International Journal of GEOMATE, Oct., 2018 Vol.15, Issue 50, pp. 38 - 44
ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: https://doi.org/10.21660/2018.50. 7212
Special Issue on Science, Engineering & Environment

FISH CATCH QUOTA ASSESSMENT FOR SUSTAINABLE MARINE FISHERIES RESOURCES IN EAST JAVA

Alfan Jauhari[1], *Defrian Marza Arisandi[1], Abu Bakar Sambah[1,2], Wildan Alfarizi[1]

[1]Faculty of Fisheries and Marine Science, Brawijaya University, Indonesia; [2]Marine Resources Exploration and Management Research Group, Brawijaya University, Indonesia
Veteran Street Malang East Java

*Corresponding Author, Received: 7 Feb. 2018, Revised: 11 April 2018, Accepted: 11 May 2018

ABSTRACT: Fish resources Information urgently needed by development planners in fisheries sectors, especially for fisheries development. The fisheries resources utilization in East Java tends to be overexploited. This caused uncertainty of fishing activities for the traditional fishermen in the East Java waters. Some studies of population dynamics and fish stock assessment described fisheries resources exploitation in some areas of East Java was on fully exploited to overexploited condition. The aim of this research were; [1] to know sustainable potential and total allowable catch of fisheries resources in the area of Pasuruan regency, Probolinggo Regency, and Banyuwangi regency; [2] tho know the utilization status of fisheries resources in the area of Pasuruan regency, Probolinggo Regency, and Banyuwangi regency; and [3] to determine the empowerment strategy for fishermen community in order to utilize fisheries resources in the area of Pasuruan regency, Probolinggo Regency, and Banyuwangi regency. The analyses were done through the calculation of sustainability potential, and total allowable catch, and determine the controlling strategy of fisheries resources utilization. The study described that the comparison analysis of fishing trip data, fish catch and total allowable catch in the sustainable condition was in the overexploited condition. Moreover, based on the analysis of fisheries resources utilization status in the research area, the controlling strategy was created based on the recommendation of all stakeholders. This strategy including the management of the fishing area, management of fishing time, and determine if alternative activities in the scope of both fisheries and non-fisheries sectors. These strategies can be used as a basic data in determining an empowerment strategy for fishermen in the fisheries resources utilization. These strategies including accompaniment approach and information services through community and ecosystem-based of fisheries resources management.

Keywords: Fisheries Resources, Sustainability, Total Allowable Catch

1. INTRODUCTION

Information on fish resources is needed by the special fisheries development planners for the development of capture fisheries. Quantitative information such as potential numbers is largely determined by the presence or absence of information from survey results of research vessels as well as from information collected through the periodic weather system, in particular, catch data, fishing seasons, and distribution for certain species of fish in each region see (Purnomo, 2002). The utilization of marine fisheries in East Java can be said to have experienced excessive levels of exploitation. This will impact the uncertainty of fishing effort done by traditional fishermen in East Java responsible area. Various studies of population dynamics and indicator estimates indicate the pressure of exploitation of fishery resources in some areas such as East Java has experienced full exploitation until more exploitation. This will affect the work being built on the coastal area of East Java, or work as a fisherman. When the level of exploitation of marine fisheries resources in the mouth of East Java has experienced more capture then the catching operation is not possible to be repaired. This situation creates social and economic problems for coastal communities. The arrangement of capture quotas is one of the solutions to regulate excessive exploitation pressure on marine fish stocks in East Java.

2. METHODS

This research is one of analytical descriptive research that is describing a real condition that exists in the field and doing situation analysis to data obtained. Descriptive method of analysis is a method of gathering facts through appropriate interpretation. This method of study is aimed at studying the problems that arise in a society in certain situations, including community relations, activities, attitudes, opinions, and ongoing processes and their effects on certain phenomena in society. This method is used to answer the research objectives, namely;

1. To know the amount of sustainable potential and JTB fish in the waters of the study area.
2. To know the status of the utilization of fishery resources in the territorial waters of the study.

The steps taken to answer the first goal are:

1. Collection of captured data
   The data collected is data collected from 10 years since 2004-2013, the data is secondary data.
2. Treatment of data
   The 10-year data is intended to obtain standard data as input for analysis using Schafer, fox and Walterhilbern formulas. The treatment technique is using the formula RFP (Relative Fishing Power).

While the steps to answer the second research objectives are:

1. Compare the sustainable potential value calculated in the previous step to the actual utilization rate in 2014.
2. Decision making to determine the status of resource utilization expressed in the sustainable utilization rate..

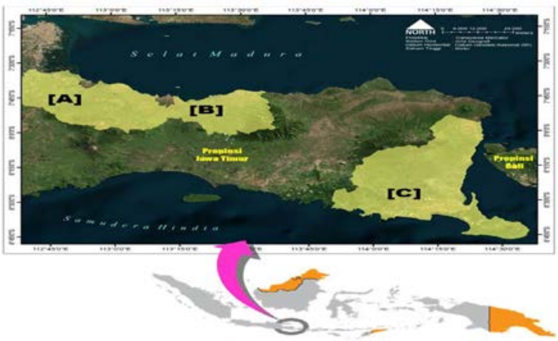

Fig. 1 Study Area
[A] Pasuruan Regency;
[B] Probolinggo Regency
[C] Banyuwangi Regency

2.1 Conversion of the Catching Efforts

The fisheries management model refers to the assumption that fishing gear must be transferred into a standard unit. Thus it can be said that the fishing gear is made into one unit equivalent to the catching equipment that is considered standard. The conversion method used with the equation:

$$\mathrm{CpUE} = \frac{Qi_{i=1}^{n} * Y_{fish}}{Ei_{i=1}^{n}} \qquad (1)$$

Where :
CpUE = Capture per unit of effort
= Average portion of fishing gear 1 to total fish production
= Average catch of fish by fishing gear
= Mean Effort of the fishing gear Considered standard (trip).

While the RFP is calculated using the equation:

$$RFP = \frac{Y/fi_{i=1}^{n}}{Y/f_{alat\ standar}} \qquad (2)$$

Dimana :
RFP = Index type conversion tool Catch
$Y/fi_{i=1}^{n}$ = Catch per unit effort respectively each fishing gear
$Y/f_{alat\ standar}$ = Catch per unit *effort* from the tool standard

2.2 Maximum Estimates Sustainable

The estimation of maximum sustainable balanced tuna is done by using holistic approach or surplus production method that is Schaefer model (1954) and Fox (1970) to determine which method is "best fit" which is able to represent actual exploitation level of tuna. The maximum amount of effort sustained (fMSY), and maximum sustainable yield (YMSY) can be calculated by the formula

(1) According to Schaefer (1954)

$$y = af - bf^2 \qquad (3)$$

$$fmsy = \frac{a}{2 \times b} \text{ dan } Ymsy = \frac{a^2}{4b} \qquad (4)$$

Where: Y = Catch
F = Attempts to catch
A = Intercept of Schaefer model
B = Slope of Schaefer model
Ymsy = Maximum sustainable catch (potential Sustainable catch)
Fmsy = Sustainable fishing effort

(2) Menurut Fox (1970)

$$Y = exp^{cf-bf} \qquad (5)$$

$$fmsy = \frac{1}{d} \text{ dan } Ymsy = \frac{1}{d}(c-1) \qquad (6)$$

Where :
c = Intercept of Fox model
d = Slope model Fox

To calculate the utilization rate of a fishery resource by the formula:
JTB = 80%Ymsy...(7)

2.3 Estimation of the Potential of Sustainable Reserves and Potential Backup

According to Walter and Hilborn (1976) biomass from year t + 1, Bt + 1 can be expected from Bt plus biomass growth for one year was reduced by a certain amount of biomass during the year reduced by the amount of biomass released by exploitation of effort (f). The determination of stock biomes follows the calculation by the equation:

$$Bt = \frac{k}{(1+e^{-r(t-t0)})} \qquad (8)$$

Where: Bt = biomass stock at time t
Pdt = dB / dt = growth rate of biomass, intrinsic (Ton / yr)
K = maximum carrying capacity of natural waters against biomass
R = intrinsic growth rate of population stock
T0 = time at Bt = ½ k
T = time, year, month and so on

The potential for sustainable reserves is obtained from the equation Be = ½.k. While the potential of fish stock in 2013 is obtained by the equation:

$Bt+1 = Bt + Pdt - Yt$.......$Yt = ft \times Bt \times$…..............(9)

$\frac{\Delta B}{\Delta t} = Pdt = r \times Bt - \times Bt^2$..(10)

2.4 Preparation of Control Strategies Fish Resources

The compilation of alternative strategies and the interest analysis of some of these structured alternatives will be based on:

- Identification of potential carrying capacity of non-fishery fisheries in Pasuruan, Probolinggo, and Banyuwangi.
- Identify issues of future utilization, problems and prospects of fishery resources in Pasuruan, Probolinggo and Banyuwangi districts through observation and interview (questionnaire distribution).
- Focus Group Discussion (FGD) with stakeholders in the fishery and non-fishery fields in Pasuruan, Probolinggo and Banyuwangi districts to prepare whether or not alternative strategies have been developed.

2.5 Measurement of Interest Scale

One of the measurement of attitude scale in the formulation of alternative interests of control strategy of utilization of Marine Fishery Resources in Pasuruan Regency, Probolinggo Regency and Banyuwangi Regency is analysis in Likert Scale. Likert scale according to Djaali (2008) is a scale that can be used to measure the attitude, opinion, and perception of a person or group of people about a phenomenon or phenomenon of education. The Likert scale is a psychometric scale commonly used in questionnaires and is the most widely used scale in research surveys.

Based on the data obtained from respondents' answers, then it is processed by multiplying each point answer with the weight that has been determined with the weighted table of values, using the equation as follows:

Total Score = (Σ Answer x Weight strongly agree) + (Σ Answer x Weight agreed) + (Σ Answer x Neutral Weight) + (Σ Answer x Weight not agree) + (Σ Answer Weight strongly disagree)

To get the result of interpretation, must first know the highest score (X) and lowest number (Y) for an item of assessment with formula as follows:
Y = highest score likert x number of respondents (5th highest score) "Notice the Value Weight"
X = Likert's lowest score x number of respondents (Lowest number 1) "Notice the Value Weight"
So the assessment of respondents' interpretation of the strategy of controlling the utilization of Marine Fishery Resources in Pasuruan Regency is the result of the resulting value using the formula Index% as follows:

Formula index% = (Total score) / (Y × 100)

3. DISCUSSION

3.1 Illustration of Concepts

The concept that try to be described in general based on the existing condition is mainly related to the utilization of marine fishery resources obtained through several previous scientific studies and inventory activities of potentials and issues at the field level (location of the study).

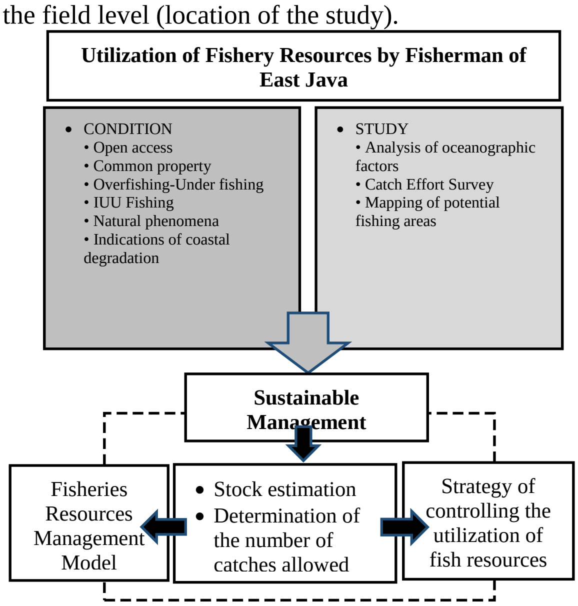

Fig 2. Concept Research Framework

3.2 Existing Fishery Potential as a Guideline for Determining the Strategy of Fish Resources Utilization Control.

A preliminary survey related to the production of capture fisheries in the three study areas is presented in Table 1.

Table 1. Production by fishery sub-sector per District (in a ton)

Regency	Total	Catch	
		Sea	Public Waters
Amount For Prov. East Java	395.046,8	381.573,9	13.472,9
Pasuruan	7.807,3	7.634,1	173,2
Probolinggo	9.755,7	9.665,2	90,5

Banyuwangi	49.663,1	49.532,0	131,1

(Source: East Java Fishery Statistics Data, 2016)

Based on Table 1, Banyuwangi Regency is the area of study with the largest fishing production in the sea when compared to Pasuruan and Probolinggo districts. Based on this data, the estimation of the utilization status of capture fishery resources in the study area can be based on dominant catch fish production, and into the catching group which has important economic value..

3.3 Analysis of marine fisheries resources Pasuruan Regency

Based on the table of fishery production in Pasuruan waters, in Figure 3 presents fluctuations in the production of catches in Pasuruan.

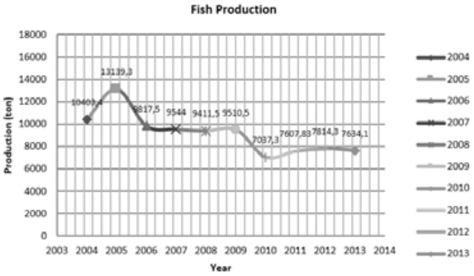

Fig 3. Graph of fish production in Pasuruanwaters (Source: East Java Fishery Statistics Data, 2016)

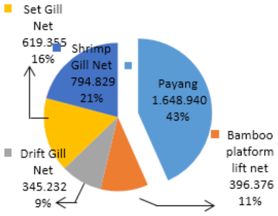

Fig 4. The proportion of trips of four types of fishing gear in waters of Pasuruan.

The development of the standard payang fishing equipment shows that gear equipment in Pasuruan waters has the highest increase of 235,438 trips from the previous year from 2004 to 2008 there was a decrease of 66,509 trips. In 2009, there was an increase of 96,539 trips from 2008. Then it decreased 112,822 trips in 2010 and then increased in 2011 With 2013 as many as 128.51 trips. The dominant fishing gear is payang, in this case the prediction of the result of the conversion of fishing gear and the amount of fish caught in Pasuruan waters is needed because this is related to the estimation of both models. The results of the conversion of fishing gear to the standard of fishing gear and the number of the fish catch can be seen through Table 2.

Table 2. Data on the number of standard converted tools

Year	Effort standard Payang (trip)	Catch fish in water (ton)	CpUE
2004	561184,6	10403,4	0.018538
2005	550286,2	13139,3	0.023877
2006	391226	9817,5	0.025094
2007	401990,1	9544	0.023742
2008	402027,5	9411,5	0.02341
2009	743624,3	9510,5	0.012789
2010	342852,1	7037,3	0.020526
2011	496436,4	7607,83	0.015325
2012	474066,3	7814,3	0.016484
2013	694523,5	7634,1	0.010992

The highest number of fishing gear was 743,624.3 trips in 2009 with catches of 9,510.5 tons. The Schaefer and Fox models refer to the principle of the Surplus Production Model, the Schaefer and Fox are also called the equilibrium state model. Schaefer and Fox models can predict MSY conditions from optimum production amount (Ymsy), optimum catcher (fmsy). Fishery status and exploitation rate can be analyzed through comparison of optimum production value with production value in the last year or it can also through the number of fishing gear. Potential Sustainable Reserve (Be) fisheries in waters can be known through the Walter-Hilborn equation approach. This method does not depend on the equilibrium conditions of a stock of fishery biomass as in Schaefer's method (1954) and Fox (1970). In addition, this method is able to estimate the values of population parameters (r = intrinsic biomass stock growth rate (constant), k = maximum natural bearing capacity, q = capture capability (catchability coefficient) in the model so as to make predictions more dynamic and closer to reality In the field This model is also known as the model of non-equilibrium state model.Based on the results of the analysis of this model obtained the following results:

Table 3. The value of the non-equilibrium state model

Variable	Walter-Hilborn	
Intercept	B0 = r	102,5054386
X variable 1	B1	2951,977462
X variable 2	B2 = q	2,02622
k	7,0359	
Be	3,5179	

Information :
R = Intrinsic population growth rate
K = The maximum carrying capacity of the water (carrying capacity)
Q = capability of catch (catchability coefficient)
Be = Potential reserve of sustainable fish

The utilization rate (TP) of fish obtained from the calculation of the average value of effort over the last five years divided by fMSY. The result of the calculation is multiplied by 100 resulting in a utilization rate of 86%. From the calculation of the utilization rate can be said that the status of fishery utilization in the waters of Pasuruan is fully exploited the stock of resources already exploited close to MSY value and the increase in the number of fishing effort is not recommended.

Table 4. Potential sustainable yield data

	Schaefer	Fox	Walter-children
MSY	9.830,9	9,419	31154,84663
JTB	7.864,7	7,535	4,34404E-10
Utilization of Fish Resources in Pasuruan			
The catch (tons)		Number of fishing trips	
7942,9		460868	

Table 5. Potential sustainable yield data

Model Schaefer	Quantity	Year 2014	Result	Utilization rate
Fe (number of trips of catching equipment in sustainable condition) unit	585.231,9	460868	124.363,9	Over
Ye (number of catches of sustainable condition) tons / year	9.830,9	7942,9	1888	Over
JTB	7.864,7	6354.3	1510.4	Over

At the level of pengoprasian fishing gear has exceeded the capacity causing the occurrence of over-fishing or overfishing. Therefore, efforts should be made to formulate strategies for controlling the utilization of fish resources in Pasuruan waters with technical fishing should not exceed MSY and for precautionary action by catching does not exceed JTB.

3.4 Analysis of Marine Fisheries Resources Probolinggo District

Participatory mapping is done by involving local fishermen in Probolinggo Regency to create a map of potential marine fisheries in Probolinggo District / City waters. Validation of this map is done through active participation in several trips fishing operations at sea. This active participation also records the main fishing grounds of all fishermen who conducted fishing operations and had a fishing base in Probolinggo District / Town, including mapping the fishing grounds of Probolinggo District / local fishermen as well as local naming tablature and geographical position of fishing areas of Probolinggo

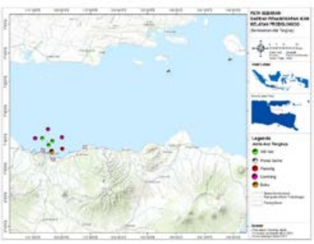

Fig 5. Map of distribution of fishing area Based on fishing gear in Kab / Kota Probolinggo

Production of catches increased significantly from 2004 to 2006 by 56.9%. Production of this catch in 2006 is the largest fish production that is as much as 65,854.50 tons. While the production of the lowest fish is 21,361,7 tons in 2012. In 2008 the production of the catch is relatively fixed until 2010, and began to decline until 2013. Fish production in 2006 to the year of 2007 decreased production by 32%, and continues to decline Until 2013. If compared with the highest production (in 2006) then the decline until the year 2013 amounted to 34, 4%

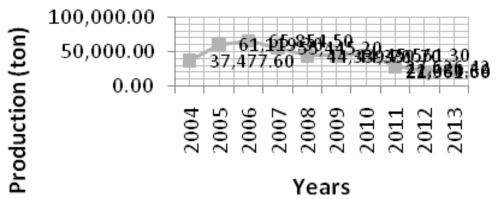

Fig 6. Graph production yield in probolinggo

Potential Sustainable Reserve (Be) fisheries in waters can be known through the Walter-Hilborn equation approach. This method does not depend on the equilibrium conditions of a stock of fishery biomass as in Schaefer's method (1954) and Fox (1970). In addition, this method is able to estimate the values of population parameters (r = intrinsic biomass stock growth rate (constant), k = maximum natural bearing capacity, q = capture capability (catchability coefficient) in the model so as to make predictions more dynamic and closer to reality In the field This model is also known as the model of non-equilibrium state model.

Table 6. The value of the non-equilibrium state model

b1 = r	1,014468592
b2	0,17940405
b3 = q	3,50335E-05
k =b1/(b2*b3)	161407,0965
Be = k/2	80703,54824
Pd = (r*k)/4	1,57129E-06
Y_MSY = (b1*k)/4	40935,60749
f_MSY = r/(2*q)	14478,5434
U_MSY = C/E	2,827329128
JTB = 80%*Y_MSY	32748,48599
TP (rata2 E /Y_MSY)*100	79%

Information :
R = Intrinsic population growth rate
K = The maximum carrying capacity of the water (carrying capacity)
Q = capability of catch (catchability coefficient)
Be = Potential reserve of sustainable fish

The utilization rate (TP) of fish obtained from the calculation of the average value of effort over the last five years divided by fMSY. The result of the calculation is multiplied by 100 to yield the utilization rate of 79%. From the calculation of the utilization rate can be said that the status of fishery utilization in Probolinggo waters is fully exploited ie the stock of resources already exploited close to MSY value and the increasing number of fishing effort is not recommended.

Table 7. Potential sustainable yield data

	Schaefer	Fox	Walter-children
MSY	65.511,55	59.817,56	40.935,61
JTB	52.409,24	46.053,11	32.748,49
Utilization of Fish Resources			
The results of the catch(ton)		Number of fishing trips	
22.686		159.054	

3.5 Analysis of marine fisheries resources in Regency of Banyuwangi

Mapping of capture areas is done through participatory mapping. This participative mapping is done by involving local fishermen of Banyuwangi Regency in making a map of the potential of the marine fishery in Banyuwangi Regency waters. Validation of this map is done through active participation in several trips fishing operations at sea. This active participation also records the main fishing grounds of all fishermen who have been engaged in fishing operations and have a fishing base in Banyuwangi Regency, including mapping the fishing areas of local fishermen in Banyuwangi Regency as well as local naming tablature and geographical position of Banyuwangi fishermen fishing area.

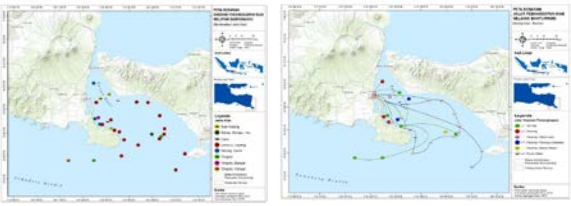

Fig 7. Map of distribution of fishing areas and fish catching line in the Regency of Banyuwangi

Calculation of the result of the conversion of fishing gear and the number of fish catches in Banyuwangi waters is needed because this is related to the estimation of both models. The results of the conversion of fishing gear to the standard of fishing gear and the number of the fish catch can be seen in Table 8. While Table 9 illustrates the calculation of the Potential Lestari And Total Allowable Catch / Number of Fishes Captured (JTB).

Table 8. Data on the number of standard converted tools

Year	f (Trip)	Y (Ton)	CpUE
2004	20.443,68	2.406,50	0,117714
2005	101.189,86	13.876,80	0,137136
2006	2.277,46	62.223,50	27,32148
2007	174.374,14	61.801,00	0,354416
2008	7.104,27	51.371,00	7,231004
2009	69.562,34	51.371,00	0,738489
2010	17.163,03	29.264,00	1,70506
2011	226.194,26	31.018,46	0,137132
2012	65.406,91	38.879,95	0,594432
2013	126.123,81	46.366,10	0,367624
2014	460868	7942,9	0,017235

Table 9. Result of sustainable potential calculation and Total Allowable Catch / number of fish that can be caught (JTB)

b1 = r	1,778348467	Y_MSY = (b1*k)/4	1187559,319
b2	0,080916473	f_MSY = r/(2*q)	108070,0588
b3 = q	8,22776E-06	U_MSY = C/E	
k =b1/(b2*b3)	2.671.150,99	JTB = 80%*Y_MSY	950047,4553
Be = k/2	1.335.575,50	TP (C thntrakhir/Y_MSY)*100	32%
Pd = (r*k)/4	1.187.559,32		

3.6 Analysis of FGD Results on Formulation Strategy

Based on the results of FGD analysis it can be explained that the three alternatives of the compiled strategy are alternative strategies that are agreed by all FGD groups. This is evidenced by the choice of all groups against the four strategies that have been compiled. Based on the score of interest, then strategy number 2 or is the preferred strategy that ranks first the FGD results. The last strategy is the alternative of other substitution fishery activities in the hope that the stock of marine resources in the waters of the research area is given time to recover naturally. This indicates that it takes a certain period of time for fishermen to be able to try alternative fisheries and other non-fishery activities in response to the catch status of more fish resources in the research area.

3.7 Measurement of Interest Scale

Likert scale is done to measure approval and disapproval of respondent to all alternative of strategy which is arranged, with level consist of [1] strongly disagree; [2] disagree; [3] neutral between agree and not; [4] agree; [5] strongly agree. Likert-scale analysis in this research is based on a strategy which has been arranged in FGD and also analysis of Likert scale result using weighted value table.

Table 10. Percentage of values of all alternative strategies

strategy	Response Answer				
	[1]	[2]	[3]	[4]	[5]
1. The strategy for controlling the utilization of fish resources includes 1. Capture time settings 2. The arrangement of catch areas 3. Alternative fishing and other non-fishery activities	**0**	**0**	**5**	**11**	**7**

Information :
[1] strongly disagree; [2] disagree; [3] neutral; [4] agree;
[5] strongly agree

Total Score = (7 x 5) + (11 x 4) + (5 x 3) + (0 x 2) + (0 x 1)
= 94

Based on the total score above, then the interpretation result is calculated as follows :
Y = 5 x 23 = 115
X = 1 x 23 = 23
Respondent's interpretation of the strategy of controlling the utilization of Marine Fishery Resources are:

$$Rumus\ index\ \% = \frac{94}{115\ \times 100}$$

$$Rumus\ index\ \% =\ 81,74$$

(category highly agree)

4. CONCLUSIONS

Based on the results of the study that has been done can be concluded :
[1] Research on the regulation of capture quota for sustainable management of marine fishery resources can be done one of them based on the study of potential lestasi and fishery resource utilization status first. [2] Comparison of data analysis on the number of fishing trips in sustainable condition, the number of fish catches in sustainable condition and the number of catches allowed in the research area indicates the utilization level of marine fishery resources experiencing more catching condition. [3] Based on the analysis of the utilization status of marine fishery resources in the research area, the strategy of controlling the utilization of fishery resources is prepared based on the recommendation of all relevant stakeholders. These strategies include setting up fishing grounds, setting up fishing seasons, and setting alternative fisheries / non-fisheries alternatives. This strategy forms the basis for determining the setting of catch quotas for sustainable management of marine fisheries resources in the research area. This strategy includes advisory approach and information services through community-based fishery resource management programs and ecosystems provided to fishermen**.**

5. ACKNOWLEDGEMENTS

The researchers would like to thank the East Java Provincial Government, the Faculty of Fisheries and Marine Sciences of Brawijaya University, the Stakeholders, and the Laboratory of Marine Resources Exploration, Brawijaya University Indonesia.

6. REFERENCES

[1].Djaali, 2008. *Skalalikert.* Jakarta: PustakaUtama.

[2].Data Statistik Perikanan. 2014. Potensi Perikanan Kabupaten Pasuruan. Dinas Perikanan dan Kelautan Provinsi Jawa Timur.

[3].Fox, W.W. Jr., 1970. An Exponential Surplus-Yield Model for Optimizing Exploited Fish Population. Trans.Am.Fish.Doc., 99:80-88.

[4].Purnomo, H. 2002. Analisis Potensi dan Permasalahan Sumberdaya Ikan Pelagis Kecil Di Perairan Utara Jawa Tengah. Universitas Diponogoro. Semarang.

[5].Schaefer, M., 1954. Some Aspects of the Dynamics of Pupolations Important to the Management of the Commercial Marine Fisheries. Bull.I-ATTC/Bol.CIAT, 1(2):27-56

[6].Walters, C. J., and R. Hilborn. 1976. Adaptive control of fishing systems. Journal of the Fisheries Research Board of Canada 33:145-159.