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Original Research Article

Sustainable Gill Fisheries Management in South Kalimantan Water Territory

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ABSTRACT

The main purpose of this research is to analyze gillnet capturer instrument and gillnet fishery reource continuity and creating strategic scenario in sustainable gillnet fishery management. The research is conducted in Tanah Laut regency. Research method used Participatory Rural Apraisal (PRA) technique. Data Analysis employs analythical descriptive and sustainability analysis with Multidimensional Scaling (MDS) method and RAPFISH (The Rapid Appraisal of Status of Fisheries) application.

Research result shows that gillnet capturer instrument observed from technology and ecology dimension has highest sustainability (good), from economy dimension (quite sustainable), meanwhile from ethic dimension (less sustainable) and from social dimension has lowest sustainability (bad). White shrimp regression Y = 0.054200429-7.93E-08X with optimum catch result 9,266.19 ton/year, effort optimum 431.923 trips/year; croackers regression Y= 0.012407688-8.96408E-09X, optimum catch result 4.293 ton/year, effort optimum 692.078 trips/year, it means that in term of gulamah fish (Nibea Albiflora) and white shrimp resource is still can be improved. Another research result shows that a priority used as sustainable management strategy, i.e., species in the same geography, catching range, fish size, the catched fishes are not in mature age yet, the high subsidy, how big the market is, rules of management, ethic formation influence, fishery sector role, education level, fish handling on ship, ship size. Those factors need to be well managed in the future in order to maintain or even improve catch fisheries in Tanah laut Regency continuity.

Keywords: Management, capture fishery, environmentally friendly, sustainable, territorial waters, South Kalimantan.

1. INTRODUCTION

In the management of capture fisheries, there are some rules / regulations that should be understood and understood to be properly implemented, especially by the main fishing actors (fishermen), business actors and other capture fisheries stakeholders. Some of the rules governing fishing activities are the Regional Authority in the Management of Fishing Areas. As stated in Law Number 32 Year 2004 regarding Regional Government (UU Autonomy Region), that area is given the authority to manage the catching area in accordance with the ability of each region. Territorial waters are 12 miles whose management is an area of regional autonomy.

Tanah Laut Regency is one of 13 regencies / cities in South Kalimantan

Province with an area of 3,631.35 km2 or about 9.71% of the total area of South Kalimantan Province that has fishery development and potential of marine and fishery resources which is quite large on the coast. Territorial waters in *Tanah Laut* Regency have the potential of fishery resources such as *Manyung* (Giant catfish), Jerbung prawn (Banana prawn / White shrimp / Indian banana), Common squids, *Gulamah (Croackers)* and others. The dominant fishing gear used for catching fish is the Mini Trawl, Drift Gill net, Trammel net, Purse Seine, Rawai (Long line), Hand Picking (Hand line).

Sustainable fish resource utilization can be done if the operation of a fishing gear is planned carefully and planned. Fish resources, although including renewable resources but not necessarily limited, therefore need to be preserved. So, the use of fishing equipment should still pay attention to the balance and minimize the negative impact for another biota. This is important to consider considering the loss of biota in the ecosystem structure will affect the overall ecosystem (Wiyono 2005).

Another approach can be used to analyze the natural biological factors of each species of fish and to evaluate the interactions between species (Andersen & Ursin, 2009) May et al. 1977), developed a simulated model for the North Sea that combines the response of predators to prey and the influence of the displacement of the fishing industry. This approach is bound to require a very complex model of biological parameter estimation.

Currently the ecosystem approach in fisheries management has been implemented in several fishery areas in the world. But until now the approach has not been formally done in Indonesia. If the management of fish resources is only concentrated on how to achieve maximum catch, then fishery management now consider the balance of fish resource utilization economically, ecologically and environmentally, but the failure of the management of some stock resources either regionally or globally is caused by mistake in planning and early anticipation of the impact of the operation of fishing gear and its dynamics (Wiyono, 2005).

In existing studies or references, the modeling that has developed for the management of fish resources is a simple model that is the model bioeconomic fishery resources. Several previous studies that have been conducted related to the management of capture fisheries resources are those undertaken by (Amin, Rahman, Haldar, Mazid, & Milton, 2002; Garcia, Sparre, & Csirke, 1989; Nadon, Ault, Williams, Smith, & DiNardo, 2015) states that the rate of sustainable use occurs at the natural rate of death (M) equal to the deaths from capture (F) or the rate of exploitation of 0.5.

(Garcia et al., 1989) Samoilys (1977) in his research emphasized that if the natural rate of death is greater than 0.8 then the remaining 0.2 of biomass is a critical level of recruitment in order to avoid overfishing. (Safina, Rosenberg, Myers, Quinn, & Collie, 2005) also mentioned that MSY values based on biomass values are better to prevent levels of utilization at critical levels. According to (Katsukawa, 2004, Mace, 2001) states that the rate of sustainable use of fish if done at 0.6 from the existing biomass or lower than the MSY value of each species.

According to (Pitcher & Preikshot, 2001) research in the field of fishery is very complex. Thus, the assessment of resource sustainability is not only mapped on single criteria but encompassing various aspects (multi-dimensional). It takes a new paradigm in fishery resources management, because fishery resources that exist in coastal and marine areas are an ecosystem that cannot be separated ecologically, then fishery management should be based on ecosystem.

In general, this research is expected to produce a model of sustainable fisheries management with ecosystem approach to obtain a clear and comprehensive picture to ensure sustainable fisheries management.

This research is expected to have value for government benefit in determining policy.
For this purpose, it is necessary to learn in a multidimensional approach in the management of sustainable capture fisheries resources both conceptually and technically. This research is very appropriate to ensure the future of fishery for the people of South Kalimantan. The purpose of this study is to analyze gillnet fishing technology, analyze the sustainability of gillnet fishery resources and develop strategic scenarios in the management of sustainable capture fisheries.

2. Literature Review

2.1 Gillnet Capture Technology

Gill net fishing gear is a technology that is less environmentally friendly fishing, still selective on catches, because the mesh size of the tool has a uniform size so that the fish caught has a uniform size Rasdani, et al. (2001).

According to Garcia et al., 1989, there are four ways of catching fish by gillnet, being caught in a snare right behind the eyes (snagged), trapped behind gill lids and trapped in front of the wedged, due to prominent body parts (teeth, jaws, fins) without having to break through the eye of the net (entangled).

Research Nikijuluw (2002), fish caught with gill net is a fish that suits the size of the mesh and fish smaller than the size of the mesh will escape from capture.

In previous research (Rusmilyansari, 2012) stating that fishing equipment category less responsible ie fishing equipment; encircling gill net, drift gill net, trammel net. While Sadhori (1985), states that in the operation of trammel net is considered as an environmentally friendly fishing gear because in the operation of trammel net does not damage the waters ecosystem. The operation of trammel net also includes easy and harmless for fishermen. Furthermore, Supardi (2007) stated that gill net includes passive, selective and environmentally friendly fishing equipment. Operation of conventional gill net (which is commonly operated in Indonesia) is relatively simple, most of the operation uses human power. Furthermore, previous research conducted by Sutanto (2005) in the sea catching business activities in govt catchment districts with gill net is quite profitable.

Research (Radarwati, Baskoro, Monintja, & Purbayanto, 2010) which states that the hazard levels received by fishermen in operating fishing gear is highly dependent on the type of fishing gear and skills possessed by fishermen and based on the likely impacts received. Rasdani, et al. (2001), illegal fishing and fishing practices is where fishing gear and its fishing practices are prohibited by applicable laws and regulations.

2.2 Potential Fish Resources by Using Gillnet

The potential condition of fish resources captured in the territorial waters of Tanah Laut Regency is crucial to undertake appropriate fisheries development planning, in order to realize optimal, sustainable and sustainable capture fisheries activities. Although the biology of the fish is recoverable (renewable resources) but not infinite, therefore according to (Nikijuluw, 2002), need to be managed responsibly and sustainably.

The potential of fish resources can be seen from the value of CPUE from fishery activities. Haluan (2011) stressed that the observation of CPUE should be done as a preventive measure to prevent the extinction of resources due to high levels of puposes. Level of utilization of fish resource potential in Territorial waters of *Tanah Laut* Regency of White shrimp and Croackers which are still in moderate Exploited status, although not yet exceeded TAC, but should receive attention. In contrast to the results of research (Oktariza, 2016) which states that the catching of squid in Bangka regency has been overfishing because the value has reached the optimum catch limits. According to Striadi (2011), fluctuations in catch are influenced by the presence of fish,

the number of fishing effort and the success rate of fishing operation.

According to Widodo and Suadi (2006) some of the characteristics that become the benchmark of a fishery is on the way to catch more is the time to go to sea longer than usual, the catching location becomes farther, the net eye size becomes smaller accompanied by decreased yield productivity per unit effort. According Susilo (2009) one of the characteristics of over fishing is the graph of arrest in units of time fluctuate or erratic and decreased production significantly and decreased the results of catch per unit effort.

The high fishing effort is not followed by the size of the catch. As the highest effort is done to catch Gulamah fish that is equal to 692,078 trips with the catch 4,473 tons maximum. Differences in the value of fishing trips show differences in productivity values. This difference in productivity values is influenced by the number of fishing trips, operating frequency and fishing grounds. This is in line with (McCluskey & Lewison, 2008; Rijnsdorp, Dol, Hoyer, & Pastoors, 2000) who say that fishing effort is closely related to the number of fishing trips and the number of fishing trips. (Jumsurizal, Nelwan, & Kurnia, 2016) stated that capture fishing activity is also determined by the amount of fishing effort conducted to reach a capture area.

2.3 Priorities for the Development and Sustainability of Gillnet Fisheries

To undertake sustainable gillnet fisheries development in *Tanah Laut* District, there needs to be a proper strategy, priority. According to Nikijuluw (2002), the choice of alternative solutions / management depends on the specificity, condition and condition of the managed fisheries, so that each choice should be based on the following criteria: acceptable to the fisherman, gradual implementation, flexibility, driven by efficiency and innovation, the perfect knowledge of the rules and the costs required to follow the regulation are implications for labor, unemployment and justice.

Some of the things that can be considered against this environmentally friendly fishing gear is that the catch must be recorded neatly (reported) as a control medium to prevent protected fish to be protected. The licensing mechanism of the fishing gear must be run by a "pick up ball" system which means the authorities must be pro-active in the process of granting licenses to fishermen directly to the field.

To find the solutes steps of managing the caught gear categories are less environmentally friendly and not environmentally friendly, then there are some things that should be used as initial information. That is how large the number and intensity of the use of fishing gear categories less environmentally friendly and environmentally friendly that operate.

Some management alternatives to fishing gear are less friendly as follows: modification or design of environmentally friendly fishing gear is urgent for immediate action. The size of the mesh should be adjusted to the size of the fish targeted for capture. Selective and eco-friendly fishing gear concepts such as the Turtle Excluder Device (TED), which in Indonesia is modified to Bycatch Excluder Device (BED) should begin to be implemented, thereby ensuring less pressure on resources and the environment.

Control of the number of fishing gear can be implemented by determining the number of fishing units that may be operated through a licensing system. In this case, the Regional Regulation (Perda) no. 3 of 2003 concerning Retribution of Sea and Fishery Business License in Regency of *Tanah Laut* territory which was ratified on 14 August 2003 must be updated by adding clause on the limit of number of fishing gear that can obtain permit so that only permitted fishing gear is allowed to operate. Then the next important thing is how the allocation of licensing must really apply the principle of justice so that there is no conflict between fishermen.

The closure of the fishing area means stopping fishing in a permanent water (conservation area) or temporary at the time of spawning ground and nursery ground. This policy is to protect fish resources from destructive fishing gear. This prohibition may be exempt if the fishing gear has been modified so as to guarantee the preservation of marine resources. However, in its implementation must pay attention to the consideration of the principle of prudence, in the sense that it must still pay attention to the social, political and economic dynamics that develop among fishermen / stakeholder capture fisheries, so that will not trigger social conflict.

An important thing in implementing any policies related to sustainable fisheries is to make continuous efforts on raising awareness of fishing communities to the environment. The form of activities that can be done to build awareness of these fishermen can vary, can be in the form of dissemination of information through the mass media (newspapers, television, radio), exhibitions, tours, training, promotional shirts that convey the message of activity by staying focused on awareness purposes (Salm, Clark, & Siirila, 2000).

As a follow-up of the implementation of Law Number 31 Year 2004 regarding Fishery Chapter V Article 26 paragraph (1), namely the field of fishery that must have a license is; fishing, fish cultivation, fish transporters, fish processors and fish marketers. And in Chapter VII article 48 paragraph (1) that every person who get direct benefit from fishery and fishery resources in fishery management area of Republic of Indonesia shall be imposed fishery levy. Government Regulation of the Republic of Indonesia Number 54 Year 2002 concerning fishery business that regulates the issue of licensing authority, and Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number KEP. 10 / MEN / 2003 concerning Fishing Business License, then in *Tanah Laut* Regency made Local Regulation no. 3 of 2003 on Retribution of Sea and Fishery Business License in Regency of *Tanah Laut* Regency which was ratified on 14 August 2003. This was reinforced by the emergence of South Kalimantan Provincial Regulation No. 24 Year 2008 on Supervision and Protection of Fish Resources in South Kalimantan.

Education for fishermen should be approached in a participatory manner as needed and designed together to achieve the objectives. Education required by the fishing community is education that can improve the adaptation of fishermen to various changes. This can be done through efforts to improve life skills such as diversification of skills so as to develop alternative business.

3. MATERIAL AND METHODS

3.1 Study sites

The method applied in this research is survey method. As for the sampling method is done in a possessive area *Takisung* District and *Kintap* District *Tanah Laut* Regency, South Kalimantan Province (Figure 1). In this study, the samples are fishing gear that operates around the territorial waters of *Tanah Laut* Regency: Mini Trawl operates in waters (1-4 miles); Drift gill net (15 - 49 miles); Purse seine (17 - 52 miles); Long line (1 - 3 miles). Trammel net (3 - 7 miles); Troll line (15 - 35 miles). The study was conducted from February 5 to October 27, 2017. The species of fish sampled are dominant caught and sedentary fish that do not do long migration to the surrounding sea area.

3.2 Research Design

The research was conducted by Survey method (Nazir, 1985) by RAPFISH (Rapidly Appraisal for Fisheries) technique based on ordination technique (putting something in order of measured attribute) by using Multi-Dimensional Scaling (MDS). RAPFISH concerns aspects of ecological, economic, technological, social and ethical sustainability. Each dimension has an attribute or indicator related to the

sustainability implied in the FAO CCRF. The following descriptive method is defined as the problem-solving procedure investigated by describing the state of the subject or object of research (someone, institutions, society and others) at the present moment based on facts that appear or as it is (Nawawi, 1993) and (Sugiono, 2009).

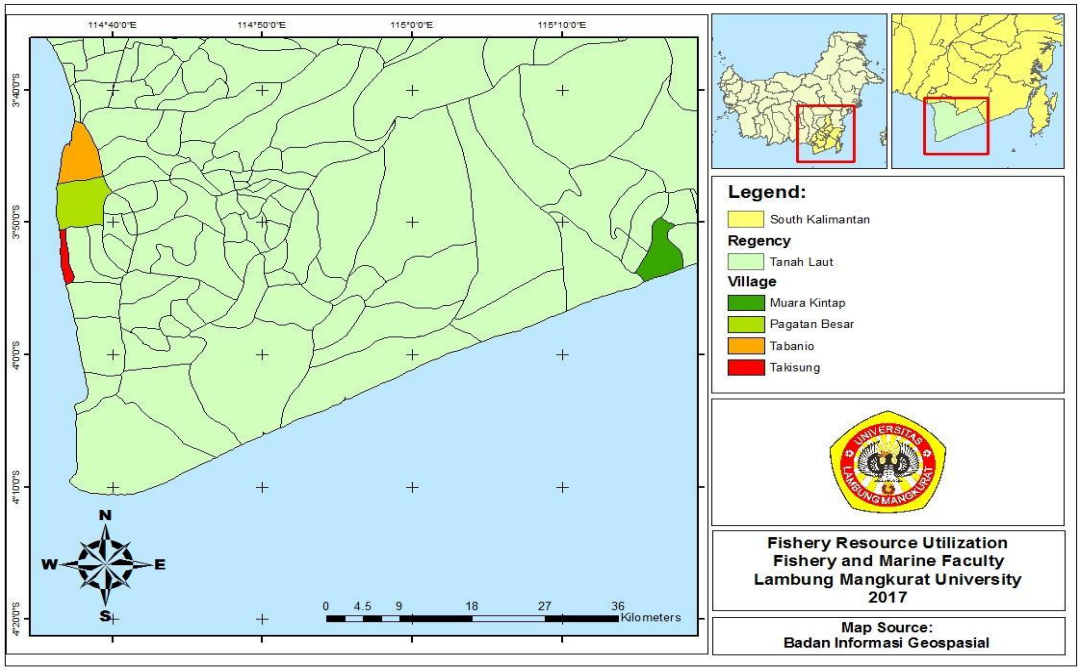


Figure 1. Location Research Map

3.3 Types and Sources of Data

Data collected in this study include primary and secondary data. Primary data include fish resources, technological level of fishing units, fish catch characteristics (type, quantity, weight and size of captured fish, trip, area and fishing season). Secondary data include the contribution of fisheries to the regional economy, time series data of catches, fishing effort, average price of catch. These secondary data are obtained from Fish Landing Base, Fisheries Department, PEMDA, BPS, BLHD, Community Institution or other related institutions.

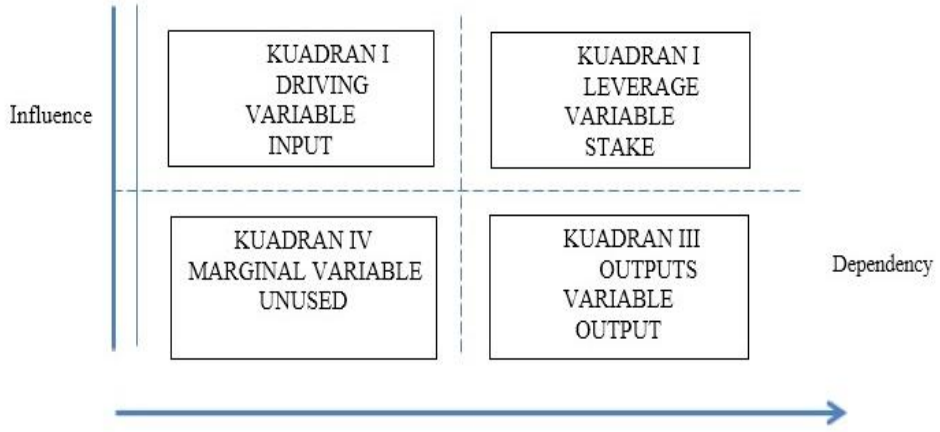


Figure 2. Interpretation of the degree of influence and interdependence between factors in the system. Source: Bourgeois and Jesus (2004)

3.4 Analysis Data Method

The analytical methods used in this study were Rapid Appraisal Management Systems adopted from (Pido, Pomeroy, Garces, & Carlos, 1997), RAPFISH adopted from (Pitcher & Preikshot, 2001). RAPFISH is a technique for evaluating the condition of fishery and marine resources. According to Hartono, et al (2005) results from the RAPFISH method development activities to assess the performance indicators of fisheries sector development.

Sustainability analysis is conducted through 3 (three) stages, namely (1) determining the attributes of sustainable fisheries management criteria covering ecological, technological, economic, social and environmental dimensions; (2) the assessment stage of each attribute on an ordinal scale based on the sustainability criteria of each dimension, (3) the analysis phase of the ordinate value of the sustainability index or by using a kite diagram.

According to (Bourgeois & Jesus, 2004) that the Participatory Prospective Analysis (PPA) is a tool designed to identify and anticipate changes with the participation of experts including appropriate policy holders.

4. RESUL

4. 1 Gill net fishing technology

The gill net is a type of fishing gear made of mesh material in the shape of a rectangle where the mesh of the main part is of the same size, the number of mesh in the long or horizontal direction (Mesh Length / ML) is much higher than the number of mesh webs to vertical or inward direction (Mesh Dept / MD), on top of which is equipped with some floats and at the bottom is equipped with several sinkers so that in the presence of two opposing forces allows gill nets to be installed in the fishing area within upright state.

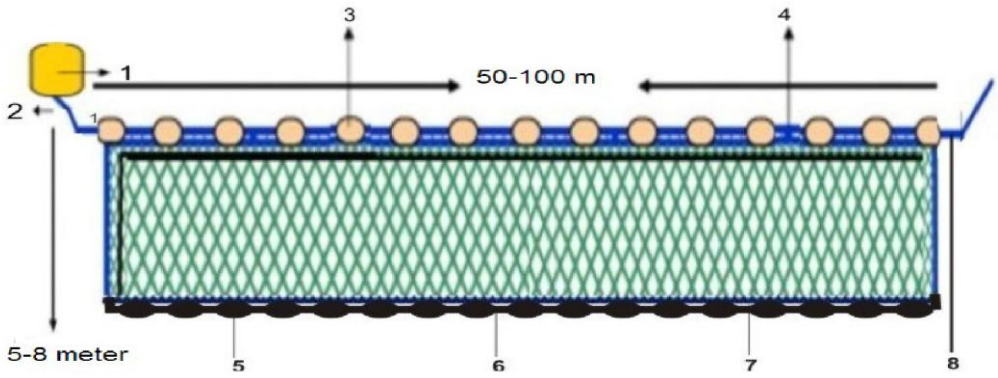


Figure 3 Gillnet Designs operated in the waters of *Tanah Laut* District (Source: Arifin F, 2008).
Information:
1. Buoy sign, 2. Life rope, 3. Main buoys, 4. Top rope, 5. Weighing, 6. Weighing rope, 7. Bottom line, 8. Rope sheet

Gillnet fishery using a ship made of wood. This gillnet ship consists of several rooms, namely: work space or deck to store the catch, fishing room, machine room, and space for cooking or kitchen.

Buoys on the basic gillnet only serve to lift the top rope just so that gillnet can stand upright (vertical) in the water. For mid gillnets and surface gillnets, in addition to the buoys attached to the top rope, an additional buoy that serves as a mark on the surface of the water is also needed. Buoys used are usually made of Styrofoam, polyvinyl chloride, plastic, rubber or other objects that have buoyancy. The number, weight, type and volume of buoys installed in one piece determine the size of the buoyancy. The size of the buoyancy attached to one piece is very influential on the good of the catch.

The ballast serves to drown the mesh body. The weights on gill nets are generally made of tin, iron and cast cement. The draw strap is a rope attached to both ends of the fishing gear to tie the end of the gillnet to the sign buoy, and the other end is attached to the vessel. The length of the drawn string used is generally 25-50 meters depending on the size of the fishing gear and the used vessel.

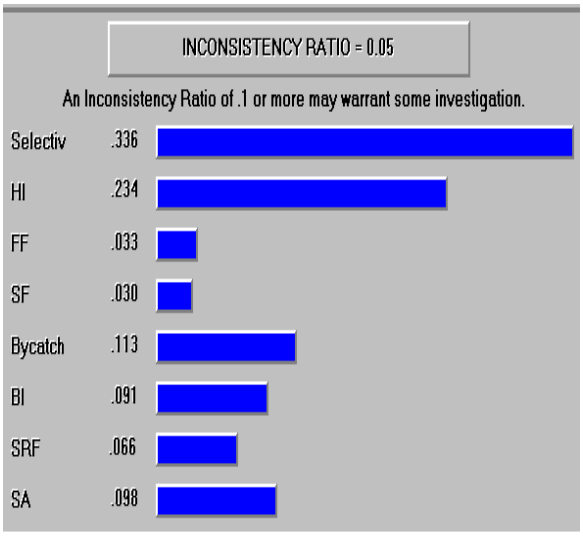
The operational time of the fishing vessel starts from 17:00 pm to 22:00 pm, with a crew of 7 to 10 people. Fishing season with gill nets is shorter than other fishing gear that is between November to April, Fishing ground or Fishing ground operation of this gill net is done with distance reaching 10 - 15 Miles.

Based on the analysis of the function of the value of the fishing gear operated in the territorial waters of *Tanah Laut* Regency, it is obtained the grouping of fishing gears based on environmental friendliness category, all gill net classification tools including the less environmentally friendly are presented in Table 1.

Table 1. Sustainability Status of Gear based on CCRF Analyzer

No.	Categories	Type of Fishing Tool
1	Inhospitable (Total <2.67)	Mini trawl
2	Less Environmentally Friendly (2.67 ≤ Total ≤ 5,33)	Drif Gillnet Set gillnet Trammel net
3	Environmentally Friendly (Total> 5.33)	Long line Hand line

Source: Primary data is processed



Node	Definition	Notes
GOAL		
Selectiv	Selectivity of fishing gear	
HI	Habitat Impact	
FF	Freshness of fish	
SF	Safety for fishermen	
Bycatch	Bycatch	
BI	Biodiversity impact	
SRF	Safety for rare fish	
SA	Social accepted	

Figure 4. The appeals scale in pairs between the criteria of the environmentally friendly status of the gillnet fishing gear is based on a relatively important level.

Based on Fig.4, it can be seen that the aspect of gillnet selectivity is considered as the most priority criterion can be developed as environmentally friendly with the value of 0.336 (34%), then the next priority scale is the impact on habitat with value 0,234 (23%), sized by value 0,113 (14%), socially accepted with value 0,098

(0,98%), impact on biodiversity with value 0,091 (0,91), security to protected fish with value 0,066 (0,07%), freshness of catch with value 0,033 (0,33%) and last security criterion to fisherman with value 0,030 (0,03%). Based on the value of inconsistency ratios obtained by 0.05 indicates that the representative model is used. This is based if the value of inconsistency ratio of a developed model of 0.1 or more. Then, required reinvestigation efforts assessment of each object criterion built in the model.

4.2. Potential Fish resources caught with Gillnet.

The development of the result of exploitation of fish resources in coastal and marine waters of *Tanah Laut* Regency from 2011 to 2015 can be seen in Figure 5.

The availability of fish as a potential fish is critical to sustainable gillnet fisheries management. Potential of gillnet catch can be seen based on catch and level of fishing effort and sustainable fish production function. The dominant fish species caught in the territorial waters of *Tanah Laut* Regency from 2011 to 2015, namely Giant catfish total of 29,893 tons of dried fish with an average of 5,978.6 tons / year, then White shrimp total catch of 25,346 tons (average 5,069.2 ton / year), common squids total catch of 18,047 tons (average 3,609.4 tons / year) and Croakers total catch of 12,307 tons (2,461.4 tons / year).

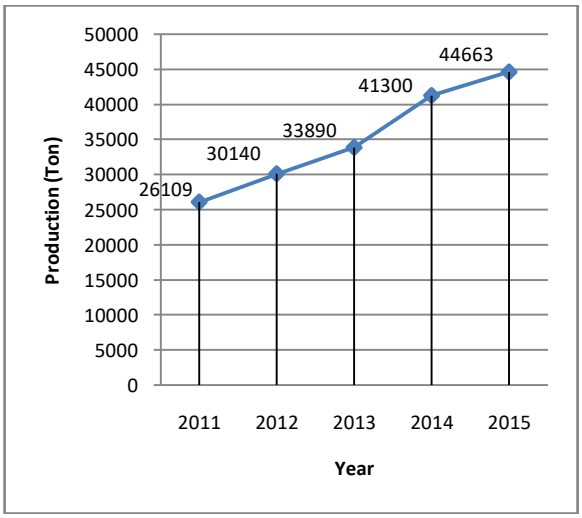


Figure 5. The development of Fish catches production in Territorial and Marine waters Regency of *Tanah Laut* (Source: Fishery Statistics Data of South Kalimantan Province, 2017).

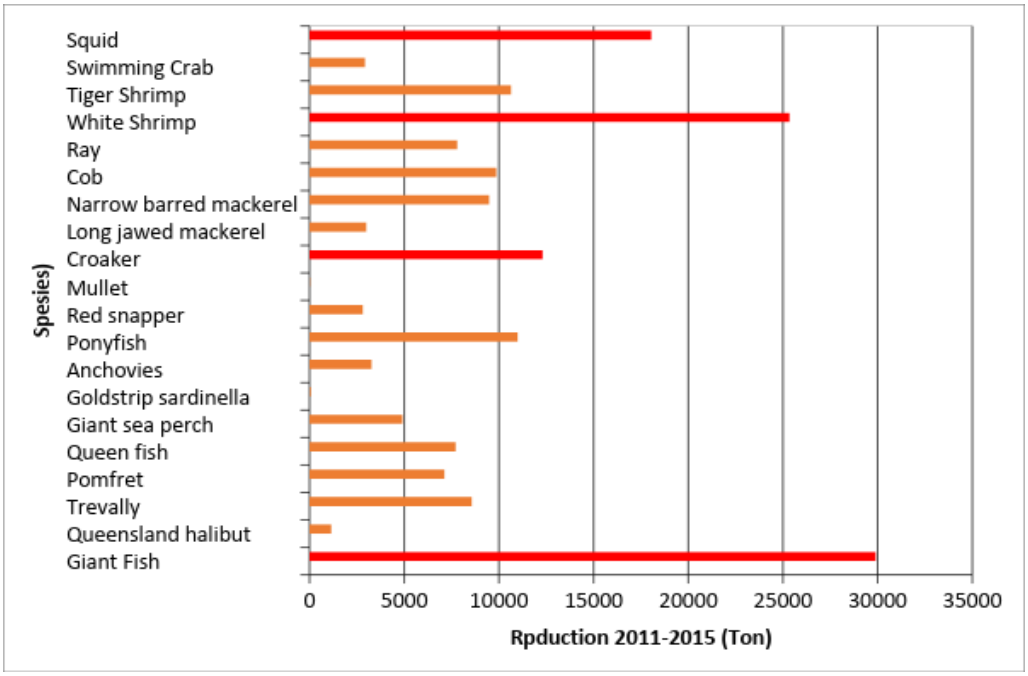


Fig. 6 Types of fish resources based on production quantities.

Types of fish resources based on total production can be seen in Figure 6. The largest fish of *Manyung* (Giant catfish) with total catch of 29,893 tons, followed by white shrimp / *Jerbung* (Banana prawn / White shrimp / Indian banana) 25,346 tons,

squid (common squids) with catch of 18,047 tons and types of fish *Gulamah / Tigawaja* (Croakers) with the catch of 12,307 tons.

The dominant species of fish caught with Gill net in Territorial waters of *Tanah Laut* Regency are *Gulamah / Tigawaja* (Croakers) and white shrimp / *Jerbung* (Banana prawn / White shrimp / Indian banana) (Figure 7)

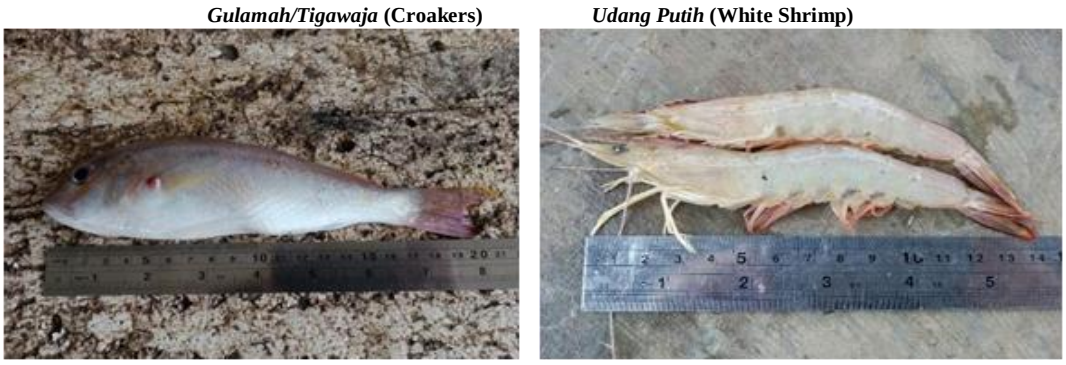


Figure 7. Types of dominant fish caught by gillnet fishing gear in waters Territorial *of Tanah Laut* Distric.

The value of CPUE with Effort in the utilization of fish resources known as sustainable production functions need to know the correlation so that it can know the tendency of productivity of fishing gear. In Figure 8. shows a negative relationship, the higher the effort the lower the CPUE. This indicates that the productivity of fishing gear equipment used to win the fish will decrease if efforts are increased.

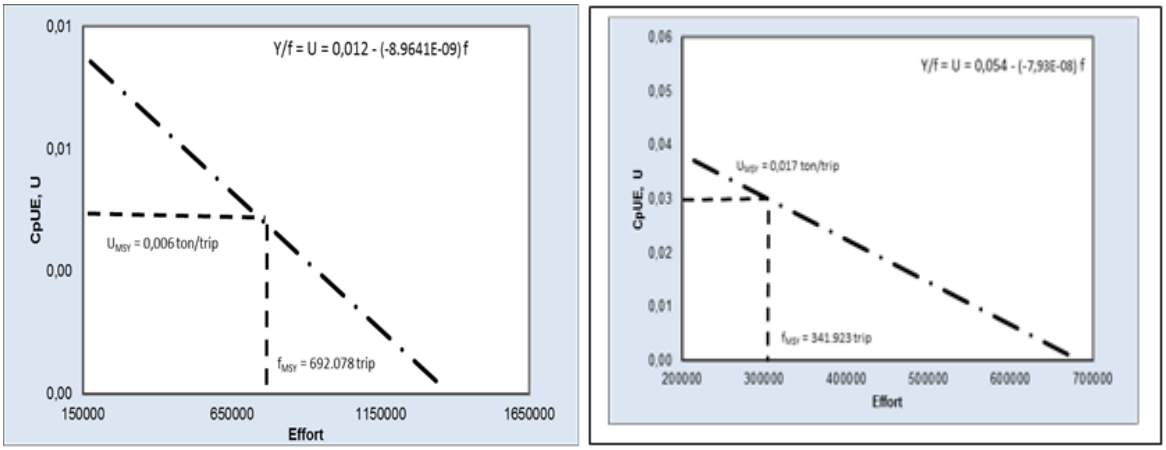


Figure 8. CPUE Relationship with Gillnet Catch Effort 2011-2015 in *Tanah Laut* District

In Figure 8, we can see that the relationship between CPUE and Effort model Schaefer has the following equation: Y = 0,037 f - (-6.82594E-08) f2 it can be explained that each addition of squid capture for one unit of effort will decrease CPUE of -6.82594E-08. Increasing the resource effort of the squid may deplete the squid's resources itself, and in the long run will lead to biological overfishing.

Further Effort at the maximum sustainable production level (Emsy) in each species of fish can be seen in figure 9. MSY is the largest catch amount that can be taken from the stock of fish resources indefinitely. A condition where fish resources can still be utilized without disturbing its sustainability. The MSY concept aims to maintain fish populations at the point of maximum growth.

Based on the figure 9, the result of calculation with Schaefer model is parabolic (meaning quadratic), it means that every addition of catch effort level will produce the catch until reaching maximum point, then there will be decrease of catch to increase the intensity of resource exploitation.

Knowledge of potential fish resources is very important to know in order to see how far the ability of fish resources can be exploited without giving the impact of disturbing the regeneration process of the fish. The results of calculating the potential for sustainable fish resources are presented in Table 2.

Table 2. The biological multi-species parameter values of fishery resources in the territorial waters of *Tanah Laut* District.

No	Species	*Coefficients*		R^2	C_{msy} (ton)	E_{msy} (trip)
		a	B			
1	Udang putih (*White shrimp)*	0.054200429 (4.35636)**	-7.93E-08 (-2.59788)**	0.692274748	9.266,19	341.923
2	Gulamah (*Croackers*)	0.012407688 (4.751719)**	-8.96408E-09 (-2.8882)**	0.735489307	4.293	692.078

Description: (numbers in brackets show t-statistics)
** significance at the 5% level

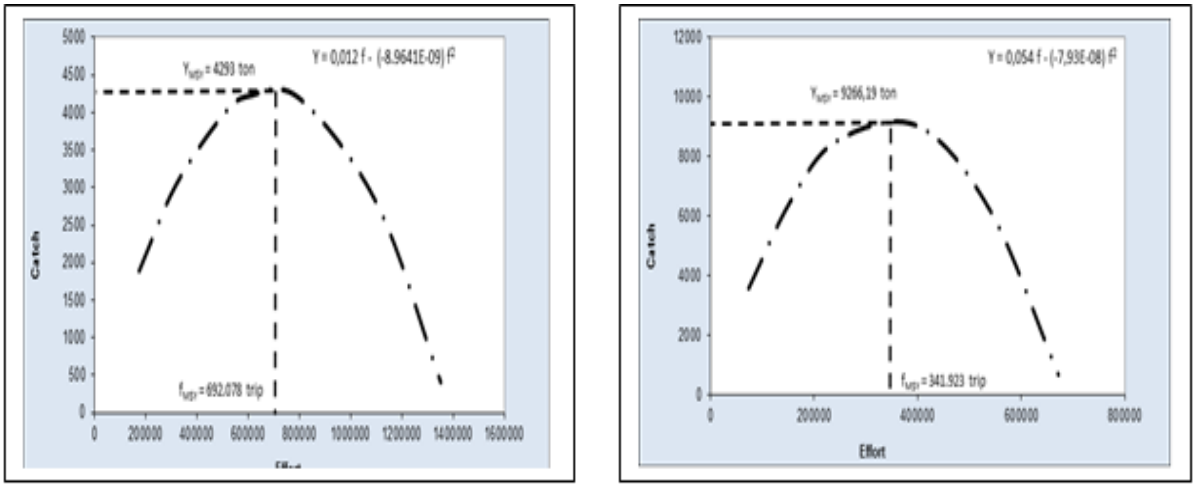


Figure 9. Relationship of sustainable yield of several species of fish with Effort year 2011-2015 in Territorial waters of *Tanah Laut* Regency.

Based on the results of the test of the production equation of the dominant fish species caught with gillnet fishing gear has got the best fit result. The maximum production management condition of white shrimps without threatening the sustainability of resources is 9,266.19 tons with an optimum effort of 341,923 trips. The highest effort is to catch *Gulamah* fish that is 692,078 trips with maximum catch 4,293 tons. Differences in the value of fishing trips show differences in productivity values.

One of the management efforts that have been done to prevent overfishing is by conducting fishery resources sustainably through TAC (Total Allowable Catch). The average comparison of Total Catch and TAC over the period of five years (2011-2015) is presented in Table 2.

Table 2 Average Comparison of Catch and TACs over five years (2011-2015)

No	Species	Total Cach (ton)	TAC (ton)	Selisih	Resilience	Utilization Rate (%)	Status
1	Udang putih (*White shrimp)*	5069,2	7412	2342,8	(+)	68,4	Moderate Exploited
2	Gulamah (*Croackers*)	2461,4	3434	972,6	(+)	71,8	Moderate Exploited

Based on Table 2, it is seen that all types of *Gulamah* fish and white shrimp catches in the territorial waters of *Tanah Laut* regency have not exceeded the Total Allowable

catch (TAC), so no one has achieved overfishing. All types of fish are relatively safe utilization if done good. The highest production of *Gulamah* fish during the 5-year period averaged 2461.4 tons per year, compared to Cmsy of 4,293 tons per year. Thus, it is necessary to consider the fishing gear used by the fishing communities in *Tanah Laut* District.

5. DISCUSSION

5.1 Sustainable Gillnet Fisheries Management

5.1.1 Ecological Sustainability

RAPFISH Ordination - Monte Carlo Scatter Plot is used to evaluate the impact of errors from random error (random error) to all aspects. In Figure 10 there is a plotting plot that indicates the model used appropriately to analyze the sustainability of ecological catch fisheries.

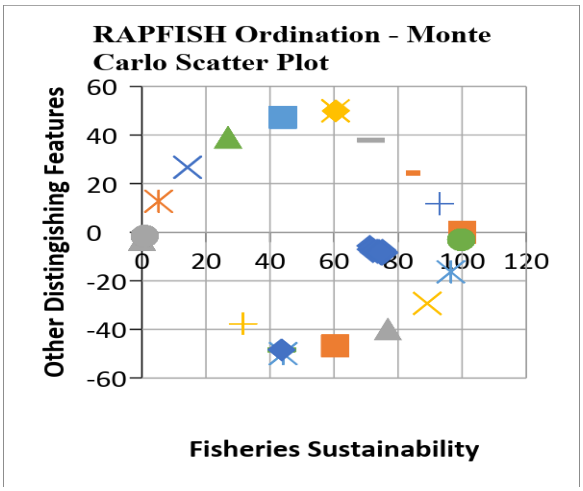


Figure 10 Ecological monte-carlo scatter plot .

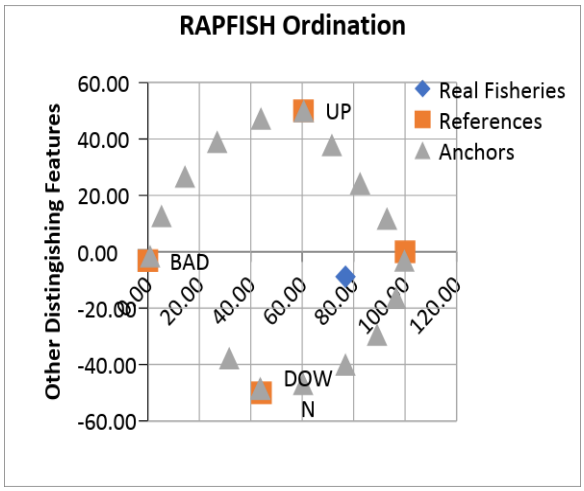


Fig. 11. Ecological Rapfish ordination.

Table 3. The statistical value obtained from the result RAPFISH analysis on ecological dimensions

Stress =	0.1347759
Squared Correlation (RSQ) =	0.9456229
Number of iterations =	3
Memory needed (words) =	5214
Return value (error if > 0)	0
Rotation angle (degrees) =	80.503464

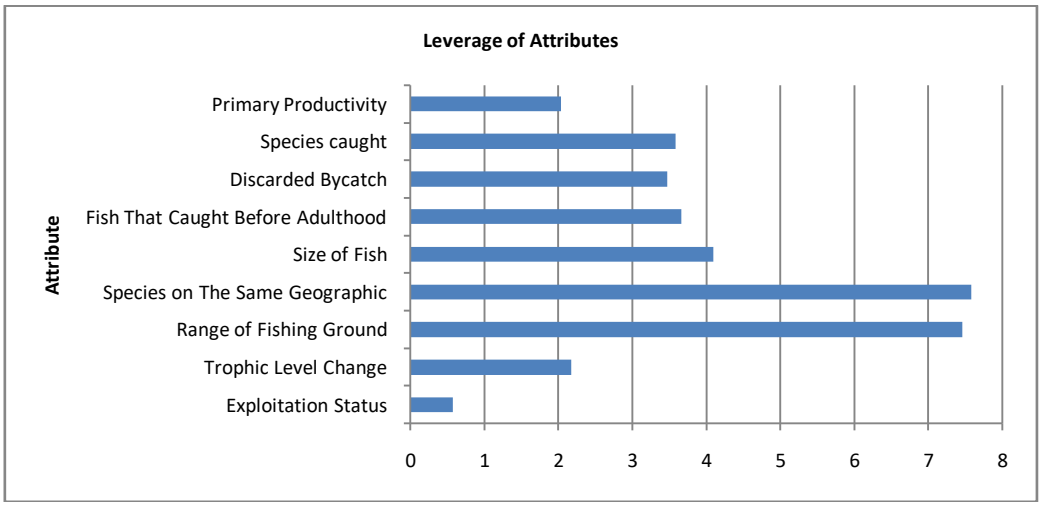


Fig. 12. Root Mean Square Change in Ordination when Selected Attribute Removed
(on Sustainability scale 0 to 100) Ecologi Dimention.

Table 3. shows the value of stress (S) obtained for ecological dimension is 13, 47%. This shows the value of S has met the condition of good ness of fit because S <25% (Fauzi Anna). To check the level of confidence (Table 2) is shown by the value of the coefficient of determination (hose of trust) for R2 of; 94.56%. The other information obtained in Table 1 is the number of iterations. This number of iterations declares a repetition of the count of 3 times on the RAPFISH method. The iteration or repetition of calculations on this ecological dimension is to see the effect of scoring errors on each attribute as well as procedural error. The number of iterations can also be said to know the level of trust of the sustainability index of capture fisheries that have been obtained from the ecological side. Therefore, the number of iterations has been considered sufficient if the stress value is already less than 25%.

Based on the ecological dimension, it can be seen that the value of the sustainability index of capture fisheries in *Tanah Laut* Regency is in 75-100 intervals, including the "good" sustainable category based on the attributes that exist on the ecological dimension, each with a value of 79 on the scale of sustainability 1 -100.

Based on the result of leverage analysis to know the sensitive attribute of ecology dimension that have contribution to Gillnet fishery sustainability index value in territorial waters of *Tanah Laut* Regency, the highest attribute contribution is species on the same geographic and Range of Fishing Ground> 6, fish caught before adulthood and catching fish species> 2. While attributes Changes in trophic level and exploitation pressure = 2 and exploitation status <2. (Figure 12).

5.1.2. Economic Sustainability

RAPFISH Ordination - Monte Carlo Scatter Plot on the economic dimension, the error impact of random error (random error) intercepted all aspects. In Figure 13 there is a plotting plot that indicates the model used exactly to analyze the sustainability of capture fisheries by economy.

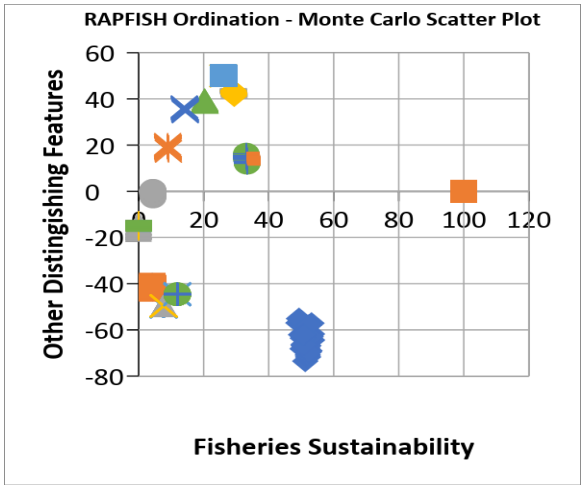


Figure 13. Monte-carlo scatter plot of Economic dimension.

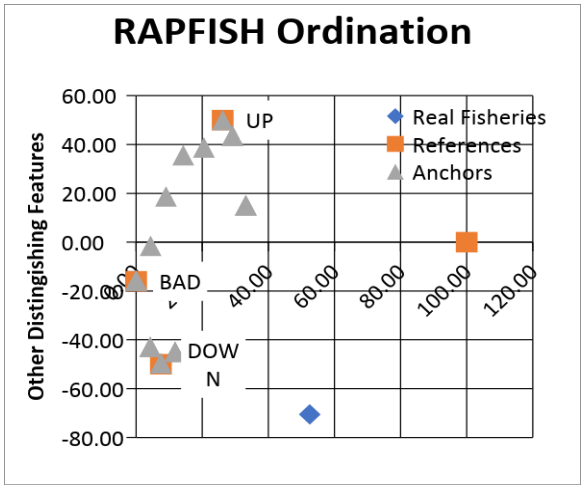


Figure 14. Rapfish ordination of economic dimension.

Table 4. The statistical value obtained from the results RAPFISH analysis on the economic dimension

Stress =	0.0874146
Squared Correlation (RSQ) =	0.9833319
Number of iterations =	3
Memory needed (words) =	5622
Return value (error if > 0)	0
Rotation angle (degrees) =	3.9450116

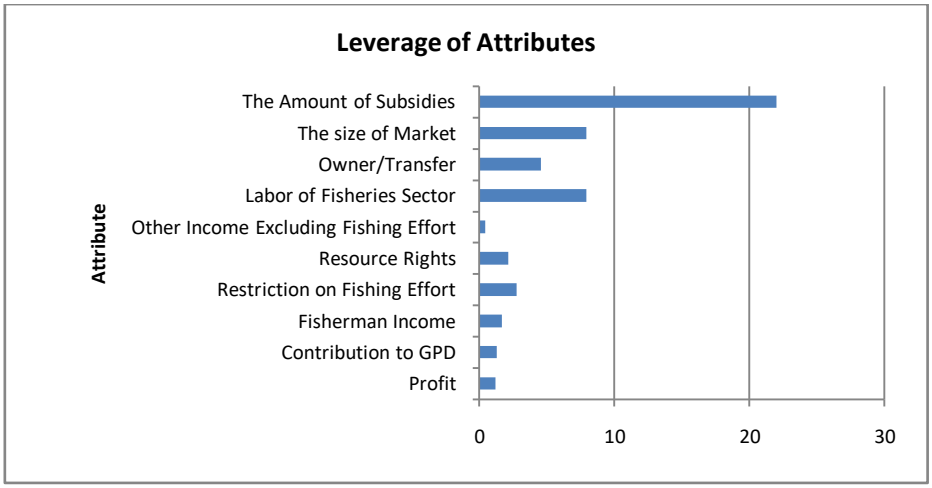


Figure 15. Leverage analysis of economic dimension.

The value of stress (S) obtained for the economic dimension is 8.74%. This shows the value of S has met the condition of good ness of fit because S <25% (Fauzi Anna). The value of coefficient of determination (confidence interval for R2 is 98.33%) Based on ordination analysis of RAPFISH / Ordination of gillnet fishery in *Tanah Laut* Regency in the form of two-dimensional image based on the economic dimension presented in figure 14 shows "quite sustainable".

Based on the economic dimension, it can be seen that the value of the index of sustainability of capture fisheries in *Tanah Laut* regency is in 51-75, including the "Self-sustained" category based on the attributes that exist in the ecology dimension, each with 51 on the sustainability scale of 1 -100.

As for knowing the sensitive attributes that contribute to the value of sustainability index of catch fishery in *Tanah Laut* Regency based on economic dimension, hence conducted leverage analysis. Based on the results of the leverage analysis, the attribute that has the highest contribution is the subsidy> 20, almost three times more than the other attributes. Furthermore, fisheries sector labor and market size, each above 15.

Based on the feasibility aspect analysis, it is intended to find out how the feasibility level of the development of gillnet fishery in *Tanah Laut* regency to two types of fish *Gulamah* and *Udang putih (white shrimp)*. The business feasibility assessment parameter is based on 4 (four) criteria: NPV, Net B / C ratio, BEP and ROI. Based on the results of business feasibility analysis based on the above criteria can be seen in Table 5.

Table 5 Results of feasibility analysis of gillnet fishery business and gill net in *Tanah Laut* District.

Catching tool	Criteria					
	Net B/C	NPV (juta)	ROI (%)	BEP		
	Value	Value	Value	Value (Rp)	Value (kg)	Decision
Gillnet	2,08	124	33,33	2.552.204	255,2	good

Source: Primary data processed

The Net B / C value for Gillnet is 2.08. This means that the income earned is 2.08 times the amount of cost incurred so that the business is feasible while for the value of Net Present Value (NPV) gillnet of 124 where the profit earned during the economic life of the business value of NPV> 0 shows the average value average net profit gillnet business gained over the next 10 years. ROI value of 33.33% indicates that gillnet fishery business investment in *Tanah Laut* Regency in every one rupiah to be invested will give

minimum profit or minimum catch (BEP) from a capture unit for 1 business year.

BEP is the sum of the minimum value that must be obtained in order to cover the total cost of production per year so that this business will provide benefits if it is at the same point or greater than Rp. 2.552.204, - with annual production volume of 255.2 kg.

Also, worth noting in gill net fisheries is the influence of seasons. gill net capture usually done in the West Season is November - June. The peak of the Arrest occurred in January - February, while the *Drowsiness* arrest occurred in March - April. Based on the economic dimension in the tenth although still provide benefits, but the benefits obtained are so small that it can be interpreted less sustainable.

5.1.3. Ethical Sustainability

RAPFISH Ordination - Monte Carlo Scatter Plot is used to evaluate the impact of errors from random error (random error) to all aspects. Figure 16 shows the plot collecting which indicates the model used appropriately to analyze the sustainability of capture fisheries based on ethics.

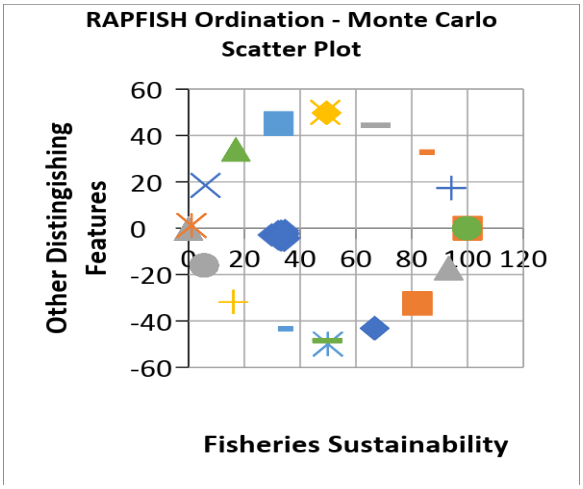


Fig. 16 Eonte Carlo Scatter Plot Ethical dimension.

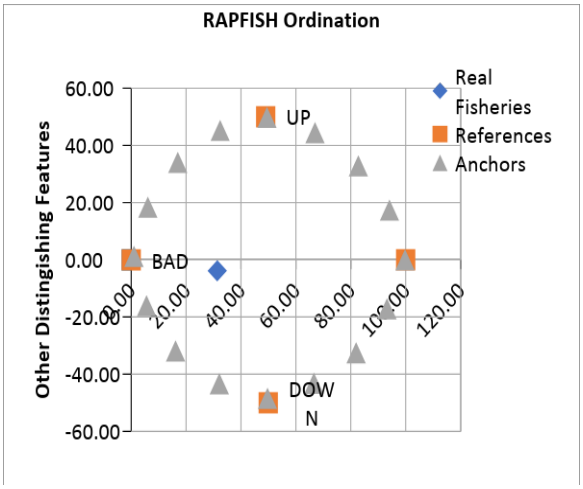


Fig. 17. Rapfish ordination of ethical dimension.

Tabel 6. The statistical value obtained from the RAPFISH analysis on the ethical dimension

Stress =	13.97%
Squared Correlation (RSQ) =	0.941288
Number of iterations =	2
Memory needed (words) =	4838
Return value (error if > 0)	0
Rotation angle (degrees) =	171.84816

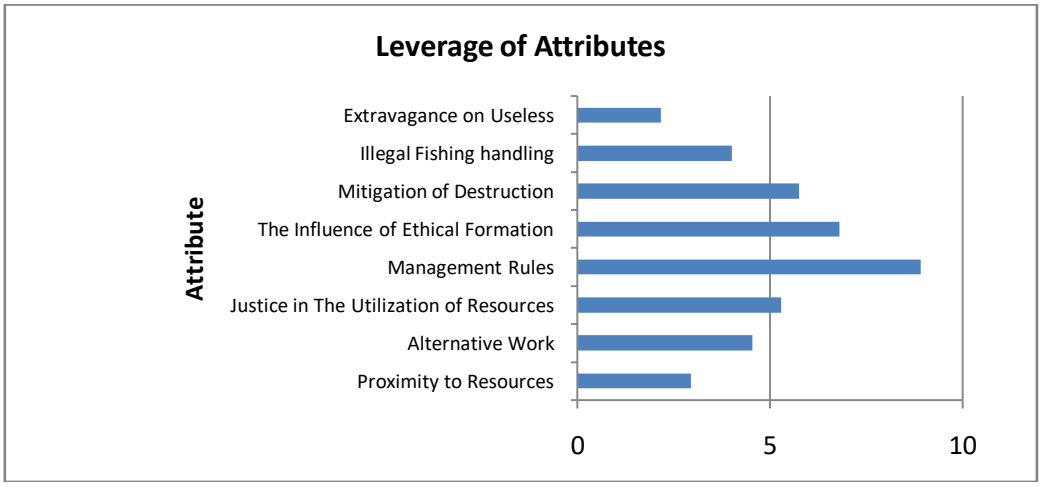


Fig. 18. Leverage analysis of ethical Dimension.

The value of stress (S) obtained for the ethical dimension was 13, 47%. This shows the value of S has met the condition of good ness of fit because S <25% (Fauzi Anna). Determination coefficient value (confidence interval for R2 equal to 94.56%.

Based on ordination analysis of RAPFISH / Ordination of gillnet fishery in *Tanah Laut* District which in the form of two-dimensional drawings based on the ethical dimension presented in Figure 17, are in the 26-50 interval including the less "sustainable" category. Factors whose most powerful influence contributes are the rules of management, the influence of ethical formation, the mitigation of destruction and justice in the utilization of fishery resources.

Sensitive attributes that contribute to the value of the sustainability index of capture fisheries in *Tanah Laut* District based on the ethical dimension are the management attributes of the roles> 8, the influence of ethical formation> 4, Mitigation of Destruction and Justice in the Utilization of Resources.

Ethically, the length of time between setting and hauling gillnet generates a lot of dead fish. The operation of drift gill net is done traditionally without mechanical aids, it can cause temporary health problems as it takes a long time on board.

Drift gill net is a catching tool that produces more than 3 species of byproducts but all the byproducts of both devices are still economically viable. Drift gill net once caught the unsold species of turtles but then released again.

Drift gill net is a fishing gear that has been caught several times by hawksbill turtles. According to the Act. No. 5 Th.1990 on marine biota and beaches protected by the government, one of the protected turtles is the Hawksbill turtle.

5.1.4. Social Sustainability

RAPFISH Ordination - Monte Carlo Scatter Plot is used to evaluate the impact of errors from random error (random error) to all aspects. In Figure 19 there is a plotting plot that signifies the model used appropriately to analyze the sustainability of capture fisheries by social dimension.

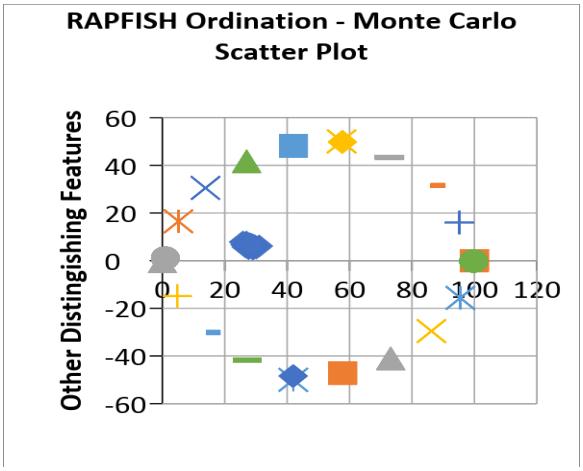


Fig. 19. Monte-carllo scatter plot of social dimension

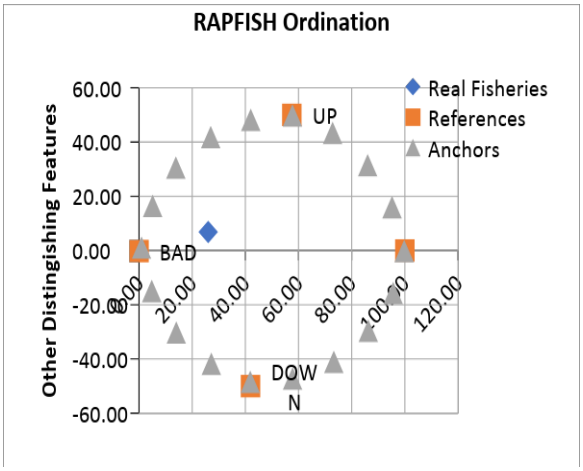


Fig. 20. Rapfish ordination of social dimension

The value of stress (S) obtained for the ethical dimension is 13, 53%. This indicates that the value of S has met the good ness of fit condition because S <25% (Fauzi Anna) The coefficient of determination (confidence interval for R2 is 94,89% (Table 7).

Based on ordination analysis of RAPFISH / Ordination of gillnet fishery in *Tanah Laut* District which in the form of two-dimensional images based on social dimension is presented in figure 20, it is in the 26-50 interval including the "less" sustainable category.

Table 7. The statistical value obtained from RAPFISH analysis results social dimension.

Stress =	0.13533
Squared Correlation (RSQ) =	0.9489599
Number of iterations =	2
Memory needed (words) =	5214
Return value (error if > 0)	0
Rotation angle (degrees) =	208.76028

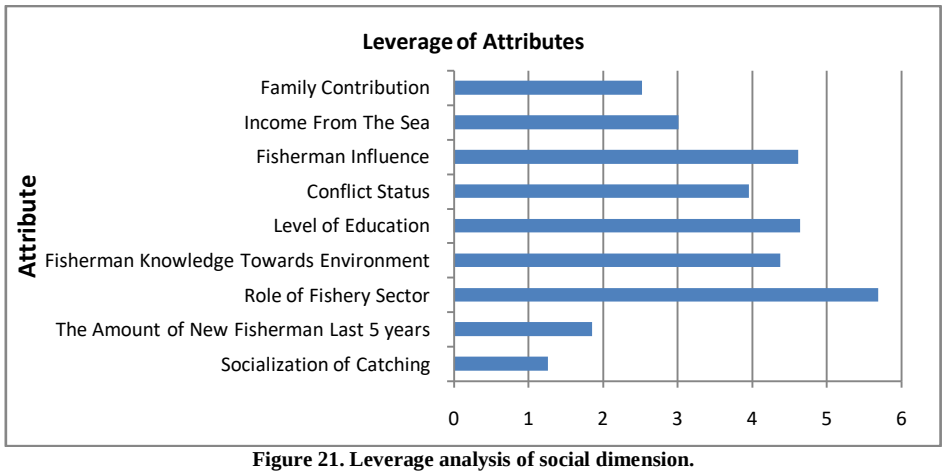


Figure 21. Leverage analysis of social dimension.

Factors with the strongest influence contributing to the social dimension are Role of Fishery sector attributes, level of education, fishermen influence, conflict status and Fishermen knowledge> 4, Fisherman Knowledge Towards Environment = 2, Income from the sea and Family contribution> 2.

5.1.5. Technology Sustainability

The analysis in looking at the stability of the ordination result to see the perturbation level on the value of ordinance result of RAPFISH Ordination - Monte Carlo Scatter Plot on the dimensions of this technology in Figure 22 visible plot collecting depicting data analyzed in stable and precise position to analyze the sustainability of capture fishery based on the technology dimension.

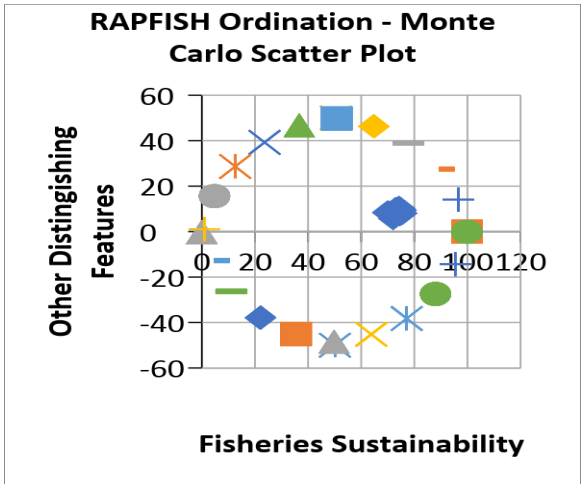


Figure 22. Monte Carlo scatter plot of dimension Technological dimension.

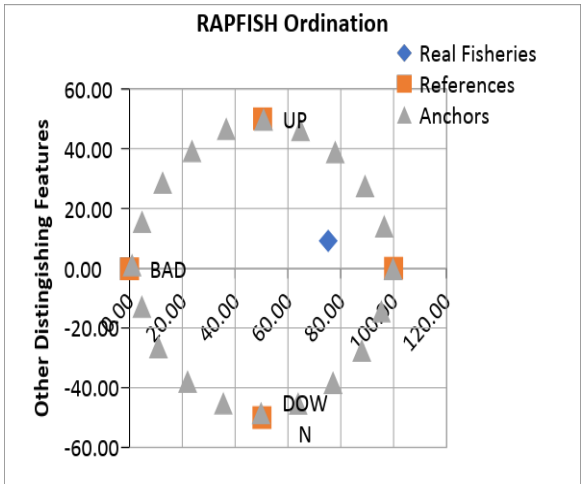


Figure 23. Rapfish ordination of technological.

The value of stress (S) obtained for the technological dimension is 13, 25%. This shows the value of S has met the condition of good ness of fit because S <25% (Fauzi Anna). The value of

coefficient of determination (hose of trust) for R2 of; 94.97%. (Table 8).

Based on ordination analysis of RAPFISH / Ordination of gillnet fishery in *Tanah Laut* District which in the form of two-dimensional drawings based on the technological dimension is presented in Figure 20, shows the status of sustainable "Good" sustainability.

Table 8. The statistical value derived from RAPFISH analysis results in dimensions technology.

Stress =	0.1327578
Squared Correlation (RSQ) =	0.9497598
Number of iterations =	2
Memory needed (words) =	5622
Return value (error if > 0)	0
Rotation angle (degrees) =	22.153421

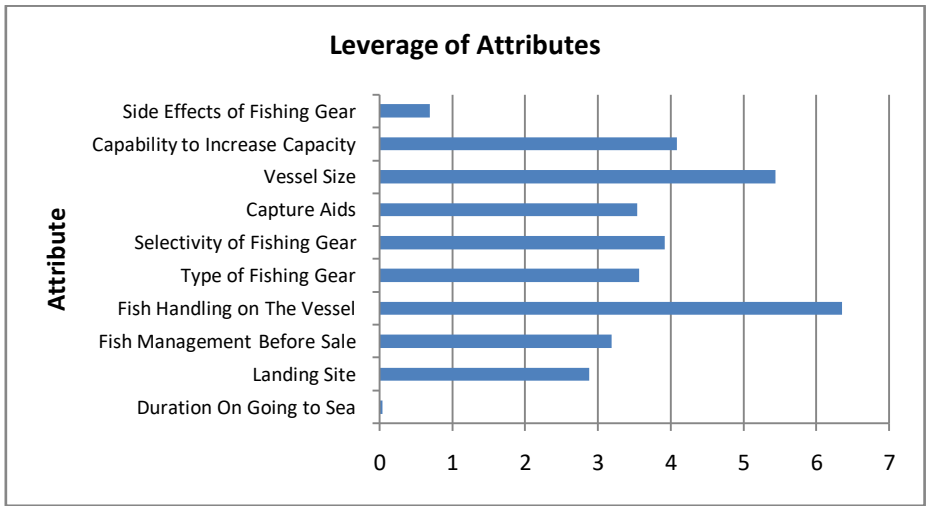


Figure 24. Leverage analysis of technological dimension.

Sensitivity analysis on technology dimension shows that Fish Handling on the vessel, vessel Size, capability to increase capacity, selectivity of fishing gear attributes is very influential on sustainability of gillnet fishery. A slight change in these attributes will have a major impact on the sustainability of the technology dimension.

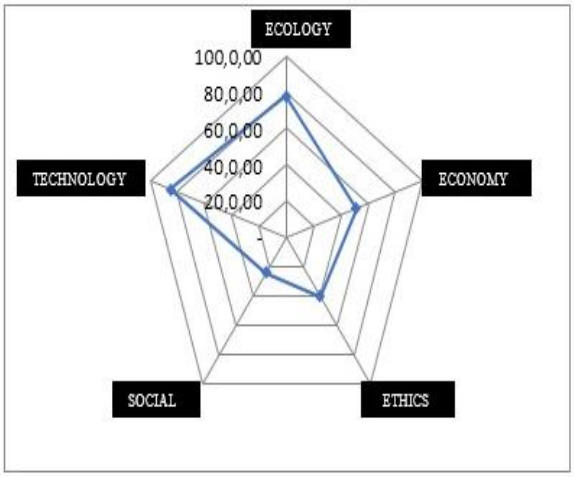


Figure 25. Kite Diagram Status of Gill Net Fisheries Sustainability in *Tanah Laut* District.

Overall based on kite diagrams is shown in Figure 25. The technology dimension is the highest sustainability (Good) on gill net fishing equipment, then Ecology (Good), then economic (sustainable) and ethical (less sustainable) dimensions. Social dimension has the lowest sustainability (bad).

6. CONCLUSION

Based on the results of the research described above, it can be concluded that gillnet fishing tools when viewed from the dimensions of technology and ecology is the highest sustainability (good), then economic (sustainable) and ethics (less sustainable). Social dimension has the lowest sustainability (bad). The gill net gizmo is based on a combination of technological, ecological, economic, ethical and social dimensions of the "quite" sustainability index.

White shrimp regression Y = 0.054200429-7.93E-08X with optimum catch 9.266,19 ton / year, effort optimum 431,923 trips / year; Croakers regression Y = 0.012407688-8.96408E-09X, optimum catch 4,293 ton / year, effort optimum 692,078 trips / year. Utilization of *Gulamah* fish and white shrimp resources can still be improved.

Priority to be sustainable fisheries management strategy that is attribute of Species on same geography, catch area, Fish Size, Fish caught before adult, Subsidy size, Market size, Management Rule, Effect of Ethical Formation, Role of Fishery Sector, Education Level, Handling fish on board, Size of ship. These factors need to be well managed in the future so that the sustainability of capture fisheries in the regency of the Sea can be maintained even more enhanced.

In order to develop environmentally friendly and sustainable gill net fisheries, it is necessary to restore the tropic level of fish resources to produce a variety of fish species in the same geographical area, the manufacture of artificial reef or fish house on the coast to restore the fish habitat for fishing not far from fishing base, Increased selectivity of fishing gear used by using mesh size according to the size exceeding the size of fish first mature gonad (length at first maturity), it will maintain the availability of fish.

7. ACKNOWLEDGEMENTS

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