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CHARACTERISTIC OF ECO-BIOLOGYCAL AND ECONOMIC VALUE OF WEDGEFISH (RHYNCHOBATUS AUSTRALIAE) IN TANJUNG LUAR, EAST LOMBOK

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ABSTRACT

White Spotted Wedgefish (Rhynchobatus australiae) is one of the member Elasmobranch family which is categorized as an endangered species. The R. australiae is the main target by fishers in Tanjung Luar and Maringkik Island. This study was aimed to analyze ecobiological aspect and to estimate economical incentive value of R. australiae fisheries in Tanjung Luar. The Total of 616 samples were collected from Tanjung Luar Fishing Port from 2017-2021, consisting of 64 males and 552 females. Total 150 fisher respondents from Tanjung Luar and Maringkik Island were interviewed. R-Studio software was used to estimate the ecobiological aspects based on life history parameters. Contingent Valuation Method (CVM) and Discrete Choice Experiment (DCE) were used to estimate economical incentive. The result show that the average length of R. australiae was 213,12 ± 2,63 (cmTL) which is accordance with the regulation. However, the sample of R. australiae was dominated by immature size fish. The growth rate of female R. australiae was lower and have a longer lifespan than male. The condition of R. australiae in Tanjung Luar waters was categorized as biological overfishing. The value of Total Willingness to Pay (WTP) for R. australie conservation was Rp11.226.000/month, whereby the value for individual was Rp.62.340/person. Education and income are the most significant variables affecting WTP.

Keywords: *Rhynchobatus Australiae; Insentif; Willingness To Pay; Tanjung Luar*

INTRODUCTION

Indonesia is one of the largest shark and ray producing countries in the world with an average production of 106,034 tons / year or 13% of world production in 2000-2011(Dent & Clarke, 2015). East Lombok Regency is one of the areas whose waters contribute greatly to the catch of sharks and rays in West Nusa Tenggara. Tanjung Luar Fish Landing Base (PPI) is one of the shark and ray fishery centers in Indonesia, and Tanjung Luar PPI is famous as the starting point for elasmobranch landings in Indonesia (Wahyudin et al., 2019). Pandrung rays (*Rhynchobatus australiae*) are the most caught stingray species in Tanjung Luar PPI and almost all parts of their body can be used. Pandrung fins have a market value of 1.6-2 million rupiah for fins measuring 40 cm / kg and the lowest price is in the range of 200 to 400 thousand rupiah for those measuring 12-15 cm / kg (Dharmadi & Fahmi, 2017; Dharmadi & Kasim, 2010; Fahmi & Dharmadi, 2013).

According to Mutaqqin *et al*. (2018), the fin part has the main destination of shipment to Hong Kong, Singapore, and Malaysia, the bone and dry skin part is shipped to China, and the meat part is shipped to Sri Lanka and Singapore in 2018. All parts of the body of Pandrung rays can be utilized. Based on *the Conservation of Migratoy Species of Wild Animals* (CMS) in 2017, the pandrung ray (*Rhynchobatus australiae*) is included in the Appendix II category and in 2019 was included in the *IUCN (*International Union for Conservation of Nature*) Red List* in the *Critically Endangered (CR*) category). The classification of this threatened species shows that the level of consumption of pandrung rays in Tanjung Luar has reached an alarming stage .

In particular, management efforts that refer to the protection of a species can refer to *life history parameters* that can be used in assessing the availability of fish stocks as information related to the condition of the threat of the ray. These parameters can be total landing data, total fish length data, and gender. The results of analysis on ecobiological aspects can be used to find out how fish should be caught and fish that should be returned to nature assuming that if the fish are released and left alive, it will produce new offspring to maintain the fish population in nature(Faizah & Chodrijah, 2020).

Providing economic incentives to stingray capture fisheries actors which is an alternative solution to overfishing. The incentives are expected to make fishermen voluntarily and happy to divert their catch targets. According to (Bahamondes, 2003), incentive can be interpreted as an ability that can shape a person's desire (*willingness and attitute*). This approach can be used to determine the estimated rupiah value that respondents are willing to obtain these goods (Setyawan et al., 2020). According to (Prasetyawati et al., 2018), the willingness value of each individual obtained from the questionnaire can be accumulated into a holistic population value measured in Rupiah (Rp). Based on the above problems, this study aims to analyze ecobiological aspects based on *life history parameters* and estimate the value of economic incentives in Tanjung Luar which is expected to be the latest breakthrough to various agencies related to policy strategies in an effort to protect sustainable pandrung rays.

RESEARCH METHOD

Location and Time of Research

The research was conducted at two locations, namely in Tanjung Luar village and Maringkik Island, East Lombok District, West Nusa Tenggara (Figure 1). The research was conducted from October 2020 to December 2020.

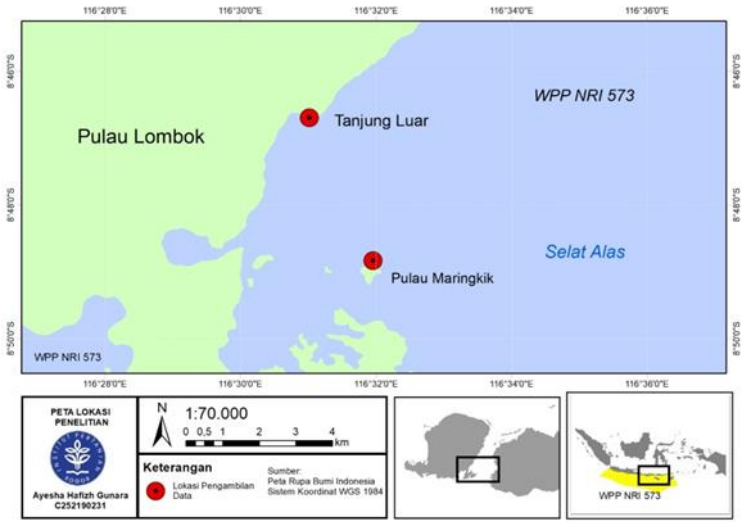

Figure 1 Research Location

Data Collection

As many as 150 ray shark respondents became the target of informants from various scenarios which were carried out directly at the research location. Most of the respondents referred to (Ahmad & Halim, 2017), That is, from a population of 180 people, the number used was as many as 123 respondents which was then rounded up to as many as 150 respondents. Primary data collection is carried out by providing several questions referring to questionnaires that have been arranged in such a way with the selection of respondents randomly selected (Suryatati et al., 2020). This questionnaire uses 4 interview scenarios, namely: B.A.U (Business as usual), Carrot (Positive Incentives / Giving Gifts), Stick (Negative Incentives / Punishment), Non monetary carrot (in the form of scholarships), which are aimed at priority species, namely pari pandrung. Secondary data were obtained through the Wildlife Conservation Society (WCS). Rstudio software version 4.1.2 (TropFishR package library; FSA; car; DPRLYR; magrittr; nlstools; lessR; PerformanceAnalytics; psych) and Ms. Excel is used to quantitatively analyze the data that has been obtained both primary and secondary data.

Data Analysis

1. Ekobiologists Pari Pandrung

Ecobiological analysis of Pandrung rays uses an approach based on *life history parameters*. The parameters used are growth parameters, theoretical age estimation, natural mortality and total mortality. The calculation of the growth of the stingray is carried out following the Von Bertalanffy equation as follows :

$$L_t = L_\infty (1\text{-}e^{[-K(t-t0)]})$$

Information:
L_t = The length of the fish at the time of life t (unit of time) ,
L_∞ = asymptotic width theoretically,
K = Growth coefficient (per unit time),
t_0 = The theoretical lifespan at the time of the length of the fish is equal to zero.
The estimation of theoretical age (t_0) was done with Paully's empirical equation (1980):

$$t_0 = t_{max} - (2{,}9957/K)$$

Where $t_{max} \approx 3/K$
Information:
K = growth coefficient (per unit time),
t_0 = The theoretical lifespan at the time of the length of the fish is equal to zero.
tmax = lifespan by the time the length of the fish reaches its maximum width (L_{max})

Maximum fish length (L_{max}) is generally achieved about 95% of the length of asymptotic fish (L_∞) (Beverton 1963 in Pauly 1980). Natural mortality can be estimated using Pauly's (1980) empirical formula as follows: :

$$\text{Log } M = -0{,}0066 - 0{,}279 \log L_\infty + 0{,}6543 \log K + 0{,}4634 \log T$$

Information:
M = Natural mortality,
L_∞ = asymptotic width theoretically,
K = growth coefficient (per unit time),
T = average water temperature (^{0}C).

The estimation of total mortality (Z) was carried out using the *length converted catch curve* method in the R *software* package. The calculation of the utilization rate (E) is obtained from the values of suspected natural mortality (M) and arrest mortality (F). The formulaic approach of these values refers to Pauly 1980 as follows: :

$$E = \frac{F}{F + M}$$

The stock is already overcaptured (E > 0.5) or not yet (E < 0.5), assuming that the optimal E value (E opt) is 0.5. The use of E ~ 0.5 as the optimal value for the exploitation ratio of a stock is based on the assumption that a balanced yield is optimal when F = M (Gulland 1971).

2. Economic Incentives

a. Contingent Valuation Method (CVM)

In estimating economic incentives, the Contingent Valuation Method (CVM) is used. Contingent assessment analysis is a direct economic assessment of ecosystem services by providing several questions related to one's willingness to pay (Yulianto,

2019). The calculation of the total value of willingness to pay pari pandrung fishermen in Tanjung Luar is calculated using the formula (Hasiani, 2013):

$$TWTP = \sum_{i=1}^{n} WTP\, i \left(\frac{n_i}{N}\right) P$$

TWTP = Σ WTP
WTP i = Willingness To Pay individual sample to- i
ni = The total number of i-th samples who are able to pay is the value of Willingness To Pay
N = Total sampel
P = Total populasi nelayan pari
i = Narasumber ke- i yang bersedia membayar (i = 1, 2,.., n)

b. Discrete Choice Experiment (DCE)

In the analysis used the Random Utility Model (RUM) approach by (Jin et al. 2006) sebagai berikut:

1. $Uij = Vij + \mathcal{E}ij$
2. Vij = α + β1KDPI + β2DN + β3PI + βs Individual characters + βcBID

Furthermore, to calculate WTP, the following equation is used::

$$WTP = \frac{\beta zi}{\beta c}$$

RESULT AND DISCUSSION

Ekobiologists Pari Pandrung

Data on the total length of pandrung rays landed at PPI Tanjung Luar obtained from the *Wildlife Conservation Society* (WCS) amounted to 616 individuals (64 males and 552 females), with lengths varying each year. The minimum and maximum catch length of fish landed is 100 cm and 315 cm (213.12 ± 2.63 cm).

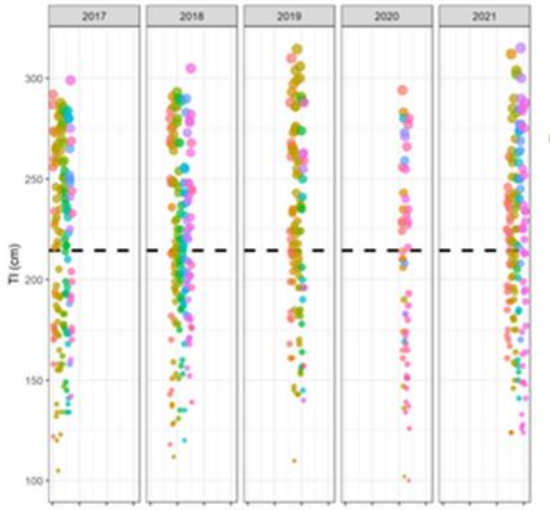

Figure 2 Long frequency distribution of pandrung rays in 2017 – 2021

Based on Figure 2. in 2017, 2018, 2019, 2021 data were obtained that the catch of pandrung rays (R. australiae) was above the average length (213.22 cm) and only a few were below average. Unlike other years, in 2020 it showed long results with the same total catch length.

1. Growth of male fish

Based on the results of the analysis of growth parameters (L∞ and K) directly calculating the value of t0, it is known that the equation of Von Bertalanffy male pandrung stingray (*R. australiae*) is L_t = 302 (1-$e^{[-0.18(t+3.04)]}$). The growth curve of male fish shows that the male pandrung ray population will reach its maximum age by the time it reaches the age of 13.6 years (Figure 3).

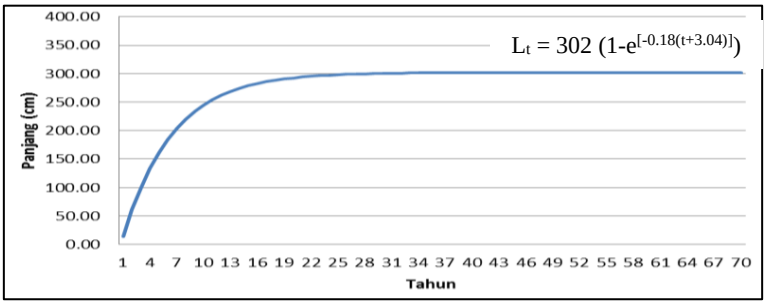

Figure 3 Growth curve of male pandrung stingrays

2. Growth of Female Fish

Based on the results of the analysis of growth parameters (L∞ and K) directly calculating the value of t0, it is known that the equation of Von Bertalanffy female pandrung stingray (*R. australiae*) is Lt = 328.13 (1-$e^{-0.21(t-0.04]}$). The growth curve of female fish shows that the population of female pandrung rays will reach their maximum age when they reach the age of 14 years (Figure 4).

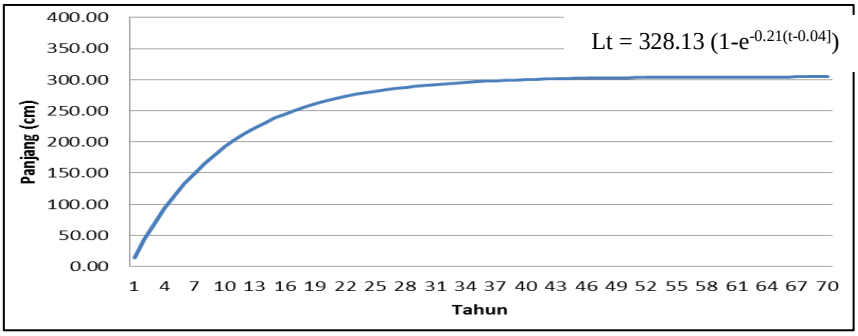

Figure 4 Growth curve of female pandrung stingrays

Catch Conditions

Based on the results of the analysis, 2017 to 2021 showed a decrease in the relative total length of fishermen landed at PPI Tanjung Luar (Figure 5) in the period from February to April, the period from May to August there was an increase in the length of fish caught and there was a decrease in size in the September period and increased again in October to November and relatively decreased in December.

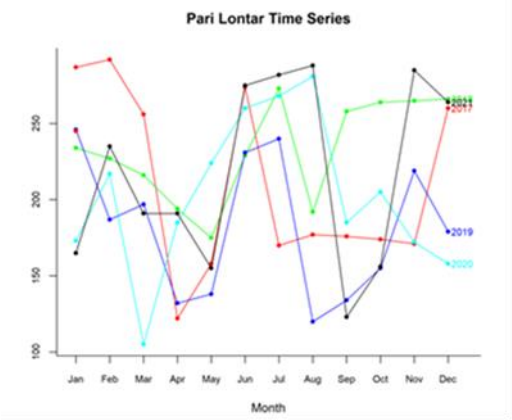

Figure 5 Time series data plot of total length of pandrung stingrays (R. australiae) landed at PPI Tanjung Luar in 2017-2021

Catch pattern based on total length of pandrung stingrays (R. australiae) for 5 years (Figure 6) shows the frequency of length of fish caught in 2017 there was a fluctuating decrease in the size of fish catches until mid-2019 to 2020 and tended to increase the frequency of length of fish caught in 2020 to the end of 2021.

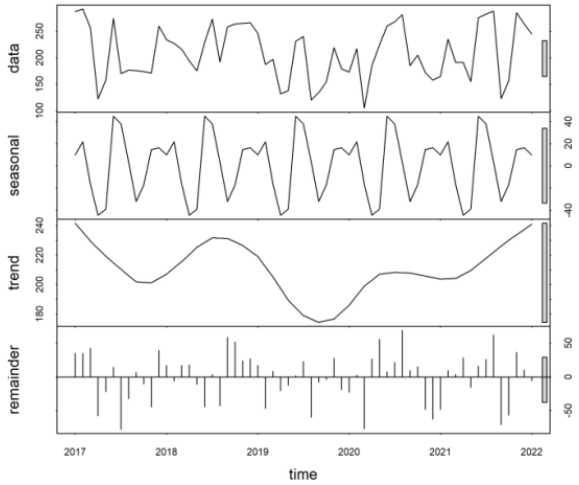

Figure 6 Plot trend of pandrung ray catches landed at PPI Tanjung Luar in 2017-2021

Mortality and rate of exploitation (E)

Based on the results obtained, it is known that the natural mortality value (M) obtained is smaller than the capture mortality value (F) (Table 1). So that the results show that the value of the exploitation rate of pandrung rays (R. australiae) in Tanjung Luar in 2017-2021 has been indicated in overexploited conditions. This is because the value of the exploitation rate (E) exceeds the optimum exploitation rate of 0.5 and the mortality of pandrung rays (R. australiae) is predominantly due to fishing rather than natural mortality.

Table 1 The Rate of Exploitation of Pandrung Rays in Tanjung Luar in 2017-2021

Parameter	Value per-year
Total Mortality (Z)	0.59
Natural Mortality (M)	0.21
Arrest Mortality (F)	0.38
Rate of Exploitation (E)	0.65

From the results obtained from Table 1. Then it was done by estimating the total mortality rate constant (Z) of pandrung rays (R. australiae) which was carried out using a catch curve based on long data (Figure 7).

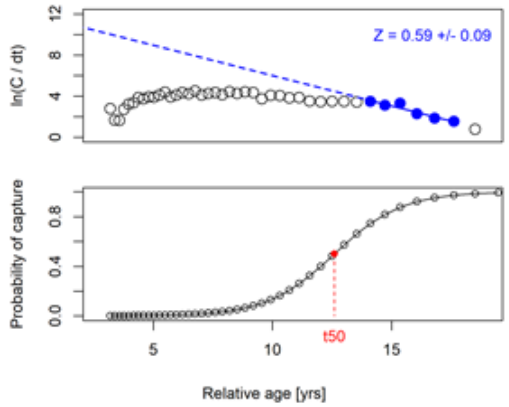

Figure 7 Pandrung ray capture curve (R. australiae) in Tanjung Luar Year 2017-2021

Estimation of Pari Pandrung Economic Incentives

1. Contingent Valuation Method (CVM)

According to the results obtained related to the estimation of incentives as an effort to manage pandrung rays in Tanjung Luar are very varied. Of the total population of stingray shark fishermen who are still active in fishing, 180 people were used as many as 150 respondents in assessing the willingness to pay fishermen. The nominal offered starts from Rp. 20,000 to Rp. 100,000, the majority of respondents stated that if the nominal offered is Rp. 100,000 it will be burdensome for their economy, so the majority of respondents take the value of willingness to pay Rp. 50,000 (Table 2).

The level of willingness to pay the most chosen is Rp 50,000, which is 59% of respondents with the least selected nominal of Rp 25,000 as many as 1% of respondents. The total amount of willingness to pay from the entire Tanjung Luar stingray fishing population is Rp 11,226,000 per month, with an average of Rp 62,340 per month per person (Table 2). The determination or selection of the WTP value is obtained by determining the nominal amount that has been carried out by a previous willingness to pay survey, namely the highest nominal of Rp. 100,000 and the lowest nominal of Rp. 20,000 using game bidding techniques.

Table 2 The total value of willingness to pay pandrung ray fishermen

WTP (Rp) (w)	Number of respondents (n)	Percentage (%)	Population (P)	Total (Rp) W(n/N)P
20.000indv^{-1}	12	8.00	180	288.000
25.000indv^{-1}	2	1.00		60.000
30.000indv^{-1}	8	5.00		288.000
50.000indv^{-1}	74	49.00		4.440.000
75.000indv^{-1}	11	7.00		990.000
100.000indv^{-1}	43	29.00		5.160.000
Total	**150^{N}**	**100**	**180**	**11.226.000**
Average				**62.340/indv**

2. Discrete Choice Experiment (DCE)

Conditional logit regression analysis was chosen as the Dicrete Choice Experiment method because this method can explain all independent variables having a significant number of no more than α = 5%. These variables are (DN) or Impact on Fishermen and (DH) or Impact on prices with both having a significance value of 0.00 (Table 3)

Table 3 Regression Test Results

Choice	Coefficients	Std. Error	z-value	Pr(>|z|)	[95% Conf. Interval]	
ASC	0,486	0,5869	0,83	0,408	-0,6644	1,6361
KDPI	0,2094	0,1751	1,20	0,232	-0,1338	0,5527
DN	4,0680	0,239	16,96	0,00***	3,598	4,5381
DH	6,9982	0,4112	17,02	0,00***	6,1922	7,8043
BID	-7,36e-06	6,72e-06	-1,09	0,274	-.0000205	5,82e-06
Log Likelihood: -322,3366						
Number of iterations: 9						
Prob > Chi^2: 0,000						
Pseduo-R^2: 0,8592						

The results obtained from Table 3 are then calculated through the value of the regression coefficient to obtain the value of willingness to pay :

$$\text{Logit (p)} = 0{,}4858374 + 0{,}2094583 + 4{,}068079 + 6{,}998296 - 7{,}36\text{e-}06$$

$$\text{WTP} = \frac{0{,}2094583 + 4{,}068079 + 6{,}998296}{-7{,}53\text{e-}06}$$

$$= \text{Rp}1.532.043$$

In using the preferred experimental method, the results of the model calculation were obtained which showed the value of respondents' total willingness to pay Rp1,534,856.

3. Comparison of Contingent Valuation and Discreate Choice Incentives Model

Based on the results of the two methods, it is obtained that the total nominal price for willingness to pay obtained for the Contingent Valuation (CV) method is Rp. 11,226,000 with an average value of Rp. 62,340 / individual / month. In the Discrete Choice Model (DCE), the total value of willingness to pay for conditional logistics regression is Rp. 1,532,043 with an average of Rp. 8,500/individual/month (Table 4).

Table 4 Comparison of CVM and DCE values

No	Method	Total WTP ($Rp.Tahun^{-1}$)	Total WTP ($Rp.Bulan^{-1}$)	Average (Rp/Bulan/Individu)
1	CVM	134.712.000	11.226.000	62.340
2	DCE	18.384.516	1.532.043	8.500

CONCLUSION

The condition of pandrung fishery stocks in Tanjung Luar has experienced biological overfishing and has been overexploited. The total willingness to pay Tanjung Luar fishermen was Rp. 11,226,000 per month with an average of Rp. 62,340 / individual / month in the use of the CVM method, and Rp. 1,532,043 per month with an average of Rp. 8,500 / individual / month in the use of the DCE method.

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