Status of the Thunnus albacares fishery in the Fisheries Management Area (FMA) 714, Banda Sea, Indonesia

by Cek Turnitin

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Abstract. The Banda Sea is a potential fishing area for large pelagic fish, especially tuna. Exploitation of this resource is carried out by various forms of fishing activities, including purse seine, pole and line, longline tuna, and handline tuna. In addition, the utilization of fish resources in FMA RI 714 is still dominated by small-scale fishermen using vessels <5 GT. Based on the large potential and condition of the available large pelagic fish resources, it is necessary to study the status of large pelagic fisheries, especially tuna in the Maluku region. This study aimed to examine the biological aspects of tuna and the fisheries management. The research was carried out from 4 March to 25 May 2021 in the Maluku Sea. This study used a survey method, namely by observing in the field the observed fish samples. Determination of the location and fishing gear was carried out by purposive sampling, while the determination of respondents was carried out by accidental sampling. The results showed that the growth pattern of *Thunnus albacares* was isometric. The size of the first caught in the purse seine for *T. albacares* was 39.09 cm Fork Length. In Fisheries Management Area of Republic Indonesia (FMA RI) 714, the actual production and tuna fishing effort shows that its utilization did not reach the maximum sustainable level and economically, tuna fishing did not yet reach the maximum profit value so that its utilization can still be increased.

Key Words: yellowfin tuna, Banda Sea, length of first caught, CPUE.

Introduction. The Banda Sea is located in the Eastern Indonesia Region and is included in the waters of the West Pacific Ocean, being bordered by the Indian Ocean (Firdaus 2018). The Banda Sea has also become a potential tuna fishing area in Maluku Province (Satrioajie et al 2018; Tangke et al 2011). Exploitation of tuna resources is carried out in various forms of fishing activities, including purse seiner, pole and liner, longliner and tuna handliner (Tauda et al 2021; Khan et al 2018; Widodo & Nugraha 2009). Tuna resources are spread throughout almost all Indonesian waters, from western Indonesian waters (Indian Ocean) to Eastern Indonesia (Banda Sea and North Irian Jaya) (Chodrijah & Nugraha 2013). The waters of Eastern Indonesia are known as sources for the production of tuna and skipjack, which are commonly called tuna in Indonesia (Manurung 2016). Banda Sea is a fishing ground for large pelagic fish in eastern Indonesia (Hidayat et al 2014).

Based on the results of a study of tuna stocks by the Western and Central Pacific Fisheries Commission (WCPFC) in 2012, it was reported that stocks of yellowfin tuna (*Thunnus albacares*) were not overfished, while bigeye tuna (*Thunnus obesus*) experienced overfishing (Post & Squires 2020; Hare et al 2020; Widodo et al 2015). The utilization of fish resources in WPP 714 is still dominated by small-scale fishermen using vessels <5GT (JICA 2010; Adam 2016), due to the availability of large pelagic fish resources. Therefore, monitoring the status of large pelagic fisheries in the Maluku region, especially those targeting tuna, is required.

This study aimed to examine several aspects of *T. albacares*: a) biological aspects, including length-weight relationship, b) *T. albacares* exploitation characteristics, including production trends, fishing effort, fishing grounds, fishing season, fishing gear and CPUE and c) management of tuna resources, which includes calculating the catch rate, Maximum Sustainable Yield, Maximum Economic Yield, and Total Allowable Catches of *T. albacares* in the Maluku region.

Material and Method

The research was conducted for 90 days, from March 4 to May 25, 2021, in the Banda Sea, by focusing on fishing ports with high tuna landing potential. Data collection was carried out at several sampling points, as shown in Figure 1.

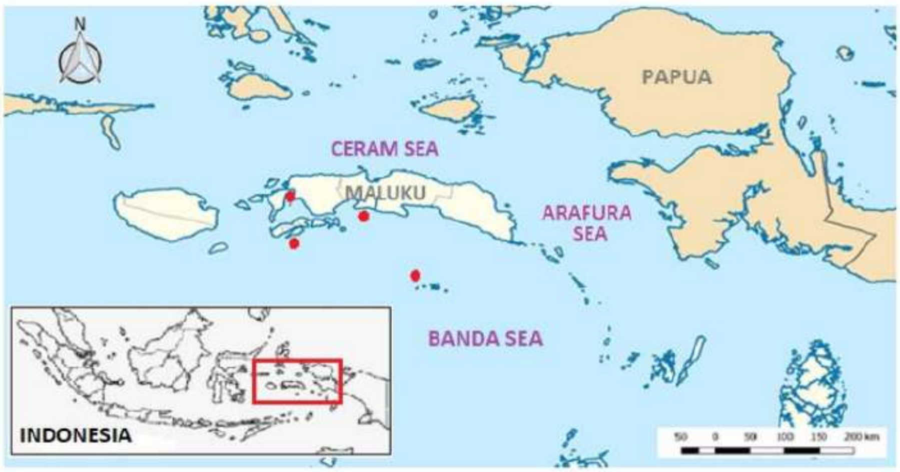

Figure 1. Map of research locations.

Tools and materials. The tools and materials used in this study are as follows: rulers, tape measure, digital scales, cameras, stationery, identification labels, and some samples of tuna.

Methods of data collection. In this study, the applied survey method was the field observation. Determination of the location and fishing gear was carried out by purposive sampling, namely collecting data deliberately according to the desired conditions (Tongco 2007). Meanwhile, the determination of respondents was carried out by accidental sampling, namely the accidental determination of tuna fishermen (Siburian et al 2020). Data collection for *T. albacares* sampling was carried out using the simple random sampling method, by measuring the specimens' length and weight of 10% of the total catch (Mous et al 1995). Secondary data are time series of catches and fishing effort for 5 to 10 years, from the relevant agencies.

Data collection. Primary data collection was carried out by direct observation and measurement (Hardani et al 2020) of landed *T. albacares*. The data collected included: fork length, total weight, sex, and GML. Secondary data needed is in the form of periodic data (time series) of catches and fishing effort for the last 10 years obtained from the Maritime Affairs and Fisheries Service of Maluku Province.

Data analysis

Length frequency distribution. The frequency distribution was obtained by determining the class interval, class mean, and frequency in each length group, then the results were presented in a diagram.

Length-weight relationship. The relationship between length and weight uses a linear allometric model. This model is used to calculate parameters a and b through measurements of length and weight (Brinkman 1993; Nugraha et al 2020; Effendie 1979):

$$W = aL^b$$

Where:
W - individual weights of fish (grams);
L - fork length fish (cm);
a - intercept (intersection of the curve of the relationship of the length of the weight with the y-axis);
b - slope.

To determine the values of a and b, a linear regression analysis, based on the logarithm of the formula above. The linear equation becomes:

$$L_n\ W_{(i)} = L_n\ q + bL_n$$

Then a simple linear equation can be made (Agustian et al 2021; Muhsoni 2019):

$$Y = a + bX_{(i)}$$

Where:
Y - L_n W;
X - Ln;
a' - antilog intercept;
b - slope.

The coefficients of determination and correlation can also be determined through equations.

In this analysis of weight length relationships, what needs to be considered is the value of b which can be interpreted as follows:

1. b < 3: Length gain is faster than weight gain (negative allometry)
2. b = 3: Length gain balanced with weight gain (isometric)
3. b > 3: Weight gain is faster than length gain (positive allometry) (Perangin-angin et al 2015).

To determine the growth pattern, Bailey's t_{test} was needed (Thomas 2013; Nair et al 2015). The t_{test} was run to determine significant differences from the isometric value (b=3) with significant level at 5% (P<0.05). The formula of Bailey's t_{test} is as follows (Fauziyah et al 2021):

$$t_s = \left|\frac{3-b}{Sb}\right|$$

Where:
t_s - Bailey's t_{test};
b - the slope of the linear regression;
Sb - standard error of the b coefficients.

The correlation coefficient (r) to see the closeness of the relationship between length and weight is obtained from the formula bellows (Nurhayati et al 2016).

$$r^2 = \frac{(\sum X_i Y_i)^2}{(\sum X_i^2)(\sum Y_i^2)}$$

$$r = \sqrt{r^2}$$

Where:
r - correlation coefficient is an abstract measure of the degree of closeness of the relationship between x and y ($-1 < r < 1$);
1 - there is a close and positive relationship;
-1 - there is a close and negative relationship;
0 - there is no close relationship.

Length at first caught (Lc). The length of first caught fish (Lc) was estimated by the method (Sparre & Venema 1998):

$$SL = \frac{1}{a + \exp(a - bL)}$$

Where:
SL - estimated value;
a – intercept;
b – slope.

The value of Lc was obtained by plotting the percentage of the cumulative frequency of fish caught with the standard length, where the intersection point between the 50% cumulative frequency curve is the length when 50% of the fish are caught (Diningrum et al 2019). The value of Lc can be calculated through the formula (Sparre et al 1989):

$$Lc = \frac{a}{b}$$

Catch Per Unit Effort (CPUE). Catch data and fishing effort were obtained, then tabulated to determine the value of CPUE. The fishing effort can be expressed as the number of operating days or months, the number of fishing trips or the number of fleets carrying out fishing operations. In this study the fishing effort (effort) used is expressed as the number of trips. The formula that can be used to determine the CPUE value is as follows (Imron et al 2022):

$$CPUE_i = \frac{Catch_i}{Effort_i}$$

Where:
$CPUE_i$ - catch per unit of fishing effort for the period i (tons trip^{-1});
$Catch_i$ - catch for the period i (tons);
$Effort_i$ - fishing effort for the period i (trip).

Standardization of fishing gear. According to Ardelia et al (2018), standardization is done by finding the Fishing Power Index (FPI) value of each fishing gear. The fishing gear used as standard has an FPI value equal to one, while the FPI value for other fishing gear is obtained from the CPUE of the other fishing gear divided by the CPUE of the standard fishing gear. The Gulland formula for calculating FPI is as follows (Gulland 1983):

$$RFP_i = \frac{Ci/Ei}{Cs/Es}$$

Where:
RFP_i - relative fishing power factor of the i^{th} fishing unit;
C_i - the number of catches of the i^{th} fishing unit;
C_s - the standard number of catches of the fishing unit type;
E_i - the effort of catching with the i^{th} fishing unit;
E_s - the standard effort of catching with the fishing unit type.

After obtaining the RFP_i value, the standardized fishing effort is calculated using the formula:

$$\text{Standard effort} = \sum(FPI_i \times effort_i)$$

Production surplus model. The purpose of using the Production Surplus Model is to determine the level of optimal effort, corresponding to a maximum sustainable catch without affecting long-term stock productivity which we usually call Maximum Sustainable Yield (Sari & Nurainun 2022).

MSY can be estimated using the Schaefer model with data on catch and fishing effort in several years using the formula (Sparre & Venema 1998):

$$CPUE = \frac{Y}{f} = \frac{Y(i)}{f(i)}, i = 1, 2, ... n$$

Where:
Y(i) - catch for the period i, I = 1, 2, ...n;
f(i) - fishing effort for the period i.

Determining the value of a (intercept) and b (slope) requires linear regression off(i) to Y(i)/f(i). After the a and b values are obtained, the optimum effort (f_{MSY}) and Maximum Sustainable Yield (MSY) can be calculated by the formula (Kartini et al 2021):

$$f_{MSY} = -\frac{a}{2b} \text{ and } MSY = -\frac{a^2}{4b}$$

The level of utilization of fish resources is a fraction of the maximum Sustainable Yield (MSY) (Zahra et al 2019):

$$\text{Utilization rate \%} = \frac{Ci}{MSY} \times 100$$

Where:
Ci - number of fish caught in year I;
MSY - maximum sustainable yield.

Results and discussion

Distribution of T. albacares length frequency. Based on observations of 339 samples of *T. albacares*, the shortest length was 31 cm and the longest is 126 cm. The length frequency distribution is presented in Figure 2.

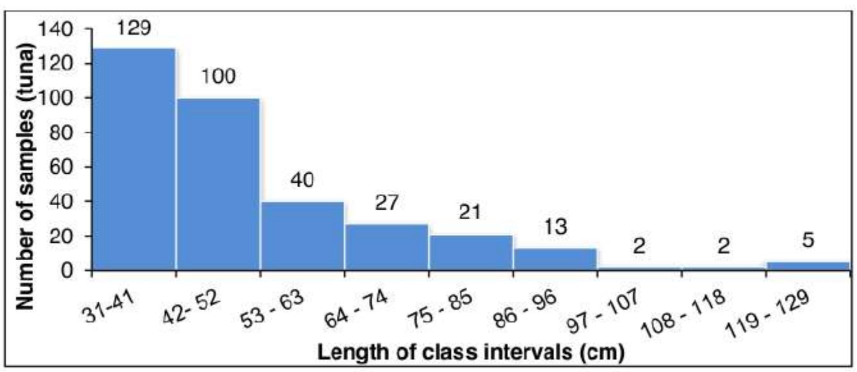

Figure 2. Length frequency distribution of *Thunnus albacares.*

The modal class interval was 31-41 cm: many small fish are caught by trolling liner and purse seiner.

The relationship between length and weight of T. albacares. The relationship between length and weight is presented on the graph, according to the characteristics of the fish growth pattern, as shown in Figure 3.

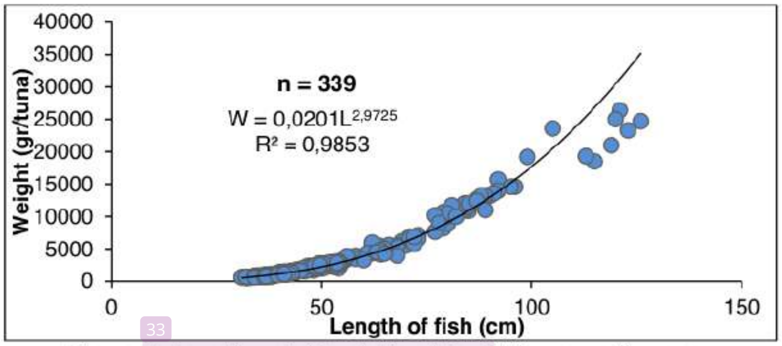

Figure 3. Length-weight relationship of *Thunnus albacares*.

From the results of the analysis of the length-weight relationship of the species *T. albacares*, the following equation was determined: $W=0.0201\ L^{2.9725}$, with a value of $b=2.9725$. Then a t_{-test} was carried out on the value of b at a 95% confidence interval and obtained $t_{count}<t_{table}$ ($t_{count}=1.393$; $t_{table}=1.967$), therefore H_0 was accepted, which means that the increase rates in length and weight are not significantly different, so that it can be said that the increase in length is proportional to the increase in weight (isometric).

From the results of the t_{test}, it is necessary to carry out further calculations to obtain a new *T. albacares* length-weight relationship equation, by substituting the values of $\bar{Y}$ and $\bar{X}$ using $\bar{Y} = a'-3\bar{X}$, namely $W=0.018055\ L^3$. Calculation of the growth pattern was carried out using the t_{test} ($t_{count}=0.05$), at a 95% confidence interval ($\alpha=0.05$), producing a coefficient of determination (R^2) of 0.9928 and a correlation coefficient (r) close to 1. This shows that an increase in the length affects the weight gain, meaning that the correlation or relationship between length and fish weight is strong and positive.

Length at first capture (Lc). Calculation of the size of the first catch of *T. albacares* was carried out using data on the length and number of fish caught in purse seine catches. Based on the observation of the 70 caught specimens, the Lc was 39.55 cm as it can be seen in Figure 4.

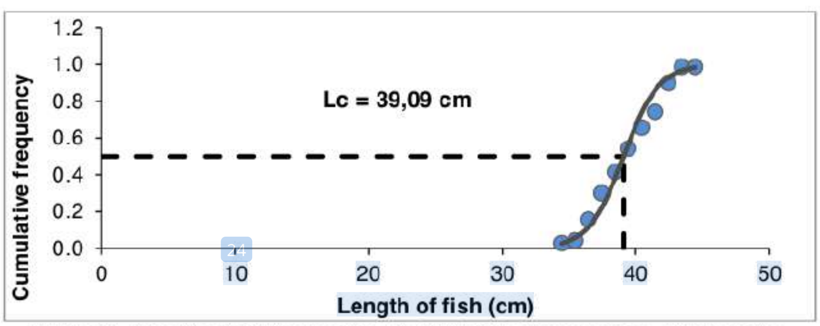

Figure 4. Length at first capture of *Thunnus albacares* on purse seine.

Fishing ground. The dominant fishing grounds for fishermen in the province of Maluku are located in the Banda Sea (FMA RI 714). These areas are usually approached by *T. albacares* due to environmental factors, food availability and they are also spawning and egg-laying areas. The highest catch occurs at the beginning of the East season, also called the harvest season, from October to December. The lean season is from May to July, the western season is from December to January and the transition season is from April to May. The catches obtained depend on the season, currents and wind, which might be obstacles for going to sea and succeeding to make catches.

Stock status in Fishery Management Area - Republic of Indonesia (FMA-RI 714)

CPUE and MSY T. albacares. Table 2 shows the production data and fishing effort of *T. albacares* in FMA RI-714 by hand liner, troll liner, purse seiner, and the pole and liner.

Table 2

FMA RI-714 production and fishing effort

Year	*Production (tons)*					*Trip*			
	Purse seiner	*Trolling liner*	*Hand liner*	*Pole and liner*	*Total*	*Purse seiner*	*Trolling liner*	*Hand liner*	*Pole and liner*
2008	3,868.71	3,813.07	39.29	3,127.51	10,848.57	23,419	427,899	201	8,546
2009	3,997.51	4,961.22	1,500.39	3,754.16	14,213,28	21,373	392,497	248,406	9,457
2010	3,982.52	1,335.69	993.14	2,752.55	9,063.90	43,622	474,562	311,339	8,429
2011	4,710.08	9,739.77	2,424.13	6,639.34	23,513.32	35,888	433,171	191,396	7,641
2012	5,169.07	14,869.32	1,017.65	4,037.61	25,093.65	42,027	432,897	226,447	10,617
2013	19,288.48	10,298.59	3,125.72	3,964.70	36,677.49	32,010	484,526	186,753	10,646
2014	6,094.66	3,863.20	4,381.17	4,397.88	18,736.91	39,017	141,506	293,614	7,797
2015	4,505.92	381.21	2,587.83	5,494.17	12,969.12	34,787	247,776	85,352	8,922
2016	10,159.34	879.72	3,675.05	7,856.27	22,570.37	41,596	291,150	204,868	8,657
2017	13,102.44	1,476.79	5,140.45	8,321.75	28,041.43	38,453	226,620	191,767	8,125
2018	13,661.33	2,145.53	6,076.82	12,722.25	34,605.93	48,078	255,188	157,874	8,698

There are differences in fishing productivity between hand liner, troll liner, purse seiner, and pole and liner, it is necessary to standardize productivity, to obtain the Fishing Power Index (FPI) as can be seen in the Table 3.

Table 3

Productivity and fishing power index (FPI) in *Thunnus albacares*

Year	*Productivity (tons trip^{-1})*			
	Purse seine	*Trolling line*	*Hand line*	*Pole and line*
2008	0.1652	0.0089	0.1955	0.3660
2009	0.1870	0.0126	0.0060	0.3970
2010	0.0913	0.0028	0.0032	0.3265
2011	0.1312	0.0225	0.0127	0.8689
2012	0.1230	0.0343	0.0045	0.3803
2013	0.6026	0.0213	0.0167	0.3724
2014	0.1562	0.0273	0.0149	0.5641
2015	0.1295	0.0015	0.0303	0.6158
2016	0.2442	0.0030	0.0179	0.9075
2017	0.3407	0.0065	0.0268	1.0242
2018	0.2841	0.0084	0.0385	1.4627
Average	0.2232	0.0136	0.0334	0.6623
CPUE	0.2232	0.0136	0.0334	0.6623
FPI	0.3370	0.0204	0.0504	1

Based on Table 3, the huhate is used as standard fishing gear, because its productivity is larger than other fishing gear. Furthermore, the standardization process, resulting from the multiplication of the FPI with the number of fishing gears, produces the standard effort values presented in Table 4.

Table 4

Standardization of *Thunnus albacares* catching efforts

Year	*Purse seiner*	*Trolling liner*	*Hand liner*	*Pole and liner*	*Total effort standard*	*CPUE (ton trip^{-1})*
2008	7,892	8,765	10	8,546	25,213	0.4303
2009	7,203	8,040	12,515	9,457	37,215	0.3819
2010	14,701	9,721	15,686	8,429	48,538	0.1867
2011	12,094	8,873	9,643	7,641	38,251	0.6147

Year	Purse seiner	Trolling liner	Hand liner	Pole and liner	Total effort standard	CPUE (ton trip^{-1})
2012	14,163	8,868	11,409	10,617	45,057	0.5569
2013	10,787	9,925	9,409	10,646	40,768	0.8997
2014	13,149	2,899	14,793	7,797	38,637	0.4849
2015	11,723	5,076	4,300	8,922	30,022	0.4320
2016	14,018	5,964	10,322	8,657	38,961	0.5793
2017	12,959	4,642	9,662	8,125	35,388	0.7924
2018	16,202	5,227	7,954	8,698	38,082	0.9087

The effort and yield data shown in Table 3 will produce CPUE fluctuations every year as shown in Figure 5.

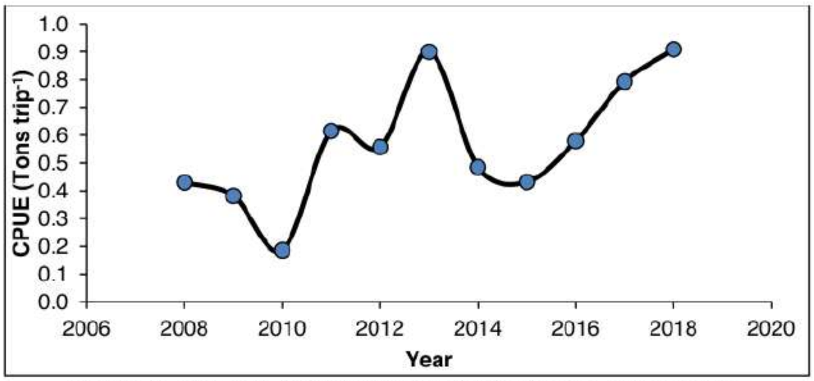

Figure 5. *Thunnus albacares* CPUE fluctuation in FMA-RI 714.

From Figure 5 it can be concluded that 2013 was the highest CPUE point. Even though the CPUE decreased from 2014 to 2015, the conditions did not disturb the sustainability of tuna fishing activities in FMA-RI 714.

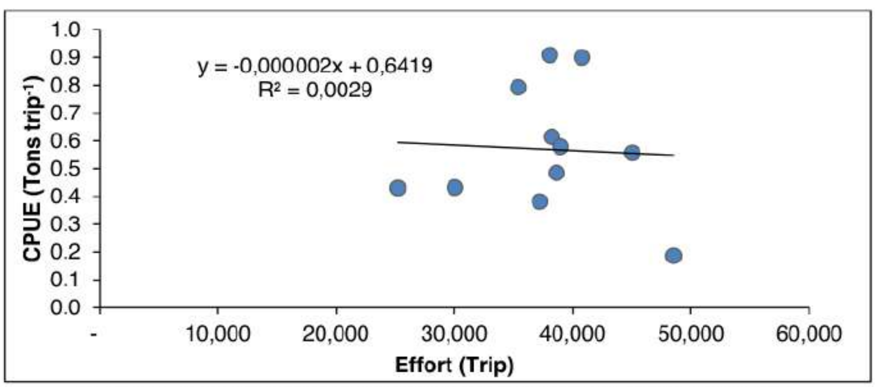

Figure 6. Linear equations of CPUE and effort *Thunnus albacares*.

The relationship between CPUE and effort in Figure 6 shows that the value of the estimation parameter for tuna fish is obtained by an intercept (a) = 0.6419 and a slope (b) = -0.000002 so as to form the Schaefer linear equation CPUE = -0.000002x + 0.6419. This relationship can be interpreted that by catching x units per year, it will reduce the CPUE value by 0.000002 tons per year. The conditions described in the linear equation produce a value of R^2 = 0.0029 which means that around 0.29% the CPUE is influenced by the effort. Thus, the R^2 value indicate that the influence of the variables used in this model is not strong.

Maximum Sustainable Yield (MSY) and Economic Maximum Sustainable Yield (EMSY) calculation data for *T. albacares* in FMA-RI 714 using the Schaefer Linear method are presented in Table 5. The results of biological analysis using the Schaefer Linear model approach can produce an MSY value of 54,027 tons with a standard effort/EMSY of 168,332 trips.

Table 5

MSY and EMSY *Thunnus albacares* Based on Schaefer linear model calculations

Year	*Number of catches (Tons)*	*Total standard effort*	*CPUE (Schaefer)*
I	*Yi*	*X*	*Y*
2008	10,848.5	25,213	0.4303
2009	14,213.2	37,215	0.3819
2010	9,063.9	48,538	0.1867
2011	23,513.3	38,251	0.6147
2012	25,093.6	45,057	0.5569
2013	36,677.5	40,768	0.8997
2014	18,736.9	38,637	0.4849
2015	12,969.1	30,022	0.4320
2016	22,570.3	38,961	0.5793
2017	28,041.4	35,388	0.7924
2018	34,605.9	38,082	0.9087
Total	236,333.9	416,131	6.2676
Average	21,484.9	37,830	0.5697
Intercept a			0.6419
Slope b			-0.000002
MSY Schaefer: -a^2/4b			54,027
EMSY Schaefer: -a/2b			168,332
Total Allowable Catch (TAC) 80% MSY			43,221.80

Based on linear model calculations, biological saturation yields have not occurred in *T. albacares* from FMA RI-714, which is indicated by actual catches that are not close to their sustainable potential (MSY). This is evidenced by the actual catch in 2018 which reached 34,605.9 tonnes, not yet exceeding the potential TAC of 80% of the MSY value (43,221.80 tonnes). The sustainable potential curve (MSY) of *T. albacares* can be seen in Figure 7.

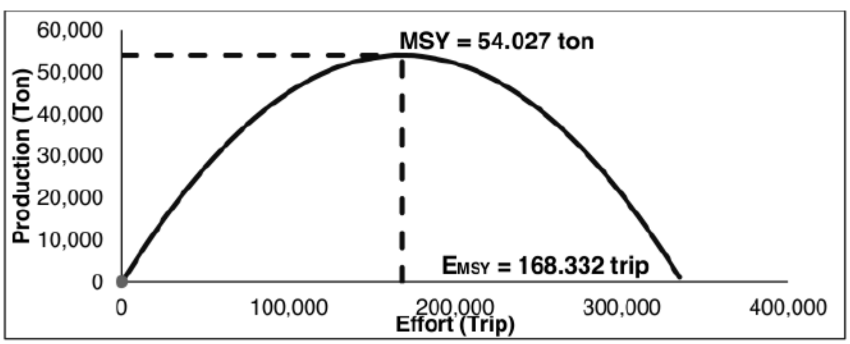

Figure 7. Stock equilibrium curve (MSY) of *Thunnus albacares* in FMA RI-714.

Conclusions. The biological aspects of *T. albacares* in Maluku waters show that the growth pattern of tuna is isometric. The exploitation of *T. albacares* is in a condition where production continues to increase with a low level of fishing gear selectivity, therefore regulating and supervising the fishing gear are required.

Conflict of interest. The authors declare no conflict of interest.

References

Adam L., 2016 [Policy of prohibition on fishing of yellowfin tuna: Impact analysis and solution]. Journal of Economics & Public Policy 7(2):215-227. [In Indonesian].

Agustian D., Megantara E. N., Ihsan Y. N., Cahyandito M. F., 2021 [Analysis of size trends for bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) in Palabuhanratu Archipelago Fishing Port]. Journal of Fisheries and Marine Research 5(3):685-693. [In Indonesian].

Ardelia V., Boer M., Yonvitner Y., 2018 [Precautionary approach for (*Euthynnus affinis*, Cantor 1849) resources nanagement in Sunda Strait]. Journal of Tropical Fisheries Management 1(1):33-40. [In Indonesian].

Barata A., Prisantoso B. I., 2009 [Some types of pomfret fish (Angel fish, *Bramidae*) caught by longline tuna (tuna long line) in the Indian Ocean and aspects of their catch]. BAWAL Widya Capture Fisheries Research 2(5):231-235. [In Indonesian].

Barata A., Novianto D., Bahtiar A., 2012 [Distribution of tuna based on temperature and depth in the Indian Ocean]. Marine Science: Indonesian Journal of Marine Sciences 16(3):165-170. [In Indonesian].

Brinkman A. G., 1993 Estimation of length and weight growth parameters in populations with a discrete reproduction characteristic. IBN Research Report 93/5, Institute for Forestry and Nature Research (IBN-DLO), Wageningen, 42 p.

Chodrijah U., Nugraha B., 2013 Size distribution of tuna caught by longline fishing and their catchment areas in the Banda Sea. Indonesian Fisheries Research Journal 19(1):9-16. [In Indonesian].

Dewi A. N., Saputra S. W., Solichin A., 2016 [Composition of Cantrang catches and biological aspects of greater lizardfish (*Saurida tumbill*) at PPP Bajomulyo, Juwana]. Management of Aquatic Resources Journal 5(2):17-26. [In Indonesian].

Diningrum T. D. B., Triyono H., Jabbar M. A., 2019 [Biological aspects of skipjack tuna in Southeast Celebes]. Journal of Fisheries and Maritime Extension 13(2):139-147. [In Indonesian].

Effendie M. I., 1979 [Fisheries biology method]. Dewi Sri Foundation, 112 p. [In Indonesian].

Fauziyah, Mustopa A. Z., Fatimah, Purwiyanto A. I. S., Rozirwan, Agustriani F., Putri W. A. E., 2021 Morphometric variation of the horseshoe crab *Tachypleus gigas* (*Xiphosura: Limulidae*) from the Banyuasin estuarine of South Sumatra, Indonesia. Biodiversitas 22(11):5061–5070.

Firdaus M. L., 2018 Physical properties and nutrients distribution of seawater in the Banda Sea - Indonesia. IOP Conference Series Earth and Environmental Science 184(1):1-7.

Gulland J. A., 1983 Fish stock assessment. A Manual of basic methods. John Wiley and Sons. Inc., 223 p.

Hardani, Auliya N. H., Andriani H., Fardani R. A., Ustiawaty J., Utami E. F., Sukmana D. J., Istiqomah R. R., 2020 [Qualitative & quantitative research methods]. CV. Yogyakarta Group Science Library, 245 p. [In Indonesian]

Hare S. R., Williams P. G., Ducharme-Barth N. D., Hamer P. A., Hampton W. J., Scott R. D., Vincent M. T., Pilling G. H., 2020 The western and central Pacifictuna fishery: 2019 overview and status of stocks. Tuna Fisheries Assessment Report no. 20. Noumea, New Caledonia, Pacific Community, 49 p.

Hidayat T., Chodrijah U., Noegroho T., 2014 [Characteristics of trolling in the Banda Sea]. Indonesian Fisheries Research Journal 20(1):43-51. [In Indonesian].

Imron M., Baskoro M. S., Komarudin D., 2022 [Production, Fishing Season and Fishing Ground of the Dominant Fish (*Euthynnus affinis*, *Menemaculata, Leiognathus equulus*) Caught by Boat Seine in Palabuhanratu Indonesia]. Omni-Akuatika 18(2):107-116.

Karman A., Martasuganda S., Sondita M. F. A., Baskoro M. S., 2013 Capture fishery biology of skipjack in western and southern water of North Maluku Province. International Journal of Sciences: Basic and Applied Research (IJSBAR) 16(1):432-448.

Kartini N., Boer M., Affandi R., 2021 [CPUE analysis (catch per unit effort) and sustainable potential Tembria fisheries *(Sardinella fimbriata)* resources in Sunda strait waters]. Manfish Journal 1(3):183-189. [In Indonesian].
Khan A. M. A., Gray T. S., Mill A. C., Polunin N. V. C., 2018 Impact of a fishing moratorium on a tuna pole and line fishery in eastern Indonesia, Marine Policy 94:143-149.
Manurung V. T., 2016 [Performance and institutional credit for small-scale tuna fishing in Eastern Indonesia]. Agro Economics Research Forum 16(2):60-74. [In Indonesian].
Mous P. J., Goudswaard P. C., Katunzi E. F. B., Budeba Y. L., Witte F., Ligtvoet W., 1995 Sampling and measuring. In: Fish stocks and fisheries of Lake Victoria. A handbook for field observations. Witte F., van Densen W. L. T. (eds), pp. 55-82, Samara Publishing Ltd.
Muhsoni F. F., 2019 [Fish population dynamics (Practicum guidelines and applications)]. Utmpress 8(2):1-79. [In Indonesian].
Noegroho T., Chodrijah U., 2015 [Population parameters and recruitment patterns of bullet tuna (*Auxis rochei* Risso, 1810) in West Sumatera waters]. BAWAL Widya Capture Fisheries Research 7(3):129-136. [In Indonesian].
Nugraha E., Yudho G. S., Jaenudin A., Yusrizal, Kusmedy B., Kusnidar A., Husen E. S., 2020 Relationship between length and weight of skipjack tuna (*Katsuwonus pelamis*) purse seine catching in the Maluku Sea, Indonesia. AACL Bioflux 13(1):330-345.
Nurhayati N., Fauziyah F., Bernas S. M., 2016 [Length-weight relationship and fish growth patterns in the Musi River Estuary, Banyuasin Regency, South Sumatra]. Maspari Journal 8(2):111–118. [In Indonesian].
Perangin-angin H. T., Afiati N., Solichin A., 2015 [Study biological fisheries aspect of pelagic cephalopods landed at TPI Tambaklorok, Semarang]. Management of Aquatic Resources 4(1):107-115. [In Indonesian].
Post V., Squires D., 2020 Managing bigeye tuna in the western and central Pacific Ocean. Frontiers in Marine Science 7(619):1-9.
Sari C. P. M., Nurainun, 2022 [Bioeconomic analysis and sustainable potential of skipjack tuna in Aceh Province]. Journal of Agricultural Economics Unimal 5:22-27. [In Indonesian].
Satrioajie W. N., Suyadi, Syahailatua A., Wouthuyzen S., 2018 The importance of the Banda Sea for tuna conservation area: A review of studies on the biology and the ecology of tuna. IOP Conference Series Earth and Environmental Science 184(1):1-11.
Siburian E., Ginting M., Salmiah, 2020 Analysis of consumer behaviour in purchasing fresh fish in traditional and modern market (case study: Medan Sunggal District, Medan City). IOP Conference Series Earth and Environmental Science 454:1-5.
Sparre P., Ursine E., Venema S. C., 1989 Introduction to tropical fish stock assessment Part 1. Manual, FAO Fisheries Technical paper, No. 306.1, Rome, FAO, 337 p.
Sparre P., Venema S. C., 1998 Introduction to tropical fish stock assessment Part 1. FAO Fisheries Technology Paper No.306/1, Rev. 2, Rome, FAO, 407 p.
Tangke U., Mallawa A., Zainuddin M., 2011 [Analysis of the relationship between oceanographic characteristics and catches of yellowfin tuna (*Thunnus albacares*) in the Banda Sea waters]. Agrikan: Journal of Fisheries Agribusiness 4(2):1-14. [In Indonesian].
Tauda I., Hiariey J., Lopulalan Y., Bawole D., 2021 Management policy of small-scale tuna fisheries based on island cluster in Maluku. IOP Conference Series Earth and Environmental Science 777:1-10.
Thomas S., 2013 Allometric relationships of short neck clam *Paphia malabarica* from Dharmadom estuary, Kerala. Journal of the Marine Biological Association of India 55(1):50–54.
Tongco M. D. C., 2007 Purposive sampling as a tool for informant selection. Ethnobotany Research and Applications 5:147–158.
Udupa K. S., 1986 Statistical method of estimating the size at first maturity offishes. Fishbyte 4(2):8-10.
Widodo A. A., Nugraha B., 2009 [Tuna fishery based in Kendari, Southeast Sulawesi]. BAWAL 299–307. [In Indonesian].

Widodo A. A., Mahulette R. T., Satria F., 2015 [Stock status, exploitation and management options for tuna resources in the Banda Sea]. Journal of Indonesian Fisheries Policy 7(1):45–54. [In Indonesian].

Zahra A. N. A., Susiana S., Kurniawan D., 2019 [The sustainable potential and utilization rate of yellowtail scad fish (*Atule mate*) landed on Kelong Village, Bintan Regency, Indonesia]. Akuatikisle: Journal of Aquaculture, Coasts and Small Islands 3(2):57-63. [In Indonesian].

*** JICA, 2010 Data collection survey on outer-ring fishing ports development in the Republic of Indonesia (Final Report). Japan International Cooperation Agency (JICA) INTEM Consulting Inc., 155 p.

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