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BIOECONOMIC ANALYSIS OF RED SNAPPER (*Lutjanus* sp.) RESOURCES AT THE WATERS SURROUNDING REMBANG REGENCY

Analisis Bioekonomi Sumberdaya Ikan Kakap Merah (Lutjanus sp.) di Perairan Sekitar Kabupaten Rembang

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ABSTRACT

The stock of fisheries resources has decreased every year due to increasing fishing activity and the use of inappropriate fishing gear which does not comply with Peraturan Menteri Kelautan dan Perikanan Nomor 18 Tahun 2021. Meanwhile, fisheries production in Rembang Regency showed fluctuation and many catches were found to be undersized. This issue is particularly evident in red snapper (Lutjanus sp.), one of the region's economically significant fisheries resources. The purpose of this study was to analyze the condition of red snapper resources in Rembang Regency using the bioeconomic approach of the Gordon-Schaefer model and to analyze the level of utilization and exploitation of red snapper (Lutjanus sp.). Data were collected from 90 purposively selected respondents who owned Danish Seines at Tasikagung Fishing Port. The findings revealed a Maximum Sustainable Yield (MSY) of 2,002 tons/year and an Effort at MSY (EMSY) of 8,857 trips/year. The Maximum Economic Yield (MEY) analysis showed a Catch at MEY (CMEY) of 1,936 tons/year, an Effort at MEY (EMEY) of 7,241 trips/year, and an optimal profit of IDR 74,773,571,716. The Open Access Equilibrium (OAE) analysis yielded a Catch at OAE (COAE) of 1,194 tons/year and an Efort at OAE (EOAE) of 14,483 trips/year. The permissible utilization rate of red snapper in Rembang Regency is 3,670,532 kg/year. The permissible utilization rate of red snapper (Lutjanus sp.) in Rembang Regency is 3,670,532 kg/year. In the last 9 years, the utilization rate is 45% and the effort rate is 158%.

Keywords: *MSY, MEY, Rembang Regency, Red Snapper, Gordon Schaefer*

ABSTRAK

Stok sumberdaya perikanan setiap tahunnya mengalami penurunan yang diakibatkan oleh peningkatan aktivitas penangkapan dan penggunaan alat tangkap yang tidak sesuai dengan Peraturan Menteri Kelautan dan Perikanan Nomor 18 Tahun 2021. Sementara itu, dari segi hasil tangkapan jumlah produksi perikanan di Kabupaten Rembang cenderung fluktuatif serta banyak ditemukan hasil tangkapan di bawah ukuran layak tangkap. Kondisi tersebut juga terjadi pada salah satu jenis sumber daya ikan ekonomis penting di Kabupaten Rembang, yaitu kakap merah. Tujuan penelitian ini adalah menganalisis kondisi sumberdaya ikan kakap merah di Kabupaten Rembang dengan pendekatan bioekonomi model Gordon-Schaefer dan menganalisa tingkat pemanfaatan dan tingkat pengupayaan kakap merah (*Lutjanus* sp.) di Kabupaten Rembang. Penelitian menggunakan metode deskriptif dengan metode *purposive sampling* untuk memilih sampel sebanyak 90 responden pemilik alat tangkap jaring tarik berkantong di PPP Tasikagung. Hasil pengolahan data diperoleh *Maximum Sustainable Yield* (MSY) dengan nilai C_{MSY} sebesar 2.002 ton/tahun, E_{MSY} sebanyak 8.857 trip/tahun. Perhitungan *Maximum Economic Yield* (MEY) diperoleh nilai C_{MEY} sebesar 1.936 ton/tahun, E_{MEY} sebanyak 7.241 trip/tahun, dan profit optimal sebesar Rp. 74.773.571.716 serta perhitungan *Open Access Equilibrium* (OAE) dimana diperoleh nilai C_{OAE} sebesar 1.194 ton/tahun, E_{OAE} sebanyak 14.483 trip/tahun. Tingkat pemanfaatan ikan kakap merah (*Lutjanus* sp.) di Kabupaten Rembang yang diperbolehkan yaitu 3.670.532 kg/tahun. Pada 9 tahun terakhir, diperoleh rata-rata tingkat pemanfaatan sumberdaya sebesar 45% dan tingkat pengupayaan rata-rata sebesar 158%. Tingkat pengupayaan ini telah melebihi batas penangkapan, sehingga perlu dilakukannya pengurangan atau pembatasan upaya penangkapan.

Kata kunci: MEY, MSY, Gordon Schaefer, Ikan Kakap Merah, Kabupaten Rembang.

INTRODUCTION

Rembang Regency is situated on the North Coast of Java and has a significant fisheries center. Tasikagung Fishing Port is based in Tasik Agung Village, Rembang City, Central Java Province. The fishing vessel at Tasikagung Fishing Port is dominated by purse seiners and Danish seiners. This is because mini purse seine and Danish seine, also known as cantrang, provide large profits compared to other fishing gear. Red snapper (*Lutjanus* sp.) is one of the catches of Danish seine which is popular with a high production amount and economic value, where the recorded production of red snapper fisheries in 2021 reached 4,560.6 tons with a production value of red snapper reaching IDR 24,029,952,620 (DKP Rembang 2022). Rembang waters have a basic character of the substrate waters of muddy sand by the habitat of demersal fish, one of which is snapper (*Lutjanus* sp.) (Amir *et al.* 2018; Oktaviyani 2018; Koeshendrajana *et al.* 2018; Wijayanto *et al*. 2020).

Red snapper fishing with bagged drag net gear that is carried out continuously will affect the ecosystem of fishery resources inside. Overutilization and the use of inappropriate fishing gear without any control cause a decrease in fish resource stocks, especially fish with high economic value. Bioeconomic analysis of red snapper is one of the studies that need attention because it is an important factor in determining future resource utilization and economy. Fisheries Management Area (WPP) 712 has a potential fish resource of 1,341,632 tons/year. The type of fish with the greatest potential is demersal fish with an estimated potential of 358,832 tons/year and a total allowable catch (TAC) of 179,416 tons where the utilization rate is 1.1 (Keputusan Menteri Kelautan dan Perikanan No.19/Men/2022).

Red snapper fishing in Rembang is currently at unsustainable and overfishing levels. The average length of fish first caught (Lc) was 22.3 cm and the length at first maturity (Lm) was 41.5 cm. The percentage of fish length caught below the length of gonadal maturity was 91.67% or almost all fish were caught before maturity (Lc<Lm). The value of Lc<Lm also indicates an indication of overfishing (Daisy *et al.* 2023). Fishery resources can be categorized as sustainable if the size value of the first time caught is more than the size of the first time mature gonads (Tampubolon *et al.* 2019; Tampubolon *et al.* 2021; Limbong *et al*. 2022).

Research on red snappers has not been commonly conducted and it has a high demand with exports to various countries (Dafiq et al. 2019), therefore this research aimed to analyze the condition of Red Snapper resources in Rembang Regency using the Gordon-Schaefer bioeconomic model approach and analyzing the level of utilization and the level of effort of red snapper (Lutjanus sp.) in Rembang Regency. The bioeconomic approach is intended to identify the level of utilization and the level of control to have an impact on improving the economy of Danish seine fishermen. The bioeconomic approach used is Gordon-Schaefer. The biological process is to consider the development and availability of red snapper currently landed at Tasikagung Fishing Port. The economic strategy is to consider the fishermen's economy at Tasikagung Fishing Port.

METHODS

The research was conducted from October to September 2022 at Tasikagung Fishing Port (PPP), Rembang Regency, Central Java-Indonesia, especially at TPI II Tasikagung (Figure 1). The research method used a descriptive method with a case study. A descriptive method is a technique that portrays events or conditions in a specific area based on existing facts after the researcher observes primary and secondary data (Ramdhan 2021). Data were collected through interviews and observations regarding the management of Danish seine fishing operations such as details of fishing units, total cost and total revenue. Respondents were selected from a group of Danish seine boat owners at Tasikagung Fishing Port using a purposive sampling method. Meanwhile, the number of samples was determined by using the Slovin formula.

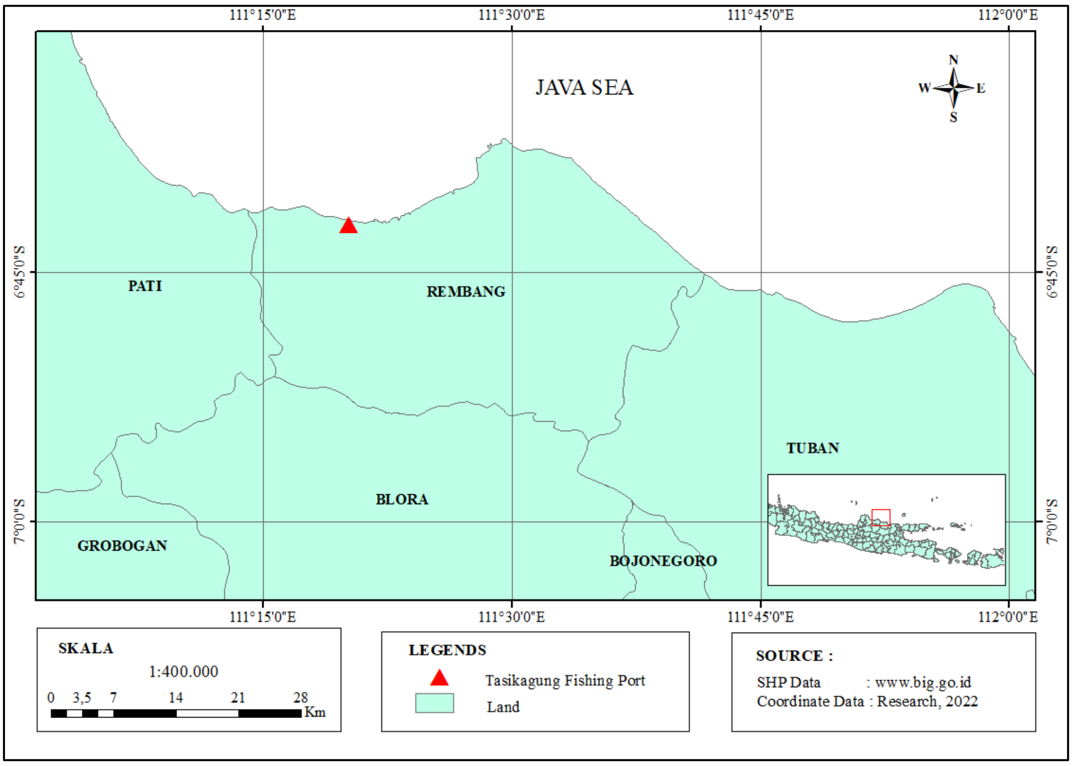

Figure 1 The research location (Δ) is on the north coast of Rembang Regency, Central Java, Indonesia

Figure 2 The position of the red snapper (*Lutjanus sp*.) when weighing is carried out.

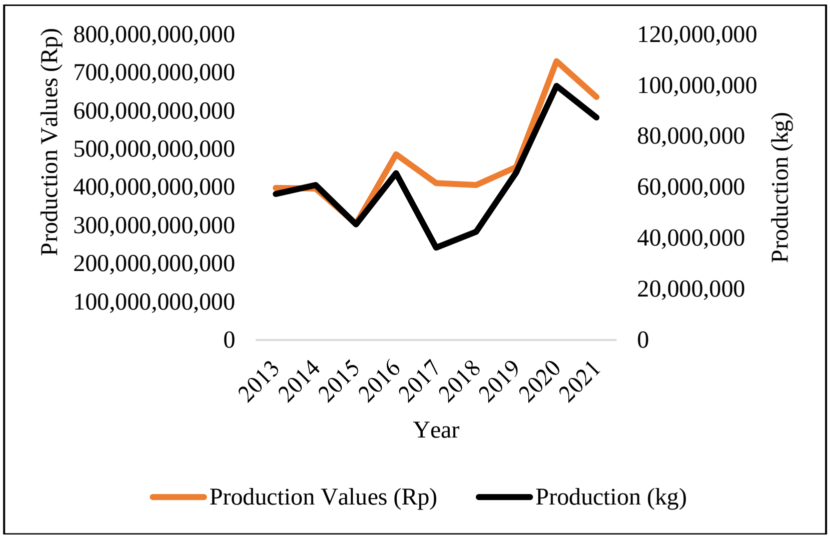

Figure 3 Total production and production value of Marine Fisheries in Rembang (Indonesia) Regency from 2013-2021

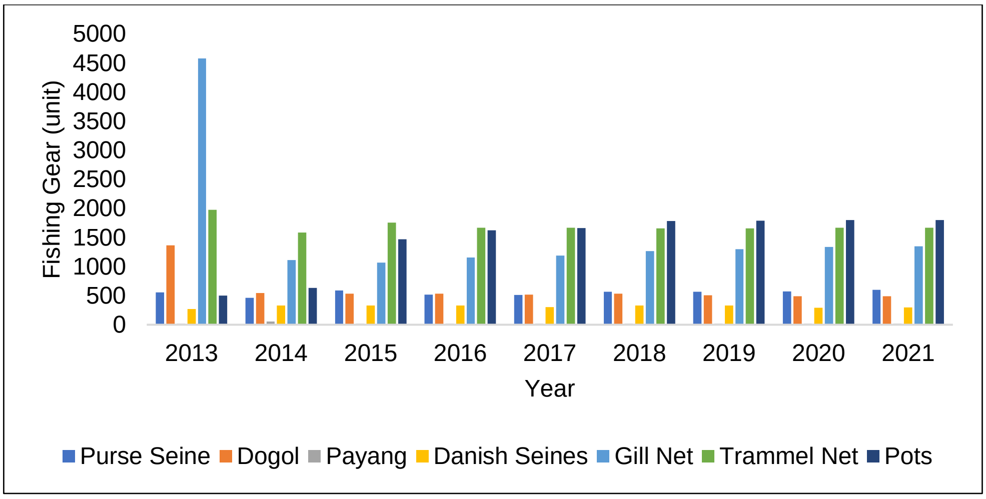

Figure 4 The number of capture gears operating in Rembang Regency (Indonesia) for the last nine years from 2013-2021

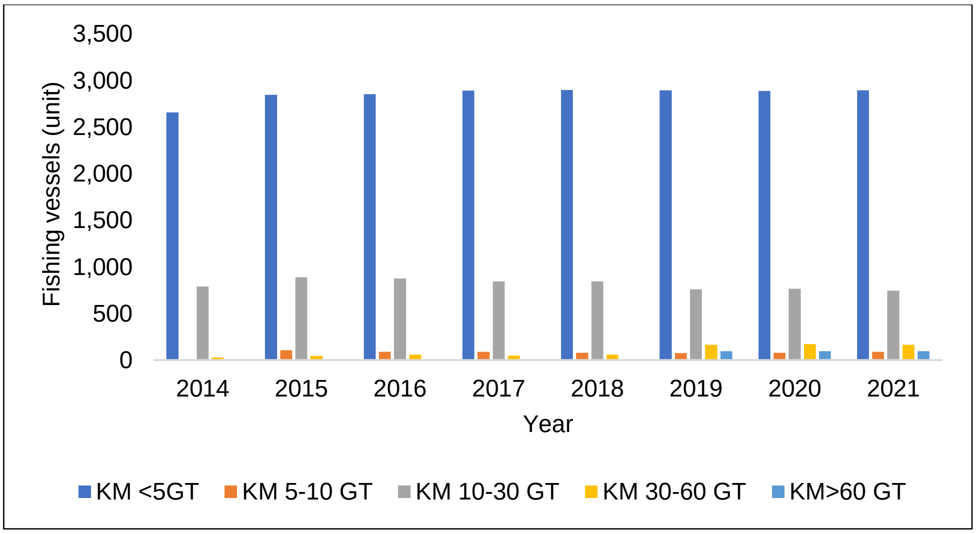

Figure 5 The number of fishing vessels in Rembang Regency (Indonesia) for the last eight years from 2014 – 2022

Table 1 *Gordon-Schaefer* Analysis Method

	MSY	MEY	OAE
C	$\alpha^2 / 4\beta$	$\alpha E_{MEY} - \beta(E_{MEY})^2$	$\alpha E_{OAE} - \beta(E_{OAE})^2$
E	$\alpha / 2\beta$	$(p\alpha\text{-}c) / (2p\beta)$	$(p\alpha\text{-}c) / (p\beta)$
TR	$C_{MSY}.p$	$C_{MEY}.p$	$C_{OAE}.p$
TC	$c.E_{MSY}$	$c.E_{MEY}$	$c.E_{OAE}$
Π	$TR_{MSY} - TC_{MSY}$	$TR_{MEY} - TC_{MEY}$	$TR_{OAE} - TC_{OAE}$

Source: Wijayanto *et al.* (2016)

With:
C = Total catch (kg/year)
E = Fishing effort (trip/year)
TR = Total Revenue (IDR/year)
TC = Total Cost (IDR/year)
II = Profit (IDR/year)
α = intercept
β = Slope
c = Cost (IDR)
P = Price (IDR/kg)

Data Analysis

CPUE (*Catch Per Unit Effort*)

The calculation of CPUE is the ratio of catch to effort. According to Sparre & Venema (1999), the CPUE formula is as follows:

$$CPUE = \frac{Catch}{Effort} \quad \text{....................................} (1)$$

With:
CPUE = Total catch per unit fishing effort (kg/trip)
Catch = Total catch (kg)
Effort = Fishing effort (trip)

Gordon Schaefer Bioeconomic Analysis

The Gordon Schaefer bioeconomic analysis model is an analysis of exploiting capture fisheries resources that combine economic forces that affect the fishing industry and biological factors that determine fish production and supply. Gordon-Schaefer model static approach can be used MSY, MEY, and OAE. The Gordon Schaefer analysis formula is presented in the following table 1.

Analysis of Utilization Rate and Effort Level

The utilization rate estimation was carried out by presenting the total catch in a particular year with the maximum sustainable potential (MSY) value. The equation of the utilization rate, according to Sparre & Venema (1999), is as follows:

$$TPc = \frac{Ci}{MSY}\, x\ 100\% \quad \text{...........................} (2)$$

With:

TPc = Utilization rate in year-i (%)

Ci = The total fish catch in year-i (tons/year)

MSY= *Maximum Sustainable Yield* (tons/year)

The level of exploitation was estimated to determine the level of fishing effort of red snapper resources in Rembang waters. Estimation is done by presenting the standard effort in a particular year with the optimal effort value (f opt). The equation of the level of effort, according to Sparre & Venema (1999), is as follows:

$$TPe = \frac{Ei}{fopt}\, x\ 100\% \quad \text{...........................} (2)$$

With:

TP e = Level of effort in year-i (%)

Ei = Standard effort in year-i (trip/year)

Fopt = Optimum catch effort (trip/year).

RESULTS

The Situation of the Research Location

Geographically, Rembang Regency (Indonesia) is located at 111° 00'-111° 30' East Longitude and 06° 30'- 07° 00' South Latitude. Rembang Regency is one of the regencies in Central Java, where 35% of the area is coastal. Rembang consists of 14 districts where 6 of them are coastal areas, namely Kaliori, Rembang, Lase, Sluke, Kragan, and Sarang. Rembang Regency has the longest coastline in Central Java, with 63 km of coastline (DKP Rembang 2022). Rembang Regency has ten fish landing sites, including TPI Tanjungsari, TPI Tunggulsari, TPI Tasikagung I, TPI Tasikagung II, TPI Pasar Banggi, TPI Pangkalan, TPI Karang Anyar, TPI Pandangan, TPI Karang Lincak, and TPI Sarang, all of these are not actively operating. In 2021, Rembang Regency will have a total of 3,989 units of fishing vessels. According to Dinas Kelautan dan Perikanan Kabupaten Rembang (2022), the fishing vessels by GT totaled 2,989 which were dominated by motorboats under 5 gross tonnage (GT).

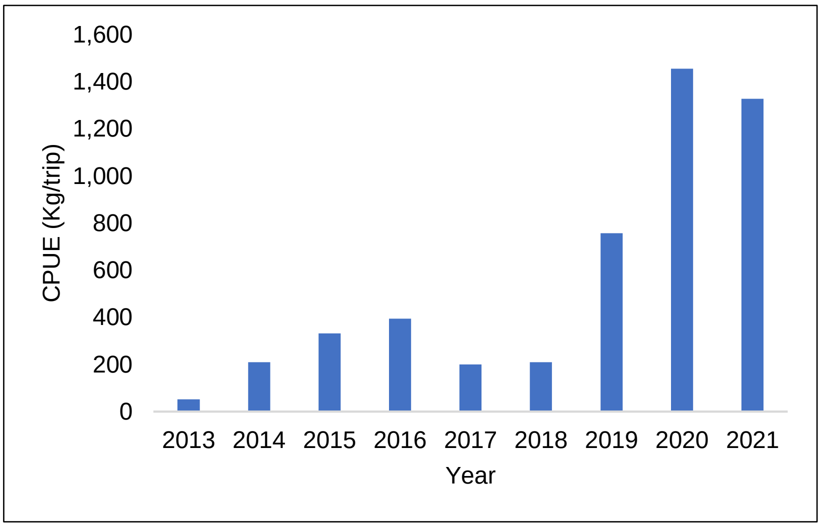

Figure 6 CPUE fluctuation of red snapper

Most of Rembang Regency fishermen's fishing grounds are located in WPP (Fisheries Management Area) 712, namely the waters of the Java Sea. WPP 712 includes East Java, Central Java, West Java, Banten, Jakarta, Lampung, Central Kalimantan, and South Kalimantan. The Java Sea (WPP 712) is dominated by demersal fish with an estimated fish resource of 358,832 tons (Keputusan Menteri Kelautan dan Perikanan No.19/Men/2022).

***Catch Per Unit Effort* (CPUE)**

CPUE indicated stock abundance parameters as well as monitoring the impact of long-term fisheries. The fluctuation of CPUE for nine years from 2013 to 2021 is seen in Figure 6.

Based on Figure 6, it is known that the smallest CPUE value was in 2013 and the largest was in 2020. The CPUE value in 2013 was 52 kg/trip with a fishing effort of 3,266 trips and a catch of 170,407 kg. The largest CPUE result in 2020, where the CPUE value was 1,452 kg/trip with a fishing effort of 3,890 trips and a catch of 5,664,300 kg.

The catch per fishing effort is calculated based on the total yield (kg) divided by the total effort (trip). The relationship between CPUE and effort is seen in Figure 7.

Figure 7 shows the acquisition of the equation Y = -0.802x + 3,904.8 with a value of R^2 = 0.7205. The intercept value or a value of 3,904.8. The slope value or b value in the equation is -0.802x. The coefficient of determination (R^2) in Figure 7 is 0.7205. The correlation value (correlation coefficient or r) between effort and CPUE, obtained from $r=\sqrt{R^2}$, is 8.488. Based on the calculation, Figure 5 shows the relation between effort and CPUE. The graph above shows the acquisition of the equation Y = -0.802x + 3,904.8 with R^2 = 0.7205. This equation shows

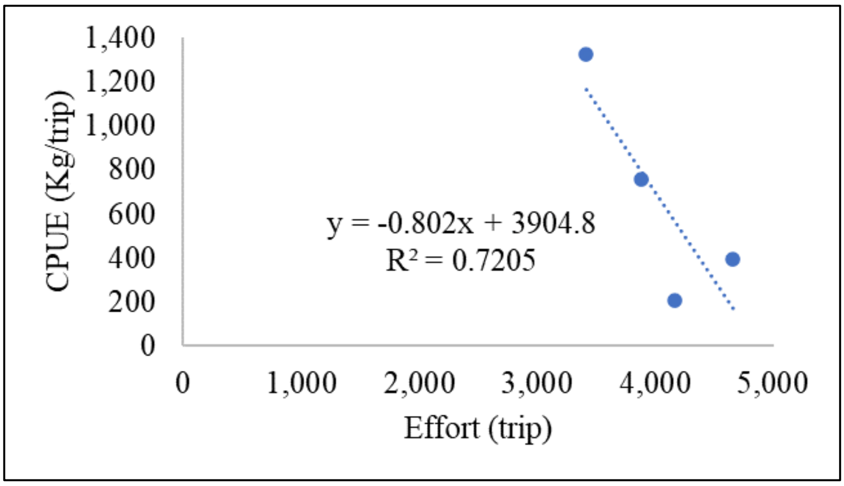

Figure 7 Effort and CPUE of red snapper

1. The intercept value or a value is 3,904.8, which means that if the fishing effort is close to 0, the CPUE is around 3,904.8 kg/trip.
2. The slope value or b value in the equation is -0.802x. This shows a negative relationship where the higher the fishing effort (X), the smaller or lower the CPUE value. If the fishing effort is reduced or decreased by 1 effort, the CPUE value increases by 0.802 kg/trip. Effort indicates the number of days at sea and the number of trips made to conduct fishing operations.
3. The coefficient of determination (R^2) in this graph is 0.7205. The model is able to calculate and predict 72.05% of the observed variability in CPUE based on changes in fishing effort, whereas the remaining 27.95% is influenced by other factors not explained in the model.
4. The correlation value (correlation coefficient or r) between effort and CPUE, where obtained from $r = \sqrt{R^2}$, is 8.488. It means that effort and CPUE have a strong correlation.

CPUE tends to decrease when there is an increase in the number of fishing gear and fishing efforts. The relationship between CPUE value and fishing effort is inversely proportional. The amount of CPUE is used as an indicator of the technical efficiency of the use of effort. The higher the CPUE value, the better the efficiency of the use of effort whereas the higher the productivity (Juniko *et al.* 2018, Dafiq *et al.* 2019).

Gordon Schaefer Model

Gordon Schaefer's bioeconomic analysis combines the logistical growth of fish resources with economic principles that maximize profits. Static bioeconomic calculations include Maximum Sustainable Yield, Maximum Economic Yield, and Open Access Equilibrium. Analyses include catch, fishing effort, total revenue, total costs, and profits from each equilibrium. The profit (π) is obtained by the difference between total revenue (TR) and total cost (TC). If the result of the difference is positive, it can be considered profitable but if the result of the difference is negative, then a business tends to be disadvantaged (Ratnawati *et al.* 2021). To determine the MSY, MEY and OAE values, the cost and price of red snapper are needed. The price of the snapper is Rp. 55,853/kg with a cost of Rp. 4,542,943, an intercept value of 452.24, and a slope value of 0.026. The results of the Gordon Schaefer analysis are presented in Table 2. Meanwhile, an illustration of the Gordon Schaefer Model is presented in Figure 8.

The figure reveals that the increasing effort provides less yield when compared to the catch at the MEY point. Overutilization of red snapper resources occurred from 2019 to 2021 when the utilization rate exceeded 100%. The profit from MEY is larger than the MSY profit because the MEY condition produces more catches but fewer fishing trips than when the MSY condition. It can reduce or minimize expenditure costs and be able to maximize income so that a larger profit is obtained. Figure 8 shows TR_{MSY} and TC_{MSY} are greater than TR_{MEY} and TC_{MEY}.

1. Maximum Sustainable Yield

In the MSY calculation, the total production has the highest value of the three Gordon Schaefer model approaches. Based on the results of Figure 8, it is known that the maximum catch (C_{MSY}) in the Gordon Schaefer model is 2,002 tons/year, whereas the fishing effort (E_{MSY}) is 8,857 trips/year. Overfishing of red snapper resources occurred in 2019-2021.

2. Maximum Economic Yield

The MEY point in the Gordon Schaefer model where the catch (C_{MEY}) is 1,936 tons/year. The fishing effort in MEY conditions (E_{MEY}) was 7,241 trips. At the Maximum Economic Yield level, the profit is larger than MSY and OAE, IDR 74,773,571,726.

Table 2 Gordon-Schaefer Bioeconomic Analysis

	MSY	MEY	OAE
C (tons/year)	2,002	1,936	1,194
E (trip/year)	8,857	7,241	14,483
TR (IDR/year)	111,853,050,353	108,132,437,834	66,717,732,218
TC (IDR/year)	40,800,091,146	33,358,866,109	66,717,732,218
Π (IDR/year)	71,052,959,207	74,773,571,726	0

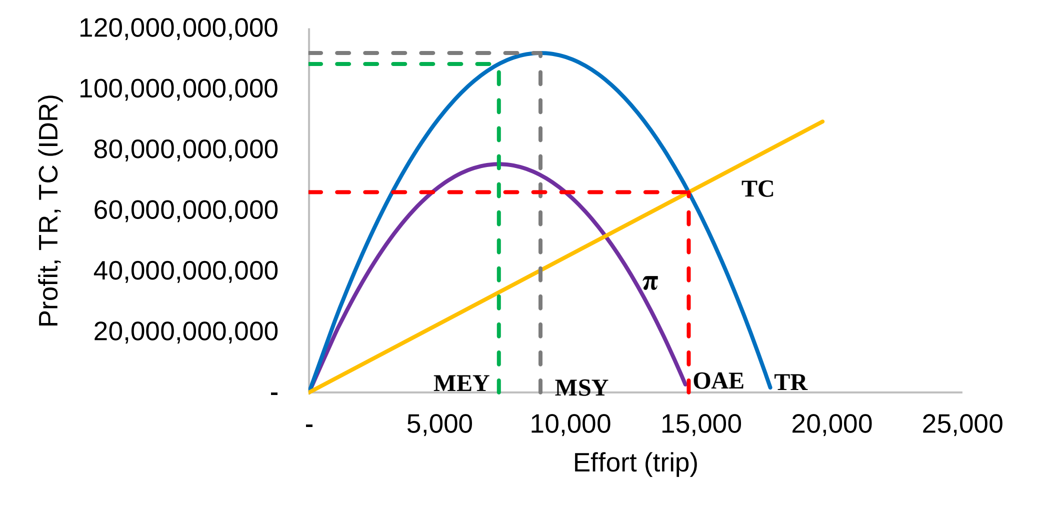

Figure 8 Gordon Schaefer Mode

3. *Open Access Equilibrium*

Based on data processing, the OAE catch is 1,194 tons/year, with a fishing effort of 14,483 trips/year. In OAE conditions, total revenue is equal to the total cost. Open access conditions or open conditions make the situation of overfishing and inefficient utilization.

Utilization Level and Effort Level of Red Snapper (*Lutjanus* sp.)

The utilization and effort levels were parameters that became the benchmark of how much the utilization of fishery resources in waters. A graph of utilization level and effort level is seen in Figure 9.

Utilization rate is a parameter that measures how much fishery resources are utilized in waters. The highest utilization rate occurred in 2020, with a percentage of 283%, and this value indicates that WPP 712 is overfished. The lowest utilization rate occurred in 2013, with a percentage of 9%, and this value is included in the low utilization rate where the value is below 33.3%. The highest level of effort was in 2016, with 53%. The lowest level of utilization level in 2017, with 36%. The level of utilization of red snapper fishing in WPP 712 each year has shown overfishing which is over 100%.

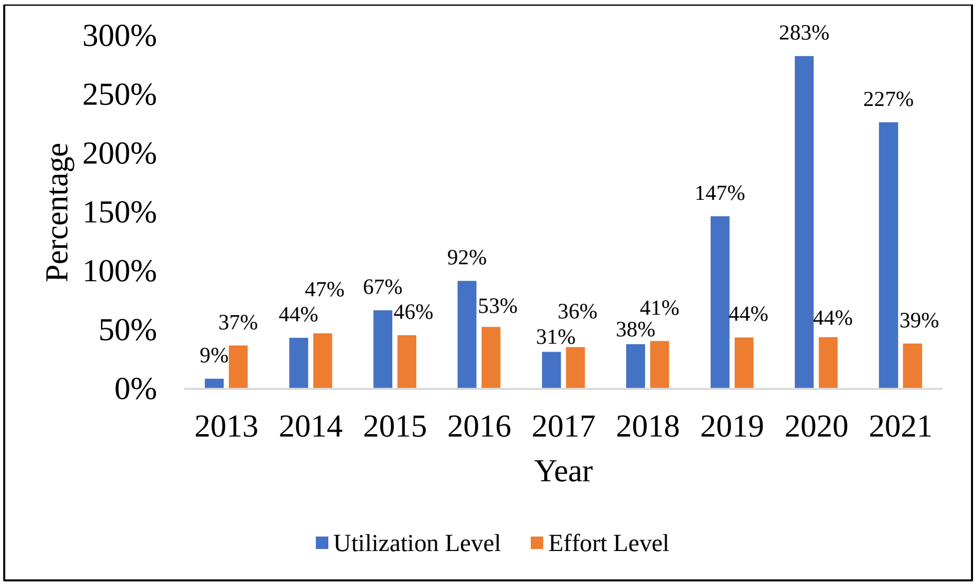

Figure 9 Utilization and Effort Levels of red snapper

The effort level is influenced by fishing effort, where if the actual fishing effort exceeds the fishing effort of MSY conditions, it indicates that the waters have many fishing trips. The highest effort level occurred in 2016 with a percentage and the lowest level of effort occurred in 2017.

DISCUSSION

The Situation of the Research Location

Based on the research, 90 respondents of Danish Seine fishermen in Tasikagung Fishing Port operate fishing vessels with various GT ranging from 23 GT to 118 GT and crew of about 14-22 people. The average investment cost each year is around IDR 1,288,544,444. Fixed costs spent are around IDR 236,831,759/year. Variable or operational costs spent by bagged drag net fishermen range from IDR 1,382,645,778. The costs spent in the fishing business consist of fixed costs and non-fixed costs. Fixed costs are spent in a year with the same amount. Variable costs are the amount of costs required in each fishing operation with a changing amount. Variable costs of Danish Seine fishing include operational costs or supplies, retribution costs, and transportation service costs (Setiawan *et al.* 2018, Auralia *et al*. 2021). The fisheries sector is one of the sectors that dominates and becomes the support of Rembang Regency, where the largest contribution of marine fisheries in Rembang Regency comes from the Tasikagung Fishing Port (PPP) as the research location (Wijayanto and Kurohman 2018).

The production of snapper in 2021 decreased to 4,536 tons from 5,664 tons in the previous year (DKP Kabupaten Rembang, 2022). Based on the research, more than 50 % indicated that the total length of red snapper was below the catchable size. According to the global fish species database website 'fishbase.se' (accessed on December 26, 2022), red snapper gonad maturity occurs at Lm (Length at first mature) 57.6 cm with a typical length of 50-100 cm. Referring to this source, red snapper fishing is still below the standard, where the average catch has a total body length of 32.9 cm. Size differences are influenced by several reasons, including differences in the type and selectivity of fishing gear used and differences in biological factors that make variations in fish length. This affects fish growth and the stock of red snapper resources in the waters (Rapi *et al*. 2019; Panggabean *et al.* 2023)

Rembang Regency has various types of fish obtained from several fishing gears. The types of fish that are commonly found in demersal fish include Swanggi fish (*Priacanthus tayenus*), shortfin scad (*Decapterus macrosoma*), tembang fish (*Sardinella fimbriata*), red snapper (*Lutjanus* sp), grouper (*Epinephelus* sp.), squid (*Loligo* sp.), and many others. The highest production occurred in 2020 with 99,744,659 kg, and the highest production value reached IDR 729,572,022,500, while the lowest marine fisheries production in Rembang Regency occurred in 2017, where the show was only 36,243,036 with a production value of IDR 410,814,488,000. The fluctuation in the amount of production is affected by the season or weather. Rembang Regency is the regency with the largest fisheries production based on demersal fish species in Central Java. Fisheries production in Central Java is dominated by small pelagics and demersal. This is because many fish caught are landed by ship sizes over 10 gross tonnage (GT). The Java Sea, in its fisheries resource utilization, is experiencing a tragedy of the commons where the utilization is excessive due to the large number of fishing vessels (Nababan *et al.* 2020, Tiku *et al.* 2021).

Catch Per Unit Effort (CPUE)

CPUE values that tend to fluctuate are caused by several factors. These factors include the number of fishing trips, fishing season, and fish availability. The rising CPUE value shows that the exploitation rate of fish resources can be said to be still at the developing stage. The CPUE value indicates the level of exploitation of fish resources is approaching saturation of effort. The decreasing CPUE value indicates the level of exploitation of fish resources and leads to overfishing where the availability of fish resources is depleted. According to Sari *et al.* (2021), the rising CPUE trend indicates that the level of fish resource exploitation can be considered to be in the developing stage. The stable CPUE trend suggests that the level of fish resource exploitation is fully exploited, while a declining CPUE trend is an indication that if left unchecked, the level of fish resource exploitation will lead to overfishing.

Gordon-Schaefer Model

1. **Maximum Sustainable Yield**

Maximum Sustainable Yield (MEY) is the maximum allowable catch, where utilization is carried out maximally and sustainably so as not to disturb the sustainability of existing fish resources. The MSY calculation has a relationship between effort and catch. In the MSY calculation, the amount of production has the highest value of the three Gordon Schaefer model approaches. Based on the results of Table 2, it is known that at the MSY point where the maximum catch (C_{MSY}) in the Gordon Schaefer model is 2,002 tons/year and the fishing effort (E_{MSY}) is 8,857 trips/year. Based on this value, it means that the catch of 2,002 tons is the highest catch of red snapper. Production that exceeds the C_{MSY} value has a negative impact such as the threat to fish resource sustainability. The results of the calculation obtained the fishing effort carried out by Danish seine fishermen at Tasikagung Fishing Port with an average of 3,785 exceeds the MSY fishing effort (E_{MSY}) which is 8,857 trips. This indicates that the fishery resources in the waters of WPP NRI 712 have been biologically overfished. According to Widayanto *et al.* (2021), the waters of the Java Sea show an overfishing condition. This is caused by the increasing number of fishermen and the use of fishing gear that is not environmentally friendly. To avoid overfishing situations, it is necessary to conserve fish resources. This conservation is done by limiting the catch by fishermen according to the value of sustainable catch (C_{MSY}). The addition and reduction of fishing efforts will affect the size of the fish production obtained. According to Prasetyo (2020), factors influencing the sustainability of fishery resources include the price of fish acceptable to buyers, the cost of fishing operations, and the price expectations of fishermen from the catch obtained.

2. Maximum Economic Yield

Maximum Economic Yield (MEY) is the level of utilization or exploitation of red snapper resources by maximizing profit. MEY calculations relate fishing effort (effort) and catch (catch). In the MEY calculation, the amount of profit or profit has the highest value of the three Gordon Schaefer model approaches. Based on the results, MEY point in the Gordon Schaefer model where the acquisition of catch (C_{MEY}) is smaller than the catch of MSY conditions (C_{MSY}) which is 1,936 tons/year. The fishing effort under MEY conditions (E_{MEY}) was 7,241 trips. At the Maximum Economic Yield (MEY) point, the profit is greater than MSY and OAE, IDR 74,773,571,726. Based on this value, it means that the profit of IDR 74,773,571,726 is the highest profit from the red snapper fishing industry in Tasikagung Fishing Port. According to Dafiq *et al.* (2019), Maximum Economic Yield conditions are economically better conditions, whereas, 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.

3. Open Access Equilibrium

Open Access Equilibrium (OAE) is the exploitation or utilization of red snapper resources in open access conditions where neither profit nor loss occurs. OAE conditions occur without government intervention thus, there is no structured management. Based on data processing, the OAE catch is 1.194 tons/year with a fishing effort of 14.483 trips/year. In the OAE (condition, revenue equals expenditure, which can be interpreted as a situation where neither profit nor loss occurs. Open access conditions cause overexploitation and inefficient utilization due to the absence of government intervention in management. According to Wijayanto *et al.* (2016), the occurrence of Open Access Equilibrium conditions is located in aquatic resources that are open-access. This makes the utilization of fish resources found at the break-even point position where the cost of revenue (TR) is equal to the value of the total cost incurred (TC). The fishing industry in OAE conditions occurs when fishing effort increases, but the number of catches decreases, or this will harm the fishing business. According to Rahayu *et al.* (2019); Usman *et al.* (2022), open access conditions cause economic inefficiency. This inefficiency is due to a fairly high fishing effort with a smaller catch or production. This makes fishing in open access conditions without profit or utilization of fishery resources at the break-even point (BEP).

Utilization Level and Effort Level of Red Snapper (*Lutjanus* sp.)

The utilization rate is influenced by the catch according to MSY and the actual catch, where if the actual catch is larger than the MSY catch, it indicates that there has been overfishing in the production of resources in it. The highest utilization rate occurred in 2020, with a percentage of 283%, while the lowest occurred in 2013, with a percentage of 9%. In 2013 the utilization rate of red snapper only reached 9% because the production of red snapper catches has not been exploited much, which makes the utilization rate of red snapper still low. This is inversely proportional to the utilization rate of red snapper in 2020, which reached 283%, where the production of red snapper catches was abundant, getting 5.664 tons. Based on the calculation of the allowable catch (JTB), it is known that 80% of the potential MSY is from 4,588,165 kg to 3,670,532 kg (Mayu *et al.* 2018). The amount of red snapper catch for the fish resource to remain sustainable is 3,670,532 kg. In 2020, the highest utilization rate of red snapper resources was 283%, and this percentage is categorized as an overfishing level where additional fishing efforts can endanger the resource so that extinction occurs. This is under Keputusan Menteri Kelautan dan Perikanan Republik Indonesia No. 19 tahun 2022, the estimated potential of demersal fish in the Java Sea Waters (WPP NRI 712) is 358,832 tons with a total allowable catch of 179,416 tons and a utilization rate of 1.1 or 110%. The utilization rate that exceeds 100% is caused by uncontrolled fishing. According to Irhamsyah *et al.* (2021), the level of utilization is classified into four classes, including a low level with a utilization percentage of 0-33.3%, a medium level with a utilization percentage of 33.3-66.6%, an optimum level with a utilization percentage of 66.6-99.9%, and an overfishing level with a utilization percentage of >100%.

CONCLUSION

Based on the explanation above, conclusions can be obtained from this study. The condition of red snapper resources in Rembang Regency was carried out with the Gordon Schaefer bioeconomic model approach. In MSY conditions, including CMSY of 2.002 tons/year with EMSY of 8,857 trips/year. In the MEY conditions, including CMEY of 1,936 tons/year with EMEY of 7,241 trips/year. OAE conditions, including COAE of 1,194 tons/year with EOAE of 14,483 trips/year. TRMSY and TCMSY are greater than TRMEY and TCMEY. MEY profits are larger than MSY and do not generate profits at OAE. The profit obtained when the MSY condition is IDR 71,052,959,207. The profit received when the MEY condition is IDR 74,773,571,726. Under OAE conditions, the total revenue received is equal to the total costs incurred, which is IDR 66.717.732.218. The allowable utilization rate of red snapper in Rembang Regency is 3.670.532 kg/year with a utilization rate of red snapper in Rembang Regency of 104% which indicates an overfishing level and the level of red snapper in Rembang Regency is included in a moderate level condition with an average of 43%.

SUGGESTION

Based on the above conclusions, several suggestions can be given in this study including the following:

1. The relevant agencies should conduct monitoring so that the utilization of red snapper (*Lutjanus sp*.) resources is detected.
2. The government socialize and educates fishermen about the importance of maintaining the stock of red snapper fish resources (*Lutjanus sp*.) to promote sustainable and repressive action solutions to overcome overfishing.
3. Further research should be conducted on the management of red snapper (*Lutjanus sp*.) resources.

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