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Length-Weight Relationships of Brown-Marbled Grouper Epinephelus fuscoguttatus Forsskål, 1775 in Bobong Taliabu Waters of North Maluku, Indonesia

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ABSTRACT
Length-weight relationship (LWR) species Epinephelus fuscoguttatus Forsskål, 1775 by gender (male and female) were collected from September 2016 to June 2017 in Bobong Taliabu waters, North Maluku, Indonesia. Fish captured using bottom trap, size 80 x 60 x 35 cm with mesh size 5 cm. LWRs of significant male and female E. fuscoguttatus ($P<0.05$) were calculated as $W = 0.0098\ L^{3.1475}$ ($r^2 = 0.9252$), $W = 0.0752\ L^{2.5030}$ ($r^2 = 0.9029$), and $W = 0.9987\ L^{1.6789}$ ($r^2 = 0.9093$) for both. This study recorded the new maximum length by sex of E. fuscoguttatus.
***Keywords**: grouper, length-weigth, Epinephelus fuscoguttatus*

1. INTRODUCTION
Length-weight relationship (LWR) is the basis of the biological parameter to be an important source of information in the assessment of fishery resources (Froese, Tsikliras, & Stergiou [1], Tangke et al [2], Tangke et al. [3]. LWR obtained information about fish growth conditions so as to determine the growth pattern (i.e., allometric vs. isometric growth) Richter et al. [4], Vega-Cendejas et al. [5]. In turn, LWR is used for comparative growth studies by Tangke et al. [6], Froese & Pauly,[7], Ricker [8]. In addition, LWR can convert length to weight and vice versa, providing insight into fish ecology by Froese [9], as well as having many important applications in fisheries management by Pauly [10], Rochmady & Susiana [11].

Besides, LWR is used for many studies of fisheries biology, i.e., total biomass, fish conditions (overweight, food and reproduction), age structure, inter-regional growth rate, regional comparison of fish life history and specific species, Farooq et al. [12], Hashim et al. [13], Özdemir et al. [14]. Environmental suitability, Froese et al. [1], Jellyman et al. [15], Le Cran et al. [16], Reñones et al. [17], significant to develop conservation strategies fish and ensure sustainable development, Castilla [18], Patanda et al. [19]. However, LWR analysis is important to pay attention in fish gender. Nevertheless, despite having different applications, LWR data for many species of fish worldwide is still insufficient, Froese & Pauly [20].

The north coast sea of North Maluku are considered as one of the diversity hotspots of fish in the Banda Sea. Dalzell & Pauly, [21], Hariey & Baskoro, [22]. The waters of Bobong Taliabu North Maluku are similar to the Bengal Sea, Bangladesh have the resources of fish with high levels of diversity, Hanif et al. [23]. The waters of Bobong Taliabu North Maluku and its surroundings are abundant with ichthyofaunal diversity, one of which is Perciformes species (E. fuscoguttatus). This study aims to analyse LWR species E. fuscoguttatus by gender (male and female).

2. METHOD
Specimens are collected by monthly from September 2016 to June 2017 in the waters of Bobong Taliabu (02°02'09.568" S - 124°23'11.473" E) North Maluku, one of the largest waters in North Maluku, Indonesia. The sampled fish is taken by using a "bottom trap" size specification (80 x 60 x 35 cm) the slit size is 5 cm with the help of local fisherman. The fish samples are identified against the species level, and the scientific name for each species was checked against FishBase, Froese & Pauly, [20]. Specimens were identified on the spot and sorted by gender. The total length (TL) and body weight (BW) specimens were measured with a precision of 0.1 cm and 0.01 g, respectively. Length-weight relationship ($W = a\ L^b$) is estimated using a linear regression equation of log transformation. Le Cren, [16]: $\log (W) = \log (a) + b \log (L)$, where W is the total wet weight (g), L is the total length (cm), a is the intercept, and b is the slope. The

regression parameters (a and b) at 95% confidence intervals (CI) and correlation coefficient values (r^2) (Froese, [9]). Prior to regression, was performed a log-log plot of length and weight relationships to eliminate extreme imaging (Froese et al., [1]). All calculations and statistical analysis using Excel 2013.

III. RESULTS AND DISCUSSION

The statistical summary of sex, sample size (N), size range: length (cm) and weight (g) minimum and maximum, LWR parameters (a and b) at 95% confidence intervals (CI) and correlation coefficients (r^2) in Table 1. The regression parameters (b) and the correlation coefficient (r^2) are respectively in the range of 3.1299-3.1651 and 0.9155-0.9572 for males, ranging from 2.4788-2.5272 and 0.8688-0.9691 for females, and ranged from 1.6579-1.7000 and 0.9093 for the whole.

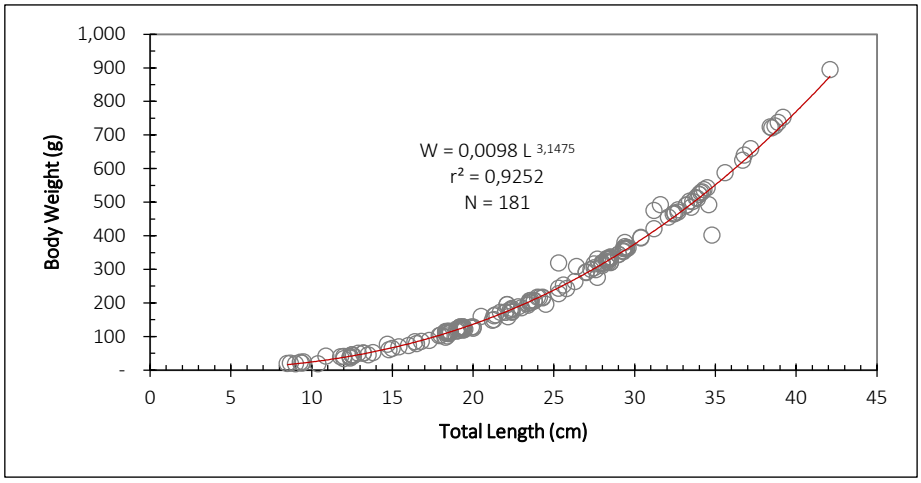

Figure 1. LWR of Brown-Marbled Grouper in Bobong,

Table 1. Descriptive statistics and LWRs parameters for *Epinephelus fuscoguttatus* captured by monthly from Bobong Taliabu waters of North Maluku, Ternate, Indonesia.

			Total Length (cm)		Weight (g)		Regression parameters				
Month	**Sex**	**N**	**Min**	**Max**	**Min**	**Max**	***a***	***b***	***r²***	***95% CI a***	***95% CI b***
Sep-16	Male	20	10,40	36,70	18,73	624,97	0,0502	2,6244	0,9155	0,0363-0,0491	2,6012-2,6475
	Female	22	33,40	44,60	33,40	1.045,08	0,0875	2,4475	0,8688	0,0265-0,0383	2,4062-2,4889
Okt-16	Male	24	9,30	33,60	20,40	501,27	0,9040	1,7056	0,9327	0,0422-0,0536	1,6814-1,7298
	Female	21	28,56	36,00	28,56	608,76	0,1084	2,3900	0,9142	0,0378-0,0509	2,3709-2,4091
Nov-16	Male	17	8,50	29,60	18,67	363,27	0,1037	2,4018	0,9432	0,0489-0,0641	2,2357-2,5680
	Female	14	18,67	41,30	18,67	861,93	0,0661	2,5426	0,9390	0,0308-0,0425	2,5336-2,5515
Des-16	Male	12	10,90	38,90	33,97	736,63	1,0749	1,6367	0,9385	0,0311-0,0448	1,5805-1,6930
	Female	18	10,40	41,30	24,13	861,94	0,0642	2,5532	0,9267	0,0307-0,0414	2,5442-2,5622
Jan-17	Male	16	12,40	38,50	39,30	721,14	0,0576	2,5847	0,9538	0,0325-0,0419	2,5781-2,5913
	Female	17	10,00	47,30	17,94	1.215,83	0,0578	2,5848	0,8961	0,0255-0,0373	2,5697-2,5999
Feb-17	Male	19	12,90	35,60	49,44	587,77	0,0715	2,5281	0,9424	0,0342-0,0441	2,5046-2,5516
	Female	16	10,70	40,70	21,10	912,89	0,0555	2,5967	0,8991	0,0280-0,0414	2,5720-2,6213
Mar-17	Male	16	16,50	42,10	78,90	894,29	0,0591	2,5765	0,9499	0,0273-0,0356	2,5677-2,5853
	Female	16	12,20	42,50	62,17	924,89	0,1441	2,3158	0,9267	0,0267-0,0369	2,2886-2,3430
Apr-17	Male	17	12,40	33,20	39,30	492,18	0,0791	2,4898	0,9340	0,0376-0,0505	2,4645-2,5151
	Female	16	13,40	32,00	50,14	448,79	0,0717	2,5149	0,9691	0,0399-0,0490	2,5037-2,5260
Mei-17	Male	21	12,00	36,80	39,97	639,92	0,6203	1,8438	0,9464	0,0362-0,0455	1,8229-1,8646
	Female	17	12,70	33,40	45,55	497,89	0,0872	2,4502	0,9306	0,0352-0,0476	2,4124-2,4880
Jun-17	Male	18	12,60	39,20	42,03	752,545	0,0643	2,5549	0,9572	0,0308-0,0386	2,5454-2,5643
	Female	14	14,60	36,70	52,20	665,45	0,0710	2,5243	0,9456	0,0325-0,0441	2,4991-2,5494
Overall	Male	181	8,50	42,10	18,67	894,29	0,0098	3,1475	0,9252	0,0381-0,0414	3,1299-3,1651
	Female	171	9,00	47,30	17,94	1.215,83	0,0752	2,5030	0,9029	0,0329-0,0364	2,4788-2,5272
	Both	352	8,5	47,3	17,94	1.215,83	0,9987	1,6789	0,9093	0,0355-0,0380	1,6579-1,7000

LWRs for the species *E. fuscoguttatus* are reported for the umpteenth time in FishBase. This study recorded the total length (TL) and the maximum weight of E. fuscoguttatus each of 17.94 cm and 1,215.83 g. All parameter estimation b during the study period was in the range of 1.6367-2.6244 for males, the range of 2.3158-2.5967 for females as expected. Besides that, it was found the estimated species values were within in approximate Bayesian length-weight ranges in FishBase, Froese & Pauly, [20].

Based on the scientific literature and data from FishBase, no information was found on LWR for male and female E. fuscoguttatus. The study found a maximum total length of E. fuscoguttatus of 42.10 cm for males, and of 47.30 cm for females thus giving new total length information based on gender in FishBase. Although the sample size is large enough it covers 80% of the total known maximum length, but for this species is generally smaller than the total size of a reported total of 120 cm. The difference in total length size may be due to the dominance of small size fish in this geographic area or environmental constraints, Rochmady & Susiana [24], Susiana et al. [25]. The values of 'b' for this fish species have not been reported. In this study, the parameter value 'b' is within the normal range of 2.5-3.5., Froese. [9]. However, the regression parameters 'a' and 'b' may vary with sample size, different length standards, sampling season, gonadal maturity, sex, and stomach fullness, Sang & Fotedar, [26], Siddik et al [28], Wang et al. [27]. The values of 'a' and 'b' for each species compared to the 95% confidence limit of the Bayesian value estimate of LWRs in FishBase are found as new information. In addition, this study provides new information on LWR species E. fuscoguttatus by sex.

IV. CONCLUSION

In conclusion, the findings of this study offer new information about the biological aspects of E. fuscoguttatus species that are part of Perciformes based on their gender from the waters of Bobong Taliabu North Maluku, Indonesia that will be useful for sustainable fisheries development.

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