The International Journal of Engineering and Science (IJES)
|| Volume || 8 || Issue || 2 Series I|| Pages || PP 71-74 || 2019 ||
ISSN (e): 2319 – 1813 ISSN (p): 23-19 – 1805

Bioeconomic Approach on Management of Squid *(Loligo* spp*)* Fishery Empirical Study at Kejawanan Archipelagic Fishing Port Cirebon Indonesia

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---*ABSTRACT*---
Squids (Loligo spp) is a kind of Indonesian export commodity, and is as a leading seafood product which landed at Kejawanan Archipelagic Fishing Port (AFP Kejawanan). Based on data of AFP Kejawanan 2015, production volume of squids was 2.775,26 tons or 66,24% from total production. This squids was catched by a Bouke ami. Bouke ami vessel was as much as 89 units or 83,18% from total number of fishing vessel in AFP Kejawanan. The squids production which landed at AFP Kejawanan potentially affects biological conditions and sustainability of squids fishing. This research was purposed to estimate Maximum Sustainable Yield (MSY), Effort Maximum Sustainable Yield (E_{MSY}), Maximum Economic Yield (MEY), Effort Maximum EconomicYield (E_{MEY}), Open Acces Equilibrium (OAE), and CatchOpen Acces (COA).The methods of this study applied survey method. The sampling of vessel is done by convenience sampling method and for the respondents is used purposive sampling. The analysis of data adopted bioeconomics approach. Result of this study showed H_{MSY} of 303,56 tons per years, E_{MSY} of 95 trips per years, H_{MEY} of 240,41 tons per years, E_{MEY} of 52 trips per years, H_{OA} of 301,23 tons per years, and E_{OA} of 104 trips per years.

KEYWORDS: *Bioeconomic Approach, Bouke Ami, AFP Kejawanan, Squid*

Date of Submission: 04-02-2019 Date of acceptance: 20-02-2019

I. BACKGROUND

Squid (*Loligo* spp) is important economic commodity and having strategic value for foreign exchange. Supply of the squid is supporting by many of fishing port spreading in Indonesia, Kejawanan Archipelagic Fishing Port (AFP) is one of the port which contribute more in this supply, as total landing of squid was 2.775,26 ton or 66.24% of the total landing catch. The most type of fishing vessel in Kejawanan AFP was bouke ami as 83.18% of the total of operated fishing vessel, of which reasonable that the landing catch is dominated by squid (Supriadi, 2012).

As capture fishery activity, squid fishery also tends increasing product which it stresses on the resources. Main problem of the activity is that fishing effort exceeds of the sustainable carrying capacity of the resource MSY*(Maximum Sustainable Yield)* so that indicated overfishing and resulting on decreasing of catch per unit effort and reducing fishers income (Suyasa, 2007).

To get more benefit inline with protecting resources sustainability, the squid fishery activity have to consider both biology and economic aspects. Bioeconomic approach applied on this study to calculate estimating of biology aspect on fish resources Maximun Sustainable Yield (MSY, E_{MSY}), economic aspects Maximum Economic Yield (MEY, E_{MEY}), and socio aspect of open access (OAE, COA) (Zulbainarni, 2015).

II. METHODOLOGY

This study with bioeconomic approach was conducted based on squid fishery which disembarked at Kejawanan AFP in Cirebon West Jawa. All fishing vessel of bouke ami landed at Kejawanan AFP during January to March 2016 was treated as sample of the fishing vessel population. This sample provides enough evidence that it is not need expanded sample (Siagian dan Sugiarto, 2002).

Sample of respondents applied purposive sampling which considered of their experience and communication on understanding study need of data and information. The respondents consist of fishers or owner of the fishing vessel, squid fishery company, fishing port officer, and fisheries business cooperation.

Primary data was focused on the data of technical aspect, secondary data, obtained from Kejawanan AFT and related institution, such as time series data of squid catch and effort during year 2006 to 2015.

Economic approach was applied to estimate sustainable rate of utilization MSY, economic condition potential MEY, and open access condition (OA).

Bioeconomic Analysis

Bioeconomic analysis is done using the Schaefer model formulasaccording to (Wijayanto, 2008. Fauzi and Anna, 2005. Fauzi, 2010). as follows:

	MSY	**MEY**	**OAE**
C	a^2 / 4b	aEMEY – b(EMEY)^2	aEOAE – b(EOAE)^2
E	a / 2b	(pa-c) / (2pb)	(pa-c) / (pb)
TR	C MSY.p	C MEY.p	C OAE.p
TC	c.EMSY	c.EMEY	c.EOAE
M	TR MSY – TC MSY	TR MEY – TC MEY	TR OAE – TR OAE

Table 1. The Bioeconomic Formula of Schaefer's Model

III. RESULTS AND DISCUSSION

Catch dan effort data of squid fishery during 2006 to 2015 shown on Table 1, which described fluctuation during those years, increased at 2006 to 2008, and decreased from 2009 to 2010 but gradually increased from 2011 as 191.5%, and the most high catch was in 2015 as 2,769.949 ton.

Average effort of the squid fishery was 128 trip per year during 2006 to 2015, the lowest was 60 trip at 2005 and the highest was 205 trip at 2013. Increasing effort followed by decreasing trends of catch. Fluctuation of effort mainly was caused of active fishing vessel that landed at Kejawanan AFP.

Year	Catch (kg)	Effort (trip)	CPUE
2006	398.385	60,372	6.599
2007	491.529	70,845	6.938
2008	848.136	82,704	10.255
2009	726.749	76,122	9.547
2010	680.846	70,791	9.618
2011	1.984.945	151,304	13.119
2012	2.226.588	183,570	12.129
2013	2.273.228	205,321	11.072
2014	2.312.515	199,479	11.593
2015	2.769.949	178,384	15.528

Table 2. Catch, Effort , and CPUE of Squid during 2006 to 2015

Catch per unit effort (CPUE) tended to fluctuate according catch and effort condition during 2006 to 2015. The cpue explained productivity of fishing vessel of bouke ami on squid catch that landed at Kejawanan AFP. The productivity was highest at 2015 dan the lowest at 2006, and comparing the cpue was shown that 2015 most efficient as illustrated at Figure 1.

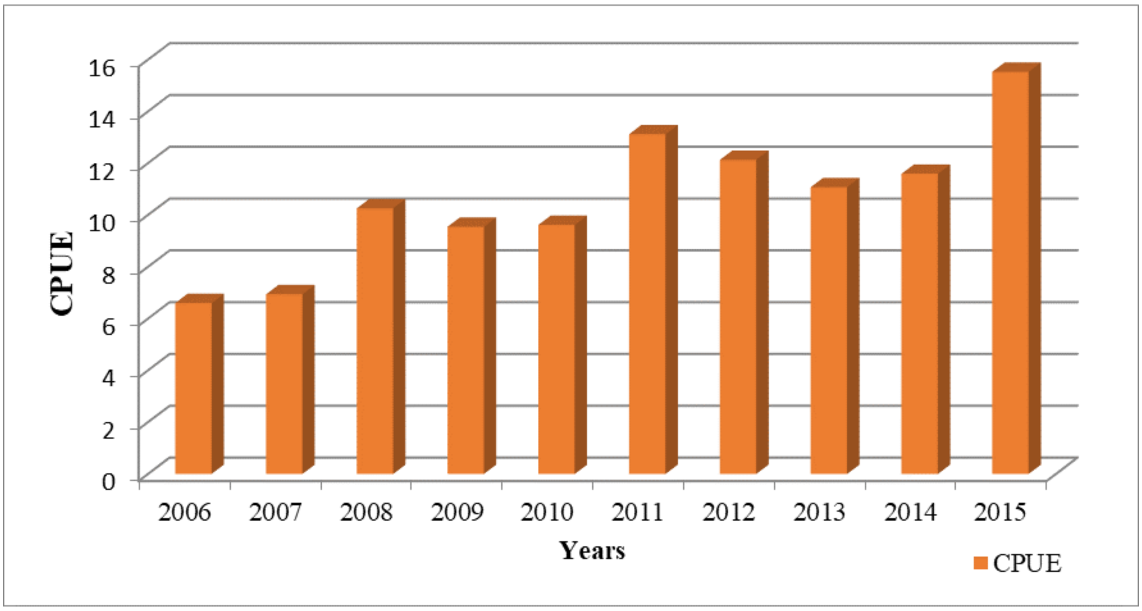

Figure 1. CPUE of Squid Fishery Landed at Kejawanan AFP during 2006 to 2015

Trends of productivity can be calculated by correlate cpue with effort. The correlation of squid fishery landed at Kejawanan AFP shown negative value that indicated more effort caused less cpue or the productivity is decreasing.

Sustainable production parameter a and b was calculated with linier regression $h = aE - bE^2$.Catch (ton) is stated h, rate of effort E is trip per year, E is independent variable and h/E is dependent variable, based on the data of 2006 to 2015 it is made regression calculation on spread sheet program. The regression analysis resulted coefficient value of a = 6,368187872 and b = 0,033398014, so that production functionsquid fishery landed at Kejawanan AFP can be stated ash = 6,368187872 E – 0,033398014 E^2.

Stock production of squid fishery can be estimated by quantitative model which influenced some aspect such as biology, climate, and human activity either effort, management and resources regulation. Using Fox algorithm, estimation of biology parameter of the squid fishery was shown at Table 3.

Biology Parameter	Value
Intrinsic growth rate (r)	0,0750
Catchability coefficient (q)	0,0003932
Carrying capacity (K)	16.196,775

Table 3. Estimation for BiologyParameter of Squid Fishery Landed at Kejawanan AFP

As shown at Table 2 that instrinsic growth rate 0.075 described squid resource naturally grow with rate as 0.075 ton per year. Indication of increased effort relation to catch per trip is shown on catchability coefficient of which increasing effort affected on 0.0003932 ton catch per trip. On the other side it shown environment supports squid resources as 16,196.775 ton per year, from biology aspect such as food abundance, population grow, and size of squid as stated by Febrianto (2016).

The results of these three biological parameters are very useful in determining the level of sustainable production, such as *MSY*, *MEY* and *Open Access (OA)*. Based on the value of biological parameters in Table 3, the value of sustainable production can be calculated. Sustainable production is the relationship between catches and effort in quadratic form, where the effort level and the catch results will not threaten the sustainability of squid *(Loligo* spp*)* resources.

Using a computer spreed sheet program, the results of the squid resources bioeconomics approach *(Loligo* spp*)* were landed in AFPKejawanan data from 2006 - 2015 following the Gordon-Schaefer and Fox models can be seen in Table 4.

Parameter	MEY	MSY	OA
x (ton)	11.787,18	8.098,39	7.387,58
h (ton)	240,41	303,56	301,23
E (trip)	52	95	104
µ (IDR)	3.915.691,13	1.161.846,24	-

Table 4. The Bioeconomic Approach in Various Conditions for the Cultivation of Squid Resources is Landed in AFP Kejawanan.

Based on Table 4, the potential value of sustainable squid *(Loligo* spp*)* which is subjected to the AFP Kejawanan is 303.56 tons / year, which can be captured with an effort of 95 trips per year. The economic rent value obtained in the exploitation of MSY conditions is IDR. 1,161,846,240, - per year.

MEY conditions or statically optimal conditions are ideal conditions for fish resource utilization. The calculation results show that the effort on the MEY management regime, which is 52 trips per year is lower when compared to the OA and MSY management regime, namely 104 and 95 trips / year. When viewed from the level of economic rent, the MEY value is IDR. 3,915,691,130, - is the highest compared to the management regime of MSY, which is IDR. 1,161,846,240, -. In other words, the MEY economic value is in maximum condition. This shows that at this level of production the level of fishing effort has been carried out efficiently, so that a better catch is obtained and then followed by maximum economic achievement.

Utilization of resources that are limited by the conditions of MEY (controlled) will provide the maximum economy, due to controlled fishing efforts, so that the total revenue obtained is greater than the total expenditure. The implications of controlled resource utilization can be seen from the use of the required effort (E_{MEY}) in fishing far smaller than that needed to reach the MSY point and the OA condition. More clearly it can be said that the MEY management regime looks more environmentally friendly (conservative minded) than the E_{MEY} condition.

Efforts on the OA management regime are 104 trips per year. The effort is greater than the effort on the conditions of managing MSY and MEY. The amount of effort on the OA management regime is caused by the nature of the OA regime where everyone can carry out fishing activities. The production obtained in the OA management regime is 301.23 tons per year where the revenue obtained is zero (TR = TC). This means that if squid resources are allowed to be captured by fishermen, then business competition in these conditions will be unlimited and the impact of the level of risk that must be borne by fishermen will be greater because the competition for production becomes tighter. Due to the nature of open resources, fishermen tend to develop the number of fishing gears and the level of fishing efforts to get as many catches as possible.

IV. CONCLUSION

There were symptoms of economic overfishing in squid resources *(Loligo* spp*)* landed at the AFP Kejawanan. Bioeconomic optimization was achieved at the level of 52 trip capture efforts with a catch of 240.41 tons per year and economic rent of IDR. 3,915,691,130. Care should be taken not to issue a new permit for the Bouke Ami vessel because actual efforts have exceeded the effort at the MEY (Maximum Economic Yield) level.

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Suharyanto" Bioeconomic Approach on Management of Squid (Loligo spp) Fishery Empirical Study at Kejawanan Archipelagic Fishing Port Cirebon Indonesia" The International Journal of Engineering and Science (IJES), 8.2 (2019): 71-74