JIP
Jurnal Ilmiah PLATAX
Universitas Sam Ratulangi
Terakreditasi Ristekdikti No: 28/E/KPT/2019
ISSN : 2302-3589 (Online)
E_mail : jm_platax@unsrat.ac.id

The length-weight relationship of the bigeye scad (*Selar crumenophthalmus*) captured by purseseiner from FMA 716 of North Sulawesi seawaters: A comparative study of the target species sizes on May and August 2022

Effendi P. Sitanggang[1]*, Johnny Budiman[1], Anneke V. Lohoo[2], Dyan F.D Sitanggang[3], and Flora P. Kalalo[4]

[1]Dept. of Fishing Technology, Fac.of Fisheries and Marine Sciences, Sam Ratulangi University, Manado, Indonesia
[2]Dept. of Fish Processing Technology, Fac.of Fisheries and Marine Sciences, Sam Ratulangi University, Manado, Indonesia
[3]Dept of. International Law, Fac.of Law, Parahyangan University, Bandung, Indonesia
[4]Fac.of Law, Sam Ratulangi University, Manado, Indonesia
*Corresponding autors *epstagg@unsrat.ac.id*
Manuscript received: 19 Nov. 2025. Revision accepted: 20 Dec. 2025

Abstract. Bigeye scad (*Selar crumenophthalmus* Bloch 1793) is rich source of proteins, Omega-3 fatty acids, and various important vitamins and minerals for human body, that makes the fish has an important economic value. Additionally, because of forming an important shoal on coastal seawaters, the fish is frequently captured, notably by purseseiners in an important quantity from the FMA 716 of North Sulawesi seawaters. The intensiveness captures of the fish may affect the sustainability and continuity life of the species. The research aims at analyzing some biological reproduction aspects of species based on gender and fishing season. The 400 samples, 200 tails on May and 200 tails on August 2022, have selected by a purposive random sampling from the captures. Data analisys refers to some common formulas, such as the length and weight size structure, sex and weight ratio, W-L relationship ($W = aL^b$, W = weight, g), L = length (cmFL), a and b constants, condition factor (K), length at first capture ($L_c50\%$). The legal size is determined by comparing the length at first capture ($L_c50\%$) observed and at first maturity ($L_m50\%$) reference. On May, the sample weight is 33,439 g (51.8% of 400 samples), the sex and weight ratios are 1:1.08 and 1:1.36 respectively with the conversion factor (cf) of 1.26. The average length and weight sizes are 21.62 ± 0.17 cm and 167.20 ± 5.15 g respectively, where the average weight per 1 cmFL is 7.67 ± 0.18 g. The L-W relationship follows $W = 0.1492\ L^{3.0785}$ (r = 0.86) for male, $W = 0.0566\ L^{3.8088}$ (r = 0.90) for female, and $W = 0.0864\ L^{3.4940}$ (r = 0.91) for all, with K average of 1.60 ± 0.02 for male, 1.66 ± 0.03 for female, and 1.63 ± 0.02 for 200 samples. On August, the sample weight is 31,115 g (48.2% of 400 samples), the sex and weight ratios are 1:1.50 and 1:1.82 respectively, with cf of 1.21. The average length and weight sizes are 21.49 ± 0.16 cm and 155.58 ± 4.71 g respectively, where the average weight per 1 cmFL is 7.19 ± 0.17 g. The L-W relationship follows $W = 0.1515\ L^{3.047}$ (r = 0.88) for male, $W = 0.0789\ L^{3.5485}$ (r = 0.88) for female, and $W = 0.0836\ L^{3.5023}$ (r = 0.90) for all samples, with K average of 1.50 ± 0.02 for male, 1.58 ± 0.03for female, and K of 1.55 ± 0.02 for 200 samples. On both fishing seasons, all captures are categorized a positive allometry (b>3) and 96.75% of captures has a legal size. All females have passed their first maturity stage. For this reason, the fishermen must consider carefully when they catch the fishes, outside of the two months. Considering the intensiveness of fishing activities to such species, it is indispensable since early for all stakeholders designing a regulation to limitate captutes by gender size and fishing seasons, for all species of high potential and economic value of high density of shoals.

Key words: *bigeye scad, biological reproduction aspects, FMA 716, North Sulawesi, fish conservationn*

INTRODUCTION

Categorized as pelagic fish economically important and moderately cheap and loved by the community; the fish, bigeye scad (*Selar crumenophthalmus*) (Fig. 01) that stocks are always available all year round, live in forming a *shoal*, and frequently associated with the presence of coral reefs on the sea floor of less than 170 m of depth (Djuhanda *in* Hidayat, 2005; White *et al*., 2013; Fauzi *et al*., 2018). Referring to Widodo *et al*., (1993), the fish with total length can reach 23 cm or 20 cm in general average, is classified into class *Actinopterygii*, family *Carangidae*, and genus *Selar*. This voracious carnivore species actively search at nightday the larvaes of the *family Clupeidae, Balastidae, Cephalopoda, Serranidae,* and crabs as foods (Kimura, 2011). The high demands on the fish increase the catching activities of the spesies, and in turn, it will interfere.

the fish stock sustainability, notably in FMA 716 coastal seawaters as a whole. The goal is aimed at analyzing the comparison of some biological reproduction aspects of bigeye scad (*Selar crumenophthalmus*) by gender size and fishing season, captured by purse seiners from

that coastal seawaters

Fig. 01. Bigeye scad (*Selar crumenophthalmus*, Bloch 1793)

the fish stock sustainability, notably in WPP 716 coastal seawaters as a whole. The goal is aimed at analyzing some biological reproduction aspects of the bigeye scad (*Selar crumenophthalmus*) captured by purse seiners from WPP 716 of North Sulawesi seawaters.

METHODS

The research uses a purposive random sampling technique of a descriptive-quantitative method. Some common outils and formulas are applied to measure and determine the length and weight size structure, sex and weight ratio, W-L relationship ($W = aL^b$, W = weight, g), L = length (cmFL), a and b constants, condition factor (K), length at first capture ($L_c50\%$), while the legal size is determined by comparing the length at first capture ($L_c50\%$) observed and at first maturity ($L_m50\%$) reference, distiguished by gender and fishing season. A total of 400 tails of bigeye scad from the capture of purse seiners from FMA 716 of North Sulawesi seawaters which unloaded the catches at the fish auction of the coastal fishing port of Tumumpa-Manado, are taken as sample, which consisting of 200 tails on May 2022 (representing a 1st transition season, April to May 2022) and 200 tails on August 2022 (representing a dry season, June to September 2022). Some formulas commonly used to the biological reproduction aspects are briefly described below.

Sex and weight ratio

Fish gender is determined by a fish stomac surgery. The calculation of sex ratio of the captured species is to show the fish population steadiness between male and female of captured fish at certain period (Effendie, 1979). The sex and weight ratio can also be used to assess the success of spawning by comparing the number or weight of male and female fishes in certain seawaters, to be used on production, recruitments, and conservation of the fish resources. Sex ratio (SR) is a ratio between the number of male and the number of female fishes. Statitically, the sex ratio is expected to have a ratio 1:1. Weight ratio is the ratio between the total weights of all male fishes and the total weights of all female fishes.

Fish length-weight size structure

The grouping of the fish length and weight sizes in some adequate interval class, both by fishing season (May and August) and both by gender (males and females), is intended to make easily understanding the physically biological structure of the target species in the histogram form, which consisted of the number of species by lengrh or by weight (in persentage) of each class interval groupe by unit of length (cm) or weight (g). The frequency distribution figured by histogram or curve, consists of the percentage of captured fish plotted on y-axis and class interval (length or weight of captured fish) plotted on x-axis (Steel and Torrie, 1980; Walpole, 1995).

L-W relationship

The length of fish size samples is determined by using the ruler of 30 cm (0.1 mm) of length, while the weight by using the electronic kitchenscale of 500 g (0.1 g). All data is used to assess the fish growth. Which meant the changement of both length and weight of a living organisms in certain period of time (Erna, 1996). Physically, the growth is expressed by the changement of number or size cells forming fish body tissues in a certain period of time and measured then in length and weight units (Rahardjo, *et al.*, 2011). The research is to assess the L-W relationship and the distribution of their physical body size which is very important to predict the physical growth model of target fish in certain fishing seasons (Bayliff, 1966 *in*Omar, 2012).

According to Ricker (1975) *in* Effendie (1979), Sparre and Venema, 1998) and Omar (2012), the legth and weight relationship is expressed as $W = aL^b$ or log W = log a + b log L, where (log W) = Y and (b log L) = X with W weight (g), L *fork length* (cm), a and b are growth coefficients,which is confirmed with a simple liniear regression of Y = a + bX, **a** and **b** are contants and **r** (coefficient of regression) are calculated using a common formula. After *t-test students* on b value (Everhart and Youngs, 1981), there will be three possible types of fish growth, such as: (1) if b = 3, means the fish has an isometric growth (increasing an growth is in fish length is followed by increasing in weight); if $b < 3$, means fish growth is a negative allometric (increasing in fish length is faster than increasing in weight); and if $b > 3$, means fish growth is a positive allometric (increasing in fish length is slower than increasing in weight). The student's t-test ($p < 0.05$) is used to test whether b = 3 or not, where if b = 3 means the fish has an isometric growth type; consevely, if $b \neq 3$ means the fish has an allometric growth type (Rahardjo and Simanjuntak, 2008). The above formulas are also applied to each season and gender. The L-W relationship may be also influenced by sex, maturity stages, geographical variation, condition factor, and the fullness level of stomach (Rahardjo *et al*., 1997).

Condition factor

Condition factor (K) is a non-invasive assessment tool for determining whether the fish are properly nourished or not. Based on the L-W relationship, condition factor is expressed as a numerical value of K. The condition factor of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951). The study of the fish condition factor may be suposed as a physical study of external condition of fish body whether the body is fatness or flatness for the role of seawater conditions as the environment where the fish naturally live and grow.

There are two ways to compute a condition factor. Firstly, according to Htun-Han (1978), by using a Fulton's condition factor, $K = 100WL^{-3}$ where W is a given weight of fish (g), L is a given length of fish (cmFL). This Fulton's condition factor (K) is intended for the fishes having an isometric growth type (b = 3) (Okgerman, 2005), with K varies 0.5 to 2.0. Secondly; according to Effendie (1979), by using a relative condition factor, $K_n = 100$ W/W' where W is a given weight (g), W' (= aL^b) is an estimation weight (g) with L is length of fish (cmFL), while a and b are constants. If K_n ranges from 1.0 to 2.0, the fish is categorized as a less flattened fish, and if K_n ranges from 2.0 to 4.0 means a quite flattened fish (Vakily *et al*., 1986). The condition factor is closely related to the seawater fertility. If K < 100 means the fish population lives in a bad fertile seawater; conversely, if K > 100 the fish population lives in a very good fertile seawater (Anderson and Newmann, 1996).

Length at first maturity (L_m50%)

Data of the length at first maturity (L_m50%) of bigeye scad (*Selar crumenopththalmus*) is obtained, as a reference, from the precedent research carried out by Muharam, Kantun and Moka (2020) on 2,352 samples of bigeye scad (1,151 males and 1,201 females) captured from FMA

716 of North Gorontalo seawaters unloaded on Kwandang national fishing port from March to May 2020. They found L_m 50% at 18.91 cmFL for male and 17.98 cmFL for female, used as reference based on the same.FMA of 716, but administratively different areas.

Length at first capture (L_C50%) and legal size to be captured

The determinaton of the length at first capture (L_C50%) is carried out by forming a graph of the relationship between the fish size (sb-x) and the cumulative frequency of captured fish (sb-y), resulting a S-curve. Furhermore, the value of (L_C50%) ic compared with the reference value of the length at first maturity L_m50% to determine whether the length sizes of target fish is legal or not to be catched (Dewanti, 2018), where if L_c50% > L_m50% the fish length size is legal to be captured, and if L_c50% < L_m50% the fish length size is legal to be captured (Atikasari, 2021). We can conclude that the higher percentage of legal captured size (%) i.e. (Nbr. of Lc > Lm) / total captures , the higher fishing gears performaces; conversely, the worse percentage of illegal captured size (%) i.e. (Nbr. of Lc < Lm) / total captures , the worse fishing gears performaces. In other words, the strictly recommended fishing gears to be used are fishing gears having a capability to capture a target fish when the length at first capture (L_c50%) is greater than the length at first maturity (L_m50%), known as an eco-friendly fishing gears.

DISCUSSION

Coastal fishing port of Tumumpa-Manado

Before 2005, the fish landing place (PPI, type D), was builded along the river side of Kuala Jengki, close to the traditional market 'Bersehati' of Manado. After that time, this place was replaced to Tumumpa Dua village of Tuminting District of Manado City, and their status became a coastal fishing port (Tipe C) refers to the Maritime and Fishery Ministry's Decision No. Kep.10/Men/2005 which is now under-administered by *The Marine and Fisheries Rresources Managment* (PSDKP) of Marine and Fisheries Service of the Maritime and Fishery Ministry.

PSDKP (2021) reported that at least 135 purse seiner fishing vessels using this coastal fishing port as their fishing base for various sizes of gross tonnage (GT), namely, 5.2% of ≤ 10 - 20 GT, 62.2% of 20-30 GT, 31.1% of > 30 GT), and others (1.5%) of < 10 GT with the widths varying from 4,5 m to 5,5 m in average, which captured the fishes at *Fishery Management Area* (FMA) 716, situated around the north of Manado and Amurang, and Siau and Talaud archipelago of the Celebes Sea. The captures are generally dominated by skipjacks (*Katsuwonus pelamis*), *Decapterus* sp., *Auxis* sp. *Euthinnus* sp., *Selar* sp., and *Sardine* sp. baby or little tuna, and sometimes tunas of modeste sizes which were accidentally entering the webbing.

Length-weight size features of samples

Table 1 briefly presents some statistic parameters of 400 samples of bigeye scad captured by different sizes of purseseiners at two different fishing seasons from FMA 716 of North Sulawesi seawaters, which consisting of 200 samples on May 2022 and 200 samples on August 2022, by weight (W), length (L), gender, and fishing season. The grand total of weight for 400 sample is 64,554 g, where the length size (in cmFL) and weight size (in g) are 21.56 cm (with s ± 0.12 cm) and 161.39 g (± 3.53 g) in average respectively. Table 2 shows that the average weight per cm might be equivalent to 7.43 g (± 0.13 g).

On May 2022 (Table1) , the weight of 200 samples (50% of grand samples) is 33,439 g (51.8% of grand total weight), they have the average length and weight of 21.62 cm (± 0.17 cm) and 167.20 g (± 5.15 g) respectively, where 1 cm in average length might be equivalent to 7.67 g (± 0.18 g) in average weight (Table 2) While on August 2022 (Table 1), the weight of 200

samples (50% of grand samples) was 31,115 g (48.2% of grand total weight), they have the average length and weight of 21.49 cm (± 0.16 cm) and 155.58 g (± 4.71 g) respectively, where 1 cm in average length might be equivalent to 7.19 g (± 0.17 g) in average weight. From these two facts, with the same number of samples (each 200 tails of samples), the average size of weight on May 2022 is heavier than 0.49 g than on Agust 2022. Or, there is a significantly difference in average size of weight between May 2022 and August 2022 where on May 2022 is greater than on August 2022 (Table 2).

Table 1. Length and weight structure of bigeye scad (*Selar crumenophthalmus*) captured by purse seiners from FMA 716 by gender and fishing season

Gender	Season	n (tails)	Length (cmFL)		Weight (g)			
			L ± sd	Range	W ± sd	Range	Total	%
May	Male	96	20.94 ± 0.22	20.72 - 21.16	147.79 ± 5.52	142,27 - 153.31	14,188	48.0
	Female	104	22.25 ± 0.21	22.04 - 22.46	185.11 ± 6.89	178.22 - 192.00	19,251	52.0
Sub-total		200	21.62 ± 0.17	21.45 - 21.79	167.20 ± 5.15	162.05 - 172.35	33,439	50.0
August	Male	80	20.91 ± 0.20	20.71 - 21.11	138.08 ± 4.93	133.15 - 143.01	11,046	40.0
	Female	120	21.88 ± 0.20	21.68 - 22.08	167.24 ± 6.34	160.90 - 173.58	20,069	60.0
Sub-total		200	21.49 ± 0.16	21.33 - 21.65	155.58 ± 4.71	150.87 - 160.29	31,115	50.0
Male	May	96	20.94 ± 0.22	20.72 - 21.16	147.79 ± 5.52	142,27 - 153.31	14,188	48.0
	August	80	20.91 ± 0.20	20.71 - 21.11	138.08 ± 4.93	133.15 - 143.01	11,046	52.0
Total		176	20.93 ± 0.15	20.78 - 21.08	143.38 ± 3.81	139.57 - 147.19	25,234	44.0
Female	May	104	22.25 ± 0.21	22.04 - 22.46	185.11 ± 6.89	178.22 - 192.00	19,251	54.55
	August	120	21.88 ± 0.20	21.68 - 22.08	167.24 ± 6.34	160.90 - 173.58	20,069	45.45
Total		224	22.05 ± 0.15	21.90 - 22.20	175.54 ± 4.80	170.74 - 180.34	39,320	56.0
GRAND TOTAL		400	21.56 ± 0.12	21.44 - 21.68	161.39 ± 3.53	157.86 - 164.92	64,554	100

Source: Original research data (2022)

Furthermore, we also count the average size of lenght and weight for all samples which consists of 176 males (39.1% of samples) with 44% of grand total weight and 224 females (60.9% of samples) with 56% of grand total weight. For males, the average size of length and weight are 20.93 cm (± 0.15 cm) and 143.38 g (± 3.81 g) respectively, which means that every 1 cm of length size might be equivalent to 6.82 g (± 0.14 g) of weight size in average (Table 1 and 2). For females, the average size of length and weight are 22.05 cm (± 0.15 cm) and 175.54 g (± 4.80 g) respectively, which means that every 1 cm of length size might be equivalent to 7.91 g (± 0.17 g) of weight size in average (Table 2). In the simple words, the female weight size is heavier than 1.09 g in average than the male for every 1 cm of length size. The female length size is longer than 1.12 cm in average than the male. The female weight size is heavier than 32.16 g in average than the male. By these facts, the difference of every 1 cm of the length size of male might be equivalent to the increasing of 28.71 g in average weight size of female. With 200 tails, the average size of length and weight on May 2022 are greater than those on August 2022.

On May 2022, we found 96 males (52% of 200 samples with 42.4% of the total weight) and 104 females (48% of 200 samples with 57.6% of its total weight of 33,439 g). For 96 males, the average size of length and weight are 20.94 cm (± 0.22 cm) and 147.79 g (± 5.52 g) respectively, which means that every 1 cm of length size might be equivalent to 7.02 g (± 0.20 g) of weight size in average (Table 1 and 2); For females, the average size of length and weight are 21.88 cm (± 0.20 cm) and 167.24 g (± 6.34 g) respectively, which means that every 1 cm of length size might be equivalent to 7.59 g (± 0.25 g) of weight size in average (Table 1, 2). Or, in the simple words, the female weight size is heavier than 1.25 g in average than the male for every 1 cm of length size. The female length size is longer than 1.31 cm in average than the male, while the female weight size is heavier than 37.16 g in average than the male. By these facts, the difference of every 1 cm of the length size of male might be equivalent to the increasing of 28.49 g in average weight size of female.

On August 2022, we found 80 males (40% of 200 samples with 35,5% of the total weight he total weight) and 120 females (60% of 200 samples with 64.5% of its total weight of 31,115 g). For males, the average size of length and weight are 20.91 cm (± 0.20 cm) and 138.08 g (± 4.93 g) respectively; which means that every 1 cm of length size might be equivalent to 6.58 g (± 0.18 g) of weight size in average (Table 1 and 2). For females, the average size of length and weight are 21.88 cm (± 0.20 cm) and 167.24 g (± 6.34 g) respectively, which means that every 1 cm of length size might be equivalent to 7.59 g (± 0.23 g) of weight size in average. From the above cases, we can say that the female weight size is heavier than 1.01 g in average than the male for every 1 cm of length size. The female length size is longer than 0.97 cm in average than the male while the female weight size is heavier than 29.16 g in average than the male. By existing data, the difference of every 1 cm of the length size of male might be equivalent to the increasing of 30.06 g in average weight size of female.

Table 2. Average weight of each cmFL of bigeye scad (*Selar crumenophthalmus*) captured by purse seiners in FMA 716 by gender and fishing season

Season	Gender	n	(W/cmFL) ± s (g)	Range (g)
Grouped	All	400	7.43 ± 0.13	7.30 - 7.56
	Male	176	6.82 ± 0.14	6.68 - 6.96
	Female	224	7.91 ± 0.17	7.74 - 8.08
May	All	200	7.67 ± 0.18	7.49 - 7.85
	Male	96	7.02 ± 0.20	6.80 - 7.22
	Female	104	8.27 ± 0.25	8.02 - 8.52
August	All	200	7.19 ± 0.17	7.02 - 7.36
	Male	80	6.58 ± 0.18	6.40 - 6.76
	Female	120	7.59 ± 0.23	7.36 - 7.82

Sex ratio of captured fish on May and August 2022

Fauzi, Setyobudiandi and Suman (2018) stated that the sex ratio of the species target was 1:1.05 captured on Natuna seawaters, but by Chodrijah and Faizah (2016), the capture in FMA 716 which landed at national fishing port (PPN) of Kwandang, North Gorontalo on February-November 2016, had a sex ratio of 1:1.2. This value was not too different compared by Zamroni and Suwarso (2011) in Banda seawaters of 1:1.44, and by Syam (2006) in Central and North Molucca seawaters, and Iwai *et al*., (1996) in Hawai seawaters. This rresearh shows the sex ratio of 1:1.08 on May 2022 and 1:1.50 on August 2022(Table 3). Sex ratio of 1:1.08 on May 2022, is very close to 1:1.05 by Fauzi, Setyobudiandi and Suman (2018). Overall, the sex ratio of combined fishing seasons, May and August 2022, is 1: 1.27; but, the *chi-square test* (χ^2) requires statistically, the sex ratio must be 1:1 between gender.

By using α 5% for X^2 test on each 200 samples on May 2022 (96 males, 104 females) and 200 samples on August 2022 (80 males, 120 females), or total of 176 males and 224 females, $X^2_{corrected}$ (2.283) < $X^2_{0.95}$ (3.841), which mean that the number of captures is statistically proportional both in gender and in fishing season, with C (coef. of contigency) 0.075 and r (correlation among attributes) 0.076. *The Levene's test of equality of variances* shows that the average size of length was from the same varian; conversely, it does not find for the average size of weight.

The number of male and female fish in nature is expectedly ideal or in equal number i.e. 1:1, in order to the fish stock has a chance to reproduce higher for sustainining their life in nature. In other words, the number of female must be at least greater than male (Effendie, 1977). Both on May and August, or grouped, the female numbers are always greater (more than 50%) than male numbers, 52.0, 60,0, and 56.0% of its total number, respectively (Table 3). Furhermore, Senen *et al.* (2011) affirmed that the equal number between males and females

indicates that one male fish is expected to fertilize at least one female fish. Data above shows that the sex ratio of 1:1.08 on May is a quite proportional compared to 1:1.50 on August, however, the secondly is more adequate because one male fish has a possibility to fertilize more than 1 female or 10 males can fertilize 15 females. For a fish shoal lives in natue, an optimal condition can be reached if the number of females is greater than males to assure and sustain their process recruitment in the population

Table 3. Sex and weight ratio of bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May and August 2022

Parameter	May 2022			August 2022			Grouped		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Nbr. of samples (n)	96	104	200	80	120	200	176	224	400
(%)	48.0	52.0	100	40.0	60.0	100	44.0	56.0	100
Sex ratio (M/F)	**1 : 1.08**			**1 : 1.50**			**1 : 1.27**		
Weight (gram)	14,188	19,251	33,439	11,046	20,069	31,115	25,234	39,320	64,554
(%)	42.4	57.6	100	35.5	64.5	100	39.1	60.9	100
Weight ratio (M/F)	**1 : 1.36**			**1 : 1.82**			**1 : 1.56**		
Conversion factor*	**1.26**			**1.21**			**1.23**		

**Conversion factor from sex ratio to weight ratio (*Ex: 1.08 in SR_F = 1.36 in WR_F, 1 SR_F = 1.26 WR_F)

Referring to the fishing season above, the sex ratio will be different from time to time and from one fishing season to another one. It might be influenced by the uncertainty of gender to catch, and also the ignorance of the richness of these aquatic resources where fish live and reproduce. The higher sex ratio results the higher weight ratio and the lower conversion factor from sex ratio to weight ratio. The sex and weight ratio on August (1:1.50 and 1:1.82 respectively) are higher than those on May (1:1.08 1and 1:1.36 respectively). It means that the conversion factor is lower on August than May (1.21and 1.26 respectively). Or, the higher female number, the higher total weight and the lower convertion factor between them. Totally, on May and August, the sex ratio is noted 1:1.27 which is equivalent to weight ratio of 1:1.56 with 1.23 of conversion factor.

Table 4. Relationship among gender, season and its interaction on L-W size of bigeye scad captured by purse seiners from FMA 716 North Sulawesi seawaters on May dan August 2022

Source of variation	df	Length (cmL)				Weight (g)			
		SS	MS	F_c	Sig.	SS	MS	F_c	**Sig.**
Intercept	1	180,895.7	180,895.7	161,185.9	0.000	9,967,292.5	9,967,292.5	10,009.5	0.000
Gender (G)	1	126.7	126.7	112.9	0.000	108,152.5	108,152.5	108.6	0.000
Season (S)	1	3.9	3.9	3.5	0.062*	18,614.8	18,614.8	18.7	0.000
GS	1	2.8	2.8	2.5	0.116*	1,624.4	1,624.4	1.6	0.202*
Std. error	396	444.4	1.1			394,331.2	995.8		

In Table 4 above, in the column independent variable L (cmFL), it can be seen that there was a significant difference in average size of length (0.00 < 0.05) between gender (G), male and female; on the contrary, it was no different (0.062 > 0.05) between fishing season (S), May and August, and between the interraction of gender and fishing season (GS) (0.116 > 0.005). In the coloumn of dependent variable W (g), there was a significant difference in average size of weight between gender (0.00 < 0.05) and between fishing season (0.00 < 0.05); conversely, there was no statistically difference (0.202 > 0.05) between the interraction of gender and fishing season in average size of weight.

W-L relationship of target fish

The b coefficient from $W = aL^b$ is one important cofficients in determining the growth type of the target fish, bigeye scad (*Selar crumenopthalmus*). Table 5 below presented statistically the relationship of L-W of target species by gender and fishing season, where all b

coefficients is greater than 3 (b > 3) varying from 3.0473 (for males on August) to 3.8088 (for females on May). For grouped season (May and August), the b value was 3.0742 for 176 males and 3.7287 for 224 females, while for both gender (male and female), the b value was 3.4940 on May and 3.5023 on August. Furthermore, for 176 males on both seasons, the b value was 3.0785 for 96 males on May and it is 3.0473 for 80 males on August, while for 224 females on both seasons, the b value is 3.8088 for 104 females on May and it is 3.5485 for 120 females on August. For the grand total of 400 samples of both fishing seasons and genders, the b value is 3.5198. At a glance, we see that all b coefficients were a significantly difference between male and female fishes, where the b coefficient for males is lower than females, and it is directly related to the average size of length and weight of the target species.

Using α 5% (0.05), we conclude that all L-W relationship has a high significant correlation (0.00 < 0.05, r ≈ 1) with r 0.86 on May and 0.88 on August for males; while for females, r 0.90 on May and 0.88 on August. In both fishing seasons, we found r 0.86 for males and 0.89 for females and r 0.89 for both genders. *T-student test* of 95% level of convidence for b coefficient on $W = aL^b$, resulted that we have to accept that $b \neq 3$, means, the fishes have a positive allometric growth where the increasing in fish weight is followed by the increasing in the fish length for both fishing seasons and genders. In Table 5, all b coefficients, both on gender (male and female fish) and on fishing season (May and August 2022), and also without taking into consideration the gender and the fishing season, we found b > 3 for all equation of $W = aL^b$, mean all samples have the growth type classified positive allometry, with a strong correlation between the weight and length size.

Table 5. W-L relationship of bigeye scad captured from FMA 716 of North Sulawesi seawaters by gender and fishing season

Fishing season	Gender	n	Variable	Unstandardized Coef.		$t_{(\alpha/2)}$	Sig.	**r**	R^2	Regression equation
				B	Std. Error					
May + August	M+F	400	(Constant)	-2.4942	0.114	-21.951	0.000	0.900	0.810	Y = -2.4942 + 3.5198 X
			Length	3.5198	0.085	41.297	0.000			$W = 0.0826\ L^{3.5198}$
	Male	176	(Constant)	-1.9087	0.186	-10.288	0.000	0.856	0.732	Y = -1.9087 + 3.0742 X
			Length	3.0742	0.141	21.878	0.000			$W = 0.1483\ L^{3.0742}$
	Female	224	(Constant)	-2.7724	0.172	-16.135	0.000	0.890	0.792	Y = -2.7724+ 3.7287 X
			Length	3.7287	0.128	29.144	0.000			$W = 0.0625\ L^{3.7287}$
May	M+F	200	(Constant)	-2.4491	0.153	-16.007	0.000	0.908	0.823	Y = -2.4491+3.4940 X
			Length	3.4940	0.115	30.472	0.000			$W = 0.0864\ L^{3.4940}$
	Male	96	(Constant)	-1.9027	0.245	-7.782	0.000	0.864	0.744	Y = -1.9027+ 3.0785 X
			Length	3.0785	0.185	16.627	0.000			$W = 0.1492\ L^{3.0785}$
	Female	104	(Constant)	-2.8711	0.252	-11.380	0.000	0.896	0.800	Y = -2.8711+ 3.8088 X
			Length	3.8088	0.187	20.331	0.000			$W = 0.0566\ L^{3.8088}$
August	M+F	200	(Constant)	-2.4815	0.159	-15.561	0.000	0.901	0.811	Y = -2.4815+ 3.5023 X
			Length	3.5023	0.120	29.252	0.000			$W = 0.0836\ L^{3.5023}$
	Male	80	(Constant)	-1.8873	0.249	-7.571	0.000	0.877	0.767	Y = -1.8873+ 3.0473 X
			Length	3.0473	0.189	16.137	0.000			$W = 0.1515\ L^{3.0473}$
	Female	120	(Constant)	-2.5391	0.232	-10.941	0.000	0.883	0.779	Y = -2.5391+ 3.5485 X
			Length	3.5485	0.173	20.484	0.000			$W = 0.0789\ L^{3.5485}$

Chodrijah and Faizah (2018) also found in FMA 716 of Kwandang (North Gorontalo) seawaters that bigeye scad (*Selar crumenophthalmus*); however, some researcher found different results. For exemple, Siwat *et al.*(2016), confirmed that bigeye scad had a negative allometric growth captured from FMA 712 of Semarang seawaters, a part of Java Sea, while Barr *et al.*, (2016) found that the sepecies had a positive isometric growth in the Gulf of Manzanillo. According to Tesch *in* ElHaweet (2013), the varition of b value, can be caused by some factors, such as growth phases, seasonal impact, length range, relatic condition factor, and s of size selectivity of capture. Damora & Wagiyo (2012) added that the different of b value on the relationship length-weight shows a relative growth,which meant that the growth can be

changed by time. Jenning *et al*. (2001), declared that, in general, the b value is lied to physiological and environmental condition, such as: temperature, pH, salinity, geographic features and sampling technique. Biological condition, such as gonad development and food avalibility may affect the b value (Froese, 2006).

L-W size structures of bigeye scads on May and August 2022

Figure 2 below presented the structures of fish length size (cmFL) and fish weight size (g) of 400 samples where he length and weight size ranged from 18.5 to 24.8 cm and 101 to 276 g, respectively. For the length size structure, 83.8% of samples had the length of 20.1 - 23.2 cm, that consisted of 27.8% of fishes had the length of 21.7 - 22.4 cm, 23.3% of 20.9 - 21.6 cm, 18.5% of 20.1 - 20.8 cm and 14.2% of 22.5 - 23.2 cm; the rests (16.2%) were grouped into other interval classes of length. Then, 76.7% of samples had the weight of 121 - 200 g, which was 26.8% of 121 - 140 g, 19.5% of 141 - 160 g, and 15.5% of 181 - 200 g, and 14.9% of 201 - 280 g); the rests (23.3%) were grouped into other interval classes of weight.

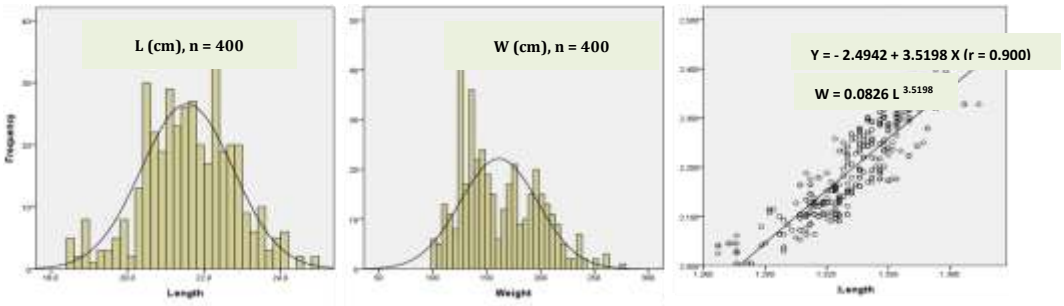

Fig.2. L-W size structures of 400 tails of bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May and August 2022

L-Wsize structures of male bigeye scad captured on both fishing seasons

Figure 3 below presented the structures of fish length size (cm) and fish weight size (g) of 176 males where the length and weight size ranged from 18.5 to 23.4 cm and 101 to 208 g, respectively. For the length size structure of 176 males, there were 84.1% of samples having the length size of 19.9 - 22.6 cm. which consisted of 33.0% of 20.6 - 21.2 cm, each 19.3% of 19.9 – 20.5 cm and 12.5% of 22.0 - 22.6 cm, and; the rests (15.9%) were grouped into other interval classes of length. Next, there were 26.8% of samples having the weight size range from 121 to 140 g, 19.5% of 141 - 160 g, and 15.5% of 181 - 200 g, and 14.9% of 201 - 280 g); the rests (23.3%) %) were grouped in the other interval class of weight. Furhermore, 64.8% of the males had the weight of 115 - 156 g, which was grouped into 26.1% of 115 - 128 g, 25.0% of 129 - 142 g, and 13.7% of 143 - 156 g, while the rests (35.2%) were classified into other interval classes of weight.

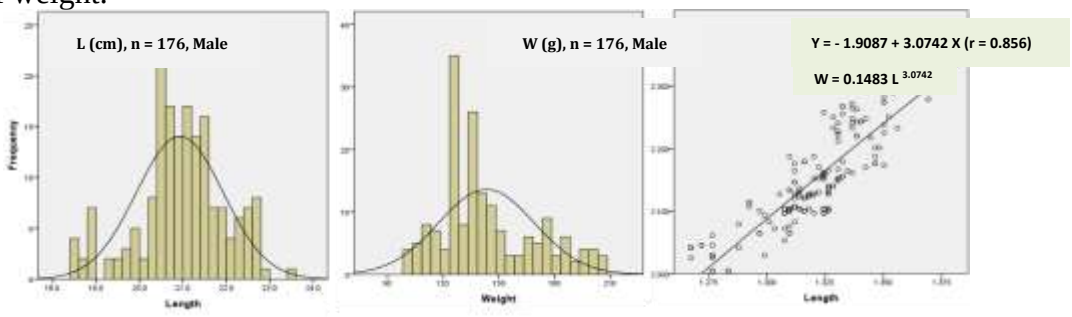

Fig.3. L-W size structures of 176 tails of male bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May and August 202

L-Wsize structures of female bigeye scad captured on both fishing seasons

Figure 4 below presents the structures of fish length size (cm) and fish weight size (g) of 224 females, where the length and weight size ranged from 18.5 to 24.8 cm and 101 to 276 g, respectively. For the length size structure of 224 males, there are 84.8% of samples having the length size of 20.9 - 24.0 cm, which consists of 36.6% of 21.7 - 22.4 cm, 21.0% of 22.5 - 23.2 cm and 16.5% of 20.9 - 21.6 cm, and 10.7% of 23.3 - 24.0; the rests (15.2%) are grouped into other interval classses of length. Next, there are 88.2% of samples having the weight size range from 123 to 232 g, which divided into 23.2% of 189 - 210 g, 18.8% of 123 –144 g, 17.4% of 145 - 166 g, 16.5% of 167 -188 g, and 12.1% of 211 - 232 g; the rests (11.8%) ere grouped into other interval classes of weight.

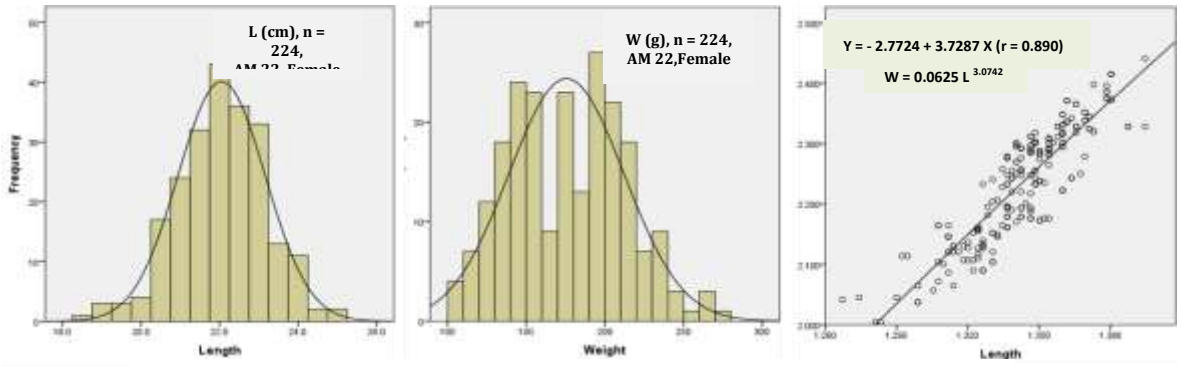

Fig.4. L-W size strucures of 224 tails of female bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May and August 2022

L-Wsize structures of bigeye scad captured on May 2022

The length and weight size of 200 samples on May, ranges from 18.5 to 24.4 cm and 101 to 260 g, respectively. Fig. 5 shows there are 81.5% samples had the length size of 20.1 – 23.2 cm, where 30.5% of samples have the lenght of 21.7 - 22.4 cm, 19.5% of 20.5 - 21.6 cm, 17.0% of 22.5 - 23.2 cm, 14.5% of 20.1 - 20.8 cm), and the rests (18.5%) are grouped into other interval classes of length. Furthermore, in the weight view, 93.0% of targets have the length size of 101 - 220 g, where 20.5% of them have the weight of 181 - 200 g, 19.0% of 121 - 140 g and each 16.0% of 141 - 160 g and 161 - 180 g, 11.0% of 201 - 220 g, and 10.5% of 101 - 120 g; the rests (7.0%) are grouped into other interval classes of weight.

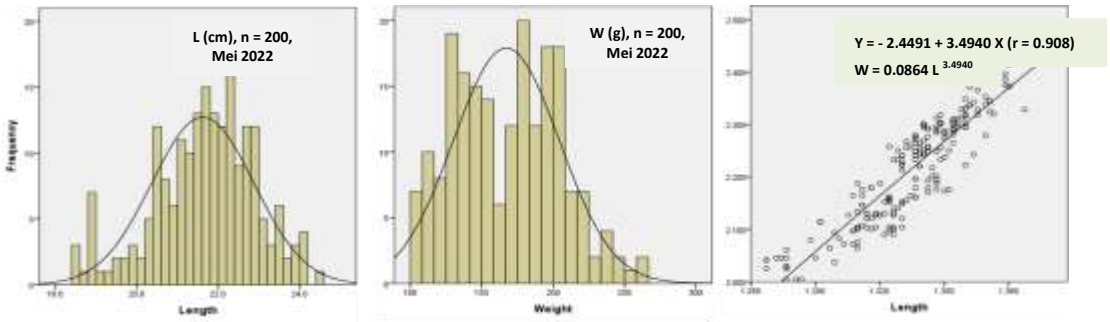

Fig.5. L-W size structures of 200 tails of bigeye scad captured by purse seiners from FMA 716 of Noth Sulawesi seawaters on May 2022

L-Wsize structures of males on May 2022

Data analysis of 96 males on May results the length and weight size of the samples vary from 18.5 to 22.6 cm and 101to 205 g, respectively. Figure 6 below shows 66.7% of samples have the length of 17.8 - 19.5 cm which distributed into 25.0% of 19.0 - 19.5 cm, 21.9% of 18.4 - 18.9 cm, 19.8% of 17.8 - 18.3 cm and 11.5% of 22.1 - 22.6 cm, and the rests (33.3%) are

grouped into other interval classes of length At weight term, there are 69.8% of samples are at the weight size range of 115 - 184 g, which distributed in 21.9% of 115 - 128 g, 16.7% of 129 - 142 g and each 15.6% of 143 - 156 g and 171 - 184 g, and the rests (30.2%) are grouped into other interval classes of weight.

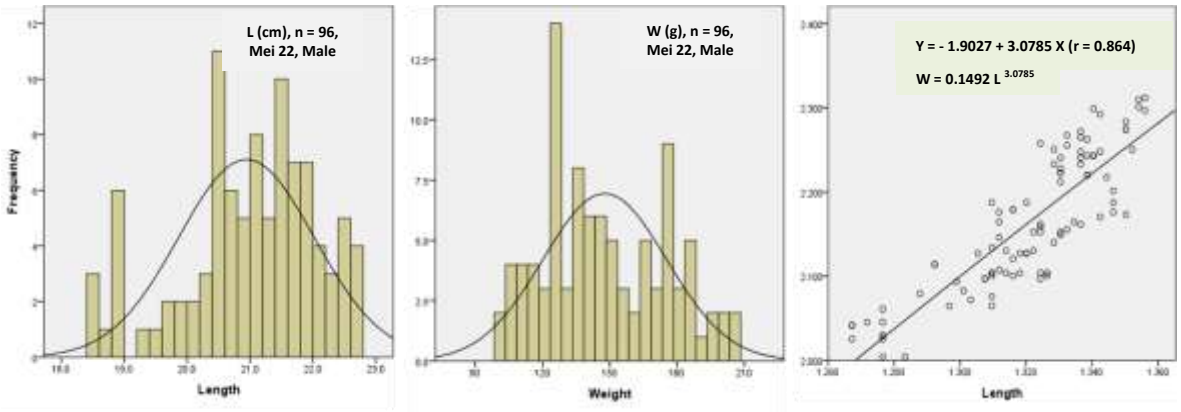

Fig.6. L-W size structures of 96 tails of male bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May 2022

L-Wsize structures of females on May 2022

Based on the data analysis of 104 females of the target fish on May, the result shows the length and weight size ranged from 18.8 to 24.4 cm and 101 to 260 g, respectively. Figure 7 shows that 79.8% of samples have the length range of 18.6 - 21.3 cm, which distributed into 29.8% of 19.3 - 19.9 cm, 26.0% of 20.0 - 20.5 cm, 13.5% of 20.7 - 21.3 cm, 10.6% of 18.6 - 19.2 cm, and the rests (20.1%) are grouped into other interval class distribution. Furthermore, 75.0% of samples are in the weight range of 143 - 226 g, which distributed in 28.8% of 185 - 205 g, 19.2% of 206 - 226 g, 15.4% of 164 - 184 g, 11.5% of 143 - 163 g), and the rests (25.0%) are grouped into other interval class of weight.

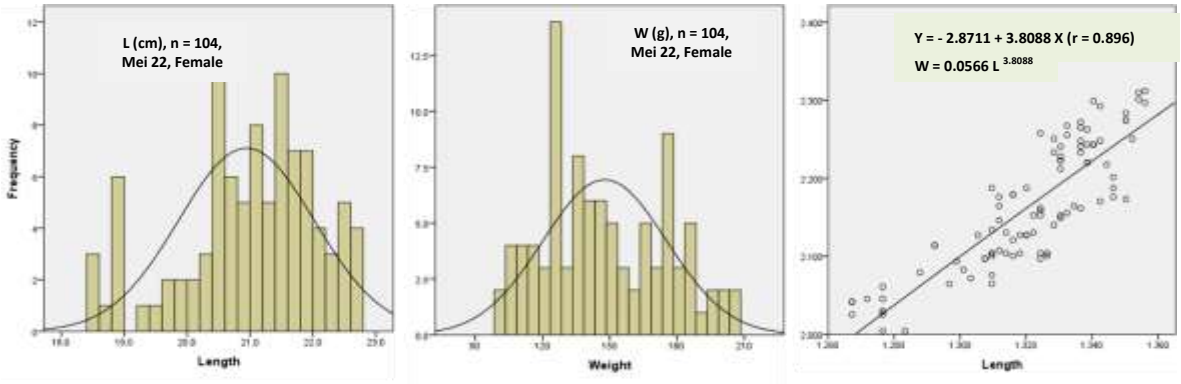

Fig.7. L–W size structures of 104 tails of female bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May 2022

L-Wsize structures of bigeye scad captured on August 2022

Analyzing on 200 samples of bigeye scad captured on August 2022, obtained the length and the weight size ranged from 18.5 to 24.8 cm and from 101 to 276 g, respectively. Figure 8 below shows that 86.0% of samples captured at the length size of 20.1 - 23.2 cm, where 27.0% of them havedthe lenght of 20.9 - 21.6 cm, 25.0% of 21.7 - 22.4 cm, 22.5% of 20.1- 20.8, and 11.5% of 22.5 -23.2 cm; the rests (14.0%) are grouped into other interval classes of length. Furthermore, we counted 40.5% of them have the weight of 123 - 144 g, 18.0% of 145 - 166 g

and each 12.0% of 167 - 188 g, 11.5% of 189 - 210 g, and the rests (18.0%) are grouped into other interval classes of weight.

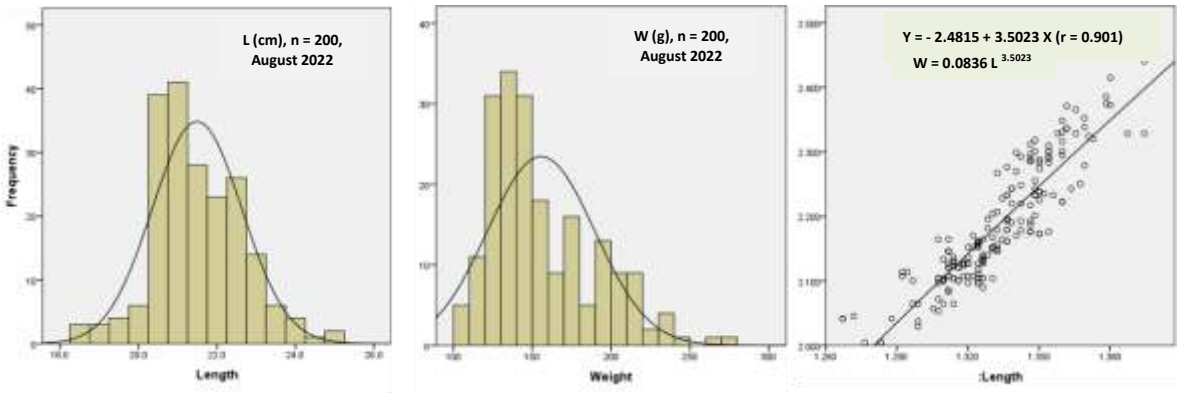

Fig.8. L-W size structures of 200 tails of bigeye scad captured by purse seiners from FMA 716 of Noth Sulawesi seawaters on August 2022

L-Wsize structures of males on August 2022

Analyzing on 80 male bigeye scads, 40.0% of 200 samples on August 2022, we obtain the length and weight size vary from 18.5 to 23.4 cm and 101 to 208 g, respectively. Figure 9 below shows that 67.6% of samples have the length size of 19.9 - 21.2 cm, where 46.3% of them had the lenght of 20.6 - 21.62 cm and 21.3% of 19.9 - 20.5 cm and the rests (32.4%) are grouped into other interval classes of length. Furthermore, we count also 71.3% of males have the weight of 131 - 160 g, which 40.0% of them range from 131 to 145 g and 31.3% from 116 to 130 g, and the rests (28.7%) are grouped into other interval classes of weight.

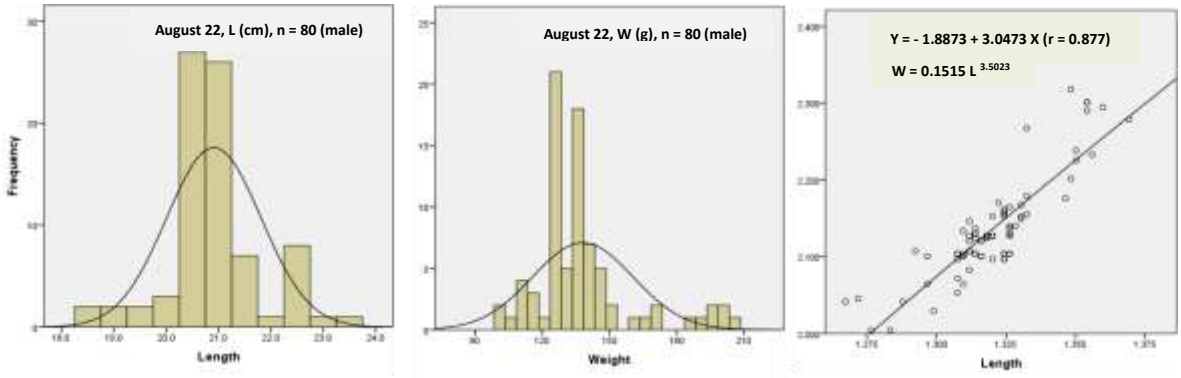

Fig.9. L-W size structures of 80 tails of male bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on August 2022

L-Wsize structures of females on August 2022

Analyzing on 120 female bigeye scads that 60.0% of 200 captured samples on August, have the length and the weight size varying from 18.5 to 24.8 cm and 101 to 276 g, respectively. Figure 10 below shows that 79.2% of samples have the length size of 20.3 - 22.9 cm, which 29.2% of them have the lenght of 21.2 - 22.0 cm 22.1 - 22.9 g respectively, and the rests (20.8%) are grouped into other interval classes of length. Furthermore, 88.3% of females have the weight of 124 - 215 g, which consisit of 28.3% of 124 - 146 g, 21.6% of 147 - 169 g, and 16.7% of 170 - 192 g and 193 - 215 g respectively, while the rests (16.7%) are grouped into other interval classes of weight.

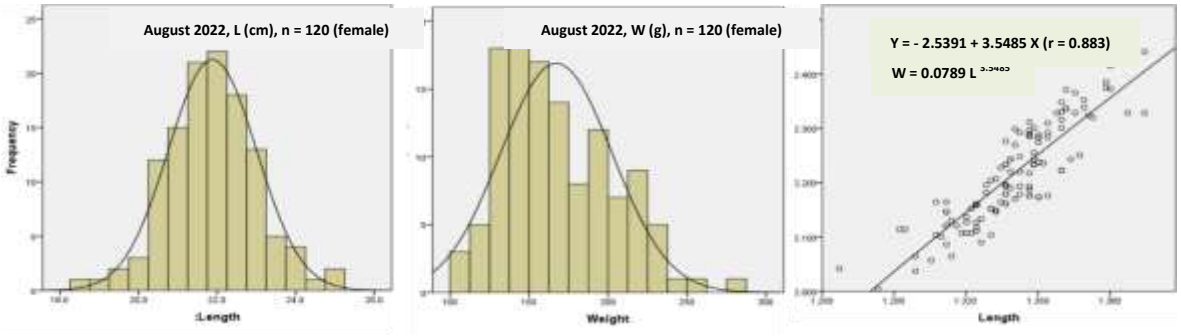

Fig.10. L-W size structures of 120 tails of female bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on August 2022

Condition factor (K)

Table 6 below shows the value of condition factors (K) for the target fishes captured on May and August 2022. The K average is 1.59 ± 0.02 for of 400 total samples, where 1.55 ± 0.02 for 176 males and 1.62 ± 0.02 for 224 females. The K value for females is greater than males on both fishing season, where K value on May is greater than August. All samples have a less flattened body form follsowing the K range of 1.0 - 2,0 (Effendie, 1997). According to Anderson and Newmann (1996) and Sparre, P dan SC. Venema (1999.), if K > 1.0 means that the seawater conditions, includes in FMA 716 of North Sulawesi where bigeye scads as target fish, are very suitable.which such seawater conditions for sustaining their life.

Table 6. Condition factors of bigeye scad captured by purse seiners from FMA 716 of North Sulawesi seawaters on May and August 2022

Fishing season	Gender	n	L ± s (cm)	W ± s (g)	K ± s
Grouped	TOTAL	400	21.56 ± 0.12	161.39 ± 3.53	1.59 ± 0.26
	Male	176	20.93 ± 0.15	143.38 ± 3.81	1.55 ± 0.02
	Female	224	22.05 ± 0.15	175.54 ± 4.80	1.62 ± 0.02
May	Total	200	21.62 ± 0.17	167.20 ± 5.15	1.63 ± 0.02
	Male	96	20.94 ± 0.22	147.79 ± 5.52	1.60 ± 0.02
	Female	104	21.25 ± 0.21	185.11 ± 6.89	1.66 ± 0.03
August	Total	200	21.49 ± 0.16	155.58 ± 4.71	1.55 ± 0.02
	Male	80	20.91 ± 0.20	138.08 ± 4.93	1.50 ± 0.02
	Female	120	21.88 ± 0.20	167.24 ± 6.34	1.58 ± 0.03

Veronika, *et al*. (2018) researched the L-W relationship of *Cucumber* sp. from four different seawaters in Northeast coastal areas of Sri Lanka and stated that the K value of species > 1.00 (2.26 ± 0.020), which means that the seawater conditions contains fish abundant foods (preys), or lack of predator density. Conversely, if K value < 1.00 means that the seawaters contains an insufficient fish food avofailability in nature, such as less of preys, high predator density (Muchlisin, 2014). Besides of the food availability in nature and the presence of many predators, biotic and abiotic factors and the lost of fishery management, they all may also affect the declining.of K value.

Legal and illegal fish size to catch

Table 7 below shows the average length and weight sizes, condition factors, and weight per 1 cmFL of the target fish after being categorized based on the moment at first captured (Lc50%) for both gender and fishing seasons and both genders, captured by *purse seiners* from the seawaters are categorized as legal fish size to catch ($L_c50\% > L_m50\%$), which passing their maturity stage (Table 7 and 8).

Using α 5%bon χ^2_{table} with v = 1or χ^2 0.95(1) = 3.84, we find that Lc (< L_c50% and (≥ L_c50%) on May ($\chi^2_{calculated}$ = 0.21) and August ($\chi^2_{calculated}$ = 0.33) or both fishing seasons ($\chi^2_{calculated}$ = 0.53) are less than χ^2_{table} (3.84), which means the difference of Lc50%, less than or more than or equal to Lc50%, has statistically proportional distribution in number between gender. As previous discussion, the average length and weight size, and also their condition factors and the weight of each 1 cmFL of female are greater than male, for both fishing seasons and/or grouped.

Furthermore, in the next following Table 8, by comparing the value of L_m (50%) of the fish target i.e. 18.91 cmFL for male and 17.98 cmFL for female as reference which is determined by Muharam, Kantun and Moka (2020) from FMA 716 of North Gorontalo seawaters unloaded on Kwandang national fishing port. The use of this reference for own research, is based on the same.FMA of 716, but administratively different areas.

In general, all female target fishes, captured on May, August and both, have a different size at first captured (L_c50%) which all are higher than the size of first maturity (L_m50%), that means that all those females have a legal size to catch (catchable female fishes) and the condition is assured by the official regulating, because of those female fishes are assumed passing their maturity stage, and have a possibility to reproduce more for sustaining their life in nature for the future. While the male fishes, we count 13 tails (3.25%) of 400 tails of < L_m50% captured on both fishing season, which are divised 10 tails (5.0%) of 200 samples on May and 3 tails (1.5%) of 200 samples on August. In other hand, the purse seiner fishing gear could be assumed as a high performance and a high selective fishing gear to catch the target fishes on both fishing season.

Table 5. The fork length size (cmFL) and weight (g) of the bigeye scad at first captured by gendre from FMA 716 of North Sulawesi seawaters on May and August 2022

Fishing season	Gender	Lc	n	W (g)	L ± s (cmFL)	W ± s (g)	K ± s	W/L ± s (g/cm)
Grouped	M + F	Lc < 21.52	190	25,055	20.55 ± 0.11	131.87 ± 2.18	1.52 ± 0.02	6.41 ± 0.09
		Lc ≥ 21.52	210	39,499	22.47 ± 0.10	188.09 ± 3.72	1.65 ± 0.02	8.35 ± 0.14
	Grand Total		400	64,554	21.56 ± 0.12	161.39 ± 3.53	1.59 ± 0.26	7.43 ± 0.86
	Male	Lc < 20.90	80	9,994	20.09 ± 0.15	124.93 ± 2.66	1.54 ± 0.02	6.21 ± 0.10
		Lc ≥ 20.90	96	15,240	21.63 ± 0.12	158.75 ± 4.81	1.56 ± 0.03	7.32 ± 0.19
	Total		176	25,234	20.93 ± 0.15	143.38 ± 3.81	1.55 ± 0.02	6.82 ± 0.14
	Female	Lc < 22.11	110	16,364	21.17 ± 0.14	148.76 ± 4.52	1.56 ± 0.03	7.00 ± 0.18
		Lc ≥ 22.11	114	22,956	22.90 ± 0.12	201.37 ± 4.91	1.67 ± 0.03	8.78 ± 0.18
	Total		224	39,320	22.05 ± 0.15	175.54 ± 4.80	1.62 ± 0.02	7.91 ± 0.17
May	M + F	Lc < 21.68	95	13,097	20.48 ± 0.18	134.44 ± 4.26	1.56 ± 0.03	6.54 ± 0.17
		Lc ≥ 21.68	105	20,342	22.56 ± 0.13	193.73 ± 4.95	1.68 ± 0.03	8.57 ± 0.18
	Total		200	33,439	21.62 ± 0.17	167.20 ± 5.15	1.63 ± 0.02	7.67 ± 0.18
	Male	Lc < 21.05	44	5,537	20.00 ± 0.23	125.84 ± 4.23	1.57 ± 0.03	6.28 ± 0.16
		Lc ≥ 21.05	52	8,651	21.74 ± 0.13	166.37 ± 5.94	1.62 ± 0.05	7.64 ± 0.25
	Sub total		96	14,188	20.94 ± 0.22	147.79 ± 5.52	1.60 ± 0.02	7.02 ± 0.20
	Female	Lc < 22.27	51	8,150	21.42 ± 0.22	159.80 ± 7.94	1.61 ± 0.05	7.43 ± 0.31
		Lc ≥ 22.27	53	11,101	23.05 ± 0.15	209.45 ± 6.09	1.71 ± 0.03	9.08 ± 0.23
	Total		104	19,251	21.25 ± 0.21	185.11 ± 6.89	1.66 ± 0.03	8.27 ± 0.25
August	M + F	Lc < 21.31	95	12,284	20.54 ± 0.12	129.31 ± 2.16	1.49 ± 0.02	6.29 ± 0.08
		Lc ≥ 21.31	105	18,831	22.35 ± 0.15	179.34 ± 5.77	1.60 ± 0.03	8.00 ± 0.21
	Total		200	31,115	21.49 ± 0.16	155.58 ± 4.71	1.55 ± 0.02	7.19 ± 0.17
	Male	Lc < 20.80	36	4,479	20.20 ± 0.19	124.42 ± 3.32	1.51 ± 0.03	6.15 ± 0.13
		Lc ≥ 20.80	44	6,567	21.49 ± 0.20	149.25 ± 7.01	1.49 ± 0.04	6.92 ± 0.26
	Sub total		80	11.046	20.91 ± 0.20	138.08 ± 4.93	1.50 ± 0.02	6.58 ± 0.18
	Female	Lc < 21.83	59	8,332	20.99 ± 0.18	141.22 ± 4.56	1.52 ± 0.03	6.71 ± 0.18
		Lc ≥ 21.83	61	11,737	22.74 ± 0.18	192.41 ± 7.41	1.63 ± 0.04	8.44 ± 0.28
	Sub total		120	20,069	21.88 ± 0.20	167.24 ± 6.34	1.58 ± 0.03	7.59 ± 0.23

Table 8. The comparaison between the fish size at first captured and the size at first maturity of bigeye scad caught from FMA 716 of North Sulawesi seawaters on May and August 2022

Fishing season	Gender	Lc 50% (cmFL)	< Lc	< Lm	≥ Lc	Total (tails)
May	M	21.05	34	10	52	96
	F	22.30	51	0	53	104
	M+F		85	10	105	200
August	M	20.80	33	3	44	80
	F	21.83	59	0	61	120
	M+F		92	3	105	200
Grouped	M	20.90	67	13	96	176
	F	22.11	110	0	114	224
	M+F		177	13	210	400

Notes:
(1) The sizes at first maturity ($L_m50\%$) for bigeye scad captured from WPP 716 of North Gorontalo seawaters are 18.91 cm for male and 17.98 cm for female (Muharam, et al., 2020).
(2) All female fish passed their first maturity stage ($L_c50\% > L_m50\%$) by reference (1)
There is no significant different size at first time (Lc50% cm) to catc ($\chi^2_{hit} < \chi 2_{table}$ by fishing season and gender

CONCLUSION AND RECOMMENDATION

Conclusion

On May, 200 samples have a weight of 33,439 g (51.8% of 400 samples), the sex and weight ratio of 1:1.08 and 1:1.36 respectively with the conversion factor of 1.26. The average length and weight size are 21.62 ± 0.17 cm and 167.20 ± 5.15 g respectively, with average weight per 1 cm of 7.67 ± 0.18 g. The L-W relationship follows $W = 0.1492\ L^{3.0785}$ (r = 0.86) for male, $W = 0.0566\ L^{3.8088}$ (r = 0.90) for female, and $W = 0.0864\ L^{3.4940}$ (r = 0.91) for all samples, with K average of 1.60 ± 0.02 for male, 1.66 ± 0.03 for female, and 1.63 ± 0.02 for all samples. The female length size is longer than 1.31 cm in average than the male, while the female weight size is heavier than 37.16 g in average than the male.

On August, 200 samples have a weight of 31,115 g (48.2% of 400 samples), the sex and weight ratio of 1:1.50 and 1:1.82 respectively, with the conversion factor of 1.21. The average length and weight size are 21.49 ± 0.16 cm and 155.58 ± 4.71 g respectively, with average weight per 1 cm of 7.19 ± 0.17 g. The L-W relationship follows $W = 0.1515\ L^{3.047}$ (r = 0.88, R = 0.77) for male, $W = 0.0789\ L^{3.5485}$ (r = 0.88) for female, and $W = 0.0836\ L^{3.5023}$ (r = 0.90) for all samples, with K average of 1.50 ± 0.02 for male, 1.58 ± 0.03for female, and K of 1.55 ± 0.02 for all samples. The female length size is longer than 0.97 cm in average than the male while the female weight size is heavier than 29.16 g in average than the male.

On both fishing seasons, 400 samples have a weight of 64,554 g, the sex and weight ratio of 1:1.27 and 1:1.56 respectively with the conversion factor of 1.23. The average length and weight size are 21.56 ± 0.12 cm and 161.39 ± 3.53 g respectively, with average weight per 1 cm of 7.43 ± 0.86 g. The L-W relationship follows $W = 0.1483\ L^{3.0742}$ (r = 0.86) for males, $W = 0.0625\ L^{3.7287}$ (r = 0.89) for females, and $W = 0.0826\ L^{3.5198}$ (r = 0.90) for all samples, with K average of 1.55 ± 0.02 for male, 1.62 ± 0.02 for female, and 1.59 ± 0.26 for 400 samples. The female length size is longer than 1.12 cm in average than the male. The female weight size is heavier than 32.16 g in average than the male. All captures are categorized a positive allometry and the grand mayoritycapture has a legal siz where aal female fihes have passed their first maturity stage.

Recommendation

For this reason, the fishermen must consider carefully when they catch the fishes, outside of the two months. Byconsidering the intensiveness of fishing activities to such species, it is obliged since early for all stakeholders designing an official regulation to limitate the capture of species by sizes and fising seasons, including all species of high potential and economic

values which forming a highdense fish shoals.

ACKNOWLEDGMENT

This research are finanf ced by PNBP Unsrat in 2022 based on DIPA BLU Unsrat No. SP DIPA - 023.17.2.677519/2022 under-scheme of "Riset Dasar Unggulan University Sam Ratulangi (RDUU)'. By publishing research by Platax Scientific Journal (SINTA 2), the writers, from the bottom of our deepest hearts,are so grateful for your assistance and we are cannot thank you enough for everything you have done, especially for Prof. Oktovian B.A Sompie as Rector of Sam Ratulangi University, Prof. Jefrey I. Kindangen as the Chef of LPPM and Prof. Roike I Montolalu as the Dean of Fac.Fisheries and Marine Scieces, and all the team members who assist the data collection. Special thank is also destined for Alex Kambey as Editor in chef and all Editorial Board of Platax and all reviewers for giving us some unvaluable advices.

REFERENCES

Anderson RO and RM Newmann. 1996. Lenghtah-weight and associated srtuctural indices in: Fisheries techniques, 2nd ed. BR Murphy and DW Willis (eds). American Fisheries Society, Bethesda Mariland, p.447-481

Atikasari M. 2021. Studi tngkat keramahan lingkungan alat tangkap di Pesisir Desa Kranji Kec.Paciran, Kab. Lamongan, Jawa Timur. Skripsi. Fakultas Sains dan Teknologi, Universitas Islam Negeri Sunan Ampel., Surabaya

Chodrijah U dan R Faizah. 2018. Biologi reproduksi selar bentong (*Selar crumenophtahlmus* Bloch, 1793) di Perairan Kwandang, Gorontalo Utara. *BAWAL*, 10(3): 169-177.

Damora A dan K Wagiyo. 2012. Parameter populasi ikan kadah (*Valamugil) (speigleri*) sebagai indikator pemanfaatan sumber daya perairan estuaria di Pemalang. *BAWAL*, 4 (2), 91-96.

Dewanti MZ. 2018. Evaluasi selektivitas dan keramahan alat tangkap dogol di Kab. Pangandaran Propinsi Jawa Barat. *Jurnal Airaha*, 7(1), 030 – 037

Effendie MI. 1979. Metode biologi perikanan. Yayasan Dewi Sri, Bogor, 163 p.

ElHaweet AEA. 2013. Biological studies of the invasive species *Nemipterus japonicus* (Bloch, 1791) as a Red Sea immigrant into the Meditteranian. Egyptian *Journal of Aquatic Research*, 39, 267-274.

Everhart WH and WD Youngs. 1981. Principles of fishery science. 2nd Ed. Comstock Publ.Associates, a division of Cornell University Press, London.

Fauzi M., I Setyobudiandi, dan A Suman. 2018. Biologi reproduksi ikan selar bentong (*Selar crumenophthalmus*, Bloch, 1793) di Perairan Natuna, Laut Cina Selatan. *BAWAL*., 10 (2): 121-133.

Froese R. 2006. Cube law, condition factor and weight length relationship: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22, 241- 253.

Htun-Han M. The reproductive biology of the Limanda limanada (L.) in the North Sea: gonadosomatic index, hepatosomatic index and condition factor. J Fish Biol. 1978;13(1):351–377

Hidayat T. 2005 Pembuatan hidrolisat protein dari ikan selar kuning (*Caranx leptolepis*) dengan menggunakan enzim papain. Prodi Teknologi Hasil Perikanan Fakultas Perikanan dan Ilmu Kelautan, IPB, Bogor. 70.

Iwai TY, CS Tamaru, L Yasukochi and M Mitsuyasu. 1996.Natural spawning of captive bigeye scad *Selar crumenophthalmus* in Hawaii. *Journal of the World Aquaculture Society*, 27(3), 332 - 339

Jennings S, MJ Kaiser, and JD Reynolds. 2001. Marine Fishery Ecology. Blackwell Sciences, Oxford. p.417.

Kimura S. 2011. Fishes of Terengganu. Proceeding of Carangidae Jacks (Scad, Trevallies).National Museum of Nature and science. Malaysia, 99

Le Cren ED. 1951. The length-weight relationships and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis) *J. Anim Ecol.* 1951;20:201–219

Muharam NH, W Kantun, dan WJ Moka. 2000. Indeks kematangan gonad dan ukuran pertam kali matang gonad ikan selar bentong (*Selar crumenophthalmus*), BLOCH, 1793) di Perairan Kwandang, Gorontalo Utara. *Siganus: Journal of Fisheries and Marine Science*, 2 (1) : 74-79.

Muchlisin ZA. 2014. A General Overview on Some Aspects of Fish Reproduction. Aceh Int. *J. Sci. Technol*., 3(1): 43-52 April 2014

Omar SAB. 2012. Dunia Ikan. Yogyakarta (ID): Gadjah Mada University Press.

Okgerman H. 2005. Seasonal variation of the lenghth -weight and condition faktor of Rudd (*Scardinius erythrophtalmus* L) *in*: Spanca Lake *International Journal of Zoological Research* Vol. 1(1): 6-10

PSDKP. 2022. Statistik PSDKP Wilayah Kerja Tumumpa: Laporan Tahunan Perikanan Tangkap Pelabuhan Perikanan Pantai Tumumpa, Direktorat Jenderal Perikanan Tangkap. Kementerian Kelautan dan Perikanan Republik Indonesia.

Rahardjo MF dan CPH Simanjuntak. 2008. Hubungan panjang-bobot dan faktor kondisi ikan tetet, *Johnius Belangerii Cuvier* (Pisces: Sciaenidae) di Perairan Pantai Mayangan, Jawa Barat. *Jurnal Ilmu-Ilmu Perairan dan Perikanan Indonesia*, Vol.15 (2), 135-140

Rahardjo MF, DS Sjafei, R Affandi R, Sulistiono, dan J Hutabarat. 2011. Iktiologi. Bandung (ID): Penerbit Lubuk Agung

Sparre P dan SC Venema. 1999. Introduksi pengkajian stok ikan tropis. Buku-I manual (edisi Terjemahan). Kerjasama FAO dengan Puslitbang Perikanan, Balittan RI. Jakarta. 438 p.

Steel, RGD dan JH Torrie. 1989. Prinsip dan prosedur statistika: Suatu pendekatan biometrik. Terjemahan Bambang Sumantri. ED.3 McGraw Hill, Inc. Book Co., New York, 352-358.

Syam AR. 2006. Parameter stok dan laju eksploitasi ikan kawalinya (Selar crumenophthalmus) di Peraian Maluku. *Prosiding Seminar Nasional Ikan IV*. 51-62.

Siwat A, Ambariyanto, and I Widowati. 2016. Biometrics of bigeye scad, *Selarcrumenophthalmus* and shrimp scad, *Alepesdjedaba* from Semarang waters, Indonesia. *AACL Bioflux*, 9 (4), http://www.bioflux.com.ro/aacl.

Veronika, U. Edrisinghe, K Sivashanthini, and ARSB Athauda. 2018. Length-weight relationships of four different sea Cucumber species in North-East Coastal Region of Sri Lanka. *Tropical Agricultural Research*. 29 (2): 212 – 217.

Walpole RE. 1995. Pengantar statistika: 3rd Ed. Jakarta: PT Gramedia Pustaka Utama.

White J, MR Heupel, CA Simpfendorfer and A J Tobin. 2013. Shark-like batoids in Pacific fisheries: prevalence and conservation concerns. *Endang. Species Res.* Vol. 19: 277–284. doi: 10.3354/esr00473.

Widodo J, H Suwarso dan H Suryono. 1993.Biologireproduksi dan perikanan selar bentong, *Selar crumenophthalmus* (Carangidae), di Laut Jawa. *Jurnal Penelitian Perikanan Laut*, 72, 1-9.

Zamroni A. and Suwarso. 2011. Studi tentang biologi reproduksi beberapa species ikan pelagis kecil di perairan Laut Banda. *BAWAL*, 3 (5),337-344