Length-Weight Relationships of *Lutjanus decussatus* as Conservation Target Species in Anambas Islands Marine Protected Area, Indonesia

Gita Endang Palufi[1], *Satria Putra* Anggara[1], *Dominikus Yoeli Wilson* Laia[1], *Anugrah Riskel* Shabari[1], *Nadia Amalina* Daniel[1], *Rahmat* Irfansyah[1], *Huong Mai* Nguyen[2], and *Susiana* Susiana [3,*]

[1]National Marine Protected Area Office of Pekanbaru, Ministry of Marine Affairs and Fisheries, Indonesia
[2]YSEALI Professional Fellow Vietnam, Vietnam
[3]Department of Aquatic Resources Management, Faculty of Marine Science and Fisheries, Raja Ali Haji Maritime University, Indonesia

Abstract. Lutjanus decussatus, commonly known as the checkered snapper or sadang fish (locally), is a key coral reef species in the Anambas Islands Marine Protected Area (MPA) and serves as a conservation target and indicator of reef health. This study analyzes the length-weight relationship and growth patterns of sadang fish within the MPA. Purposive sampling was conducted from February to October 2023, with 537 samples collected (175 males, 362 females). Male fish reached a total length (TL) of 29 cm and a weight of 345 g, while females attained a TL of 30 cm and a weight of 410 g. The R^2 values were 0.93 for males and 0.90 for females. The length-weight regression exponent b was 2.762 for males and 2.748 for females, indicating negative allometric growth ($b < 3$), where length increases faster than weight. This is the first study to examine the length-weight relationship of L. decussatus in the Anambas Islands MPA, providing essential biological and fisheries data to inform species management strategies.

1 Introduction

The Anambas Islands Marine Protected Area (MPA), established in 2014, is one of Indonesia's national MPAs located in the Riau Islands Province. Situated in the Natuna Sea - the southern part of South China Sea, this MPA safeguards important marine ecosystem including mangroves, seagrass meadows, and coral reefs, and a rich diversity of marine biota. In the Anambas Islands MPA management plan, conservation efforts focus on preserving these habitats alongside a conservation target species, the coral reef fish *Lutjanus decussatus* [1]. Lutjanids are among the most abundant fish species in the coral

* Corresponding author: susiana@umrah.ac.id

reef ecosystems of the Anambas Islands, making them a priority for monitoring as an indicator of the MPA's management effectiveness.

L. decussatus is a commercially important fish species in Indonesia, commonly targeted by local traditional and small-scale fisheries due to its economic importance and availability [1]. This species has a strong ecological association with coral reef habitats, where it primarily engages in foraging activities [2]. As a result, fluctuations in *L. decussatus* populations can serve as a key indicator of coral reef health, making its monitoring crucial for assessing the status of these vital ecosystems. Furthermore, as a large predatory fish within the reef ecosystem, *L. decussatus* helps maintain the balance of nature. It helps prevent the overpopulation of smaller prey species, which can otherwise lead to imbalances that negatively impact the structure and function of the coral reef ecosystem.

Monitoring of coral reef fish by LKKPN Pekanbaru from 2020 to 2023 revealed that the highest abundance of *L. decussatus* was recorded in 2020, with 117 individuals per hectare. This number declined to 87 individuals per hectare in 2022 but showed a slight increase to 88 individuals per hectare in 2023 [3]. The abundance of *L. decussatus* can be influenced by a range of factors, both natural and human-induced, particularly fishing activities. The declines in fish populations mainly result from overfishing, habitat destruction, and ineffective management strategies [4]. This trend emphasizes the need for further assessment of the species' biological aspects to better understand the phenomena, especially since *L. decussatus* has been designated as a conservation target species within the Anambas Islands MPA.

Research on Lutjanus decussatus in Indonesia remains limited, with little information available on its morphometric variation, length-weight relationship, and growth patterns. This study, the first of its kind in the Anambas Islands MPA, seeks to examine the length-weight relationship and study the growth patterns of *L. decussatus*. The findings will provide a basis for future studies, such as Spawning Potential Ratio analysis, condition factor determination, and other crucial aspects of managing the Anambas Islands MPA. Furthermore, understanding the length-weight relationship is also essential for estimating growth rates, age structure, and population dynamics, offering vital insights for effective fisheries management [5,6].

2 Material and methods

2.1 Sample collection and laboratory methods

L. decussatus samples were collected using purposive sampling, obtained from fish caught by local fishermen within the Anambas Islands MPA. A total of 537 individuals were collected between February and October 2023, consisting of 175 males and 362 females. All specimens were measured to an accuracy of 0.1 cm and weighed using digital scales with an accuracy of 0.1 grams.

Fig. 1. L. *decussatus sample*

2.2 Length-weight relationship

The length-weight relationship (LWR) of the fish was determined by developing a regression model to describe the relationship between body weight and total length. This was achieved using a log-transformed version of the power function $W=aL^b$, expressed as $\log W=\log a+b\log L$, where W represents the fish's body weight, L is the total length, a is the intercept coefficient (reflecting body shape), and b is the exponent coefficient (indicating growth pattern) [7–9]. Additionally, the coefficient of determination (R^2) was calculated to evaluate the fitness of the regression model.

3 Results

3.1 Fishing grounds

Local fishers in the waters of the Anambas Islands share a commitment to using only non-destructive and selective fishing gear. Commonly employed fishing methods include handlines, trolling lines, longlines, fish traps, lift nets, and crab traps [10–12]. This aligns with information provided by the fishermen involved in this study, indicating that Anambas fishers primarily catch *L. decussatus* using handlines from small traditional fishing boats (2-5 GT). The gear typically consists of hooks, swivels, fishing lines, weights (lead), and bait [13]. Samples for this study were predominantly collected from three districts: Central Siantan, South Siantan, and East Siantan, encompassing the waters surrounding Samak Island, Meriam Island, Pempang Island, Temburun Village, Batu Belah Village, Selaih Island, Air Sena Village, Akar Island, and Mengkait Island. (Fig. 2)

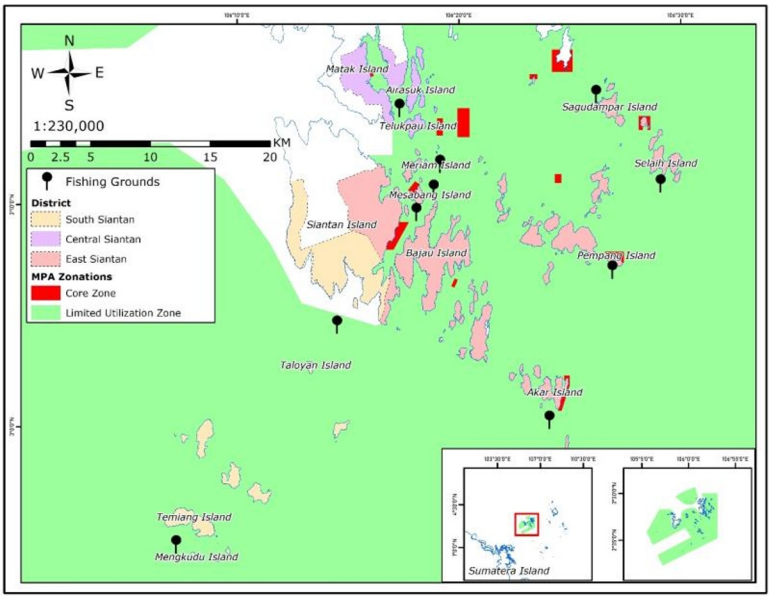

Fig. 2. *L. decussatus* fishing ground in Anambas Islands MPA

3.2 Length frequency distribution

A total of 537 *L. decussatus* were observed during the study (Table 1), with 33% (175) being male and 67% (362) female. The total length (TL) of male fish ranged from 15 to 29 cm, while females ranged from 16 to 30 cm. The average body weight of females exceeded that of males. The minimum weight recorded for male fish was 56 g, and the maximum weight reached 345 g, while the weight of female fish ranged from 66 to 410 g. This resulted in the largest male reaching a TL of 29 cm and a weight of 345 g, while the largest female measured 30 cm in length and weighed 410 g. Among the samples, the most frequently caught fish had a TL between 22 and 23.9 cm, accounting for 171 individuals (32.2% of the total sample). The captured fish were reaching their maximum length, as [14] and [15] research noted that *L. decussatus* can grow to a maximum TL of 30 cm. Additionally, FishBase data show that the maximum TL for male *L. decussatus* is 35 cm, with a standard length typically around 25 cm.

In this study, one factor that may influence the variation in the size of *L. decussatus* catches is the type of fishing gear used, particularly the size of the hook. The different characteristics and selectivity of each type of gear can lead to variations in the size structure of the fish caught. Additionally, biological factors along with environmental conditions in various waters, can result in differences in fish length, as these factors influence growth rates [16].

Table 1. Length distribution of samples

Total Length (cm)	Number of Samples									
	Month									Total
	Feb	March	April	May	June	July	August	Sept	Oct	
14 - 15.9	0	0	0	0	6	0	0	0	0	**6**
16 - 17.9	1	1	1	0	12	0	0	0	0	**15**
18 - 19.9	4	4	3	2	21	1	7	7	0	**49**
20 - 21.9	3	10	13	4	21	1	25	14	4	**95**
22 - 23.9	2	18	33	8	14	1	62	12	22	**171**
24 - 25.9	1	11	14	12	13	0	53	14	21	**139**
26 - 27.9	0	7	5	6	4	0	12	1	17	**52**
28 - 29.9	0	0	0	0	1	0	3	0	5	**9**
30 - 31.9	0	0	0	0	0	0	0	0	1	**1**
Total Samples	**11**	**51**	**69**	**32**	**92**	**3**	**162**	**47**	**70**	**537**

2.3 Length-weight relationship and growth pattern

Based on the analysis of the correlation between total length and weight of *L. decussatus*, the regression equations are $W=0.0357L^{2.7481}$ for males and $W=0.0336L^{2.7621}$ for females. These equations indicate that the length-weight regression exponent b is 2.748 for males and 2.762 for females, both suggesting negative allometric growth ($b<3$), where length increases faster than weight. Research conducted in the Seribu Islands National Park also found similar results in both the core and settlement zones [4]. The coefficient determination (R^2) for the length-weight relationships are 0.9267 for males and 0.9003 for females, demonstrating a high degree of accuracy in estimating the fish's weight based on its length [17]. Additionally, the study reveals that male fish tend to be longer than females, aligning with findings from [18], who reported that males are slightly larger than females.

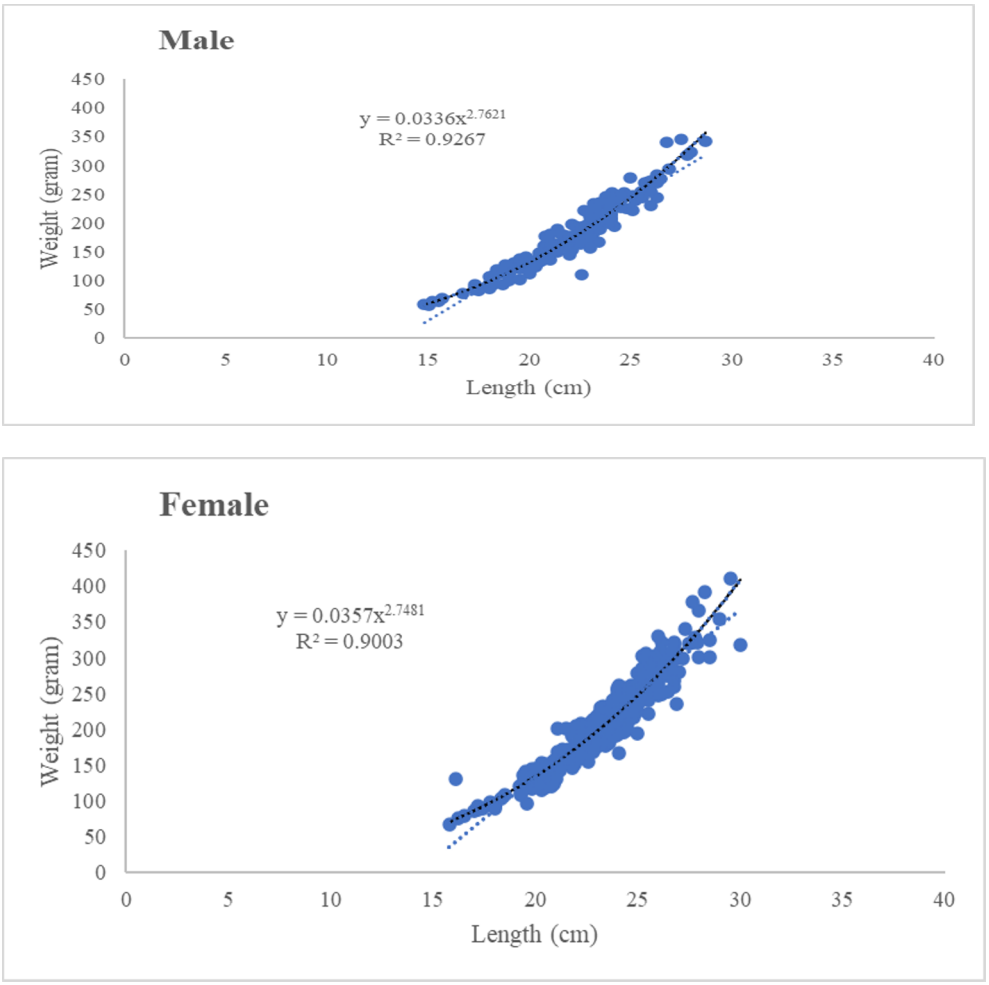

Fig. 3. Length-weight regression of *L. decussatus*

The value of *b* being close to the isometric growth (*b*=3) value indicates that the environmental conditions in the Anambas Islands MPA are favorable for the growth of this fish species. The variation in *b* can be attributed to several factors, including environmental variables including season, habitat, food availability (including quantity, quality, and size), temperature, salinity, and sampling techniques (including fishing gear, mesh size, size range, and number of specimens). Additionally, biological factors including diet, growth phase, spawning periods, sex, stomach fullness, gonadal development, parasitic infections, and overall health, as well as geographical influences, can also affect growth patterns [7,9,17,19–21]. Therefore, it is essential to assess the length-weight relationships (LWR) of fish within local populations to gain insights into local fish ecology, provide more accurate estimates of fish weight and length, and establish a foundation for effective conservation strategies [7].

This research provides valuable insights for the management of the Anambas Islands MPA, particularly regarding the status of L. decussatus as a conservation target. Monitoring

the condition of this species can help MPA management better understand the health of the marine ecosystem, especially coral reefs. Previous studies have emphasized the species' reliance on coral reefs as its primary habitat, where L. decussatus is frequently observed foraging. It utilizes a variety of coral species, including branching Acropora spp., branching Porites spp., corymbose Acropora spp., tabular Acropora spp., and massive Porites spp., [2] all of which are abundant in the Anambas Islands MPA. The study of length-weight relationships (LWR) has been recognized in numerous studies as an important variable in species management and fish conservation efforts [6,22]. Future studies that compare these relationships, along with other key parameters, will contribute to more effective exploitation and conservation strategies [23].

4 Conclusion

This study shows a strong positive correlation ($R^2 > 0.90$) between the length and weight of *L. decussatus* in the Anambas Islands MPA for both males and females. The correlation indicates a negative allometric growth pattern, with a slope value of $b < 3$, where length increases faster than weight. This study can serve as a foundation for more comprehensive research and as baseline data for sustainable fisheries management.

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