Analysis of growth and exploitation rate in yellowfin tuna (*Thunnus albacares*) landed in OFP Bungus and NFP Palabuhanratu, Indonesia

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Abstract. Determining the fish population structure is one of the strategies for predicting population conditions in an aquatic area. Data on the population structure include the estimation of age, growth, and mortality. Therefore, this research aimed to identify biological aspects, including size distribution, growth parameters, and exploitation rate of yellowfin tuna (*Thunnus albacares*) landed in OFP Bungus and NFP Palabuhanratu, Indonesia. The analysis at OFP Bungus showed that the number of *T. albacares* samples was 7,830 for a frequency distribution pattern of 55-189 cmFL. The relationship between length and weight had a negative allometric coefficient (b=2.8353), with a K_{nn} value of 0.86-0.97. Furthermore, the growth parameters L∞, condition factor (K) and Lc50 showed values of 194.25 cmFL, 0.40 $year^{-1}$ and 143.21, respectively. Estimation of mortality and exploitation rates returned values of 1.58, 0.48, 1.10, and 0.70 $years^{-1}$ for total mortality (Z), natural mortality (M), fishing mortality (F), and exploitation rate (E), respectively. The analysis of *T. albacares* catch at NFP Palabuhanratu was based on a number of 2,313 fish samples, the class range was 100-164 cmFL, and the length-weight relationship had a negative allometric (b=2.9435), with a K_n value of 0.84-0.86. The growth parameter L∞ value was 168.8 cmFL, with a K and Lc50 values of 0.44 $year^{-1}$ and 141.56, respectively. Estimation of mortality and exploitation rate values obtained 1.43, 0.53, 0.60, and 0.63 $year^{-1}$ for Z, M, F, and E, respectively. In terms of the usage rate, overfishing occurs when the fishing-related mortality exceeds the natural mortality. However, there are differences in the exploitation rate of *T. albacares* landed at OFP Bungus and NFP Palabuhanratu, with a status categorized as "overfished", and in their maximum sustainable yield.
Key Words: analysis, biological aspect, estimation, population, yellowfin tuna.

Introduction. Biology data is one of the basic information in fishery management and is very important to realize the optimum sustainable and responsible management of the resources. Excessive, not environmentally friendly and unmeasured fishing activities affect the condition of fishery resources, therefore raising awareness is necessary. The tuna fishing business has experienced an increase in catch productions, but Nurdin (2017) stated that many landed *Thunnus albacares* specimens still have a size that is not suitable for catching. Furthermore, the addition of supplementary fishing fleet and the increase of the effort lead to other problems related to the exceeded catch capacity. The high effort to catch *T. albacares* that is not suitable for catching in the wild and the technological advances in the fishing sector also cause a decrease in the fish size. The frequency of fishing trips can impact the number, spawning opportunities and low recruitment of *T. albacares* in the wild.

Information related to the fish species' relationship between length and weight, as well as to the conditional factors of their biological aspect is very useful for estimating the body weight, as an indication of the body condition (e.g. obesity) and health (in terms of physical capacity), and the relationship to the water conditions. According to Kumar et al

(2022), the length-weight relationship is important in determining the fish population's growth pattern. The "K" value can indicate the health level of a fish species, while the current nutritional conditions or the sources of the energy spent by cyclical activities describe the relationship between the environmental conditions and the behavioral features of the species (Yilmaz et al 2012; Mensah 2015; Bulanin et al 2017). The fish stock population in seas is dynamic: both additions and losses of stocks occur in nature. The addition can be caused by recruitment, entry of other individuals from different locations, birth, and growth. Meanwhile, the reduction can be caused by the population's fraction exiting the community and by the mortality, both natural and due to fishing activities (Nurdin 2017).

The status and structure of population dynamics are used to understand the current state of fishery changes. Policymakers and resource managers need to implement sustainable resource utilization strategies (Kaymaram et al 2014). Reproductive biology in fisheries is an important prerequisite for a sustainable management and utilization (Soe et al 2022). These biological parameters are age, growth, mortality, and size at maturity. The differences in the growth and exploitation rate parameters of *T. albacares* landed in the two locations were hypothesized. Research on *T. albacares*'s growth and exploitation rate has already been carried out, but in other locations. This study provides policymakers with scientific criteria for managing the *T. albacares* fisheries, nationally. Based on the collected information, it aims to identify the biological aspects, including size distribution, growth, and exploitation rate parameters of yellowfin tuna landed at OFP Bungus and NFP Palabuhanratu.

Material and Method

Description of the study sites. The research was carried out from January to December 2021, at the Ocean Fishing Port (OFP) Bungus, in the Western Sumatra, and at the Nusantara Fishery Port (NFP) of Palabuhanratu, in the Western Java, from January to December 2019 (Figure 1).

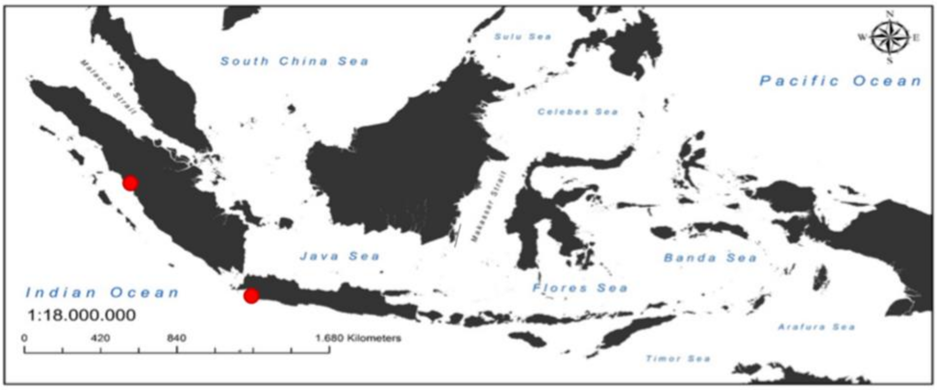


Figure 1. Sampling sites of *Thunnus albacares* captured in the OFP Bungus and NFP Palabuhanratu.

Data collection method. The primary data collection was conducted from January 2021 to December 2021 on the length and weight, assuming the fish came from the same stock. Data collection for a year represented the catch data from all seasons in Indonesia. They were obtained from 260 and 72 *T. albacares* hand line fishing units based on OFP Bungus and NFP Palabuhanratu, respectively. These fishing fleets operate in 228 FADs scattered in the waters of the fishery management area (WPP) 572 and 573. Enumerators recorded the entry data at each location, and the number of samples successfully measured was 7,830 at the OFP Bungus and and 2,313 fish at the NFP Palabuhanratu. Measurements were made on the total length from the tip of the mouth to the tail, using a meter with an accuracy of 0.5 mm.

Data analysis method. The data used to achieve the research objectives was analyzed as presented below.

Length frequency distribution*.* The length frequency distribution was obtained by determining the class interval, the median of the class, and the frequency in each length group. The length frequency distribution determined in the same class interval was plotted in a graph (Omar 2003).

Weight length analysis. Analysis of the relationship between length and weight was performed to determine the growth pattern of yellowfin tuna landed at OFP Bungus and NFP Palabuhanratu, following the equation (Effendie 2002):

$$W=aL^b$$

Where:
W - the weight of the fish (kg);
L - the total length of the fish (cm);
a and b - the coefficients of weight growth.

The relationship between length and weight can be seen from the value of constant b (as an estimator of the closeness level of the relationship between the two parameters) by using the hypothesis:
H_0: $b = 3$, the relationship between length and weight is isometric (the weight growth pattern is proportional to the length growth pattern)
H_1: $b \neq 3$, the relationship between length and weight is allometric (the weight growth pattern is not proportional to the length growth pattern)

The two kinds of growth patterns are positive allometric (b>3), indicating that weight grows faster than length, and negative allometric (b<3), indicating that length grows faster than weight.

Condition factor. The condition factor shows the good condition of the fish, in terms of physical capacity for survival and reproduction. It was calculated using a metric system based on the relationship between the length and weight of the sample fish. The isometric fish growth is given as (Effendie 2002):

$$K = \frac{10^5 W}{L^3}$$

Where:
K - the condition factor;
W - the weight of the fish (g);
L - the total length of the fish (cm).

If fish growth takes place allometrically, then the following equation is used (Effendie 2002):

$$K_n = \frac{W}{aL^b}$$

Where:
K_n - the relative condition factor;
W - the weight of the fish (g);
L - the total length of the fish (cm);
a and b - constants.

Estimation of growth parameters. Growth parameters (K and $L\infty$) were analyzed using the ELEFAN (Electronic Length Frequency Analysis) method in the FISAT II program package (Gayanilo et al 2005). The growth parameter t_0 was calculated through Pauly's (1983) equation as follows:

$$\text{Log}(-t_0) = -0.3922 - 0.2752 \text{ Log } L\infty - 1.038 \text{ Log } K$$

Length first caught (Lc). Estimation of fish length at a certain age (Lt) was based on the von Bertalanffy equation (Sparre & Venema 1999) as follows:

$$Lt = L\infty\ (1 - e\text{-}K(t\text{-}t_0))$$

Where:
Lt - theoretical length of fish at a certain age;
L∞ - asymptotic length;
K - growth coefficient;
t - theoretical age of fish;
t_0 - theoretical age of fish at zero length.

Mortality and exploitation rate. The estimation of the total mortality rate (Z) was analyzed using the "catch curve" in the FISAT II program package (Gayanilo et al 2005). Meanwhile, the natural mortality rate (M) was estimated using Pauly's (1983) empirical formula with data on the average annual water surface temperature (T) as follows:

$$\text{Log}(M) = -0.0066 - 0.279 \text{ Log } L\infty + 0.6543 \text{ Log } K + 0.4634 \text{ Log } T$$

Where:
M - natural mortality rate;
L - maximum fish fork length (cm);
K - growth coefficient (cm $year^{-1}$);
T - average surface temperature (°C).

Mortality and exploitation rate (E) were calculated by the equation (Pauly 1983) as follows:

$$Z = M + F$$
$$E = F/Z$$

Where:
Z - total mortality;
M - natural mortality;
F - fishing mortality.

Results

Length frequency distribution. During the research, the number of *T. albacares* obtained at OFP Bungus and NFP Palabuhanratu was 7,830 and 2,313 fish, with a total length of 55–189 cm and 100-164 cm can be seen in Figure 2, with a weight of 5–98 kg and 19-84 kg, respectively. The class interval from the two locations is shown in Figure 1. Based on the analysis, these results are not different from Nugroho et al (2018), with the catch size of *T. albacares* ranging from 76-176 cmFL. The data on the size distribution is not different from Zhu et al (2010), where the value in the waters of the Atlantic, Indian, and East Pacific Oceans is 83-176, 78-171, and 93-170 cm with a mode size of 143, 125, and 129 cmFL, respectively.

Based on the analysis results, the length frequency distribution of *T. albacares* between the two locations has different class interval values. This can be caused by several influencing factors, including the use of fishing gear by fishermen in both locations. In using gear such as fishing rods, the bait used greatly affects the distribution in the class intervals of fish obtained. The selection of fishing gear and bait used is also influenced by the waters characteristics and fishermen's habits in using fishing gear in each area.

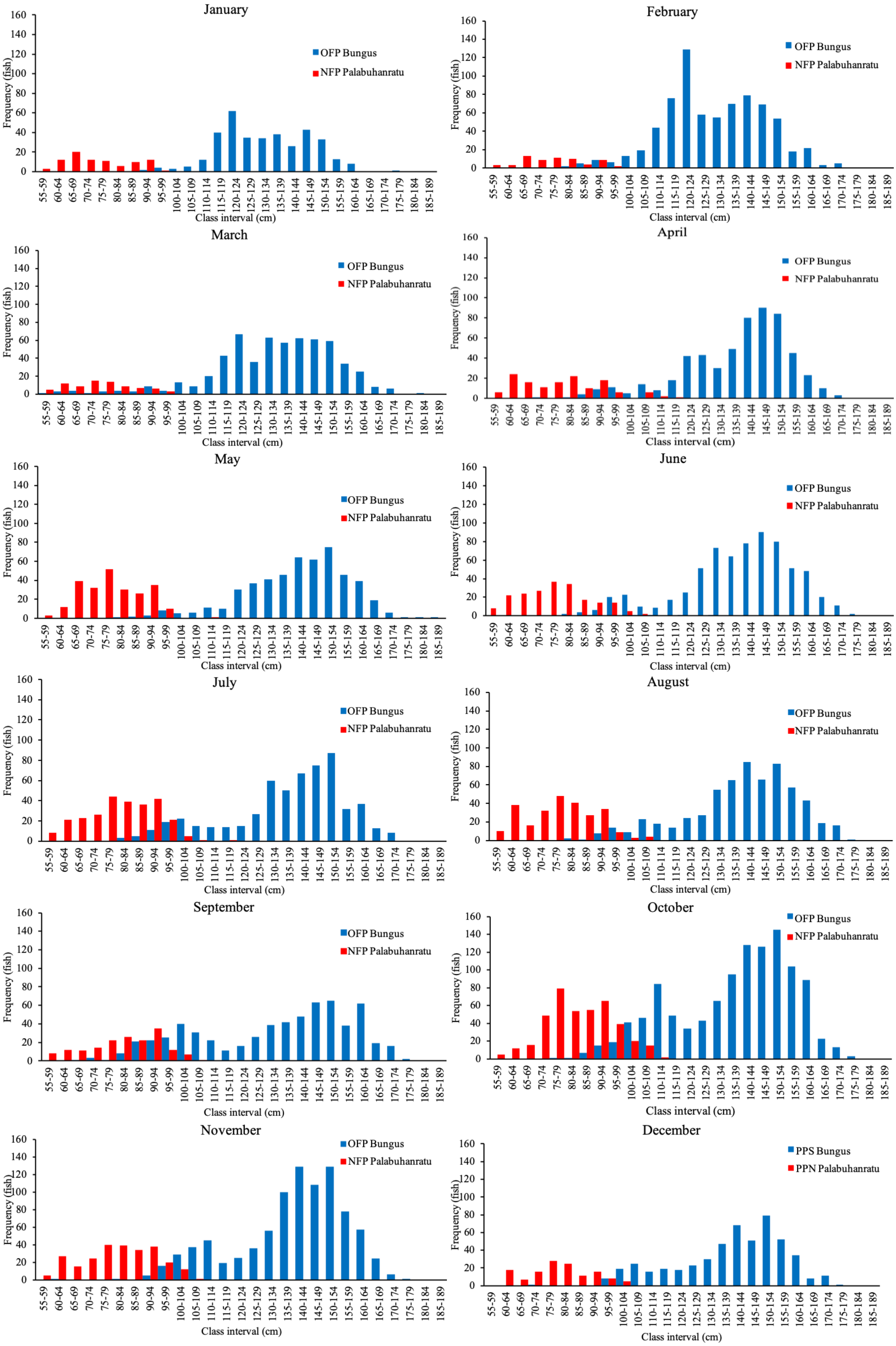
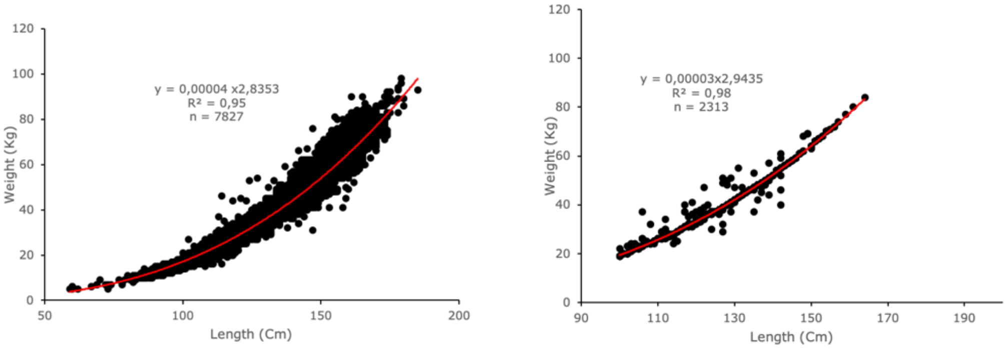


Figure 2. Length frequency distribution of *Thunnus albacares*.

The relationship between length and weight of T. albacares. Analysis of the relationship between length and weight produced the growth pattern model shown in Figure 3.

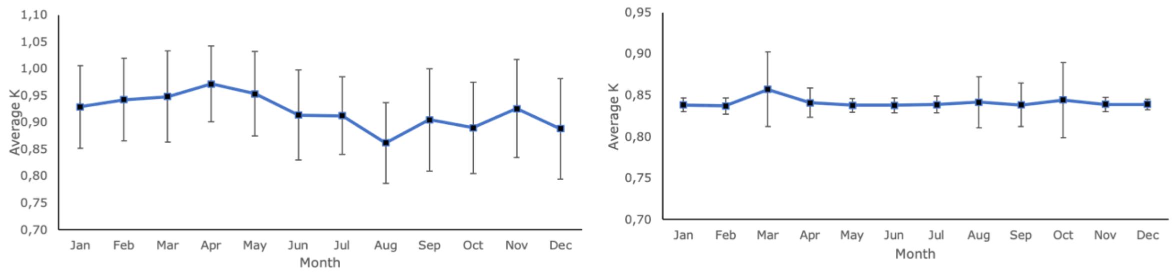


(a) (b)

Figure 3. The relationship between the length and weight of *Thunnus albacares*: (a) OFP Bungus, (b) NFP Palabuhanratu.

Based on the measurement results, the relationship between the length and weight of *T. albacares* showed a negative allometric growth pattern. OFP Bungus and NFP Palabuhanratu obtained an a-value of 0.000004 and 0.00033 and a b-value of 2.8353 and 2.9435 with a correlation coefficient of 0.95 and 0.98, respectively. This result is similar to the research by Nugroho et al (2018) related to the relationship between length and weight of *T. albacares*, which obtained a correlation coefficient of 2.848, with a determination of 0.95, in the negative allometric. From both research sites, negative allometric means that *T. albacares* has faster growth in length than weight.

Condition factor. The condition factor value at OFP Bungus and NFP Palabuhanratu ranged from 0.86–0.97 and 0.84–0.86, respectively, as shown in Figure 4.



(a) (b)

Figure 4. Condition factor value (K_n) of *Thunnus albacares*: (a) OFP Bungus, (b) NFP Palabuhanratu.

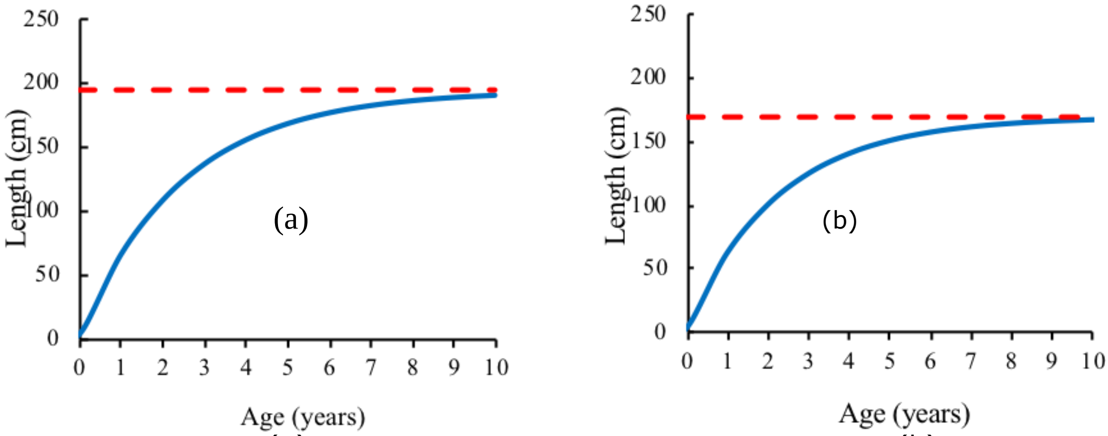
T. albacares caught has a fluctuating condition factor value based on the length of the FL and the fishing season, age differences, gonad maturity, environmental conditions, and food availability. Generally, smaller fish have a higher relative condition factor that decreases with the size increase (Agustina et al 2021). The difference in the relative condition factor between small and larger fish is caused by the difference in the growth and maturity level of the gonads. Smaller fish are in the somatic growth phase, thus, they grow more quickly and have a greater condition factor. In larger fish, the energy is used for the gonad development process hence the condition factor value is smaller (Faizah et al 2011).

Estimation of growth parameters. Estimating growth parameters was performed through an analysis of size cohort separation using the ELEFAN I method in the FISAT II program. Based on fish size cohort data, growth parameters could be estimated, including asymptotic length (L∞), growth coefficient (K), and theoretical age at zero fish length (t_0) analyzed using the von Bertalanffy model presented in Figure 5 and estimation of growth parameters in Table 1.

Table 1

Estimation of yellowfin tuna growth parameters

Location	*Growth parameters*		
	L∞	*K (years^{-1})*	*t_0*
OFP Bungus	194.25	0.40	-0.690
NFP Palabuhanratu	168.8	0.44	-0.635



(a) (b)

Figure 5. Von Bertalanffy's growth curve; (a) OFP Bungus, (b) NFP Palabuhanratu.

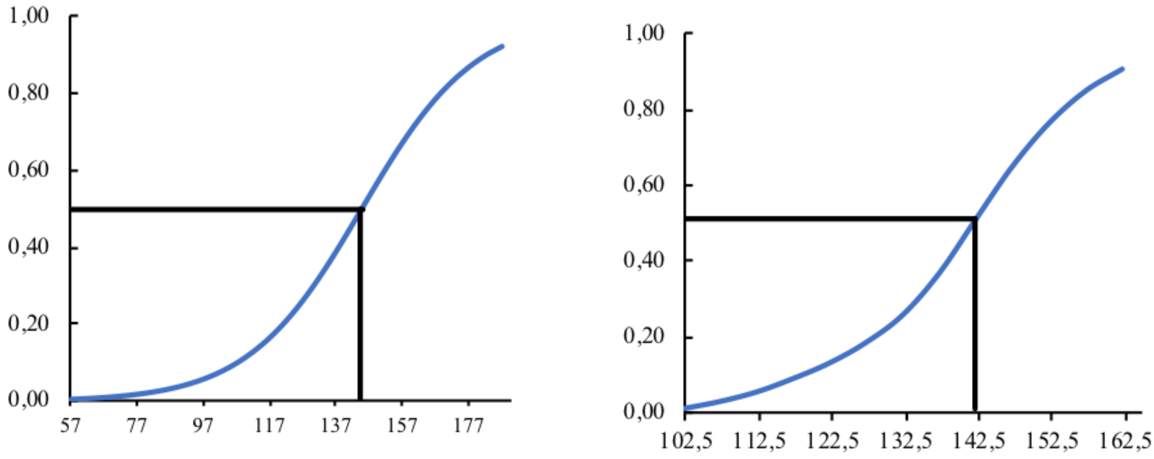
Observation of growth parameters in *T. albacares* landed in OFP Bungus showed asymptotic length (L∞)=194.25 cmFL, K=0.40 years^{-1}, and t_0=-0.690 years. Meanwhile, the growth parameters at NFP Palabuhanratu produced asymptotic length (L∞)=168.8 cmFL, K 0.44 years^{-1}, and t_0=-0.635 years. This value is close to several observations in other locations, with an asymptotic length (L∞) ranging from 151 to 233 cmFL, a growth rate (K) from 0.3 to 0.88 years $^{-1}$, and a theoretical age at zero length (t_0) ranging from -0.70 to 0.19 years. Based on the results, the asymptotic length (L∞) of *T. albacares*in OFP Bungus and NFP Palabuhanratu is 194.25 and 168.8, respectively. The maximum length in OFP Bungus is greater than in NFP Palabuhanratu. According to Langley et al (2009), in the Indian Ocean, the size of yellowfin tuna caught ranged from 30 to 180 cm (fork length). based on the results of research by Hashemi et al (2020), the value (L∞) is 177 cm and the growth coefficient K=0.54 years^{-1}. The maximum age is less than 10 years, with the gonad maturity at 2 to 5 years, and can grow to a maximum size of 180-200 cm (ICCAT 2011; ISSF 2012; IOTC 2012). Damora & Baihaqi (2013) stated that the slow growth of yellowfin tuna (Thunnus albacares) is strongly influenced by food factors, aquatic environment, and growth phase. Young *T. albacares*will grow faster, hence it is necessary to consider the right time to catch this fish based on resources and economy.

Length first caught (L_c). The length at the first capture is the length of 50% of fish caught in the water. The analysis for the length at the first capture is presented in Table 2, with the graph in Figure 6.

Table 2

Length first caught (Lc)

Location	*Lc (cm)*
OFP Bungus	143.21
NFP Palabuhanratu	141.56



(a) (b)

Figure 6. Length of *Thunnus albacares* first capture; (a) OFP Bungus, (b) NFP Palabuhanratu.

The results showed that the length at the first capture (Lc) of *T. albacares* landed at OFP Bungus and NFP Palabuhanratu was 143.21 cmFL and 140 cmFL, respectively. According to Damora & Baihaqi (2013), the Lc of yellowfin tuna caught using a hand line or longline was 133.85 cmFL. In this research, TKG observation was not carried out because the fishermen cleaned the entrails of the caught fish on the boat. This was conducted to maintain the freshness of the caught fish, and thus the meat could last a longer time, avoiding a quick rotting. Therefore, the length at first maturity (Lm) was seen from several existing research references. According to Nugroho et al (2018), the Lm was 100 cmFL, and the ½ L∞ value of yellowfin tuna in July-August 2019 was 93 cmFL. The calculation result of the size first caught (Lc) was 140 cmFL. The value of Lc>Lm indicates that *T. albacares* in the Indian Ocean have mostly spawned and can be caught. The average fish first caught has passed the gonad maturity size, hence yellowfin tuna in the Indian Ocean is thought to have reproduced.

Mortality and exploitation. The total mortality rate (Z) was estimated using a linearized catch curve method based on length data. Mortality (Z) consisted of natural (M) and fishing mortality (F). The exploitation rate of fish resources was estimated through the relationship between natural and fishing mortality. The exploitation rate was analyzed using fish length data, hence the calculation was based on primary biological data. The values of mortality (M, F, Z) and exploitation rate (E) are shown in Table 3.

Table 3

Mortality and exploitation of *Thunnus albacares*

Location	*Mortality*			
	Z (years^{-1})	*M (years^{-1})*	*F (years^{-1})*	*E (%)*
OFP Bungus	1.58	0.48	1.10	0.70
NFP Palabuhanratu	1.19	0.53	0.90	0.63

The decrease in the catch of *T. albacares* indicates a decrease in the water's potential as fishing ground. This can also be seen in the high mortality rate of fish as a result of exploitation or natural conditions. The catch mortality value (F) for *T. albacares* from both locations was higher than the natural mortality (M). Therefore, more fish die from fishing activities than naturally. Natural mortality is a dynamic parameter that will change due to predators, indirectly changing the size cohort and fish age (Powers 2014). Factors that affect mortality rate include egg and larval phases, environmental factors, such as temperature and salinity, predation, hunger and disease (Houde 2002), physiological changes (Geffen et al 2007), and the density of a fish population (Jorgensen & Holt 2013; Nash & Geffen 2012). According to Widodo & Suadi (2006), a high fishing mortality rate can indicate a growth of the overfishing. According to IOTC (2021), the probability of the stock being in the red Kobe quadrant in 2020 is estimated to be 68%. On the weight-of-evidence available since 2018, *T. albacares* stock is subject to overfishing.

Conclusions. *T. albacares* landed in both locations and were included in the negative allometric. The caught fish had a faster length growth than weight, with a wide length distribution. A large asymptotic length (L∞) was found in sample specimens from OFP Bungus. In terms of the usage rate, overfishing occurs when the fishing-related mortality exceeds the natural mortality. However, there are differences in the exploitation rate of *T. albacares* landed at OFP Bungus and NFP Palabuhanratu, with a status categorized as overfishing, and in their maximum sustainable yield.

Conflict of interest. The authors declare no conflict interest.

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References

Agustina M., Sulistyaningsih R. K., Wujdi A., 2021 The relationship between length and weight and condition factors of yellowfin tuna (*Thunnus albacares*, Bonnaterre, 1788) was landed in Prigi, East Java. BAWAL, pp. 109-117.

Bulanin B. M., Masrizal Z. A., Muchlisin, 2017 Length-weight relationships and condition factors of the white spotted grouper *Epinephelus coeruleopunctatus* Bloch, 1790 in the coastal waters of Padang City, Indonesia. Aceh Journal of Animal Science 2(1):23-27.

Damora A., Baihaqi, 2013 Fish size structure and population parameters of yellowfin (*Thunnus albacares*) in Banda Sea Waters. BAWAL 5(1):59-65.

Effendie M. I., 2002 Fisheries biology. Nusantara Library Foundation, Yogyakarta, Indonesia, 163 p.

Faizah R., Aisyah, 2011 Species composition and size distribution of large pelagic fish caught by hand line in Sendang Biru, East Java. BAWAL, pp. 377-385.

Gayanilo F. C. J., Sparre P., Pauly D., 2005 FAO-ICLARM stock assessment tools II (FiSAT II). FAO Computerized Information Series (Fisheries) No. 8, FAO, Rome, 168 p.

Geffen A. J., van der Veer H. W., Nash R. D. M., 2007 The cost of metamorphosis in flatfishes. Journal of Sea Research 58:35-45.

Hashemi S. A. R., Doustdar M., Gholampour A., Khanehzaei M., 2020 Length-based fishery status of yellowfin tuna (*Thunnus albacares* Bonnaterre, 1788) in the northern waters of the Oman Sea. Iranian Journal of Fisheries Science 19(6):2790-2803.

Houde E. D., 2002 Mortality. In: Fishery science. The unique contributions of early life stages. Fuiman L. A., Werner R. G. (eds), pp. 64–87, Blackwell Publishing, Oxford.

Jorgensen C., Holt R. E., 2013 Natural mortality: its ecology. How is shapes fish life histories, and why it may be increased by fishing. Journal of Sea Research 75:8-18.

Kaymaram F., Seyed A. H., Mohammad D., 2014 Estimates of length-based population parameters of yellowfin tuna (*Thunnus albacares*) in the Oman Sea. Turkish Journal of Fisheries and Aquatic Sciences 14:101-111.

Langley M., Herrera J. P., Hallier, Million J., 2009 Stock assessment of yellowfin tuna in the Indian Ocean using MULTIFAN-CL. IOTC 2009-WPTT-10, IOTC CTOI, 72 p.

Mensah S. A., 2015 Weight-length models and relative condition factors of nine freshwater fish species from the Yapei Stretch of the WhiteVolta. Ghana. Elixir Applied Zoology 79(1):30427-30431.

Nash R. D. M., Geffen A. J., 2012 Mortality through the early life-history of fish: What can we learn from European plaice (*Pleuronectes platessa* L.). Journal of Marine Systems 93:58-68.
Nugroho S. C., Jatmiko I., Wujdi A., 2018 The growth patterns and condition factors of yellowfin tuna, *Thunnus albacares* (Bonnaterre, 1788) in the Eastern Indian Ocean. Journal Iktiologi Indonesia 18(1):13-21.
Nurdin E., 2017 The FADs as a tool for managing sustainable tuna fisheries; yellowfin tuna (*Thunnus albacares*). PhD thesis, Bogor Agricultural Institute Graduate School, Bogor, Indonesia, 145 p.
Omar A. B. S., 2003 Fishery Biology practicum module. Faculty of Marine Science and Fisheries, Hasanudin University, 168 p.
Pauly D., 1983 Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical Paper, No. 234, 52 p.
Powers J. E., 2014 Age-specific natural mortality rates in stock assessment: size-based vs density-dependent. ICES Journal of Marine Science 71(7):1629-1637.
Soe K. K., Hajisamae S., Petchsupa N., Jaafar Z., Fazrul H., Pradit S., 2022 Reproductive biology of short mackerel, *Rastrelliger brachysoma*, of Pattani Bay, Lower Gulf of Thailand. Songklanakarin Journal Science Technology 44(1):103-111.
Sparre P., Venema S., 1999 Introduction to tropical fish stock assessment. Center for Fisheries Research and Development, Book 1: Manual. Fisheries Research and Development Agency, Jakarta, Indonesia, 438 p.
Widodo J., Suadi, 2006 Marine fisheries resource management. Gadjah Mada University Press, Yogyakarta, Indonesia, 252 p.
Yilmaz S., Yazıcıoğlu O., Erbaşaran M., Esen S., Zengin M., Polat N., 2012 Length-weight relationship and relative condition factor of whitebream, *Blicca bjoerkna* (L., 1758), from Lake Ladik, Turkey. Journal of Black Sea/Mediterranean Environment 18(3): 380-387.
Zhu G., Xu L., Zhou Y., Song L., Dai X., 2010 Length-weight relationships for Bigeye Tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*) and albacore (*Thunnus alalunga*) (Perciformes: Scombrinae) in the Atlantic, Indian and Eastern Pacific Oceans. Collective Volume of Scientific Papers, ICCAT, pp. 717-724.
*** ICCAT, International Commission for the Conservation of Atlantic Tunas, 2011 Report of the 2011 ICCAT yellowfin tuna stock assessment session. San Sebastian, Spain, SCRS 2011/020.
*** IOTC, Indian Ocean Tuna Commission, 2021 Report of the status summary for species of yellowfin tuna under the IOTC mandate, https://iotc.org/node/3379.
*** IOTC, Indian Ocean Tuna Commission, 2012 Report of the fifteenth session of the IOTC scientific committee. Mahé, Seychelles, IOTC–2012–SC15–R.
*** ISSF, International Seafood Sustainability Foundation, 2012 Status of the world fisheries for tuna management of tuna stocks and fisheries. ISSF Technical Report 201207.

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