Holistic Approach for Stock Estimation and Utilization Status of Silver Grunt (Leiognathus splendens): A Case Study of Catch Data at PPN Karangantu, Serang Banten

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Abstract

The limitation of information on Peperek fish (Leiognathus splendens) stock is one of the issues that needs to be addressed. Therefore, this research aims to estimate the stock of Peperek fish (Leiognathus splendens) landed at Nusantara Karangantu Fishing Port, Serang Banten, for the last ten years from 2010 to 2020 using a holistic approach. This holistic approach does not require many details from analytical models, such as age structure and fish length, but assumes that the stock is a homogeneous biomass. In this case, there are two simple methods: the swept area, which is the catch per unit area captured by the trawl, and the surplus production, which uses the catch per unit effort. Generally, the data is taken annually and comes from samples of commercial fishing. In this study, the surplus production model with two methods is used: the equilibrium state, such as the Schaefer (1954) and Fox (1970) models, and the non-equilibrium state, such as the Walter-Hilborn (1976) model. The result of this research is to find out how effective the selected method is in estimating Peperek fish (Leiognathus splendens) stock by producing the best R square value for each method. The results of this research will provide useful information for related parties to make appropriate policies for preserving the Peperek fish (Leiognathus splendens) stock.

Keywords: peperek fish stock estimation (leiognathus splendens); holistic approach; equilibrium state; non-equilibrium state

A. INTRODUCTION

One of the leading fish catches in PPN Karangantu is peperek fish (Leiognathus splendens). Peperek fish (Leiognathus splendens) is one type of fish that can be found by the method of catching nets in water areas such as Banten, the North Coast of West Java, Central Java, East Java, and the East Coast of Lampung.(Badrudin, Aisyah, & Ernawati , 2011). Based on information in the Karangantu PPN statistical annual report for the period 2010–2020, peppercorn (Leiognathus splendens) accounts for 20–25% of the total catch of fishermen landed at Karangantu PPN each year. (Direktorat Jendral Perikanan Tangkap, 2020)

This peperek fish has a high economic value, even though some people consider it a trash fish. At an affordable price, it can be enjoyed by all people, from the lower middle class to the upper middle class. Because this fish has a very high nutritional content, every 100 grams of peppercorn (Leiognathus splendens) contains 120 mg of calcium, 32 grams of protein, 2.4 mg of niacin, and 200 mg of phosphorus. This is, of course, very good for consumption by children. (Farm, 2023). As market demand increases and the catch from

year to year continues to increase. Therefore, it is necessary to conduct a study on the estimation of the peperek fish resource stock (Leiognathus splendens) landed by PPN Karangantu to ensure the survival of demersal fish resources, especially peppercorn (Leiognathus splendens), so as not to be over-exploited.

According to (Muhsoni 2019) The best system for utilizing marine biological resources is by analyzing estimated fish stocks. The purpose of the analysis of fish stock estimation is to provide recommendations on the best use of marine living resources such as fish and shrimp. Fish stock analysis aims to estimate the number of fish in a body of water and how fast these fish resources can be renewed. In the analysis of fish stocks, there are two main types commonly used: the analytical model and the holistic model. The holistic approach model when determining fish stocks does not require a lot of detail from analytical models, such as data on the age structure and length of fish, in determining stocks. However, estimate that the stock is a homogeneous biomass. In the holistic approach model, there are two types of simple methods: swept area, which is the catch per unit area caught by the net (trawl), and surplus production, which uses the catch per unit effort. In general, the data needed for the surplus production model is taken on an annual basis and comes from samples of commercial fisheries. In this study, a surplus production model is used that has two methods, namely equilibrium state like models Schaefer (1954) and Fox (1970) and non-equilibrium state like models Walter-Hilborn way one and way two (1976). (Muhsoni, 2019)

This research aims to estimate the stock of peppercorn (Leiognathus splendens) by using a holistic approach at PPN Karangantu. The purpose of using two methods, equilibrium state and non-equilibrium state, is to compare the more effective methods based on analyzing the data for the value results R Squared (R2) of each method. This will minimize the catch of peperek fish (Leiognathus splendens) and assist in developing policies aimed at preserving peppercorn populations (Leiognathus splendens).

B. METHODS

Data Collection

The method used in this study involved collecting data using secondary data obtained from the 2010–2020 Karangantu PPN Capture Fisheries Statistics Report, which was taken during direct observation and interviewing stakeholders related to PPN Karangantu, Serang Banten, in September 2022. Secondary data is in the form of time series production and fishing efforts for peperek fish (Leiognathus splendens). The unit of fishing effort used is the number of fishing gear trips.

Data Analysis

The estimated sustainable catch (MSY) of pepperek (Leiognathus splendens) was analyzed with a holistic approach using two methods, equilibrium state and non-equilibrium state, to compare the more effective methods based on analyzing the data to the value results of R Squared (R2) for each method. Approach equilibrium state models of models Schaefer (1954) and Fox (1970), while non-equilibrium state models of models Walter-Hilborn (1976)

Model Schaefer (1954) argued that in an approximate equilibrium state, there is a negative linear relationship between catch per unit of effort (CpUE) and fishing effort. To see the effect of fishing effort on catch per trip effort (CpUE), regression analysis was used. In this analysis, the values of a and b are obtained to obtain several equations, as conveyed by (Sparre, 1999) regarding the relationship between catch per unit effort

(CpUE) with effort and the relationship between catches (catch) peperek fish (Leiognathus splendens) with effort.

$$CpUE = \frac{TC}{TT}$$

Note:
CpUE = catch per unit effort
TC = Total Catch
TT = Total Trip

U_{est} or death rate or mortality rate obtained from the value of an (intercept) and b (slope) results of the regression analysis. Value Uest obtained by the equation:

$$U_{est} = a + (b * TT)$$

FMSY (Fishing Mortality at Maximum Sustainable Yield) is obtained by equating the first derivative of the total catch (TC) to Total Trip (TT) or effort with the equation:

$$F_{MSY} = \frac{-a}{(2*b)}$$

YMSY (Yield at Maximum Sustainable Yield) refers to the maximum catch that can be maintained in the long term without destroying the balance of the fish population. Value YMSY obtained by the equation:

$$Y_{MSY} = \frac{-a^2}{(4*b)}$$

Based on the equilibrium state approach, model Fox 1970 is designed to estimate changes in the number of fish stocks in a fishery population over a certain period. In search of CpUE values (Catch per Unit Effort Estimation) according to (Azuma & Yoshimoto, 1979) was carried out through regression analysis to obtain values a and b with total trips as variable X and Ln CpUE as variable Y. After that, you can find the value of CpUEEast with the following equation:

$$CpUE_{est} = EXP\,(a + (b * TT))$$

FMSY obtained by the equation:

$$F_{MSY} = ABS\,(\frac{1}{b})$$

YMSY obtained by the equation:

$$Y_{MSY} = ABS\,(\frac{-a^b}{4*b})$$

YMSY obtained by the equation:

$$Y_{MSY} = F_{MSY} * U_{MSY}$$

According to (Kekenusa 2008) Estimation of sustainable potential can be known using the concept of non-equilibrium. using models Walter-Hilborn 1976 ways one and two are to estimate the population parameters (r, k, and q):

$$\frac{CpUE_{(t+1)}}{CpUE_t} - 1 = r - \left[\frac{r}{kq}\right]CPUE_t - q * f$$

Keterangan:

$CpUE_{(t+1)}$	= Catch per unit Effort (CPUE) awal pada saat ((Ut+1/Ut)-1)
$CpUE_t$	= Catch per unit Effort (CPUE) awal pada saat t
r	= laju pertumbuhan alami stok biomasa (konstan)
k	= daya dukung maksimum lingkungan alami
q	= koefisien cathability (0 < q < 1)
f	= Jumlah Effort pada tahun t

to get the values of the population parameters (r, k, and q) the calculation model (Walter and Hilborn way one):

$b_0 = r$ $\quad b_2 = q$ $\quad k = \left[\frac{b0}{b1+b2}\right]$

to get the values of the population parameters (r, k, and q) the calculation model (Walter and Hilborn way two):

$b_1 = r$ $\quad b_3 = q$ $\quad k = \left[\frac{r}{b2+b3}\right]$

The potential for sustainable reserves (Be) or the current condition of the fish is obtained by using the equation

$$Be = \frac{k}{2}$$

FMSY or Fe (effort optimum) is obtained by the equation:

$$F_{MSY} = \left[\frac{r}{2*q}\right]$$

YMSY or Ye (hasil tangkapan lestari) is obtained by the equation:

$$Y_{MSY} = \left[\frac{r*k}{4}\right]$$

C. RESULT AND DISCUSSION

Fishing activities at PPN Karangantu can be categorized as active activities in catching fish. There are nine types of fishing gear used by fishermen. Based on data from (Direktorat Jendral Perikanan Tangkap, 2020) the types of fishing gear that actively catch peperek fish (Leiognathus splendens) in active categories such as gill nets (Gill net), stupid nets (Danish his), floating chart (Boat lift net), step chart (Stationary life net), umbrella net (Included lampara), fishing line (Hook and lines), sero (Guiding barrier), the net (Trammel net) and other fishing gear (Others).

Data from the 2020 Karangantu PPN statistical report book shows that the production of peppercorn (Leiognathus splendens) of 570 tonnes. During the 2010-2020

period, the production of peperek (Leiognathus splendens) experienced various fluctuations. Graph showing the development of peperek production (Leiognathus splendens) can be seen in Figure 1. (Direktorat Jendral Perikanan Tangkap, 2020)

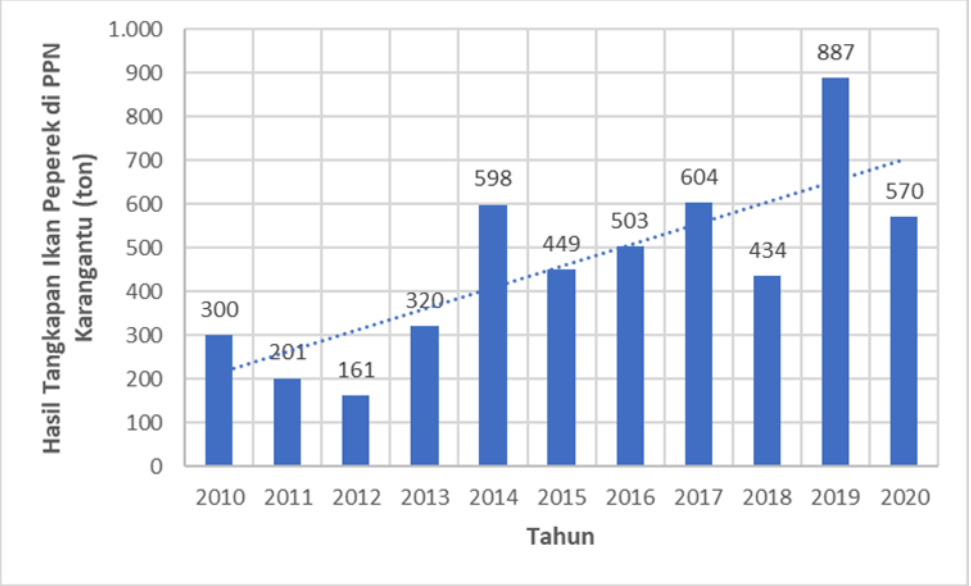

Figure 1. Production of Peperek Fish at Karangantu PPN 2010-2020

Estimation results using modelsSchaefer 1954 obtained a value (intercept) of 0.22, b (slope) of -0.00002, the value of R2 of 0.79 which means effort affects the CpUE value by 79%, while 21% is influenced by other factors such as fish production, fish season, fishing ground, and others. The results of the model regression analysis Schaefer 1954 obtained the equation y = -2E-05x + 0.2209. the potential of pepper fish (Leiognathus splendens) was analyzed and the Y value was obtained of 529 tonnes/year and a value of FMSY 4791 trips/year. With the utilization status of fish reaching 108%, it means that the fish has over-exploited, suggestions for preserving peperek fish are by reducing the number of peperek fishing efforts (Leiognathus splendens) so as not to damage the preservation of peppercorns in the sea. Model Schaefer 1954 has a significant f value of 0.00002 < value 0.05 which means model Schaefer can be used to estimate the stock of peppercorns.

Table 1. The results of the analysis using the model Schaefer 1954

Parameter	Rumus	Hasil	Satuan
a (*intercept*)	-	0.22	-
b (*slope*)	-	-0.00002	-
Batas Trip	-ab	8849	Trip
F_{MSY}	-a2*b	4791	Trip/Tahun

Y_{MSY}	-a24*b	529	Ton/Tahun
U_{MSY}	ABS-a2	0.11	Ton/Trip
F_{JTB}	a±a2-4bc))/2b	0.2209	Trip
Y_{JTB}	80%*MSY	423.33	Ton
Parameter	**Rumus**	**Hasil**	**Satuan**
T.Pemanfaatan	YJTBRata-rata dari Total Catch	108 %	-
R^2	-	79%	-
Signifikansi f	-	0.00002	-
α	-	0.05	-

Estimation results using modelsFox 1970, the results obtained were a value (intercept) of -0.53, a value of b (slope) of -0.0004. The results of the model regression analysisFox 1970 obtained the equation y = -3E-05x + 0.2366. potential for peppercornLeiognathus splendens) was analyzed and the Y value was obtained of 563 tonnes/year and a value of FMSY of 2591 trips/year. With the utilization status of fish reaching 102%, it means that the fish have over-exploited, suggestions for preserving peperek fish are by reducing the number of peperek fishing efforts (Leiognathus splendens) so as not to damage the preservation of peppercorns in the sea. on models Fox 1970 has a significant f value of 0.00002 < value 0.05 which means models Fox can be used to estimate the stock of peppercorns.

Table 2. Results of analysis using the modelFox 1970

Parameter	Rumus	Hasil	Satuan
a (*intercept*)	-	-0.53	-
b (*slope*)	-	-0.0004	-
Batas Trip	-ab	16.531	Trip
F_{MSY}	-a2*b	2591	Trip/Tahun
Y_{MSY}	-a24*b	563	Ton/Tahun
U_{MSY}	ABS-a2	0.22	Ton/Trip
F_{JTB}	f*expa+b*f-YJTB	3626	Trip
YJTB	80%*MSY	450.12	Ton
T.Pemanfaatan	YJTBRata-rata dari Total Catch	102 %	-
R^2	-	87%	-

Signifikan f	-	0.00002	-
α	-	0.05	-

Estimation results using models non-equilibrium state from Walter-Hilborn 1976 method one yields the r-value (intrinsic growth rate of biomass stock in a constant state) of 2.4, the q-value (capability coefficient) of 6.3 and the k-value (max carrying capacity of the natural environment) of 1020. Meanwhile, the sustainable catch value (Ye) of 607 tonnes/year with YJTB 486 tons/year and the value of sustainable fishing effort (Fe) is 3221 trips/year. With the utilization status of fish reaching 94%, it means that the fish have fully exploited, suggestions for preserving peppercorns can still be taken but not recommended even though the catches of peppers (Leiognathus splendens) have the possibility of increasing but this can also affect the balance and sustainability of peppercorn resources in the sea. on models Walter-Hilborn 1976 way, one has a significant value of f of 0.0012 <α value of 0.05 means the model Walter-Hilborn 1976 method one can be used to estimate the stock of peperek fish.

Table 3. Results of analysis using the modelWalter-Hilborn way one

Variabel	Rumus	WH Cara Satu
B0 = r	r=ABS(a)	2.4
B1	r(k*q)	6.3
B2 = q	-	0.0004
K	b0b1*b2	1020
Be	K2	510
Y_{MSY}	(r*k)4	607
F_{MSY}	r(2*q)	3221
U_{MSY}	(q*k)2	0.188
Y_{JTB}	80%*MSY	486
T.Pemanfaatan	YJTBRata-rata dari Total Cath	94%
R_2	-	44%
Signifikan f	-	0.0012
α	-	0.05

Estimation results using models non-equilibrium state fromWalter-Hilborn (1976) method two yielded the r-value (intrinsic growth rate of biomass stocks in a constant state) of 1.23, q value (capability coefficient) of -0.00006 and k value (max carrying capacity of the natural environment) of 2950. Meanwhile, the value of sustainable catches (Ye) of 909 tonnes/year with YJTB 728 tons/year and the value of sustainable fishing effort (Fe) is 10888.84 trips/year. With the utilization status of fish reaching 6278167.47%, it means that

the fish has depleted, the suggestion to preserve the peperek fish is by significantly reducing the number of fishing efforts for the peperek fish (Leiognathus splendens) so as not to damage the preservation of peppercorns in the sea. on modelsWalter-Hilborn 1976 method, two has a significant f value of 0.35 > α value of 0.05 means that the modelWalter-Hilborn 1976 method two cannot be used to estimate peppercorn fish stocks.

Table 4. Results of analysis using the modelWalter-Hilborn way two

Variabel	Rumus	WH Cara Dua
B1 = r	-	1.23
B2	r(k*q)	-7.38
B3 = q	-	-0.00006
K	rb1*b2	2950
Y_{MSY}	(r*k)4	909.68
F_{MSY}	r(2*q)	10888.84
U_{MSY}	(q*k)2	0.08
Y_{JTB}	80%*MSY	728
T.Pemanfaatan	YJTBRata-rata dari Total Catch	6278167,47%
R_2	-	37%
Signifikasn f	-	0.35
α	-	0.05

Based on testing two methods, namelyEquilibrium State like modelsSchaefer (1954) andFox (1970), andNon-Equilibrium State like modelsWalter-Hilborn method one and method two (1976), then the selected stock estimation approach model is the modelFox 1970. It is based on the value of the R2 model Fox the highest of the four models that have been tested which has a mean value of 87%.effort (trip) effect on catch per Unit Effort pepper fish resources (Leiognathus splendens) landed at PPN Karangantu.

Table 5. Comparison of the results of estimating peppercorn stocks using the four models

Variabel	Model				Satuan
	Schaefer	Fox	WH1	WH2	
F_{MSY}	4791	2591	3221	10888	*Trip*
Y_{MSY}	529	563	607	909	Ton
F_{JTB}	0.2209	3626	-	-	*Trip*
Y_{JTB}	423	450	486	728	Ton

R^2	79%	87%	44%	37%	•

D. CONCLUSION

The estimation model for fish resource stocks of peperek fish (Leiognathus splendens) selected is the Fox (1970) model with stock status over exploited and the management recommendation is not to increase the number of fishing efforts (fishing gear units or fishing trips). Sustainable reserve stock (Be) of peppercorn (Leiognathus splendens) at the current stock condition is 510.15 tons/year.

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