Submission letter

Article title: "**Bioeconomic model of largehead hairtail fisheries (*Trichiurus lepturus*) in Cilacap waters, Central Java, Indonesia as an approach to fisheries management** "

Name of the authors: Fajar Hermawan, Suharyanto, Mulyono S Baskoro

Hereby I would like to submit the manuscript entitled "**Bioeconomic model of largehead hairtail fisheries (*Trichiurus lepturus*) in Cilacap waters, Central Java, Indonesia as an approach to fisheries management** " to Aquaculture, Aquarium, Conservation & Legislation - International Journal of the Bioflux Society.

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All authors

Name :

Fajar Hermawan Dr.Suharyanto Prof. Mulyono S Baskoro, Ph.D.

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Review 1

Bioeconomic model of largehead hairtail fisheries (Trichiurus ~~lepterus~~lepturus) in ~~cilacap~~ Cilacap waters, ~~central~~ Central ~~java~~Java, Indonesia as an approach to fisheries management

[1]Fajar Hermawan, [2]Suharyanto, [3]Mulyono ~~Sumitro~~ S. Baskoro

[1]Department Fishing Technology, Faculty of Utilization Fisheries Resources, Jakarta Fisheries University, Jakarta, Indonesia; [2]Departement Fishing Technology, Faculty Fishing Technology Jakarta Fisheries University, Jakarta, Indonesia; [3]Faculty of Fisheries and Marine Science, Bogor Agricultural University, Bogor, Indonesia. Corresponding author: ~~Fajar~~ F. Hermawan, fjr.hermawan@gmail.com

Abstract. ~~The management of small scale fisheries gives its stakeholders complexity. One of the products produced in this fishery is layur fish (trichiurus lepterus). is one of the important value commodities which is T~~The main fishery product~~production~~ in Cilacap district is the largehead hairtail (*Trichiurus lepturus*), a high value added commodity. The environmental management of small scale fisheries does not lack complexity, under economic imperatives, and it should be~~However, the management has not been~~ carried out properly, by considering factors like ~~looking at~~ the size of the fishing gear, the uncertainty of the catch and the trips number, which ~~that~~ tends to increase. ~~Fishermen are very hunting for layur fish~~ have a marked preference for *T. lepturus*, ~~because~~ due its elevated price on the international trade markets, under a strong demand pressure~~the selling value is high following high export demand~~. The study aims to provide a sustainability management tool based on the evaluation of ~~a simulation simulation covering calculations about~~ the catch per unit effort (CPUE)~~CPUE~~, the Fishing Power Index, the Maximum Sustainable Yield (MSY), the Maximum Economic Yield (MEY) and the actual conditions. The results ~~showed~~ suggested an ~~that the~~ MSY value ~~was~~ of 505,300 kg/year and an optimal effort ~~(~~(F_{opt}~~)~~) of 24,139 trips, a~~the~~ MEY value ~~was~~ of 497,098 kg/year tons and its corresponding effort of F_{Mey} 21,064 trips. MSY profits were ~~of~~ 844,591~~,~~.46 USD and MEY profits were ~~of~~ 860,343~~,~~.61 USD.

Key Words: Cilacap waters, Gill net, Hairtail fish, Bioeconomic aproach, MSY, MEY.

Introduction. Cilacap is one of the legal ~~regency~~ regencies located in the south of ~~central~~ Central Java ~~Province~~ province which is a center ~~for~~ of fishery activities~~ies~~ (capture fisheries and aquaculture). This ~~area~~ is a minapolitan area~~city~~ established by the Ministry of Maritime Affairs and Fisheries (MMAF). Cilacap ~~sea~~ coastal area is part of the Fisheries Management Area Republic of Indonesia (FMA RI-573), with ~~there are~~ many types of ~~damersal~~ demersal fish ~~with~~ having various density structures ~~in these area. The most~~ and a dominant species, ~~damersal fish is~~ the largehead hairtail ~~fish~~ (~~trichiurus~~ *Trichiurus* ~~lepterus~~*lepturus*) (Suman et al 2014). Based on~~-~~ the ~~Minister~~ Ministry of Maritime Affairs and Fisheries decree No. 47 of 2016, *T. lepturus* ~~the~~ exploit~~utiliz~~ation rate has reached ~~by~~ the maximum authorized limit~~fully exploited category~~.

The carrying capacity of the region has a~~is~~ ~~very~~ significant potential, the coastline length of 103 km ~~is~~ being much longer than in ~~the~~ other districts~~, in~~ from the eastern part of Kebumen Regency (52 km), Purworejo Regency (32 km) and Pangandaran Regency (91 km), situated ~~in~~ at the ~~west~~West. ~~It~~ The potential is directly proportional to~~,~~ the number of fishing vessels and to the number of ~~fisherman~~fishermen, and it generates~~. A good thing because it can open up~~ employment opportunities. In exchange, fisheries management ~~but also~~ can be a real challenge, as the main priority is to keep ~~in fisheries management so that~~ fish

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Review 1

resources ~~remain~~ in a sustainable condition without reducing the local fishermen livelih~~o~~oods. Many large rivers pass through the area and there is an sea inlet, the ~~sea~~ "Segara Anakan", which determines ~~making it~~ an ecosystem ~~area~~ with ~~for~~ a ~~the~~ large number of fish and other marine life. ~~in these water area~~. The area of magrove land coverage in Cilacap reaches 2618 Ha (Pangesti et al 2012), ~~–~~which is suitable as a nursery ground area, being ~~and~~ a habitat for ~~damersal~~ demersal fish (including ~~hairtail fish~~*T. lepturus*) and shrimp, species living ~~. This fish located more like in a~~ the muddy zones of river mouths ~~and muddy base~~ (Nakamura & ~~parin~~ Parin 1993; Badrudin & Wudianto~~,~~ 2004).

T. lepturus~~Hairtail fish become~~ became a high-value commodity on both ~~in~~ the domestic and export markets, ~~. This fish is highly hunted~~and consequently a preferred target ~~by~~ for ~~fisherman~~ fishermen, due to: (1) a high export demand and a diversified processing~~diversification~~, adding ~~of layur processing (dried fish, boiled and other processed fish) which has high~~ economic value. and (2) a catch season ~~by~~during most of the year, ~~which is even though with a smaller amount~~ even if the fish population is reduced during the fish famine season. However, ~~It must also be used as~~ a standardized reference ~~for stakeholders so that the~~is necessary for the *T. lepturus* exploitation control ~~of layur fishes still pay attention to the rules of responsible~~ and sustainable fishing.

T. lepturus ~~Hairtail~~ fishing in Cilacap Regency is operated~~carried out with~~through various ~~fishing operation~~ methods, ships and fishing gears. ~~But it has not been managed well looking at the various types of models and sizes of vessel used are diferent.~~ Small scale fisheries ~~has~~ are identified by their simple technology, having limited capital assets and depending on the catch season. Fisheries management ~~is needed with~~should consider that~~ation of~~ fish resources ~~that~~ are renewable but the process is ~~not too short~~rather slow, therefore an ~~management~~ approach ~~with~~ based on time series data provides a more accurate assessment, avoiding ~~. The management approach has to based on~~ the fish resources depletion, while the ~~and still pay attention to~~ fisheries business is still preserved~~es,~~ and ~~avoid~~ social conflicts avoided. ~~with fisheries management policies that are carried out.~~ Uncertainty patterns ~~Trends~~ in the catches ~~products~~ productivity trends ~~that are uncertain~~ and ~~depend on the~~ its seasonal dependence ~~of fish give an illustration that fisheries need to be managed that way is by using~~ demonstrate the need of appropriate policies promoting environmentally friendly fishing gear, fishing trip arrangements, open close season, zoning arrangements for fishing areas, supervision of fisheries resources by the government (~~nickyjulluw~~ Nickyjulluw 2012).

T. lepturus ~~Hairtail fish~~ can be caught with various fishing gear namely gill net, payang and arad. The three of them have different sensitivity in catching fish with a different number~~s~~ of fishermen:~~,~~ the gill net ~~fishermen~~ team numbered 2-3 people ~~/~~ per boat, the payang 10-15 people and the arad 3-4 people. The benefits for each fishing gear are ~~different~~limited, ~~by~~ in a sustainable management ~~a~~ bioeconomic approach ~~that is expected to provide a permanent and sustainable management~~ related to~~of~~ the *T. lepturus*~~hairtail~~ fisheries.

Fisheries management conducted by the government ~~has~~ have not yet been comprehensive and still tend~~s~~ to remain unchanged, giving the difficulties ~~for fishermen~~ to achieve ~~fishermen who are prosperous~~ prosperity and fair revenues among fishermen. The ~~concept of~~ Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY) ~~is~~ are ~~a~~ basic concepts ~~part~~ in determining fisheries policy. ~~in an area with a~~ ~~F~~fisheries production database (with ~~caeth~~ catch and effort time series) ~~secondary data (time series)~~ ~~is~~ are the more accurate in estimating fish abundance ~~in an area,~~ allowing the calculation of an annual cumulative balance of the fish resource. ~~because it inherits data from year to year.~~ ~~So in carrying out development aspects of the potential of fish resources is the main thing that is the key to success in developing sustainable fishing. That way it is hoped that fisheries management can be carried out on target.~~ Other studies ~~management approaches use~~suggest the ecosystem management approach (Airlangga et al 2018), the Rapfish method (Hutapea et al 2019), the quota output approach using the Total Allowable Catch (TAC) (Widagdo et al 2019).

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Review 1

The current research analyzed the Catch Per Unit Effort (CPUE), optimum effort, catch MSY, MEY, profit, total revenue, total cost of *T. lepturus*. Considering that each~~the~~ fishing trip is expected to provide~~will have~~ an economic benefit~~impact~~, a~~n~~ MEY ~~economic~~ approach ~~(MEY) is important to be carried out~~was performed for a cost efficiency evaluation, ~~.~~ but the priority remained the ~~This article contains the importance of~~ controll~~ing~~ of the catch effort, like fishing trips number and duration, or gear. ~~and other efforts in fisheries management~~ as suggested by ~~(~~Widodo ~~and~~ & Suadi 2006~~)~~. ~~In this reseach writer has analyzed the Cacth Per Unit Effort (CPUE), effort optimum, cacth MSY, MEY, profit, total revenue, total cost of hairtail fish.~~

Material and Method. This research used the survey descriptive method. Material research cover ~~all of~~ *T. lepturus*~~hairtail~~ catch and efforts ~~in~~ reported by the auction fish centers ~~sites that land at~~of the Cilacap fishing port. The data on the~~f~~ *T. lepturus*~~hairtail~~ catches, ~~which~~ collected for~~on~~ this research, focused on small-scale fisheries with 1 day fishing duration~~time~~, without using~~ed~~ auxilliary engine ~~with same~~, excepted the native ~~of~~ vessel engint, according to the ~~spesification~~specification. In this study there are 2 types of data, namely primary data and secondary data. Primary data were obtained from questionnaires with fishermen, direct observation and interviews. Secondary data was obtained through the collection of the Cilacap fisheries department's annual report literature from 2013-2018, presenting all combined production and effort data from all fish auction sites (TPI) and Cilacap Ocean Fisheries Port.

Research location and time. The study was conducted in the Cilacap district, Central Java Province in July-October 2019.

Data analysis. ~~the data analyzed are data~~ Catch effort and production annual time series data for *T. lepturus* catches were collected from the Cilacap district fisheries service for the past 6 years (2013-2018). ~~consisting of production data for layur fish catches (*trichiurus lepterus*) and effort attempts based on anual time series data. The data that~~, then it ~~is~~was processed in depth ~~is to look for~~and complemented by information extracted from fishermen through questionnaires and, finally, it was validated~~ion~~ directly ~~to~~ at the fish auction marketplace (TPI) and by direct observation ~~to~~ on the gill net vessels, at the research location. Equipment ~~Ship type~~ is ~~limited~~ restricted to the type of gill net with a mesh size of 1.75 inches to 2.5 inches, ~~danish~~Danish seine "payang" and ~~danish~~Danish seine "arad". The data ~~is~~ are ~~then~~ combined ~~with data~~ from the Cilacap district marine and fisheries service and ~~data at~~from the Cilacap ocean fishery port (PPS). Data analyzed were the *T. lepturus* CPUE ~~layur fish~~, MSY and F_{MSY}, MEY and F_{MEY}.

Catch per unit effort (CPUE). The data needed for the CPUE calculation is the catch data and the capture attempt data. ~~Effort~~ The effort is ~~the~~ reflected by the the number of ships and~~number of~~ fishing gear used ~~in~~ during the fishing trip period ~~a certain time through several options, namely the number of ships, the number of fishing trips, the~~ (number of days at sea). In this research, the effort data used are trip fishing data of gill net ~~and danish~~Danish seine "payang" and~~,~~ Danish seine "arad", ~~because it is~~ in accordance with the conditions in the field. ~~, that is if by using the~~ If only the number of vessels was used as surrogate for the effort, ~~every ship in one year has different fishing trips, this will cause~~a bias ~~for~~ would be induced in the estimation of these~~se~~ fish resources: vessels could use various gear, making the fishing trips different, in terms of efficiency. So the CPUE is calculated~~ion~~ by dividing the total ~~catch~~ capture with the catch per trip (Sparre ~~and~~ & Vanema 1998;~~,~~ Widodo ~~and~~ & Suadi 2006~~,~~; Fauzi ~~A~~ 2010).

~~the~~The ~~matematis~~mathematic formula is as follows:

$$CPUE = \frac{Ci}{Fi}$$

Where:

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Review 1

CPUE : Catch Per Unit Effort
C : Total number of total catches of the fishing fleet per unit of time
F : Jumlah upaya penangkapan dari satu armada tangkap per satuan waktu Number of capture attempts of the fleet from one fishing trip per unit of time

Fishing power index (FPI). The highest value of CPUE is defines the standard CPUE. Each fishing gear has different capabilities in catching *T. lepturus*hairtail fish catching capabilities and , so it needs to be standardized, based on. Standardization of fishing gears will result in the value of the Fishing Power Index (FPI). The fishing gear with the highest FPI value can be used as the standard or reference. In general, the fishing gear with the highest CPUE value has FPI value of 1. The FPI value of other fishing gears can be calculated by dividing the CPUE value of the fishing gear with the standard CPUE of the fishing gear. The mathematical formula mathematically is presented as follows:

$$CPUEi = \frac{Ci}{Fi} r = 1,2,3 \dots p$$

$$CPUEs \frac{Cs}{Fs} \; s = 1,2,3 \dots Q$$

$$FPI \frac{CPUEi}{CPUEs} \; i = 1,2,3 \dots K$$

Where:
P = standardized fishing gear;
Q = standard fishing gear;
K = type of fishing gear;
$CPUE_r$ = total catch (catch) per catch effort (effort) from r fishing gear that will be standardized (tons/trip);
$CPUE_s$ = total catch (catch) per catch effort (effort) from fishing gear s which is used as a standard (ton/trip);
FPI_i = fishing power index of i capture devices (standardized and standard capture devices).

Maximum sustainable yield (MSY). Formula of the surplus production model only apply if the slope parameter (b) is negative, ; if it is positive, then stock estimation or optimum effort cannot be made, but it can only be concluded that fishing can still increase fishing efforts. The surplus production method according to Schaefer (1954), the effort and catch relationship produces a symmetrical parabolic curve (Zulbainarni 2012).

$$MSY = \frac{a^2}{4b}$$

$$Fopt \frac{-a}{2b}$$

The magnitude of a and b can be searched using the equation:

$$a = y - bx$$

$$b = \frac{n.\sum xy - \sum x.\sum y}{n.\sum x^2 - (\sum x)^2}$$

Where:
a = intersepintercept;
b = slope;
x= effort;
y= CPUE.

Comment [WU15]: Use simple text, not tables.

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Comment [WU16]: Put index r instead of i.

Comment [WU17]: Put sign "=".

Comment [WU18]: Put sign "=",FPI_i instead of FPI and $CPUE_r$ instead of $CPUE_i$.

Comment [WU19]: Please take the time to clarify the selected text and also to correct the mathematical expressions and variables definitions.

Comment [WU20]: Sign "="

Comment [WU21]: Please include an explanatory section. Who is "n". Develop the expressions interpretation and explain why is this optimum "sustainable", for example where is the link with the carrying capacity? We understand that there is a relationship defining the yield per effort unit, but this is only a purely economic consideration, without any environmental reference (to the fish population or reproduction rate or maturation rate, for example).

Review 1

Maximum economic yield (MEY). The bioeconomic model used is ~~a~~ static ~~model~~, in which the determination of the cost of fishing and the price of fish is fixed. The model used is the ~~gordon~~Gordon-~~schaefer~~ Schaefer model. ~~Calculations with a database in the dominant TPI with layur fish~~ ~~L~~landing *T. lepturus* ~~are~~ calculations were based on data selected from database records for the dominant TPI, the Fish Auction Place (TPI) Jetis, PPSC, at Pandanaran~~,~~ and Sentolo kawat, ~~-~~ which were published by the Cilacap Fisheries Agency (DKP Cilacap). This model is stated as a function of the capture effort. The assumptions underlying this model are: (1) changes in the level of output (production) do not affect the price, because the fishery analyzed is one of ~~a~~ the ~~number~~ numerous~~of~~ small fisheries, (2) there is ~~freedom~~ no restriction in ~~to participate~~ initiating or stopping the attempts ~~trying~~ to catch fish, (3) all natural conditions and biological relationships are constant, (4) selectivity of fishing gear does not change, and (5) there is a linear relationship between costs and the level of effort (Zulbainarni 2012).

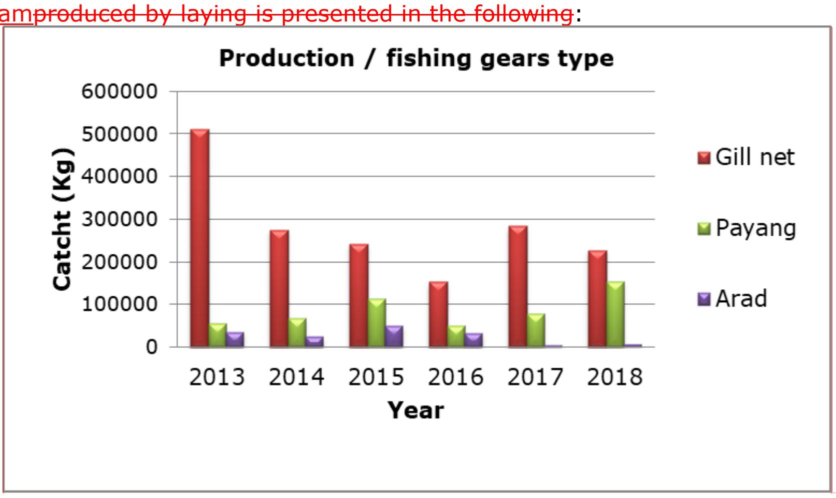
Wijayanto (2008)~~,~~ ~~formulates~~ expressed ~~conditions (~~MSY~~,~~ and MEY~~)~~ as depending on catch, effort, total revenue, total cost and profit conditions, according to the following formulas: ~~in tabulations to facilitate calculation and compare the two conditions.~~

Table 1~~.~~

Gordon-Schaefer ~~Equilibrium~~ equilibrium formulas

	MSY	*MEY*
Catch (C)	$a^2/4b$	$aF_{MEY} - b(F_{MEY})^2$
Effort (F)	$a/2b$	$(pa-c)/(2pb)$
Total revenue (TR)	$C_{MSY}*p$	$C_{MEY}*p$
Total cost (TC)	$c*E_{MSY}$	$c*E_{MEY}$
Profit	$TR_{MSY} - TC_{MSY}$	$TR_{MEY} - TC_{MEY}$

Results and Discussion. ~~Hairtail fish (*trichiurus*~~*T.* ~~*lepterus*~~*lepturus*~~)~~ production in 2013-2018 has fluctuated, with a tendency to decrease. The highest ~~*trichiurus lepterus*~~ production occurred in 2013 with a total of 603.48 tons. ~~in the following year production did not reach that number.~~ The research data shows that the gill net is the ~~most~~ dominant fishing gear, optimal for a ~~specifically a fishing gear that catches Hairtail fish~~*T. lepturus* ~~as a~~ targeted capture~~catch target~~, while in the payang and arad fishing gear there can be found~~are~~ byproducts. From the capture fisheries statistics, 72% is the result of gill net fishing, while ~~the other~~ 22% ~~is~~ represents the payang catches~~,~~ and the remaining 7% correspond to the~~is~~ arad catches. Overall, the production of *T. lepturus* ~~hairtail fish (trichiurus lepterus)~~ in ~~cilacap~~ Cilacap waters ~~experiencing~~ experienced uncertainty and ~~higly~~ significant fluctuationsed, as shows~~.~~ the ~~Histrogram~~ Figure 1 histrogram~~produced by laying is presented in the following~~:



Comment [WU22]: In what year? Harmonize the references from the list with the text, to be easily identified.

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Comment [WU25]: Please include a legend to the table, explaining all the variables / coefficients symbols, and also a section / paragraph for the interpretation of these relationships. Explain step by step how did you use them in your work and the progression towards your results, in a clear manner and a scientific English.

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Comment [WU26]: Correct "catch", instead of "catcht".

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Figure 1. Histogram of *T. lepturus* ~~hairtail~~ production in the ~~cilacap~~ Cilacap waters between 2013-2018.

Fishing power index. The ~~f~~Fishing power index was used to determine the ~~make~~ standard effort.~~,~~ ~~so that in~~ For correctly predicting the abundance of ~~Cmax~~ fish, the maximum total catch (C_{max}) and the optimum ~~Effort~~ effort ~~done correctly~~, the fishing gear that ~~is~~ should have ~~constantly with~~ a constant ~~stable~~ CPUE value, which is the rationale of using ~~is the net net, then the net net becomes the~~ standards for the fishing gear. The calculation results are found in ~~the following table~~ Table 2:

Comment [WU27]: Please include a section where you explicitly present the calculation or estimation of the "abundance of fish". Did you mean "abundance of fish" (in the fishing zone waters) or total catch (amount of captured fish)?

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Table 2

Production, fishing effort (trip), CPUE of ~~hairtail fish (*trichiurus*~~ *Trichiurus* ~~*lepterus*~~*lepturus*~~)~~

Year	Gill net			*Danish seine "Payang"*			*Danish seine "Arad"*		
	Catch (kg)	*Effort (Trip)*	*CPUE (kg/trip)*	*Catch (kg)*	*Effort (Trip)*	*CPUE (kg/trip)*	*Catch (Kg)*	*Effort*	*CPUE (kg/trip)*
2013	511,813	20490	22~~,~~.66	56031	7097	7~~,~~.90	35632	7869	4~~,~~.53
2014	274,992	24484	11~~,~~.23	67075	7678	8~~,~~.74	24736	7302	3~~,~~.39
2015	242,095	23746	10~~,~~.20	113507	12633	8~~,~~.98	50398	7768	6~~,~~.49
2016	152,749	24037	6~~,~~.35	49703	4734	10~~,~~.50	33108	9668	3~~,~~.42
2017	284,184	26520	10~~,~~.72	79179	8420	9~~,~~.40	5604	1412	3~~,~~.97
2018	227,085	22972	9~~,~~.89	153781	3861	39~~,~~.83	6971	3402	2~~,~~.05

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~~Tabel~~Table 3

Value of Fishing Power Index (FPI)

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Year	*Fishing Power index (FPI)*			*Effort standard*			*Total effort*
	Gill net	*Danish seine (Payang)*	*Danish seine (Arad)*	*Gill net*	*Danish seine (Payang)*	*Danish seine (Arad)*	
2013	1	0~~,~~.35	0~~,~~.20	20490	2473	1573	24536
2014	1	0~~,~~.78	0~~,~~.30	24484	5972	2202	32658
2015	1	0~~,~~.88	0~~,~~.64	23746	11133	4943	39823
2016	1	1~~,~~.65	0~~,~~.54	24037	7821	5210	37068
2017	1	0~~,~~.88	0~~,~~.37	26520	7389	523	34432
2018	1	4~~,~~.03	0~~,~~.21	22972	15557	705	39234

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~~Tabel~~Table 4.

Standarization data on *Trichiurus lepturus* ~~hairtail~~ fishing efforts

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Year	*Total ~~Catch~~catch (Kg)*	*Effort ~~Standarized~~standarized (Trip)*	*CPUE (Kg/Trip)*
2013	603476	24536	22~~,~~.66
2014	366803	32658	11~~,~~.23
2015	406000	39823	10~~,~~.20
2016	235560	37068	6~~,~~.35
2017	368967	34432	10~~,~~.72
2018	386627	39234	9~~,~~.89
Average	394572	34625	11~~,~~.84

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Review 1

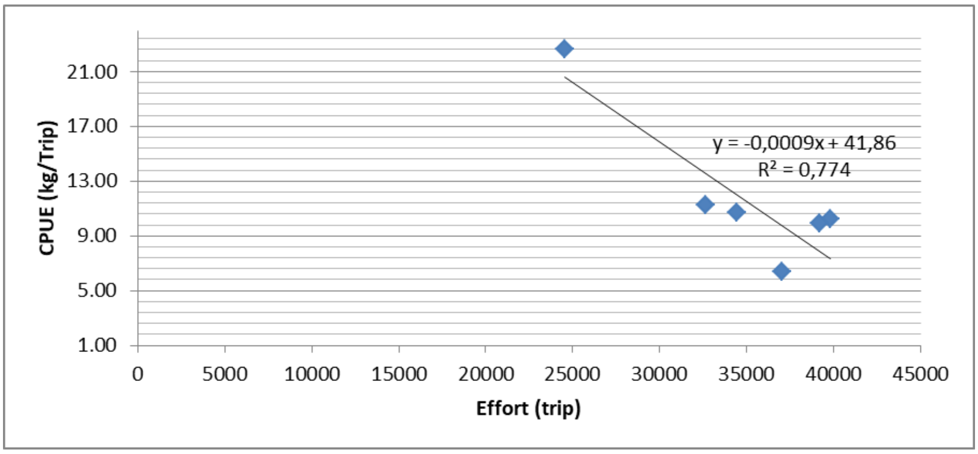

Figure 2. CPUE Correlation correlation CPUE and with the Effort.

Correlation between CPUE and effort. CPUE values illustrate the trend in catch productivity in the Cilacap district. Correlation analysis results show a negative relationship where each additional effort will reduce the catch per unit effort. R^2 = 0.740 indicates that effort gives an effect of 74% on fishing production and the rest is due to other factors, such as the ecosystem species abundance, the weather conditions and other parameters.conditionss,. The marginal efficiency a = 0,.0009 indicates that each addition of 1 attempt will reduce the catch by 0,.0009 kg, while the constant b = 41.86 means that in absence of an incrementation of the catch if there is no attempts, to the capture per attempt the (CPUE) reaches its maximum value of 41.86 kg. The results of the negative correlation analysis between CPUE and Effort effort means suggests that every additional fishing effort of fishing effort will reduce the catch.

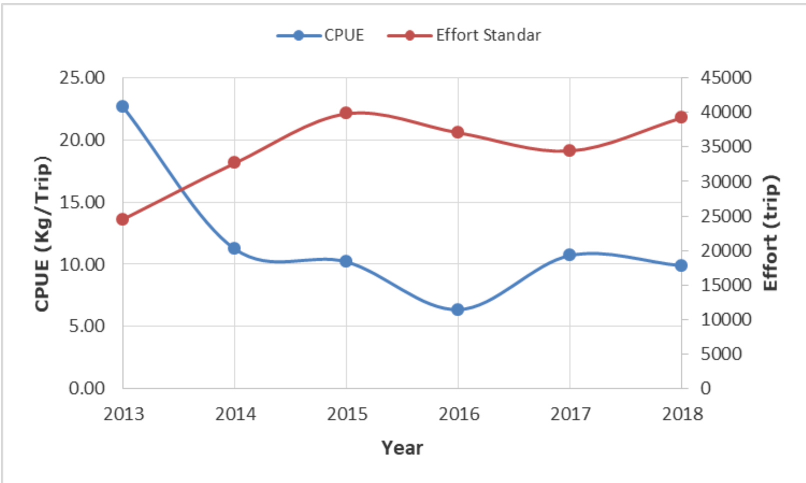

Figure 3. CPUE relation with effort concerning hairtail fish (*trichiurus Trichiurus lepterus lepturus*) exploitation.

MSY and F_{Opt}. The results of calculations using the Schefer equation get the MSY results in the amount of 505,300 kg / 505.30 Tons for the MSY, with a Fmsy F_{MSY} value of 24,139 Triptrips. From The calculations using the Schefer equation return value the

Comment [WU30]: There is no reference made in the text regarding this figure.

Comment [WU31]: Your interpretation is unclear: for almost 25,000 trips (for the year 2013), you have a CPUE of around 22.66 kg/trip (from your table of the standardized values of CPUE). Why do you refer to a maximum CPUE of 41.86 kg? Why is the number of trips correlated with the yield per trip? The causal factors of the fluctuations of the marginal efficiency of a trip are related to the gear technology (numbers of hooks used, kilometers of nets used, vessel capacity, …), to the time spent fishing, to the fish abundance at the fishing spot, to the season,… What is the reason to study the influence of the number of trips on the fishing efficiency per trip. There might exist correlation patterns, but this might be a coincidence and yet, for a sample of 8 values, the correlation test might be irrelevant. Correlation is not causation and a function of the marginal CPUE dependence cannot be built on the number of trips increment: the concept is ill defined. Please take your time to review this part of the study. There are no other assumptions related to the other parameters (fish resource depletion, weather or season, gear change). Supposing they are constant, please explain how can the sole number of trips increment reduce or increase the efficiency of the unit of effort? We would rather admit that a decrease of the efficiency per trip would determine the decrease of the number of trips and, eventually, the abandon of the fishing spot on the basis of assumptions related to the fish population dispersion.

Comment [WU32]: There is no reference made in the text regarding this figure.

Comment [WU33]: Please correct "Effort Standar" with "Effort standard", in the graphic representation legend.

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Review 1

results of the tabulation in 2014-2018 the capture journey has exceeded the optimal Fmsy or Fopt journey. Laying fisheries successfully MSY can be concluded in Figure 4.

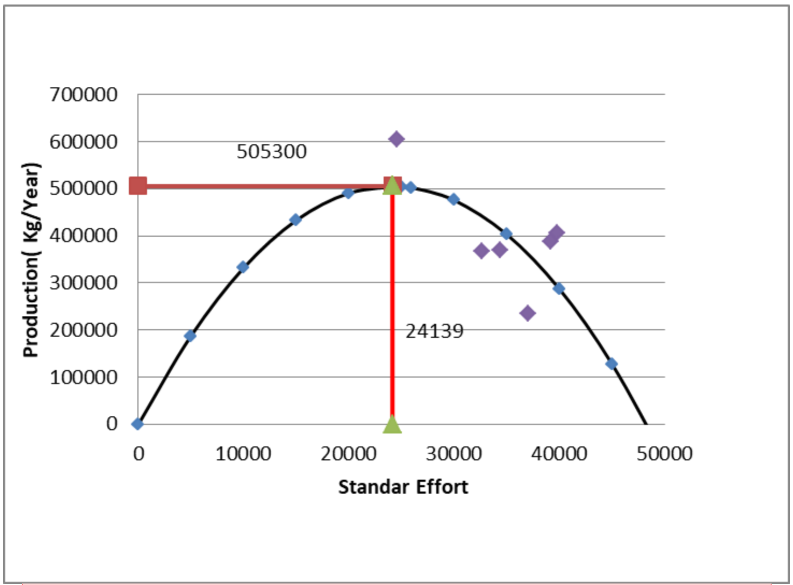

Figure 4. ~~hairtail fish (*trichiurus* ~~*Trichiurus* ~~*lepterus*~~*lepturus*~~)~~ MSY.

Bioeconomic approach. The MSY and MEY points are a reference to the fisheries management approach based on the catches, that exist in ports and other fish landing sites in an area. The MSY approach provides an impact of leeway on resources, economic efficiency approaches and the effectiveness of fishing trips, so the MEY approach is used. ~~Actual conditions are conditions that describe the current condition of hairtail fish (*trichiurus lepterus*) in Cilacap Regency.~~

~~Tabel~~Table ~~4~~5.
Calculation of values from MSY, MEY and Actual Condition

	MSY	*MEY*	*AKTUAL*
Catch (C) (kg/Year)	505,300	497,098	310,272
Effort (F) (Trip)	24,139	21,064	39,765
Total ~~R~~revenue (USD)	1,109637~~,~~.32	1,091626~~,~~.01	903,137~~,~~.88
Total ~~C~~cost (USD)	265,045~~,~~.86	231,282~~,~~.4	436,619~~,~~.1
Profit (∏) (USD)	844,591~~,~~.46	860,343~~,~~.61	244,737~~,~~.28

~~From the table above~~Table 5 shows that the highest profit value is found at the MEY point with a total profit of 860,343~~,~~.61 USD, while at the MSY point the profit is 844,591~~,~~.46 USD. The ~~A~~actual ~~condition Price~~ price obtained from the ~~survey results to~~ gill net fishermen survey results~~in Cilacap district~~, the average fish price in Cilacap district is 2.2 USD~~-~~/~~-~~kg, while the cost incurred for an average of 1 fishing trip is 10.98 USD~~-~~/~~-~~trip. The results of the calculation show that, at the MSY ~~e~~Efforts of 24,139 trips, the level of profit gained was 1,111,660 USD per year,~~11.53 billion at effort 24,139 and at~~for a capture of 505,300 kg~~/~~per~~-~~year~~,~~. ~~W~~with the MEY model approach ~~from~~ the ~~calculation of~~ calculated profits ~~obtained~~ wereas 860,343~~,~~.61 USD on trip 21,064.

Comment [WU34]: 2013?

Comment [WU35]: Please take the time to explain clearly, in a scientific manner and using the appropriate English language, in order to make this paragraph understandable. Also, please do not forget to define F_{MSY}. What is the difference between F_{OPT} and F_{MSY} ?

Comment [WU36]: "Standar Effort" ? please correct.

Comment [WU37]: Please rephrase, this statement is not intelligible.

Comment [WU38]: Please correct.

Review 1

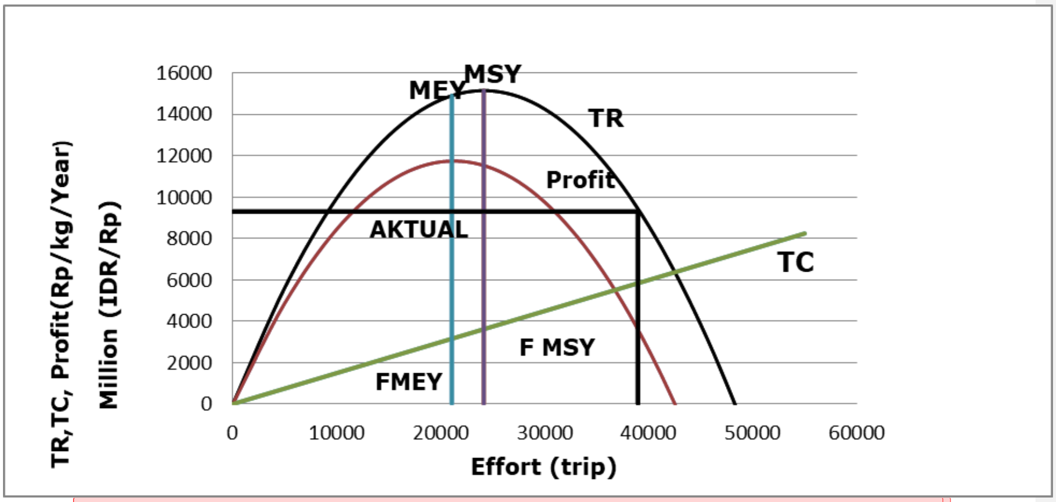

Figure 5. ~~bieoconomic~~ Bio-economic curve ~~gordon~~ Gordon–~~schaefer~~Schaefer.

T~~From t~~he bioeconomic equilibrium curve in Figure 5 provides a view for relevant stakeholders in ~~making~~ polic~~y~~ies making. The first indicator of decreasing fish resources is a decrease in CPUE value from year to year, when the annual production value exceeds the MSY point limit and~~,~~ the number of trips exceeds F_{MSY} and F_{MEY}.

Conclusions. ~~Value of maksimum profit obtained from Total Revenue (TR)- total Cost (TC) , IDR 1091626,01 USD – 265045,86 USD= 860343,61 USD.~~The MSY approach recommendations provide the threshold for a balance of resources and production, while the MEY approach provides the threshold for a higher efficiency with an optimal effort. ~~with fewer trips, Catching~~In the current study scenario, the ~~–~~catching effort has not passed the MSY point, but the trip of over–capacity in laying fisheries in Cilacap is characterized by an excess of effort, which is ~~far~~ not adjusted to the optimal effort values,~~from the~~ F_{OPT} and F_{MEY} ~~values~~. ~~It is necessary~~The policy strategy suggested by the study results would be to reduce the number or the capacity of vessels and fishing gear. ~~Other management approaches use the ecosystem approach (Airlangga et al 2018), the quota output approach using total allowable catch (TAC) (Widagdo et al 2019).~~

Acknowledgements. ~~Thank you~~Special thanks are addressed~~, the authors,~~ to all the staff of the Cilacap fisheries service and to the stakeholders of~~in~~ the capture fisheries sector, as well as to the ~~ministry~~ Ministry of Maritime Affairs and Fisheries (MMAF) of ~~affair and fisheries~~ Republic of Indonesia, which~~o~~ has founded this research.

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Badrudin ~~&~~, Wudianto, ... Biology, ~~Habitat~~habitat, and fish ~~distribusion~~distribution of hairtail fish the distribution of fish and some aspects of fisheries, Co Fish Project~~.~~ 13 ~~P~~p.

Cilacap Sea fishing Port (PPSC Cilacap) anual report for 2013-2018.

Department Fisheries Cilacap Regency (Government Agency) annual report for 2013-2018.

Decree of Ministry of Marine Affairs and Fisheries, Republic of Indonesia, No. 18 of 2014 regarding Fishieries managemen area , republic Indonesia.

Comment [WU39]: Please adjust the figure to your calculations. Also, please use a legend to define the symbols (TC, TR) in full words.

Comment [WU40]: Please correct "AKTUAL"..

Comment [WU41]: Please give a detailed and clear interpretation.

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Comment [WU42]: In this section, please resume your research outcomes, without making references to other studies. You can move this phrase to the introduction.

Comment [WU43]: Is this the correct reference? https://pdfs.semanticscholar.org/7f4e/7546198f19d32cac7b524b853a872d91f6f9.pdf?_ga=2.33008894.1948692835.1560199053-1387998330.1560199053 Please check and make the necessary corrections.

Comment [WU44]: Year.

Comment [WU45]: Distribution of....the distribution? Please provide the link/source of this reference.

Review 1

Decree of Ministry of Marine Affairs and Fisheries, Republic of Indonesia, No. 46 of 2016 on Status, stock , Estimation of Potential Fish Resources in the Territory of the Republic of Indonesia Fisheries Management.

Fauzi A., 2010~~.~~ Fisheries ~~Economics~~economics. Policy and ~~Management~~ management ~~Theory~~theory. Gramedia Pustaka Utama, Jakarta,~~.~~ 221 p.

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Zulbainarni N. 2012. Theory and Practice of Bioeconomic Modeling in Capture Fisheries Management. IPB Press ,Bogor, 310 p.

Comment [WU46]: Please mention these references in the text as well, for an easy identification.

Comment [WU47]: Please mention this reference in the text.

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Authors:
Fajar Hermawan, Jakarta Fisheries University, Faculty Utilization Fisheries Resources, Department Fishing Technology, 12520 Pasar Minggu, Jakarta, Indonesia, e-mail: fjr.hermawan@gmail.com
Suharyanto, Jakarta Fisheries University, Faculty Fishing Technology, Department Fishing Technology, 12520 Pasar Minggu, Jakarta, Indonesia, e-mail: suharyanto.jfu@gmail.com
Mulyono Sumitro Baskoro, Bogor Agricultural University, Faculty of Fisheries and Marine Science, 16680 Bogor, Indoneisa, e-mail: baskoro.mul@gmail.com

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Review 2

Bioeconomic model of largehead hairtail fisheries (Trichiurus lepturus) in Cilacap waters, Central Java, Indonesia as an approach to fisheries management

[1]Fajar Hermawan, [2]Suharyanto, [3]Mulyono S. Baskoro

[1] Department Fishing Technology, Faculty of Utilization Fisheries Resources, Jakarta Fisheries University, Jakarta, Indonesia; [2] Departement Fishing Technology, Faculty Fishing Technology, Jakarta Fisheries University, Jakarta, Indonesia; [3] Faculty of Fisheries and Marine Science, Bogor Agricultural University, Bogor, Indonesia. Corresponding author: F. Hermawan, fjr.hermawan@gmail.com

Abstract. The main fishery product in Cilacap district is the largehead hairtail (*Trichiurus lepturus*), a high value added commodity. The environmental management of small scale fisheries does not lack complexity, under economic imperatives, and it should be carried out properly, by considering factors like the size of the fishing gear, the uncertainty of the catch and the trips number, which tends to increase, have a marked preference for *T. lepturus*, due its elevated price on the international trade markets, under a strong demand pressure. The study aims to provide a sustainability management tool based on the evaluation of the catch per unit effort (CPUE), the Fishing Power Index, the Maximum Sustainable Yield (MSY), the Maximum Economic Yield (MEY) and the actual conditions. The results suggested an MSY value of 505,300 kg/year and an optimal effort F_{MSY} of 24,139 trips, a MEY value of 497,098 kg/year and its corresponding effort of F_{MEY} 21,064 trips. MSY profits were 844,591.46 USD and MEY profits were 860,343.61 USD.

Key Words: Status stock, CPUE, MSY, MEY, Fishing policy.

Introduction. Cilacap is one of the legal regencies located in the south of Central Java province which is a center of fishery activities (capture fisheries and aquaculture). This is a minapolitan area established by the Ministry of Maritime Affairs and Fisheries (MMAF). Cilacap coastal area is part of the Fisheries Management Area Republic of Indonesia (FMA RI-573), with many types of demersal fish having various density structures and a dominant species, the largehead hairtail (*Trichiurus lepturus*) (Suman et al 2014), and specifically in Cilacap water and its surrounding (Panggabean et al 2015; Apriliani et al 2018). Based on the Ministry of Maritime Affairs and Fisheries decree No. 47 of 2016, *T. lepturus* exploitation rate has reached the maximum authorized limit.

The carrying capacity of the region has a significant potential, the coastline length of 103 km being much longer than in other districts from the eastern part of Kebumen Regency (52 km), Purworejo Regency (32 km) and Pangandaran Regency (91 km), situated at the West. The potential is directly proportional to the number of fishing vessels and to the number of fishermen, and it generates employment opportunities. In exchange, fisheries management can be a real challenge, as the main priority is to keep fish resources in a sustainable condition without reducing the local fishermen livelihoods. Many large rivers pass through the area and there is an sea inlet, the "Segara Anakan", which determines an ecosystem with a large number of fish and other marine life. The area of magrove land coverage in Cilacap reaches 2618 Ha Pangesti et al 2015, which is suitable as a nursery ground area, being a habitat for demersal fish (including *T. lepturus*) and shrimp, species living the muddy zones of river mouths (Nakamura & Parin 1993). Eating habit of *T. Lepturus* is carnivor, because they eats damersal fish, shrimp and squid (Abidin et al 2013; Prihatiningsih & Nurulludin 2014).

Comment [WU1]: According to the international standards in scientific writing it is desirable to display 5 key words which do not appear in the title. This will increase findings via key words and implicit citations.
(Already corrected)

Comment [U2]: The addition of references to strengthen the argument (Pangabean et al 2015; Apriliani et al 2018) already mentioned in references)

Comment [WU3]: Not listed in the references.
(already mentioned in the reference)

Comment [U4R3]: Ministry of Maritime Affairs and Fisheries decree No. 47 of 2016

Comment [WU5]: Not mentioned in the reference list.
Pangesti et al 2015

Comment [U6R5]: Already mentioned in the reference

Comment [U7]: Reference addition

Review 2

T. lepturus became a high-value commodity on both the domestic and export markets, and consequently a preferred target for fishermen, due to: (1) a high export demand and a diversified processing, adding economic value. and (2) a catch season during most of the year, even if the fish population is reduced during the fish famine season. However, a standardized reference is necessary for the *T. lepturus* exploitation control and sustainable fishing.

T. lepturus fishing in Cilacap Regency is operated through various methods, ships and fishing gears. This situation forces the fisheries manager to be wise and careful when making decision in maintaining the abundance of resource due to fishing pressure. Fisheries management should consider that fish resources are renewable but the process is rather slow, therefore an approach based on time series data provides a more accurate assessment, avoiding the fish resources depletion, while the fisheries business is still preserved and social conflicts avoided. Uncertainty patterns in the catches productivity trends and its seasonal dependence demonstrate the need of appropriate policies promoting environmentally friendly fishing gear, fishing trip arrangements, open close season, zoning arrangements for fishing areas, supervision of fisheries resources by the government (Nikijuluw 2012).

T. lepturus can be caught with various fishing gear namely gill net, Danish seine "payang "and Danish seine "arad". According to Facrudin & Hudring (2014) gill net is the most ecofriendly fishing gear than danish seine "payang" and danish seine "arad". It catches fish selectively based on the mesh size and has species target. On the other hand, payang and arad are not selective in *T.lepturus* fishing. Both fishing gears have very small mesh size, and fish caught are still small (immature) even jouvenil. So it is not based on Code of Conduct for Responsible Fisheries (CCRF) FAO (1995.The three of them have different sensitivity in catching fish with a different number of fishermen: the gill net team numbered 2-3 people per boat, the payang 10-15 people and the arad 3-4 people. The benefits for each fishing gear are limited, in a sustainable management bioeconomic approach related to the *T. lepturus* fisheries.

Fisheries management conducted by the government have not yet been comprehensive and still tend to remain unchanged, giving the difficulties to achieve prosperity and fair revenues among fishermen. The Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY) are basic concepts in determining fisheries policy. The concept of the bioeconomic approach was first introduced by Gordon in 1954 Other studies suggest the ecosystem management approach (Airlangga et al 2018), the Rapfish method (Hutapea et al 2019), the quota output approach using the Total Allowable Catch (TAC) (Widagdo et al 2019).

The current research analyzed the Catch Per Unit Effort (CPUE), optimum effort, catch MSY, MEY, profit, total revenue, total cost of *T. lepturus*. Considering that each fishing trip is expected to provide an economic benefit, a MEY approach was performed for a cost efficiency evaluation, but the priority remained the control of the catch effort, like fishing trips number and duration, or gear. as suggested by Widodo & Suadi 2006.

Material and Method. This research used the survey descriptive method. Material research cover *T. lepturus* catch and efforts reported by the auction fish centers of the Cilacap fishing port. The data on the *T. lepturus* catches, collected for this research, focused on small-scale fisheries with 1 day fishing duration, without using auxilliary engine, excepted the native vessel engine, according to the specification. In this study there are 2 types of data, namely primary data and secondary data. Primary data were obtained from questionnaires with fishermen, direct observation and interviews. Secondary data was obtained through the collection of the Cilacap fisheries department's annual report literature from 2013-2018, presenting all combined production and effort data from all fish auction sites (TPI) and Cilacap Ocean Fishery Port.

Research location and time. The study was conducted in the Cilacap district, Central Java Province, Indonesia in July-October 2019.

Comment [WU8]: This phrase is redundant.
(Already corrected)

Comment [U9]: Already corrected

Comment [WU10]: Nikijuluw in the reference list, check the correct form.

Comment [U11]: Already corrected (Nikijuluw)

Comment [U12]: (Reference addition) Facrudin & hudring (2014), FAO 1995 has been mentioned in referense

Comment [WU13]: Please justify this statement, by explaining in a clear way and in a proper English.
(Already corrected)

Comment [WU14]: Not mentioned in the reference list.

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Comment [U17]: 2019 (already corrected)

Review 2

Data analysis. Catch effort and production annual time series data for *T. lepturus* catches were collected from the Cilacap district fisheries service for the past 6 years (2013-2018), then it was processed in depth and complemented by information extracted from fishermen through questionnaires and, finally, it was validated directly at the fish auction marketplace (TPI) and by direct observation on the gill net vessels, at the research location. This research is restricted by using Equipment fishing gears such as gill net with a mesh size of 1.75 inches to 2.5 inches, Danish seine "payang" and Danish seine "arad". The data are combined from the Cilacap district marine and fisheries service and from the Cilacap Ocean Fishery Port (PPSC) 2018. Data analyzed were the *T. lepturus* CPUE , MSY and $F_{MSY,}$ MEY and F_{MEY}

Catch per unit effort (CPUE). The data needed for the CPUE calculation is the catch data and the capture attempt data. The effort is reflected by the the number of ships and fishing gear used during the fishing trip period (number of days at sea). In this research, the effort data used are trip fishing data of gill net Danish seine "payang" and Danish seine "arad", in accordance with the conditions in the field. If only the number of vessels was used as surrogate for the effort, a bias would be induced in the estimation of the fish resources: vessels could use various gear, making the fishing trips different, in terms of efficiency. So the CPUE is calculated by dividing the total capture with the catch per trip (Sparre & Vanema 1998; Widodo & Suadi 2006; Fauzi 2010).The mathematic formula is as follows:

$$CPUE = \frac{C\,(i)}{F\,(i)}$$

Where:

CPUE : Catch Per Unit Effort in years (kg/trip);
i : Year;
C : Total number of total catches of the fishing fleet per unit of time;
F : Number of capture attempts of the fleet from one fishing trip per unit of time.

Fishing power index (FPI). The highest value of CPUE defines the standard CPUE. Each fishing gear has different *T. lepturus* catching capabilities and needs to be standardized, based on the value of the Fishing Power Index (FPI). The fishing gear with the highest FPI value can be used as the standard or reference. In general, the fishing gear with the highest CPUE value has FPI value of 1. The FPI value of other fishing gears can be calculated by dividing the CPUE value of the fishing gear with the standard CPUE of the fishing gear. The mathematical formula is presented as follows:

$$CPUE = \frac{Cs}{Fs}$$
$$FPIs = \frac{CPUEs}{CPUEs}$$
$$StdEffort\ i = FPIi\ x\ Fi$$
$$CPUEi = \frac{Ci}{Fi}$$
$$FPIi = \frac{CPUEi}{CPUEs}$$
$$StdEffort\ s = FPIs\ x\ Fs$$
$$StdEffort\ (total) = (\sum FPIi\ x\ Fi)) + (FPIs\ Fs)$$

Where:

Cs : The catch per year of standard fishing gear (kg);
Fs : The effort of catching per year of standard fishing gear (trip);
Ci : Catch per year other types of fishing gear (kg);
Fi : Attempts to effort per year other types of fishing gear (trip);
FPIs : Fishing Power Index standard fishing gear;
FPIi : Fishing Power Index of other types of fishing gear;
$CPUE_S$:Catch per capture per year of standard fishing gear (kg/trip);

Comment [WU18]: Limited due to a lack of capital or restricted by laws/rules?

Comment [U19]: The research limitation.

Comment [U20]: Mentioned in referense

Comment [WU21]: Please define the variable symbol in full letters, when used for the first time in the manuscript.

Comment [U22R21]: Already corrected based on the first manuscript. (F_{MEY})

Comment [WU23]: 1992 in the reference list, please check and correct.

Comment [U24R23]: Correct (1998)

Comment [WU25]: Put index r instead of i.
(Already corrected)

Comment [WU26]: Put sign "=".
(Already corrected)

Comment [WU27]: Put sign "=",FPI_i instead of FPI and $CPUE_r$ instead of $CPUE_{i.}$
(Already corrected)

Review 2

$CPUE_i$: Catch per capture per year of other types of fishing gear (kg/trip);
$StdEffort_s$: Fish cathing effort (trip) after standardization;
$StdEffort_i$: Other fishing gear after standardization;
StdEffort (total) : Over all capture effort after standardization.

Maximum sustainable yield (MSY). Formula of the surplus production model only apply if the slope parameter (b) is negative; if it is positive, then stock estimation or optimum effort cannot be made, but it can only be concluded that fishing can still increase efforts. The surplus production method according to Schaefer (1954), the effort and catch relationship produces a symmetrical parabolic curve (Zulbainarni 2012).

$$MSY = \frac{a^2}{4b}$$

$$F_{MSY} = \frac{a}{2b}$$

Where:
a = intercept;
b = slope in the linear regression equation.

Maximum economic yield (MEY). The bioeconomic model used is static, in which the determination of the cost of fishing and the price of fish is fixed. The model used is the Gordon-Schaefer model (Gordon 1954; Purwanto 1988; Zulbainarni 2012; Anna 2016). Landing *T. lepturus* calculations were based on data selected from database records for the dominant TPI, the Fish Auction Place (TPI) Jetis, PPSC, Pandanaran and Sentolo kawat, which were published in fisheries production data statistics report by Cilacap Fisheries Agency (DKP Cilacap) 2018 . This model is stated as a function of the capture effort. The assumptions underlying this model are: (1) changes in the level of output (production) do not affect the price, because the fishery analyzed is one of the numeroussmall fisheries, (2) there is no restriction in initiating or stopping the attempts to catch fish, (3) all natural conditions and biological relationships are constant, (4) selectivity of fishing gear does not change, and (5) there is a linear relationship between costs and the level of effort (Zulbainarni 2012).

According to Wijayanto (2008) stated bioeconomic approach included (MSY and MEY) as depending on catch, effort, total revenue, total cost and profit conditions) summarized in the following formulas:

Table 1

Gordon-Schaefer equilibrium formulas

	MSY	*MEY*
Catch (C)	$a^2/4b$	aF_{MEY} - $b(F_{MEY})^2$
Effort (F)	a/2b	(pa-c)/(2pb)
Total revenue (TR)	C_{MSY}*p	C_{MEY}*p
Total cost (TC)	C*F_{MSY}	C*F_{MEY}
Profit	TR_{MSY} - TC_{MSY}	TR_{MEY} - TC_{MEY}

Where :
a : Intercept;
b : Slope in the linear regression equation;
p : Fish price *T. lepturus* (kg/USD);
C : Cost of *T. lepturus* fishing per trip (USD);
TC : Total Cost *T. lepturus* fishing (USD/Year);
TR : Total Revenue *T. lepturus* fishing (USD/Year) .

Comment [WU28]: Please take the time to clarify the selected text and also to correct the mathematical expressions and variables definitions.

Comment [U29R28]: Already Correct

Comment [WU30]: Sign "=" (Already corrected)

Comment [U31R30]: Already corrected)

Comment [WU32]: Please include an explanatory section. Who is "n". Develop the expressions interpretation and explain why is this optimum "sustainable", for example where is the link with the carrying capacity? We understand that there is a relationship defining the yield per effort unit, but this is only a purely economic consideration, without any environmental reference (to the fish population or reproduction rate or maturation rate, for example).

Comment [U33R32]: Already Reevaluated

Comment [U34]: Mentioned in referense

Comment [U35]: Based on production data statistic report 2018

Comment [WU36]: In what year? Harmonize the references from the list with the text, to be easily identified.

Comment [U37R36]: 2018

Comment [U38]: 2018, mentioned in referense

Comment [U39]: This table is wijayanto formula 2008

Comment [WU40]: This table is not referred to/mentioned in the text.

Comment [U41R40]: Alredy corrected (base on wijayanto formula)

Comment [WU42]: The reference must be specified. (base on wijayanto formula)

Comment [U43R42]: (base on wijayanto formula)

Comment [WU44]: Please include a legend to the table, explaining all the variables / coefficients symbols, and also a section / paragraph for the interpretation of these relationships. Explain step by step how did you use them in your work and the progression towards your results, in a clear manner and a scientific English.

Comment [U45]: Caption for Table 1. (Wijayanto formula)

Review 2

Results and Discussion. *T. lepturus* production in 2013-2018 has fluctuated, with a tendency to decrease. The highest production occurred in 2013 with a total of 603.48 tons. The research data shows that the gill net is the dominant fishing gear, optimal for a *T. lepturus* targeted capture, while in the payang and arad fishing gear there can be found byproducts. From the capture fisheries statistics, 72% is the result of gill net fishing, while 22% represents the payang catches and the remaining 6% correspond to the arad catches. Overall, the production of *T. lepturus* in Cilacap waters experienced uncertainty and significant fluctuations, as shows the Figure 1 histrogram:

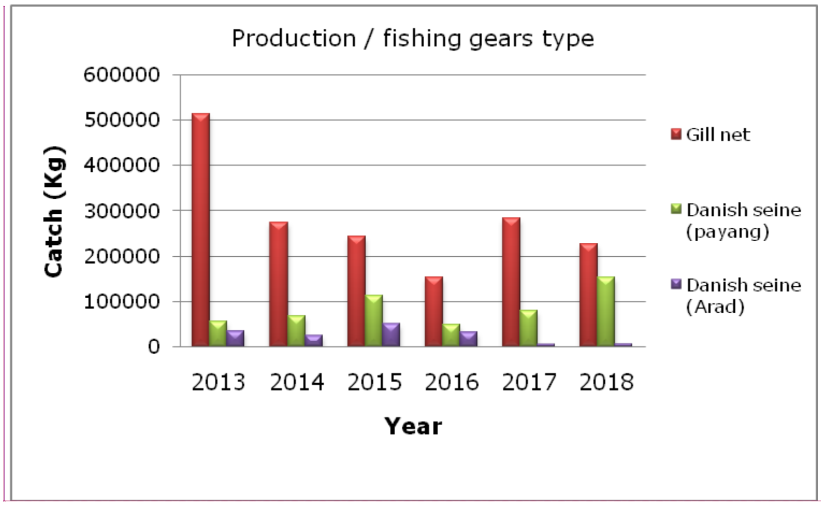

Figure 1. Histogram of *T. lepturus* production in the Cilacap waters between 2013-2018.

Fishing power index. The fishing power index was used to determine the standard effort. This calculation is necessary because each fishing gear has different capabilities in catching a spesies of fish. Therefore it is necessary to standardize fishing effort first the fishing gear that should have a constant CPUE and the highes value is the rationale of using standards for the fishing gear. The calculation results are found in Table 2, 3 and 4:

Table 2

Production, fishing effort (trip), CPUE of *Trichiurus lepturus*

Year	*Gill net*			*Danish seine "Payang"*			*Danish seine "Arad"*		
	Catch (kg)	*Effort (Trip)*	*CPUE (kg/trip)*	*Catch (kg)*	*Effort (Trip)*	*CPUE (kg/trip)*	*Catch (Kg)*	*Effort*	*CPUE (kg/trip)*
2013	511,813	20490	22.66	56031	7097	7.90	35632	7869	4.53
2014	274,992	24484	11.23	67075	7678	8.74	24736	7302	3.39
2015	242,095	23746	10.20	113507	12633	8.98	50398	7768	6.49
2016	152,749	24037	6.35	49703	4734	10.50	33108	9668	3.42
2017	284,184	26520	10.72	79179	8420	9.40	5604	1412	3.97
2018	227,085	22972	9.89	153781	3861	39.83	6971	3402	2.05

Based on the table above, there are three fishing gears to catch *T. lepturus* fishing (gill net, payang & arad). The gill net has a constant value to catch *T. lepturus* so it becomes a standard fishing gear. The highest CPUE value in 2013 was 22.66 kg / trip, the lowest CPUE value in 2016 was 6.35 kg / trip. The other fishing gears have lower CPUE value than the gill net.

Comment [WU46]: Correct "catch", instead of "catcht".

Comment [U47R46]: The figure has been changed

Comment [U48]: Already corrected

Comment [WU49]: Please include a section where you explicitly present the calculation or estimation of the "abundance of fish". Did you mean "abundance of fish" (in the fishing zone waters) or total catch (amount of captured fish)?

Comment [U50]: Explanation of table

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Table 3

Comment [WU51]: There is no reference made in the text regarding this table.

Value of Fishing Power Index (FPI)

Year	Fishing Power index (FPI)			Effort standard			Total effort
	Gill net	Danish seine (Payang)	Danish seine (Arad)	Gill net	Danish seine (Payang)	Danish seine (Arad)	
2013	1	0.35	0.20	20490	2473	1573	24536
2014	1	0.78	0.30	24484	5972	2202	32658
2015	1	0.88	0.64	23746	11133	4943	39823
2016	1	1.65	0.54	24037	7821	5210	37068
2017	1	0.88	0.37	26520	7389	523	34432
2018	1	4.03	0.21	22972	15557	705	39234

Table 3 explains that to get a standardized effort, the payang and arad trips are reduced according to the value of the fishing power index of each fishing gear so that a standard trip is obtained

Comment [U52]: Explanation of table 3

Table 4.

Comment [WU53]: There is no reference made in the text regarding this table.

Standarization data on *Trichiurus lepturus* fishing efforts

Year	Total catch (Kg)	Effort standardized (Trip)	CPUE (Kg/Trip)
2013	603,476	24536	22.66
2014	366,803	32658	11.23
2015	406,000	39823	10.20
2016	235,560	37068	6.35
2017	368,967	34432	10.72
2018	386,627	39234	9.89
Average	394,572	34625	11.84

Based on table 4 explains that the average catches of T. Lepturus in 2013-2018 was 394,572 kg/year, the highest in 2013 was 603,476 kg, the lowest in 2016 was 235,560 kg. The average capture trip was 34,625 trip /year and the average CPUE was 11.84 kg / trip. The catch value and CPUE fluctuated and tended to decrease.

Comment [U54]: Explanation of table 4

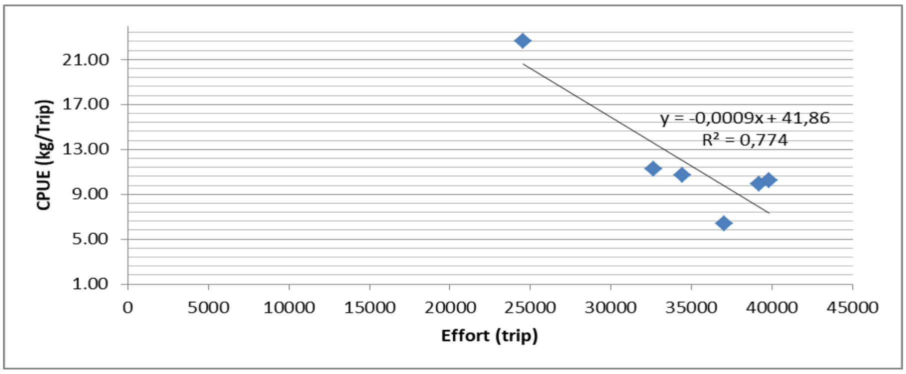

Figure 2. CPUE and effort relationship .

Comment [WU55]: There is no reference made in the text regarding this figure.

Based on the linear regression from figure 2, is obtained a constant value is 41,86 and the constant value b is - 0,0009, where "a" is intercept and "b" is Slope in the linear regression. To find out the assessment stock, the next step is to look at the relationship between CPUE and Effort. CPUE value of *T. lepturus* fishing experienced a negative productivity tendency, the results of the correlation analysis between CPUE and effort show a relationship where the addition of effort (trip) will decrease the catch.

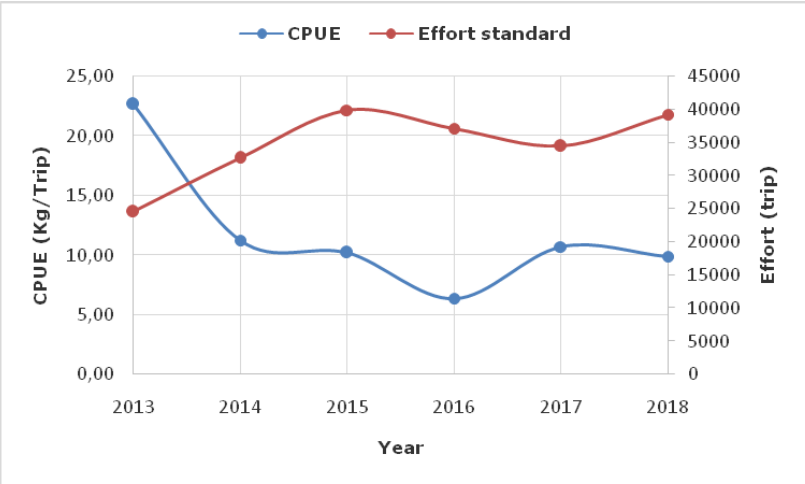

Figure 3. CPUE relation with effort concerning *Trichiurus lepturus* exploitation.

Based on Figure 3, CPUE condition and effort fluctuated, but the intensity of fishing effort (trip) tended to increase and CPUE value tended to decrease from 2013-2018. The intersection of CPUE line and standard effort occurred between 2013 and 2014, indicated that in that year there had been a decrease in catch as a result of increased fishing effort.

MSY and F_{MSY}. Maximum Sustainable Yield is the value of the highest catch and F_{MSY} is the maximum amount of fishing effort (fishing trips) produced as a limit to the safe stock of fish resources (Widodo dan Suadi 2006).Based on the linear regression from figure 2, is obtained value of a : 41,86 and value of b :- 0,0009 so that the MSY analysis and optimum effort (FMSY calculated as follows :

MSY = a²/4b
MSY = (41,86)² / 4*(0.0009)
= 505,300 kg/year
F_{MSY} = a/2b
= (41,86)/ 2 (0,0009)
= 24,139 trips.

Value MSY = 505,300 kg /year and F_{MSY} value of 24,139 trips. From The calculations using the Schefer equation is obtained value of the fishing effort has exceeded the optimal F_{MSY} , because the average annual trip yield (2013-2018) is 34,625 trip / year. The interpretation of MSY and F_{MSY} can be cancluded in Figure 4.

Comment [WU56]: Your interpretation is unclear: for almost 25,000 trips (for the year 2013), you have a CPUE of around 22.66 kg/trip (from your table of the standardized values of CPUE). Why do you refer to a maximum CPUE of 41.86 kg? Why is the number of trips correlated with the yield per trip? The causal factors of the fluctuations of the marginal efficiency of a trip are related to the gear technology (numbers of hooks used, kilometers of nets used, vessel capacity, …), to the time spent fishing, to the fish abundance at the fishing spot, to the season,… What is the reason to study the influence of the number of trips on the fishing efficiency per trip. There might exist correlation patterns, but this might be a coincidence and yet, for a sample of 8 values, the correlation test might be irrelevant. Correlation is not causation and a function of the marginal CPUE dependence cannot be built on the number of trips increment: the concept is ill defined. Please take your time to review this part of the study. There are no other assumptions related to the other parameters (fish resource depletion, weather or season, gear change). Supposing they are constant, please explain how can the sole number of trips increment reduce or increase the efficiency of the unit of effort? We would rather admit that a decrease of the efficiency per trip would determine the decrease of the number of trips and, eventually, the abandon of the fishing spot on the basis ...

Comment [U57R56]: my explanation is shortened. (the relationship CPUE and Effort with linear regression)

Comment [WU58]: There is no reference made in the text regarding this figure.

Comment [U59R58]: is a further explanation of figure 2

Comment [WU60]: Please correct “Effort Standar” with “Effort standard”, in the graphic representation legend.

Comment [U61R60]: Effort standard

Comment [U62]: Explanation of table 4

Comment [WU63]: Please take the time to explain clearly, in a scientific manner and using the appropriate English language, in order to make this paragraph understandable. Also, please do not forget to define F_{MSY}. What is the difference between F_{OPT} and F_{MSY} ?

Comment [U64R63]: Already corrected F_{MSY} & F_{OPT} (same). I will be consistent with F_{MSY} from the start page

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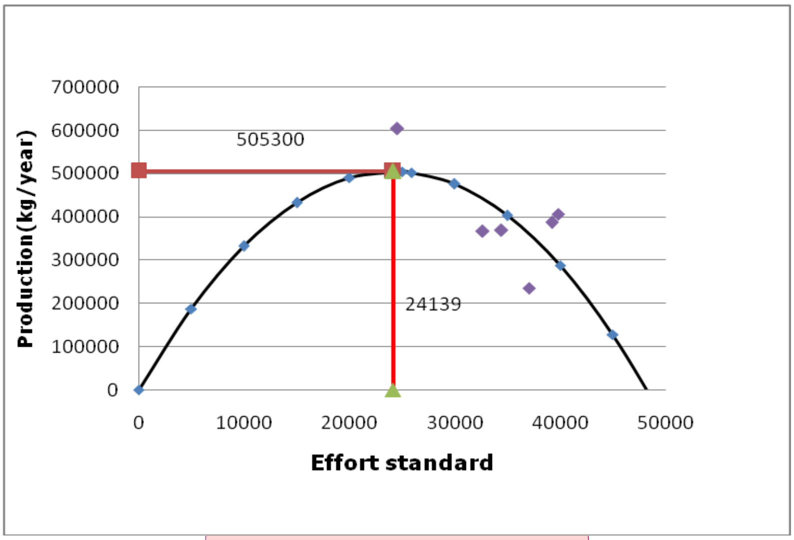

Figure 4. *Trichiurus lepturus* MSY.

Comment [WU65]: "Standar Effort" ? please correct.

Comment [U66R65]: already corrected Effort standard

Bioeconomic approach. The MSY and MEY points are a reference to the fisheries management approach based on the catches, that exist in ports and other fish landing sites in an area. The MSY approach provides an impact of leeway on resources, economic efficiency approaches and the effectiveness of fishing trips. Both conditions are simulation of fisheries management. Stakeholders and Fisheries managers can choose which approach to use depending on the condition of fish resources and the available fishing fleet. Actual condition is the conditions in the last year of production data collection, the three conditions are summarized in Figure 5.

Comment [WU67]: Please rephrase, this statement is not intelligible.

Comment [U68R67]: Already corrected

Table 5.

Calculation of values from MSY, MEY and Actual Condition

	MSY	*MEY*	*ACTUAL*
Catch (C) (kg/Year)	505,300	497,098	386,627
Effort (F) (Trip)	24,139	21,064	39,234
Total revenue (USD)	1,109637.32	1,091626.01	849,031.73
Total cost (USD)	265,045.86	231,282.4	430,788.73
Profit (∏) (USD)	844,591.46	860,343.61	418,243.00

Comment [WU69]: Please correct. ACTUAL (Already corrected)

Comment [U70R69]: ACTUAL

Table 5 shows that the highest profit value is found at the MEY point with a total profit of 860,343.61 USD, while at the MSY point the profit is 844,591.46 USD. The actual price obtained from the gill net fishermen survey results, the average fish price in Cilacap district is 2.2 USD/kg, while the cost incurred for an average of 1 fishing trip is 10.98 USD/trip. The results of the calculation show that, at the MSY effort of 24,139 trips, the level of profit gained was 844,591.46 USD per year, for a capture of 505,300 kg per year. With the MEY model approach the calculated profits were 860,343.61 USD on trip 21,064.

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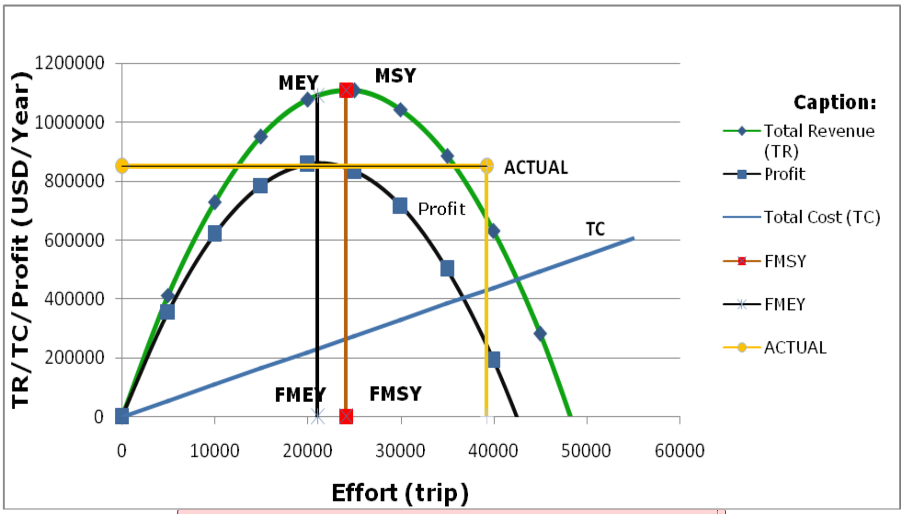

Figure 5. Bio-economic curve Gordon–Schaefer.

The bioeconomic equilibrium curve in Figure 5 provides a view for relevant stakeholders in policy making. The explanation of the picture above is the value of F_{MEY} to the left of the F_{MSY}, this condition shows that the catch trip approach in F_{MEY} is more profitable, because with fewer trip but resulting in greater profit, the actual condition in 2018 still has a profit of USD 418,243.00 with fishing effort (trip) 39234 /year. The *T.lepturus* fishing in Cilacap water, MEY condition is implemented better because of the diversity of fishing gears and fishing system used is a one day fishing. So economic benefit gained is getting reduced. The first indicator of decreasing fish resources is a decrease in CPUE value from year to year, when the annual production value exceeds the MSY point limit and the number of trips exceeds F_{MSY} and F_{MEY}

Conclusions. The MSY approach recommendations provide the threshold for a balance of resources and production, while the MEY approach provides the threshold for a higher efficiency with an optimal effort. In the current study scenario, the catching effort has not passed the MSY point, but the trip of overcapacity in laying fisheries in Cilacap is characterized by an excess of effort, which is not adjusted to the optimal effort values, F_{MSY} and F_{MEY}. The policy strategy suggested by the study results would be to reduce the number or the capacity of vessels and fishing gear.

Acknowledgements. Special thanks are addressed to Marine and Fishery Education Center, Ministry of Maritime Affairs and Fisheries (MMAF) of Indonesian Republic, which has founded this research and journal publication costs, as well as to all the staff of the Cilacap fisheries service and to the stakeholders of the capture fisheries sector.

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Comment [WU71]: Please adjust the figure to your calculations. Also, please use a legend to define the symbols (TC, TR) in full words.

Comment [U72R71]: already corrected

Comment [WU73]: Please correct "AKTUAL"..

Comment [U74R73]: already corrected (ACTUAL)

Comment [WU75]: Please give a detailed and clear interpretation.

Comment [U76R75]: Already Expalined

Comment [U77]: Reference to page 1 paragraf 2

Comment [WU78]: Is this the correct reference? https://pdfs.semanticscholar.org/7f4e/7546198f19d32cac7b524b853a872d91f6f9.pdf?_ga=2.33008894.1948692835.1580038903-1387998330.1560199053 Please check and make the necessary corrections. ://ejournal-balitbang.kkp.go.id/index.php/sosek/article/download/6761/5858

Comment [U79R78]: already corrected

Comment [U80]: Reference to page 1 paragraph 1

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Comment [U81]: Reference to page 4 paragraph 2.

Comment [WU82]: Distribution of....the distribution? Please provide the link/source of this reference.
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Comment [U83R82]: delete reference
Reference to page 4

Comment [U84]: Reference to page 3 paragraph 2

Comment [U85]: 2018. Reference to page 4

Comment [WU86]: Please mention these references in the text as well, for an easy identification.
(Already mentioned)

Comment [U87]: Reference to page 1, paragraph 1

Comment [WU88]: Please mention this reference in the text.

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Comment [U94]: Reply [WU] 12
Hutapea et al 2019 Page 2 paragraf 3

Comment [WU95]: Nickyjulluw in the text, check and correct.

Comment [WU96]: Publisher full name please.
Already corrected
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Comment [U97]: reference to page 1 paragraph 2

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Comment [U100]: reference to page 4 paragraf 2

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Comment [WU102]: Not listed in the text. (Delete Reference and change : Pangesti, T. P., Wiyono, E. S., Baskoro, M. S., Nurani, T. W., & Wiryawan, B. 2015. Bioeconomic ...

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Authors:
Fajar Hermawan, Jakarta Fisheries University, Faculty Utilization Fisheries Resources, Department Fishing Technology, 12520 Pasar Minggu, Jakarta, Indonesia, e-mail: fjr.hermawan@gmail.com
Suharyanto, Jakarta Fisheries University, Faculty Fishing Technology, Department Fishing Technology, 12520 Pasar Minggu, Jakarta, Indonesia, e-mail: suharyanto.jfu@gmail.com
Mulyono Sumitro Baskoro, Bogor Agricultural University, Faculty of Fisheries and Marine Science, 16680 Bogor, Indoneisa, e-mail: baskoro.mul@gmail.com

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Bioeconomic model of largehead hairtail fisheries (*Trichiurus lepturus*) in Cilacap waters, Central Java, Indonesia as an approach to fisheries management

[1]Fajar Hermawan, [2]Suharyanto, [3]Mulyono S. Baskoro

[1] Department Fishing Technology, Faculty of Utilization Fisheries Resources, Jakarta Fisheries University, Jakarta, Indonesia; [2] Departement Fishing Technology, Faculty Fishing Technology Jakarta Fisheries University, Jakarta, Indonesia; [3] Faculty of Fisheries and Marine Science, Bogor Agricultural University, Bogor, Indonesia. Corresponding author: F. Hermawan, fjr.hermawan@gmail.com

Abstract. The main fishery product in Cilacap district is the largehead hairtail (*Trichiurus lepturus*), a high value added commodity. The environmental management of small scale fisheries does not lack complexity, under economic imperatives, and it should be carried out properly, by considering factors like the size of the fishing gear, the uncertainty of the catch and the trips number, which tends to increase. have a marked preference for *T. lepturus*, due its elevated price on the international trade markets, under a strong demand pressure. The study aims to provide a sustainability management tool based on the evaluation of the catch per unit effort (CPUE), the Fishing Power Index (FPI), the Maximum Sustainable Yield (MSY), the Maximum Economic Yield (MEY) and the actual conditions. The results suggested an MSY value of 505,300 kg/year and an optimal effort F_{MSY} of 24,139 trips, a MEY value of 497,098 kg/year tons and its corresponding effort of F_{MEY} 21,064 trips. MSY profits were 844,591.46 USD and MEY profits were 860,343.61 USD.
Key Words: status stock, CPUE, MSY, MEY, fishing policy.

Comment [U1]: Final correction. F_{MEY}

Introduction. Cilacap is one of the legal regencies located in the south of Central Java province which is a center of fishery activities (capture fisheries and aquaculture). This is a minapolitan area established by the Ministry of Maritime Affairs and Fisheries (MMAF). Cilacap coastal area is part of the Fisheries Management Area Republic of Indonesia (FMA RI-573), with many types of demersal fish having various density structures and a dominant species, the largehead hairtail (*Trichiurus lepturus*) (Suman et al 2014) and specifically in Cilacap water and its surrounding (Panggabean et al 2015; Apriliani et al 2018). Based on the Ministry of Maritime Affairs and Fisheries decree No. 47 of 2016, *T. lepturus* exploitation rate has reached the maximum authorized limit.

The carrying capacity of the region has a significant potential, the coastline length of 103 km being much longer than in other districts from the eastern part of Kebumen Regency (52 km), Purworejo Regency (32 km) and Pangandaran Regency (91 km), situated at the West. The potential is directly proportional with the number of fishing vessels and with the number of fishermen, and it generates employment opportunities. In exchange, fisheries management can be a real challenge, as the main priority is to keep fish resources in a sustainable condition without reducing the local fishermen livelihoods. Many large rivers pass through the area and there is a sea inlet, the "Segara Anakan", which determines an ecosystem with a large number of fish and other marine life. The area of magrove land coverage in Cilacap reaches 2,618 ha (Pangesti et al 2015), which is suitable as a nursery ground area, being a habitat for demersal fish (including *T. lepturus*) and shrimp, species living in the muddy zones of river mouths (Nakamura & Parin 1993). The eating habit of *T. lepturus* is carnivor,

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because they eat damersal fish, shrimp and squid (Abidin et al 2013; Prihatiningsih & Nurulludin 2014).

T. lepturus became a high-value commodity on both the domestic and export markets, and consequently a preferred target for fishermen, due to: (1) a high export demand and a diversified processing, adding economic value, and (2) a catch season during most of the year, even if the fish population is reduced during the fish famine season. However, a standardized reference is necessary for the *T. lepturus* exploitation control and sustainable fishing.

T. lepturus fishing in Cilacap Regency is operated through various methods, ships and fishing gears. Small scale fisheries are identified by their simple technology, having limited capital assets and depending on the catch season. Fisheries management should consider that fish resources are renewable, but the process is rather slow, therefore an approach based on time series data provides a more accurate assessment, avoiding the fish resources depletion, while the fisheries business is still preserved and social conflicts avoided. Uncertainty patterns in the catches productivity trends and its seasonal dependence demonstrate the need of appropriate policies promoting environmentally friendly fishing gear, fishing trip arrangements, open close season, zoning arrangements for fishing areas, supervision of fisheries resources by the government (Nikijuluw 2012).

T. lepturus can be caught with various fishing gear namely gill net, Danish seine "paying" and Danish seine "arad". According to Facrudin & Hudring (2014) gill net is the most ecofriendly fishing gear than danish seine "payang" and danish seine "arad". It catches fish selectively based on the mesh size and has species target. On the other hand, payang and arad are not selective in *T. lepturus* fishing. Both fishing gears have very small mesh size, and fish caught are still small (immature) even jouvenil. So it is not based on the FAO Code of Conduct for Responsible Fisheries (CCRF 1995). The three of them have different sensitivity in catching fish with a different number of fishermen: the gill net team numbered 2-3 people per boat, the payang 10-15 people and the arad 3-4 people. The benefits for each fishing gear are limited, in a sustainable management bioeconomic approach related to the *T. lepturus* fisheries.

Fisheries management conducted by the government has not yet been comprehensive and still tends to remain unchanged, giving the difficulties to achieve prosperity and fair revenues among fishermen. The Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY) are basic concepts in determining fisheries policy. The concept of the bioeconomic approach was first introduced by Gordon in 1954. Other studies suggest the ecosystem management approach (Airlangga et al 2018), the Rapfish method (Hutapea et al 2019), the quota output approach using the Total Allowable Catch (TAC) (Widagdo et al 2019).

The current research analyzed the Catch Per Unit Effort (CPUE), optimum effort, catch MSY, MEY, profit, total revenue, total cost of *T. lepturus*. Considering that each fishing trip is expected to provide an economic benefit, a MEY approach was performed for a cost efficiency evaluation, but the priority remained the control of the catch effort, like fishing trips number and duration, or gear, as suggested by Widodo & Suadi (2006).

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Material and Method. This research used the survey descriptive method. Material researches cover *T. lepturus* catch and efforts reported by the auction fish centers of the Cilacap fishing port. The data on the *T. lepturus* catches collected for this research focused on small-scale fisheries with 1 day fishing duration, without using auxiliary engine, except the native vessel engine, according to the specification. In this study there are 2 types of data, namely primary data and secondary data. Primary data were obtained from questionnaires with fishermen, direct observation and interviews. Secondary data was obtained through the collection of the Cilacap fisheries department's annual report literature from 2013-2018, presenting all combined production and effort data from all fish auction place (TPI) and Cilacap Ocean Fisheries Port.

Comment [U3]: Final correction
fish auction place

Research location and time. The study was conducted in the Cilacap district, Central Java Province in July-October 2019.

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Data analysis. Catch effort and production annual time series data for *T. lepturus* catches were collected from the Cilacap district fisheries service for the past 6 years (2013-2018). Then it was processed in depth and complemented by information extracted from fishermen through questionnaires and, finally, it was validated directly at the fish auction place (TPI) and by direct observation on the gill net vessels, at the research location. This research is restricted by using fishing gears such as gill net with a mesh size of 1.75 inches to 2.5 inches, Danish seine "payang" and Danish seine "arad". The data are combined from the Cilacap district marine and fisheries service and from the Cilacap Ocean Fishery Port (PPSC 2018). Data analyzed were the *T. lepturus* CPUE, MSY and F_{MSY}, MEY and F_{MEY}.

Comment [U4]: Final correction fish auction place

Catch per unit effort (CPUE). The data needed for the CPUE calculation is the catch data and the capture attempt data. The effort is reflected by the the number of ships and fishing gear used during the fishing trip period (number of days at sea). In this research, the effort data used are trip fishing data of gill net Danish seine "payang" and Danish seine "arad", in accordance with the conditions in the field. If only the number of vessels was used as surrogate for the effort, a bias would be induced in the estimation of the fish resources: vessels could use various gear, making the fishing trips different, in terms of efficiency. So the CPUE is calculated by dividing the total capture with the catch per trip (Sparre & Vanema 1998; Widodo & Suadi 2006; Fauzi 2010).The mathematic formula is as follows:

$$CPUE = \frac{Ci}{Fi}$$

Where:
CPUE - Catch per unit effort;
C - Total number of total catches of the fishing fleet per unit of time;
F - Number of capture attempts of the fleet from one fishing trip per unit of time.

Fishing power index (FPI). The highest value of CPUE defines the standard CPUE. Each fishing gear has different *T. lepturus* catching capabilities and needs to be standardized, based on the value of the Fishing Power Index (FPI). The fishing gear with the highest FPI value can be used as the standard or reference. In general, the fishing gear with the highest CPUE value has FPI value of 1. The FPI value of other fishing gears can be calculated by dividing the CPUE value of the fishing gear with the standard CPUE of the fishing gear. The mathematical formula is presented as follows:

$$CPUE = \frac{Cs}{Fs}$$
$$FPIs = \frac{CPUEs}{CPUEi}$$
$$StdEffort\ i = FPIi\ x\ Fi$$
$$CPUEi = \frac{Ci}{Fi}$$
$$FPIi = \frac{CPUEi}{CPUEs}$$
$$StdEffort\ s = FPIs\ x\ Fs$$
$$StdEffort\ (total) = (\sum FPIi\ x\ Fi)) + (FPIs\ Fs)$$

Where:
Cs - The catch per year of standard fishing gear (kg);
Fs - The effort of catching per year of standard fishing gear (trip);
Ci - Catch per year other types of fishing gear (kg);
Fi - Attempts to effort per year other types of fishing gear (trip);
FPIs - Fishing Power Index standard fishing gear;
FPIi - Fishing Power Index of other types of fishing gear;
$CPUE_s$ - Catch per capture per year of standard fishing gear (kg/trip);
$CPUE_i$ - Catch per capture per year of other types of fishing gear (kg/trip);
$StdEffort_s$ - Fish cathing effort (trip) after standardization;

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$StdEffort_i$ - Other fishing gear after standardization;
StdEffort (total) - Over all capture effort after standardization.

Maximum sustainable yield (MSY). The formula of the surplus production model only apply if the slope parameter (b) is negative; if it is positive, then stock estimation or optimum effort cannot be made, but it can only be concluded that fishing can still increase efforts. The surplus production method according to Schaefer (1954), the effort and catch relationship produces a symmetrical parabolic curve (Zulbainarni 2012).

$$MSY = \frac{a^2}{4b}$$

$$F_{MSY} = \frac{a}{2b}$$

Where:
a - intercept;
b - slope in the linear regression equation.

Maximum economic yield (MEY). The bioeconomic model used is static, in which the determination of the cost of fishing and the price of fish is fixed. The model used is the Gordon-Schaefer model (Gordon 1954; Purwanto 1988; Zulbainarni 2012; Anna 2016). Landing *T. lepturus* calculations were based on data selected from database records for the dominant TPI, the Fish Auction Place (TPI) Jetis, PPSC, at Pandanaran and Sentolo kawat, which were published in fisheries production data statistics report by the Cilacap Fisheries Agency (DKP 2018). This model is stated as a function of the capture effort. The assumptions underlying this model are: (1) changes in the level of output (production) do not affect the price, because the fishery analyzed is one of the numerous small fisheries, (2) there is no restriction in initiating or stopping the attempts to catch fish, (3) all natural conditions and biological relationships are constant, (4) selectivity of fishing gear does not change, and (5) there is a linear relationship between costs and the level of effort (Zulbainarni 2012).

According to Wijayanto (2008), the bioeconomic approach included MSY and MEY, as depending on catch, effort, total revenue, total cost and profit, according to the formulas from Table 1:

Table 1

Gordon-Schaefer equilibrium formulas

	MSY	*MEY*
Catch (C)	$a^2/4b$	$aF_{MEY} - b(F_{MEY})^2$
Effort (F)	a/2b	(pa-c)/(2pb)
Total revenue (TR)	$C_{MSY}*p$	$C_{MEY}*p$
Total cost (TC)	$c*F_{MSY}$	$c*F_{MEY}$
Profit	$TR_{MSY} - TC_{MSY}$	$TR_{MEY} - TC_{MEY}$

a-Intercept; b-Slope in the linear regression equation; p- Fish price *T. lepturus* (kg/USD); C- Cost of *T. lepturus* fishing per trip (USD); TC- Total cost *T. lepturus* fishing (USD/year); TR- Total revenue *T. lepturus* fishing (USD/year).

Comment [U5]: Final correction F_{MSY}

Comment [U6]: Final correction F_{MEY}

Results and Discussion. *T. lepturus* production in 2013-2018 has fluctuated, with a tendency to decrease. The highest production occurred in 2013 with a total of 603.48 tons. The research data shows that the gill net is thedominant fishing gear, optimal for a *T. lepturus* targeted capture, while in the payang and arad fishing gear there can be found byproducts. From the capture fisheries statistics, 72% is the result of gill net fishing, while 22% represents the payang catches and the remaining 7% correspond to the arad catches. Overall, the production of *T. lepturus* in Cilacap waters experienced uncertainty and significant fluctuations, as shows the Figure 1 histrogram:

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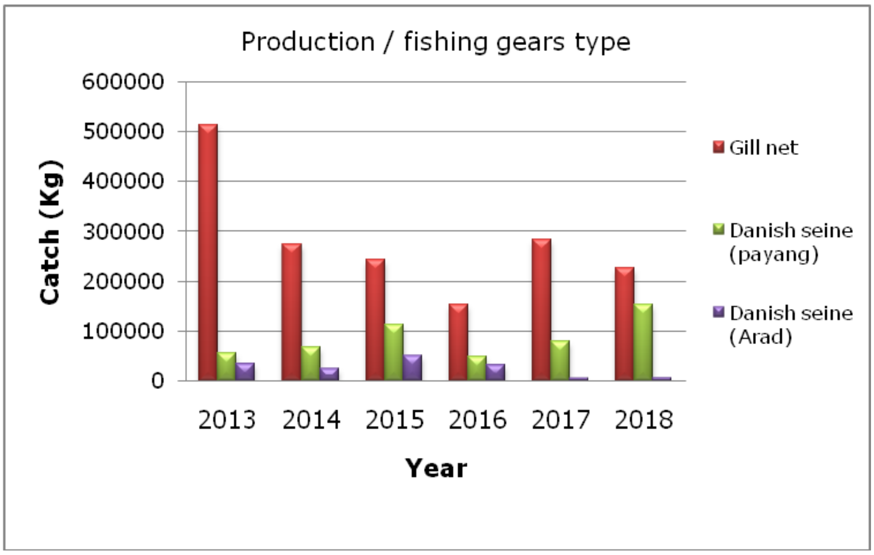

Figure 1. Histogram of *T. lepturus* production in the Cilacap waters between 2013-2018.

Fishing power index. The fishing power index was used to determine the standard effort. This calculation is necessary because each fishing gear has different capabilities in catching a species of fish. Therefore it is necessary to standardize fishing effort first the fishing gear that should have a constant CPUE and the highes value is the rationale of using standards for the fishing gear. The calculation results are found in Table 2:

Table 2

Production, fishing effort (trip), CPUE of *Trichiurus lepturus*

Year	*Gill net*			*Danish seine "Payang"*			*Danish seine "Arad"*		
	Catch (kg)	*Effort (Trip)*	*CPUE (kg/trip)*	*Catch (kg)*	*Effort (Trip)*	*CPUE (kg/trip)*	*Catch (Kg)*	*Effort*	*CPUE (kg/trip)*
2013	511,813	20,490	22.66	56,031	7,097	7.90	35,632	7,869	4.53
2014	274,992	24,484	11.23	67,075	7,678	8.74	24,736	7,302	3.39
2015	242,095	23,746	10.20	113,507	12,633	8.98	50,398	7,768	6.49
2016	152,749	24,037	6.35	49,703	4,734	10.50	33,108	9,668	3.42
2017	284,184	26,520	10.72	79,179	8,420	9.40	5,604	1,412	3.97
2018	227,085	22,972	9.89	153,781	3,861	39.83	6,971	3,402	2.05

Based on the table above, there are three fishing gears to catch *T. lepturus* fishing (gill net, payang & arad). The gill net has a constant value to catch *T. lepturus* so it becomes a standard fishing gear. The highest CPUE value in 2013 was 22.66 kg/trip, the lowest CPUE value in 2016 was 6.35 kg/trip. The other fishing gears have lower CPUE value than the gill net.

Table 3 explains that to get a standardized effort, the payang and arad trips are reduced according to the value of the fishing power index of each fishing gear so that a standard trip is obtained.

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Table 3

Value of fishing power index (FPI)

Year	Fishing power index (FPI)			Effort standard			Total effort
	Gill net	Danish seine (Payang)	Danish seine (Arad)	Gill net	Danish seine (Payang)	Danish seine (Arad)	
2013	1	0.35	0.20	20,490	2,473	1,573	24,536
2014	1	0.78	0.30	24,484	5,972	2,202	32,658
2015	1	0.88	0.64	23,746	11,133	4,943	39,823
2016	1	1.65	0.54	24,037	7,821	5,210	37,068
2017	1	0.88	0.37	26,520	7,389	523	34,432
2018	1	4.03	0.21	22,972	15,557	705	39,234

Table 4 explains that the average catches of *T. lepturus* in 2013-2018, the catch value and CPUE fluctuated and tended to decrease.

Table 4

Standarization data on *Trichiurus lepturus* fishing efforts

Year	Total catch (Kg)	Effort standardized (Trip)	CPUE (Kg/trip)
2013	603,476	24,536	22.66
2014	366,803	32,658	11.23
2015	406,000	39,823	10.20
2016	235,560	37,068	6.35
2017	368,967	34,432	10.72
2018	386,627	39,234	9.89
Average	394,572	34,625	11.84

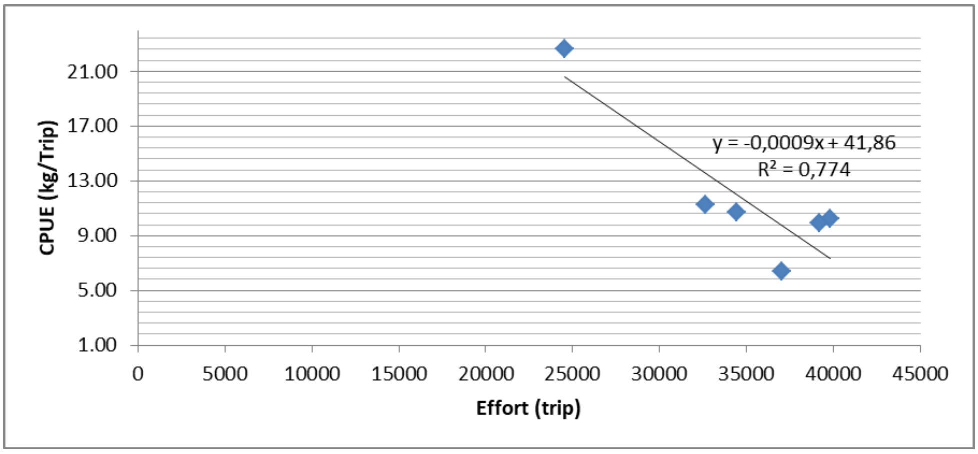

Figure 2. CPUE correlation with the effort.

Correlation between CPUE and effort. Based on the linear regression from Figure 2, is obtained a constant value is 41,86 and the constant value b is - 0,0009, where "a" is intercept and "b" is Slope in the linear regression. To find out the assessment stock, the next step is to look at the relationship between CPUE and effort. CPUE value of *T. lepturus* fishing experienced a negative productivity tendency, the results of the

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correlation analysis between CPUE and effort show a relationship where the addition of effort (trip) will decrease the catch.

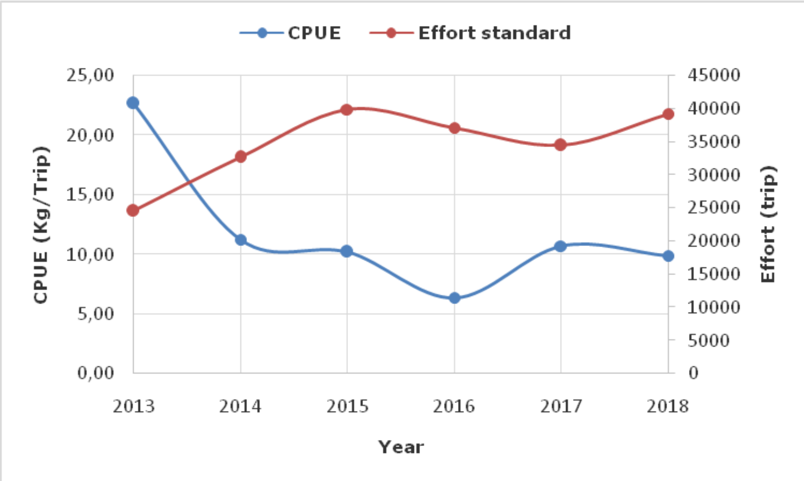

Figure 3. CPUE relation with effort concerning *Trichiurus lepturus* exploitation.

Based on Figure 3, CPUE condition and effort fluctuated, but the intensity of fishing effort (trip) tended to increase and CPUE value tended to decrease from 2013-2018. The intersection of CPUE line and standard effort occurred between 2013 and 2014, indicated that in that year there had been a decrease in catch as a result of increased fishing effort.

MSY and F_{MSY}. The Maximum Sustainable Yield (MSY) is the value of the highest catch and F_{MSY} is the maximum amount of fishing effort (fishing trips) produced as a limit to the safe stock of fish resources (Widodo & Suadi 2006). Based on the linear regression from Figure 2, is obtained value of a:41.86 and value of b:-0,0009, so that the MSY analysis and optimum effort F_{MSY} was calculated as follows:

MSY = $a^2/4b$
= $(41.86)^2/4*(0.0009)$
= 505,300 kg/year

F_{MSY} = a/2b
= (41.86)/2 (0,0009)
= 24,139 trips.

From the calculations using the Schefer equation the fishing effort has exceeded the optimal F_{MSY}, because the average annual trip yield (2013-2018) was 34,625 trip/year. The interpretation of MSY and F_{MSY} can be seen in Figure 4.

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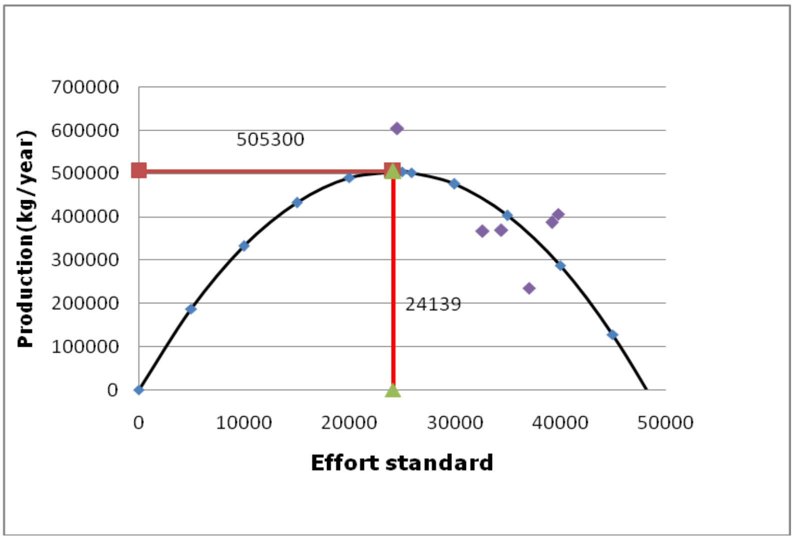

Figure 4. *Trichiurus lepturus* MSY.

Bioeconomic approach. The MSY and MEY points are a reference to the fisheries management approach based on the catches, which exist in ports and other fish landing sites in an area. The MSY approach provides an impact of leeway on resources, economic efficiency approaches and the effectiveness of fishing trips. Both conditions are simulation of fisheries management. Stakeholders and fisheries managers can choose which approach to use depending on the condition of fish resources and the available fishing fleet. Actual condition is the condition in the last year of production data collection, the three conditions are summarized in Figure 5.

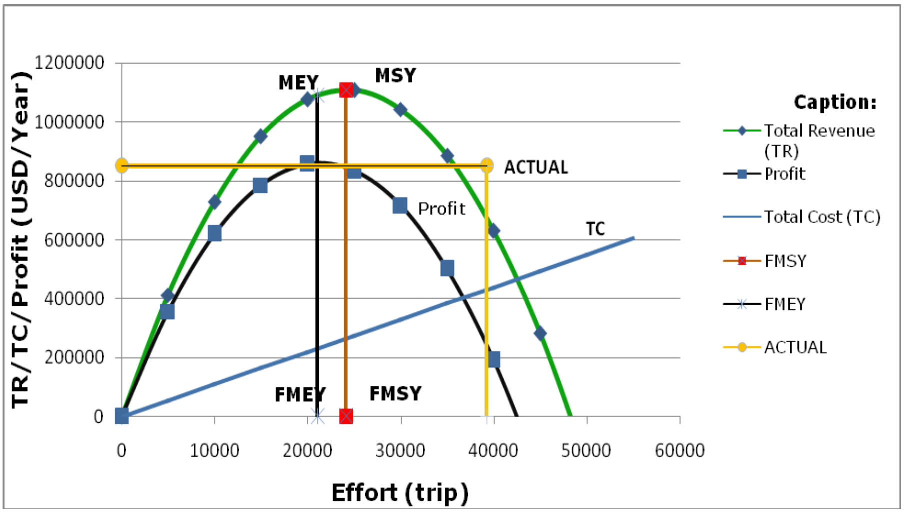

Figure 5. Bioeconomic curve Gordon–Schaefer.

The bioeconomic equilibrium curve in Figure 5 provides a view for relevant stakeholders in policy making. The explanation of the picture above is the value of F_{MEY} to the left of the F_{MSY}, this condition shows that the catch trip approach in F_{MEY} is more profitable, because with fewer trip, but resulting in greater profit, the actual condition in 2018 still had a profit of USD 418,243.00 with fishing effort (trip) 39,234/year. The *T. lepturus* fishing in Cilacap water, MEY condition is better implemented because of the diversity of

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fishing gears and fishing system used is a one day fishing. Thus, the economic benefit gained is getting reduced. The first indicator of decreasing fish resources is a decrease in CPUE value from year to year, when the annual production value exceeds the MSY point limit and the number of trips exceeds F_{MSY} and F_{MEY}.

Table 5

Calculation of values from MSY, MEY and actual condition

	MSY	*MEY*	*ACTUAL*
Catch (C) (kg/year)	505,300	497,098	386,627
Effort (F) (Trip)	24,139	21,064	39,234
Total revenue (USD)	1,109637.32	1,091626.01	903,137.88
Total cost (USD)	265,045.86	231,282.4	430,788.73
Profit (∏) (USD)	844,591.46	860,343.61	418,243.00

Comment [U7]: Final correction Base on catch 2018 table 4) .

Comment [U8]: Final correction (Base on effort 2018 table 4)

Comment [U9]: Final correction

Comment [U10]: Final correction

Comment [U11]: Final corrected (Base on bioeconomic curve figure 5)

Table 5 shows that the highest profit value is found at the MEY point with a total profit of 860,343.61 USD, while at the MSY point the profit is 844,591.46 USD. The actual price obtained from the gill net fishermen survey results, the average fish price in Cilacap district is 2.2 USD/kg, while the cost incurred for an average of 1 fishing trip is 10.98 USD/trip. The results of the calculation show that, at the MSY effort of 24,139 trips, the level of profit gained was 1,111,660 USD per year, for a capture of 505,300 kg/year. With the MEY model approach the calculated profits were 860,343.61 USD on trip 21,064.

Conclusions. The MSY approach recommendations provide the threshold for a balance of resources and production, while the MEY approach provides the threshold for a higher efficiency with an optimal effort. In the current study scenario, the catching effort has not passed the MSY point, but the trip of overcapacity in laying fisheries in Cilacap is characterized by an excess of effort, which is not adjusted to the optimal effort values, F_{MSY} and F_{MEY}. The policy strategy suggested by the study results would be to reduce the number or the capacity of vessels and fishing gear.

Comment [U12]: Final correction F_{MSY}

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Comment [U13]: Final correction I will give first priority to Marine and Fishery Education Center, Ministry of Maritime Affairs and Fisheries (MMAF) of Indonesian Republic.

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Authors:
Fajar Hermawan, Jakarta Fisheries University, Faculty Utilization Fisheries Resources, Department Fishing Technology, 12520 Pasar Minggu, Jakarta, Indonesia, e-mail: fjr.hermawan@gmail.com
Suharyanto, Jakarta Fisheries University, Faculty Fishing Technology, Department Fishing Technology, 12520 Pasar Minggu, Jakarta, Indonesia, e-mail: suharyanto.jfu@gmail.com
Mulyono Sumitro Baskoro, Bogor Agricultural University, Faculty of Fisheries and Marine Science, 16680 Bogor, Indonesia, e-mail: baskoro.mul@gmail.com

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Comment [U14]: Final correction Indonesia