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Growth Patterns, Length-Weight Relationships, and Condition Factors of Bullet Tuna (*Auxis rochei*) from PPI Bias Lantang, Seraya Timur, Bali

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Abstract. The growth pattern analysis using the length-weight relationship and condition factor of the bullet tuna (*Auxis rochei*) landed at PPI Bias Lantang, Seraya Timur, Bali, has not yet been determined. This study was conducted to determine the growth pattern using the length-weight relationship and the condition factor of bullet tuna. Fish samples were collected from March to May 2024, three times over a three-month period, with intervals of three weeks. The research methods employed were descriptive, quantitative, and involved simple random sampling. The bullet tuna fishing season starts in March and lasts until May. The fishing was conducted around the waters of the Bali-Lombok Strait. A total of 300 bullet tuna samples were obtained during the study. The growth pattern of bullet tuna at PPI Bias Lantang, as determined by length-weight relationship analysis, yielded a positive allometric result with a b-value of 3.0308. The length-weight relationship shows a strong coefficient of determination with R2 = 0.7468. The graph and equation of the length-weight relationship for bullet tuna (*Auxis rochei*). The condition factor values of the bullet tuna ranged from 1.0048 to 1.0062, indicating that the body shape is relatively less slender.

Keywords: bullet tuna, condition factor, growth pattern, length-weight relationship, PPI Bias Lantang

I. INTRODUCTION

Indonesia's fishing potential is immense and can pave the way to prosperity for its people. Indonesia's waters are recognized as a prime area for catching various high-value neritic tuna species, with marine fisheries resources including large pelagic fish at 2,340 tons per year, small pelagic fish at 31,630 tons per year, and demersal resources at 16,750 tons per year. Tongkol fish, highly sought after by the community, is among the main commodities with significant economic value [6]. Bali's waters, part of WPPNRI 573, show abundant potential, with bullet tuna production increasing from 3,082 tons in 2012 to 17,509 tons in 2013 [16]. Indonesia's fishing sector continues to grow rapidly, with bullet tuna (*Auxis rochei*) being one of its primary commodities [13].

According to [17], Seraya Timur Village has significant marine and fisheries potential, with bullet tuna (*Auxis rochei*) as one of the main targets caught by fishermen. Seraya Timur Banjar Dinas Kangin has five fishing groups, and the fishermen of Seraya Timur generally fish in the waters of the Bali-Lombok Strait, using gill nets and trolling lines. The tongkol fish season, according to [4], occurs from July to November, with transitional seasons in March, April, May, and June, and an off-season in December, January, and February. According to data released by the Central Statistics Agency (BPS) of Karangasem Regency in 2019, tongkol fish contributed about 52.27% of the total catch in Karangasem Regency, with production reaching 8,442.50 tons [13].

Bullet tuna (*Auxis rochei*) is a type of small pelagic fish. Its morphological characteristics include a sturdy, elongated, and rounded body. It has a bluish back and a white belly, with short pectoral fins that do not reach the vertical line from the anterior edge of the area, and it lacks

scales above the corselet. Bullet tuna (*Auxis rochei*) typically inhabits offshore waters with temperatures ranging from 18-29°C. The distribution of tongkol fish spans the entire Western Indo-Pacific waters, the Archipelagic Seas, and the Archipelago Seas [8]. Several studies have been conducted on bullet tuna (*Auxis rochei*), including [21] in the waters of Bone Bay, [2] in the Bintaro Fish Collection Market and Kebon Roek Market in Ampenan District, and [10] in the Makassar Strait. The growth pattern using length-weight relationships and condition factors of bullet tuna (*Auxis rochei*) has not yet been conducted at PPI Bias Lantang Seraya Timur, Bali. Based on this, the research is expected to serve as a database in formulating sustainable and responsible fisheries management strategies.

This research aims to reveal the growth patterns, length-weight relationships, and condition factors of bullet tuna (*Auxis rochei*) at PPI Bias Lantang Seraya Timur, Bali.

II. METHODS

The research was conducted from March to May 2024 at PPI Bias Lantang Seraya Timur, Bali. The equipment used in the study included worksheets and writing tools, a measuring tape, a digital scale, and trays. The material used in this research was bullet tuna (*Auxis rochei*). Fish samples were first identified through morphological observation, based on [8], to ensure the correct species, which is the bullet tuna (Auxis rochei). Data were obtained through direct field observation, with fish samples collected using simple random sampling without consideration of population strata [15]. Growth pattern analysis was performed using length-weight relationships and condition factors at the Faculty of Marine and Fisheries, Udayana University. Bullet tuna samples were collected three times at three-week intervals. The total number of samples obtained was 300. The research location is shown in Figure 1.

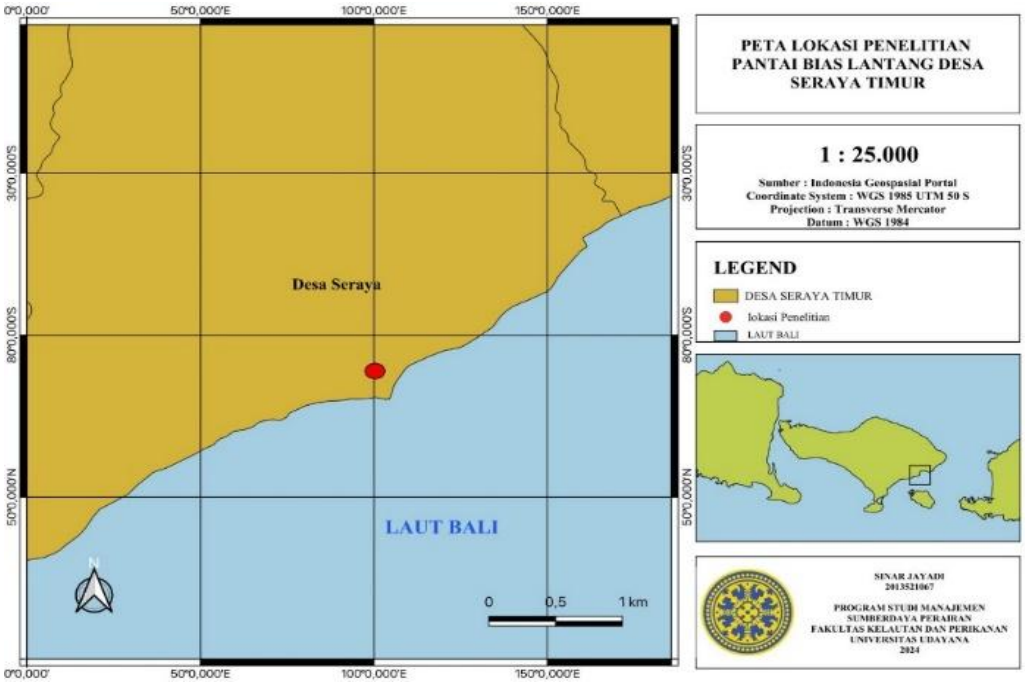

Figure 1. Research Location

Morphometric measurement of fish involves measuring the length and weight of the fish, including total length and standard length. The length of the fish is measured using a ruler or measuring tape, while its body weight is measured using a digital scale and recorded on a worksheet. The measurement data is processed using MS Excel to obtain growth patterns and the condition factor of the fish. The measurement of bullet tuna fish is shown in Figure 2.

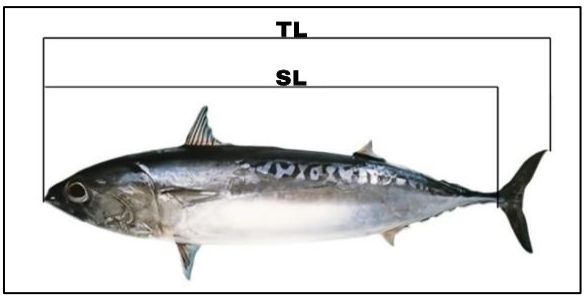

Figure 2. Measurement of the Length of Bullet Tuna

Data Analysis

The growth pattern

The growth pattern was analyzed using the length-weight relationship of the fish. The length-weight relationship analysis was calculated using the formula [7].

$$\mathbf{W = a}L^b$$

Descriptions:
W = weight of fish (grams)
L = length of fish (cm)
a, b = constants
- b=3 indicates that the growth in length and weight is proportional, which is called isometric.
- b≠3 indicates that the growth in length and weight is not proportional, which is called allometric.
- b>3 indicates that the weight increases faster than the length (positive allometric).
- b<3 indicates that the length increases faster than the weight (negative allometric).

To determine whether the value of b equals 3, a t-test is used, with the formula from [6].

$$t_{count} = |\frac{b-3}{Sb}|$$

Descriptions:
b = the value of b (from the length-weight relationship)
Sb = the standard deviation of the coefficient b
$t_{count} > t_{tabel}$: reject the null hypothesis (H0)
$t_{count} < t_{tabel}$: accept the null hypothesis

Condition factor

The calculation of the condition factor based on the length-weight relationship uses the formula W = aL^b. Thus, the calculation of the condition factor can use the relative condition factor (Kn), which was formulated by [7].

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

Descriptions:
Kn = condition factor in total weight
W = average weight of fish (g)
L = average length of fish (cm)
a, b = constants

III. RESULTS AND DISCUSSION

The Growth Pattern

The growth pattern of bullet tuna (*Auxis rochei*) based on the length-weight relationship analysis of bullet tuna landed at PPI Bias Lantang results in the equation W= 0,0158SL $^{3.0308}$. The b value from the resulting equation is 3.03. T-test results show that the growth pattern of bullet tuna landed at PPI Bias Lantang exhibits a positive allometric growth pattern. The length-weight relationship shows a strong coefficient of determination, with R^2= 0.7468. The graph and equation of the length-weight relationship of bullet tuna (*Auxis rochei*) are presented in Figure 3.

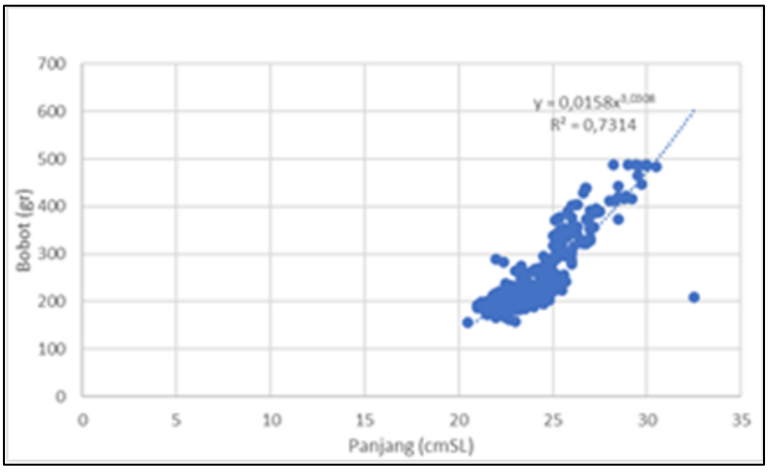

Figure 3. Graph and Equation of the Length-Weight Relationship of Bullet Tuna (*Auxis rochei*) Landed at Bias Lantang Fishing Port (N=300 Individuals)

The growth pattern based on the length-weight relationship analysis of bullet tuna (*Auxis rochei*) in the waters of Bali shows a positive allometric growth pattern (b=3.0308). A similar result was also found by [16]. However, a study by [9] reported a different finding, indicating a negative allometric growth pattern for bullet tuna. Positive allometric growth refers to a growth pattern where weight increases faster than length, whereas negative allometric growth indicates that length increases faster than weight [7].

Different studies have yielded varying growth patterns. According to [7], factors affecting growth are divided into internal and external factors. Internal factors include heredity, sex, age, parasites, and diseases. External factors affecting growth include the quantity and quality of available food, temperature, dissolved oxygen levels, and water quality. This is also supported by [15], who stated that the value of b generally depends on physiological and environmental conditions, such as temperature, salinity, geographical location, sampling techniques, and biological conditions, including gonad development and food availability.

Condition Factor

The average condition factor of bullet tuna is calculated on a monthly basis. The average condition factor of bullet tuna (*Auxis rochei*) landed at PPI Bias Lantang during the study was 1.0054. The condition factor of bullet tuna remained relatively stable throughout the study, exhibiting no significant monthly fluctuations. The monthly condition factor of bullet tuna landed at PPI Bias Lantang is presented in Table 1.

TABLE 1.
CONDITION FACTOR OF BULLET TUNA (*Auxis rochei*) LANDED AT PPI BIAS LANTANG FROM MARCH TO MAY 2024

No	Month	Condition Factor Value
1	March	1.0054
2	April	1.0048
3	May	1.0062

Description: condition factor value with N = 300 individuals

The condition factor measured in this study is the relative condition factor (Kn). The relative condition factor of the bullet tuna (*Auxis rochei*) at PPI Bias Lantang ranges from 1.0048 to 1.0062. Similar results were reported by Hasanah et al., in the Makassar Strait, where the relative condition factor of the bullet tuna (*Auxis rochei*) ranged from 1.0079 to 1.0506. Meanwhile, [21] in the waters of Bone Bay found that the relative condition factor of the bullet tuna ranged from 0.95 to 1.03. In general, the condition of the bullet tuna landed at PPI Bias Lantang is not significantly different from those in the waters of the Makassar Strait and Bone Bay.

Based on the obtained relative condition factor, the body shape of the bullet tuna (*Auxis rochei*) is less flat. According to [7] a relative condition factor ranging from 2 to 4 indicates a somewhat flat body, while a factor ranging from 1 to 3 indicates a less flat body. The condition factor depends on various factors, such as the number of organisms, organism condition, food availability, and environmental conditions [14]. It is noted that food availability is influenced by fish feeding habits and growth. A higher condition factor indicates a better match between the fish and its environment. The condition factor can also be used to assess the overall health, productivity, and physiological condition of fish populations and is derived from growth, explaining the "well-being" of the fish organism from a physical perspective for survival and reproduction [7].

The relative condition factor of the bullet tuna during the study remained generally stable, with slight increases or decreases observed each month. The highest value was in May at 1.0062, the lowest in April at 1.0048, and in March it was 1.0054, as shown in Figure 4.2. The condition factor can change due to the primary energy source used for gonad development and spawning, as the condition factor value increases approaching the peak of spawning and decreases afterward. The increase in the condition factor may also be due to the fish experiencing growth or gonad development (the fish filling its gonads with egg sacs before spawning) [14].

V. CONCLUSION

The weight gain of the bullet tuna (*Auxis rochei*) at PPI Bias Lantang Seraya Timur, Bali is faster than its length increase, with a value of b=3.0308 (positive allometry). . The length-weight relationship shows a strong coefficient of determination with $R^2 = 0.7468$. The graph and equation of the length-weight relationship for bullet tuna (*Auxis rochei*). The bullet tuna (*Auxis rochei*) at PPI Bias Lantang Seraya Timur, Bali, is in good condition, with a relative condition factor ranging from 1.0048 to 1.0062, despite having a less streamlined body shape.

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