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Bio-Economic Analyses of Coral Trout Grouper Fish in Spermonde Archipelago, Makassar, Indonesia

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Abstract

Problems in the management of resources were namely stocks biology endangered fish resources and the economic problems because fishing business has not provided a decent profit for most fishermen. This study aims to analysis the optimal and actual production levels of the utilization effort of coral trout grouper resources in Spermonde Island Water, Makassar. A survey was conducted in Barrang Caddi and Bonetambung islands by using simple random cluster sampling. The respondents were 30 fishermen who used traps and 22 fishermen who used line fishing. The analysis was conducted by used static bioeconomic and dynamic optimal formulae. The analysis of degradation and depreciation of fishery resources was conducted by using MS. Excel and Maple 11 software's. The result revealed that the actual condition of the utilization of coral trout grouper resource in Spermonde islands has shown overfishing, both biologically and economically. The actual production was 104.05 tons and sustainable production of MSY regime was 45.72 tons. The MEY reached 42.15 tons. The open access was 36.81 tons with optimum production of 45.43 tons at OSY management regime. In general, degradation and depreciation occurred in coral trout grouper resources. It can be concluded that the actual production level of resource use coral grouper is 65.22 tons, while the optimal production that can be achieved is 45.43 tons. It is necessary to reduce the effort number from the actual condition to the OSY management regime (5503 trips).

Keywords: Bioeconomic, Utilization, Coral Trout Grouper, Spermonde Islands, Makassar

INTRODUCTION

Grouper fish is a coral fish that has a high economic value and also become important export commodity mainly to Hong Kong, Japan, Singapore and China. Total trade of coral fish in South East Asia were around 30.000 tones/year with around 15000-20000 tones to Hong Kong (Sadovy *et al*., 2003). One of the trade Centre for alive coral fish was Spermonde Island, South Sulawesi Province, Indonesia (Radjawali, 2011). LRFF traditionally consumed by Chinas people, mainly people at Southern coastal area. Many centuries ago, this tradition appear because as a symbol of prosperity and luckiness in the Chinese culture. Koeshendrajana *et al* (2006), pointed out that fresh sea fish which has high economic value and also has an important culture and social actors in the special moments such as celebration and business.

Grouper fish has already become a special menu in famous hotels and restaurants in Indonesia, Hong Kong, Taiwan, Japan and Singapore. International market demand for grouper fish tend to increase, gave big chance for Indonesia to increase fish production (Soumena, 2012). However, trading for grouper fish mainly for export purpose were created high intensity fishing pressure with several methods (Soumena, 2012).

The use of cyanide dissolved in water bottle and then sprayed onto the reef areas so that the fish be easily collected. This is a much more efficient method than hook and line fishing methods are required a lot a lot of money. However, the efficiency of this method has led to overfishing and decline of fish stocks and the biggest concern is going to kill the coral habitats, as well as another non-target species (Fabinyi, 2009).

Naturally fisheries reef fish resources (including grouper) would be very able to repair itself (self-recovery), however this will be hampered if human intervention is too large and the speed exceeds the ability of resources to renew themselves (recovery) (Mosse, 2013) and (Dann et al., 2007), stated that the fishery resource also experience limitations in conducting a fishery resources although reproduction including the type of resources that can be recovered.

Problems in resource management is divided into two issues, namely the biological and economic problems. The problem is the stock of fish biology endangered. This relates to the question of how much the number or biomass of fish can be taken without disturbing the existence of stock. As for the economic problems that fishing effort has not provided a reasonable profit for most fishermen. Thus, management of fisheries resources should be able to maximize profits by taking into account the sustainability of fishery resources in the long term (Sriati, 2011).

The existence of the general nature of the utilization of marine resources that are open (open access) increased the exploitation of which tend to be free without any restrictions as long as the possibility of obtaining benefits or advantages can still be obtained. This condition if not immediately controlled (manage) is feared to threaten the sustainability of fish resources (Susilo, 2010). According to research (Nababan et al., 2007), stating the resource use of live reef fish for food (LRFF) at Spermonde Islands has overfished because it is known the actual production is higher than the suggested optimal production (Sriati, 2011).

One way to remain sustainable fisheries management and the optimal economic benefit is the need to consider the relationship between biological aspects and economic aspects (Noordiningroom et al., 2012). Utilization of marine fishery resources must meet the requirements of the sustainable use of natural resources (sustainable use of natural resources). The utilization of the ecological aspects entailed ensuring the sustainability of fisheries resources. Although the marine fish resources are resources that can be recovered (renewable resources) but this fish resource is not unlimited. To ensure sustainability of the resource utilization should not exceed its potential (FAO, 1996).

This study focused on the case of coral trout grouper fishing for domestic and export demand is very high, resulting in high prices of products that stimulate the fishermen to exploit these resources. Increased exploitation of grouper is not necessarily comparable with the income received by fishermen. If this is not balanced with appropriate management will lead to depletion (depletion) to those resources that do not cover the possibility of extinction. This study aimed to analyze the optimal production level and the actual efforts to use resources in the coral trout grouper at Spermonde Islands waters of Makassar

MATERIALS AND METHODS

The research conducted on February through April 2014 at Spermonde Island, Makassar City with respondent focus at Bonetambung Island and Barrang Caddi Island. Research location selected on purpose with main consideration that most fishermen in that site exploited grouper fish with traps and angling.

Survey methods applied in this research through conducting sampling from population and using questionnaire to obtain data. Population in this research were fishermen's for groupers fish in the Spermonde Islands, South Sulawesi, Indonesia, with respondent obtain from Bonetambung and Barrang Caddi Islands who specialized in angling and trap. Fishermen population at Spermonde Island Makassar for angling were 218 units and for traps were 60 units.

The sampling method using a simple cluster random sampling. The elements in the cluster nature is not homogeneous (heterogeneous) (Nazir, 1999; Indra, 2007). The number of groups that should be sampled randomly, then elements in the group study examined all, but it can also be chosen randomly (Rianse and Abdi, 2008). According

Arikunto and Suharsimi (2006), stated that if a population of less than 100, it would be better if taken as a whole, and if the population of more than 100, can be taken 10-15% or 20-25% or more of population. Based on consideration of time, effort and cost, taking the number of samples taken from the trap fishing gear 50%, ie 30 units of sample and 10% for units of fishing gear to 22 sample units.

A. Data Collection

Collection techniques performed in this study are:

1. The primary data through interviews were fishermen with the help of a questionnaire covering the prices, costs of operations and investments owned by fishermen as boats, fishing gear and other, income and fishing areas. Interviews were conducted for more in-depth information and strengthen the analysis.

2. Secondary data were obtained from the Department of Marine and Fisheries, Statistics South Sulawesi, or other sources of information that is still associated with this research. The data taken is sort of time (time series) for 13 years from 2000 to 2012 with data taken as statistical data of fishery production, consumer price index, the price of fish and was data related to this study.

B. Data Analysis

1. Standarisation fo Fishing Gear

Before performing the estimation of biological parameters, first performed the standardization of fishing gear. This is done because given the coral trout grouper fishery in Makassar Spermonde Islands using more than one gear or a multi-gear. To homogenize the fishing effort is measured in traps tool then carried standardization effort between gear with standardization techniques developed by King (1995), namely:

$$\boldsymbol{E_{it} = \varphi_{it} D_{it}}$$

$$\boldsymbol{\varphi_{it} = \frac{U_{it}}{U_{st}}}$$

where :

$\boldsymbol{E_{it}}$ = effort of fishing gear standardized

$\boldsymbol{D_{it}}$ = the number of days of fishing gear i at time t

$\boldsymbol{\varphi_{it}}$ = fishing power index (FPI) of fishing gear i at time t

$\boldsymbol{U_{it}}$ = catch per unit effort (CPUE) of fishing gear i at time t

$\boldsymbol{U_{st}}$ = catch per unit effort (CPUE) of fishing gear is used as the standard

2. Estimation of Biological Parameters

Biological parameters estimated using surplus production model (Clark, Yoshimoto and Pooley, 1992) which more known as CYP methods. Equation of CYP in the mathematics form as follows (Sari et al., 2008) :

$$\ln(U_{t+1}) = \frac{2r}{(2+r)}\ln(qK) + \frac{(2-r)}{(2+r)}\ln(U_t) - \frac{q}{(2+r)}(E_t + E_{t+1})$$

Where :

U = catch per unit effort (CPUE)

q = catchability coefficient

K = carrying capacity of the environment

E = effort

r = intrinsic growth rate of the fish

C = catch

where :

$$U_t = \frac{C}{E}$$

By regressing catch per unit effort (effort) is denoted by U in period t + 1 and U in period t, and the sum of input in period t and t + 1, will be obtained coefficient r, q, and K. Then after simplified equation can be estimated by ordinary least squares (OLS):

$$\mathrm{Ln}(U_{t+1}) = C_1 + C_2\ln(U_t) + C_3\,(E_t + E_{t+1})$$

So the value of the parameter r, q and K can be obtained through the following equation:

$$r = \frac{2(1 - C\,2)}{(1 + C\,2)}$$

$$q = -C_3\,(2 + r)$$

$$K = \frac{e^{\frac{C1(2+r)}{2r}}}{q}$$

The production function in this analysis is assumed to follow the production function logistic shown by equation (Fauzi, 2004):

$$h_t = qKE_t\left(1 - \frac{qE_t}{r}\right)$$

3. Estimation of Economic Parameters

The calculation of the cost of an average fishing operating cost as the cost of fuel, food and baits. Fishing cost in the study of Gordon-Schaefer bioeconomic models based on the assumption that only the fishing of factors is taken into account. In calculating the costs, the average cost is justified by the consumer price index from the year 2000-2012 with base year 2007 = 100 obtained from Statistics South Sulawesi (2014). Calculated using the formula (Fauzi, 2004):

$$\boldsymbol{c = \sum_{ci}/n}$$

where:

$\boldsymbol{c}$ = average cost of fishing (Rp/Trip)

$\boldsymbol{ci}$ = nominal fishing cost of respondent i

$\boldsymbol{n}$ = respondent number

The price of fish that will be used in this analysis is the price of coral trout grouper sourced from interviews directly to fishermen and from BPS data with time series 2000-2012. Then the price was justified by using the consumer price index from the year 2000-2012 with base year 2007 = 100. The average price obtained from:

$$\boldsymbol{p = \sum_{Pt} /n}$$

where:

$\boldsymbol{p}$ = average fish price Rp/Kg

$\boldsymbol{Pt}$ = nominal price at year t

$\boldsymbol{n}$ = respondent number

4. Analysis on Static Bioeconomic

a. MEY (*Maximum Economic Yield*) Condition

Fisheries management at MEY condition is also known as sole owner management (Fauzi, 2004). The economic benefits of resource extraction fish on the condition that MEY :

$$\boldsymbol{\pi = pqKE\left[1 - \frac{qE}{r}\right] - cE} \quad \text{...}1$$

While to find the optimal level of fishing effort, the economic benefits above derived to E into

$$\boldsymbol{E_0 = \frac{r}{2q}\left(1 - \frac{c}{pqK}\right)} \quad \text{...}2$$

With optimal harvest levels of:

$$\boldsymbol{h_0 = \frac{rK}{4}\left(1 + \frac{c}{pqK}\right)\left(1 - \frac{c}{pqK}\right)} \text{...}3$$

With optimal biomass level by:

$$\boldsymbol{x_0 = \frac{K}{2}\left(1 + \frac{c}{pqK}\right)} \quad \text{.......4}$$

b. MSY (*Maximum Sustainable Yield*) Condition

The economic benefits of resource extraction fish on the condition (MSY) is:

$$\boldsymbol{\pi = ph_{MSY} - cE_{MSY}} \quad \text{.......5}$$

By using biological parameters obtained against the effort (E) will produce:

$$\boldsymbol{E_{MSY} = \frac{r}{2\,q}} \quad \text{....... 6}$$

With the sustainable harvest level by:

$$\boldsymbol{h_{MSY} = \frac{rK}{4}} \quad \text{.......7}$$

With the level of sustainable biomass::

$$\boldsymbol{x_{MSY} = \frac{h_{MSY}}{qE_{MSY}} = \left(\frac{\frac{rK}{4}}{q\left(\frac{r}{2q}\right)}\right) = \frac{K}{2}} \quad \text{.......8}$$

Substituting equation (5) and equation (6) into the equation (4), will obtain the benefits (rents) a sustainable economy.

c. *Open Access* (OA)

Economic benefit from fisheries resources extraction at open access condition are

$$\boldsymbol{\pi = p\,.\,h_{OA} - c\,.\,E_{OA}} \quad \text{.......9}$$

Substituting equation (5) and equation (6) into the equation (4), will Obtain the benefits (rents) a sustainable economy

$$\boldsymbol{E_{\infty} = \frac{r}{q}\left(1 - \frac{c}{pqK}\right)} \quad \text{.......10}$$

so the optimal capture the open access condition known as:

$$\boldsymbol{h_{\infty} = F(x_{\infty}) = rx\left(1 - \frac{x_{\infty}}{K}\right)}$$

$$\boldsymbol{= \left(\frac{rc}{pq}\right)\left(1 - \frac{c}{p.q.K}\right)} \quad \text{.......11}$$

With the level of biomass maximum of:

$$\boldsymbol{x_{\infty} = \frac{c}{pq}} \quad \text{.......12}$$

Substituting equation (8) and equation (9) into the equation (7), will obtain the benefits (rents) maximum economy.

5. Analysis Model Bioeconomy Dynamic

The maximization of benefit function through integration process will produce the optimal value for biomass (x *) and also harvesting optimal (h *), so that from here will get the level of effort that is optimal that will generate economic rents maximum.

$$\boldsymbol{h^* = \frac{1}{c} x(pqx - x)(\partial - r\left(1 - \frac{2x}{K}\right)} \text{ ....13}$$

With the optimal value of biomass of:

$$\boldsymbol{x^* = \frac{K}{4}\left[\left(\frac{c}{pqK} + 1 - \frac{\delta}{r}\right) + \sqrt{\left(\frac{c}{pqK} + 1 - \frac{\delta}{r}\right)^2 + \frac{8c\delta}{pqKr}}\right]} \text{........................14}$$

Efforts optimal value can be obtained by substituting x^* and h^* to the production function h = qxE therefore the optimal effort can be sought from the formula:

$$\boldsymbol{E^* = h^* / qx^*} \text{ ....15}$$

Parameter resources discount rate (δ) using the equation Clark, 1990 in Najamuddin, 2014:

$$\boldsymbol{\delta_{riil} = \ln(1 + i_{riil})}$$

$$\boldsymbol{i_{riil} = i_{nom} - inf}$$

where:

$\boldsymbol{\delta_{riil}}$ = real discount rate

$\boldsymbol{i_{riil}}$ = real interest rate

$\boldsymbol{i_{nom}}$ = nominal interest rate

$\boldsymbol{inf}$ = inflation rate

6. Analisys of Degradation Rate

Analysis of the rate of degradation of fisheries resources is very important to see the extent of resource utilization affect the condition of these resources. Estimates of the rate of degradation of fishery resources, mathematically determined by utilizing the research results Anna S (2003). Based on the research results obtained by a model of determination coefficient or the rate of degradation (∅D) for coral trout grouper resource. The following equation is used to estimate the rate of degradation of coral trout grouper resource as follows:

$$\boldsymbol{\emptyset D = \frac{1}{1 + e^{h\delta/h0}}}$$

where:

$\boldsymbol{h\delta}$ = sustainable production

$\boldsymbol{h0}$ = actual production

$\boldsymbol{\emptyset D}$ = coefficient or degradation rate

This model shows the fundamental change of the state of fisheries resources in the region. In this case, the sustainable production used as a measure of determining the rate and percentage of degradation of fishery resources.

Therefore, the model calculation involves the calculation of sustainable production models Schaefer (1954). Model estimates of biological parameters for the calculation of sustainable production by using logistic growth model, done using estimation models developed CYP Clarke, Yoshimoto and Pooley (1992).

The coefficient of the rate of degradation and depreciation (ØD / ØR) of a resource with values are between 0 to 0.500 (0≤ØD≤0,500), said that these resources have not been degraded.

There is nothing to calculate the rate of depreciation of resources, essentially the same as the degradation rate calculation formula, only in this case economic parameters into variable parameters that determine the calculation of the rate of depreciation, which is formulated as follows:

$$\emptyset \boldsymbol{R} = \frac{\mathbf{1}}{\mathbf{1} + \boldsymbol{e}^{\boldsymbol{\pi\delta}/\boldsymbol{\pi}\mathbf{0}}}$$

Where :

$\boldsymbol{\pi\delta}$: sustainable rent

$\boldsymbol{\pi}\mathbf{0}$: actual rent

$\emptyset\boldsymbol{R}$: coefficient of depreciation rate

Data Analyses

Data analysis of the data used in this research is the analysis of Gordon-Schaefer bioeconomic static and dynamic continuous with the help of software MS. Excel and Mapple 11.

RESULT

The results showed the biological and economic parameters of resource management grouper in Spermonde Islands, Makassar with individual growth rates experienced (r) is 0.92107, catching ability coefficient (q) is 0.0000771, environmental carrying capacity (K) is 198.5568, the cost of fishing (c) is 1,211,983, fish prices (p) i.e. 283 372 820 and the resources discount rate (δ) is 0.58779 (Table 2).

The results show a comparison between actual production and sustainable production with a total standardized effort is 9258 trips per year with an average actual production of 65.22 tons while the average sustainable production only amounted to 22.47 tons. The average difference between actual and sustainable production that is equal to -42.74

ton, it indicates that actual production has exceeded the recommended sustainable production (Table 1)

According to the table (3), the highest production level in a state that is equal to MSY 45.72 tons, followed OSY amounted to 45.43 tons, MEY amounted to 42.15 tons and 36.81 tons of OA. The effort level in the open access (OA) condition was far above those MSY, MEY and OSY conditions as many as 8608 trips, while for MSY as many 5972 trips, for MEY as many 4304 trips and for OSY as many 5503 trips (Table 3). Bioeconomic balance management of fish resources in the coral trout grouper Spermonde Islands, Makassar can be seen in Figure 1.

The highest economic rent obtained at MEY regime is Rp. 6729054962, MSY is Rp. 5718179259, Open Access is Rp. 0 and OSY Rp. 6206837398. The highest profit was obtained on condition MEY is because in this management regime, the level of effort required is smaller when compared to the effort at MSY regime, OA and OSY (Table 3), (Figure 2).

DISCUSSION

The research showed that average production of grouper fish at Spermonde Island Makassar were far above the production at regime management levels. The average actual production were 65.2227 ton whereas the optimal production at optimum sustainable yield level only 45.43 ton. This mean that grouper fish condition had suffered biological overfishing. Widodo et al. (2006) stated that overfishing was indication that fishing effort over than fish stock.

The average actual production was 65,22 tons while average sustainable production was only 22,47 tons. Average between maximum sustainable yield and actual yield were -42,74 tons. That mean that the actual production was already over the production at sustainable level. The main reason for this due to the increasing effort since year 2000 until 2012 caused the actual production above the sustainable yield.

Increasing the level of effort will also increase operating costs. If the condition is not relegated to the effort MEY regime, leading to increased component costs by the reception which will be reduced and economic rents received by fishermen will decrease. According to Fauzi (2010), catching more economically or economic overfishing is essentially a situation where fishing should be able to generate positive economic rents, yet it produces zero economic rents because of the utilization of input (effort) is excessive. In economic jargon fisheries, economic overfishing is often called the jargon "too many boats chasing too few fish". In this situation both fishermen and the public in general do not benefit from the resources they enjoy if the resource should be managed properly.

One of the modeling framework to answer these problems are Bio-economic terms. Model bioeconomic has two main components, namely biological parameters that define the limitations of natural and economic parameters that characterize fisheries management policy (Kugarajh, 2006).

In MSY management regimes, fishery stocks fishing activities directed at achieving the highest level of sustainable production. The approach in this concept is based entirely on biological parameters regardless of the cost of resource exploitation as has been mentioned. MSY introduced by Schaefer (1954) state that fish management is based on a purely biological approach, with the aim of obtaining the highest production. If the fish resources harvested at MSY levels, the utilization of fishery resources does not interfere with the preservation of resources, where the number of fish harvested or caught on the limitation of surplus production (Fauzi, 2005).

In the MSY regime, production (h_{MSY}) was 45.7212 ton where the highest production level compared with the level of production of MEY regime that is equal to 42.1539 tons, production OSY (h_{OSY}) amounted to 45.4390 tons and production of Open Access (h_{OA}) amounted to 36.8152 tones. So, it can be seen the highest production are at MSY regime (h_{MSY}) (Figure 1). In the MSY regime considered only biological factor while in the field condition economic factor become more considered. Most scientist more think on the biological approach and fishing business more on economic view.

The main issues of the MSY is not relevant to the economy. This is because taking into account the benefits of the exploitation of resources, but it ignores the cost of resource exploitation. This would lead to a situation where the cost of the harvest will be higher than the benefits (Kar and Chakraborty, 2009). However, if only to see the maximum production will be obtained as the MSY regime, the costs incurred to extract the resource will be higher than the MEY and OSY regime. This is because the amount of effort the highest MSY regimes when compared to with both the regime that is equal to 5972 trip. While the lowest effort was at MSY regime equal to 4304 trips and OSY regime equal to 5503 trips.

However, when viewed from the maximum benefit to be derived from any management regime, the regime MEY will provide the maximum benefit from each other's regime. Profits at MEY regime is Rp. 6729054962, OSY regime that is Rp. 6206837398, MSY regime that is Rp. 5718179259, and OA regime that is Rp. 0. The biggest advantage to the regime of MEY due to the amount of effort used in this regime is smaller when compared with other regimes so that the total cost is lower than other regimes that have a direct impact on profits will be accepted. MEY balance management conditions look more conservative minded (more environmentally friendly) compared with the level of effort in equilibrium at the MSY conditions (Hanneson 1987, Fauzi 2004; Sulistianto, 2013).

In MEY regime in which direction the fishing activities focus instead on achieving the highest production rate, but on the level of sustainable production which will provide the highest efficiency in economic terms (maximum economic yield). However, the drawback in this regime is still excess production can be optimized to the limit of sustainable production at MSY regime is 8.9060 tons. So, the proper management of the resource management efforts in coral trout grouper Spermonde Islands waters is the OSY regime.

Sangaji (2010), stated that the complexity of development issues in fisheries management to encourage new thinking to formulate the optimum better harvest. The old concept, which proved strong enough to address issues related to the utilization of fishery resources for years, felt no longer able to respond to new problems that emerged sometime later. In fact, it is evident that the assumptions used in the old concept has the potential to destroy the continuity of fisheries resources.

Social scientists stated that MEY concept proved not flexible enough to cope with the growing complexity of the problem (Sangaji, 2010). Weakness of MEY concept was recognized by some of his supporters, says that the optimum yield should not only include economic variables that directly relate to the production (exploitation costs, sales, and interest rates), but must also summarizes indirect variables such as conservation values, social values, and so on.

Management of the regime OSY, where fishing activities directed at achieving sustainable production that provides the highest social value (socially optimum yield). This concept is based on the opinion of critics of the concept of MEY (Charles, 1994; Sangaji, 2010; Pascoe et al. 2016), that the consideration in determining the optimal capture rate should not be limited to economic and biological variables alone, but must cover all relevant aspects. On the management regime OSY provide optimal value in terms of production or harvest and the economy.

Bioeconomic model have been implemented in Australian and New Zealand fisheries as a bases to set up management purposed (Pascoe et al. 2016) harvest strategy for lobster fishery (Mcgarvey et al. 2016) at North Sea Fishery (Laura et al., 2015). Optimum sustainable yield should be referred as reference point for management purpose.

CONCLUSION

The actual production conditions of utilization of coral trout grouper fish in the waters Spermonde Islands, Makassar has exceeded the limit management regime that is equal to 65.22 tons while the maximum sustainable suggested at the MSY regime amounted to 45.72 tons, at the MEY amounted to 42.15 tons and at the OA amounted 36.81 tons. Suggested optimal production is at OSY regime amounted to 45.43 tons. To keep resources of coral trout grouper, remain stable and profits or economic rent maximum for fishermen, necessary management policies that can be done so that the level of effort of the actual condition that 9258 trips reduced to 5503 trips according to an effort optimal regime OSY that economic rents received by fishermen would more optimal Rp. 6206837398.

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APPENDIXES:

Table 1. Compare sustainable yield and actual production and also total fishing effort of grouper fish in Spermonde Island waters, Makassar, year 2000 to 2012

Year	Effort (trip)	Sustainable Yield (ton)	Actual Production (ton)	Production Difference (ton)
2000	6938	44,5260	54,1011	-9,5751
2001	6378	45,5096	50,9342	-5,4246
2002	6700	45,0415	56,3669	-11,3254
2003	6372	45,5166	63,2685	-17,7519
2004	7184	43,8377	65,4104	-21,5727
2005	7489	42,7695	66,8479	-24,0784
2006	8421	38,0311	68,8773	-30,8462
2007	8954	34,3217	65,1406	-30,8189
2008	10551	18,8431	70,9823	-52,1392
2009	11139	11,4917	65,6465	-54,1548
2010	12382	-6,9601	67,9475	-74,9076
2011	13646	-29,7669	75,9765	-105,7434
2012	14195	-40,9529	76,3956	-117,3485
Average	9258	22,4776	65,2227	-42,7451

Source : Data after analyzed, 2014

Table 2: Parameter biology and economy of grouper fish resources at Spermonde Island, Makassar.

Parameter Biology and Economy	**Symbols**	**Result**
Natural fish growth rate (%/ year)	r	1,7789
Catch ability coefficient (1/unit effort)	q	0,00007
Carrying capacity (ton)	K	192,3075
Fishing cost (Rp/Trip)	c	1211983
Fish price (Rp/Ton)	p	283372820

Source: Data after analyzed, 2014

Table 3. Level of biomass, production, optimum effort and benefit from difference grouper resources management level at Spermonde Island, Makassar.

Parameters	Management regime			
	MEY	MSY	OA	OSY
X (ton)	127.0094	99.2784	55.4620	107.0778
H (ton)	42.1539	45.7212	36.8152	45.4390
E (trip)	4,304	5,972	8,608	5,503
π (Rp)	6729054962	5718179259	0	6206837398

Source: Data after analyzed, 2014

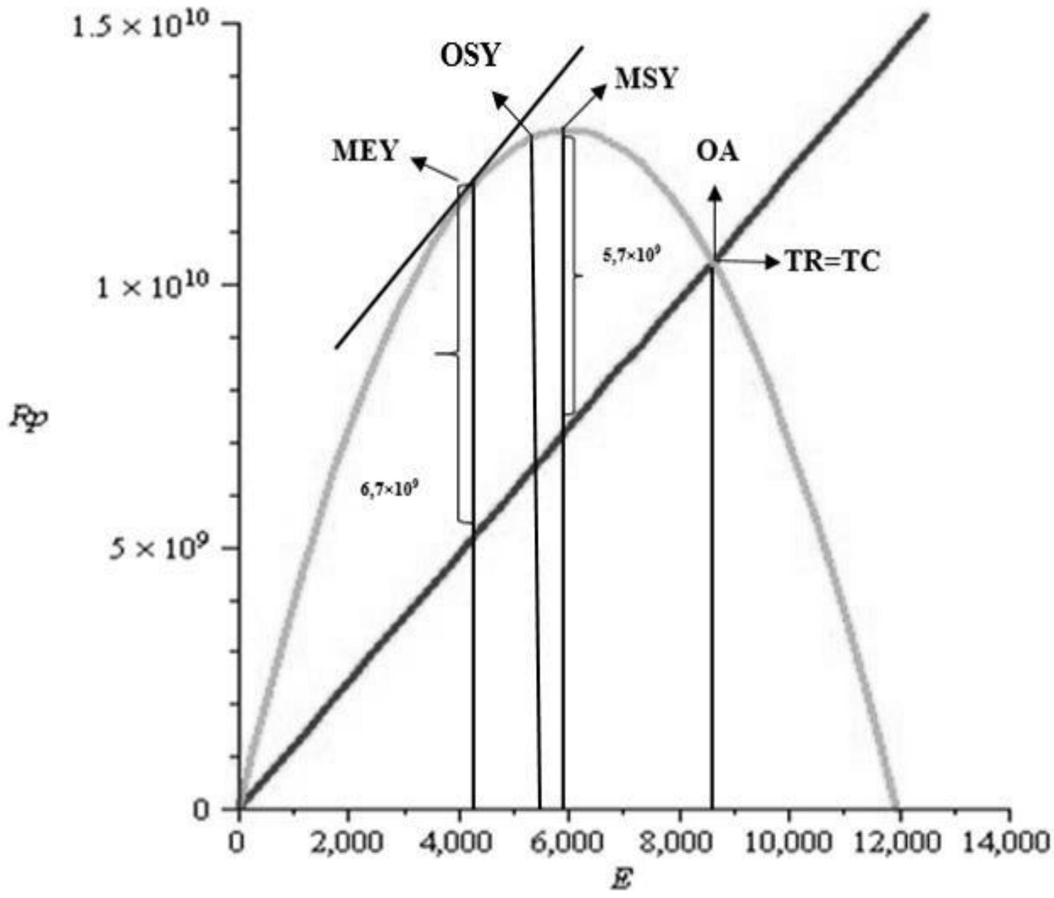

Figure 1: Bioeconomic Balance of Grouper Fisheries Resources Management in the Spermonde Island, Makassar, Indonesia