J. Appl. Environ. Biol. Sci., 2(9)469-474, 2012

ISSN 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Sustainable Management of Little Tuna Fishery [*Euthynnus sp*] in Prigi Waters Trenggalek East Java Indonesia

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ABSTRACT

This research aimed to identify condition of little tuna fishery in order to justify resource sustainability. Four types of management approach used to fulfill the aim of the research were biology, ecology, economic, and social. Stakeholders were grouped based on three classifications, namely: age, job, and education. Result showed that the highest RFP was purse seine. It was also informed that little tuna resource was ecologically over exploited. In contrast based on bio-economic approach the resource was moderately exploited. Amongst stakeholders had same vision and mission about sustainable fisheries management, source of conflict, and status of fishermen organization. Cash flow analysis informed that sustainable fishing gears for little tuna fishery were gill net, tonda, and purse seine. Different result was given by general linear model (GLM). The best three based on GLM analysis were tonda, hand line, and purse seine. Meanwhile SWOT analysis illustrated that better management had to apply for most of internal factors. It was also described that little tuna fishery had higher threat factor than chance factor. In order to achieve stock sustainability, the little tuna fishery had to apply several strategic policy such as using responsible fishing gear, keeping better quality of marine ecology, providing fishery log book, applying socialization about sustainable fisheries approach for stakeholders, and limitation for fishing license.

Keywords: SWOT analysis, responsible fishing, purse seine, tonda, gill net, GLM model

INTRODUCTION

Prigi waters is located in Southern region of East Java waters (WPP-ROI 573). It is part of north section of Indian Ocean. Purpose of sustainable management of fishery resource is both to prevent biological overfihing and optimize revenue in undefinite period of time [1]. In order to reach this purpose, several actions are needed such as proper estimation of spawning season of fisheries resource [2], policy framework of precautionary approach management, participatory and inclusive government system, ecosystem approach, and simultaneous management of human activity both at sea and coastal [3][4]. In addition, impact analysis of fisheries resource management toward stock density is needed to increase fish stock [5]. Sustainability of fisheries resource depends on cooperative and participatory of all stake holders in managing the resource [6].

In general the decrease of fisheries resource is mainly based on the number of fish stock point of view. However, precautionary approach is economically needed to manage the decrease of fisheries resource, including the improvement of the resource. Hence proper method for resource exploitation has to be adopted through individual initiative and management reformation rather than quota management [7] [8].

Failure of fishery resource management may have been caused by mistaken scientific information, bad management decision, lack of action by decision maker, and economic factor [7][9]. There will be fisheries collaps in 2048 caused by (a) policy, (b) environment, (c) market, (d) government authority and wrong data base [10]. This condition may also be caused by anual decrease of catch and stock as much as 27% and 10% respectively [11]. Moreover the collaps will occur a bit faster in 2020 if it is counted by using method of large marine ecosystems [[LMEs] [12]. Then we will only be able to postpone not prevent the occurence of fisheries collaps. Therefore better management was needed in order to sustain the fisheries resource [13][14][15][16]. Restraining the depletion of fisheries resource can be done by applying either the approach of ecosystem based fisheries management [EBFM] [17][18][19] or marine protected area (MPA) [20][21][22].

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MATERIALS AND METHODS

The scheme and a step of research such as in figure 1

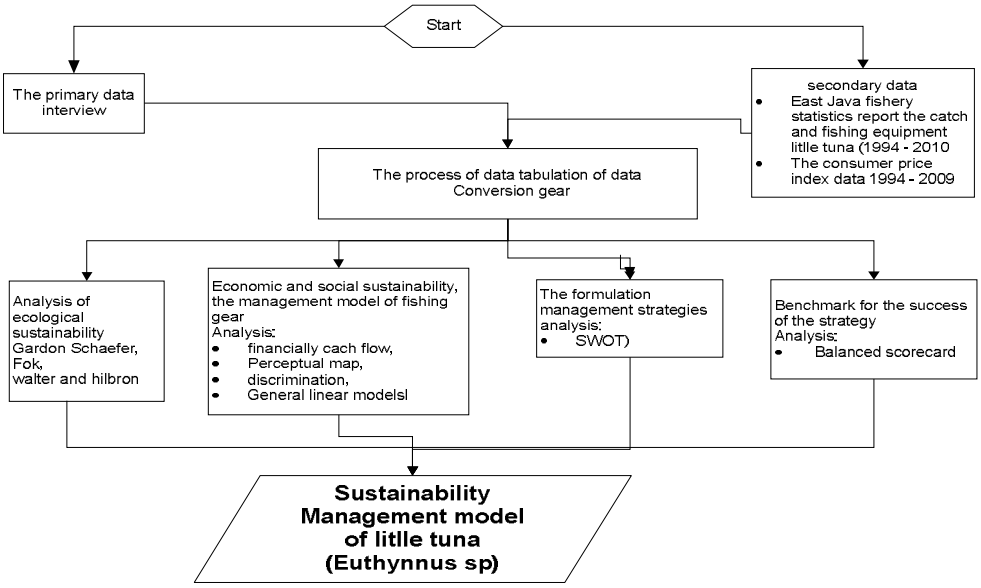

Figure 1. Framework of research methodology and data analysis

RESULTS AND DISCUSSION

Based on log book of fisheries statistic board of East Java Province (1990-2010), little tuna was only recorded as *euthynnus sp*. However, according to its characteristic, the fish consisted of three species, namely Abon/Pengpeng (*Euthynnus affinis*), Glondong (*Euthynnus alletteratus*), and Rengi (*Euthynnus lineatus*). Lack of data and ability to identify each species would lead to miss management of fisheries resource [22].

Calculation of Relatif Fishing Power (RFP) of fishing gears indicated that the highest RFP was achieved by purse seine. The second, third, fourth, and fifth were payang, drifted gill net, tonda, and another line fishing respectively. It was then decided that purse seine was set up as fishing gear standard to calculate total effort of little tuna fishery. It was believed that calculating maximum sustainable yield [MSY] was easier by means of Schaefer and Fox surplus production methed and non eqilibrium equation by Walter and Hilbron rather than analitic model.

Figure 2 informs that little tuna fishery is already fully exploited. Several things may cause this condition such as lack of control by government toward fishing activity, disobey toward fisheries regulation, and weakness of fisheries statistic record [23][24]. The most common problem in Prigi waters was lack of accuracy in recording fisheries log book. Either lack of data about capture fisheries activity or failure of fishermen behavior to adopt model analysis would lead to the failure of fisheries resource management. So that the determination of reference point about environment maximum capacity to justify decision variable limitation such as MSY would not be accurate. As the little tuna stock was already fully exploited, sustainable management needed would be to restrain the stock. This policy was reasonable in order both to sustain the stock in the future and to avoid disadvantage of management change.

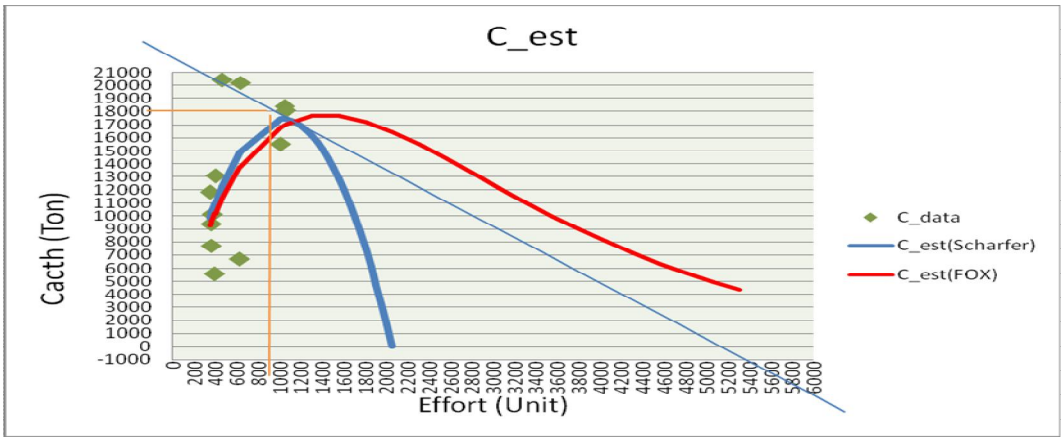

Figure 2 Maximum sustainable yield of little tuna fishery

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Monthly data about fish landed in Prigi illustrated that peak season of little tuna occured between July to September. Marine ecosystem and fishing season may have caused this phenomenon. Attention had to be paid to several factors regarding with marine ecosystem approach to manage fisheries resource sustainability such as socio economic condition, coral reef, mangrove, sea grass and sea weeds, fishing gear, and institution. This management approach toward ecosystem was known as Ecosystem Based Fisheries Management (EBFM) [13][14][17][18][25].

Another management approach was bioeconomic approach. This management was used to calculate optimum revenue gained by fishermen regarding with the stock sustainability. The development of fishing activity was strongly influenced by economic factors such fishing cost and fishermen earning. Fishermen would expand their invesment in fishing when they got enough revenue from fishing activity.

The revenue obtained by fishermen will continue to rise up as the catch increases until economic equilibrium is achieved. Regardless this, the edge sword of fishing effort will occur. As the fishing effort increases the catch will increase until it reaches its maximum level then the catch will decrease after reaching its maximum level although fishing effort continues to increase. Increase in fishing effort will not only lead to the increase of fishing cost but also decrease the revenue earned by fishermen. Amount of revenue will fall down to zero level when open access equilibrium is reached.

Effort will still increase when fishing activity is profitable. In other word, as long as revenue is higher than fishing cost, the effort will go up. In open access condition, new entry of fishing industry will enter the business if profit is guaranted. The new entry still comes up until benefit of fishing activity is in zero level. Figure 3 ilustrates that Maximum Economic Yield (MEY) results the least input than MSY and open access. On the other hand, MEY also creates the highest economic interest than other two management models, MSY and MSocY.

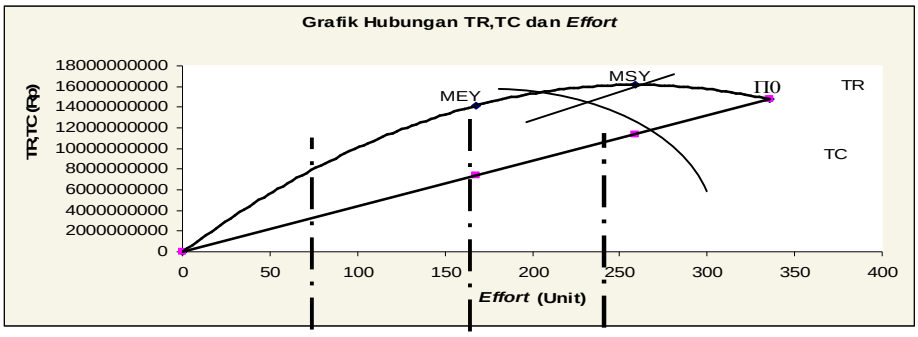

Figure 3. Showing the relationship TR, TC and Effort in bioekonomi

Economic sustainability was studied by calculating economic feasibility of dominant fishing gears for little tunafishery such as purse seine, tonda, and gillnet. If economically fishing activity is not profitable, investors will automatically take their money out from fishery. Therefore cashflow and investment criteria analysis were used to

calculate feasibility of the fishery using fishing investment cost, fixed and variable costs, depreciation, revenue, and sharing income between owner and crew (fisherman).

Table 1. Costs and Revenue of Purse seine Fishery

Costs and Revenue	(Million Rp)
Investment	518.45
Maintenance and Operational	331.97
Depreciation	54,61
Total Revenue	844.90
Sharing income	199,47
Benefit (netto)	258.85

Table 1 illustrates costs and revenue of purse seine fishery. It can be calculated that value of comparison between revenue and cost (R/C) is 2.55. It means that pay back period of invesment is about 2 years. It also means that purse seine fishery is profitable and has a good pay back period.

Calculation of Net Present Value (NPV) was based on two asumptions. Firstly, all prices were subjected to increase annually such as fishing gear (12%), fishing machine (4%), lamp, genset, and fuel (1%), bamboo basket (3%), vessel maintenance (2%), and fish (0.5%). Secondly annual discount factor was 12%. It was found that NPV purse seine (10 years period) was Rp.978.16 million. While Internal Rate of Return (IRR) was 40,08%. This value was much higher than that of d iscount factor. It meant that doing business in purse seine fishery was more profitable than saving money in the bank. In addition, value of B/C ratio was 2.89. In conclussion, based on benefit and financial loss analysis and investment criteria, purse seine fishery was suitable to continue. The reason was that purse seine fishery had good economic indicators such as value of π and NPV > 0, R/C and net B/C > 1, and value of IRR > discount factor.

Based on social sustainability approach indicated that perseption of stakeholders was quite similar toward sustainability of the resource. Whilst the sequence of fishing gears based on analysis general linear model was hand line, gill net, tonda, and purse seine. In contrast, three fishing gears that gave significantly different result were purse seine, tonda and hand line. It meant that those three fishing gears had strong influences toward little tuna production as a sustainable development model of the fishery.

Strategic formulation started by constructing SWOT analysis for ecology, economic, and social sustainability. Following this analysis, balanced scorecard was used to justify whether or not strategic objectives (short and long term) were achieved (Figure 4). Calculation for ecology, economic, and social indicators based on interview, quetionaire, and field observation was used as internal (IFAS) and external (EFAS) factors for sustainability of little tuna fishery.

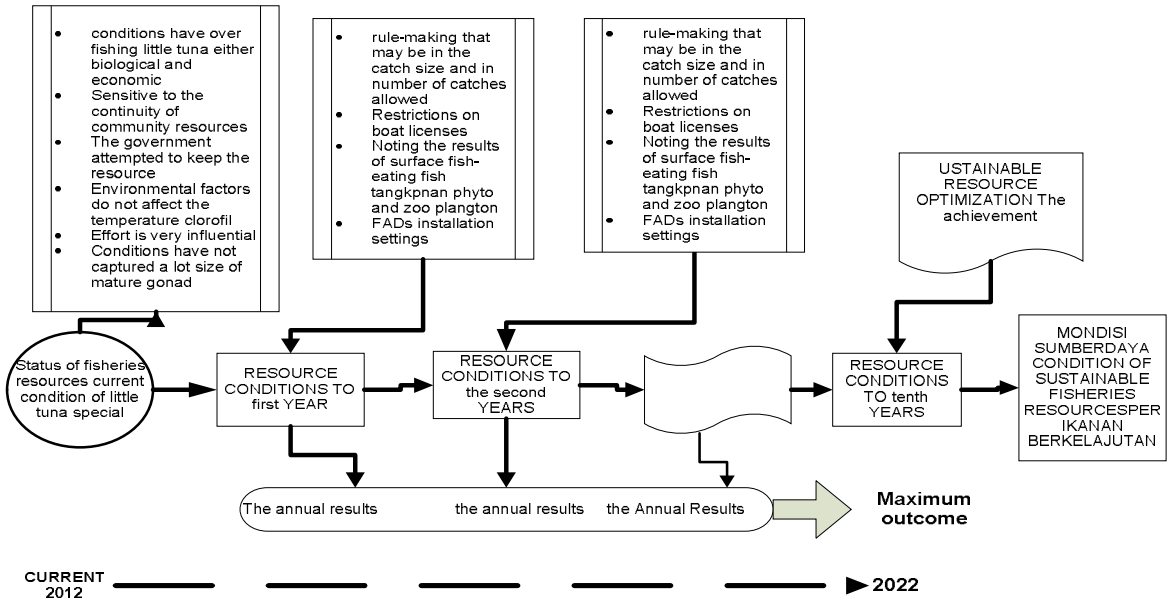

Figure 4. Strategic planning for little tuna fishery management in next 10 years

Internal Factors Analysis Summary (IFAS) was the strength and weakness of the fishery. The strenghts were community participation to keep environment, marine protected area, fish processing availability, local and interlocal buyers, and availability of fish marketing chain for local, regional, and international market. While the weaknesses were the decline and fluctuation of the stock, the catch was not kept in ice and cold condition, low quality of log book, and the number of fish agregating device (FAD) was out of control. It was found that value of IFAS was 2.589. It meant that internal score was in average range. This point indicated that the weaknesses was stronger that the strengths. So that the weaknesses had to manage properly in order to achieve better opportunilty based on the benefit of strengths.

Analysis of External Factors Analysis Summary (EFAS) indicated that demand of little tuna was very strong and potency of the resource in Economic Exclusive Zone (EEZ) has yet not been utilized properly. Therefore chance to develop information and technology dealing with fishing activity was quite bright. Other chances were also available such as new investment, increase income, and job opportunity. Third factor had to be paid attention was threat. The threat of little tuna fishery in Prigi was the present of free market which gave a chance fish production from outside to enter local market. This situation would lead to illegal, unreported, and unidentified (IUU) fishing in EEZ waters. It was found that EFAS score was about 2.202. In meant that external condition was in averge range. Threat factor of stock sustainability had higher score than chance that can be gained. Thing had to be done to solve the problem was to strengthen internal factor.

Result from EFAS and IFAS analysis was used to arrange management strategic for sustainability of little tuna fishery. This management strategic was set up by combining amongst chance, strength, threat, and weakness. Every strategic was used to become objective target to analyze using balanced scorecard.

Strategic objectives proposed were (1) Strength–opportunity (SO): using internal strength to gain benefit from outside of fisheries resource through building networking with related agencies; (2) Strength-treat (ST): eliminating negative impact of external threat by constructing better monitoring system of fishing ground, creating diversification of fisheries product, eliminating environment degradation, and cutting down the number of IIU fishing; (3) Weakness-opportunity (WO): reducing internal weakness by means of utilization of external chances through composing proper objectives such as creating better statistic data report, and building sama vision amongst stakeholders about the importancy of ice in purse seine fishery in order to keep better quality of fish; (4) Weakness-Treath (WT): avoiding and reducing bad impact of external threats by means of minimizing fully exploited status of the stock, upgrading human resource quality of stakeholders, and reducing amount of fishing fleet and FAD.

CONCLUSION

Standard measurements of achieving strategic objectives were (1) application of better fisheries management and responsible fishing gear; (2) maintaining better quality of marine ecosystem; (3) upgrading quality of statistic data report; (4) socialisation and increasing the awareness of stakeholder about sustainable fisheries; (5) creation of informal education for fishermen about fish handling from the sea until collector buyers; (6) upgrading infrastructure quality and applying intensive monitoring and controlling sections in order to reduce IUU fishing; (7) stop issuing fishing license for same fishing gear operated in same fishing ground.

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