Original Research Article

ECONOMIC STUDY OF RESOURCE MANAGEMENT OF WHITE POMFRET (*Pampus Argenteus*) AND WHITE SNAPPER (*Lates Calcarifer*) IN CIREBON DISTRICT, WEST JAVA

ABSTRACT

The result catches ~~F~~fish of ~~W~~white ~~P~~pomfret (*Pampus argenteus*), and ~~W~~white ~~S~~snapper(*Lates calcarifer*) contributed significantly to improving the welfare of ~~F~~fishermen,especially ~~C~~cirebon~~R~~regency of West Java. The study aimed to estimate the optimalutilization and formulate ~~F~~fisheries ~~M~~management ~~M~~models. To pass the estimationand management model,usedthe Model Bioeconomy.The results obtained from theestimated balance ofthe Bioeconomy optimum utilization of fishery resources fishof~~W~~white~~P~~pomfret(*Latescalcarifer*)theHarvestof707,18kg/year,effortsof7063,49 trips/year, and Phi of Rp.15.824.173, 45/yearand fish of ~~W~~white ~~S~~snapper(*Pampusargenteus*) theHarvestof280,96kg/year, effortsof2660,20 trips/year,andphiofRp.2.400.882,73/yearandthenbecreatedfortheformulationof~~E~~economic ~~M~~models of ~~R~~resource ~~M~~management fish of ~~W~~white ~~P~~pomfret and ~~W~~white ~~S~~snapperoptimal and sustainable in Cirebon Regency is the management regime based onsole owner/MEY (Maximum Economic Yield) to form the optimal management ofeffortand catch.

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***Keywords*: Management Economical,Fish, Cirebon Regency**

INTRODUCTION

White ~~P~~pomfret (*Pampus argenteus*) and ~~W~~white ~~S~~snapper (*Lates calcarifer*) are one of the ~~D~~demersal ~~F~~fish groups that are mostly caught by ~~F~~fishermen in Cirebon Regency and have economic value. According to Genisa in Mayalibit et al. (2014), economically significant means having a high market value, tall and wide macro production volume, andincreased production power. This activity allows for high profits, considerable resource potential, suitable water areas for these types of fish, and also due to the excellent market share of these fish. This opportunity has boomeranged for sustainable capture fisheries activities. Increasing fishing activity through increasing fishing effortsin terms of increasing the number of units and fishing trips will put great pressure on resources and ecosystems, leading to biologically and economically overfishing.~~(biological and economic overfishing).~~

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Biological overfishing will reduce the amount of biomass (stock) which is characterized by a decrease in the number of catches per unit, changes in the size of the fish caught that are getting smaller, and changes in the fishing ground.~~s(fishing ground).~~ This biological decline will cause a decrease in economic terms, with reduced yields of catches on the one hand and an increase in the ~~C~~cost of catches per trip; on the other hand, then fishing activities will lead to a breakeven point, where the costs incurred are equal to the results achieved and eventually will experience losses. This condition becomes inefficient, so an accurate estimate is needed.

This study aims to: (1) Determine the optimal utilization of ~~W~~white ~~P~~pomfret and ~~W~~white ~~S~~snapper fisheries in the Cirebon Regency, and (2) Formulate an optimal and sustainable resource management model.

RESEARCH METHODS

The research was conducted in Cirebon District, West Java Province. The data to be used in this study are primary and secondary data, including actual production, sustainable production, effort, CPUE, fishing costs, and fishing fleets.

Catch per Unit Effort

Catch per unit effort (CPUE) is calculated based on the total Catch of one fishing gear with the total effort of Catch (effort) in units. CPUE is calculated by the following formula:

$$CPUE_{it} = \frac{Catch_{it}}{Effort_{it}}$$

Information:
$CPUE_{it}$ = Catch per unit Effort of the time-t catching device
$Catch_{it}$ = The Catch (Catch) of fishing gear-i at time-t
$Effort_{it}$ = catching effort (effort) of fishing gear-i at time-t

Effort standardization

Considering the diversity of fishing gear operating in the research area, to measure with equal units, effort is standardized between gear using the following standardization techniques developed by King (1995), namely:

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$$E_{it} = \varphi_{it} D_{it}$$

With : $\varphi_{it} = Uit : Ustd$
Information :
Eit= effort of standardized fishing gear
Dit= number of fishing days for fishing gear-i at time-t
φit= fishing power value of fishing gear-i in period-t
Uit= Catch per unit effort (CPUE) of fishing gear-i in period t
Ustd = Catch per unit effort (CPUE) of the fishing gear used as the basis for standardization

Cost Standardization

Standardized Cost per unit effort (standardized unit effort) follows the standardization pattern used by Anna (2003), which can be written mathematically as follows:

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$$C_{et} = \left[\frac{1}{n} \sum_{i=1}^{n} \frac{TC}{\sum E_i} \left(\prod_{t=1}^{n} \frac{h_{it}}{\sum (h_i + h_j)} \right)^{\frac{1}{t=1}} \frac{CPI_t}{100} \right]$$

Information:

C_{et} =Cost per unit of standardized effort in period t

T_{ci} = total Cost for fishing geari for i = 1.2

Ei = total standardized effort for gear i

h_{it} = production of gear i at time t

∑(hi+hj) = total fish production for all fishing gear

n = number of fishing gear

CP_{It} = consumer price index in period t

Estimation of Biological Parameters

Estimating the parameters r, q, and K for the two previous equations uses a non-linear technique, so by using the weighted least squares (WLS) method, namely by dividing the function h(q, K, E) by E(Ut = ht / Et), then these two equations can be transformed into linear equations so that the ordinary least squares (OLS) regression method can be used to estimate the biological parameters of the function mentioned above, namely as follows:

Bentuk Gompertz : $\frac{h_t}{Et} = qKe^{\left[\frac{-qE}{r}\right]}$

$\ln U_t = \beta_0 - \beta_1 E_t$, dimana $U_t = \frac{h_t}{E_t}$; $\beta_0 = \ln qK$; $\beta_1 = \frac{q}{r}$

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The biological parameter estimation approach for sustainable production using the exponential-based Gompertz function is carried out using the parameter estimation model developed by Clarke, Yoshimoto, and Pooley (1992) in Fauzi (2004), namely as follows:

$$\frac{U_{t+1}}{U_t} - 1 = r - \frac{r}{qK} U_t - qE_t$$

$$\ln(U_{t=1}) = \frac{2r}{(2+r)} \ln(qK) + \frac{(2-r)}{(2+r)} \ln(U_t) - \frac{q}{(2+r)} (E_t + E_{t+1})$$

From the regression results, the value of β1 will be obtained, which will justify the value of the parameter r. In addition, the value of β2 is also brought, which will justify the parameter value q. Furthermore, the K parameter values can be obtained from these values (r and q). The following equation is a form of the Clarke, Yoshimoto, and Pooley (CYP) model approach to estimate biological parameters, namely:

$$r = \left(\frac{2 - 2\beta_1}{1 + \beta_1} \right)$$

$$q = \beta_2 (2 = r)$$

$$K = \frac{e^{\frac{\beta o (2+r)}{2r}}}{q}$$

Information :
K = carrying capacity of the environment
q = capture coefficient
r = intrinsic growth
β_1 = intercept
β_2 = slope

Estimation of Economic Parameters
Economic parameter estimation consists of price per kilogram, Cost per fishing trip, and discount rate. Prices and costs are measured in absolute terms adjusted for the consumer price index (CPI), where these values are obtained from nominal prices in period (t)~~(prt)~~and converted to accurate prices (prt). In more detail in the following equation:

$$p_{rt} = \left(\frac{p_{nt}}{IHK_t} \right) \times 100$$

Information:
P_{rt}= accurate price in the year (t)
P_{nt} = nominal price in the year (t)
CP_I = consumer price index in the year (t)

While the discount rate is the real interest rate which is calculated based on the market base discount rate, and the interest rate calculation uses the following equation:

$$\delta = ln(1+r)$$

Information:
δ = real discount rate
r = interest rate

Bioeconomic Balance Estimation

The value of resource optimization using a static approach for bioeconomic equilibrium conditions in the maximum sustainable yield regime is obtained through the following equations (Fauzi, 2004), namely:

$$x_{MSY} = K(1 - \frac{qE}{r})$$

$$E_{MSY} = \frac{r(1 - \frac{x}{K})}{q}$$

$$h_{MSY} = qKE(1 - \frac{qE}{r})\ .$$

Information:

x_{MSY} = biomass level

h_{MSY} = optimal production rate

E_{MSY} = optimal effort level

K= carrying capacity of the environment

q = capture coefficient

r = intrinsic growth

E = level of effort

Bioeconomic balance in conditions of open access can be denoted as follows:

$$x_{OA} = \frac{c}{pq}\ .$$

$$h_{OA} = \frac{rc}{pq}\left[1 - \frac{c}{pqK}\right]$$

$$E_{OA} = \frac{r}{q}\left[1 - \frac{c}{pqK}\right]$$

Information:

x_{OA} = biomass level

h_{OA} = optimal production level

E_{OA} = optimal effort level

K= carrying capacity of the environment

q = capture coefficient

r = intrinsic growth

p = price of fish

c = ~~C~~cost of catching

For the sole owner condition, optimization is obtained based on the following equations:

$$x_{SO} = \frac{K}{2}\left(1 - \frac{c}{pqK}\right)$$

$$h_{SO} = \frac{rK}{4}\left[1 + \frac{c}{pqK}\right]\left[1 - \frac{c}{pqK}\right].$$

$$E_{SO} = \frac{r}{2q}\left[1 - \frac{c}{pqK}\right].$$

Information:
x_{SO} = biomass level
h_{SO} = optimal production level
E_{SO} = optimal effort level
K = carrying capacity of the environment
q = capture coefficient
r = intrinsic growth
p = price of fish
c = ~~C~~cost of catching

Furthermore, by using a dynamic approach, the optimization of fishery resources can be obtained with the following formula (Fauzi, 2004),namely :

$$x^* = \frac{1}{c}x(pqx - c)\left(\delta - r\left(1 - \frac{2x}{K}\right)\right)$$

$$h^* = \frac{1}{4}\left[\left(x_{OA} + K\left(1 - \frac{\delta}{r}\right)\right) + \sqrt{\left(x_{OA} + K\left(1 - \frac{\delta}{r}\right)\right)^2 + \left(\frac{8Kx_{OA}\delta}{r}\right)}\right]$$

$$E^* = \frac{h^*}{qx^*}$$

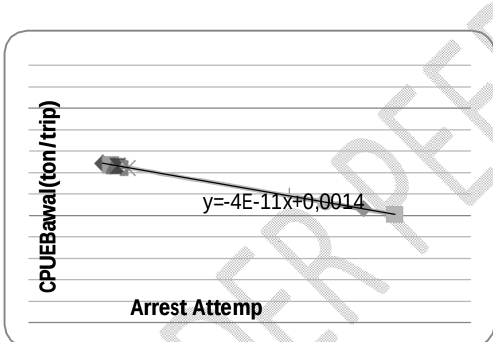
Information:
x* = biomass level
h* = optimal production rate
E* = optimal effort level
K = carrying capacity of the environment
x_{OA} = biomass in open access conditions
p = price of fish
c = Cost of catching
q = capture coefficient
r = intrinsic growth
δ = real discount rate

RESULTS AND DISCUSSION

Catch Per Unit Effort

Based on the catch per unit effort analysis results for white pomfret (*Pampus argenteus*), it was found that the highest CPUE value was the payang gear. This value illustrates the effectiveness of catching payang fishing gear, which is quite reasonable compared to other fishing gear in white pomfret fishing activities in Cirebon Regency waters. The opposite condition occurs for gill net fishing gear in white pomfret fishing activities, with an average CPUE value of 0.001560, indicating low fishing effectiveness. The results of the standardized effort analysis show that the standard fishing gear for catching the white pomfret (*Pampus argenteus*) in the waters of Cirebon Regency is the payang gear. Based on the effort of the standard fishing gear, the total effort for catching white pomfret is obtained. The following shows the actual effort and production level of ~~W~~white ~~P~~pomfret.

Furthermore, analysis of the ~~C~~catch per unit effort of barramundi (*Lates calcarifer*) found that longline fishing gear is the fishing gear that has the highest CPUE value, which is an average of 0.009834 per year. This value describes the ratio between ~~C~~catch and effort. The higher the value, the better the effectiveness of the fishing gear. In other words, with fewer fishing efforts, more catches are obtained. The average longline effort is 10,167.27 trips per year, while the average gill net effort is 332,559.07.



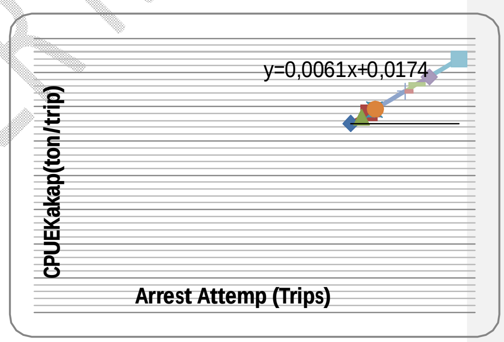


Figure 1. Graph of the Relationship Between Catch per Unit Effort (CPUE) and Trips for White Pomfret and White Snapper

Based on Figure 1, it can be seen that between CPUE and fishing effort for ~~W~~white ~~P~~pomfret (*Pampus argenteus*) in Cirebon Regency shows a negative relationship, meaning that the higher the fishing effort, the lower the CPUE value. The negative relationship indicates that the productivity of fishing gear decreases with increasing fishing effort. Stock biomass is a limited resource jointly pursued by vessels in a fishery where the smaller the share per vessel, the more vessels that enter the fishery. Furthermore, the relationship between CPUE and fishing effort for barramundi (*Lates calcarifer*) inCirebon District shows a positive relationship, meaning the higher the fishing effort, the higher the CPUE value. The positive relationship indicates that the productivity of fishing gear increases with increasing fishing effort.

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Bioeconomic Balance Estimation

The result of standardization of effort is that the payang is the standard fishing gear in white pomfret fishing activities in the waters of Cirebon Regency. The average effort is 16,100 trips per year, with an average catch of 937.50 tonnes per year. An average CPUE value of around 0.031667 per year is obtained with the average annual ~~C~~catch an average effort. Furthermore, the regression analysis results obtained the value of β1 = 0.7492 and β2 = 6.19101E-05 with a value of R2 = 0.6391. Knowing the value of the bioeconomic balance, the results of the analysis of ~~B~~biological parameters and ~~E~~economic parameters are simulated, and the optimal ~~C~~catch (~~H~~harvest), optimal effort (~~C~~catch), and optimal rent (phi) values will be obtained. Based on the results of the Gordon-Schaefer (GS) ~~B~~bioeconomic balance analysis, three bioeconomic balance points were obtained, namely, the balance that occurs at the effort level of 6,709 trips per year, the effort level of 7,063 trips per year and an effort level of 13,419 trips per year. The first bioeconomic balance occurs in managing the ~~M~~maximum ~~E~~economic ~~Y~~yield (MEY) regime, commonly known as the sole owner. MEY's bioeconomic balance occurs at an effort level of 6,709 trips per year, with an optimal production level from an economic standpoint of around 17,593.69 tons per year. This condition will provide the highest profit in the form of resource rent of IDR 318,324,363 per year.

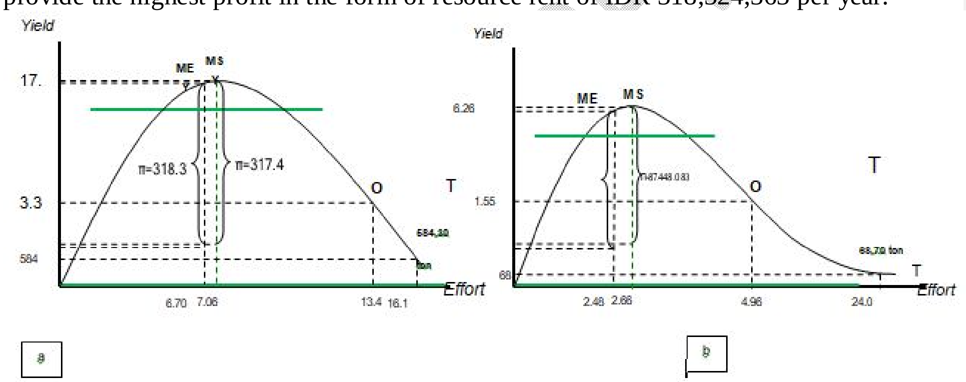

Figure 2. Bioeconomic balance (a) White Pomfret (*Pampus argenteus*) and
(b) White Snapper (*Lates calcarifer*)

The second bioeconomic balance occurs in ~~M~~maximum ~~S~~sustainable ~~Y~~yield (MSY) resource exploitation conditions, commonly known as sustainable potential. The bioeconomic balance of the MSY regime occurs at an effort level of 7,063 trips per year, with an optimal catch of 17,637.89 tons per year. This condition will provide benefits in the form of resource rents of around IDR 317,440,384 per year. Thus if the resource utilization activities

White Pomfret (*Pampus argenteus*) in Cirebon Regency want to be sustainable from an ecological point of view, so input control must be carried out at a level of 7,063, which means reducing the current input of around 7,936.51 trips per year. These inputs can only be controlledby exploiting resources in the MEY and MSY regimes. These two regimes are forms of optimal management of resources from an economic, ecological, and social perspective (economicecology and social sustainability). The

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third bioeconomic equilibrium occurs when the total cost (TC) curve intersects with the total revenue (TR) curve. This point is called the breakeven point, where TR = TC. Thus, under these conditions, no profit or resource rent equals zero (π = 0). Gordon calls this balance point the bioeconomic equilibrium of open access or the bioeconomic balance of open access (Fauzi and Anna, 2005). This happens because, in open access conditions with no rules in utilization, each increase in effort will increase the total ~~C~~cost of production so that the ~~T~~total ~~C~~cost is greater than the ~~T~~total ~~R~~revenue. Thus, the exploitation of ~~P~~pomfret ~~F~~fish ~~R~~resources ~~(*Pampus argenteus*)~~ will suffer losses so that there will be input exit~~s~~ from resource actors, and the level of effort will return to the breakeven point.

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Concerning the breakeven point of the bio-economy balance, the exploitation of white pomfret (*Pampus argenteus*) resources in the Cirebon Regency is currently experiencing overfishing and inefficiency. This can be seen in the bioeconomic balance (figure 2a)~~,~~ with an actual effort value of 16,100 trips per year, exceeding the effort level at the breakeven point of 14,126 trips per year. This situation illustrates that white pomfret (*Pampus argenteus*) fishery business activities will experience a reduction in inputs due to the large production costs incurred.

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Furthermore, the analysis of the bioeconomic balance in ~~F~~figure 2b shows that the management of ~~W~~white ~~S~~snapper (*Lates calcarifer*) in the waters of Cirebon Regency from the point of view of ~~C~~catch (~~H~~harvest) is experiencing overfishing. This can be seen from the research results, which show that the current catch value (68.70 tons per year) is far below the optimal catch value (6,269.38 tons per year). This value is unbalanced when looking at the number of actual efforts (24,084 trips), far from the optimal effort level (2,485). This condition illustrates that fishing activities for ~~W~~white ~~S~~snapper (*Lates calcarifer*) in Cirebon Regency waters are inefficient. A very high amount of effort does not give optimal catch results. If this condition is maintained, it is believed that the ~~W~~white ~~S~~snapper (*Lates calcarifer*) fishery business activity in the waters of Cirebon Regency will not last long. This can happen because of the amount of pressure ~~due to the amount of~~ and effort that is too large. While the optimal effort value can be recommended so that ~~B~~barramundi (*Lates calcarifer*) fishing activities can be sustainable from an ecological perspective, namely 2,660 trips per year, and from an economic perspective, ~~namely~~i.e. 2,485 trips per year.

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To achieve sustainable utilization of ~~W~~white ~~S~~snapper (*Lates calcarifer*) resources in Cirebon Regency, it is necessary to reduce the amount of input (effort) by around 21,424 trips per year. So that the negative excesses of reducing the amount of effort can be maintained with the assumption that each operation of longline fishing gear requires a minimum of 2 crew members (referring to the results of the survey, 2007), there will be a reduction in the number of fishery actors by around 42,848 people. Alternative efforts to manage resources must always be carried out (back-forward looking), such as changing fishing gear with different catch targets with the requirement that the fishing gear targets are not optimal or diverting activities in other forms either in the fisheries sector such as marine and coastal cultivation or product processing, as well as in supporting fisheries activities based in coastal areas. This is in line with Adrianto (2005) that the core of the transfer (transform) aims to move fishermen's livelihoods vertically and horizontally.

However, the transfer of profession must still pay attention to the characteristics and culture of the community (fishery actors). According to Charles (2001) in Adrianto (2005) that there are several general characteristics of fishermen,~~(fishermen),~~ namely; that first, fishermen differ according to social backgrounds such as age level, education, social status, and level of cohesion in micro-communities (between fishermen in one group) or the macro community (fishermen with other coastal community members). Secondly, in the commercial fishing community, fishermen can vary according to their occupational commitment, such as full-time fishermen, main part-time fishermen, and part-time fishermen, or according to their occupational pluralism, such as fishermen with particular specialties, fishermen with various sources of income, and so on. Thirdly, fishermen can vary according to motivation and behavior, where maximizers are fishermen who actively catch fish to get the maximum profit and tend to behave like a "company" and groups of fishermen satisficers or fishermen who actively catch fish to get enough results.

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CONCLUSIONS AND RECOMMENDATIONS

Conclusion

1. Obtained optimal utilization of ~~P~~pomfret (*Lates calcarifer*) resources, namely ~~H~~harvest of 707.18 kg/year, effort of 7,063.49 trips/year, and Phi of Rp. 15,824,173.45/year and ~~W~~white ~~S~~snapper (*Pampusargentus*), namely ~~H~~harvest of 280.96 kg/year, effort of 2,660.20 trips/year, and phi of IDR 2,400,882.73/year.
2. The formulation of an optimal and sustainable economic model for managing pomfret and barramundi resources in Cirebon Regency is management based on the sole owner/MEY (maximum economic yield) regime, with an optimal form of effort and catch management.

Suggestion

1. Utilization and ~~M~~management that provides ~~M~~maximum ~~B~~benefits ~~E~~economically and ~~B~~biologically while maintaining the sustainability of ~~R~~resources.
2. Arrangements are needed for the utilization of the new fishing ground.

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