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Mackerel Fish (Rastrelliger Kanagurta) Management Strategy at Karangantu Port

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Abstract: The aim of this research is to understand the management strategy for Mackerel Fish (Rastrelliger *Kanagurta)* at Karangantu Harbor. The research method used by researchers is a quantitative research method. The sample selection in this research used the primary data sampling technique, using a purposive sampling technique. Because the aim of this research was mackerel, sampling was carried out randomly on the fishing fleet that caught mackerel and landed at PPN Karangantu. Meanwhile, the researcher's data analysis used Catch Per Unit Effort (CPUE), Fox Model, Schaefer Model, Walter-Hilborn Model, Clarke Yoshimoto Pooley (CYP) Model, and Schnute Model, as well as analysis of management strategy preparation using qualitative descriptive analysis methods based on MSY values, JTB, and average annual production/catch at Karangantu Harbor. The results of the research show that the correlation coefficient (R2) at 20 days is 0.9537. The r value is close to 1 (one), indicating a close relationship between length growth and fish weight. The condition of the mackerel fishery in the waters of Serang Regency is experiencing a decline. For the management of mackerel, the size of the nets used to catch mackerel should be enlarged so that fewer fish are caught that are smaller than the size at which the gonads first mature.

Keywords: Processing, mackerel, port

I. INTRODUCTION

Indonesia is the largest archipelagic country in the world, with a coastline of 95,181 km2, a sea area of 5.8 million km2, and a total territorial area of 7.7 million km2. This potential establishes Indonesia as a country that has the greatest marine biodiversity and non-biological diversity (Ministry of Maritime Affairs and Fisheries, 2010). Indonesia is the largest archipelagic country in the world, with a sea area wider than its land area. Its fishing potential can still be said to be abundant and diverse. It's just that this abundant potential has not been utilized properly. This potential consists of pelagic fish and demersal fish, which are spread in almost all Indonesian waters, one of which is the mackerel species.

It is feared that high utilization and declining stock conditions will threaten sustainability and cause the extinction of mackerel fish resources in the future. The fishing gear that is often used for catching mackerel is the purse seine (Rosyidah 2009). According to Sania (2015), mackerel in the waters of the Sunda Strait have experienced overfishing. In addition, the effort to catch mackerel in actual conditions is greater than the optimum effort conditions (fMSY), so it is suspected that overfishing has occurred.

Mackerel is a category of small pelagic fish from the *Scombridae family* that is spread throughout Indonesian waters. This fish plays an important role in the food chain as a coarse plankton eater and lives in large groups in coastal waters (Genisa 1999). Mackerel has quite a high economic value, with an omega-3 oil content that is very good for children's intelligence. This pelagic fish has good market value, locally, nationally, and even internationally (Sonodihardjo 2015). Fish resources are needed for human life as food and as an economic activity.

The high consumption of mackerel encourages humans to continue to exploit fish resources as much as possible. The waters of Banten Bay have a very high catch of mackerel, and this also encourages an increase in catch production every year. This is what has resulted in a decline in mackerel stocks due to high market demand for mackerel fish commodities and high fishing activities, resulting in changes in the status of fish resource stocks. The results of studies, according to several researchers, show that the high

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utilization of fish resources continues to increase among the community with disproportionate management carried out, causing an imbalance in the ecosystem in nature (Widodo and Suadi 2006). Fishing efforts that must be carried out include reducing fishing effort, using more selective and environmentally friendly fishing gear, and catching results that do not exceed sustainable potential.

Climate change will affect the physiology and behavior of fish, including individuals, communities, and populations. Extreme conditions with increasing water temperatures can have a negative impact on fish, such as decreased fish catch production because fishing areas and activities carried out by fishermen are very limited. Each fish species generally has an optimum temperature range for migrating, feeding, spawning, and other activities (Chassot et al., 2005). Continuous fishing with minimal effort in management can lead to very high utilization of several types of fish in Indonesian waters, one of which is in the waters of the Sunda Strait, where the catch is landed in Lampung Province and Banten Province.

One effort that can be taken to optimize the utilization of fish resources in the waters of Serang Regency and at the same time streamline fishing business activities based on the Karangantu PPN is by providing information on potential fishing areas so that fishermen do not just rely on intuition and experience alone. The dynamics of fishing areas in Serang Regency waters need to be studied systematically so that fishermen based in PPN Karangantu can use it as a consideration in planning fishing operations. The approach used to evaluate the dynamics of fishing areas in this research is information about the composition of catches originating from the waters of Banten Bay, Serang Regency.

for fish production at the Nusantara Fisheries Port, Karangantu District. Serang is still in 3rd place, and in first place, the highest fish production in 2021 in Banten Province is Kab. Pandeglang (DKP, 2021). Seeing that the Karangantu Archipelago Fishing Harbor is one of the areas on the island of Java whose production is dominated by mackerel fish (Rastrelliger *kanagurta)* and the importance of information regarding the rate and growth patterns of fish, it is necessary to conduct research on growth patterns with the variable relationship between length and weight of mackerel fish (Rastrelliger *kanagurta)*, which can then be used as information for all groups as a reference for sustainable fisheries management. Based on the explanation above, researchers are interested in conducting research with the title Strategy for Management of Mackerel Fish (Rastrelliger *Kanagurta)* at Karangantu Harbor.

II. METHOD

A quantitative research method is what the researchers use. The sample selection in this research used the primary data sampling technique, using a purposive sampling technique. Because the aim of this research was mackerel, sampling was carried out randomly on the fishing fleet that caught mackerel and landed at PPN Karangantu. The determination and measurement of fish samples are as follows:

Determination of Fish Samples

In this research, determining the number of samples that are already known can be done using the method described according to Arikunto (2010), namely, if the research objects are less than 100, then it is better to take all of the objects so that the research is population research, and if the population is greater than 100, then these objects can be taken as 10-15% or 20–25% of the sample.

Fish Length Measurement

According to Dani et al. (2005), measuring fish length includes measuring the total length of the fish, or total length (TL), in cm units. The total length of the fish is measured from the tip (anterior) to the back of the caudal fin (posterior).

The weight of the fish is the body weight of the fish in grams (W). The way to measure the body weight of a fish is to place the fish on a scale, observe the number indicated by the pointer, and note down the number printed on the scale (Effendie, 2002).

Fish samples that have been measured for length and weight are then dissected into the stomach to identify the sex of the fish and the level of gonad maturity. The secondary data used is the 2012–2021 Karangantu VAT capture fisheries statistical data (Karangantu PPN, 2021), the Karangantu PPN annual report (Karangantu PPN, 2012; 2013; 2014; 2015; 2016; 2017; 2018; 2019; 2020; and 2021), as well as fish catches in 2022. Meanwhile, the researcher's data analysis used Catch Per Unit Effort (CPUE), Fox Model,

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Schaefer Model, Walter-Hilborn Model, Clarke Yoshimoto Pooley (CYP) Model, and Schnute Model, as well as analysis of management strategy preparation using qualitative descriptive analysis methods based on MSY values, JTB, and average annual production/catch at Karangantu Port.

III. RESULTS AND DISCUSSION

The Karangantu Fishing Port was built in 1975/1976 with a land area of 2.5 ha located in Banten Village, Kasemen District. Based on the Decree of the Minister of Agriculture Number 311/Kpts/Org/5/1978 dated May 25, 1978, it was officially operational and became a Technical Implementation Unit (UPT) under the Directorate General of Fisheries with the name Karangantu Coastal Fishing Port (PPP) type C. Furthermore, on 30 December 2010 through the Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number: PER.29/MEN/2010 concerning the second amendment to the Regulation of the Minister of Maritime Affairs and Fisheries Number PER.06/MEN/2007 concerning the Organization and Work Procedures of Fishing Ports which was preceded by the issuance of a Ministerial Letter State of Empowerment of State Apparatus and Bureaucratic Reform of the Republic of Indonesia dated 2 December 2010 Number: B.3677/M.PANRB/12/2010 concerning Proposals for the Arrangement of UPT within the Ministry of Maritime Affairs and Fisheries, PPP Karangantu officially changed its name and increased its class to VAT Karangantu type B.

Mackerel Fishery in Karangantu

Mackerel can be caught with 6 (six) types of fishing gear, namely: gill nets, dogol nets, boat nets, step nets, fishing rods and rampus nets. This research focuses on vessels that operate daily (one day fishing) with the assumption that the mackerel caught are fish that come from the waters of Banten Bay.

Rampus Net Catching Tool

Rampus nets are the dominant fishing gear at the Karangantu Archipelago Fisheries Port (PPN). The rampus net is rectangular in shape, and the mesh size is the same throughout the main net. The number of meshes towards the length (mesh length) is greater than the number of meshes towards the bottom (mesh depth) (Ronaldo, 2016). Rampus nets are included in the gill net classification with the drift gillnet type.

Rampus net fishing gear is used to catch the dominant small pelagic fish, namely mackerel. The rampus net fishing equipment at PPN Karangantu has a net size of 2 inches consisting of several parts, namely ropes and pieces with a width of 12 m and a length of 14 meters, weights totaling 60 pieces and weighing 3 kg/piece, large floats with a cylindrical shape totaling 40, small round buoys totaling 70, buoy ropes, weight ropes, net bodies, stone weights, fishing ropes, sign buoys, and flags.

Based on the results of the interview, the ship for operating the rampus net fishing equipment was a wooden ship with a 24 PK engine with the name Gagak Muara. The number of fishermen is 3–4 people, with a flexible division of tasks when carrying out fishing operations with rampus nets. Operation of the rampus net trapping equipment began at 16.00 WIB. The location of the fishing area is in the waters around Banten Bay. The net removal time is around 2 hours, such as at 17.00 WIB, the net is spread, and at 19.00 WIB, the net is pulled. The fishermen returned to land at 05.00 WIB. According to fishermen, weather factors greatly influence the catch.

Rampus net fishing equipment is generally operated by boats with outboard motor engines (outboard), but there are also mitor boats (inboard) with 8–20 PK engines. Rampus net ships generally measure 2-4 GT, with a length of 6–8 m, a width of 1.5–2 m, and a depth of 0.6–1.2 m. Rampus net vessels with onboard engines are generally used for security reasons (theft) and to prevent engine damage due to collisions with other vessels. The size of the rampus net that is widely used by Karangantu fishermen is 6 m high by 800 m wide, made from monofilament string (tansi) material with a mesh size of 2 inches. Rampus nets can be operated passively or actively. Placement of rampus nets in waters can be on the surface or in the water column. The target catch is small to medium-sized pelagic fish.

Types of Fish Caught

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The types and numbers of fish obtained during research at the Karangantu Archipelago Fisheries Port (PPN) were very diverse, namely. Mackerel fish, tuna fish, tembang fish, mullet fish, mackerel fish, peperek fish, shark fish, trevally fish, swang fish, grouper fish and red snapper fish, pompano fish, mayung fish, black pomfret, beloso fish, yellow tail fish, kurisi fish, stingrays, sailfish, sunfish and turtle fish.

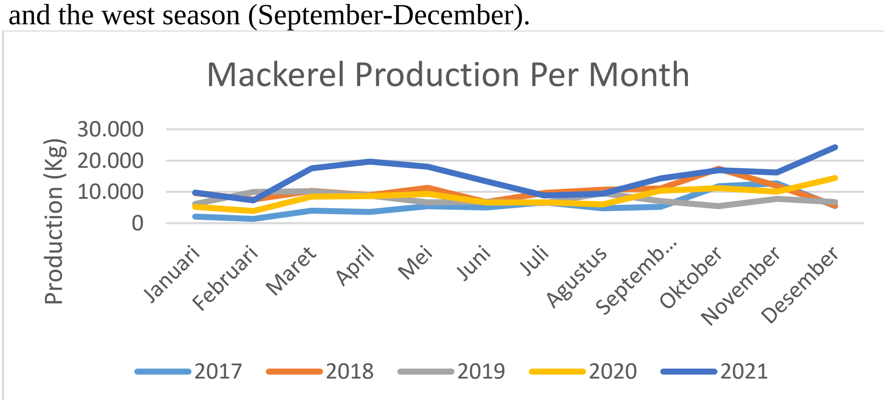
The composition of rampus net catches in 2021 shows that the largest catch is mackerel (49%). Rampus nets with a mesh size of 2 inches have proven to be quite effective in catching mackerel.

Table of Percentage of Fishing Types

No	Types of Fish	Percentage
1	Bloating	49%
2	Selanget	11%
3	Gulamah	4%
4	Mackerel	2%
5	Beloso	2%
6	Cob	2%
7	other fish	30%

Mackerel Fishing Season

Production of mackerel landed in PPN Karangantu can be found almost throughout the year, with the peak mackerel fishing season in Karangantu occurring in May-July and November-January (Figure 6.). These conditions show that the peak of mackerel fishing occurs twice a year, namely during the east season (April-August) and the west season (September-December).



Picture Mackerel Fish Production

The mackerel fishing season in Karangantu shows a different seasonal pattern from the fishing season pattern in the Java Sea where the mackerel fishing season in the Java Sea has one fishing season. According to Bardiyanto & Kasa (2007), mackerel catch production begins to increase in April and reaches its peak in July and August. According to Utami et al. (2014) fish production can fluctuate every year. This is normal because fish production is not only influenced by the amount of fishing effort undertaken, but is also influenced by other factors such as labor, abundance of fish resources, and capital.

Size of First Fish Caught (Lc)

Gear selectivity curves for mackerel are presented. The research results show that the first fish caught (Lc) of mackerel caught in the waters of Banten Bay with a rampus net was 17.77 cm, in the FL range of 17.6-18.5 cm which can be seen in Figure.

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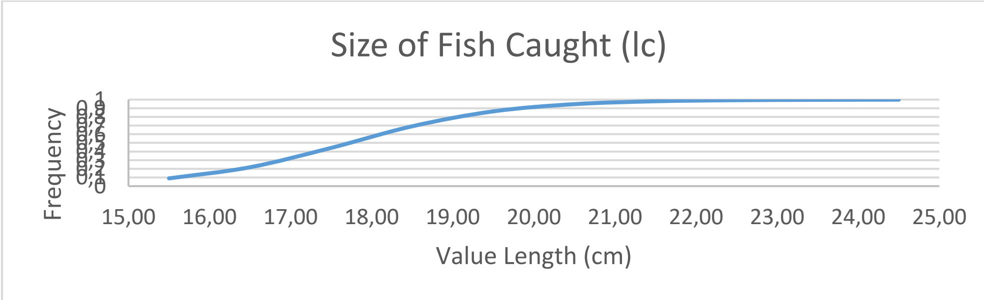


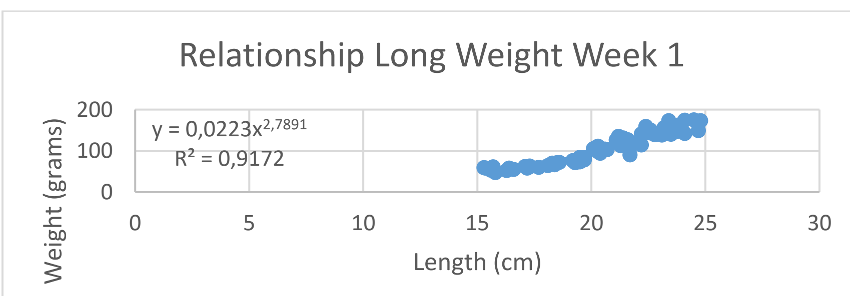
Picture of the Size of the First Time a Fish Was Caught

Long and Heavy Relationships

Analysis of the relationship between length and weight using data on the total length and wet weight of female mackerel (Rastrelliger brachysoma) The relationship between length and weight can determine a fish's growth pattern (Effendie, 2002). There are two forms of growth patterns from length and weight analysis, namely allometric and isometric growth. Results of the analysis of the relationship between length and weight of mackerel in the first, second, and third weeks, Figures 8, 9, and 10.

The results of the analysis of the relationship between length and weight of mackerel in the first, second, and third weeks were 2.7891, 2.8494, and 2.6171, respectively. The t test results showed that the growth pattern of mackerel in the waters of Banten Bay was allometrically negative in the first, second, and third weeks, which means that the growth in length of mackerel was more dominant than the growth in weight. Imbalance ($b \neq 3$) can be influenced by temperature, food, and dense fish populations. Meanwhile, the monthly value $b < 3$ indicates that there was no change in environmental conditions in the first, second, and third weeks, so the factors influencing the length-weight relationship are probably the same. According to Muchlisin (2010) in Mulfizar et al. (2012), a b value <3 can also be caused by fish behavioral factors. Fish that swim actively (pelagic fish) show a b value < 3. where length growth is faster than weight growth when compared to passive swimming fish (for example, demersal fish). It is suspected that this is related to the allocation of energy spent on movement and growth.

To test the b value, it is necessary to carry out a t test. The t test is an attempt to reject or accept the hypothesis made. Conclusions are drawn by comparing the calculated t with the t table at a 95% confidence interval. The results of the t test show that the calculated t value is < t table, so the decision is to accept the null hypothesis. The correlation coefficient (R2) value at 20 days is 0.9537. The r value is close to 1 (one), indicating a close relationship between length growth and fish weight.



Relationship Pictures Length Weight First Week

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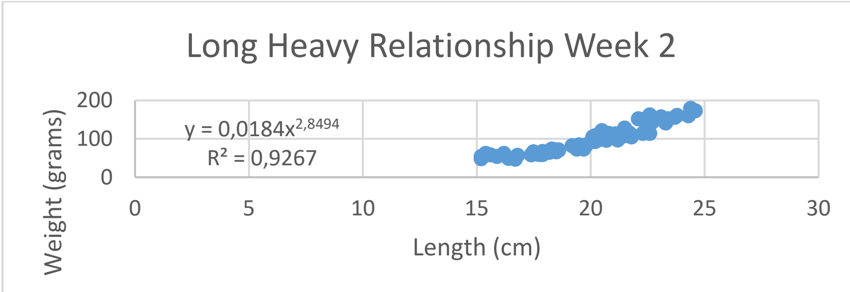
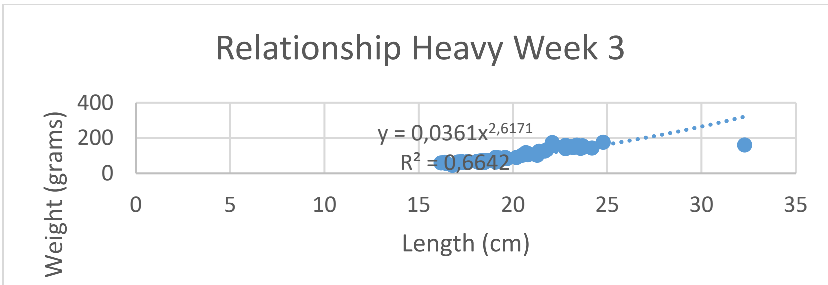


Relationship Pictures Length Weight Second Week



Relationship Pictures Length Weight Third Week

MSY and JTB analysis

The results of the standardization analysis of female mackerel fishing gear in the waters of Banten Bay show that rampus net fishing gear has a large Fishing Power Index value compared to other fishing gear with a value of 1. This rampus net fishing gear is classified as standard fishing gear. Rampus net fishing gear can be used as a reference as an environmentally friendly fishing gear based on the Fishing Power Index value . Mackerel fishing is carried out continuously. This has led to the need to analyze the potential of mackerel resources in the waters of Banten Bay.

The CPUE calculation for mackerel at Karangantu Harbor was carried out by analyzing the Fishing Power Index , through standardizing effort for each mackerel fishing gear. There are 4 (four) types of standardized fishing gear. Standardization is carried out by multiplying the effort by the FPI value. The FPI value for each fishing gear can be seen in Table 3.

Table of FPI Values for Each Fishing Gear

NO	Year	Fishing rod	Step Chart	Jr. Indecent	Floating Chart
1	2012	0.00	0.00	1.00	0.35
2	2013	0.02	0.01	1.00	0.22
3	2014	0.03	0.01	1.00	0.16
4	2015	0.03	0.00	1.00	0.33
5	2016	0.14	0.00	1.00	0.50
6	2017	0.07	0.02	1.00	0.20
7	2018	0.11	0.00	1.00	0.02
8	2019	0.02	0.00	1.00	0.03
9	2020	0.02	0.00	1.00	0.05
10	2021	0.00	0.00	1.00	0.08

The total standardized fishing effort is then used to calculate the annual CPUE value of the standardized fishing gear which is presented in Table 4 and the fluctuation graph of the annual CPUE value for mackerel is presented in Figure.

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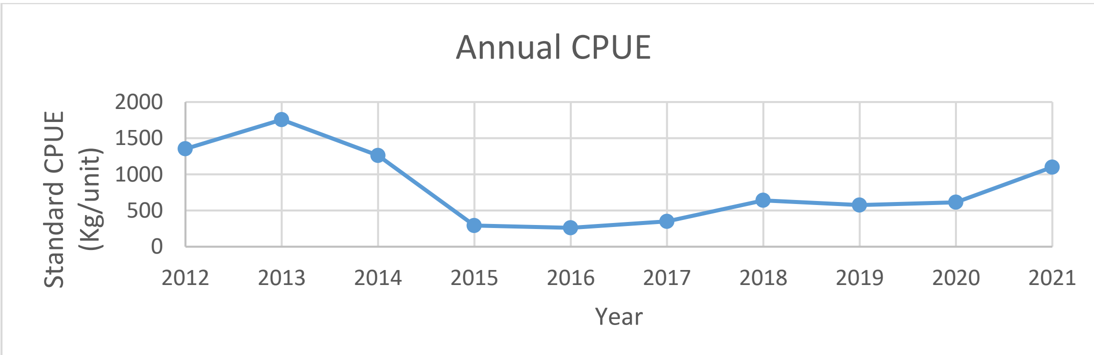
Annual CPUE Table of Fishing Gear

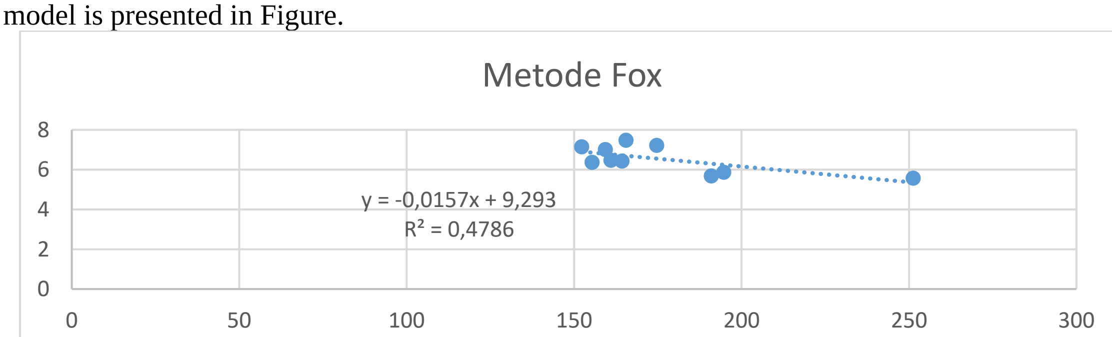
Year	Standard Effort	Total Production	Standard CPUE
2012	175	236,381	1353
2013	166	290,797	1756
2014	152	192.127	1261
2015	191	55,879	293
2016	251	65,659	261
2017	195	68093	350
2018	161	103267	641
2019	155	89496	576
2020	164	100857	614
2021	159	175242	1099



Annual CPUE Image of Mackerel

Standardization of fishing gear is carried out to produce standard catch per unit effort (CPUE) for 2012-2021. The highest CPUE was in 2013 at 1,756 kg/fleet unit and the lowest was in 2016 with a value of 261 kg/fleet unit.

The production model is used to determine the optimum level of effort in order to produce maximum sustainable catch effort. The data used in the production model analysis is data on catches and efforts to catch mackerel at the Karangantu Fishery Harbor for 5 years. The mackerel production model using the Fox model is presented in Figure.



Fox Model Image

The best Surplus Production model, which can be used to estimate mackerel in Serang Regency waters, is the Fox model compared to 5 other models. The results of the Fox model obtained a value of (R 2 = 0.4786) and obtained a value of a = 9.293, a value of b = -0.0157. The maximum sustainable catch value (MSY) of mackerel is 186,148 kg per year, the optimum effort (fMSY) is 30 trips per year and the Total Allowable Catch (TAC) is 148,918 kg. The value of actual catch and actual catch effort in 2021 is 175,242 kg per year and 74 trips per year. The actual catch value in 2021 is smaller than the MSY value

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and the actual catch effort value is greater than the fMSY value. This indicates that the mackerel has experienced overfishing.

Gonad Maturity Level (TKG)

The samples observed were 200 mackerel gonads consisting of 82 male fish gonads and 118 female fish gonads (Table 6.).

Table of Male Gonad Maturity Levels

Gonad Maturity Level	Gonads not yet mature				Mature Gonads	
	I		II		III	
	N	%	N	%	N	%
The first week	11	39.3	12	42.9	5	17.9
Second week	17	65.4	7	26.9	2	7.7
The third week	17	60.7	8	28.6	3	10.7
Amount	45		27		10	

Table of Female Gonad Maturity Levels

Gonad Maturity Level	Gonads not yet mature				Mature Gonads	
	I		II		III	
	N	%	N	%	N	%
The first week	25	59.5	11	26.2	6	14.3
Second week	23	52.3	14	31.8	7	15.9
The third week	20	62.5	10	31.3	2	6.3
Amount	68		35		15	

The results of observations on Gonad Maturity Levels showed that the gonads of male fish and female fish were more frequently found in TKG I. The gonads of male fish in TKG I were mostly found in the second week at 65.4 % . Meanwhile, the gonads of TKG I female fish were mostly found in the third week at 62.5 % . This shows that most of the mackerel fish caught in Banten Bay waters are immature. Fishing that continues to be carried out without paying attention to the continuity of resources will cause a decline in natural stocks. According to Prahadina (2013), the length of the mackerel caught should be greater than the size at which the gonads first mature (it is assumed that the fish has spawned at least once) .

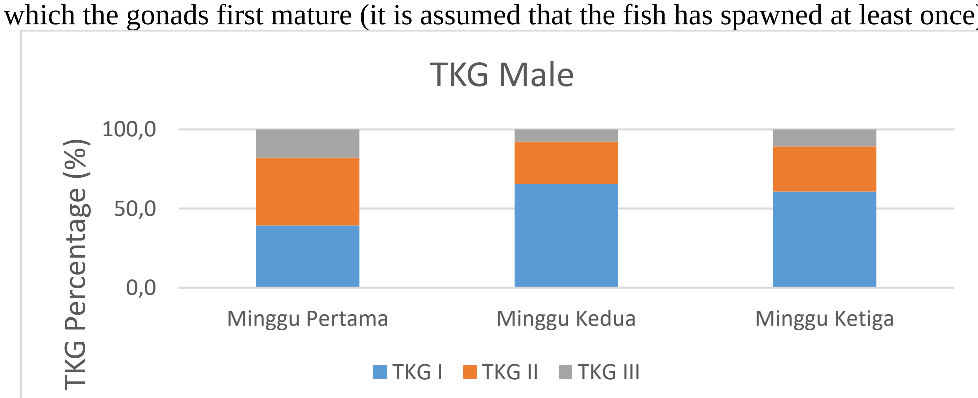

Figure Percentage of Male TKG

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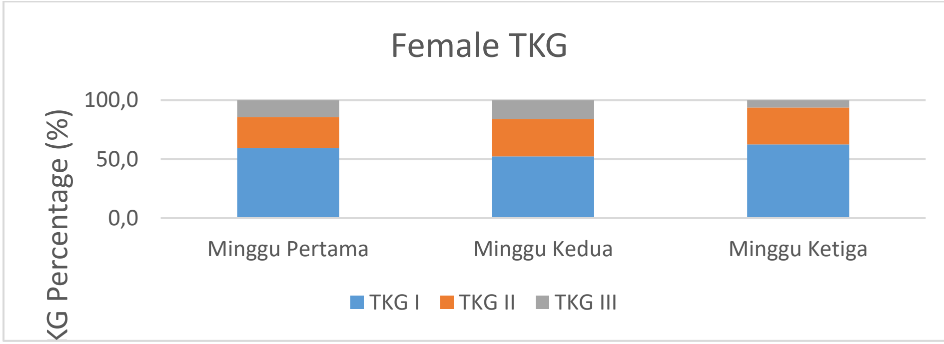

Figure Percentage of Male TKG

Overall, TKG male fish and female fish were most often found in TKG I and TKG II . In TKG observations of male and female fish, no spawning gonads were found, this is thought to be due to the continuous fishing of mackerel without paying attention to the size of the fish and the continuity of fish resources which has caused a decline in fish stocks in the waters of Banten Bay. The development of TKG I to spent (spawning) will be seen if research is carried out during one spawning cycle (Effendie, 2002). According to FAO (1975), mackerel is a type of partial spawning fish that spawns twice a year.

Management Strategy for Mackerel Fish in Serang Regency Waters

In a marine ecosystem, there are relationships between fish species, one of which is competition. This competition is either for food or space or habitat, causing one species to dominate. Therefore, several biological aspects were studied, including reproductive aspects and population dynamics, to obtain the information needed to manage fish resources. After information is obtained through research and a literature review, steps (strategies) for managing tembang and lemuru fish in the waters of Serang Regency can be made. Strategies that can be implemented include setting fishing times, determining the size of fish that can be caught, setting the number of catches that are allowed (sustainable catch) and optimal fishing effort, and so on. It is hoped that the strategy that has been created can be used as basic information to create policies by the local government (Banten Province Maritime and Fisheries Service and Serang Regency Maritime and Fisheries Service) in managing mackerel resources in Serang Regency waters so that the use of fish resources can still pay attention to sustainability. and the sustainability of these fish resources in the future. Apart from that, the implementation of the regulations must be monitored through a strict monitoring, control, and Surveillance (MCS) system.

Management that can also be carried out is to increase the mesh size and increase supervision in recording catches. The size of the net used to catch mackerel should be increased so that fewer fish below the first mature gonad size are caught. There has been an increase in the monitoring and recording of catches to avoid analytical errors due to less representative data. According to Boer and Aziz (2007), fisheries management aims to achieve the welfare of fishermen, provide food and industrial raw materials, earn foreign exchange, determine the optimum utilization portion by fishing fleets, and determine the number of permitted catches based on the maximum sustainable catch value.

IV. CONCLUSION

Based on the analysis and study above, it can be concluded that the condition of mackerel fish resources in Karangantu is still quite good, but the Gonad Maturity Level results for mackerel did not find gonads that had spawned. This is thought to be due to the continuous fishing of mackerel without paying attention to the size of the fish and continuity of fish resources, which causes a decline in fish stocks in the waters of Banten Bay. Mackerel fish resources in Karangantu have not shown a decline in production; however, looking at the Lc value of 17.77 cm and the TKG value, it can be concluded that the fish caught are fish that have not yet spawned. This needs to be watched out for as an indication of environmental damage. Mackerel fish in the waters of Banten Bay have a negative allometric growth pattern, which means

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that the length growth of mackerel fish is more dominant than the growth in weight. The correlation coefficient (R2) value at 20 days is 0.9537. The r value is close to 1 (one), indicating a close relationship between length growth and fish weight. The condition of the mackerel fishery in the waters of Serang Regency is experiencing a decline. For the management of mackerel, the size of the nets used to catch mackerel should be increased so that fewer fish are caught that are smaller than the size at which the gonads first mature.

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