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Management of Swanggi Fish (*Priacanthus Macracanthus*) in the Waters of the Port of Nusantara Fishery Port Ratu

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Abstract. Indonesia has two-thirds of its territory covered by sea, making it rich in marine resources, especially fish. According to the Census of Marine Life, there are around 950 thousand species that inhabit the world's oceans, but only about one percent have been exploited. In Indonesia itself, FishBase records around 4743 types of fish, making it the country with the largest Marine Mega-Biodiversity in the world (Jabbar, 2018). There are two main problems in the fisheries sector in Indonesia: economics and biology. Biological problems include threats to the sustainability of fish stocks, while economic problems are related to the lack of profits obtained by fishermen from catches and sustainable use of fish resources (Akoit and Nalle, 2018). The Archipelago Fisheries Port (PPN) plays an important role in supporting fishing activities in the Indian Ocean, including in Palabuhanratu, West Java. Palabuhanratu is an important location for landing various types of fish, especially large pelagic fish such as tuna and skipjack, as well as swanggi fish (Priacanthus macracanthus), which experienced a significant increase in production from 573 tonnes in 2013 to 18,730 tonnes in 2015 (Sadewi et al., 2018). Swanggi fish is a demersal fish with high economic value that is in demand by the public and is an export commodity to Korea, Japan and China. However, high demand results in overfishing and a decline in adult fish stocks (Jabbar et al., 2017). This research is descriptive quantitative research which aims to measure the level of variables through samples. The analytical methods used include analysis of biological aspects of swanggi fish, catch analysis methods, and sustainability analysis methods using Rapid Appraisal for Fisheries (RAPFISH). It is hoped that the results of this research can provide a sustainable shrimp resource management strategy based on the data obtained.

Keywords: Fishermen's Extension, Fish Resources

I. INTRODUCTION

Two-thirds of Indonesia's territory is sea. Various types of resources that can be utilized from the sea, including fish resources. The Cencus of Marine Life lists 950 thousand species inhabiting the world's oceans. It was further described that only about one percent has been utilized to date out of around 21% that has been described. Data collected by FishBase shows that there are no less than 4743 types of fish found in Indonesian seas. This figure is enough to describe Indonesia as the largest Marine Mega-Biodiversity area in the world (Jabbar, 2018). There are two problems in the Indonesian fisheries sector, namely economic problems and biological problems. The biological problem that occurs is that the sustainability of fish stocks is threatened. The economic problem is that the results of catches made by fishermen have not provided adequate profits and utilized sustainable fish resources and obtained maximum profits (Akoit and Nalle 2018).

The Archipelago Fisheries Port (PPN) plays a role in supporting fisheries activities that utilize fish resources in the Indian Ocean. PPN Palabuhanratu is also a landing place for various types of fish, especially large pelagic fish such as tuna and skipjack. Swanggi fish is one type of fish that is often landed in the Palabuhanratu PPN (Kharunisa, 2018). Palabuhanratu is a body of water on the southern coast of West Java, including the Sukabumi area. These waters have good potential in terms of fisheries resources. Palabuhanratu is the southern coastal waters of West Java, including the Sukabumi area. Geographically, it is located between 6050'–7050' South Latitude and 100010–1060 30' East Longitude with a coast length of approximately 105 km (Prihatiningsih and Nur, 2013). Swanggi fish found in PPN Palabuhanratu experience an increase in use every year. In 2013, swanggi fish production reached 573 tons, then increased in 2014 to 8,310 tons and increased again by 18,730 tons in 2015 (Sadewi et al. 2018).

Swanggi or suanggi fish (Priacanthus macracanthus) from the demersal group (fish that live near the bottom of the water) with predominantly red scales and large eyes are not widely known. The people of Palabuhanratu call bigeye fish multi-beneficial for human life. Other names are catalufas or bigeyes (big eyes), bulleye, bullseye, glasseye, and snapper. Swanggi is one of the export commodities that is quite popular because its protein content is quite high, reaching 18.26 ± 2.10% (Fawzya et al. 2011)

Swanggi fish is a demersal fish that is popular with the public and has high economic value. The high demand from the public for consumption of swanggi fish can result in high catches by fishermen. There are several companies located at the

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Palabuhanratu Archipelago Fisheries Port (PPN) that collect swanggi catches for export to Korea, Japan and China. Fish that have high economic value will increase fishing effort, resulting in overfishing. Higher demand results in higher fishing effort, the stock of adult fish of a certain size decreases due to continuous fishing, which has an impact on catching fish that have not yet reached adult size. If this condition continues, the swanggi fish stock will become extinct (Jabbar et al. 2017).

The benefits of catching this species are felt by Asian communities, including Indonesia. Swanggi fish is not only utilized by being marketed fresh, dried and salted but is also the preferred species as raw material for surimi and a potential source of natural antioxidants from fish skin gelatin hydrolyzate (Starnes 1999; Sivakami et al. 2003; Phanturat et al. 2010). Surimi solid waste such as heads, internal organs, feces and bones (Park and Morrissey 2000) can be used as nutritional ingredients in alternative feed ingredients in aquaculture (Safitri et al. 2016).

II. METHODS

The research carried out is a type of descriptive quantitative research carried out by measuring the level of a variable in the sample results. The research was carried out in several stages of activities starting with the process of data collection, data processing, data analysis, and writing up research results. The final result of the research process provides a strategy prepared based on data analysis for sustainable shrimp resource management. The data analysis process in this research used several analytical methods which include the biological aspect analysis method of Swanggi Fish, the catch analysis method, the sustainability analysis method with Rapid Appraisal for Fisheries (RAPFISH) analysis. From the results of the analysis of the biological aspects of shrimp, it will provide an analysis result in the form of a long relationship. weight, sex ratio and maturity level of caught shrimp godan Figure 1.

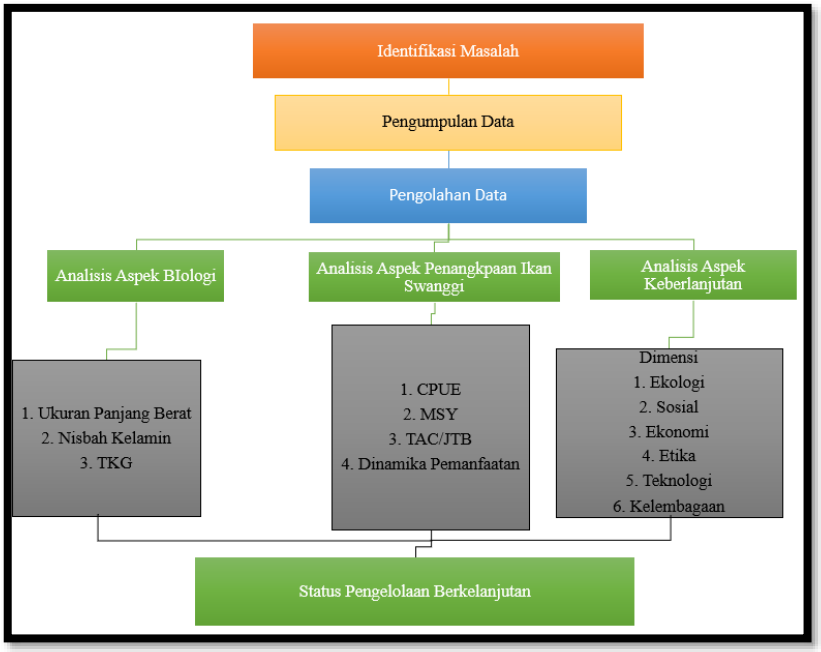

Figure 1 Research Stages.

III. RESULTS AND DISCUSSION

Ratu Harbor is one of the Sukabumi districts in West Java Province. Astronomically, Sukabumi Regency is located at coordinates 1060 5' 30" – 1060 30' 30" South Latitude and 60 90' – 60 99' 20" East Longitude. The city of Sukabumi Regency is also the center of government for Sukabumi Regency . Palabuhanratu is also a sub-district in Sukabumi Regency , West Java Province , Indonesia . It is located on the coast of the Indian Ocean , namely in the southwest part of the district

The majority of residents in Pelabuhan Ratu depend on the fishing profession for their livelihood. Geographical conditions that allow access to the coastal areas of southern Java make fishing the main livelihood in this area . Even though several generations have changed jobs because they consider the profession of fishing to be old-fashioned and high-risk, fishermen still hold the largest percentage of the livelihood chosen by the people of Pelabuhan Ratu. Without fishermen, the supply of marine and fishery products in Indonesia will not be fulfilled, and the price of marine products could soar . So, the fishing profession still plays an important role in the economy of this region

The location is approximately 94.60 km2 to the south of Sukabumi City. This beach is known to have very strong waves and is therefore dangerous for beach swimmers. The topography is a combination of steep and sloping beaches, steep coral cliffs, crashing waves and nature reserve forests. The population of Palabuhanratu District is 114,501 people, with a population density of 1,210 people/km². Then, the percentage of the population of Palabuhanratu District based on the religion adopted, namely Islam is 99.37%, then Christianity is 0.61% where Protestants are 0.35% and Catholics are 0.08%, Hindus are 0.05% (skikandi, 2020)

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Management of Capture Fisheries in Pelabuhan Ratu

One of the fisheries production activities in Sukabumi City is marine capture fisheries. In 2022, marine capture fisheries in PPN Pelabuhan Ratu, Sukabumi Regency will contribute to fisheries production with a fisheries production volume of 1,000,00 tons. The fisheries resources landed at this fishing port are very diverse. These include small pelagic fish, large pelagic fish, demersal fish, squid, scallops and scallops. These types of fish have a distinctive taste that can be served directly as food, such as fried, grilled or sauced. Apart from that, the sea fish that are landed are also processed into various processed products, such as salted fish, smoked fish and fish balls. Consumers who are often found at this fishing port generally come from restaurant entrepreneurs, seafood processing entrepreneurs, market traders and housewives.

The production volume produced is the production of various dominant species, namely large pelagic fish (Big Eye Tuna, Albacore Tuna), small pelagic fish (Cakalang), soft animals (mollusca), and hard-skinned animals (crustaceae), large demersal fish and including small demersal fish.

Fishermen land at this fishing port and go to sea daily to weekly. Daily fishermen usually leave in the afternoon and return in the morning, while fishermen who spend more than a day can go to sea for 2 weeks to 1 month with their fishing areas around Pelabuhan Ratu Bay, Ujung Genteng Waters, and Ujung Kulon Waters. The Sukabumi Regency area has 16 Fish Auction Places (TPI) and 1 fishing port which also functions as a TPI and supports the fisheries management process in Sukabumi City (PPN Pelabuhan Ratu).

Fishing Season Area Fishermen in Pelabuhan Ratu fish mostly in the Pelabuhan Ratu Bay area, Ujung Genteng. In general, the fishing season is divided into two, namely the west wind season and the east wind season. Most fishermen in Pelabuhan Ratu are reluctant to go fishing in the west wind season, this is because the waves are high and many fishermen even disappear when they go fishing in the west wind season. , the east wind season is supported by good weather, there are rarely big waves or big waves. In general, the fishing season depends on moonlight which takes advantage of the positive phototactic behavior of fish. Based on interviews with several crew members, the swanggi fishing season starts from August-January.

TPI in Pelabuhan Ratu is spread across several areas. The distribution of the 13 TPIs in the Sukabumi City area is spread across the Cikambeng, Cibangban, Legon Pari, Cisolok, PPN Pelabuhan Ratu, Cipatuguran, Loji, Sangrawang, Giri Mukti, Ciwaru, Ujunggentng, Minajaya, Tegal Buled areas. The production volume and production value produced at each TPI can be seen in Table 1.

Table 1. Volume and Value of Marine Capture Fisheries Production in Sukabumi Regency in 2023 per TPI

No.	TPI area	Production Volume (tons)	Production Value (Rp. million)
1.	Cikambeng	50,965	19,435.33
2.	Cibangban	47,674	18,463.45
3.	Legon Pari	48,696	15,342.77
4.	Cisolok	59,833	18,311.94
5.	Ratu Harbor VAT	197,368	352,961.00
6.	Cipatuguran	57,451	25,423.30
7.	Lodge	51,632	17,674.07
8.	Sangrawang	49,533	13,654.56
9.	Giri Mukti	47,321	25,292.75
10.	Ciwaru	52,044	16,876.87
11.	Ujunggentng	60.144	14,977.03
12.	Minajaya	63,896	18,564.67
13.	Tegal Buled	63,084	19,655.66
Total		990,398	576,655.66

Source: Sukabumi Regency Fisheries Service (2023)

During the last 5 years, capture fisheries production in Sukabumi Regency has experienced fluctuating conditions. The highest volume of marine capture fisheries production during 2019 to 2023 occurred in 2019, namely 10,528.85 tons.

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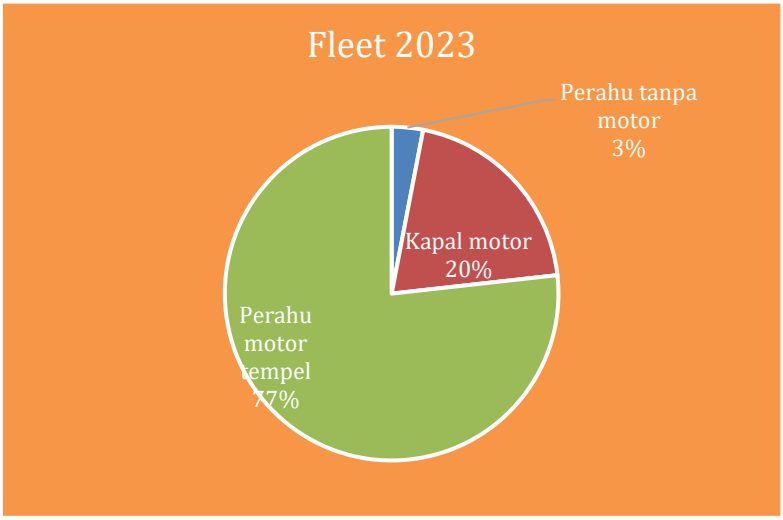

Figure 2. Composition of the Capture Fisheries Fleet in 2023

Source: Sukabumi Regency Fisheries Service (2023)

The role of cooperatives in fisheries management at PPN Pelabuhan Ratu is quite optimal. One of the fishermen groups in the Sukabumi Regency area. Apart from that, there are cooperatives which are operated by managing fish landing sites and the fish auction process. Apart from that, the cooperative also plays a role in providing fuel for fishing boats through operating fuel filling stations for fishermen or Solar Pack Dealer Fishermen (SPDN). The results of interviews with fishermen and the Sukabumi Regency Fisheries Service show that the SPDN facility is very useful for fishermen because it makes it easier for fishermen to reach the fuel needs for the boats they operate and also highly controlled bulk ice for fishermen going to sea.

Swanggi Fish Commodities

Swanggi fishing in the waters of Pelabuhan Ratu is carried out using fishing gear. This fishing gear is a fishing gear that is operated passively using a fleet (without boats). The fleet used to operate Gill net fishing gear uses outboard motor boats with a capacity of 2 - 10 Gross Tonnage (GT) and motor boats with a capacity of 10 - 20 GT. The fleet used with Gill net fishing equipment in the form of outboard motor boats can be seen in Figure 3.

Figure 3. Fleet of Boats With *Gill Net* Fishing Gear

Gill net fishing gear is a selective fishing gear. Trammel net is a fishing tool that consists of three layers of net. In general, the trammel net fishing equipment used is 22 meters long and 1.2 meters wide. Fishermen operate gill nets by spreading the net to the bottom of the water in a circular pattern. Apart from that, there are fishermen who spread their nets by spreading them lengthwise without forming a circular pattern. The technical operation of the gill net which is spread to the bottom of the water is because shrimp have a tendency to be at the bottom of the water. The mesh size (net opening) of the gill net used to catch swanggi fish is 1.25 inches for the middle net (inner net) and 5.5 inches for the outer side net (outer net).

Widodo and Suadi, 2006 in Sumartini, 2003, also stated that fisheries management can be done in several ways, including:

1. Setting the mesh size
2. Setting limits on the size of fish that may be caught, landed or marketed
3. Control the fishing season

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4. Control of fishing areas
5. Arrangement of fishing equipment and its equipment

Number of trammel net fishing gear operated in the waters of. Swanggi fishing activities using trammel net fishing gear are carried out using a one day fishing mechanism. This fishing mechanism is carried out with the consideration that the fishing ground is still accessible in one day, the fleet is a small boat and does not allow swanggi fishing to be carried out for days, and to maintain the quality of the catch so that it remains in good condition. From the results of interviews with fishing gear operations with crew members, local fishermen usually leave in the afternoon for a 2-3 hour boat trip to the fishing area. After arriving at the fishing ground, the speed of the boat is reduced so that it moves slowly. Through the left side of the stern of the vessel the descent begins with the lowering of the pockets, body, wings and crossbar. For nets that operate using an otter board, after all parts of the net are on the surface of the water, the net is pulled so that the positions of the two wings are parallel. Next, the two boards are lowered together and left to float on the surface of the water while being pulled until the position of the two boards is perfect. When the towing rope is lowered, the boat's movement accelerates slightly. The length of the towing rope is adjusted to the depth of the water. The end of the towing rope is tied to the front of the boat while at the right stern the towing rope is pulled parallel to the boat so that the position of the net is behind the boat. The boat moves forward at a certain speed (3-4 knots) and the net is pulled for 1-3 hours. After the net pulling is complete, the machine is turned off and the towing rope is pulled using human power so that the entire net is lifted. The catch is removed from the bag by opening the bag strap. The nets and rigging are rearranged for the next brawl. And on average trammel net fishermen start going to sea in the morning and return home in the afternoon to immediately sell their catch at TPI which is spread across several areas in Pelabuhan Ratu Regency.

Figure 4. Interview with fishermen

The swanggi fish caught by fishermen are marketed directly through an auction process at TPI or sold directly to middlemen (bakul). The sale of catches to middlemen by Swanggi fishermen is carried out because most of the capital used by fishermen comes from middlemen. Fishermen who utilize capital from middlemen are economically bound by an agreement, so that the catch is sold to the middlemen who provide capital.

UNDIP Research Institute, 2000 in Budiman, 2006 states that the principles of fish stock management can be categorized as follows:

1. Controlling the number of fishing attempts: the aim is to regulate the number of fishing gear to a certain amount.
2. Control of fishing gear: the aim is that fishing efforts are only aimed at catching fish that have reached a certain age and size

The production volume of swanggi fish in Sukabumi Regency this year reached tons of the total volume of marine capture fisheries production. Production of swanggi fish in Sukabumi Regency in 2023. Total production of swanggi fish in 2022 respectively for each type, namely production of bigeye tuna 8%, albacore tuna 6%, tembang 7%, layang, swanggi fish 28%, sailan 26%, layur 2%, and others. The percentage of shrimp production can be seen in Figure 5.

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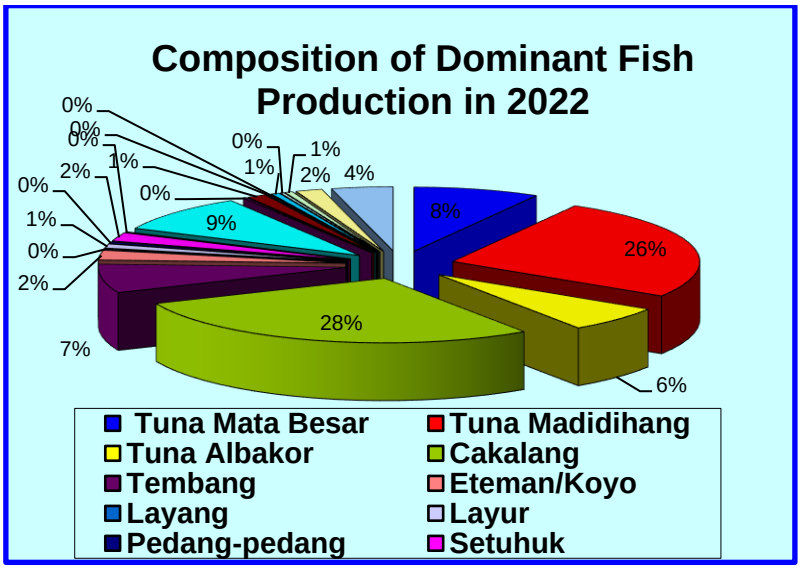

Figure 5. Swanggi Fish Production Volume in 2022 at PPN Pelabuhan Ratu
Source: Reprocessed from the Pelabuhan Ratu Fisheries Service (2022)

One of the catches in the waters of Sukabumi Regency which has high economic value is swanggi fish, but the main catch in Ratu Harbor is pelagic fish and demersal fish. Swanggi fish is part of the main catch target by fishermen who use gill nets. The selling value of swanggi fish is high compared to other types of fish. Swanggi fish is continuously used by fishermen. Images of swanggi fish can be seen in Figure 6 and Figure 7

Figure 6. Swanggi Fish

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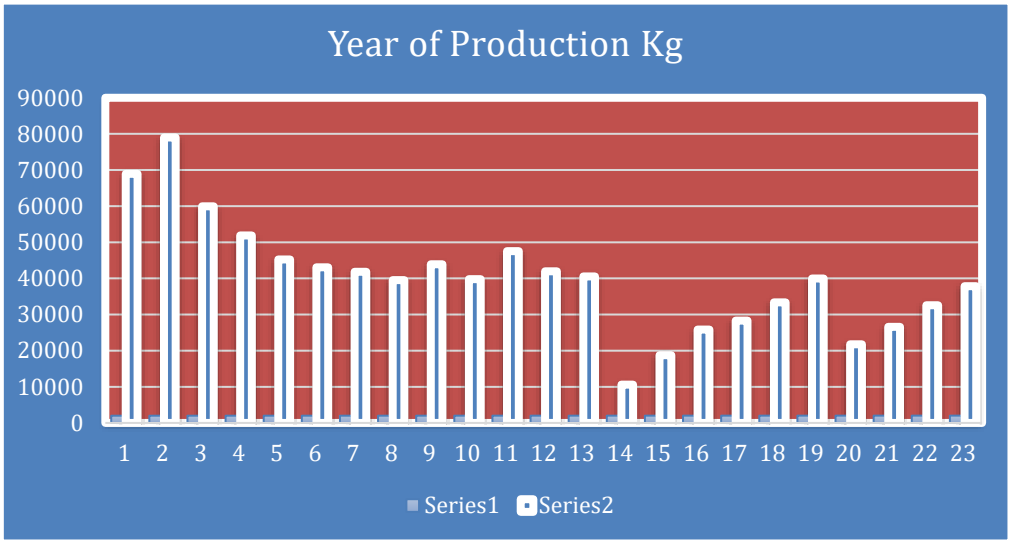

Figure 7. Swanggi Fish Production Volume (kg) at Pelabuhan Ratu 2001 to 2023

The volume results obtained in 2002 increased to 78,987 kg and decreased in 2014 to 10,609 kg and increased slightly until 2023

Biological Conditions of Swanggi Fish Resources

The results of field observations of data on the biological aspects of swanggi fish in the waters of Sukabumi Regency show the b value which is a constant from the regression results. This value provides an overview of the condition of the Swanggi Fish which was caught using gill net fishing gear. The analysis results show that the b value is . This value shows that the growth pattern of swanggi fish is negative allometric (b < 3). A negative allometric growth pattern means that the increase in body length of swanggi fish is faster than the increase in weight. The results of data calculations in the field can be seen in Figure 8.

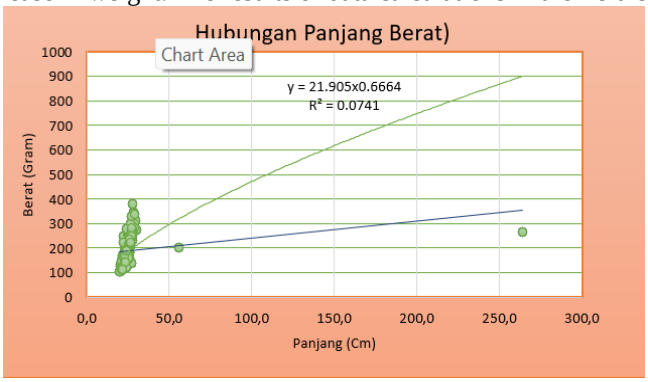

Figure 8. Relationship between Length and Weight of Swanggi Fish

The results of calculations regarding the relationship between length and weight of swanggi fish show that the increase in length is faster than the increase in weight, it can be assumed that the swanggi fish caught are still in a growing condition and not at an old age. The older the fish, the increase in weight should be greater than the increase in length Asbar (1994 in Budianto, 2012)

Sex Ratio

The sex ratio is important to determine the structure of the swanggi fish population. Field observations of the sex ratio of swanggi fish in the waters of Sukabumi Regency were carried out by observing the sex ratio of female and male swanggi fish. The sex ratio, which is a comparison of the composition of female and male swanggi fish, will indicate the condition of the balance level of female and male swanggi fish populations in the waters of Sukabumi Regency. The most dominant swanggi fish is the female.

The results of field observations of 263 swanggi fish showed that there were 57 male swanggi fish and 206 female swanggi fish. The sex ratio of swanggi fish by comparing the number of male and female swanggi fish produces a comparison value of 1: 3.6. The greater number of female swanggi fish compared to male swanggi fish indicates that a very normal situation has occurred with the presence of many females resulting in a good fish population. This is in line with Courtney (1996, in Tirtadanu and Ernawati, 2016) who stated that the dominance of swanggi fish from one sex is something that is not easy and unusual.

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Gonad Maturity Level

Observations on Gonad Maturity Level (TKG) were carried out on 206 female swanggi fish. Based on the results of the analysis of the number of female swanggi fish samples, there were TKG I, II, III, and IV. TKG details from visual observations, namely TKG I was 61.7%, TKG II was 31.6%, TKG III was 5.8%, and TKG IV was 1.0%.

The observation results showed that there were TKG II and TKG I which dominated the gonad maturity level of female swanggi fish. Referring to the dominant conditions of TKG II and TKG I, it can be assumed that the condition of the swanggi fishing ground is the area where jerbung shrimp are reared. The dominant condition of TKG II and TKG I shows that the condition of female swanggi fish is mostly swanggi fish that have become young fish (TKG I) and lead to adult swanggi fish whose gonads have not yet reached optimal maturity (TKG II).

Maximum Sustainable Yield (MSY) Potential of Swanggi Fish Resources

The growth pattern of swanggi fish, which tends to be allometrically negative, will have an impact on production results, which is one of the variables in calculating MSY. Maximum sustainable potential (MSY) is a basic reference in determining potential estimates of swanggi fish resources. MSY value in a swanggi fish resource that is always moving. The sex ratio which shows the ratio of female swanggi to dominating male swanggi fish over a certain period of time will affect the population of swanggi fish because the opportunity for spawning is minimal when compared to female swanggi fish which dominate swanggi fish. The MSY value of swanggi fish resources in a body of water can be determined using the surplus production model. Several surplus production calculation models are used, namely the Schaefer model, Fox model, Schnute model, Walter Hilbron model, and Clarke Yoshimoto Pooley (CYP) calculation method. Referring to the value of shrimp production in a certain period of time and the known swanggi fishing effort, the MSY value can be calculated using the five surplus production models. The calculation process using the surplus production model is carried out by first calculating the Catch per Unit Effort (CPUE) value of swanggi fishing. The variable in the CPUE calculation is the production value of swanggi fishing. (kg) and number of attempts to catch jerbung shrimp (trips). Results of observations in the field. The results of CPUE calculations for swanggi fishing from 2001 to 2023 can be seen in Table 2.

Table 2. Swanngi Fishing CPUE Calculation for 2001 – 2023

Year	Total Production (kg)	*Effort* (number of trips)	CPUE (kg/trip)
2001	1.763	2,663	0.66
2002	1.950	2.714	0.72
2003	3.846	3.960	0.97
2004	40.131	4.154	9.66
2005	1.999	4.317	0.46
2006	18.649	8.516	2.19
2007	3.268	11.183	0.29
2008	1.361	8.454	0.16
2009	3.123	3.552	0.88
2010	59.499	3.216	18.50
2011	9.798	5.566	1.76
2012	15.844	5.638	2.81
2013	17.630	6.374	2.77
2014	8.130	6.700	1.21
2015	18.730	9.854	1.90
2016	15.457	9.924	1.56
2017	6.289	10.192	0.62
2018	9.232	11.191	0.82
2019	17.452	14.360	1.22
2020	3.743	1.457	2.57
2021	4.551	4.910	0.93
2022	3.658	2.806	1.30
2023	21.577	2.663	1.84

Source: Reprocessed from VAT data for Pelabuhan Ratu Sukabumi Regency

MSY Calculation Results Schaefer Model

The results of the analysis using the Schaefer model showed that the a value as the Schaefer model intercept was 4.403 and the b value as the Schaefer model slope was - 0.00029633.

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Knowing the values of a and b, we can then obtain a regression equation Y = 4.403 – 0.00029633X. The results of this analysis produced a determination value (R2) of 0.71, a validation value of 3.91 and a significant coefficient of p < 0.01 and p > 0.05. The results of the analysis using the Schaefer model show that there is a mismatch in the signs in the regression equation. Apart from that, the significance of the regression coefficients is not all significant because there is a p value > 0.05. So the regression coefficient resulting from the Schaefer model calculation cannot be used as a reference.

Fox Model MSY Calculation Results

The results of the analysis using the Fox model showed that the c value as the Fox model intercept was 0.778 and the d value as the Fox model slope was - 0.249756373. Knowing the values of c and d, we can then obtain a regression equation Ln Y = 0.778 – 0.249756373X. The results of this analysis produced a determination value (R2) of 0.06, a validation value of 1.01 and a significance coefficient of all with a p value <0.01. The results of the analysis using the Fox model show that the sign of the regression equation matches equation (6). Apart from that, the significance of the regression coefficients is not significant because all the regression coefficient values are p > 0.05. So the regression coefficient resulting from the Fox model calculation cannot be used as a reference.

MSY Calculation Results Walter Hilbron Model

The results of the analysis using the Walter Hilbron model showed that the value of a as the intercept of the Walter Hilbron model was 5.972 and the value of b as the first slope of the Walter Hilbron model was - 0.342 and the value of c as the second slope of the Walter Hilbron model was - 0.00039064. Knowing the values of a, b and c, produces a regression equation Y = 5.972 – 0.342 X1 – 0.00039064X2. The results of this analysis produced a determination value (R2) of 0.13, a validation value of 4.51 and the significance of all coefficients with a p value > 0.05. The results of the analysis using the Walter Hilbron model show that there is a mismatch between the signs of the regression equation and equation (9). Apart from that, the significance of the regression coefficients is not significant because all regression coefficient values have a p value > 0.05. So the regression coefficients resulting from the Walter Hilbron model calculations cannot be used as a reference.

Schnute Model MSY Calculation Results

The results of the analysis using the Schnute model showed that the value of a as the intercept of the Schnute model was 0.57 and the value of b as the slope of the first Schnute model was 0.288 and the value of c as the slope of the second Schnute model was 0.00000149. Knowing the values of a, b and c, produces a regression equation Y = – 0.570 + 0.288X1 + - 0.00006962X2. The results of this analysis produced a determination value (R2) of 0.017, a validation value of 0.017 and a significance coefficient of all coefficients with a value of p < 0.01 and p > 0.05. The results of the analysis using the Schnute model show that there is a mismatch in the sign of the regression equation with equation (13). Apart from that, the significance of the regression coefficients is not all significant because there is a p value > 0.05, so the regression coefficients resulting from the Schnute model calculation cannot be used as a reference.

MSY Calculation Results Clarke Yoshimoto Pooley (CYP) Model

The results of the analysis using the CYP model showed that the value of a as the intercept of the CYP model was 1.147 and the value of b as the slope of the first CYP model was - 0.026, and the value of c as the slope of the second CYP mode was - 0.000063981. Knowing the values of a, b and c, produces a regression equation Y = 1.1.47 + - 0.026 X1 + 0.000063981X2. The results of this analysis produced a determination value (R2) of 0.13, a validation value of 0.99 and the significance of all coefficients with a value of p < 0.01 and p > 0.05. The results of the analysis using the CYP model show that the sign of the regression equation matches equation (17). Apart from that, the significance of the regression coefficients is all significant because all regression coefficient values have a p value <0.01.

The results of the MSY analysis using the five models show the suitability of the sign, determination value (R2), validation value, and significance of the regression coefficient. Validation of the five MSY calculations can be seen in Table 3.

Table 3. Validation of Surplus Production Model Calculation Results

Criteria	Schaefer	Fox	Walter Hilbron	Schnute	CYP
Sign compatibility	It is not in accordance with	It is not in accordance with	It is not in accordance with	It is not in accordance with	In accordance
R2 value	0.07	0.06	0.13	0.017	0.13
Validation Value	3.92	1.01	4.51	1.46	0.99
Significance of coefficients	significant	Not significant	Not significant	Not significant	Significant

The validation results using several criteria in Table 4.3 show that it can be seen that the most appropriate calculation model for the conditions of swanggi fish production in the PPN Pelabuhan Ratu waters is the result of the CYP Model calculation. From the results of the validation, it can be seen that the suitability of the signs in the analysis result equation is in accordance with the equation formula, the determination value (R2) shows a large value (0.13), the significance of the regression coefficient shows a significant value (p < 0.01), and the validation value the smallest is 0.99.

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The calculation results using the CYP Model, which is the most appropriate calculation, produce several calculation variable values. The results of calculations using the CYP model produce a CYP model intercept of 1.147 and a b value as the slope of the first CYP model of – 0.026, and a value of c as the slope of the second CYP mode of – 0.000063981. By entering the intercept and slope values into the MSY CYP Model equation, the maximum sustainable potential value (MSY) of swanggi fish can be obtained at 6,151 kg/year with a value of the allowable catch of swanggi fish (JTB) of 4,021 kg/year (obtained from the calculation results 80% of the MSY value). In the process of catching Swanggi fish, the optimal fishing effort (Fopt) which should be a reference for limiting fishing effort is 4,920 trips/year.

Dynamics of Swanggi Fish Resource Utilization

Knowing the dynamics of utilization in the period 2001 to 2023 provides an overview of trends in management of swanggi fish resources which will have an impact on the ecological conditions of swanggi fish resources in the waters of PPN Ratu Harbor, Sukabumi Regency. Utilization dynamics is a comparison between catch production. The MSY and JTB values resulting from the analysis of surplus production calculations provide an overview of the stock conditions of swanggi fish resources in the waters of Sukabumi Regency and serve as a reference in understanding utilization dynamics. The dynamics of swanggi fish resource utilization can be seen in Figure 9.

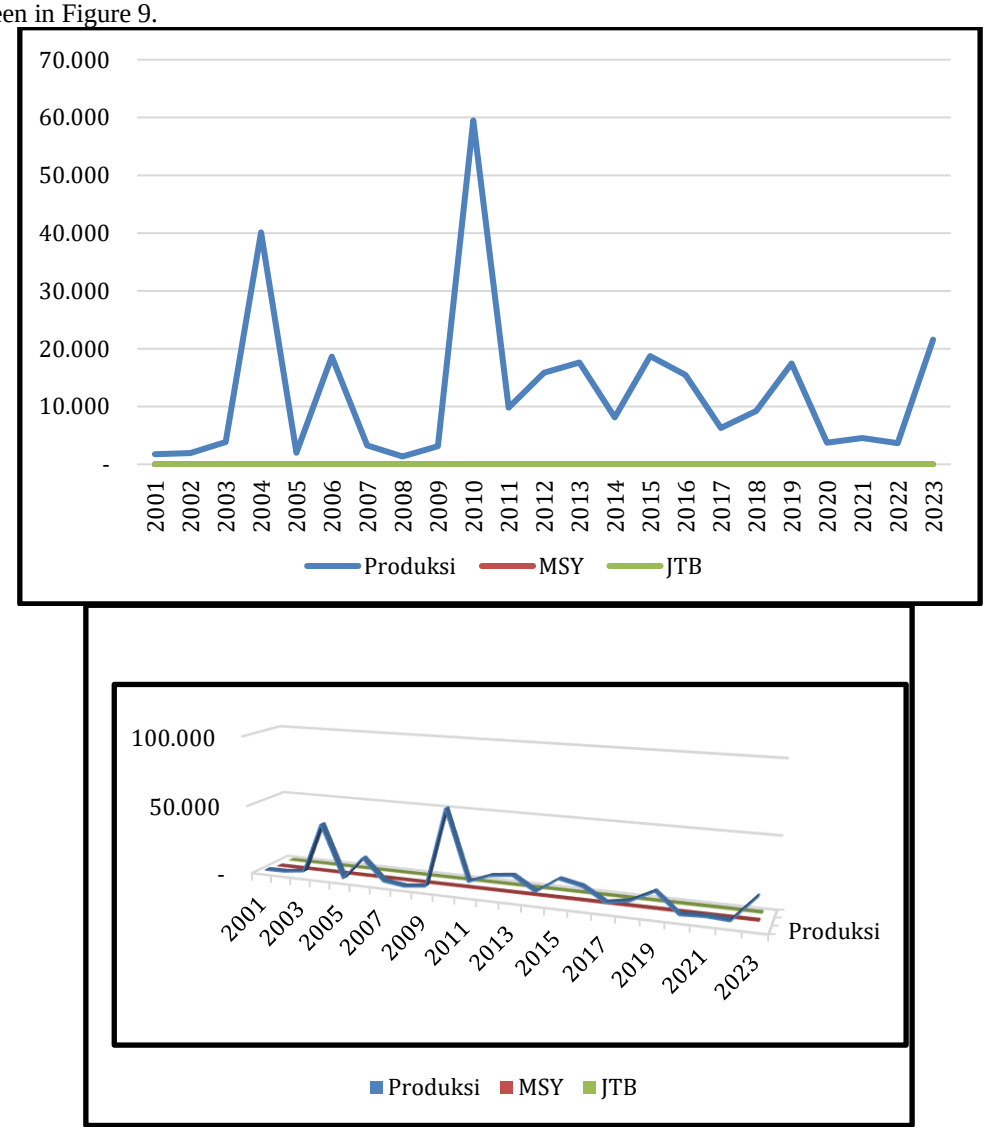

Figure 9. Graph of Dynamics of Swanggi Fish Utilization in PPN Pelabuhan Ratu from 2001 to 2023

The graph of the dynamics of the use of Swanggi fish in the PPN Pelabuhan Ratu waters shows that there is utilization of swanggi fish resources that exceeds the permitted catch (JTB) and even exceeds the MSY value limit which is the environmental carrying capacity limit for the availability of swanggi fish. In 2004, 2006, 2010, 2015, 2016, 2019, and 2023 the total production of Swanggi Fish catches has exceeded the MSY value limit. In the last 23 years, the average utilization of swanggi fish resources has exceeded the JTB value. Only in 5 (five) years, namely in 2003, 2007, 2020, 2021 and 2022, was the utilization of swanggi fish resources in the waters of Cilacap Regency still below the permitted catch amount (JTB).

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Sustainability Status of Swanggi Fish Resources

According to Susilo (2003), the ecological dimension is one of the core parameters in determining the sustainability status of management of swanggi fish resources using the RAPFISH method with reference to sustainability criteria. From the results of the analysis, it can be seen that the ecological dimension index value is 49.45. Referring to Susilo's sustainability criteria (2003), the ecological dimension index value is in the value range > 50 – 75 or in the Less Sustainable category. The sustainability index value in the ecological dimension as a result of the RAPFISH analysis can be seen in Figure 10.

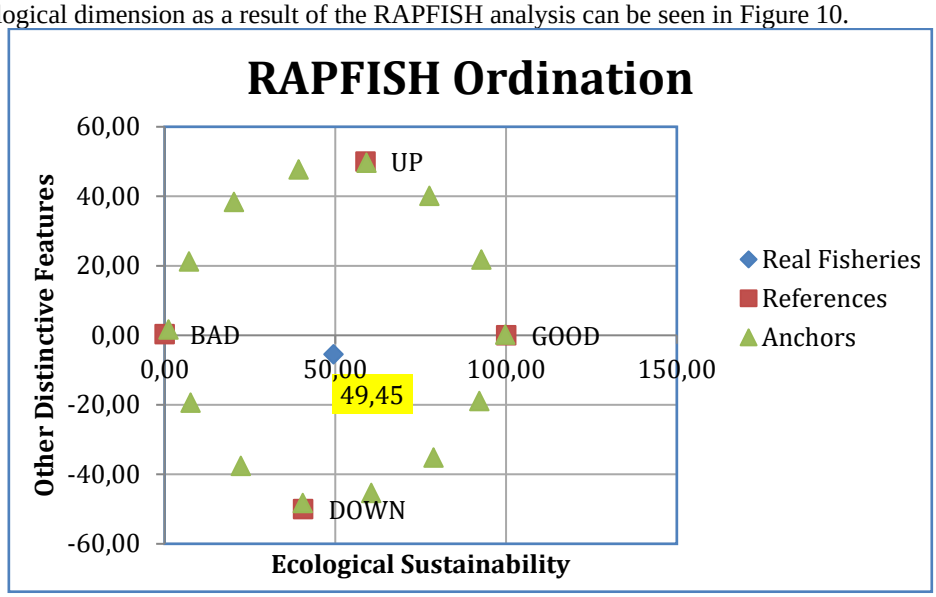

Figure 10. Results of RAPFISH Ordination on Ecological Dimensions

Leverage analysis was carried out with the aim of finding out sensitive attributes that could become leverage to influence the value of the sustainability index in the ecological dimension. The results of the Leverage Analysis on the ecological dimension produce 1 (one) attribute of wasted by-catch which has the highest leverage on sustainability value, namely the attribute . Therefore, the results of MDS ordination which produce sustainability status in the ecological dimension are then analyzed on several predetermined attributes to assess sustainability status through Leverage Analysis.

Many fishermen get turtles, tortoises, jellyfish which are thrown away because they are not suitable for consumption, so the fishermen throw them away so that the resource is sustainable and does not become extinct.

Social Dimension

The core parameters in the social dimension determine the sustainability status of management of swanggi fish resources using the RAPFISH method with reference to sustainability criteria according to Susilo (2003). From the analysis results, it can be seen that the ecological dimension index value is 41.52. Referring to Susilo's (2003) sustainability criteria, the ecological dimension index value is in the value range > 50 – 75 or in the Less Sustainable category. The sustainability index value in the ecological dimension as a result of the RAPFISH analysis can be seen in Figure 11.

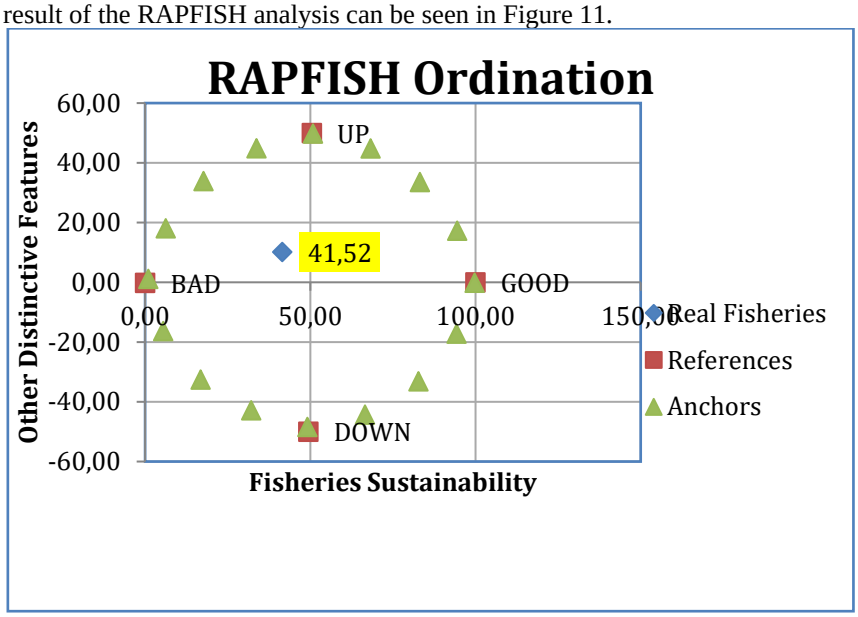

Figure 11. RAPFISH Ordination Results on Social Dimensions

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Leverage analysis is carried out with the aim of knowing sensitive attributes that can be leverage to influence the value of the sustainability index in the social dimension. The results of Leverage Analysis produce 3 (three) attributes. This attribute is the leverage attribute that has the highest leverage or most influences the value of the social dimension sustainability index. The attributes of fishermen's knowledge of the environment, influence of fishermen, and income from fishing are these attributes that leverage the results of MDS coordination.

An important element in managing swanggi fish well is paying attention to the environmental carrying capacity conditions, which need to be supported by fishermen's insight and knowledge of the environment. The results of observations in the field show that the responses from respondents regarding the attribute of environmental knowledge state that fishermen's knowledge of the environment is in a very poor condition. In terms of the influence of fishermen in the social dimension, it is related to swanggi fish management policies. Policy making for managing shrimp resources needs to involve several parties, so that the policies taken are more appropriate and in line with the expected conditions. The results of observations in the field show that the responses from respondents regarding the attribute of environmental knowledge state that fishermen's knowledge of the environment is in a very poor condition.

The contribution to total family income is compared with income from fishing which is the income obtained by fishermen from selling swanggi fish. The greater the contribution of income from fishing, the more important the swanggi fish utilization conditions are in the social life of fishermen. Field observations show that the contribution of income from fishing to total family income ranges from 50% - 80%.

Economic Dimensions

According to Susilo (2003), the economic dimension is one of the core parameters in determining the sustainability status of management of swanggi fish resources using the RAPFISH method with reference to sustainability criteria. The results of the analysis show that the social dimension index value is 67.64. Referring to Susilo's (2003) sustainability criteria, the social dimension index value is in the value range > 25 – 50 or in the Less Sustainable category. The sustainability index value in the social dimension can be seen in Figure 12.

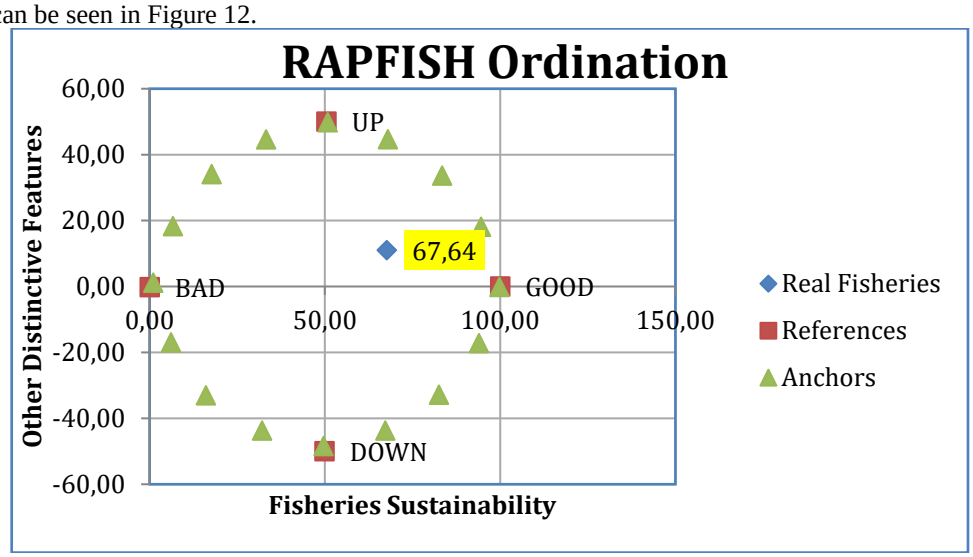

Figure 12. RAPFISH Ordination Results on Economic Dimensions

Leverage analysis is carried out with the aim of knowing sensitive attributes that can become leverage to influence the value of the sustainability index in the economic dimension. The MDS ordination results which produce sustainability status in the economic dimension are then analyzed on several predetermined attributes to assess sustainability status through *Leverage Analysis.*

The leverage attribute is an attribute that influences the value of the economic dimension of the sustainability index. There are several attributes of these levers, namely subsidy attributes, restrictions on fishing effort, resource ownership rights, average income of fishermen, contribution to GDP, market size, and profits.

This condition shows that the resource will provide incentive benefits to the resource owner. Economic sustainability is also greatly influenced by the level of people's income, where the lower the income of the people in the area, the higher the pressure on economic sustainability and conversely, if people's income is sufficient or high, the pressure on economic sustainability will be lower or the economic dimension will be more sustainable.

In providing subsidies to fishermen in the form of assistance in the form of relief for fishermen in obtaining fuel supplies or other assistance in the form of fishing gear or business capital. The results of interviews with fishermen provide information that subsidies are needed to support the swanggi fishing process. Considering that the condition of Swanggi fishing at the time of the research was not able to support the household economy of fishermen, providing subsidies by fishermen was deemed to be an (absolute) necessity. These fishermen really support what the government is doing, but also look at the condition of fishermen in

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the field. The high pressure on shrimp fishing results in the number of swanggi fish resources being reduced.

Swanggi fish resources are one of the biological natural resources that are *open access* . Referring to this characteristic, theoretically there can be depletion of resources due to utilization patterns that assume that these resources are shared property. The results of observations in the field showed that the respondents' responses stated that there were no regulations regarding restrictions on swanggi fishing efforts in the waters of Pelabuhan Ratu. The challenge of a policy limiting swanggi fishing efforts within an institutional framework and still being able to pay attention to elements of the welfare of the fishing community and also the fisheries resource management system through an ownership system. The nature of *common property* ownership is swanggi fishing activities. Swanggi fishing, which adheres to the *common property system* , provides open rights for fishermen who carry out swanggi fishing activities. Every fisherman has the right to carry out fishing activities as long as he has the ability. The results of observations in the field show that the management of swanggi fish resources in Sukabumi waters has not yet regulated the ownership rights of swanggi fish resources and management of swanggi fish is still valid as *common property* .

Ethical Dimensions

The ethical dimension is one of the parameters in determining the sustainability status of management of swanggi fish resources using the RAPFISH method with reference to sustainability criteria according to Susilo (2003). The results of the analysis show that the ethical dimension value is 76.63. Referring to Susilo's (2003) sustainability criteria, the value of the ethical dimension falls into the value range > 50 – 75 or in the Very Sustainable category. The sustainability index value in the ethical dimension as a result of the RAPFISH analysis can be seen in Figure 13.

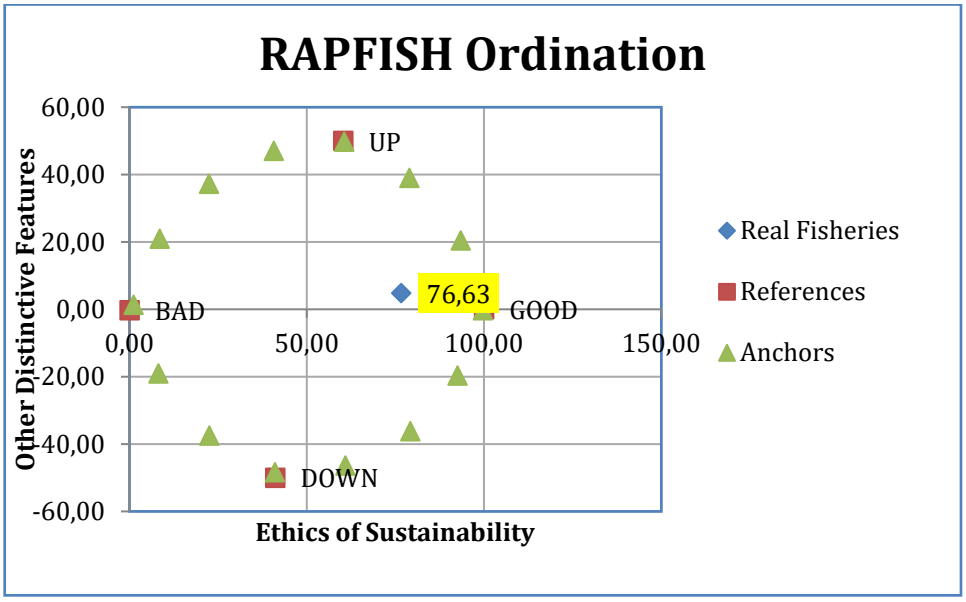

Figure 12. Results of the RAPFISH Ordination on the Ethical Dimension

The results of MDS ordination which produce sustainability status in the ethical dimension are then analyzed on several predetermined attributes to assess sustainability status through *Leverage Analysis*. *Leverage* analysis was carried out with the aim of finding out sensitive attributes that could become leverage to influence the value of the sustainability index in the ethical dimension.

The results of *Leverage Analysis* produce 5 (five) leverage attributes. Lever attributes are attributes that have an influence on the value of the sustainability index. The attributes that leverage the ethical dimension are the attributes of fairness in utilizing resources, mitigating ecosystem decline, *illegal fishing* , the influence of ethical formation, and mitigating habitat destruction.

Fairness in utilizing resources is very good. This encourages fair use of swanggi fish resources while still paying attention to environmental sustainability aspects. The results of observations in the field show that the use of swanggi fish resources in Sukabumi waters has taken into account aspects of justice. However, there is no priority utilization for fishermen who are native fishermen from Sukabumi Regency.

The mitigation process for potential ecosystem decline is an action that should be carried out in natural resource management. The results of observations in the field show that the response from respondents to mitigating ecosystem decline has not yet been carried out, although the impact on damage to the habitat of swanggi fish resources has not been felt directly by fishermen.

Illegal fishing is a fishing activity that is carried out in violation of applicable laws. *Illegal fishing* activities in shrimp fishing in Sukabumi Regency waters can involve the use of prohibited fishing gear and can damage the environment. The results of observations in the field show that the level of *illegal fishing* in Sukabumi waters is very low, it can be said that there are no Swanggi fishing activities that violate the law. So that fishermen have complied with and supported government activities so that

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they remain sustainable.

The influence of ethical formation is the influence exerted by the cultural values that exist in Sukabumi Regency on the management of swanggi fish. The results of observations in the field show that in Sukabumi Regency there is a culture of sea alms. The meaning of sea alms by Sukabumi fishermen is as a form of prayer to God for fishing activities, so that in carrying out fishing activities fishermen can obtain abundant results and be safe at sea. Apart from that, the existence of certain days which are prohibited from fishing on Friday Kliwon, means that Senaggi fish resources are not continuously depleted through fishing activities.

Mitigation of habitat destruction in the management of natural resources, especially fisheries biological resources, should be something that must be considered. Swanggi fishing activities are continuous and carried out intensively, it is necessary to carry out mitigation measures against the destruction of a habitat. The impact is also if extreme weather patterns occur, increasing global temperatures, which results in various species being forced to adapt, migrate, or face the risk of extinction due to habitat shifts and unsuitable conditions. The results of observations in the field show that mitigation measures for the destruction of swanggi fish habitat have not been carried out.

Technological Dimensions

The technological dimension is one of the parameters in determining the sustainability status of management of swanggi fish resources using the RAPFISH method with reference to sustainability criteria according to Susilo (2003). The results of the analysis show that it can be seen that the technology dimension index value is 68.17. Referring to Susilo's (2003) sustainability criteria, the technology dimension index value is in the value range > 75 – 100 or in the poor category (Sustainable). The sustainability index value in the technological dimension can be seen in Figure 14.

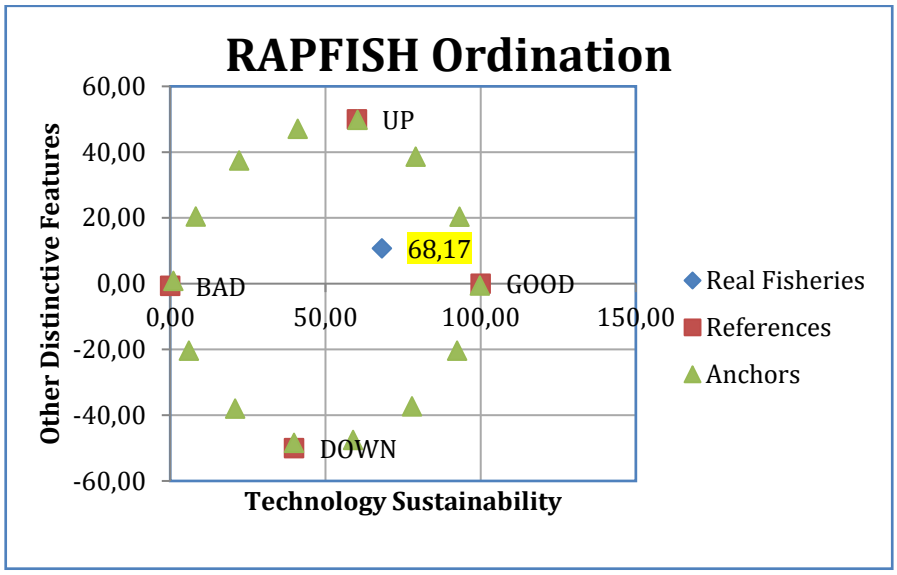

Figure 14. Results of RAPFISH Ordination on the Technological Dimension

The management/utilization of natural resources requires technology, both in the form of simple technology and modern technology. The results of the MDS ordination which produces sustainability status in the technological dimension are then analyzed on several predetermined attributes to assess sustainability status through *Leverage Analysis* . *Leverage* analysis was carried out with the aim of finding out sensitive attributes that could become leverage to influence the value of the sustainability index in the technological dimension.

The results of *Leverage Analysis* produce 5 (five) leverage attributes. Lever attributes are attributes that influence the value of the sustainability index. The lever attributes in the technological dimension, namely the attributes of fish landing location, fish handling on board, side effects of fishing gear, fishing gear selectivity, and type of fishing gear.

The fish landing location is too far away so that when they get to TPI the fish are no longer fresh and not of high quality, so that when they arrive at TPI what they are going to sell is no longer fresh and alive, so fishermen have to use more modern technology to be more environmentally friendly.

Handling on board is an attribute that needs to be improved. One of the activities carried out after the process of catching swanggi fish, handling swanggi fish on board is an action that must be carried out. This is done to maintain the quality of swanggi fish from the catch to the landing of swanggi fish. The results of observations in the field showed that the process of handling swanggi fish on board the ship was carried out using bulk ice without keeping the swanggi fish alive.

The side effect of fishing gear is that it is not environmentally friendly so that the fish's scales become damaged and even when they arrive at TPI they become pale and not fresh.

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Types of fishing gear are classified into passive fishing gear and active fishing gear. As a means of catching swanggi fish in the waters of Sukabumi Regency, *the gill net* is a passive fishing tool. This is in line with field observations which state that *gill net fishing gear* is a passive type of fishing gear. The fishing gear is operated by spreading the net at a predetermined fishing location. This fishing gear is operated by spreading the net lengthwise in the water.

Fishing gear selectivity is a level of selectivity of fishing gear in the fishing process. *Gill net* is a three-layer net fishing tool which is operated by spreading the net at the *fishing ground location* . Catching large swangggi fish also provides economic benefits to fishermen from the sales. The results of observations in the field show that the level of selectivity of the *gill net fishing gear* used in the waters of Sukabumi Regency is less selective.

Institutional Dimensions

The institutional dimension is one of the parameters in determining the sustainability status of shrimp resource management using the RAPFISH method with reference to sustainability criteria according to Susilo (2003). The results of the analysis show that the institutional dimension index value is 46.65. Referring to Susilo's (2003) sustainability criteria, the institutional dimension index value is in the value range > 25 – 50 or in the Sufficiently Sustainable category. The sustainability index value in the institutional dimension as a result of the RAPFISH analysis can be seen in Figure 15.

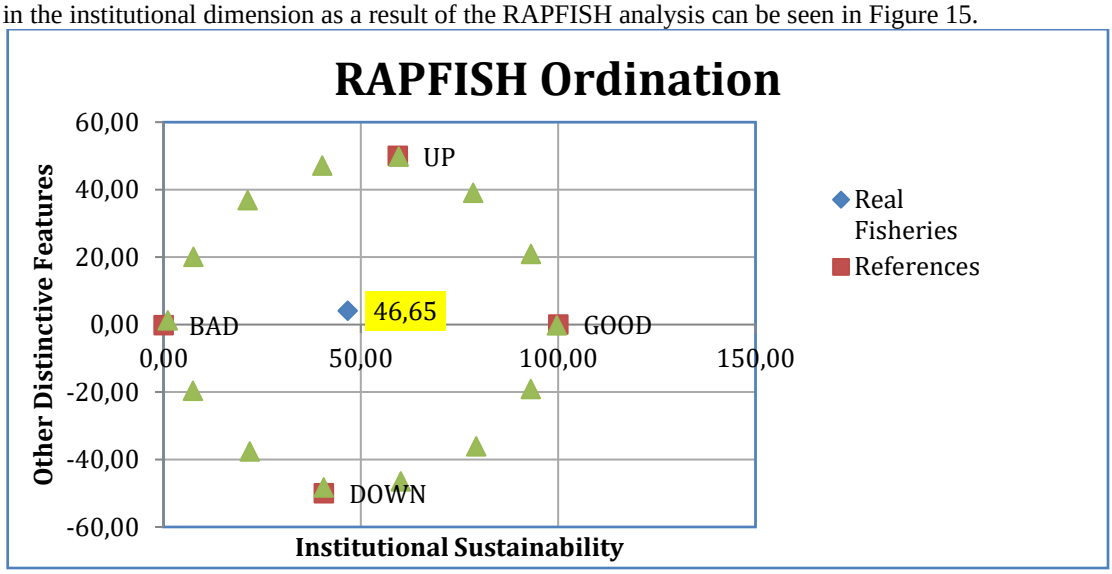

Figure 15. RAPFISH Ordination Results on Institutional Dimensions

According to Yusuf. M., 2016 states that institutions and management regulations are an important aspect in managing natural resources and the environment.

The results of MDS ordination which produce sustainability status in the institutional dimension are then analyzed on several predetermined attributes to assess sustainability status through *Leverage Analysis* . *Leverage* analysis is carried out with the aim of finding out sensitive attributes that can become leverage to influence the value of the sustainability index in the institutional dimension.

The results of *Leverage Analysis* produce 1 (one) attribute that has the highest leverage or most influences the institutional dimension sustainability index value and 1 (one) attribute that has low leverage, namely the highest attribute is management rules. The rules for managing swanggi fish resources are one of the institutional instruments so that the implementation of swanggi fishing can run well and still pay attention to environmental sustainability and carrying capacity. Management regulations can be implemented by involving several parties related to shrimp management. The results of observations in the field show that regarding the management regulations for swanggi fish resources, up to now there are no management regulations. This is also in line with the results of discussions with the Sukabumi Regency Fisheries Service and PPPN (Pelabuhan Ratu), who said that there are no regulations for managing swanggi fish in Sukabumi waters and the lowest attribute is that future fisheries management plans are still a mystery. When will this plan be sustainable?

Multidimensional Sustainability Status

The results of the RAPFISH analysis of the ecological, social, economic, ethical, technological and institutional dimensions illustrate the condition of the sustainability status of each dimension in the management of swanggi fish commodity resources in the waters of Sukabumi Regency. Successively, the value of sustainability status in each dimension is 49.45 in the ecological dimension, 41.52 in the social dimension, 67.64 in the economic dimension, 76.63 in the ethical dimension, 68.17 in the technological dimension, and a score of 46.65 in the institutional dimension. The sustainability value for each dimension shows that there are four dimensions that are in Less Sustainable status, namely the ecological, social, economic and technological dimensions. There is one dimension that is in Fairly Sustainable status, namely the institutional dimension, and there is only one dimension, namely the ethical dimension which is in very Sustainable (Good) status.

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Table 4. *Stress* Value and Coefficient of Determination (R^2) RAPFISH Analysis Results for Each Sustainability Dimension

No.	Dimensions	Sustainability Index Value	Category (Sustainability Status)	*Stress*	R^2
1.	Ecology	49.45	Less Sustainable	0.14	0.93
2.	Social	41.52	Less Sustainable	0.13	0.94
3.	Economy	67.64	Less Sustainable	0.13	0.94
4.	Ethics	76.63	Very Sustainable	0.14	0.94
5.	Technology	68.17	Less Sustainable	0.14	0.93
6.	Institutional	46.65	Quite Sustainable	0.15	0.94

The results of the RAPFISH analysis of the six dimensions that produce sustainability status values show that the analysis of the attributes in each dimension is quite accurate. This can be seen from the stress value and the relatively large value of the coefficient of determination (R2) . The results of the stress values and coefficient of determination provide an illustration that the attributes used in each dimension to assess sustainability status are quite adequate, because they have relatively small stress values (Table 4).

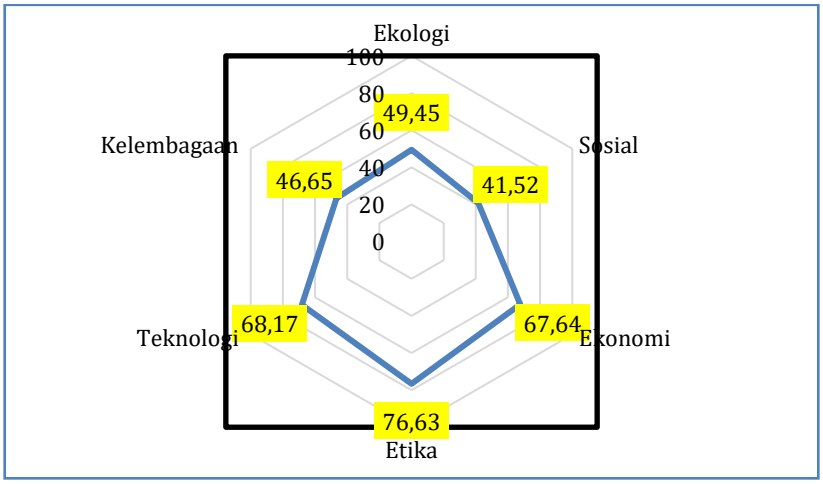

Figure 16. Flyover Diagram of the Sustainability Status of Management of Swanggi Fish Resources in the Water Area of Sukabumi Regency

The sustainability status value in each dimension resulting from the RAPFISH analysis as in Figure 4.15 is still a sustainability status that can be known partially. The combined value of these six dimensions is known so that in general the status of sustainability in swanggi fish management is known.

IV. CONCLUSIONS

Based on the research results, several things can be concluded as follows. The condition of the swanggi fish population from the biological aspect of swanggi fish in the waters of PPN Pelabuhan Ratu, namely the growth pattern of swanggi fish is negative allometric, the sex ratio with the ratio of male swanggi fish to female swanggi fish is 1:3.6 and the level of gonad maturity is dominated by TKG I and TKG II. The maximum sustainable potential value (MSY) of swanggi fish in PPN Pelabuhan Ratu waters is 6,151 tons/year, the number of permitted catches (JTB) is 4,021 tons/year, the optimal fishing effort (Fopt) is 4,920 trips/year, and the dynamics of fish utilization swanggi shows that the average utilization exceeds the JTB value limit and the MSY value. The sustainability status of Sukabumi resource management in the PPN Pelabuhan Ratu waters, Sukabumi Regency is at Less Sustainable status. Suggestion, based on the results of the research, the author suggests that the sustainable status of VAT management at Pelabuhan Ratu be immediately restored by implementing management strategy methods. Management efforts can also include determining fishing quotas, limiting fishing gear, and determining fishing grounds (fishing grounds) which aim to limit fishing efforts so as not to experience excessive exploitation. Providing more equitable and routine counseling for fishermen at PPN Pelabuhan Ratu by government officials, especially agencies involved in the fisheries sector or the surrounding environment.

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