

SMALL-SCALE FISHERIES MANAGEMENT FOR TRADITIONAL SHRIMP FISHERMEN : A BIONOMICS GOMPERTS-FOX MODEL

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Abstract: *The purpose of this study is analyzing the fishing catches and efforts at the level of Maximum Sustainable Yields (MSY), Maximum Economic Yield (MEY) and Open Access (OA). MSY, MEY and OA are the indicators of bionomics that will be used to formulate a fishery management in Cilacap Regency. The results analysis of bionomics are used to formulate appropriate policies in the shrimp resources management. The research specifically uses trammel net as an approach to the stock analysis of shrimp resources. The analysis tool is a Bionomics Fox Model.*

The sampling technique is multistages sampling, with 100 fishermen as the respondents. The analysis of Bionomics Fox indicates that there had been overfishing since 2006-2016. Based on the results of Catch Maximum Sustainable Yield (CMSY) of shrimp in Cilacap Regency is 1,715 tons/year and Effort Maximum Sustainable Yield (EMSY) is 15,713 trips/year, Catch Maximum Economic Yield (CMEY) of shrimp is 1,554 tons/year and Effort Maximum Economic Yield (EMEY) is 9,720 trips/year, and production of Open Access (COA) is 1,516 tons/year with the Effort Open Access (EOA) is 24,866 trips/year.

Keywords: *Fisheries Management, Traditional, Shrimp Fisherman, Bionomics, Fox Model, Maximum Sustainable Yield, Maximum Economic Yield, Cilacap.*

1. INTRODUCTION

Cilacap Regency has eleven TPI (Fish Auction Place), covering of six TPI Provinces and five TPI Regencies. TPI provinces covers TPI PPSC, TPI Sentolokawat, TPI Pandanarang, TPI Lengkong, TPI Sidakaya, TPI Donan and TPI Tegalkatilayu. TPI Regencies are comprises TPI Bateray, TPI Kemiren, TPI Sentolokambang, TPI Rawajarit and TPI Jetis. There are five kinds of fish in each TPI, namely: large pelagic fish, small pelagic fish,

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shrimps, demersal fish, reef fish consumption and mollusks. These fish are fished using long line fishing gear (rawai tuna), gillnet (drift gill nets), white nets (sirang) and trammel net (shrimp nets).

Based on the information of Marine and Fisheries Department of Cilacap Regency, trammel net is the dominant fishing gear used by the fisherman for shrimp fishing. Starting in 2005 the production fluctuation and production value of shrimps fishing in Cilacap Regency tends to decline. The highest production is in 2012 (1,868,727.80 kg) and the lowest is in 2013 (1,100,370.55 kg), the highest production value is in 2012 (Rp 39,579,636,213) and the lowest production value is in 2013 (Rp 8,220,939,135). Thus, this is a problem that needs to examine both of physically or economically. Marine and Fisheries Department of Cilacap Regency (2014).

Marine fisheries are the most accessed field that makes us concerning about the tragedy of the common occurred (Gordon, 1954; Homans and Wilen, 1997; Grafton et al, 2000). Seeing such conditions, this needs further study and research on the use and management of fish resources sustainably. The approach of this research is Fox surplus production to assess sustainable fisheries resources (Maximum Sustainable Yield/MSY), and assess the profitable fishery resources/profitable economically (Maximum Economic Yield/MEY) at shrimp fishery of marine resources in Cilacap Regency.

The empirical discussion regarding to bionomics models have been carried out in the past, namely, Schaefer (1954; 1957); Fox (1970); Abdulqadeif (1995); Thanh (2006); and Prellezo (2010). This study tries to figure Bionomics estimation Fox Model out in traditional small-scale shrimp fishing.

2. RESEARCH METHODS

This research is an empirical study on the bioeconomy analysis model and shrimp resource management in Cilacap waters. The population is the numbers of vessels trammel net in Cilacap Regency. The sampling technique is multistages sampling, with 100 fishermen as the respondents.

Gomperts-Fox model is used to calculate the bioeconomy Fox models (Fox, 1970; Thanh, 2006). Here is the difference equations formula used in the Gordon-Schaefer Bioeconomy model and the Fox Bioeconomy model in Table 1.

Table 1.
The Equation of Schaefer and Fox Bioeconomy Model

	Schaefer	Fox
MSY	$\left \frac{\alpha^2}{4\beta} \right $	E. $\text{Exp}(\gamma_0 + \gamma_1 \cdot E)$
E _{MSY}	$\left \frac{\alpha}{2\beta} \right $	$-\frac{1}{\gamma_1}$
O _A	$\alpha \times E_{OA} - \beta \times E_{OA}^2$	$\frac{c(\ln c - \ln p - \gamma_0)}{p\gamma_1}$
E _{OA}	$2 \times E_{MEY}$	$\frac{\ln c - \ln p - \gamma_0}{\gamma_1}$
MEY	$\frac{\alpha^2}{4\beta} - \frac{c^2}{4\beta \cdot p^2}$	$\frac{-e^{-1+\gamma+w} + \frac{c}{p}}{\gamma_1}$
E _{MEY}	$\frac{\alpha}{2\beta} - \frac{c}{2\beta \cdot p}$	$\frac{-1 \cdot w^*}{\gamma_1}$

Notes: $w^* = \frac{ce^{1-\gamma}}{p}$

Graphical-simulation is used to calculate MEY Fox model because it is difficult to find the value of w.

The above equation can be calculated using the following data:

α / γ_0 = intercept

β / γ_1 = trend line

P = price

c = average cost

TR = total revenue

TC = total cost

E = effort

3. RESULTS AND DISSCUSSIONS

To perform the analysis MSY and EMSY with the Fox model of standardized data must be calculated to get the value γ_0 and γ_1 that obtained from the linear regression equation Fox models.

$$\gamma_0 = -1,21503$$

$$\gamma_1 = -0,0000636$$

$$c = 1.922.758 \text{ (Rp/trip)}$$

$$p = 31.542.000 \text{ (Rp/ton)}$$

Table 2.
The Analysis of Fox Bioeconomy Model

	MSY	MEY	EOA
Catch	1,715	1,554	1,516
Effort	15,713	9,720	24,866
Revenue	54,096,258,738	49,002,503,179	47,811,205,629
Cost	30,211,888,725	18,689,210,194	47,811,205,629
Profit	23,884,370,014	30,313,292,985	-

Source: Analysis Results of 2016

From the analysis of table 2, the shrimp fishing in Cilacap Regency can be explained that catch maximum sustainable yield (MSY) of shrimp with Fox model is 1,715 tons per year with optimal effort at 15,713 trips per year, or the potential for sustainable allowable fishing at 1,715,000 kg/15,713 trips=109 kg per trip. Catch maximum economic yield (MEY) of shrimp with Fox model is 1,554 tons per year with optimal effort at 9,720 trips per year orvpotential maximum allowable catch at 1,554,000 kg/9,720 trips=160 kg per trip.

By the appropriate analysis during 2006-2016 observation shows that the shrimps catch in Cilacap Regency has already experienced overfishing since 2009. The actual effort since that year is 16,355 trips per year exceeds the MSY effort at 15,713 trip per year and the actual catch is at 1,355 tons per year smaller than the catch of maximum sustainable yields (MSY) that is at 1,715 tons per year.

For the utilization level of shrimp on the precautionary principle, the potential of shrimp may be caught at 80% of the sustainable potential (MSY). The utilization level of shrimp in 2006 = $\frac{1.632}{1.372} \times 100\% = 119\%$. The actual effort during the years of 2006-2016 exceeds the MSY effort if it is calculated with the average actual effort of 2006-2016 (\bar{x}), there are 16,016 trips and average production at 1,643 tons.

The relations of fishing effort and LN Y with Fox model is as follows:

$$\text{LN } Y_t = \gamma_0 - \gamma_1 X_t + e_t$$

The regression analysis between fishing efforts and LN Y with Fox model produces the following relationship:

$$\widehat{\text{LN}}_Y = -1.21503 - 0.0000636 X_t$$

$$T = (-6.04) (-5.40)$$

$$R^2 = 0.764$$

The relationship between Ln Y and effort is linear with a negative correlation relationship. Based on the equation of $\widehat{\text{LN}}_Y = -1.21503 - 0.0000636 \text{ EFFORT}$, so if the effort increases 1 unit of effort (trip), then Ln Y will reduce at 0.0000636 units lnY.

MEY and E_{MEY} analysis uses Fox model on shrimp fishing business in Cilacap Regency shows that the optimal effort (E_{MEY}) at 9,720 trips per year along with the catch economic sustainable yield at 1,554 tons per year. The total cost per trip is Rp 1,922,758 and the average price of shrimp Rp 31,542,000/ton. Thus, the total revenue (TR) is Rp 49,002,503,179; with the total cost (TC) is Rp 18,689,210,194; and the total profit obtained is Rp 30,313,292,985.

4. CONCLUSIONS

Based on the analysis of Fox Bioeconomy Model, it is obtained that catch Maximum Sustainable Yield (C_{MSY}) of shrimp in Cilacap Regency is 1,715 tons/year and Effort Maximum Sustainable Yield (E_{MSY}) is 15,713 trips/year, catch Maximum Economic Yield (C_{MEY}) of shrimp is 1,554 tons/year and Effort Maximum Economic Yield (E_{MEY}) is 9,720 trips/year, and production of Open Access (COA) is 1,516 tons/year with the Effort Open Access (EOA) is 24,866 trips/year.

The profits level (economic interest) with Fox model when the MSY is at the level of Rp 23,884,370,014, MEY is Rp 30,313,292,985 and EOA is Rp 0.-

The utilization of shrimp fishing in Cilacap Regency with Fox model has already experienced overfishing since 2009 with the average actual effort during 2006-2016 is 16,016 trips/year greater than the MSY effort at 15,713 trips/year, the average of actual production (2006-2016) is at 1,643 tons/year

lower than the MSY production at 1,715 tons/year, with the average utilization level (2006-2016) is at 119.78%.

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