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Biological Aspects and Growth of the Shortfin Scad (*Decapterus macrosoma*) in the Waters of Barru Regency, South Sulawesi, Indonesia

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ABSTRACT

Shortfin scad (*Decapterus macrosoma*) plays a crucial role for fishermen in South Sulawesi. This species is caught using various gears and utilized for local consumption as tuna bait as well as for export. However, uncontrolled exploitation led to a recent catch decline. Moreover, the lack of regulation raises sustainability concerns. The research objectives were to assess various aspects of fish biology, including sex ratio, gonad maturity stage, initial size of mature gonads, and growth patterns. The research took place in the Barru water of the Makassar Strait, South Sulawesi, applying a survey methodology. Fish samples were obtained from the catches landed by fishermen at Sumpangbinange port in Barru regency. Fish sampling was conducted from early May to December 2022. The number of male fish obtainedwas 628 fish individual, while female amounted to 452. The research results indicated an imbalance in the sex ratio of shortfin scads fish., i.e. the ratio of male to female was 1.6: 1.0. Male shortfin scads fish dominated in the young and immature fish gonads (RML I, RML II) at 62.2%, while females predominated in mature (RML III and RML IV) gonads, accounting for 53.3%. The male shortfin scads fish reached the first mature gonad on fork length with a range between 16.95 to 18.23cm and a female range between 16.63 to 17.87cm. The growth patterns of male and female were negatively allometric. The growth asymptote length ($L\infty$) was 34.250cmFL; the growth rate coefficient (K) was 0.410 per year, corresponding to a negative allometric growth pattern, as indicated by the coefficient of -0.3867. The depleted state of the shortfin scad fish population at the research site calls for management interventions, urging local governments to prioritize efforts aligned with the sustainable development goals (SDGs).

INTRODUCTION

The Makassar Strait, Flores Sea, and Gulf of Bone are a few of the coastal waters in South Sulawesi that are used for fishing **(Asni *et al.*, 2019a; Jamal *et al.*, 2021)**. In these seas, fishermen are able to catch a wide variety of fish. One of these is the shortfin scad (*Decapterus macrosoma*), an economically significant fish species **(Baso *et al.*, 2020)**. One of the most significant in the fisheries resources of Makassar Strait is the shortfin scad, which is also the primary fish that fishermen catch **(Jaiswar, 2001; Najamuddin *et al*., 2019)**. Understanding the biological parameters of various fish species such as carangids, is crucial for achieving the 2030 UN Sustainable Development Goals, particularly Goal 2 ("Zero Hunger") and Goal 14 ("Life Below Water").

The waters of the Barru Regency are recognized as a promising zone for the fisheries industry, catering to both large and small pelagic species. The region's reputation is maintained due to its nutrient-rich environment, which enhances the productivity of small pelagic fish like shortfin scad (*D. macrosoma*). Situated within Fisheries Management Area (FMA) 713, this area serves as a crucial hub for both local consumption and international trade of shortfin scads. Furthermore, tuna fishing enterprises utilize this fish as bait **(Gafa *et al*., 1993; Najamuddin, 2004; Dahlan *et al*., 2015; Najamuddin *et al*., 2019)**. However, the robust demand for shortfin scads poses a risk of overexploitation, potentially leading to population decline and ultimately, stagnation. Efforts to address this challenge through sustainable management practices are imperative to secure the sustainability of these fisheries in the long term and maintain the ecological balance of the marine ecosystem **(Najamuddin *et al*., 2021; Jamal *et al.*, 2021)**.

The productivity of shortfin scad (*D. macrosoma*) has experienced a decline over the past five years in South Sulawesi including the seas of Barru Regency. These waters are identified as particularly vulnerable to the depletion of shortfin scads resources. Despite its significant potential, irresponsible and unsustainable fishing practices pose a grave threat to the stability of shortfin scads populations **(Najamuddin, 2004; Dahlan *et al*., 2015; Asni *et al*., 2019)**. With a utilization rate of 95% in the Makassar Strait and Flores Sea, there are significant concerns about severe overexploitation. Considering its vital role as an economic asset in South Sulawesi, unregulated fishing activities pose risks to both its sustainability and the economic future of the region **(Gafa *et al*., 1993; Jamal *et al.*, 2021)**.

Unfortunately, there remains a dearth of information regarding shortfin scads in South Sulawesi, with existing studies primarily focusing on the potential and exploitation levels in the Makassar Strait **(Najamuddin, 2004; Dahlan *et al*., 2015; Asni *et al*., 2019a)**. The sustainability of shortfin scads resources is increasingly precarious due to the absence of effective regulatory mechanisms. Therefore, comprehensive research on the biological characteristics of shortfin scads is imperative to inform robust fisheries management strategies. Without such measures in place, concerns persist regarding the sustainability of shortfin scads stocks and the long-term viability of the fisheries industry in the region. The study intended to learn more about the following topics: growth patterns, sex ratio, gonad maturity stage, and the initial size of mature gonads. The research's findings would be helpful in managing the shortfin scad fish population at the study location in an effort to preserve its sustainability.

MATERIALS AND METHODS

The study took place in Barru Regency, South Sulawesi, Indonesia, spanning from May to December 2022. Shortfin scads fish samples were obtained from fishermen using purse seine and lift net fishing gear in the waters of Barru Regency (Fig. 1).

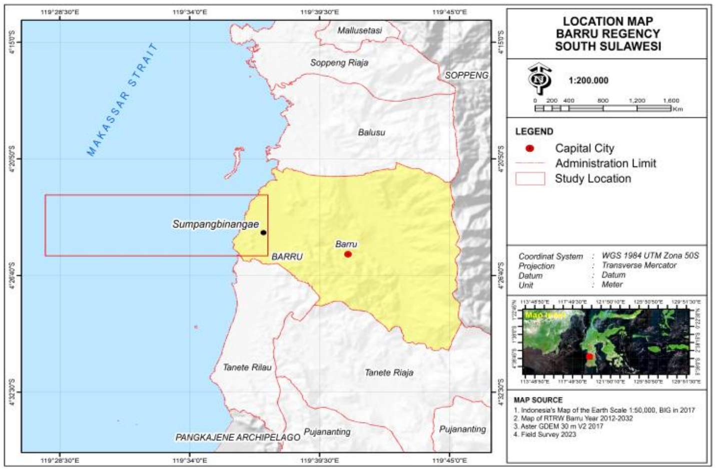

Fig. 1. Research location map

Sampling took place at the fish landing site in Sumpang Binangae, Barru Regency, South Sulawesi, Indonesia, twice a month from May to December 2022. This research utilized a survey approach to study shortfin scads caught by fishermen using various fishing gears, with primary data collected through measurements of fish fork length, weight, and reproductive maturity level (RML). Shortfin scads were randomly obtained, and their fork length was measured using a caliper ruler with 1mm accuracy, while weight was determined with a digital balance accurate to 0.01g. Gender determination was conducted post-dissection.

Fish reproductive maturity level (RML) was morphologically observed using indicators similar to those described by **Effendi (1997)** (Table 1). Length and weight measurement results were processed using Microsoft Excel and FAO-ICLARM Stock Assessment Tool (FiSAT II Version 1.2.2). To produce data in the form of growth, length-weight relationship, size of first catch, and size at first maturity, the classification of reproductive maturation in female and male fish was included.

Data analysis

Sex ratio

Sex ratio is the proportion of sex in the population. The sex proportion value of male and female fish was calculated using the formula:

$$GP = A/B$$

Where, GP = Gender proportion (male/female); A = The number of male/female shortfin scads; B = The total number of shortfin scad fish.

Furthermore, the chi- square test (X^2) was carried out at a 95% confidence interval to determine a balanced or unbalanced state from the proportion values obtained.

Table 1. Classification of reproductive maturation levels in shortfin scads

RML	Male gonad morphology	Female gonad morphology
I	Testes are very small, and threadlike, and occupy half of the abdominal cavity.	Ovaries are white, band-like, and occupy less than half of the abdominal cavity.
II	Testes are thin, white, often covered with gray spots, and occupy half of the abdominal cavity.	Ovaries are white, band-like, and occupy half of the abdominal cavity.
III	Testes are white or pale and occupy the abdominal cavity.	Ovaries are yellow or pale and occupy half of 1⁄2 of the abdominal cavity. Ova is not visible to the naked eye.
IV	Testes are pale, increased in length, and occupy the abdominal cavity.	The ovaries are getting bigger, the eggs are colored yellow, easily separated. Details no visible oil, fill 2⁄3 abdominal cavity.
V	The back testes are deflated and in the section near the release still containing.	Ovaries wrinkled, thick walls, granular the remaining eggs are located near the release.

Source: **Effendi (1997)**

Size at first gonadal maturation

Fish length at first gonadal maturation (Lm) was calculated using the Spearman–Kärber method **(Udupa, 1986)**, with a 95% confidence interval using the following formula:

$$log\ m = X_k + \frac{X}{2} - \left(X \sum p_i\right)$$

Where, Xk = last log size at which 100% of fish gonads are fully mature; X = log size increment; Xi = log of median; pi = ri/ni; ri = number of fish with mature gonads in group i; ni = number of fish in class i; and qi = 1 - pi.

Where, variance:

$$Variance = X^2 \sum_{i}^{n} \left[\frac{p_i * q_i}{n_i - 1}\right]$$

Length-weight relationship

The relationship between fish length and body weight was analyzed based on gender determined using the following formula **(Effendie, 1997)**:

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

$$\text{or: } \log W = \log a + b \log L$$

Where, W = fish weight (grams); L = fish length (cm); a = constant or intercept; b = growth exponent (regression coefficient). To test whether b = 3 or b ≠ 3, a t-test (partial test) is performed with the hypothesis: H_0: b = 3 (isometric) and H_1: b ≠ 3 (allometric). If b = 3, the growth is considered isometric or the growth rate of fish length, width, and height are similar. If b> 3, the growth rate exhibits positive allometric or a tendency to be plump. On the other hand, if b< 3, the growth exhibits negative allometric or a tendency to be slender.

Size at first gonadal maturation

Fish length at first gonadal maturation (Lm) was calculated using the Spearman–Kärber method **(Udupa, 1986)** with a 95% confidence interval using the following formula:

$$log\ m = X_k + \frac{X}{2} - (X \sum p_i)$$

Where, Xk = last log size at which 100% of fish gonads are fully mature; X = log size increment; X_i = log of median; p_i = ri/ni; r_i = number of fish with mature gonads in group I; n_i = number of fish in class I; q_i = 1 - p_i.

Where, variance:

$$Variance = X^2 \sum_i^n \left[\frac{p_i * q_i}{n_i - 1}\right].$$

Growth estimation

Growth rate was measured using FiSAT (FAO Iclarm Stock Assessment Tools) II V. 1.2.2 software. The research data arepresented in fork length frequency. Before calculating the growth rate, the maximum total length (L∞) was identified. The maximum total length was achieved by using Indian mackerel without natural mortality (M) and the growth rate coefficient (K) by importing the analysis data of fish fork length frequency during the study.

The generated growth coefficient values were processed using the VBGF (von Bertalanffy Growth Formula) method through FISAT II method **(Sparre & Venema, 1992)**, and the growth rate was identified by inserting those values. The estimation of growth parameters for shortfin scads was calculated using a fish length-related growth model, which follows the von Bertalanffy growth equation presented as follows:

$$Lt = L\infty\,(1 - e - K(t - t0))$$

Where, Lt = fish length at age t (cm); L∞ = asymptotic length (cm); K = coefficient of growth rate (per year); t0 = theoretical age of zero fish length (years); t = fish age. After that, the theoretical age of zero fish length (t_0) was determined using the following formula **(Pauly 1983; Gayanilo *et al*., 2005)**:

$$Log\,(-t0) = -0.3992 - 0.2752\,(Log\,L\infty) - 1.038\,(Log\,K)$$

Where, L∞ = asymptotic length (cm); t0 = theoretical age at zero length (years); K = coefficient of growth rate (per year).

RESULTS

Sex ratio

The sampling conducted during the research yielded 1395 shortfin scads (*D. macrosoma*), comprising 870 males and 525 females. The sex ratio among the sampled shortfin scads was 62.37% males to 37.63% females, indicating a male-to-female ratio of 1.6:1.0. This imbalance in the ratio between male and female shortfin scads suggests a prevalence of males over females. The chi-square test results revealed a significant difference ($P< 0.05$) between the numbers of males and females (Fig. 2).

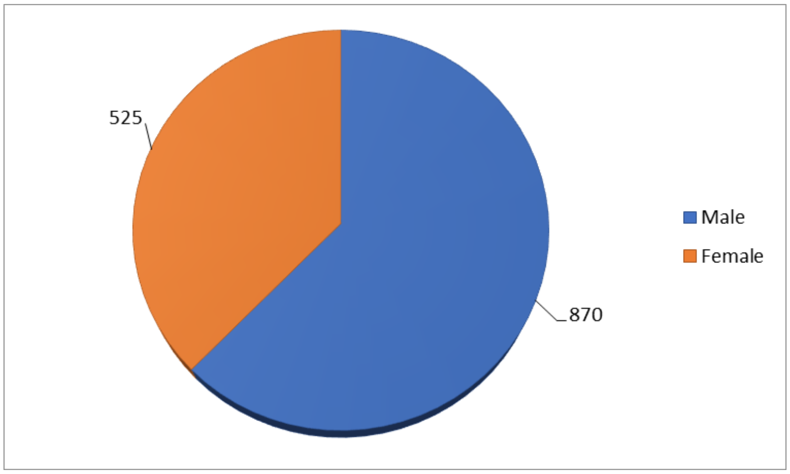

Fig. 2. Percentage and sex ratio of male and female shortfin scads

Reproductive maturation

The level of reproductive maturity level (RML) during the research period can be seen in Figs. (3, 4). The appearance of gonads on RML IV for male and female fish is shown in Fig. (4). In general, female shortfin scads dominated the adult gonads (RML III and RML IV), whereas male shortfin scads prevailed in the juvenile and immature gonads (RML I, RML II). Juvenile shortfin scads and immature gonads (RML I and II) constituted 73.91% of male fish and 53.14% of female fish, while adult gonads (RML III and RML IV) accounted for 26.09% of males and 46.86% of females.

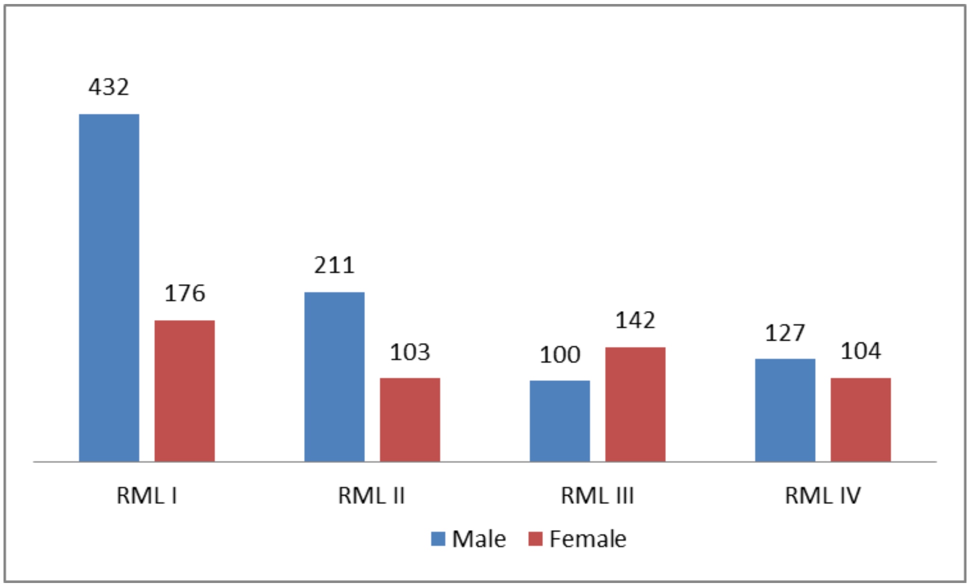

Fig. 3. Comparison of RML of male and female shortfin scads (*D. macrosoma*)

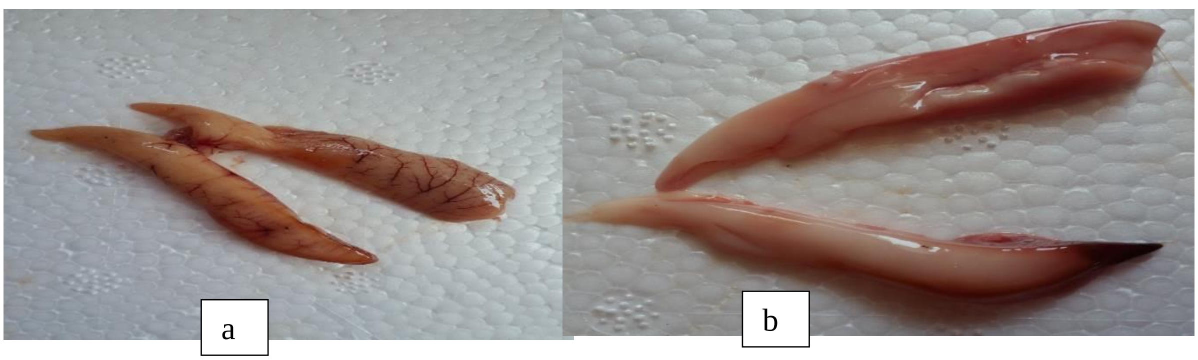

Fig. 4. Reproductive maturation level (RML) IV of **(a)** Female; **(b)**Maleshortfin scads (*D. macrosoma*)

Size at first maturity of gonads

Regularly conducted studies on the size of fish at first gonadal maturity serve as an indicator of population pressure. A total of 1395 shortfin scads were measured and observed. Among male fish, lengths ranged from 10.20 to 34.79cm, with 26.09% being gonadally mature and 73.91% immature. Female fish, ranging from 9.50 to 35.3 cm in length, exhibited 46.86% gonadal maturity and 53.14% immaturity. These findings suggest a dominance of immature males and females in the catch. The analysis revealed that male shortfin scads (*D. macrosoma*) typically reach initial maturity at fork lengths ranging from 16.95 to 18.23cm, while females attain maturity within the range of 16.63 to 17.87cm.

Link between length and weight in shortfin scads

Male shortfin scads in the Barru Regency's waters exhibit an isometric growth pattern with a b value of 2.89 that is not substantially different from 3 ($P > 0.05$) or b = 3, while female shortfin scads have a negative allometric growth pattern with a b value of 2.85 which is significantly different from 3 ($P < 0.05$) or b< 3 (Figs. 5, 6). **Effendie (1997)** elucidated that a value of b= 3 signifies a harmonious fish growth pattern, where the shortfin scad's length gain aligns with its weight gain. Conversely, a value of b< 3 indicates an imbalanced growth pattern, with the shortfin scad's length increasing more rapidly than its body weight. This relationship between fish condition and the value of b is intricately linked to various biological factors, including food availability, age, sex, and gonadal maturity. These factors collectively influence the overall condition of the fish, underscoring the importance of considering multiple variables when assessing fish growth and health.

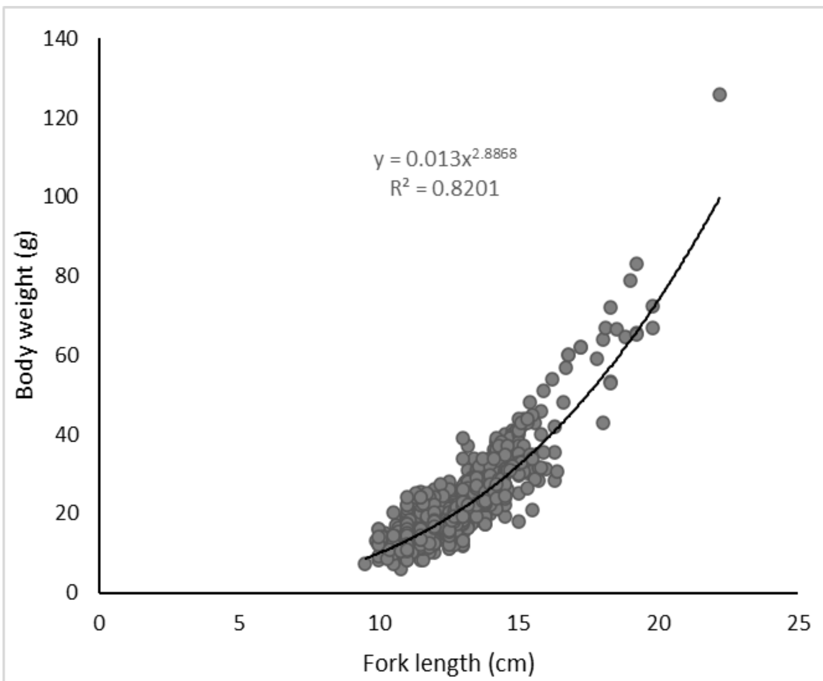

Fig. 5. The length-weight connection graph for male shortfin scads

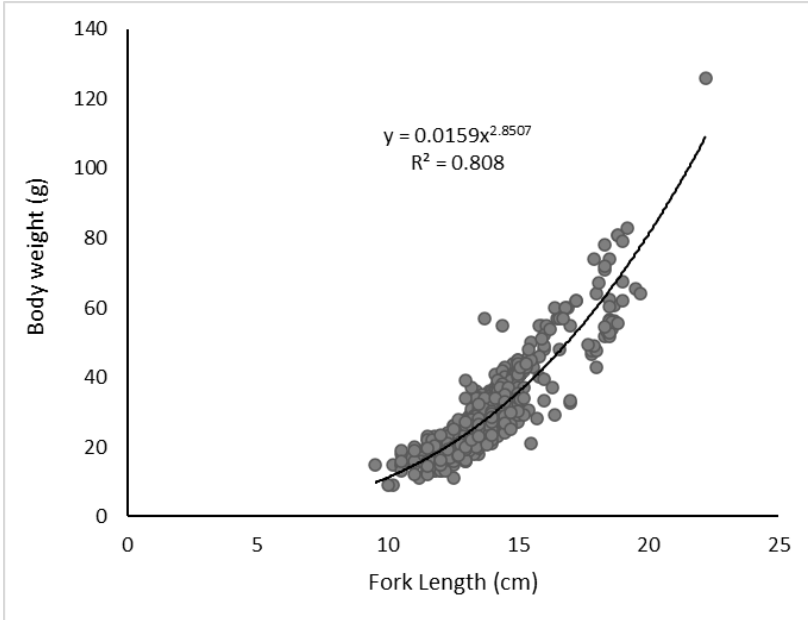

Fig. 6. The length-weight connection graph for female shortfin scads

Growth

The results of the analysis using the von Bertalanffy formula **(Sparre & Venema, 1992)** showed that the asymptote length (L∞) of shortfin scads was 34.250cmFL, and the growth rate coefficient (K) was 0.410 per year and to = -0.3867 (Fig. 7).

The results of the analysis using the von Bertalanffy formula **(Sparre & Venema, 1992)** showed that the theoretical age of shortfin scads at the start (to) was -0.410 years. Based on the growth values (L∞, K and to) obtained, the growth equation for female shortfin scads is: $Lt = 34.250\ [\ 1 - e^{(-0.410\ (t\ +\ 0.38))}]$

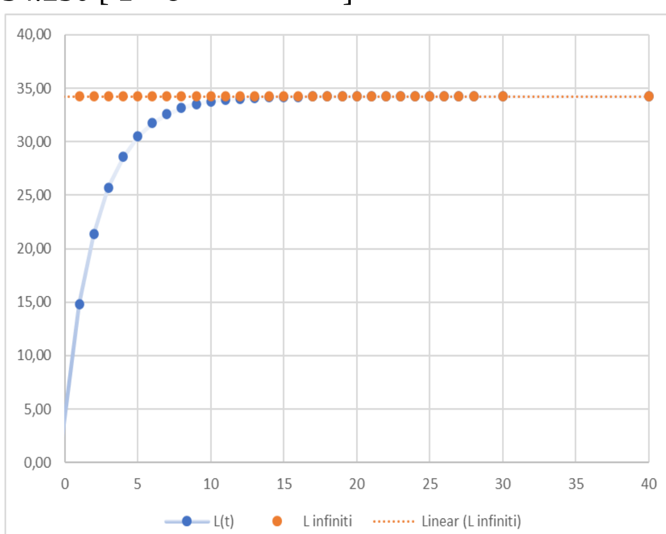

Fig. 7. Growth curve of shortfin scads (*D. macrosoma*)

DISCUSSION

The research findings indicate that the population of shortfin scad fish in the study location is unbalanced, with a higher proportion of male fish compared to females. This imbalance is likely caused by high exploitation pressure and environmental conditions in the water. Another possibility is the difference in the timing of the research. The study location, situated on the western part of the island, experiences a significant influence from the west monsoon season. During the west monsoon season, which occurs from December to April, strong winds, heavy rains, and large waves make it difficult for fishermen to go fishing, resulting in limited fish catches. Consequently, obtaining research samples becomes challenging. Sex ratio of male to female shortfin scads obtained in the Makassar Strait was 3.02:1.00 and in the Gulf of Bone was 1.75:1.00 **(Omar *et al.*, 2014)**. This shows that there are relatively more male fish (50.32%) than female fish **(Najamuddin, 2004)**. Shortfin scads (*D. macrosoma*) in Sadeng waters, Yogyakarta with a sex ratio of male to female was 57.96: 42.04% or 1.4: 1 **(Liestiana, 2015)**. Shortfin scads (*D. macrosoma*) in Banda Aceh Waters had a balanced ratio of the number of male and female fish of 1: 2 **(Senen *et al.*, 2011)**. In the Gulf of Ambon, the sex ratio between male and female fish is reported to be balanced **(Sumadhiharga, 1991; Tetelepta, J.M.S., 2018)**. However, in the Gulf of Bone, where shortfin scads are caught by purse seine in fisheries, the sex ratio is predominantly female, with nearly 70% of the catch comprised of females **(Jamal *et al*., 2021)**. Meanwhile, the sex ratio of shortfin scads (*D. macrosoma*) caught in Malaka waters between male and female was 1:1.01 **(Faizah & Sadiyah, 2019)**. Shortfin scads in Maluku Waters have a balanced 1:1 sex ratio **(Ajub *et al*., 2023)**. Moreover, shortfin scads in Banjarmasin waters have a sex ratio of 1.3: 1 **(Ahmadi, 2020)**. Additionally, shortfin scads in Madura waters have a sex ratio (male: female) of 1:1.7 in Paiton and 1:1.14 in Mayangan **(Bintoro *et al.*, 2019; Ajub *et al*., 2023)**. The sex ratio of shortfin scads in Sulawei waters between males to females is not balanced, namely 1: 1.963 **(Zamroni *et al*, 2019)**. In the Makassar waters, the sex ratio of shortfin scads (*D. macrosoma*) was reported as 1.1 males to 1.0 females **(Asni *et al*, 2019b)**.

The study revealed that over 50% of shortfin scads were within RML I and II, indicating a prevalence of young fish and unsustainable fishing practices, predominantly through non-selective gear such as boat lift nets and purse seines. Shortfin scads (*D. macrosoma*) captured in Maluku Waters are predominately at reproductive maturity levels I and II and make up a higher percentage than those at reproductive maturity levels III and IV **(Ajub *et al.*, 2023)**. Male shortfin scads (*D. macrosoma*) obtained in Makassar waters exhibited a dominance of immature gonad classes (RML I and RML II), whereas female fish showed a predominance of RML III and RML IV **(Asni *et al.*, 2019b)**. Understanding gonadal maturity levels is important for understanding fisheries biology since it can be used to calculate the proportion of fish that reproduce and those that do not in aquatic environments. Moreover, it is theorized that fish in tropical climates mature at an accelerated rate and generally spawn year-round, enabling the determination of spawning seasons through the calculation of mature fish proportions. Analyzing a substantial proportion of gonad maturity levels can aid in predicting the timing of spawning peaks **(Magallanes *et al*., 2022; Osman *et al*., 2022)**.

This research revealed that the size at first gonadal maturity ranged from 16.95 to 18.23cm for males and fluctuated from 16.63 to 17.87cm for females. This suggests that fish tend to reach mature gonad size at smaller lengths compared to previous research in the same area. **Najamuddin (2004)** found that shortfin scads (*D. macrosoma*) reached first gonadal maturity at an average fork length of 19 to 20cm, which contrasts with earlier studies. For instance, **Sumadhiharga (1991)** reported the size of the first adult gonads at a total length of 15cm in the Gulf of Ambon, while **Widodo *et al*. (1998)** recorded 15.53cm in Java Sea waters. **Tiews *et al*. (1970)** found lengths ranging from 180 to 200mm in the waters off the Philippines. Additionally, **Atmaja and Nugroho (1995)** reported that shortfin scads (*D. macrosoma*) reached gonadal maturity at 20.7cm. **Prihatini (2006)** estimated the size of the first mature gonads of the shortfin scads (*D. macrosoma*) to be 232mm, while **Shiraishi *et al.* (2010)** recorded mature gonads measuring 250mm in length. Moreover, **Liestiana *et al*. (2015)** reported male and female first mature gonad sizes at fork lengths of 24.7 and 25.0cm. **Costa *et al*. (2020)** suggested female first maturity sizes to be 24.1cm FL and male first maturity sizes to be 26.6cm FL. Notably, the minimum legal size (20cm FL) currently set for the management of the species in Cabo Verde exceeds these values.

This is comparable to the 8.4 to 25.2cm size range of shortfin scads found in the Gulf of Likupang, North Sulawesi **(Manik, 2009)**. **Widodo *et al*. (1998)** stated that shortfin scads in the Java Sea reached their first maturity at 13.9cm and a catchable size of 14.8cm. Furthermore, according to **Prihatini (2006)**, as the majority of the shortfin scads taken for this study are mature and acceptable for fishing, the size of 14.0cm has been considered mature because it has achieved RML III. The method approach adopted and the difference in length are the causes of the discrepancy in the outcomes. While earlier studies employed the entire length, this study used the fork length. In order to ensure measurement accuracy, the fork length was used in this study **(Atmaja & Nugroho, 1995)**. One of the natural reproduction methods to prevent extinction is likely to be exploitation pressure, which accelerates the reproductive process. The size of each fish first determines how its gonads develop, and even within the same species, gonads can develop in different environments **(Ongkers *et al*., 2016)**. Growth and environmental impacts on growth and reproductive strategies are connected to size at first gonad maturity. Overfishing stress causes fish to grow up at reduced sizes for gonads maturity from 11.0 to 24.5cm (mean 17.22± 2.48cm) **(Magallanes *et al.*, 2022)**.

The discrepancy in the outcomes can be attributed to two reasons: the method approach employed and the variation in length taken. While earlier researchers used the overall length, this investigation used the fork length with measurement accuracy in perspective **(Atmaja & Nugroho, 1995)**. Another factor is most likely due to exploitation pressure that causes the reproduction process to be faster, which is one of the natural reproductive strategies to avoid extinction **(Najamuddin, 2004; Asni *et al*., 2019)**. The size at which each fish's gonads first mature varies, and even within the same species, different habitats can influence gonad maturation. The size of the first mature gonads correlates with growth and environmental factors impacting their growth and reproductive strategies. Fish subjected to increased fishing pressure tend to mature their gonads at smaller sizes **(Ongkers *et al.*, 2011)**.

The analysis reveals that male *D. macrosoma* in the waters of Barru demonstrate an isometric growth pattern, aligning with the findings from a study on the length-weight relationship in *D. macrosoma* within its native Southeast Maluku waters **(Ajub *et al*., 2023)**. While the female shortfin scads (*D. macrosoma*) have an allometric development pattern that is negative, the length-weight relationship study results show a positive association. The shortfin scads have an allometric growth pattern that is negative and has a b- value of 2.88. In terms of biology, fish condition and the value of b are connected, with fish condition being influenced by food, age, sex, and gonad maturity **(Liestiana *et al*., 2015)**. For the analysis findings, male *D. macrosoma* in the waters of Barru exhibit an isometric growth pattern, which is consistent with the outcomes of a study on the length-weight relationship in shortfin scads (*D. macrosoma*) native Southeast Maluku Waters **(Ajub *et al*., 2023)**.

While the female shortfin scads (*D. macrosoma*) have an allometric development pattern that is negative, the length-weight relationship study results show a positive association. According to **Liestiana *et al*. (2015)**, the shortfin scads have an allometric growth pattern that is negative and has a b- value of 2.88. Shortfin scad in Java Sea exhibits a negative allometric growth pattern according to thestudy of **Prihatini (2006)**. Shortfin scads studies in Halmahera produced a negative allometric pattern with b = 2.4200- 2.5478, which is identical to b = 2.30 in the Gulf of Ambon **(Syahailatua & Sumadhiharga, 2004)**. The growth trend of shortfin scads in Monokwari waters is allometrically negative **(Randongkir *et al.*, 2018)**. As reported by **Zamroni *et al.* (2019)**, the shortfin scads in the Sulawesi waters displays a positive allometric growth pattern. Shortfin scads in Makassar waters exhibit a favorable allometric length-weight relationship growth pattern **(Asni *et al*., 2019b)**. Shortfin scads in Bulukumba Waters exhibit favorable allometric growth patterns **(Jamal *et al.*, 2021)**. Male and female shortfin scads correlation coefficients demonstrated favorable and very strong connections r> 0.82 and r> 0.80. This suggests that in male and female shortfin scads collected in the waters of Barru Regency, there is a tight correlation between body weight and fork length. No significant difference was found in the F- test of the regression coefficients between the body length and weight of male and female shortfin scads (*P*> 0.05). This suggests that the body weight and length increase of male and female shortfin scads are often comparable.

The von Bertalanffy parameters for *Decapterus punctatus* in the coastal waters of Greater Accra, Ghana were computed as follows: Asymptotic length (L∞) = 29.8cm, growth rate (K) = 0.35 per year, and growth performance index (Φ′) = 2.49 **(Asiedu *et al.*, 2022)**. Shortfin scads in the Malaka Strait obtained an asymptote length value (L∞) = 24.25cmFL, growth rate (K) = 1.03 per year and to = 0.1635 **(Faizah & Sadiyah, 2019)**. Shortfin scads in the Malaka Strait growth rate coefficient (K) = 0.560 per year, asymptote length (L∞) = 33.35cm, equal to zero (to) = -0.2799 **(Silooy *et al.*, 2019)**.

In the research location, the growth rate of shortfin scads demonstrates a low value, below 0.5 per year, indicating a slow progression toward reaching the asymptote length. Conversely, if the growth rate exceeds 0.5 per year, the time required to reach the asymptote length is faster. This is in accordance with the statement of **Sparre and Venema (1992**) that fish with a high growth coefficient rate will need a short time to reach their asymptote length and conversely, fish that have a low growth coefficient rate will need a long time to reach their asymptote length.

Variations in growth parameter values for the same fish species across different locations are influenced by internal factors, including genetic factors such as species differences, parasites, and diseases, as well as external factors like environmental conditions such as food availability, water temperature, dissolved oxygen levels, fish size, gonad maturity, and fishing pressure **(Shiraishi *et al.*, 2010; Faizah & Sadiyah, 2019; Magallanes *et al.* 2022; Osman *et al*, 2022)**.

Overall, the shortfin scads fish population at the research site appears to be in a depleted state, necessitating management interventions. With reference to the Sustainable Development Goals (SDGs), local governments must make special efforts to sustain the shortfin scads fish resources. One such effort involves regulating selective fishing gear to prevent the capture of young fish. Furthermore, strict enforcement of laws against the use of illegal fishing gear is essential to ensure the sustainability of the nation's fisheries.

CONCLUSION

During the research period, there was an uneven distribution of male and female shortfin scads, with a sex ratio of 1.6 males to 1 female. The average fork length of male shortfin scads ranged from 16.95 to 18.23cm, while that of females ranged from 16.63 to 17.87cm. Females exhibited a negative allometric growth pattern, while males displayed an isometric growth. The growth parameters were as follows: the asymptotic length (L∞) was 34.25cm fork length (FL) & the growth rate coefficient (K) was 0.410 per year and t0 -0.3867. The depleted state of the shortfin scads population at the research site underscores the need for management interventions. Local governments should prioritize efforts aligned with the Sustainable Development Goals (SDGs), such as regulating selective fishing gear and enforcing laws against illegal fishing practices, to ensure the sustainability of the nation's fisheries.

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