic value, export commodities and can not be cultivated, it is necessary to conduct a more in-depth study to analyze the stock of mantis shrimp whether it is classified as over exploited or still abundant which aims to maintain its sustainability in the waters of Labuhanbatu and the welfare of fishermen.

2. RESEARCH METHOD

Time and Place

This research was conducted from November 2024 to April 2025 in Labuhanbatu, North Sumatra Province, Indonesia.

Method

The research method used is secondary data analysis. In this study, the data sources are the results of mantis shrimp catches and mantis shrimp fishing trips by fishermen from 2017 to 2024. Data were obtained from the Marine and Fisheries Service of Labuhanbatu Regency.

Procedures

Catch per unit effort (CPUE)

To determine the abundance and utilization rate of mantis resources in the water of Labuhanbatu, it is necessary to calculate Catch per Unit Effort (CPUE). This calculation requires production data (number of catches) and fishing effort (number of trips or days at sea). The formula used to calculate the CPUE value is as follows[11]:

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

Description:

CPUE	:	Catch per fishing effort (tons/year/trips)
Catch	:	Total catch (tons/year).
Effort	:	Total fishing effort (trips).

Utilization of Mantis Shrimp Resources

The mantis shrimp resource utilization was analysed in Labuhanbatu waters using the Gordon-Schaefer bioeconomic model approach[12-13]. This analysis was conducted to determine the level of welfare of mantis shrimp fishermen and the level of stock utilization under maximum sustainable yield (MSY) and economic potential known as maximum economic yield (MEY), so that it is known whether there is a change in profitability or economic rents from mantis shrimp fishing activities that apply the minimum legal size policy. To calculate the Gordon-Shaefer bioeconomic analysis, the following data are required:

MSY : Maximum sustainable yield (tons/year)
MEY : Maximum economic yield (tons/year)
OA : Open access (tons/year)
h : Production (tons)
c : Average cost per unit effort (IDR/trips)
E : Total effort of all crab fishing gear (trips/year)
K : Environmental carrying capacity
p : Average price of crab (IDR/ton)
q : Capture coefficient
TR : p * c
TC : c * E

The bioeconomic analysis formula utilising mantis shrimp resources in Labuhanbatu, North Sumatra Province, is presented in Table 1.

Table 1. Bioeconomic analysis formula in the utilization of mantis shrimp resources in Labuhanbatu Waters, North Sumatra Province

Variable	Management Regime		
	MSY	MEY	OA
Stock (X)	$\frac{K}{q}$	$\frac{hmey}{q.Emey}$	$\frac{hoa}{q.Eoa}$
Production (h)	$\frac{rK}{4}$	$\frac{rK}{4}\left(1+\frac{c}{pqK}\right)\left(1-\frac{c}{pqK}\right)$	$\frac{rc}{pq}\left(1-\frac{c}{pqK}\right)$
Effort (E)	$\frac{r}{2q}$	$\frac{r}{2q}\left(1-\frac{c}{pqK}\right)$	$\frac{r}{q}\left(1-\frac{c}{pqK}\right)$
Economic Rent (π)	$(p.h_{MSY})-(c.E_{MSY})$	$(p.h_{MEY})-(c.E_{MEY})$	$p.h_{OA})-(c.E_{OA}$

Utilization and Fishing Capacities

According to Sparre and Venema in Kristiana et al.[14], the utilization rate is expressed in percent (%) with the following formula:

$$TP_i = (C_i/C_{MSY})\ x\ 100\%$$

Description:
TP_i : Utilization rate of year-i.
C_i : Catch of year-i.
MSY : Maximum Sustainable Yield.

Furthermore, Widodo *in* Listiani et al.[15], the level of effort is also expressed in percent (%) *with* the following formula:

$$TP_e = (E_i / E_{Msy})\ x\ 100\%$$

Description:
TP_e : Effort level of the i-th year.
E_i : Catch effort of year-i.
f_{opt} : Optimum fishing effort.

3. RESULT AND DISCUSSION

Mantis Shrimp Catch

Mantis shrimp fishing activities in Labuhanbatu waters are primarily carried out traditionally, using vessels under 2 GT with fishing gear, specifically a gill net operating at the bottom of the waters. The data of mantis shrimp catch data from 2017 to 2024 can be seen in Table 2.

The heko shrimp fishing gear has the highest responsible fishing gear value of 3,88 because the heko shrimp caught are all due to market demand. This fishing gear does not cause extinction in the heko shrimp species, which has a high selling value; one shrimp can reach IDR 100.000. Fishermen who catch heko shrimp catch them daily, where they go at dawn and return in the afternoon, so the capital spent is not so significant, and the use of boats is below 2 GT, and fishermen who catch heko shrimp are small fishermen. This fishing gear has no bycatch and discards catch[16].

In Figure 1, the CPUE value fluctuates, with an average value of 0,046 tons/unit. The highest CPUE value was 0,067 tons/unit in 2020. The lowest current CPUE value obtained in 2024 was 0,036 tons/unit. In 2020, the mantis shrimp fishery was most productive, and the CPUE value decreased until 2024. The decrease in CPUE value every year indicates that the level of exploitation of mantis shrimp in the village of Parit III, if left unchecked, will lead to a state of overfishing[17].

While the declining CPUE trend indicates that the level of exploitation of fishery resources has reached the point of saturation of effort, the horizontal CPUE trend indicates that the level of exploitation of fishery resources left unchecked will lead to overfishing[18].

Table 2. Mantis shrimp catch data from 2017 to 2024

Year	Effort (Number of catches/Trip)	Catch (Ton/kg)
2017	8.424	354,43
2018	8.024	320,45
2019	7.190	330,51
2020	3.304	221,04
2021	4.030	254,00
2022	6.943	267,53
2023	7.445	278,50
2024	8.343	301,40
Total	53.703	2327,86
Average	6.713	290,98

Source: Labuhanbatu Marine and Fisheries Service in 2025

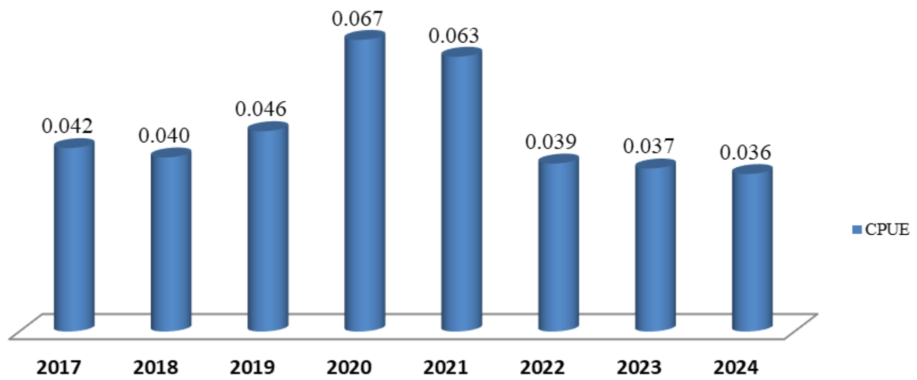

Figure 1. Mantis shrimp CPUE values from 2017 to 2024 in the study area

Analysis of Mantis shrimp *(H. raphidea)* Resources utilization (Bioeconomic Conditions)

The results of mantis shrimp resource utilization according to bioeconomic conditions are reviewed from the calculation of Catch per Unit Effort (CPUE), Maximum Sustainable Yield (MSY), Maximum Economic Yield (MEY), and Open Access (OA). Bioeconomic results in the utilization of mantis shrimp resources can be seen in Table 3.

Table 3. Bioeconomic results in the optimization of mantis shrimp resource utilization

Parameters	MSY	MEY	OA
Catch (C)	312,84	304,84	168,18
Effort (E)	7.357	6.180	12.359
Revenue (TR)	IDR 41.087.688.673	IDR 40.035.880.668	IDR 22.088.428.411
Catching Cost (TC)	IDR 13.147.830.215	IDR 11.044.214.206	IDR 22.088.428.411
Rent/profit (π)	IDR 27.939.858.458	IDR 28.991.666.462	IDR 0

Table 3 presents the maximum economic yield (MEY), maximum sustainable yield (MSY) and *Open Access* (OA). At the *maximum sustainable yield*

(MSY), the value of the optimal level of production (catch) is 312,84 tons/year, and the optimal amount of effort is 7.357 trips. In the maximum economic yield (MEY) regime, production and effort are 304,84 tons/year and 6.180 trips. Open access (OA) for the maximum production that can be obtained is 168,18 tons/year, and the maximum number of trips allowed is 12.359. The profit rents obtained by applying MSY are IDR 27.939.858.458, while MEY is IDR 28.991.666.462, and the open access conditions do not exist, which are zero.

The interaction between fishing costs, revenues, and profits in the mantis shrimp resource can be illustrated by revenues exceeding fishing costs, resulting in significant profits for fishers up to the MEY point. If fishing efforts continue beyond the MEY level, physical production may increase, but economic profits will decrease. If fishing continues, they will eventually break even.

The relationship between total cost, revenue, and profit in the mantis shrimp resource can be seen in Figure 2.

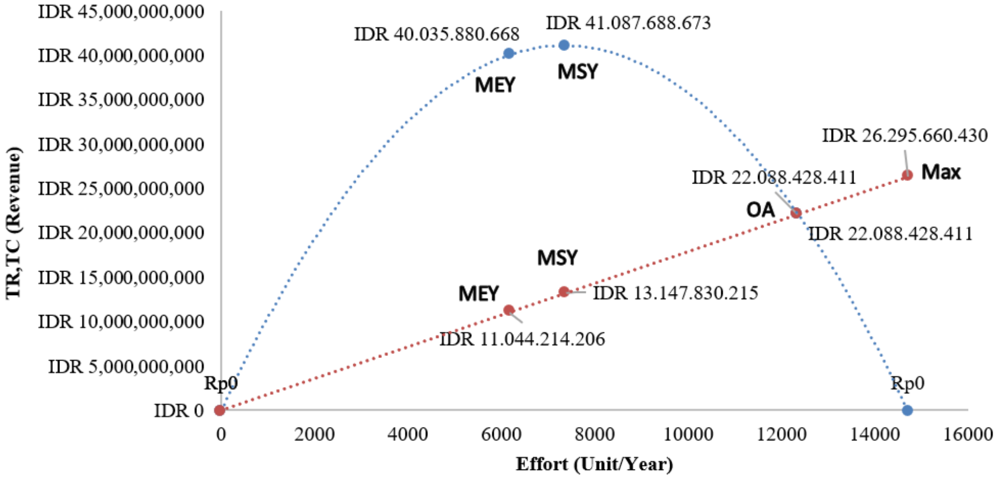

Figure 2. Relationship between total costs and revenue and profit on mantis shrimp

Figure 2 shows that the income (TR) obtained is greater than the cost of fishing (TC), so mantis shrimp fishermen will get a large profit until the EMEY point. If the fishing effort continues until EMSY, physical production will increase, but economic profits will decrease. The fishing effort, if continued, will reach the point of open access (breakeven).

The analysis of resource utilisation in mantis shrimp waters in Labuhanbatu, North Sumatra Province, revealed that MSY management is the optimum approach. It is seen that the rent value of mantis shrimp resources in open conditions is zero. If the mantis shrimp stock is left open, commercial competition in this situation will become uncontrollable, resulting in zero profit value. The rent value received by MEY management is the largest compared to other circumstances. Additionally, the number of mantis shrimp in the water at MSY is the highest. Therefore, mantis shrimp resources in Labuhanbatu waters of North Sumatra Province should be managed statically through MEY management.

According to Dafiq et al.[19], Maximum Economic Yield (MEY) conditions are economically better. In contrast, in MEY conditions, the value of fishing effort (effort) and total costs (TC) is lower but obtains a higher economic value than MSY and OAE conditions. MEY analysis provides the most effective evaluation in bioeconomic modelling. A considerable amount of data on fishery costs, prices, and fish biology is required for this model. This analysis aims to estimate a set of control variables, including fleet size, or to capture effort to optimise a particular variable, such as profit.

Based on the rents obtained under MEY management, the value obtained is the highest compared to other conditions. In addition, fish stocks of the highest MSY are produced in these waters. Therefore, fishery resources in Labuhanbatu waters need to be managed under MEY management[20]. A bioeconomic model approach can be used to optimise economic returns in fisheries to determine the optimal catch based on economic returns[21]. Timmermann et al.[22], said bioeconomic models incorporate relationships between sectors to provide a broader understanding and representation of complex systems.

Utilization Level and Level of Effort for Catching Mantis Shrimp *(H. raphidea)*

The utilization level and effort for catching mantis shrimp resources can be seen in Figure 3.

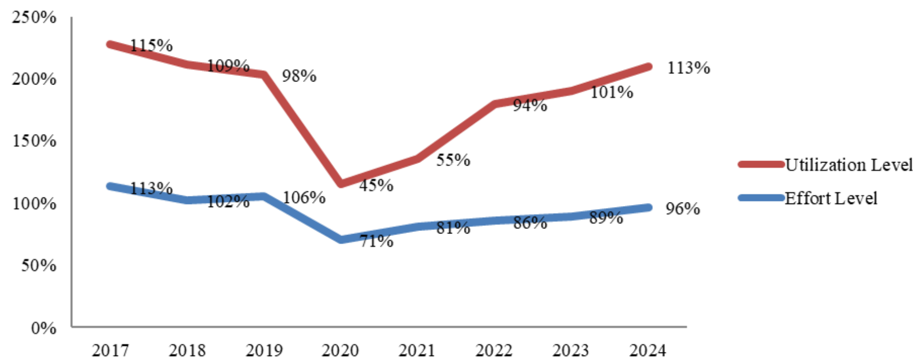

Figure 3. Utilization level and level of effort for catching mantis shrimp

Figure 3 illustrates an average utilization level of 93%, which exceeds the permitted capacity of a maximum of 80% effort for catching mantis shrimp. The average annual fishing effort, from 2017 to 2024, was 7,357 times. This indicates that mantis shrimp utilisation exceeded fishing effort, which is MSY. The average fishing effort was set at 91%, which indicates that the effort level has almost reached its maximum point of 100%.

The percentage calculation results show that the fishing effort level for mantis shrimp in the waters of the East Coast of Jambi over the past six years has averaged 94%. This indicates that overfishing has not occurred in the waters of the East Coast of Jambi, where the potential for catching Mantis shrimp is optimal. However, if additional efforts are made, it will be hazardous for the sustainability of the Mantis shrimp resource[18].

Overfishing is a biological phenomenon when the utilization rate in a fishery has exceeded the MSY level. The level of fishing effort needs to be limited because utilisation rates and fishing effort levels that exceed the sustainable potential (MSY) can threaten the sustainability of fish resources[23].

Tiger shrimp utilization rates can be attributed to various factors, such as declining catches. Declining catches are the result of declining population numbers due to overfishing efforts. On the other hand, an increase in catch can be attributed to an increase in population size due to reduced fishing effort or an increase in fishing effort triggered by a spike in fish prices. The average utilization rate of tiger shrimp is 313%[24].

According to Desiani et al.[25], tiger shrimp utilization is considered over-exploited, exceeding 100%. This is due to the excessive catch of tiger shrimp, which exceeds the sustainable potential (MSY). Further fishing efforts will inevitably lead to the extinction of the tiger shrimp resource. To address this problem, one possible solution is to implement an ecosystem-based management strategy.

Sari & Akbarsyah[26], argue that the addition of fishing gear will not always increase production. Although fishing efforts have increased, the decline in catch is most likely due to fishing efforts exceeding the limit.

4. CONCLUSION

The research results on mantis shrimp resource utilization analysis from 2017 to 2024 show that mantis shrimp in Labuhanbatu waters, North Sumatra Province, have been overexploited. This conclusion is based on bioeconomic analysis using the Gordon-Schaefer model. The utilization rate of 93% indicates that overexploitation has occurred because it has exceeded the Maximum Sustainable Yield (MSY) limit. Meanwhile, the level % of mantis shrimp fishing effort of 91% indicates that it has almost reached the maximum capacity set at 100%. Future research can contribute significantly to the sustainable management of mantis shrimp. One important aspect is assessing the socioeconomic impacts on local fishing communities, including their economic dependency, through careful socioeconomic analysis. Assessing various management policies and strategies, such as implementing catch limits, gear restrictions, or establishing conservation areas, will help direct effective measures. Furthermore, evaluate the potential impacts of climate change on mantis shrimp populations will highlight the importance of flexible management strategies to ensure the long-term survival of fishers.

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