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The Utilization of Skipjack tuna, *Katsuwonus pelamis* (Linnaeus, 1758) Availability for Sustainable Fisheries Management in Prigi, East Java

Jonathan Graydam Genti[1], Marsoedi[2], Aminudin Afandhi[3]

[1] Environmental Resources Mangement and Development Master's Degree Program, Brawijaya University
[2] Aquaculture Master's Degree, Faculty of Fisheries and Marine Sciences, Brawijaya University
[3] Agricultural Product Technology Master's Degree, Faculty of Agricultural Technology, Brawijaya University

Abstract

Skipjack tuna is one of the fishery commodities which has high economy value due to the high demand and high prices in the export commodities. The purpose of this research is to identify and analyze the potential resources of tuna and also determine its alternative management in Prigi Fishing Port (*Pelabuhan Perikanan Nusantara Prigi*). This research was carried out at Prigi Fishing Port, Trenggalek, East Java from February to April 2016. The method used in this research was descriptive method. The data analysis methods were the standardization of the fishing gear, the analysis of catch per unit effort (CPUE), total allowable catch (TAC), and the skipjack tuna fishery management concept at Prigi Fishing Port. The fishing gears which were used to catch skipjack tuna are payang seine, trolling line and purse seine. However, the standard fishing gear used to catch the skipjack tuna was trolling line. CPUE analysis results were obtained from the CPUEstd average value in 2005-2014 as many as 4.79 kg/unit. The allowed amount of the skipjack tuna fish farming was 3,028 tons/year and the result in 2014 was 460.82 tons, means that the skipjack tuna utilization was still *under fishing*. Meanwhile, the fishing attempt of 224 units was exceeding because it has passed the optimum limit of fishing by 102 units. The results of the study recommended several policies of the skipjack tuna management which are: (1) the amount limitations of the fish farming; (2) the management of the fishing attempts; and (3) the regulation of the fish farming closing season.

Keywords: Fisheries management, Prigi Fishing Port, Skipjack tuna (*Katsuwonus pelamis*), TAC

INTRODUCTION

Skipjack tuna is one of the most economically important fish in Indonesia. Ministry of Marine Affairs and Fisheries (2013) mentioned that in 2013 the export growth target was up to 19% where Tuna, Mackerel Tuna (Tongkol) and Skipjack Tuna (Cakalang) are very strategic in generating foreign exchange to the State, as well as the fulfillment of animal protein for the people in Indonesia. The current report mentions that the TTC (Tuna Tongkol Cakalang) contribute for as much as 12% from the total of 40% in the fishery products export industry. The average production of Albakora Fish, Big-eyed Tuna, Yellowfin Tuna, Skipjack Tuna, and Southern Bluefin Tuna in 2005-2012 was as much as 133,574 tons/year. The economy development in some regions significantly had increase which one of the factor is due to the effort of catching skipjack tuna. Provisional data show that the largest portion of the landed fish generally do not have the standard decent length to be farmed [1]. One of the reasons is the development of the fishing fleet has exceeded the limits of optimum fishing capacity in some areas.

The fishing efforts development leads to a decrease in the stock of fish resources availability. If the size of the captured skipjack tuna continue to be shrink, this would have resulted in a reduced number of fish to breed, so that it would reduce the number of fish recruitment.

One of the central port of small scale fisheries which is located in the south of Java Island is the Prigi Fishing Port, East Java. The fishing activities which were carried out in this area is by using rumpon or fish aggregating devices (FADs) as the fishing gear. The fleet which is used the FADs to catch Tuna and Skipjack Tuna is the trolling line fleet and purse seine fleet.

The main problem of tuna management faced by the fisheries management authority currently is the lack of understanding of the society particularly the fishing communities which is

Writer Correspondence Address:
Jonathan Graydam Genti
Email : john.gdam@yahoo.com
Address : Program Pascasarjana, Universitas Brawijaya
Jl. MT Haryono 169, Malang 65145

about the balance relationship of the ecosystem as well as the requirement to fulfill the necessities of life and the requirement to earn great benefits in the industry. On the other hand, because of the lack of knowledge, capability and technology, the exploitation of marine biological resources due to the necessities of life is still far below the optimal conditions (under fishing) [2].

The skipjack tuna management needs to be applied to keep its sustainability and to control its utilization. Through this effort of management, it is expected that it could be able to reach the optimum utilization rate, where the exploitation activities can be continued to be done without threatening the sustainability of the existed skipjack tuna resources [3].

The research about the utilization of skipjack tuna (Katsuwonus pelamis) availability aims to identify and analyze the potential resources of skipjack tuna as well as to determine its alternative management in Prigi Fishing Port, Trenggalek, East Java.

RESEARCH METHODS

Data collection is carried out in the Prigi Fishing Port, East Java from February up to April 2016. It is located in the territorial authorized area of the Prigi Fishing Port due to the abundance of resources in Indian Ocean specifically the south of East Java, where it rich of skipjack tuna. Most of the fishermen in this area are still use the traditional fishing gear, so that the fishing management can still be improved.

This research used a quantitative approach method. The data of the quantitative research method was collected by taking a number of samples which were considered to represent the total population. Primarily, this method was used by the time when there are only few respondents that are in the location of research, or it is often used when a quick research needs to be performed [4].

Data collection method is divided into two, namely, primary data and secondary data.

a. Primary data

The primary data which were taken in this study include: (1) the specification of the fleet that operates the skipjack tuna (Katsuwonus pelamis) fishing gear such as the length, width, height, purse seine and trolling line completeness; (2) The specification of purse seine and trolling line; (3) the results of the fishing gear in the skipjack tuna businesses (Katsuwonus pelamis).

b. Secondary data

Secondary data obtained from some related institutions such as: (1) Ministry of Marine Affairs and Fisheries; and (2) Prigi Fishing Port.

Fishing Gear Standardization

There are three types of fishing gears used by the fishing communities in Prigi Fishing Port to exploit the skipjack tuna resources, so that it needs a form of standardization to the dominant fishing gear which is considered to be appropriate enough [5]. From this case, it is proven that our fishery is *multi spesie*s and *multi gear,* so it needs a fishing gear standardization by using the Gulland equation [6]. Fishing gear standardization is calculated using these following equations:

$$\boldsymbol{CpUE = \frac{Q^3_{i=1} \times C_{fish}}{E^3_{i=1}}}$$

where:

CpUE	=	Catch per unit effort (ton/unit)
$Q^3_{i=1}$	=	Fishing gear (1) average catching portion to the total production of skipjack tuna
i	=	The amount of the fishing gear (3 types)
C_{fish}	=	Average catching results by the fishing gear (1) (ton)
E	=	the average effort total of skipjack tuna fishing gear (unit)

$$\boldsymbol{RFP = \frac{U^3_{i=1}}{U_{std}}}$$

where:

RFP	=	Conversion index of the fishing gear (i)
$U^3_{i\,i=1}$	=	Catch per unit effort of each three types
U_{std}	=	Catch per unit effort, a total from the standard tool

$$\boldsymbol{E_{(std)t} = \sum_{i=1}^{3}(RFP_i \times E_{i(t)})}$$

where:

$E_{(std)t}$	=	the amount of the standard fishing gear in the year of t-*th* (unit)
RFP_i	=	Conversion index of the fishing gear (i)

$E_{i(t)}$ = the amount of the fishing gear types (i) in the year of t-*th* (unit)

The Estimated Availability of SDI

Biological analysis by using a holistic approach with a surplus production model through the equilibrium state models of Schaefer and Fox as well as the non equilibrium state models of Walter and Hillborn which is able to analyze the population parameters in the form of k (maximum power capacity of the environment), q (fishing gear effectiveness) and r (intrinsic growth rate of the skipjack tuna stock population) [7].

According to the approach of equilibrium state model, the results of the catch per unit effort (U) and (E) had a negative linear relationship, namely:

$$\boldsymbol{U = a - b \times E}$$

where:

U = the results of the catch per unit effort
E = the standard catching effort
a, b = Schaefer constant regression model

From the linear equations above, the optimum catching effort (E12) and balance catching effort (C0) is calculated by the equation:

$$\boldsymbol{E_0 = \frac{a}{2b}}$$

$$\boldsymbol{C_0 = \frac{a^2}{4b}}$$

The approach of non equilibrium state model is capable to estimate the population parameters (r, k and q) so it will make the prediction more dynamic and closer to the reality in the field. In which it stated that the biomass in the t + 1 year, P (t + 1) could be expected from Pt plus a year of biomass growth minus a number of biomass which is issued through the exploitation and the effort (E) [8]. This statement was formulated as follows:

$$\boldsymbol{P_{t+1} = P_t + \left(r \times P_t + \frac{r}{k} \times P_t^2\right) - q \times E_t \times P_t}$$

where:

P_{t+1} = biomass amount when t+1
P_t = biomass amount when t
r = intrinsic growth rate of the biomass stock (constant)
k = maximum power capacity of the environment
q = catchability coefficient
E_t = the effort to exploit biomass in the year of t-*th*

Skipjack Tuna Fishery Management Alternatives

Fisheries management arrangements, generally include: effort control, catch control, technical measures, ecologically based measures, economic instruments [9].

Back then, the main purpose of the fisheries management is the conservation of fish stocks. In modern fisheries, that purpose is developed for the benefit of economic matter, social and environment [10]

RESULTS AND DISCUSSION

Prigi Fishing Port is geographically situated in Desa Tasikmadu, Kecamatan Watulimo, Kabupaten Trenggalek, East Java. Prigi Fishing Port is located in the Prigi bay, so it called as the Prigi Fishing Port. Prigi Fishing Port was built on an area of 27,5 Ha, with the solid area of 11,5 Ha and the harbour area of 16 Ha.

Geographically, Desa Tasikmadu is located at the position of 8° 20’ 27” LS to 8° 23’ 23” LS as well as 111° 43’ 27” BT until 111° 46’ 03” BT with an area less than 2,803 Ha. Prigi Bay waters conditions is sheltered water with an average depth of 9m up to 35m. The existence of upwelling in the mid season of the Western and Eastern area caused the water productivity becomes high enough, i.e. with the increasing number of plankton as the food for Pelagic Fish that lived in a group.

The portion of skipjack tuna which was caught by the purse seine, payang and trolling line respectively: purse seine (0,443), payang (0,361) and trolling line (0,479). While the RFP (*Relative Fishing Power*) value which is the fishing gear relative capabilities compared to standard fishing gear or equal to 1 is the trolling line with the highest CpUE values of 6, 475,44 tons/unit. Therefore, trolling line is used as the standard effort of the standardization calculation as shown in table 1.

After the value of the standard effort is obtaine, then the CPUE value which has been standardized can be calculated. It can be seen in table 2.

The negative correlation between CPUE with the effort indicated that the productivity of skipjack tuna fishing gears (Purse seine, payang and trolling line) will be decreased if the effort has increased (Figure 1).

Table 1. The Average Production of Skipjack Tuna, the Production Portion of Each Tool, the Amount of the Effort, CpUE, and the Relative Catch of the Dominant Fishing Gear and the Standard Fishing Gear in Prigi Fishing Port (2005-2014)

Number	Fishing Gear Types	Average Catch	Average Effort	CpUE	Portion (%)	RFP	Ratio
1	Purse Seine	329,472.13	152.19	2,164.91	16.0066	0.334	2.99
2	Payang	200,273.44	41.00	4,884.72	36.1160	0.754	1.33
3	Trolling Line	423,331.75	65.38	6,475.44	47.8773	1.000	1.00

Source: Processed from Prigi Fishing Port, 2016

Table 2. Total Production, Standard Effort, and CPUE

No	Year	Catch (ton)	Effort STD (unit)	CPUE Total (ton/unit)
1	2005	1,134.00	146	7.7499
2	2006	1,327.00	123	10.8235
3	2007	942.00	139	6.7636
4	2008	918.00	139	6.5912
5	2009	493.54	151	3.2725
6	2010	631.83	195	3.2319
7	2011	555.22	204	2.7221
8	2012	495.43	202	2.4564
9	2013	475.56	217	2.1888
10	2014	460.82	224	2.0563

Source: Processed from Prigi Fishing Port, 2016

Thus, Skipjack Tuna CPUE in Prigi Fishing Port can be described, namely of 16.929 – 0,0698x. This indicates that any addition in the effort as many as *x* will lower the CPUE of 0.0698 ton times *x*.

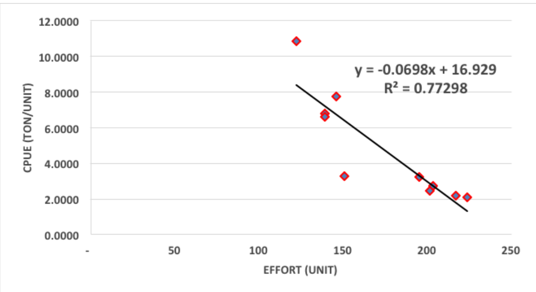

Figure 1. The graph of the relationship between CPUE with the skipjack tuna effort inPrigi Fishing Port, period 2005-2014

The Estimation of Maximum Sustainable Balanced Condition

In the development of fisheries, the potential number is very necessary and actually this number indicates that the fish resources have a limit [10]. This means that the development of fisheries cannot be powered continuously regardless of the resources limitation and supporting power; and in fisheries industry that is not rapidly developed, controlling is really needed and it is should refer to the calculation of total allowing catch (TAC), to the fish resources potential and to the allocation of the fleet that is allowed to operate in their respective territorial water area. If it is implemented, a sustainable fisheries development can be implemented, so a balanced fish resources will be very assured.

The prediction of Schaefer and Walter Hilborn model with the data in table 3 showed the coefficients of *a* for 16.9294 and *b* for 0068 while *r* (intrinsic growth rate) for 0,743%, *k* (the environmental resources) for 35.233,85 tons and *q* (the catching ability) for 0,0045.

From the calculation above, the maximum sustainable yield (MSY) is 3.786,05 tons/year. In the management of total allowing catch (TAC), the value that is obtained from MSY is multiplied to 80% in order to maintain the sustainability of the fishing effort that is amouned to 3,028.86 tons/year. However, in 2014 it was amounted to 460,82 tons, it indicates that the utilization of skipjack tuna is still in under fishing condition. The catching effort of 224 units is exceeding because it has passed the optimum effort of catching in the amount of 102 units.

From the results of previous research about skipjack tuna which was situated in Pelabuhan ratu, the allowed catching amount is 263.837 kg/year and the average utilization rate is 105,82%. As seen from the total allowed catching amount in that research, it indicates that the resource utilization of skipjack tuna was already experiencing overfishing [11].

Table 3. Schaefer and Walter Hilborn Data Analysis

Year	Catch (ton)	Effort STD (unit)	CpUE(ton/unit)	Ut^2	Cacth (Ton)	Ut+1-Ut
2000	1,471.00	67	22.0253	485.1146	1,471.00	-1.1607
2001	1,362.00	65	20.8646	435.3308	1,362.00	32.1193
2002	3,183.00	60	52.9838	2807.2879	3,183.00	-49.9766
2003	192.00	64	3.0072	9.0433	192.00	3.5237
2004	823.00	126	6.5309	42.6524	823.00	1.2190
2005	1,134.00	146	7.7499	60.0603	1,134.00	3.0736
2006	1,327.00	123	10.8235	117.1474	1,327.00	-4.0599
2007	942.00	139	6.7636	45.7459	942.00	-0.1723
2008	918.00	139	6.5912	43.4445	918.00	-3.3188
2009	493.54	151	3.2725	10.7092	493.54	-0.0406
2010	631.83	195	3.2319	10.4454	631.83	-0.5098
2011	555.22	204	2.7221	7.4100	555.22	-0.2657
2012	495.43	202	2.4564	6.0341	495.43	-0.2677
2013	475.56	217	2.1888	4.7908	475.56	-0.1325
2014	460.82	224	2.0563	4.2284	460.82	

Source : Processed from Prigi Fishing Port, 2016

The Concept of Skipjack Tuna Fisheries Management in Prigi Fishing Port

Based on the various optimal value of the examined components as well as the linkages between the various components, it has generated some concepts of the fisheries management obtained from the patterns of skipjack tuna utilization in Prigi Fishing Port:

1) The skipjack tuna fishing gear technology which is done by the fleet of purse seine and trolling line must release the fish which is sized under the size of the first mature gonads.
2) The TAC results of skipjack tuna does not exceed the optimum production based on the utilization allocation of stock as well as consider the aspects of skipjack tuna resources sustainability which is amounted to 3.028 tons/year.
3) The attempts of the optimum catch in order to reach MSY has to considered the sustainability of 102 units (purse seine and trolling line)
4) The operation arrest was closed simultaneously at the time (months) of the peak season or when the fish size is not yet ready to be catched.
5) The prohibition towards landing and selling the fish that is small and not yet ready to be catched (size ≤ 40 cm FL).
6) The catching unit is restricted through the restrictions of the catching permits.
7) Provide a water conservation area in Indian Ocean, South of Java Island, to serve as a skipjack tuna nursery ground that the operations must be carried out by the community with the help of the Government.

CONCLUSION

The results showed that the fishing gears used to catch skipjack tuna are payang, purse seine and trolling line. The standardized fishing gear is the trolling line. CpUE analysis results showed CpUEstd average value in the year of 2005-2014 as many as 4,79 kg/unit. The TAC result of skipjack tuna is 3.028 tons/year and the catch in 2014 is 460,82 tons, while the catching effort of 224 units is exceeding because it has passed the optimum effort of catching in the amount of 102 units. It shows that the utilization rate of skipjack tuna in Prigi Fishing Port has exceeded the MSY value with the effort which is continue to rise in each year.

RECOMMENDATION

With the results of the analysis, generally, the management of skipjack tuna can be done through: (1 the amount limitations of the fish farming; (2) the management of the fishing attempts; (3) the determination of the fish farming season based on the appropriate fish size.

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