

LENGTH WEIGHT RELATIONSHIP AND REPRODUCTION OF WAULANG FISH (*Priacanthus hamrur*) IN THE WATERS OF BANDA, MALUKU

Hubungan Panjang Berat dan Reproduksi Ikan Waulang (*Priacanthus hamrur*) di Perairan Banda, Maluku

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ABSTRACT

The waters of Banda Neira in Central Maluku have high marine biodiversity, including the waulang fish (*Priacanthus hamrur*) which has ecological and economic value. This study aims to examine the length-weight relationship, gonad maturity level, and gonad maturity index (GMI) as a basis for sustainable management. The study was conducted from March to April 2024 in Tanah Rata Village, Banda, by sampling fish caught by fishermen using a simple random sampling method. Data collected included total length, body weight, sex, and gonad weight, which were then analyzed descriptively. The results showed that waulang fish have a negative allometric growth pattern, with a b value of 1.6664 (females) and $b = 0.9055$ (males). Fish length ranged from 21–42.3 cm with a weight of 105–327 grams. The gonad maturity level (GMI) consists of five stages of reproductive development, in both females and males. The gonad maturity index varied from 0.075 to 2.382 in females and 0.04 to 2.35 in males, with a tendency for the GMI to increase with increasing body size. Females generally exhibited a higher GMI than males, indicating greater reproductive readiness. These results provide important information on the reproductive status and population dynamics of the waulang fish in the Banda Waters, which can be used as a basis for sustainable fisheries resource management and conservation.

Keywords: *Priacanthus hamrur*, TKG, IKG, Management

ABSTRAK

Perairan Banda Neira di Maluku Tengah memiliki keanekaragaman hayati laut yang tinggi, termasuk ikan waulang (*Priacanthus hamrur*) yang bernilai ekologis dan ekonomis. Penelitian ini bertujuan untuk mengkaji hubungan panjang-berat, tingkat kematangan gonad, dan indeks kematangan gonad (IKG) sebagai dasar pengelolaan berkelanjutan. Penelitian dilakukan

selama Maret–April 2024 di Desa Tanah Rata, Banda, dengan pengambilan sampel ikan hasil tangkapan nelayan menggunakan metode simple random sampling. Data yang dikumpulkan meliputi panjang total, berat tubuh, jenis kelamin, dan berat gonad, kemudian dianalisis secara deskriptif. Hasil penelitian menunjukkan ikan waulang memiliki pola pertumbuhan alometrik negatif, dengan nilai $b = 1,6664$ (betina) dan $b = 0,9055$ (jantan). Panjang ikan berkisar antara 21–42,3 cm dengan berat 105–327 gram. Tingkat kematangan gonad (TKG) terdiri dari lima tahap perkembangan reproduksi, baik pada betina maupun jantan. Indeks kematangan gonad bervariasi dari 0,075 hingga 2,382 pada betina, dan 0,04 hingga 2,35 pada jantan, dengan kecenderungan IKG meningkat seiring bertambahnya ukuran tubuh. Betina umumnya menunjukkan IKG lebih tinggi dibanding jantan, mengindikasikan kesiapan reproduksi yang lebih dominan. Hasil ini memberikan informasi penting tentang status reproduksi dan dinamika populasi ikan waulang di Perairan Banda, yang dapat digunakan sebagai dasar pengelolaan dan konservasi sumber daya perikanan secara berkelanjutan.

Kata kunci: *Priacanthus hamrur*, TKG, IKG, Pengelolaan

INTRODUCTION

The waters of Banda Neira in Central Maluku Regency are known for their high marine biodiversity, including pelagic, demersal, and reef fish (Andradi-Brown *et al.*, 2022). This diversity is supported by the abundance of coastal ecosystems such as mangroves, seagrass beds, and coral reefs, which serve as important habitats for various fish species (Tuapetel *et al.*, 2022; La Ima *et al.*, 2023; Pattikawa *et al.*, 2023). One type of reef fish with ecological and economic value is the waulang fish (*Priacanthus hamrur*), which is often consumed by local people as a daily protein source due to its relatively affordable price. This fish is known as a predator of zooplankton and small crustaceans and plays a crucial role in maintaining the balance of the trophic structure of coral reef ecosystems (La Ima & Yusuf, 2025).

As a demersal fish associated with coral reef bottoms at depths of 30–40 meters, waulang are commonly caught using handlines by local fishermen. However, high fishing intensity without proper management can lead to population decline, particularly if the individuals caught are mature but have not yet spawned (Tuapetel, 2021; Wahyudi *et al.*, 2021). This phenomenon threatens stock sustainability by inhibiting the population's reproductive potential (Tuapetel *et al.*, 2024). This situation is exacerbated by the capture of immature juveniles, which risks disrupting natural population regeneration (La Ima *et al.*, 2023; Soukotta *et al.*, 2024).

In the context of sustainable fisheries management, a comprehensive biological data-driven approach is needed to support conservation and utilization policies (Abrahamsz *et al.*, 2022; Petza & Katsanevakis, 2024). Data such as length-weight relationships, gonad maturity levels, and gonad maturity index (GMI) are important indicators for assessing the reproductive status and population dynamics of a fish species (Munira *et al.*, 2024). Therefore, this study was conducted to examine the reproductive biology of waulang fish (Figure 1) landed in Tanah Rata Village, Banda District, Central Maluku Regency. The purpose of this study was to determine the length-weight relationships, gonad maturity levels, and GMI values as a basis for information on sustainable management of waulang fish resources in the waters of the Banda Islands.



Figure 1. Waulang fish (*Priacanthus hamrur*)

RESEARCH METHODS

This research was conducted over two months, from March to April 2024, in Tanah Rata Village, Banda District, Central Maluku Regency. The tools and materials used in this study included various equipment to support the biological data collection process of *Parupeneus hamrur* (waulang fish). Basins were used to store fish samples prior to analysis, while measuring rulers and digital scales were used to measure body length, weight, and gonad weight. Stationery was used to record data, and tissues were used to clean the tools used. Sample documentation was performed using a camera, while a dissecting set and cutting board were required for dissection and placement of the fish for internal organ examination. Additionally, a laptop was used for data analysis and processing. The primary material used in this study was samples of waulang fish (*P. hamrur*), the object of study.

The fish samples were collected from randomly landed catches of handline fishermen in Tanah Rata Village. Sampling was conducted weekly from March to April 2024, with samples of varying sizes. The sample fish were weighed for body weight and total length. The length of the sample was measured using a ruler with an accuracy of 1 cm. The weight of the sample fish was measured using an Ohausse digital scale. Fish sampling was carried out using simple random sampling, i.e., fish of varying sizes were selected (Tuapetel & Rahman, 2025). The primary data required for this study were fish length and weight, sex, and gonad weight. Secondary data was used to support this study, obtained from books, journals, articles, literature, or related research.

Data Analysis

Length-Weight Relationship. Analysis of growth patterns by looking at the length-weight relationship uses the Hile formula (Pauly, 2024), which is as follows:

$$W = aL^b$$

Description: W = Fish weight (g), L = Total length of fish (cm), a and b = Constants, The value of b as an estimate of the relationship between length and weight with the following criteria: Value of $b = 3$, the fish has an isometric growth pattern (weight gain is balanced with length gain) Value of $b > 3$, the fish has an allometric growth pattern (weight gain is greater than length gain) Value of $b < 3$, the fish has a negative allometric growth pattern (weight gain is smaller than length gain).

Gonad Maturity Level

The description of the level of gonad maturity refers to the criteria explained by Wujdi *et al.*, (2013) which is divided into five phases, namely phase I (immature), phase II

(developing), phase III (ripening), phase IV (ripe of fully mature) and phase V (spent spawning).

Table 1. Criteria for gonad maturity levels of female and male fish

Maturity Level	Condatiion	Description
I	Immature	The ovaries and testes are approximately 1/3 the length of the body cavity. The ovaries are a translucent reddish color. The testes are whitish. The eggs are invisible to the naked eye.
II	Developing	The ovaries and testes are approximately half the length of the abdominal cavity, clear or translucent. The testes are whitish and more or less symmetrical. The eggs are not visible to the naked eye.
III	Ripening	The ovaries and testes are approximately two-thirds the length of the abdominal cavity. The ovaries are reddish-yellow, and the egg masses are starting to appear. The testes are whitish to cream-colored. There are no translucent or clear eggs.
IV	Ripe or Fully Matu	The ovaries and testes fill 2/3 of the abdominal cavity. The ovaries are pink/orange with blood vessels clearly visible on their surface. Eggs are visible on their surface. The mature eggs are translucent. The testes are whitish/creamy and soft.
V	Spent	The ovaries and testes shrink to approximately half the abdominal cavity. The walls relax, and egg remains are found in the ovaries.

Gonad Maturity Index

The gonad maturity index analysis was conducted to complement the TKG analysis, which is considered somewhat subjective because its observations are based solely on morphological characteristics and are qualitative in nature. This gonad maturity analysis was conducted because during gonad development, its weight also increases, providing additional information that can then be described quantitatively. The gonad maturity index (Przybył *et al.*, 2022):

$$\text{GSI (\%)} = \frac{Wg}{Wb} \times 100$$

Description: GSI = Gonadosomatic index, Wg = gonad weight (g) Wb = body weight (g).

RESULT

Length Weight Relationship

Based on the analysis of the relationship between the length and weight of the waulang fish (*P. hamrur*), the b value was obtained for female fish, the coefficient value of R² = 0.773 and the b value for male fish was 0.9055 with an R² value of 0.615. The equation for the relationship between the length and weight of female waulang fish was $W = 0.0282L^{1.6664}$ and for males $W = 0.0174L^{0.9055}$ (Figure 2).

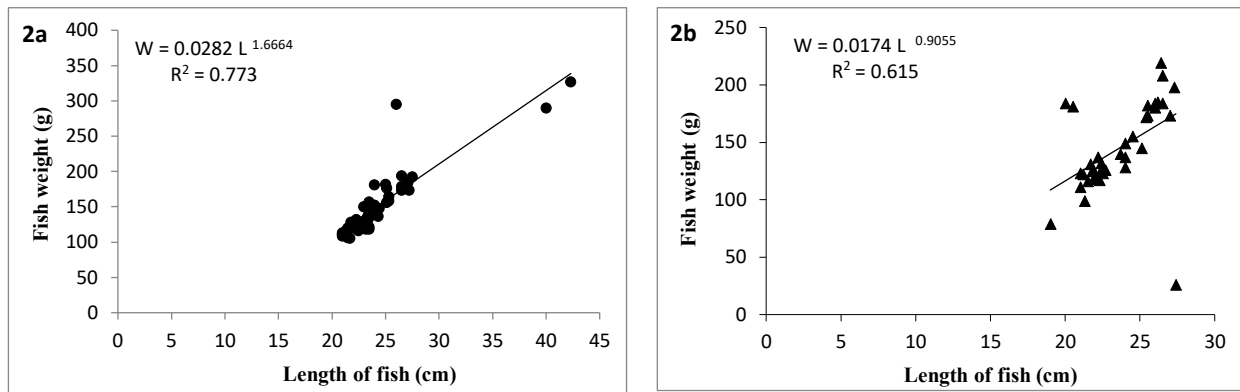


Figure 2. Graph of the relationship between the length and weight of female (a) and male (b) waulang fish.

Based on data from measurements of total length (Lt) and body weight (Wt) of fish obtained from 43 individuals, the range of fish lengths was between 21 cm and 42.3 cm and body weights between 105 grams and 327 grams. The average length of the observed fish ranged from 23–26 cm, with some individuals measuring larger, up to over 40 cm. Fish body weight generally ranged from 120–180 grams, although there were individuals weighing nearly 330 grams.

Gonad Maturity Level

Based on the results of TKG observations of 80 samples of waulang fish (*P. hamrur*) during the study, 37 male fish were found to have five levels of gonad maturity: 9 individuals were at TKG I, 4 individuals at TKG II, 10 individuals at TKG III, 11 individuals at TKG IV, and 3 individuals at TKG V. Meanwhile, the 43 female fish also comprised five levels of TKG: 12 individuals at TKG I, 9 individuals at TKG II, 3 individuals at TKG III, 8 individuals at TKG IV, and 11 individuals at TKG V. The results are presented in Figure 3.

Based on the observations (Table 3), both male and female waulang fish have five levels of gonad maturity, indicating the development of their reproductive organs before, during, and after spawning. At TKG I (immature), the female ovaries and male testes are still very small, only about one-third the length of the body cavity, with a clear reddish color in females and whitish in males. Eggs are not yet visible to the naked eye. Entering TKG II (development), the gonads enlarge to about half the length of the body cavity, their color remains clear or translucent, and the eggs are also not yet visible. At TKG III (maturation), the female ovaries begin to show a reddish-yellow color and egg grains begin to appear, while the male testes enlarge and become whitish to creamy in color. Next, at TKG IV (mature), the gonads of both female and male fish enlarge to two-thirds or even fill the body cavity. The female ovaries are pink or orange with clear blood vessels, and mature eggs are clearly visible. Similarly, the male testes appear softer and creamy, with mature sperm. Finally, at TKG V (spawning/salin or spent), the gonads appear to shrink again after the spawning process. The ovaries and testes appear shrunken with loosened walls and remnants of eggs are still visible..

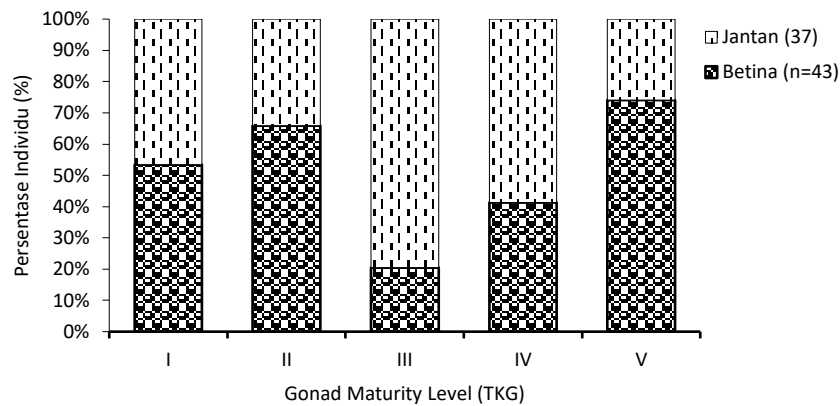








Figure 3. TKG of Female & Male Waulang Fish

Table 3. Results of TKG observations of female and male waulang fish.

TKG	Gonad Maturity Level Condition		Description
	Female	Male	
I. Immature			<p>The ovaries are approximately 1/3 the length of the body cavity and are clear reddish in color. Eggs are not visible to the naked eye.</p> <p>The testes are approximately 1/3 the length of the body cavity and are whitish in color. The eggs are invisible to the naked eye.</p>
II. Developing			<p>The ovaries are approximately half the length of the body cavity, clear or translucent. Eggs are not visible to the naked eye.</p> <p>The testes are approximately half the length of the body cavity, clear or translucent, and whitish in color, and more or less symmetrical. The eggs are not visible to the naked eye.</p>
III. Ripening			<p>The ovaries are approximately 2/3 the length of the body cavity. The ovaries are reddish yellow and the egg pellets begin to appear. There are no translucent or clear eggs.</p> <p>The testes are approximately 2/3 the length of the body cavity and are whitish to cream</p>

in color. There are no translucent or clear eggs.

IV. Ripe or Fully Mature



The ovaries fill two-thirds of the body cavity. They are pink/orange in color with blood vessels clearly visible on their surface. Mature, translucent eggs are visible.

The testes fill two-thirds of the body cavity and are whitish/creamy and soft. Mature, translucent eggs are visible.

V. Spent



The ovary shrinks to approximately 10% the body cavity and the cell walls loosen. The ovary contains the remains of eggs.

The testes shrink to approximately 10% the body cavity walls relax.

Gonad Maturity Index

Observations of the gonad maturity index of female and male waulang fish showed significant variation between individuals (Figure 4). The 43 females observed had a total body length (TL) ranging from 21 cm to 42.3 cm, with highly variable IKG values, ranging from 0.075 to 2.382. Most females measuring over 25 cm showed higher IKG values, indicating they were in the mature phase or nearing spawning. For example, a 25 cm female had a IKG of 1.527, while a 42.3 cm female had a IKG of 2.195. This indicates that the larger the female, the higher the level of gonad maturity.

Meanwhile, the 37 males had a body length ranging from 19 cm to 27.4 cm. Male IKG values also varied, ranging from 0.04 to 2.35. Most male fish exhibit lower IKG values than females, especially in smaller, immature fish. However, some males, approximately 24–27 cm in length, exhibit IKG values above 1, indicating high gonadal maturity and readiness for spawning.

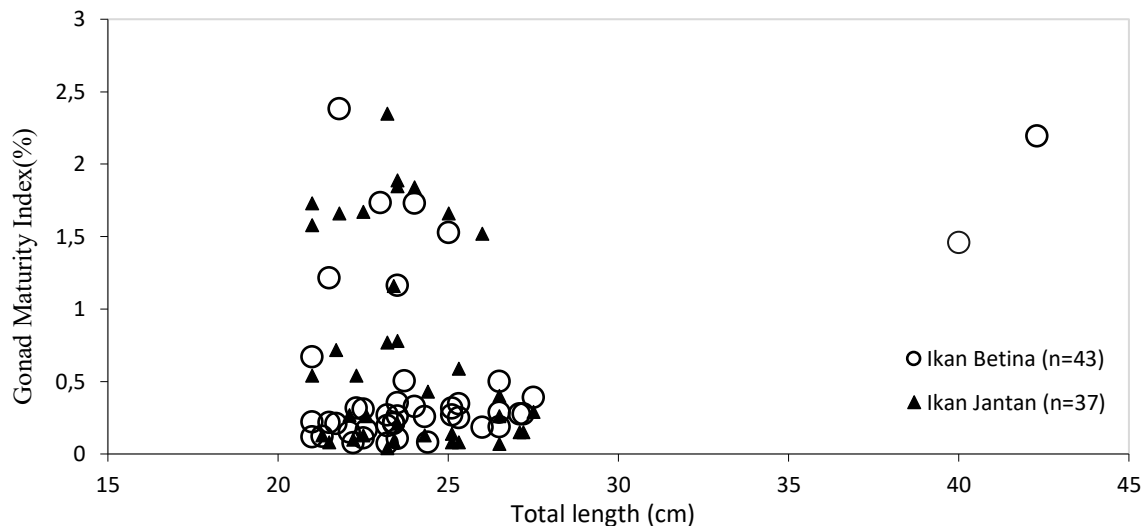


Figure 4. Relationship between length and IKG of female and male waulang fish

DISCUSSION

The results of the study showed that the relationship between body length and weight of the waulang fish (*Parupeneus hamrur*) differed between females and males. The b value for females was 1.6664 with a coefficient of determination (R^2) of 0.773, while males had a b value of 0.9055 with an R^2 of 0.615. The resulting length-weight equation was $W = 0.0282L^{1.6664}$ for females and $W = 0.0174L^{0.9055}$ for males. The b value far from 3 indicates that the growth of the waulang fish is negatively allometric, meaning that the increase in body length is not followed by a proportional increase in body weight. This means that although the fish grows longer, the increase in body weight tends to be slower. This finding is in line with the research of Flores *et al.*, (2024) which explains that allometric growth in fish often occurs due to environmental factors, food availability, or the reproductive phase. The body size of the waulang fish studied ranged from 21 cm to 42.3 cm, with a body weight between 105 grams and 327 grams. The average fish caught was approximately 23–26 cm long and weighed between 120–180 grams. Larger fish, particularly those over 40 cm in length, exhibited significantly higher body weights, indicating they were likely in the reproductively mature phase.

Observations of gonadal maturity levels (GMT) revealed clear variations between females and males. Both females and males were found in five maturity stages, ranging from GMT I (immature) to GMT V (spawning/spent). Of the 43 females, the majority were found in GMT I (12) and GMT V (11), indicating that the female population comprises both immature and completed spawning groups. Similarly, among the 37 males, the highest proportions were found in TKG IV (11 individuals) and TKG III (10 individuals), indicating that many males were in the mature phase and approaching spawning. Morphological descriptions of the gonads support this finding, with the ovaries and testes showing characteristic development in size and coloration according to their maturity stage. In TKG I, the gonads were very small and did not display any egg granules. In TKG IV, the gonads enlarged to fill the body cavity, with striking coloration and mature eggs or sperm. After spawning, in TKG V, the gonads shrank again, leaving only egg remnants. These results align with the theory that fish gonadal development exhibits a regular pattern as part of their life cycle (Nishimura & Tanaka 2014; Whitfield *et al.*, 2023).

IKG values in female fish ranged from 0.075 to 2.382, with a tendency for larger fish to have higher IKGs. For example, a 25 cm female had a GCI of 1.527 and a 42.3 cm female had a GCI of 2.195. This indicates that fish body size is closely related to the readiness of its

reproductive organs. In contrast, males have GCI values between 0.04 and 2.35. Most males with a length below 24 cm showed a low GCI, but some males measuring 24–27 cm showed a high GCI indicating gonadal maturity. This phenomenon reinforces the concept that gonadal maturation is closely related to the size and age of skipjack tuna, as explained in the study of Soukotta & Tuapetel (2024) on fish population dynamics. These results are also in line with the findings of Chen *et al.*, (2022) who stated that GCI is an important biological indicator for determining the period and readiness of fish to spawn.

The results of this study show a similar pattern to previous studies on tropical reef fish, such as Matthias *et al.* (2018), which reported that most demersal fish exhibit negative allometric growth due to environmental influences and reproductive needs. Furthermore, the results regarding the distribution of TKG and IKG are also consistent with the study by Nguyen *et al.*, (2021), which confirmed that tropical fish have a long spawning period, with varying stages of maturity within a single population (Rojo *et al.*, 2022). However, the finding of relatively low *b* values in the waulang, particularly in males, could be a novel finding that enriches the biological information of this species, given that few previous studies have specifically examined the length-weight relationship and gonadal maturity dynamics of *P. hamrur* in Eastern Indonesian waters.

The ecological implications of these results suggest that the fishing of the waulang (*Priacanthus hamrur*) needs to be strictly regulated by establishing minimum catch sizes and no-take periods during the spawning season to maintain stock sustainability and prevent declines in broodstock biomass. This effort is important because the exploitation of fish that have not reached their first gonadal maturity can disrupt natural recruitment processes and reduce population productivity (Oo *et al.*, 2025). According to the FAO (2022), implementing a minimum landing size is an effective biological management strategy to ensure that some individuals reach reproductive stage before being caught. Meanwhile, a fishing ban period during the spawning season (seasonal closure) has been shown to increase spawning success and maintain spawning stocks in various tropical demersal species (Trenggono, 2023). Prihatiningsih *et al.*, (2013) also emphasized that without restrictions on size and fishing time, economically important fish populations such as *Priacanthus* sp. are at risk of significant stock declines due to intensive fishing pressure during the reproductive season. Therefore, the combination of a minimum catch size policy and a spawning season closure is a strategic step in maintaining ecosystem balance and the sustainability of coral fisheries in tropical waters, particularly the Banda Maluku waters.

CONCLUSION

This study shows that the waulang fish (*Priacanthus hamrur*) in the Banda Waters exhibits a negative allometric growth pattern with a *b* value of 1.6664 for females and 0.9055 for males. Both females and males experience five stages of gonadal maturity, reflecting an active reproductive cycle. The Gonad Maturity Index (GMI) increases with body size, with females exhibiting a higher GMI than males. These findings provide an important basis for the sustainable management and conservation of waulang fish resources.

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