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BIOECONOMIC OF PURPLE-SPOTTED BIGEYE (PRIACANTHUS TAYENUS) IN THE WATERS OF BATANG REGENCY OF CENTRAL JAVA, INDONESIA

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ABSTRACT
The study of Purple-spotted bigeye resources management especially in Batang waters is still minimal, therefore intensive attention and proper management is needed. The objective of this study is to determine the utilization of Purple-spotted bigeye resources in Batang waters. The research was conducted in March – July 2020. Bioeconomic analysis was carried out using the Gordon-Schaefer formula to analyze the fishery production trends in the form of time series. The result shows that the sustainable yield (E_{MSY}) of Purple-spotted bigeye is 2473.16 tons year^{-1} with optimum effort (F_{MSY}) 2075 trips year-1. The maximum production at maximum economic yield (E_{MEY}) level is 2225.94 tons year^{-1} with effort (F_{MEY}) 1366 trips year-1. Open access condition of Purple-spotted bigeye will be achieved when the number of fishing effort (E_{OA}) reaches 2732 units with production (E_{OA}) of 2184.03 tons year^{-1}. The production and fishing effort in actual condition showed that the utilization of Purple-spotted bigeye can still be optimized, but it should be done carefully and wisely without exceeding the optimum catch limit to prevent overfishing.

KEY WORDS
Purple-spotted bigeye, trunk, bioeconomic model.

Purple-spotted bigeye (*Priacanthus tayenus*) is one of the important commodities that are dominantly caught in Batang Regency, Central Java. This fish is widely used in the form of fresh fish, processed into crackers or as a mixture of processed surimi so that it can be said that Purple-spotted bigeye has important economic value. The important economics in question are having a high market value, high and wide macro production volume, and having high production power (Mayalibit, 2014; Jabbar, 2017). Purple-spotted bigeye are generally caught by danish seine fishing gear, which is one of the most common fishing gears used in Batang Regency.

Exploitation that exceeds the maximum limit will interfere the development and growth even lead to the extinction of a species. Based on this, intensive attention and wise management is needed to maintain the exploitation of fish resources (Jabbar *et al*., 2018). Efforts to restore existing resources must be carried out as early as possible so as not to run out. Fish resources in the sea is common property ownership, it has the impact of an open access fishing process in the sense that everyone has the right to catch, so good management of fishery resources is needed to keep fish resources in a sustainable condition (LPSPL Sorong, 2018).

The potential of fishery resources in Indonesia still cannot be managed and utilized optimally and sustainably. In addition, almost all regions in Indonesia lead to overfishing conditions, namely the catch of fish that exceeds the amount needed to maintain fish stocks in an area (Mustaqim, 2018). In order to maintain the sustainability of fish resources in Indonesian waters, it is necessary to estimate fish stocks. Especially with the lack of studies on the presence of demersal fish in Indonesian waters (Masrikat, 2012). Fish stock estimation is an activity of applying statistics and mathematics to a group of data to determine the status of fish stocks quantitatively for the purpose of estimating fish stocks and alternative policies in the future. In the presumption of fish stocks, measuring changes in abundance is one important thing to do.

The first stage in the bioeconomic analysis is through calculating the abundance from the annual time series catch and effort data. One method for estimating the abundance of a fish stock is by looking at the abundance index based on CPUE data. CPUE can be used as a standard tool for determining fish stock development. The catch per unit of effort (CPUE) is a quantity that can be considered proportional to the number of fish in the sea. If there are twice as many fish available in the sea, then the fish caught per fishing operation will be doubled. The abundance of marine fish populations is always changing and fluctuates from time to time on a global scale (Ravard et al. 2014). Based on the description that has been conveyed. The purpose of this study in general is to conduct a fish bioeconomic analysis of Purple-spotted bigeye resources in Batang Regency as a basis for sustainable management of fish resources.

MATERIALS AND METHODS OF RESEARCH

The research was conducted in March-July 2020 at the Klidang Lor Coastal Fishing Port, Batang Regency. The research method used in this research is descriptive. Descriptive method is a method in examining the status of a group of people, an object, a set of conditions, a system of thought, or a class of events in the present to create descriptive, factual and accurate information, and the relationship among the phenomena investigated (Nazir, 2011; Fitri *et al.*, 2016). While the survey method is an investigation carried out to obtain facts and existing symptoms and seek factual information, both about social, economic, or political institutions of a group or an area.

Data collection techniques were carried out by means of direct observation, documentation, and literature studies. The data collected is secondary data which includes the production of Purple-spotted bigeye (tons) and the number of fishing trips for six years, the value of fish production and the number of fishing units.

The fisheries economic model approach was first written by Gordon (1954), who in his article stated that fishery resources are generally open access so that anyone can use them. It is also said that many fisheries problems focus on maximizing catch by ignoring the production factors and costs used in fisheries. If the utilization of fish resources exceeds the ability of fish to recover resources or stock regeneration, then the fish resources stock will decline and can lead to extinction (Irnawati, 2019). Biologists treat fishermen as exogenous variables in their analytical model and fisherman's behavior is not integrated into a systematic and general bionomic theory. This situation underlies Gordon in starting his analysis based on the concept of quadratic biological production which was later developed by Schaefer (1957), and then the basic concept of bioeconomic found is known as the Gordon-Schaefer theory. There are three conditions of equilibrium in the Gordon-Schaefer model, covering MSY, MEY, and OA (Wijayanto, 2008; Irnawati 2019).

Table 1 – Statistical analysis of bioeconomic models

Variable	MEY	MSY	OA
Catch	$\frac{rK}{4}\left(1+\frac{c}{Kpq}\right)\left(1-\frac{c}{Kpq}\right)$	$\frac{rK}{4}$	$\frac{rc}{pq}\left(1-\frac{c}{pqK}\right)$
Effort	$\frac{r}{2q}\left(1-\frac{c}{Kpq}\right)$	$\frac{r}{2q}$	$\frac{r}{q}\left(1-\frac{c}{pqK}\right)$
Total Revenue (TR)	Price x Catch	Price x Catch	Price x Catch
Total Cost (TC)	Cost x Effort	Cost x Effort	Cost x Effort
Economic Rent (π)	TR – TC	TR - TC	TR – TC

RESULTS AND DISCUSSION

Batang Regency is located between 6° 51' 46” and 7° 11' 47” South Latitude and between 109° 40' 19” and 110° 03' 06” East Longitude. Administratively, the government of

Batang Regency is about 110 km from Semarang City, which is the capital city of Central Java Province. Geographically, part of the Batang Regency area is a coastal area, where one of the geographical boundaries is the Java Sea. Batang Regency has a coastline of 38,750 km and in accordance with the legislation that the marine management area for the regency/city area is 4 miles, the Batang Regency's marine waters area is 287,060 km2. With this relatively wide area of marine waters, it holds a variety of fishery potential, both capture fisheries and aquaculture, namely marine cultivation and aquaculture ponds (Department of Marine Affairs and Fisheries of Central Java Province, 2016). The high potential of fisheries encourages people to use it as a livelihood.

Fishery production in Batang Regency tends to be stable. Although there are increases and decreases every year, they are not too significant. Likewise with the production value, the increase and decrease are not too significant. Fishery production using danish seine fishing gear which can be seen in Table 2.

Table 2 – Production and Production Value of Danish seine TPI Klidang Lor 1 2014-2019

Year	Production (Tons)	Production Value (Rp)
2014	12,617.40	54,025,880,000.00
2015	12,693.90	55,887,860,000.00
2016	15,768.20	69,287,490,000.00
2017	13,353.80	59,559,710,000.00
2018	9,227.75	41,203,750,000.00
2019	14,983.10	62,853,645,500.00
Average	13,107.36	57,136,389,250.00

Source: Research Data.

The highest production was obtained in 2016 with a total production of 15,768.20 tons with a production value of Rp. 69,287,490,000.00. The average catch of danish seine is 13,107.36 tons with an average production value of Rp. 57,136,389,250.00.

Catch Composition. Purple-spotted bigeye fishing in Batang Regency is generally carried out using danish seine. Danish seine is a fishing gear resembling a large purse that is increasingly conical which is operated at the bottom of the water with the target of catching demersal fish. This type of fish has a high economic value (Aji et al., 2013). Danish seine is a modification of the trawler type of fishing gear. This modification effort was carried out by fishermen as a result of a reaction to the enactment of Presidential Decree No. 39 of 1980 concerning the Elimination of Trawl Fishing Equipment in All Indonesian Waters (Hakim, 2016).

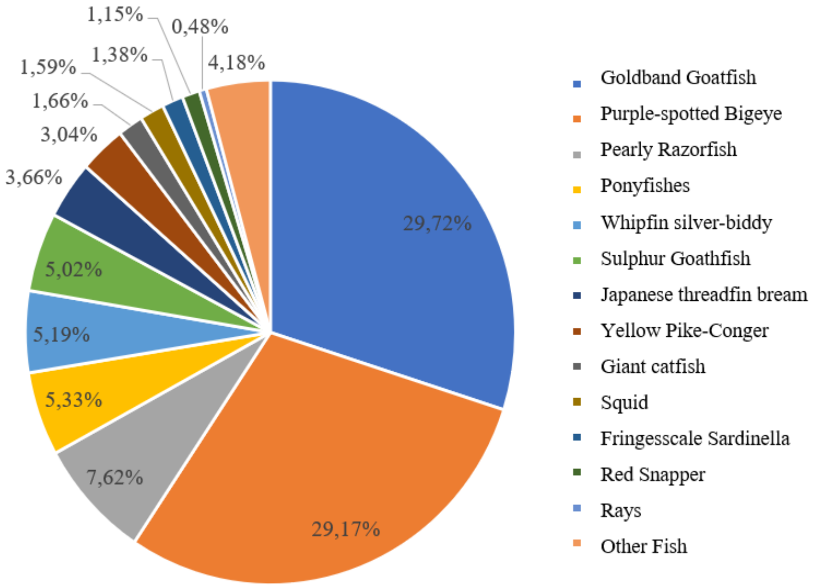

Figure 1 – Composition of Danish seine Catches

Figure 1 shows the catch of danish seine dominated by Goldband goatfish and Purple-spotted bigeye with a percentage of 29.72% and 29.1%. Furthermore, Pearly razorfish 7.62%; Ponyfishes, Whipfin silver-biddy and Sulphur goathfish by 5.33%; 5.19% and 5.02%. The rest are by-catches that are utilized (by-catch), and unused by-catches (discards).

The CPUE value shows the number of Purple-spotted bigeye catches divided by the amount of effort made. This can be seen in Table 3.

Table 3 – Total Catch, Effort, and CPUE of Purple-spotted bigeye

Year	Production (Tons)	Effort (Trip)	CPUE (Tons/Trips)
2014	1,390	1581	0.8792
2015	1,672	1871	0.8936
2016	2,174	1785	1.2179
2017	2,768	2440	1.1345
2018	1,478	718	2.0588
2019	2.156	1161	1.8571

Source: Processed data.

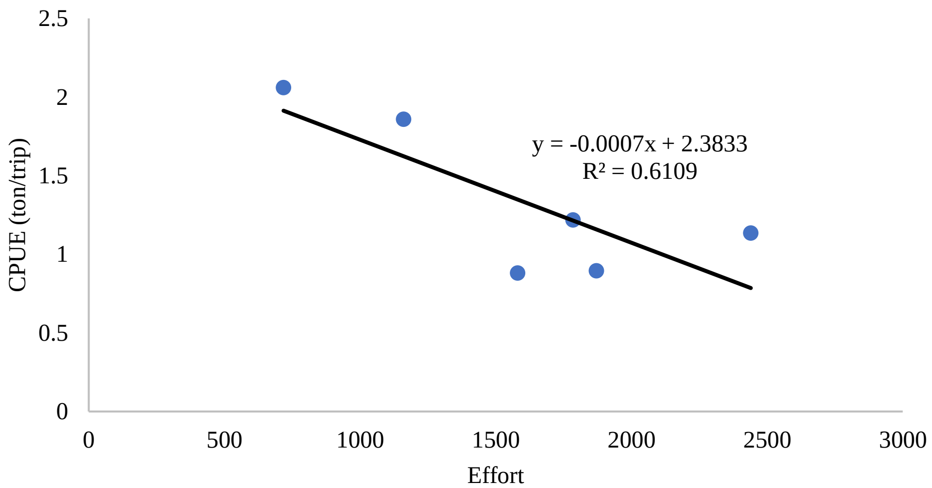

Figure 2 – Correlation between CPUE and Effort of Purple-spotted bigeye within period of 2014-2019

Figure 2 shows that the correlation between CPUE and effort has a negative correlation, where as the effort increases, the production of Purple-spotted bigeye catches (CPUE) will decrease. Changes in the CPUE value every year are affected by the addition or reduction of the number of effort (Masrikat, 2012). The CPUE value is inversely proportional to the effort value, where every additional effort will reduce the CPUE result (Rahmawati, 2013; Dewantara, 2020), this is because the resources will tend to decrease if the effort carried out continues to increase.

The CPUE value from 2014-2016 escalated due to the increase in Purple-spotted bigeye catches every year although Efforts were slightly increased in 2015 (Table 7). Then in 2017-2019 CPUE underwent changes according to the amount of Effort conducted. The linear equation of the correlation between CPUE and Effort is obtained $y = -0.0007x + 2.3833$. While the value of R2 regression obtained is 0.61; this shows that 61% of the CPUE value was influenced by the amount of Effort while the rest 39% was influenced by other factors.

Bioeconomic analysis is used to determine the potential of Purple-spotted bigeye resources from biological and economic aspects. Estimation of potential fish resources is important to determine whether the fishing process can still be carried out and is sustainable. The data used in the calculation of Bioeconomic is time series data in 2014-2019. The results of the calculation of the bioeconomic analysis using the Gordon-Schaefer model approach are presented in Table 4.

Table 4 – Bioeconomic analysis results with a model Gordon-Shaefer

Parameter	MSY	MEY	OA
Catch (H)(Tons)	2,473.16	2,184.03	2,225.94
Attempt to catch (E)(Trip)	2.075	1.366	2,732
Total Revenue (TR)(Rp.)	17,526,742,479	15,477,734,513	15,774,762,018
Total Expenditure (TC)(Rp.)	11,985,396,941	7,887,381,009	15,774,762,018
Rent/Profit (π)(Rp.)	5,541,345,538	7,590,353,504	0

Source: Processed data.

The results of the study using a bioeconomic model show that the amount of production under MSY conditions is 2,473.16 tons year^{-1}, with an effort of 2075 trips year^{-1}. This value is the maximum production level in the utilization of Purple-spotted bigeye that can be carried out without threatening the existence of the Purple-spotted bigeye resources. Utilization of Purple-spotted bigeye with maximum profit occurs in MEY conditions Rp. 7,590,353,504.97 with a production of 2184.03 tons year^{-1} and fishing effort of 1,366 trips year^{-1}.

The Profit in the MEY condition has a greater value than the Profit in the MSY condition, while the effort required to reach the MEY is smaller than the MSY. So it can be said that the level of effort in MEY conditions is more friendly to the environment and has an optimal profit value both economically and socially (Dewantara, 2020).

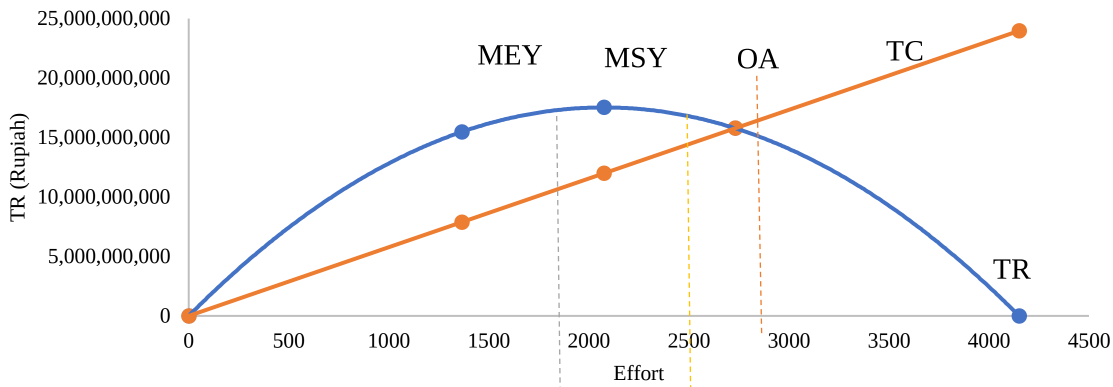

Figure 3 – Relationship Efforts with Total Profit (TR) on MSY, MEY, and OA Conditions

The Effort in 2017 was 2,440 trips, which is more than the Effort in the MSY condition 2,075 trips, this shows that in 2017 the Purple-spotted bigeye fishery experienced overfishing, the impact in 2018 the fishing trip decreased to 718 trips, assuming that fishermen reduce the number of trips to avoid losses. In 2019, the effort increased again to 1,161 trips. This amount still does not exceed MSY's effort and MEY's effort (1,366 trips) so it can be said that the use of Purple-spotted bigeye in 2019 has not experienced overfishing.

Sustainable fisheries management is an effort to regulate fishery inputs or outputs for the sustainability of fish resources themselves, by maintaining the sustainability of life resources (food) and livelihoods (income). (Wahyudin, 2018). The actual fishing Effort in 2014-2019 was 1,593 trips year^{-1} with catch of 1940.73 tons year^{-1}, the Effort value has exceeded the Effort of MEY but is still below the Effort of MSY.

CONCLUSION

Purple-spotted bigeye fishing in the waters of Batang Regency in actual conditions in 2014-2019 was obtained at 1,593 trips year^{-1}. This value does not exceed the optimum Effort (f_{MSY}) of 2,075 trips year^{-1}, so it can be said that the utilization of Purple-spotted bigeye in the waters of Batang Regency has not experienced overfishing. The utilization of Purple-spotted bigeye can still be carried out with strict supervision so as not to exceed the optimum limit so that Purple-spotted bigeye resources remain sustainable.

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