

Bioeconomic Analysis of Grouper Fish (*Plectropomus leopardus*) Utilization in Selayar Archipelago Regency

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Abstract-- The main problem in the management of fishery resources is how the fishery resources produce high economic benefit but its sustainability be maintained. This study aims to analyze the actual and optimal production levels of coral trout grouper in Selayar Archipelago Regency. A survey was conducted in Gusung island, Selayar Archipelago Regency by using simple random cluster sampling. The respondents were 32 fisherman who used fishing rods and 29 fisherman who used traps. Analysis of the data using formulas bioeconomy optimal static and dynamic with the help of software MS. Excel and Mapple 18. The results showed that the actual condition of the coral trout grouper utilization in Selayar Archipelago Regency has not experienced overfishing, both biologically and economically. The actual production was 184,57 tons while the optimum production of OSY (Optimum Sustainable Yield) management regime is equal to 213,32 tons. It is necessary to increase the amount of effort from the actual condition was 52.744 trips to the management OSY regime that is 111.339 trips to get the optimum economic rents amounting to 5.937.435.339 rupiahs.

Keywords: Bioeconomic, utilization, coral trout grouper, Selayar Archipelago

INTRODUCTION

Grouper fish is one of coral fish (Heemstra & Randall, 1993) has an important economic value either for domestic market or International market. According to Adrian (2010), grouper fish potential nationally as much as 35.000 ton per year with mariculture area potential as much 3.776.000 ha. While Ministry of Marine Affairs and Fisheries mentioned that total production for coral fish had already reach 113.368 ton per year (KKP, 2015).

Bailey & Sumaila (2015), mentioned that in Eastern Indonesia, snapper fish and grouper fish were the most required for trade in alive fish. This also supported by Ghufran & Kordi (2001) that international market demand for grouper fish tend to increase year by year, this gave big chance for Indonesia to increase fish production. Petersen *et al* (2013), mentioned that grouper fish has a good future prospects as increasing grouper fish demand from Asian market. Petersen *et al* (2015), stated that one of grouper fish which most require in Vietnam and their juvenile still

imported from Indonesia is coral trout fish (*Plectropomus leopardus*).

As a consequence of high grouper demand for International markets, their stock become decrease and high pressure as reported by Sadovy (2005), that grouper fish stock in Indonesia supper decrease and some area had already overfishing. Arfiansyah *et. Al.*, (2015), also reported that actual condition of grouper fish utilization in Spermonde Island has overfished already either biology or economy.

One of the South Sulawesi area that high potential for grouper fish is Selayar Island District, that around 31.17% of South Sulawesi total production (Badan Pusat Statistik Sulsel, 2014). The main problem was the government as the manager only focus on sustainable fisheries resources based on biological aspects whereas fishermen as a business actors were more focus on economic to gain benefit. Fauzi & Anna (2004) stated that fisheries resources management is how to manage resources so can get high economic benefit for the business owner, but the sustainability still maintained.

Many research has conducted on biological aspects of grouper fish such as Prasetya (2010), related to grouper potential in Lasongko Bay Buton; Alamsyah (2012), conducted research on biology reproduction of grouper fish in Wakatobi. Ismi *et al* (2012), on grouper larvae sustainable life. Biological aspect approach more generally used to evaluate the fisheries resources whereas ignored the economic aspects. While in the fact showed that fishermen as the business actor and natural resources user oriented mainly on economic to get the maximum benefit to fulfill their needs.

Study have been conducted on economic aspects of grouper fish in Indonesia namely Afero *et al* (2009), on analisis of tiger and duck grouper aquaculture in floating cage of Indonesia. Moreover Afero (2010) continued his research about proability study regard to decrease of production cost, increase of production and price of grouper fish in floating fish cage in Indonesia. Firman and Arfah (2012), also conducted research about grouper fish market analysis in Bonetambu Island, Makassar.

Bio-economic approach were combining among aspects biology, technology and economy (Clark, 1985; Seijo *et al.*, 1998). Research on bio-economic still limited in South Sulawesi namely Indian Mackerel (Zainuddin, 1994), Indian

Scad (Najamuddin, 2004), Flying Fish (Baso, 2004), in Macassar strait and Flores sea, Petersen *et al* (2011), with spesies Lobster in Lombok Bay and Ernaningsih (2013), with bioeconomic analisis on small pelagic fish species in Banten Bay. Arfiansyah et al. (2015), about bioekonomi of grouper sunu in Spermonde Island, Makassar. Model bioekonomi approach toward sea fisheries resources have already recommended by FAO, due to many uncertainty factors appears in the sea (Garcia & Chocrane, 2005).

This research focus on case of grouper fishing which its market demand continue to increase, and cause exploitation level getting higher. The over increasing exploitation level wondering will over the maximum sustainable yield. When this happen without proper management will cause exhausting

resources and also reducing fishermen income as well as fishermen loss. The aim of this research was to analyze the optimal production levels and actual utilization effort if grouper sunu (*Plectropomus leopardus*) in Selayar Island Regency.

MATERIAL AND METHODS

The research conducted from November 2015 until April 2016 in Selayar Island District with sampling site in Gusung Island (Figure 1). Research site was selected on purpose with the main consideration that fishermen in that site catches grouper fish with trap and line. The research used survey methods

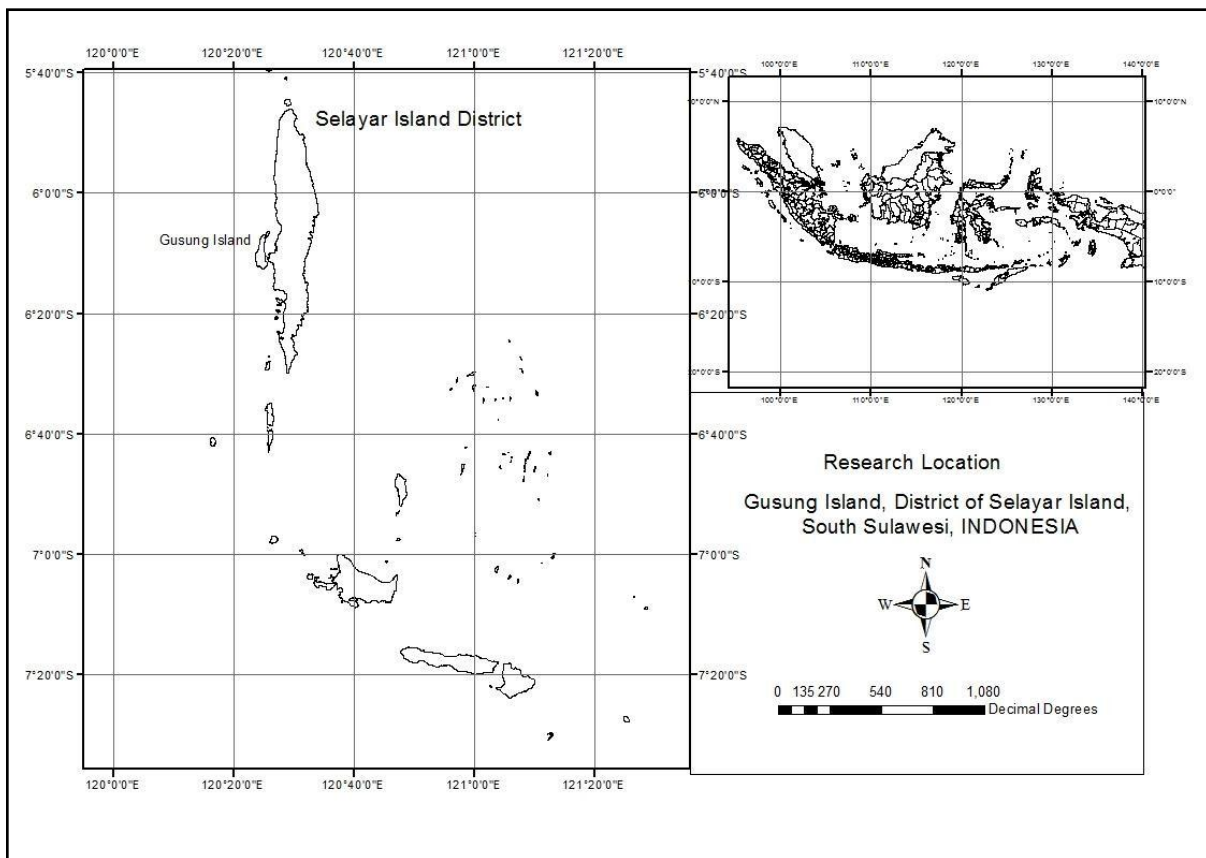


Fig. 1. Research location

Population on this research were grouper fishermen in Selayar Island Regency with respondent collected from Gusung Island as many 61 respondents with consist of 32 angling fishermen and 29 trap fishermen. Sample were collected by using simple cluster random sampling. Data source were primary and secondary data.

Data analyzed using bio-economic static and dynamic as developed by Clarke *et al* (1992), with formulate and developed based on Fox (1970) and Schnute (1977). Statistic calculation by using software *MS. Excel* and *Mapple 18*.

RESULTS

Results of this research indicated that biological and economical for grouper fish management in Selayar Island District with natural growth rate (r) 2.5, catch ability coefficient (q) 0,00000974, environmental carrying capacity (K) 346,37, rill cost of fishing (c) which are 179.144, *rill* fish price (p) 371.824.938 and resources discount rate (δ) 0.0233 or 2.3 percent (Table 1).

Catch Per Unit of Effort (CPUE) value that figure out the productivity level from fishing effort as shown in Figure 1. Based on Figure 2, cpue for grouper fish tend to decrease since 1995 to 2014. This was the indication of production decrease or fish population decrease.

Result of bio-economic analysis on Grouper fish were management regimes *Maximum Sustainable Yield* (MSY), *Sole Owner* or *Maximum Economic Yield* (MEY), *Open Access* (OA) and *Optimum Sustainable Yield*. Average effort (E) actual for grouper fish during periods 1995-2014 still below then effort of various management levels in this research. The average actual effort during year 1995-2014 were 52,744 trips/year while the result of analyses from various management regime were 220,888 trip/year for open access, 110,444 trip/year for maximum economic yield, 128,844 for maximum sustainable yield and 111,339 trip/year for *Optimum Sustainable Yield* (Table 2).

Optimal production level (h) for grouper fish had the highest value compare with the others management regime were 217.33 ton per year. Average production level for grouper fish during 1995-2014 were 184.57 ton per year (actual), 106.42 ton per year (OA), 212.90 ton per year (MEY) and 213.32 ton per year (OSY) (Table 2).

Result of analysis also showed that benefit level or economic rent be able to gain were Rp.5.937.825.557 per year for MEY management regime, Rp.5.937.435.339 per year for OSY management regime, Rp.5.773.007.700 per year for MSY management regime and Rp. 0 per year for OA management regime. Field condition showed that actual benefit level gain only Rp. 3097962334 per year. Ratio between actual condition with four management regimes based on Maple software running as shown in Figure 2.

DISCUSSION

Result of the research showed that natural growth rate (r) of grouper fish was 2.50. The value of natural growth rate classified quite high compare with the previous research such as Arfiansyah *et al* (2015) found the natural growth rate of Grouper in Spermonde Island 0.92. Compare with the other fish species such as sea bass in Kutai District, natural growth rate were 0.29 (Sulistianto, 2013). The possible reason may due to different location and environmental productivity.

Catch ability coefisien (q) was 0.00000974, indicated that each increasing one unit of effort will affect grouper catch as 0.00000974 ton per trip. Environmental carrying capacity (K) was 346,37, that indicated that water environment can support production of grouper fish per annum in term of biology such as natural productivity, foods abundance, population growth and fish size. K value for grouper fish in Selayar Island District categorized as moderate if compare to K value for snapper fish in Kutai District was 185.43 ton per year (Sulistianto, 2013) whereas mollusk species in Mary Bay, America found K value quite big was 3,900,610 (Kara & Chakraborty, 2009).

Result of the study showed that CPUE development for grouper fish in Selayar Island District during year 1995 to 2014 tent to decrease. One of the overfishing indicator were fluctuation in fishing activities or uncertainty and decreasing production significantly. Overfishing more often could detect through decreasing catch per unit of effort (cpue) and decreasing total fish catch landing (Nabunome, 2007; Tarigan *et al.*, 2015). In contrary, Atmaja & Nugroho (2013), found that trend of decreasing CPUE which still follow of increasing

production and do not show over exploitation since fishing effort still below the MSY level.

The research showed that average actual production of grouper fish in Selayar Island District was still below the maximum levels compare to all management regime. The average production at actual condition were 184.57 ton, while maximum sustainable suggested at MSY regime were 217.33 ton, MEY were 212.90 ton and OA were 106.42 ton. Optimal production suggested were at OSY management regime at 213.32 ton. Based on that actual production, the utilization of grouper fish in Selayar Island District indicated biological under fishing because the actual production was still below the production at all management regime. Widodo *et. al.* (2006), stated that *overfishing* were the number of fishing effort that over toward the fish stock. Mallawa *et al* (2006), stated that the average utilization for grouper fish in Selayar Island District during year 1995 through 2004 about 31.8% or 357 tons per year, while FAO (1997) stated that the amount of fish catch allowed only 80% of the maximum sustainable yield (MSY).

Open Access equilibrium will require more effort than effort at various management regime (OSY, MEY and MSY), so the open access regime will cause inappropriate resources allocation. Effort level required to get the optimal condition at MEY and MSY levels less compare with MSY level. For that reason, effort level at equilibrium MEY and OSY points were more conservative minded compare with effort level at equilibrium MSY point (Fauzi, 2010).

Lawson (1984), stated that fisheries resources management concept with maximum sustainable yield concept have faced hard challenges mainly from economist which stated that yield maximum gain basically valueless in term of economic. This case start from diminishing return problem that indicate that raising yield will run more slowly due to addition of effort. Idea with incorporate economic in fisheries resources management had resulted a new approach which known as maximum economic yield or MEY. This approach mainly search point for yield and effort that able to produce maximum gap between total revenue and total cost.

Cunningham & Whitmarsh (1985), found *Optimum Sustainable Yield* (OSY) concept that developed from compromised between MSY and MEY approaches. Generally the bio economic concept was modified from MSY, so that become relevant either from economic, social, environment and others point of view. Such that, the OSY amount were less than the MSY and this concept later on known as a total allowable catch (TAC). This concept also based on MEY criticized concept (Sangaji, 2010) stated that consideration on optimal fishing level should not limit on biological and economical only but also cover all relate aspect such as cost of exploitation, selling price and interest rate as direct cost. While indirect cost were conservation and social value.

Benjamin *et al* (2015), stated that government should pay more attention on policy related to grouper fish utilization. Wielgusa *et al* (2008), stated that creation of conservation area was one way to protect the grouper fish sustainability in California. Fisheries management area divided into three zone namely fishing zone 86.6%, buffering zone 12% and

conservative zone 1.34% (Merino *et al.*, 2009). Based on previous research, in developed country such as USA, they used bio economic model as a solution for policy problem strategy in Salmon fisheries. Result of bio economic analysis used to formulate policy with incorporate biology, environment, economic and institute so the business run could minimize the externality cost and gain maximum benefit (Pomeroy *et al.*, 2008).

Management for Optimum Sustainable Yield (OSY) regime was the center point for bio economic approach, so the production level of grouper fish in Selayar Island District still can raise from actual production 184.57 ton per year to optimal production 213,32 ton. Increasing production conducted through additional fishing effort up to optimum levels as many as 111.339 trip. So, the economic rent will increase from actual level to optimum level as suggested were from Rp.3.097.962.334 to Rp.5.937.435.339.

Australian and New Zealand have developed bioeconomic approach already to support fisheries management. It was realizing that bioeconomic approach can met the biological approach and economical approach in other to manage the fisheries resources (Pascoe, *et al.*, 2016). Bioeconomic also adopted in Lobster fishery in Australia to improve harvest strategy as a base to set quota strategy (Mcgarvey *et al.*, 2016). Bioeconomic approach should be set as a reference point to manage grouper fish in research area. However, conservation area also need to perform to protect the fisheries resources sustainability, in case management do not work properly.

CONCLUSION

Actual production of grouper fish utilization in Selayar Island District were still below the management regime limits. It was need management policy from the local government to maintain the grouper fish utilization level at range below to OSY management regime in order to gain maximum economic rent.

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Appendixes:

Table I
Parameter Biology and Economy for Grouper Fish Management

No.	Parameter Biology and Economy	Estimate Result	Units
1	Natural growth rate of fish (r)	2,50	ton per year
2	Catch ability coefficient (q)	0,00000974	ton per trip
3	Environmental carrying capacity (K)	346,37	ton per year
4	Fishing cost (c)	179.144	Rp per trip
5	Fish price (p)	371.824.938	Rp per ton
6	Resources discount rate (δ)	2,33	Percent

Source : Primary Data, after analysis, 2016

Table II
Comparison between actual utilization and bioeconomic analysis from various management regime for grouper fish.

No.	Management Model	Production (h) (ton)	Effort (E) (trip)	Economic Rent (Rent) (Rp)
1	Aktual	184,57	52.744	3.097.962.334
2	OA	106,42	220.888	-
3	MEY	212,90	110.444	5.937.825.557
4	MSY	217,33	128.844	5.773.007.700
5	OSY	213,32	111.339	5.937.435.339

Source : Primary Data, after analysis, 2016

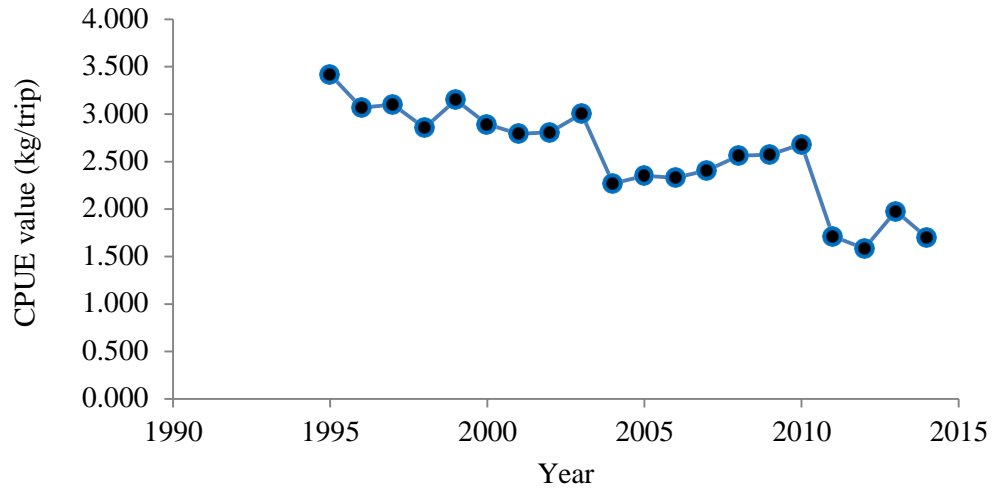


Fig. 2. Development of CPUE for grouper fish in Selayar Island Regency year 1995-2014

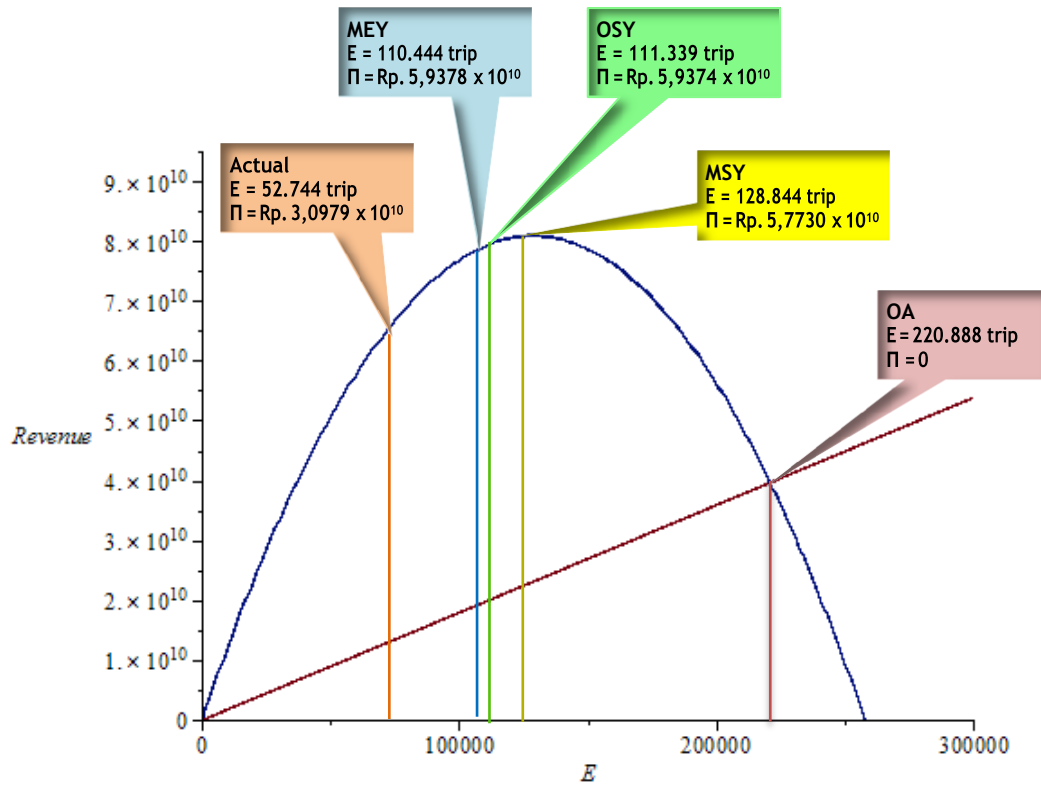


Fig. 3. Bioeconomics equilibrium curve for grouper fish