Biological aspects of *Leptobrama pectoralis* Ramsay and Ogilby 1887 (Leptobramidae) in Merauke, Papua, Indonesia

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Abstract. Long-fin beach salmon (*Leptobrama pectoralis*) is an endemic species to Arafura and distributed from northern Australia to Merauke, Southern Papua, Indonesia. The biological information of this species is still limited. This study aimed to provide biological information on long-fin beach salmon to fill the research gap of this fish. Parameters collected including length, weight and gut content. A total of 2,640 specimens were collected gill net landing based in Merauke from February to November 2016. The analysis results showed that maximum length and weight of long-fin beach salmon from Merauke waters were 40.4 cmFL and 859 g. The length-weight relationship formula was found as $W = 0.016L^{2.897}$. The average maximum length ($L_\infty$) and instantaneous growth rate ($k$) were 42 cm and 0.8 year$^{-1}$ while the total mortality ($Z$) was estimated as 4.2 year$^{-1}$ and maximum recruitment occurred in November. Length at capture lower than length at maturity ($L_c < L_m$). The stomach content of this species was dominated by fish (38.19%). The result of this study can be served as a piece of early information on the species' status.

Keywords: beach salmon, biological, growth, mortality, recruitment

1. Introduction

The Arafura Sea, together with Aru Sea and eastern part of Timor Sea, has been decided as Indonesian Fisheries Management Area (FMA) 718 base on Ministerial Decree No.18/2014. As the eastern Indonesian FMA, the waters are bordered with Australian waters in the south, Banda Sea in the west and north, and Papua New Guinea waters in the east. With an area of ±150,000 km$^2$ and depth average of 30-90 m (Sadhotomo and Mertha 2011), the waters are one of the highest productivity in the world due to the high input of organic materials from the rivers that lead to it. This caused the fishing activity very high, especially for demersal fishes and shrimp (Nugroho *et al*  2011).

The land area of this FMA includes four regencies in Papua Province namely Merauke, Mimika, Asmat, and Mappi. Merauke Regency is one of important demersal fisheries center in Papua Province where the small scale fishermen exploit the resources using gillnet. Fishing activity in this area was conducted all year round. A high fishing activity can lead to overfishing for the resources if there is no management measure. In management context, it is important to gather and identify the biological characteristics of this species (King 2007).
The long-fish beach salmon (*Leptobrama pectoralis*), along with the spotted beach salmon (*L. muelleri*) both known as Paha-paha by local fishermen, are dominant catch from small scale gillnet fishery in Lampu Satu and Binaloka village, Merauke. Other catches are the Papuan seerfish (*Scomberomorus multiradiatus*), four-finger threadfin (*Eleutheronema tetractylum*), baramundi (*Lates calcalifer*) and the black-spotted croaker (*Protonibea diacanthus*) that has high value for its swimbladder. *L. pectoralis* distributed only in western Pacific, from southern coast of Papua New Guinea, Merauke (Indonesia), to Queensland and Western Australia (Kimura et al 2016) while the Fishbase website only has record for *L. muelleri* which have the same distribution pattern with *L. pectoralis*. Kimura et al (2016) stated that this species probably living inshore and migrating into brackish water. Furthermore, Bray (2016) reported that long-fin beach salmon is pelagic off sandy beaches and in the lower reaches of rivers.

At this moment, there is not much information on the biological parameters of this species. This study aimed to provide biological information on long-fin beach salmon to fill the research gap of this fish. Understanding the fish biological information can be the first step toward a preliminary stock status that can lead to manage the fishery and prevent it from overfishing.

2. Materials and methods

2.1. Materials
A number of 2,640 specimens of *L. pectoralis* (figure 1) were collected by gillnet from February to November 2016. A set of gillnet has 50–0 m long and 1.5 m height with the mesh size of 3 inches. This gillnet operated using small boat with the length of 9–10 m, width of 1.25 m, and depth of 1 m and driven by 40 HP engine power.

![Figure 1](image)

Figure 1. The long-fish beach salmon (*L. pectoralis*) caught in the Merauke, Papua.

Fishing activity conducted by two or three fishermen in a boat with the fishing trip one to two days and towing duration about two hours in the waters of Merauke which covered Kumbe regency in the west side to the border of Papua New Guinea in the east (figure 2). Biological parameters of the fish sample included length, weight, sex, maturity, and gut content. The measured length used in this analysis is fork length (FL). Fish sampling was done by trained enumerator through semi-regular observation.

2.2. Methods
The length-frequency distribution was created with 2 cm class interval. Size structure is observed to estimate the fishing gear selectivity, the size of dominant fish caught, size at capture and maturity, and growth. The relationship between length and weight was expressed as (Le Cren 1951, Effendi 2002):
and calculated as:

\[ W = aL^b \]  

where \( W \) is the weight of fish in g, \( L \) is fork length in cm, \( a \) is the regression intercept, and \( b \) is the slope. To assess the growth pattern, t-test was performed to test the significance of different \( b \) value toward 3. When the value of \( b \) equal to 3 \((b = 3)\) then the growth pattern is isometric but if \( b \) value significantly different from 3 then the growth pattern is allometric. The \( b \) value greater than 3 \((b > 3)\) the growth pattern is positive allometric, while the \( b \) value smaller than 3 \((b < 3)\) then the growth pattern is negative allometric.

\[ \log W = \log a + b \log L \]

\[ L_t = L_\infty \left(1 - e^{-k(t-t_0)} \right) \]

where \( L_t \) is the length at age \( t \), \( L_\infty \) is asymptotic length, \( k \) is instantaneous growth rate, and \( t_0 \) is theoretical age of fish. Total mortality (\( Z \)) was calculated by length-converted catch curve (Pauly 1983, King 2007) and stated as:
\[ \ln(N_t/dt) = a - bt'; b = -Z \quad (4) \]

where \( N_t \) is the amount of fish in the \( t \)th class, \( dt \) is time needed by an individual to growth through length class \( t \), \( t' \) is relative age, and \( Z \) is total mortality. Recruitment pattern was estimated using asymptotic length (\( L_\infty \)), instantaneous growth rate (\( k \)), and theoretical age as an input of parameters (Gayanilo et al 2005). Length at first capture (\( L_c \)) was estimated using logistic function (Sparre and Venema 1998) as:

\[ S_{Lc} = \frac{1}{1 + e^{-(b-a)L}} \quad (5) \]

where \( S_L \) is gear selectivity of gillnet, \( a \) and \( b \) are a constant, \( L \) is fork length and \( L_c \) is calculated from \( aL \). Length at maturity (\( L_m \)) was estimated using the logistic equation as outlined by King (2007) by fitting the fraction of mature fish (stages III and above) against the fork length (FL). The equation formula calculated as:

\[ P = \frac{1}{1 + e^{-(b-a)(L-L_m)}} \quad (6) \]

This equation could be altered to linear form as:

\[ \ln \left[ \frac{1-P}{P} \right] = rL_m - rL \quad (7) \]

where \( P \) is a proportion of fork length at mature stages divided by fork length at immature and mature stages, \( rL_m \) is intercepted, \( r \) is the slope, then length which conforms to a proportion of 0.5 (50%) in reproductive circumstances (\( L_m \)) is equal to \((\text{intercept})/r\).

Stomach content analysis is conducted using an index of preponderance (Natarajan and Jhingran 1961):

\[ I_i = \frac{V_i \times O_i}{\sum(V_i \times O_i)} \times 100 \quad (8) \]

where \( I_i \) is index of preponderance, \( V_i \) and \( O_i \) are percentage of the volume and occurrence index of food item \( i \).

3. Results and discussion

3.1. Size structure

The length-frequency distribution of \( L. pectoralis \) showed that length class of this species ranged from 18 to 40 cm with the single modus (peak) at the length class of 28 cm which is representing the age group of this fish (figure 3). The length size of fish which lower than 22 cm and greater than 34 cm were caught in the small portion, 2%, and 1% respectively. The highest part of the length size was shared by the length class of 28 cm to 32 cm which reached 71% of the total sample.

Temporal size structure on the length and weight of \( L. pectoralis \) was presented in figure 4. Overall, the length of \( L. pectoralis \) caught by gillnet from commercial landings ranged between 18 cm and 40.4 cm with a mean length of 29.1±3.4 cm, while its individual bodyweight ranged from 64.9 to 859 g with a mean weight 297.6±114.8 g. The size structure of \( L. pectoralis \) in this study was greater than maximum published length of this species which was 30 cmSL in Australian waters (Bray 2016).
Figure 3. Length frequency distribution of *L. pectoralis* from Merauke waters, Papua, 2016.

The highest average length of *L. pectoralis* was found in June (31.5 cm) while the lowest was found on July (27.9 cm). On the other hand, the highest weight was found on September (338.3 g) while the lowest was found on August (267.6 g). The widest range of length and weight of *L. pectoralis* was found in November, whereas the narrowest range of length and weight was found in June.

Figure 4. Monthly fork length (a) and body weight (b) structure of *L. pectoralis* from Merauke, Papua, 2016.

3.2. Length and weight relationship

The length and weight relationship formula of *L. pectoralis* were found as \( W = 0.016 L^{2.897} \) by linear regression analysis of logarithm fork length versus logarithm weight (figure 5). According to the analysis of t-test on the regression coefficient (b value), it was known that the growth of *L. pectoralis* is negative allometric or hypoallometric (b<3). This means that the increases of the weight less than predicted by the increase in length and this fish becomes more elongated as it grows (Froese 2006). The length and weight relationship is useful in fisheries study since it could be used to estimate weight from length observation, condition of fish, calculate the growth, biomass, production of population as well as to compare the fish growth between regions (Stergiou and Moutopoulos 2001, Sinovcic *et al* 2004, Froese 2006, Velamala *et al* 2019).

The differences in the fish growth pattern could be arisen from biological factors such as gonadal development, feeding habit, growth phase and sexes (Froese 2006, Tarkan *et al* 2006) and ecological factors as well as season, water quality, temperature, salinity, acidity, geographical position and sampling techniques (Zargar *et al* 2012).
3.3. Growth, mortality, and recruitment

The best estimation of $L_\infty$ and k was delivered by altering the von Bertalanffy parameters and was verified by the best fitted (ESP: ASP ratio). Based on the analysis result, the asymptotic length ($L_\infty$) and instantaneous growth rate (k) were measured as 42 cm and 0.8 year$^{-1}$, respectively. These values treated as the input parameters to estimate the average length of each peak and superpose of these average lengths on the length frequency histogram expressed the growth pattern of $L. pectoralis$ (figure 6). The theoretical age ($t_0$) and maximum age of this species were -0.18 and 3.75 years. Furthermore, the von Bertalanffy growth formula for this species was $L_t = 42 \left(1 - e^{-0.8(t+0.18)}\right)$.

![Figure 5. Length-weight relationship of longfin beach salmon from Merauke, Papua, 2016.](image)

![Figure 6. The von bertalanffy growth curve as restructured using the ELEFAN program of $L. pectoralis$ in Merauke waters, Papua, 2016.](image)

![Figure 7. Length-converted catch curve (a) and recruitment pattern of $L. pectoralis$ in Merauke, Papua, 2016.](image)
The mortality was calculated by linearized length-converted catch curve method which uses the growth parameter ($L_\infty$, k, $t_0$) as input parameters. The slope of regression line from relative age at catch of the curve indicated a total mortality rate ($Z$) of 4.2. Recruitment occurred all year round with maximum recruitment occurs in October (15.98%) (figure 7).

3.4. Length at capture (Lc) and length at maturity (Lm)
Logistic curve analysis was conducted to calculate the size at capture (Lc) and the size of maturity (Lm) of $L.$ pectoralis which is defined as 50% proportion. Length at the capture of $L.$ pectoralis was estimated as 26.8 cm, while length at maturity (Lm) for females was estimated as 29 cm (figure 8). However, the smallest specimens were recorded in the catch from 18 cm onwards and mature (ripening) specimens were recorded from 24 onwards. This study showed that $L.$ pectoralis was caught before reaching their size at maturity (Lc < Lm). This result indicates that long-fin beach salmon in this study area was threatened since it caught before getting reproduction process for the first time.

Length at maturity (Lm) had an important role in the fisheries management since fisheries resources utilization should let a certain number of fish brood stock in the same size or higher to achieve maturity (Sudjastani 1974). Catching the fish which is lower than the size at maturity will be lead to reduce the fish stock resources due to the hindrance of the recruitment process (Britten et al 2016). For the sustainability of this resources and applying precautionary approach for fisheries management, it is suggested to apply the minimum catch size which is greater than size at maturity. This study suggests that the minimum catch size for $L.$ pectoralis is 29 cm.

![Figure 8](image1.png)

Figure 8. Length at capture (Lc) and length at maturity (Lm) of long-fin beach salmon in the Merauke waters, Papua, 2016.

3.5. Stomach content
Stomach content composition analysis was conducted by macroscopic examination on the presence of the food item in the fish gut. To estimate the proportion of food item in the gut we used the index of preponderance. In this study, we found that the majority of the food item in the gut $L.$ pectoralis was fish (38%), while shrimp and squid found in small portion, 4% and 1%, respectively (figure 9). Spot-fin beach salmon ($L.$ mulleri) also reported feeds on small fishes of inshore waters as well as on shrimps (Mooi 2001). This study revealed that the species member of Leptobramidae was carnivorous species.

![Figure 9](image2.png)
In summary, this study showed that maximum length and weight of long-fin beach salmon from Merauke waters were 40.4 cmFL and 859 and this size became the largest published size ever. The growth pattern is negative allometric. The asymptotic length ($L_\infty$) and instantaneous growth rate ($k$) were 42 cm and 0.8 year$^{-1}$. The total mortality ($Z$) was estimated as 4.2 year$^{-1}$, recruitment occurs all year round with maximum recruitment in October. Length at capture was lower than a length at maturity ($L_c < L_m$). The stomach content of this species was dominated by fish (38.19%). Finally, the result of this study can be served as a piece of early information on this species status.

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**Figure 9.** Composition of stomach content of long-fin beach salmon in the Merauke waters, Papua, 2016.
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