Length-Weight Relationship and Condition Factors of Keudawah (*Rasbora* sp., Family: Danionidae) in the Krueng Lanca Flows of Nagan Raya Regency, Aceh, Indonesia

Mu'amar Abdan*, Sulistiono, *Mohammad* Mukhlis Kamal, *Ali* Mashar, *Nurlisa Alias* Butet

IPB University, Aquatic Resources Management Department, 16680 Bogor, West Java, Indonesia

Abstract. *Keudawah (Rasbora sp.)* is a native species found in freshwater, especially Krueng Lanca of Aceh Province, Indonesia. Length-weight relationships (L-WR) and condition factor studies are significant in fisheries, as they offer invaluable insights into fish growth, general welfare, and fitness, especially in freshwater habitats. This study aims to evaluate the fish's length-weight relationship and condition factor, which can be used to establish monitoring and management systems for this species. Sampling was conducted purposively every month from January to June 2023 at six stations using gill and cast nets. Sampling results were then analyzed in the laboratory. 1118 individual fish (632 males and 486 females) were collected from Krueng Lanca, Aceh Province, with a length frequency of 34-112 mm for males and 46-135 mm for females. The results showed that keudawah had negative allometric growth (both males and females), with b values ranging from 2.307 to 2.962 (for males) and 1.731 to 2.669 (for females). The condition factor (Kn) fluctuated between 0.84 and 0.93 (for males) and 0.82 to 0.94 (for females), indicating less than optimal conditions for this species.

1 Introduction

Nagan Raya Regency is one of the regencies with abundant fish resources. Muchlisin et al. [1] found that 73 fish species have been identified in Nagan Raya District. Of these, 17 species have the potential to be cultured, and 10 are potential ornamental candidates. One of these is the Keudawah fish.

Keudawah (*Rasbora* sp.) is one of the economic fish commonly caught for consumption in Nagan Raya waters. This fish is usually found in several rivers and tributaries in Nagan Raya Regency. However, intensive fishing of these fish has led to population declines. Furthermore, the decrease in the fish population is also attributed to elevated levels of

* Corresponding author: muamarabdan@apps.ipb.ac.id

deforestation, alterations in land use along the river, and fishing practices that are not ecologically sustainable [1,2].

In order to fulfill the community's food and protein requirements while preserving fish stocks, it is imperative to implement fisheries management and sufficient measures that accommodate a range of factors, including economic, social, and biological concerns [3]. Ibrahim et al. [4] and Zargar et al. [5] found that biometric studies are crucial in fisheries resource management as they provide valuable information on fish species and their biomass estimation. Rodriguez-Marin et al. [6] and Morato et al. [7] highlight the significance of investigating growth characteristics associated with fish weight and length while considering the influence of diverse biological and environmental factors on the species' condition [8]. The determination of length-weight relationships in fish has been highlighted in numerous studies as paramount. Froese [9] notes that the length-weight relationship provides data on growth patterns, general health, habitat conditions, life history, fatness, body condition, and morphological traits of the fish.

The estimation of the fish length-weight relationship involves two factors: the fish weight (W) and length (L). This estimation is widely used in fish biology studies, especially when investigating gonad development, fish diet, and gonad maturity conditions [10]. De Giosa et al. [11] state that the relationship between fish length and weight fluctuates with changes in season and time, resulting in variations in the value of *b*. Flura et al. [12] explained that the *b* value indicates the level of gastric satiety, the overall condition of appetite, and the stage of gonadal maturity.

Additionally, growth and development may differ among individuals of the same species inhabiting diverse environments due to multiple biotic and abiotic influences. Le Cren [13] discussed the relative condition factor (Kn) as a biometric tool based on the relationship between length and weight. Kn is utilized to measure an organism's deviation from the sample's average weight and is used explicitly to evaluate the suitability of a particular environment for fish growth [14, 15]. Bolger and Connolly [16] stated that when the Kn value approaches or equals 1, it can be inferred that the fish species has met satisfactory fitness conditions. Therefore, undertaking biometric studies that examine the relationships between length and weight and the condition factors of keudawah (Rasbora sp.) is crucial for promoting sustainable keudawah management.

2 Materials and methods

Sampling was conducted between January and June 2023 at six different stations, as shown in Figure 1, in the waters of Krueng Lanca, Nagan Raya Regency. Gill nets were used for the sampling, with three mesh sizes of 0.5 inches, 1.0 inches, and 1.5 inches, and 6-meter-long throwing nets with a 0.5-inch mesh size. Electrofishing was also employed to ensure the collection of fish of all sizes.

Sampling was carried out starting from 9:00 a.m. to 5:00 p.m. Additionally, fish specimens were preserved with a 10% formalin solution to ensure long-term storage. The specimens were then transported to the laboratory and assessed for their length and weight using a vernier caliper with a precision of 0.01 mm and analytical scales with an accuracy of 0.01 g.

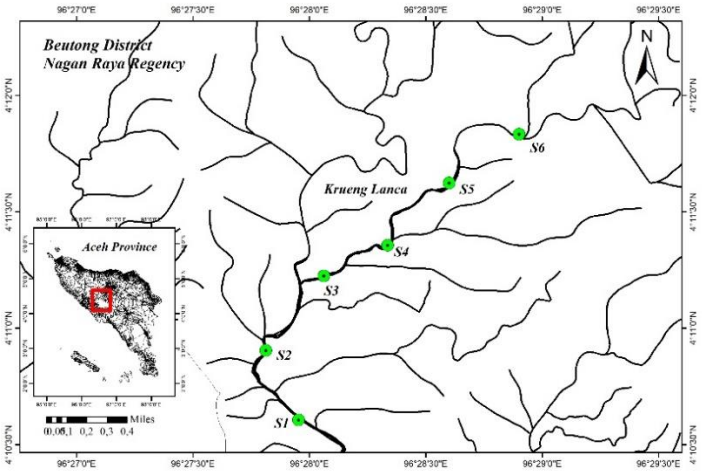


Fig. 1. Sampling location of Keudawah (*Rasbora* sp.).

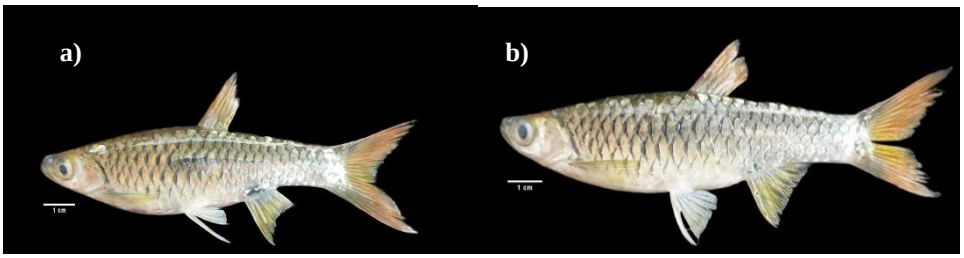


Fig 2. Keudawah fish (*Rasbora* sp.) a) Male and b) Female

Fish length-weight relationships were estimated referring [18] as follows:

$$W = a\,L^{b} \qquad (1)$$

In this formula, W represents the weight of the fish in grams, L denotes the total length of the fish, a represents the initial growth constant, and b represents the growth constant or exponent. Additionally, a t-test with a significance level of $p < 0.05$ was employed to assess whether the value of b equals 3. If b equals 3, it suggests that the fish adheres to an isometric growth pattern. Conversely, if b does not equal 3, the fish exhibits an allometric growth pattern.

The relative condition factor (Kn) is calculated by referring to [17] as follows:

$$Kn = \frac{W}{aL\,b} \qquad (2)$$

In this context, Kn stands for the relative condition factor, W represents the average weight of fish in grams, L stands for the average length of fish, and a and b denote constants.

3 Results and discussion

3.1 Result

3.1.1 Length-Weight relationship

A total of 1118 fish were collected from the Krueng Lanca waters, comprising 632 males and 486 females. The male fish length ranged from 34-112 mm, while that of females ranged from 46-135 mm, as shown in Figure 3. Figure 4 indicates a significant correlation between the length and weight of Keudawah (Rasbora sp.). The correlation coefficient (r) ranged from 0.917 to 0.934 for males and 0.904 to 0.943 for females. The results indicate a strong correlation between the length and weight of Keudawah, suggesting that variations in fish length significantly impact variations in fish weight.

The study analyzed the length-weight correlation of bottom fish by gender, with male and female samples separated by month. The acquired results can be found in Table 1, which indicates that the correlation presents variations depending on gender. The regression coefficients (b) range from 2.307 to 2.962 for males and 1.731 to 2.669 for females.

Table 1. The length-weight relationship of Keudawah fish (*Rasbora* sp.) and its growth pattern from January to June 2023.

Months	Sex	N	LW-Relationship	Value (r)	Types of growth	t-Test
January	Male	109	$W = 0.0104L^{2.8759}$	0.917	Negative Allometric	Thit>Ttab
	Female	79	$W = 0.0285L^{2.4341}$	0.920	Negative Allometric	Thit>Ttab
February	Male	129	$W = 0.0191L^{2.5996}$	0.933	Negative Allometric	Thit>Ttab
	Female	101	$W = 0.0336L^{2.3764}$	0.912	Negative Allometric	Thit>Ttab
March	Male	118	$W = 0.0225L^{2.5213}$	0.934	Negative Allometric	Thit>Ttab
	Female	97	$W = 0.0359L^{2.3481}$	0.907	Negative Allometric	Thit>Ttab
April	Male	72	$W = 0.0251L^{2.4379}$	0.920	Negative Allometric	Thit>Ttab
	Female	52	$W = 0.1268L^{1.7785}$	0.918	Negative Allometric	Thit>Ttab
May	Male	105	$W = 0.0086L^{2.9627}$	0.925	Negative Allometric	Thit<Ttab
	Female	78	$W = 0.0168L^{2.6691}$	0.943	Negative Allometric	Thit<Ttab
June	Male	99	$W = 0.0344L^{2.3077}$	0.918	Negative Allometric	Thit>Ttab
	Female	79	$W = 0.1362L^{1.7316}$	0.904	Negative Allometric	Thit>Ttab

Description: N: Number of Individuals, r: Correlation coefficient.

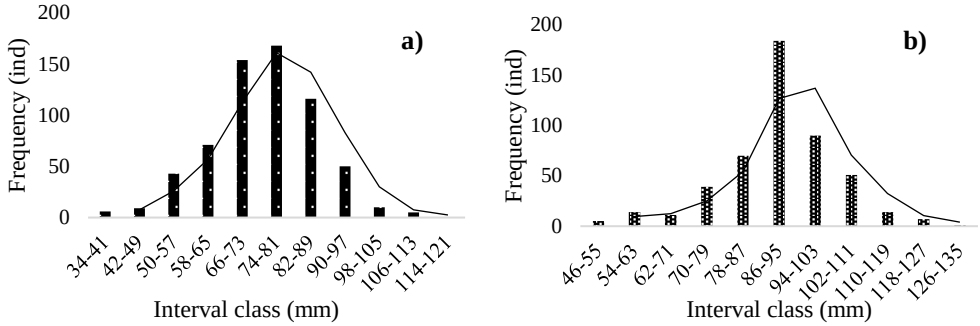
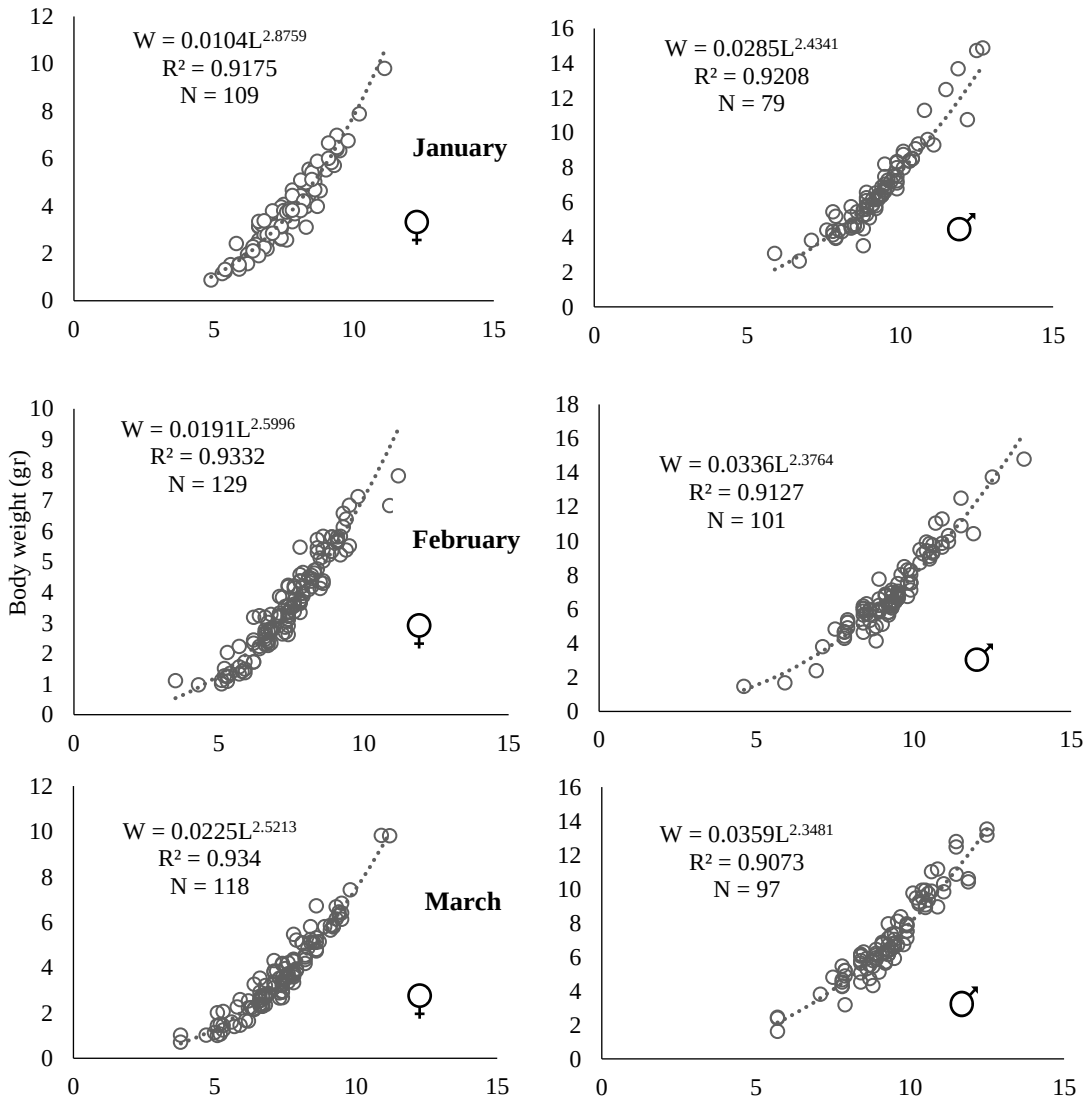


Fig. 3. Length distribution of Keudawah (*Rasbora* sp.), a) Males and b) Females.



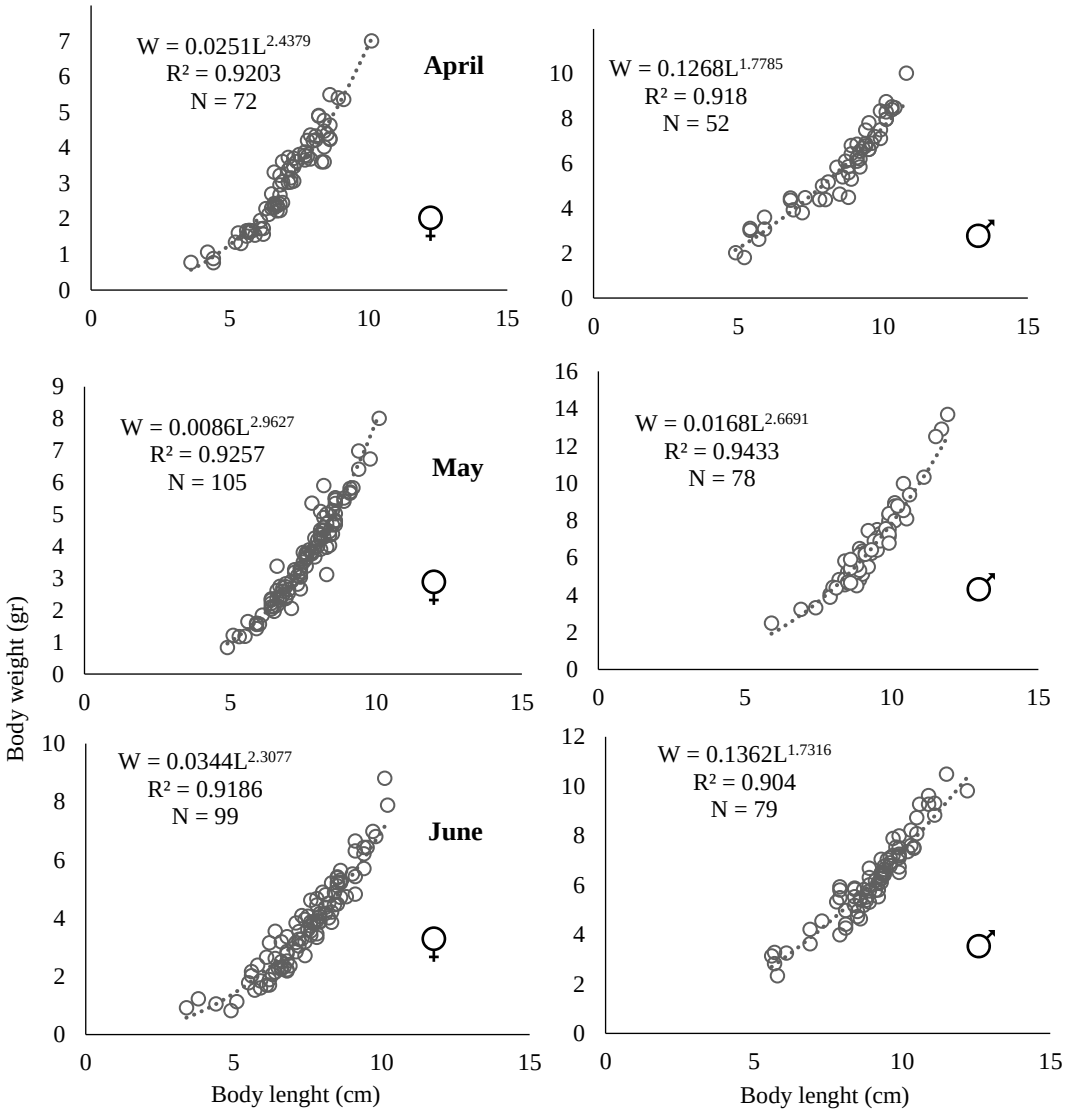


Fig. 4. Length-weight relationships of Keudawah (*Rasbora* sp.) from January 2023 to June 2023.

3.1.2 Condition Factor

The findings indicated that the condition factor of keudawah fluctuated between January and June (Figure 5). Condition factor values ranged between 0.84 and 0.93 for males and 0.82 to 0.94 for females.

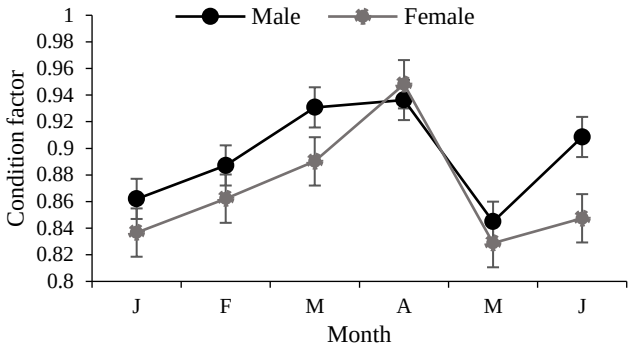


Fig. 5. Condition factor of Keudawah (*Rasbora* sp.), both male and female, from January 2023 to June 2023.

3.2 Discussion

The first step in managing the Keudawah fish species in the Krueng Lanca waters of the Nagan Raya district is the collection of data on the correlation between the length and weight of the fish. This research significantly contributes to the support of sustainable fisheries management endeavors. Biological data can assess the life history of fish species [18], analyze fish growth patterns, and approximate fish stocks in their natural habitat [19-21] [22].

The results of this study revealed an equation of length and weight relationships of Keudawah that showed the existence of a Negative Allometric growth pattern, both in male and female individuals. This growth pattern reflects that fish length growth occurs faster than weight growth. This negative allometric growth pattern may occur due to various factors related to environmental variations or habitat changes, including water temperature, availability of food, stress, and water quality and productivity [23, 24]. This finding follows the report submitted by Batubara [1,2] and Abdan [25] on deforestation and land use change in the vicinity of the Nagan Raya River. These activities pose considerable risks to the fish habitat and growth patterns [26].

Several studies have shown that changes in land use and deforestation have considerable effects on river productivity and water quality, further affecting the growth and population of fish. For example, a study conducted on the Kayan River found that changes in land use, particularly the introduction of oil palm plantations, have affected the river's ecosystem, including its habitat, fish populations, macrobenthos, and water quality [27]. In the Nemunas River in Lithuania, deforestation, pollution, and land reclamation have been the leading cause of habitat destruction and population decline of fish species [28].

Condition factors significantly impact fish physiology, encompassing their capacity to survive and reproduce [21]. Furthermore, as stated by [29], condition factors can be used to assess fish populations and natural biomass. The fish condition factor is measured by calculating the ratio of fish body weight to length [30, 31]. The fish is suboptimal when the condition factor value falls below 1 [32]. Conversely, if the value equals or exceeds 1, the fish is in good condition [17, 33, 34].

The Condition Factor values, shown in Figure 4, vary every month. They are closely related to the reproductive cycle of the fish. Nasyrah [21] suggested that fish condition factors vary according to the level of maturity of the fish gonads, with an increase occurring when reaching the peak of reproduction and then decreasing after the fish spawns. Furthermore, Rahardjo [35] also noted that a large proportion of fish food is used for reproductive purposes.

The condition factor for Keudawah in Krueng Lanca waters ranges from 0.82 to 0.94, close to 1. This observation suggests that the fish is not in an optimal condition [32].

However, it should be noted that low condition factor values do not necessarily indicate poor conditions, especially as some fish species have naturally low condition factors. This is also seen in Keudawah, which can grow and thrive in their natural environment. Some factors that influence fish condition include the relationship between body length and weight, the environmental conditions in which they live, and the availability of food sources. [35].

4 Conclusion

This study has furnished valuable information concerning the length-weight relationships and relative condition factors of Keudawah in Krueng Lanca, Aceh Province. The study's results indicate that the Keudawah displayed negative allometric growth. Furthermore, the condition factor of the Keudawah was found to be below optimal levels. The data presented in this paper will be significant for subsequent biological investigations and local fisheries management strategies, particularly concerning the Keudawah. Nonetheless, it is imperative to conduct comprehensive research to gain a deeper understanding of the population dynamics of this species, allowing an assessment of the status of the fish population in its habitat.

Acknowledgments

The author expresses his sincere appreciation to BPSDM Aceh for providing financial support to enable him to pursue higher education.

References

1. A. Batubara, D. Efizon, R. Elvyra, S. Rizal, and Z. Muchlisin, "Population dynamics of the naleh fish *Barbonymus* sp.(Pisces: Cyprinidae) in Nagan River Waters, Aceh Province, Indonesia," *Jordan Journal of Biological Sciences,* vol. 12, no. 3, pp. 361 - 366, 2019a, doi: 10.12816/0053757.
2. A. Batubara, Z. Muchlisin, D. Efizon, R. Elvyra, and M. Irham, "Length-weight relationships and condition factors of the naleh fish, *Barbonymus gonionotus* (Pisces, Cyprinidae) harvested from Nagan Raya Waters, Indonesia," *Vestnik Zoologii,* vol. 53, no. 1, pp. 75-82, 2019b, doi: 10.2478/vzoo-2019-0008.
3. FAO, *FAO Technical Guidelines for Responsible Fisheries* (The ecosystem approach to fisheries). Rome, Italy, 2008, p. 112.
4. P. S. Ibrahim, I. Setyobudiandi, and Sulistiono, "Length-Weight Relationship and Condition Factor of Yellowstripe Scads *Selaroides Leptolepis* in Sunda Strait," *Jurnal Ilmu dan Teknologi Kelautan Tropis,* vol. 9, no. 2, pp. 577-584, 2017. doi.org/10.29244/jitkt.v9i2.19292
5. U. Zargar, A. Yousuf, B. Mushtaq, and J. Dilafroza, "Length-weight relationship of the crucian carp, Carassius carassius in relation to water quality, sex and season in some lentic water bodies of Kashmir Himalayas," *Turkish Journal of Fisheries and Aquatic Sciences,* vol. 12, no. 3, 2012.
6. E. Rodriguez-Marin *et al.*, "Atlantic bluefin tuna (*Thunnus thynnus*) biometrics and condition," *PLoS One,* vol. 10, no. 10, p. e0141478, 2015. doi.org/10.1371/journal.pone.0141478

7. T. Morato, P. Afonso, P. Lourinho, J. P. Barreiros, R. S. Santos, and R. Nash, "Length–weight relationships for 21 coastal fish species of the Azores, north-eastern Atlantic," *Fisheries Research,* vol. 50, no. 3, pp. 297-302, 2001. doi.org/10.1016/S0165-7836(00)00215-0

8. A. Chadijah, S. Sulistiono, G. S. Haryani, R. Affandi, and A. Mashar, "Distribusi Ukuran, Pola Pertumbuhan, dan Faktor Kondisi Ikan Endemik Opudi (*Telmatherina prognatha*) di Danau Matano, Sulawesi Selatan [Size Distribution, Growth Patterns, and Condition Factors of Endemic Opudi Fish (*Telmatherina prognath*a) in Matano Lake, South Sulawesi]," *Jurnal Ilmu Pertanian Indonesia,* vol. 24, no. 4, pp. 295-303, 2019. doi.org/10.18343/jipi.24.4.295

9. R. Froese, "Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations," *Journal of applied ichthyology,* vol. 22, no. 4, pp. 241-253, 2006. doi.org/10.1111/j.1439-0426.2006.00805.x

10. L. Lindawati, A. Fahrudin, and M. Boer, "Karakteristik Pertumbuhan Dan Biologi Reproduksi Ikan Kuniran (*Upeneus sulphureus*, Cuvier 1829) Di Perairan Selat Sunda [Growth Characteristics and Reproductive Biology of Kuniran Fish (*Upeneus sulphureus*, Cuvier 1829) in Sunda Strait Waters]," *Jurnal Biologi Tropis,* vol. 19, no. 2, pp. 180-188, 2019. doi.org/10.29303/jbt.v19i2.1293. doi.org/10.29303/jbt.v19i2.1293

11. M. De Giosa, P. Czerniejewski, and A. Rybczyk, "Seasonal changes in condition factor and weight-length relationship of invasive *Carassius gibelio* (Bloch, 1782) from Leszczynskie Lakeland, Poland," *Advances in Zoology,* vol. 2014, 2014. doi.org/10.1155/2014/678763

12. M. Z. Flura, B. Rahman, M. A. Rahman, M. Ashraful, M. Alam, and M. Pramanik, "Length-weight relationship and GSI of hilsa, *Tenualosa ilisha* (hamilton, 1822) fishes in Meghna river, Bangladesh," *Int. J. Nat. Soc. Sci,* vol. 2, no. 3, pp. 82-88, 2015.

13. E. D. Le Cren, "The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis)*," *The Journal of Animal Ecology,* vol. 21, no. 1, pp. 201-219, 1951, doi: 10.2307/1540. doi.org/10.2307/1540

14. N. Jisr, G. Younes, C. Sukhn, and M. H. El-Dakdouki, "Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon," *The Egyptian Journal of Aquatic Research,* vol. 44, no. 4, pp. 299-305, 2018. doi.org/10.1016/j.ejar.2018.11.004

15. S. Mensah, "Weight-length models and relative condition factors of nine freshwater fish species from the Yapei Stretch of the White Volta," *Ghana. Elixir. Appl. Zool,* vol. 79, no. 1, pp. 30427-30431, 2015.

16. T. Bolger and P. Connolly, "The selection of suitable indices for the measurement and analysis of fish condition," *Journal of Fish Biology,* vol. 34, no. 2, pp. 171-182, 1989. doi.org/10.1111/j.1095-8649.1989.tb03300.x

17. M. I. Effendie, *Biologi Perikanan*. Yogyakarta: Yayasan Pustaka Nusantara, 2002.

18. Y. Li *et al.*, "Weight–Length Relationship Analysis Revealing the Impacts of Multiple Factors on Body Shape of Fish in China," *Fishes,* vol. 8, no. 5, p. 269, 2023. doi.org/10.3390/fishes8050269

19. P. Kumar, M. Kailasam, J. Sundaray, and T. Ghoshal, "Sustainable fisheries/aquaculture of hilsa, Tenualosa ilisha in changing and dynamic riverine ecosystem of India and its

neighborhood," *Ecological Significance of River Ecosystems*, pp. 455-480, 2022. *doi.org/10.1016/B978-0-323-85045-2.00010-8*

20. Y. Yin, J. A. Sameoto, D. M. Keith, and J. M. Flemming, "Improving estimation of length–weight relationships using spatiotemporal models," *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 79, no. 11, pp. 1896-1910, 2022. doi.org/10.1139/cjfas-2021-0317
21. A. F. A. Nasyrah, M. F. Rahardjo, C. P. Simanjuntak, and M. Nur, "The length-weight relationships and condition factor of an endemic *Marosatherina ladigesi* Ahl, 1936 in Walanae Cenranae River Watershed, South Sulawesi, Indonesia," in *E3S Web of Conferences*, 2021, vol. 322: EDP Sciences, p. 01002. doi.org/10.1051/e3sconf/202132201002
22. H. Latuconsina, M. M. Kamal, R. Affandi, and N. A. Butet, "Growth and reproductive biology of white-spotted rabbitfish (*Siganus canaliculatus*) on different seagrass habitats in Inner Ambon Bay, Indonesia," *Biodiversitas Journal of Biological Diversity*, vol. 23, no. 1, 2022. doi.org/10.13057/biodiv/d230133
23. A.-D. S. Segun, O. S. Ijabo, and B. Yusuf, "Length-weight relationship and condition factor of *Hydrocynus forskahlii* (Cuvier, 1819) in River Yobe, Northeast, Nigeria," *Aceh Journal of Animal Science*, vol. 7, no. 2, pp. 53-58, 2022. doi.org/10.13170/ajas.7.2.23519
24. K. Naminata, K. A. L. Boutonner, G. B. Franck, B. S. Hervis, B. Mamadou, and K. E. Paul, "Length-weight relationship and population parameters of *Pellonula leonensis* Boulenger, 1916 (Clupeidae) in man-made Lake Taabo (Bandama basin; Côte d'Ivoire)," *International journal of Biosciences*, vol. 5, no. 4, pp. 149-158, 2014. doi.org/10.12692/ijb/5.4.149-158
25. M. Abdan, "Growth patterns and reproductive aspect of Naleh (*Barbonymus* sp.) in Krueng Lanca, Nagan Raya Regency, Aceh Province," in *IOP Conference Series: Earth and Environmental Science*, 2023, vol. 1221, no. 1: IOP Publishing, p. 012014. doi.org/10.1088/1755-1315/1221/1/012014
26. A. R. Manzotti, M. Ceneviva-Bastos, F. B. Teresa, and L. Casatti, "Short-term response of fish assemblages to instream habitat restoration in heavily impacted streams," *Neotropical Ichthyology*, vol. 18, 2020. doi.org/10.1590/1982-0224-2019-0052
27. A. anak Grifin, "Impact of land use (oil palm) on the fish fauna, macrobenthos and water quality of Kayan River and its Tributaries, Lundu, Sarawak," Universiti Malaysia Sarawak, 2014.
28. V. Kesminas and R. Repecka, "Human impact on fish assemblages in the Nemunas River, Lithuania," *Large Rivers*, pp. 275-287, 2003. doi.org/10.1127/lr/15/2003/275
29. R. S. da Silva, L. R. Virgilio, F. Corrêa, and L. J. S. Vieira, "Length-weight relationships of fish species from oxbow lakes on the floodplain of the middle Purus River in western Brazilian Amazon," *Journal of Applied Ichthyology*, vol. 36, no. 2, pp. 256-258, 2020. doi.org/10.1111/jai.14013
30. N. Serdiati et al., "Length-Weight Ratio and Condition Factor of Endemic Fish *Oryzias nigrimas* (Kottelat, 1990) in Poso Lake, Central Sulawesi," in *IOP Conference Series: Earth and Environmental Science*, 2021, vol. 750, no. 1: IOP Publishing, p. 012055. doi.org/10.1088/1755-1315/750/1/012055

31. M. Munira, S. Sulistiono, and Z. Zairion, "Length-weight relationship and growth of rabbitfish, *Siganus canaliculatus (*Park, 1797) in the seagrass beds of Lonthoir Strait, Banda Archipelago, Maluku," *Jurnal Iktiologi Indonesia,* vol. 10, no. 2, pp. 153-163, 2010.

32. Q. M. Dinh, T. H. D. Nguyen, N. T. Truong, and L. Nguyen-Ngoc, "Factors regulating growth pattern and condition factor of an amphibious fish *Periophthalmus gracilis* living in the Mekong Delta," *PeerJ,* vol. 10, p. e13060, 2022. doi.org/10.7717/peerj.13060

33. O. O. Deng, J. D. A. AJAK, and O. Goang, "Length-Weight Relationship and Condition Factor of Three Commercial Fish Species in Juba-South Sudan," 2017.

34. H. Kiman and A. Ja'afaru, "Length-weight Relationship and Condition Factor of Auchenoglanis biscutatus in Kiri Reservoir, Adamawa State, Nigeria," *Asian Journal of Research in Zoology,* vol. 3, no. 2, pp. 23-29, 2020. doi.org/10.9734/ajriz/2020/v3i230088

35. M. Rahardjo and C. P. Simanjuntak, "Hubungan panjang bobot dan faktor kondisi ikan tetet, *Johnius belangerii* Cuvier (Pisces: Sciaenidae) di perairan pantai Mayangan, Jawa Barat [The relationship between length and weight and condition factors of tetet fish at Mayangan Jawa Barat]," *Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia,* vol. 15, no. 2, pp. 135-140, 2008.