The population dynamics of *Helostoma temminckii* in the swampy waters of Barumun River, South Labuhan Batu Regency, Indonesia

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Abstract. The kissing gourami (*Helosstoma temminckii*) inhabits rivers and the swampy areas of Sumatra Island, Indonesia, among other places. One of its habitats is found in the swamp waters of Barumun River, South Labuhan Batu Regency, Indonesia. *H. temminckii* is a fishing target because it has a high economic value. Its natural habitat in this region has been degraded by the expansion of oil palm plantations and settlements, leading to a decrease in population. In addition, another factor for population decline is suspected to be overexploitation. The purpose of this research was to determine the population dynamics of *H. temminckii* in the swampy waters of Barumun River. This research was exploratory, where the research station was selected using the purposive sampling method. Sampling of fish using gill nets was conducted in July, August, and September 2020. The catch of fish was quantified. Total length (cm) and total weight (g) were determined. The research data was processed using the FISAT II software. Based on the results of the analysis, *H. temminckii* growth pattern was obtained, with a value of y of $13.416x^{-120.35}$ with a regression coefficient value R^2 of 0.8563. The asymptotic length (L_∞) was 20.55 cm, the growth coefficient (K) value was 0.84 per year, the mortality rate (Z) was 3.38 per year, with an average value of $T=27.8^0C$, and the natural mortality (M) value was 1.76.
Key Words: fish resources, kissing gourami, swamp water.

Introduction. *Helostoma temminckii* is distributed in Southeast Asia, also found in several rivers on the island of Sumatra and Borneo (Kalimantan) (Hasan et al 2016). *H. temminckii* has a high economic value as a food commodity (Arifin et al 2017). In Kalimantan Island and Jambi Province, the price of this fish reaches 20000-30000 IRD or 1-2 UDD per kg (Kristanto et al 2017). Even the price of *H. temminckii* eggs in Tulang Bawang Regency, Lampung Province, Indonesia, reach 250000 IRD or 17.24 USD per kg (Ubamnata et al 2015). The high price causes continuous fishing, impacting the wild populations, production still relying on natural catches.

It is generally known that several factors of threat to the biodiversity of fish resources are: overfishing, introduction of new species, pollution, loss and changing of habitats, and global climate change (Syafei 2017). The decline in the populations of *H. temminckii* in some waters is already occurring (Ubamnata et al 2015). For example, the arrest of *H. temminckii* was carried out massively during the rainy season in the swamp of Bawang Juyeuw Tulang, Bawang Barat Regency (Tarigan et al 2015). Furthermore, according to Ubamnata et al (2015), the main factor causing the population decline is fishing by fishermen. In addition, the introduction of new species in a waterway may make the new species competitors or even serious predators for endemic fish.

The study of fish population dynamics aims to obtain data related to fish populations, their intrinsic properties and their dynamics factors, selection of fishing equipment, and ways of estimation. In addition, there are external (environmental) factors that influence it. This presumption is demonstrated with an analytical and survey approach (Saputra 2007). A large number of studies show that the main biological parameters and population dynamics are very important aspects.

Research related to fish population dynamics has been conducted Djumanto et al (2014), Agustina et al (2015), Samuel et al 2017, Sofarini et al (2018), Sawestri et al

(2018), Nurdawati et al (2019), Bintoro et al (2019), Chodrijah et al (2020), and many others. However, scarce information was found regarding the population dynamics of *H. temminckii*. The existence of *H. temminckii* in the swamp area of Barumun River should be preserved. The aim of this study is to determine and analyze data and information related to population dynamics of *H. temminckii*, as the basis for consideration of fishery resource management in South Labuhan Batu Regency.

Material and Method

Time and location. Fish samples are were collected from July to September 2020 from the swamp waters of Barumun River, Indonesia. The observation stations were determined using the purposive sampling method, based on differences in habitat characteristics of kissing gourami. There were 3 selected stations: Station 1 (1°56'23.04"N 100°6'54.61"E), Station 2 (1°56'20.76"N 100°6'50.94"E), and Station 3 (1°56'18.15"N 100°6'49.94"E). The map of the research location is presented in Figure 1.

Figure 1. Research stations.

Sample collection. Fish sampling was conducted using cast nets and gill nets. Furthermore, fish caught were measured to determine the length and weight. The total length of the fish was measured from the snout to the end of the caudal fin with a metal ruler (0.1 cm accuracy), while the total weight of each fish was determined using analytical scales with a precision up to 0.01 g. The data was analyzed to estimate the parameters of growth, mortality, and recruitment patterns.

Data analysis. The length-weight relationship was determined for measuring the variation of expected weight at a certain length of individual fish, or of a relevant group of individuals as an indication of health or gonad development (Sawestri et al 2018). Length and the total weight of *H. temminckii* was determined using the Allometric Linear Model (ALM) with Le Cren's formula (1951), as follows:

$$W = aL^b$$

Where: W - total weight (g); L - total length (cm); a and b - constants.

The presumption of growth parameters follows von Bertalanffy's growth model (Sparre & Venema 1998), with the equation:

$L_t = L_\infty\,[1-e^{-K(t-t0)}]$

Where: Lt - the length of fish at the time of t-life; L_∞ - theoretical maximum length (asymptotic length); K - growth coefficient (per unit time); t0 - theoretical lifespan at the time when length equals zero.

Asymptotic length (L∞) and growth coefficient (K) were calculated using the ELEFAN I program in the FISAT II software (Gayanilo et al 1995). The presumption of the value of t0 was calculated based on the Pauly equation (1980):

$$\text{Log}(-t0) = -0.3922 - 0.2752\ \text{Log}(L\infty) - 1.038\ \text{Log}(K)$$

Where: L_∞ - the asymptotic length of fish (cm); K - growth rate coefficient (years); t0 - theoretical lifespan of fish at a time equal to zero (years).

The rate of natural mortality (M) is thought to use empirical model Pauly (1980) namely:

$$\text{Log}\ M = 0.0066 - 0.279\ \text{Log}\ 10\ L_\infty + 0.6543\ \text{Log}\ 10\ K + 0.4634\ \text{Log}\ 10\ T$$

Where: L∞ - asymptotic length; K - growth coefficient; T - average water temperature of the swampy waters of Barumun River (27.8°C). Temperature measurements were performed using a thermometer once a month (July, August, and September) in each observation station. Furthermore, the value of temperature parameters collected in the 3 months from each station was averaged.

The total mortality coefficient (Z) was analyzed from the length converted catch curve (Pauly 1983). The calculation was conducted using the FISAT II program package (Gayanilo et al 1995). The arrest mortality coefficient (F) was calculated from the equation:

$$F=Z-M$$

The exploitation rate (E) was calculated using the following equation (Pauly 1980):

$$E=F/Z$$

The optimum capture mortality condition is achieved when the optimum F is equal to the value of M, while the optimum exploitation rate is achieved when the optimum E is equal to 0.5.

Results and Discussion

Length-weight relationship. The monthly length and weight data showed that the size of *H. temminckii* caught varied (Table 1).

Table 1

Size class distribution of *Helostoma temminckii* in the swampy waters of Barumun River, Indonesia

No	*Period of sampling*	*N*	*Station*	*Total length (cm)*				*Weight (g)*			
				Min	*Max*	*X*	*SD*	*Min*	*Max*	*Y*	*SD*
1	July	5	St. 1	11.5	13	12.2	0,54	35.2	52.9	42.18	6.71
2	August	4	St. 1	12.5	13.3	12.77	0.37	42	50	46.32	3.28
3	September	4	St. 1	12.2	13.1	12.52	0.40	37.8	53.1	45	6.33
4	July	3	St. 2	11.5	13	12.2	0.75	36.3	49	42.93	6.36
5	August	3	St. 2	11.9	12.5	12.27	0.32	36.5	46.9	41.13	5.29
6	September	2	St. 2	11.1	12.4	11.75	0.92	32.1	47	39.55	10.53
7	July	2	St. 3	12.1	12.2	12.5	0,70	47.4	54.6	51	5.09
8	August	5	St. 3	11.4	16.3	13.18	1.99	35.6	110	58.62	30.59
9	September	3	St. 3	11.2	12.3	11.8	0.55	35.1	52.7	42.6	9.08

The length-weight relationship of fish in the swamp waters of Barumun River has a slope value (b) less than 3, suggesting that the growth pattern is allometric negative, meaning that the growth of its length is faster than its weight growth. The value of growth patterns obtained in this study could be influenced by food factors and water quality parameters. The results of Ubamnata et al (2015) showed that, in December, the growth of *H. temminckii* in the waters of the swamp of Bawang Latak is allometric negative ($b<3$), which means length growth is faster than body weight increase. This is because the total organic material decreases in December, resulting in the lower availability of food, so that growth is hampered. Furthermore, according to Wudji et al (2012), fish growth parameters are related to water quality. According to Sawestri et al (2018), the variation in fish length can be caused by different types and sizes of fishing equipment used. The growth pattern of the fish is defined as the increase in the length or weight of the fish over a certain period of time. Growth is one of the population parameters widely used for fishery stock analysis (Muhsoni 2019).

According to Zhu et al (2010) and Ubamnata et al (2015), the length-weight relationship in fish is influenced by several factors, including the season, habitat, food availability, feeding speed, development of gonads, sex, spawning period, health condition and others. Faizah (2010) explained that the growth of tuna (*Thunnus obesus*) is influenced by many environmental factors including the size and type of the food eaten, the number of fish in the water, oceanographic conditions (temperature, oxygen, etc.) and the condition of fish (age, heredity, and genetics).

Von Bertalanffy growth model. The results of analysis of length distribution frequency showed the following fish growth model in the swamp of Barumun River (von Bertalanffy's equation): $Lt=20.55*(1^{-(-0.50*(t+0.31))})$ or $Lt= 20.55*(1-e^{-0.50(t+0.31)})$.

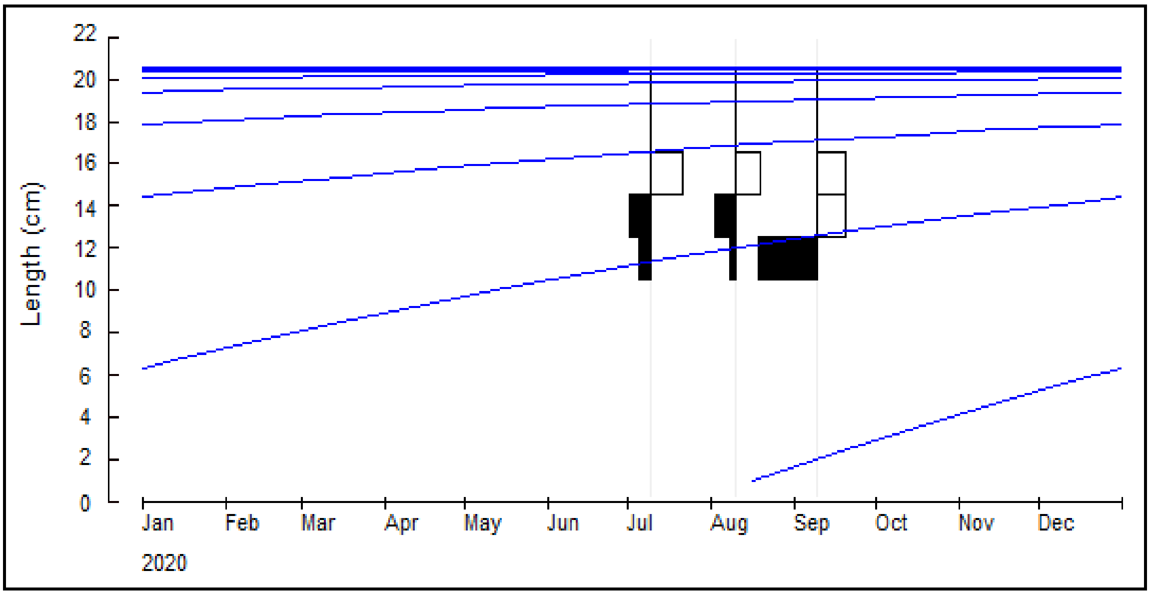

Figure 2. Von Bertalanffy growth curve for *Helostoma temmincki* in the swamp waters of Barumun River, Indonesia.

The results of the analysis of growth parameters showed an asymptotic length (L_∞) of 20.55 cm, a growth coefficient (K) of 0.84, and life at the time of length 0 (t_0) of -0.21 years. The growth performance index (ø') was 2.43 (Figure 4).

The growth of *H. temmincki* in the swampy waters of Barumun River is constant, allegedly due to food factors, water quality parameters and its reproductive cycle. Fish growth concept is autocatalytic: growth will run slowly, then it will be faster until it reaches maximum size. As long as the fish eats and it is in good health, growth will occur continuously (Effendie 2002). Food is a more important factor than water temperature for fish growth in tropical areas. The success of getting food and first time gonad maturation can determine and affect growth. Reproduction will also slow growth rate because the energy from food consumed and digested by the fish will be first used for the development of gonads (Pellokila 2009). The theoretical estimate of the longevity of fish at time zero (t_0) is L∞=63. 4 cm and K=0. 15 per year (Pauly 1983). According to Tangke (2014), using the FISAT-II program, the First Catch (FC) of *Rastrelliger* sp. in the coastal waters of Ternate Island was 14.9 cm. Based on von Bertalanffy's growth equation, the lifespan of *Rastrelliger* sp. at the time of FC was 8 months, with a length of 14.9 cm.

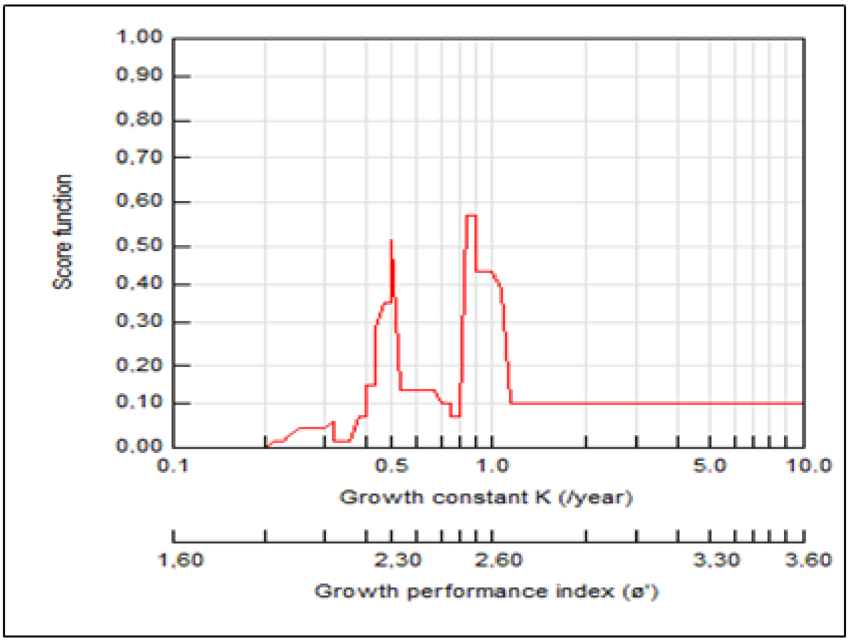

Figure 3. Growth parameters *Helostoma temminckii* in the swampy waters of Barumun River, Indonesia.

Recruitment. The results of analysis of *H. temminckii*'s alleged recruitment pattern in the swampy waters of Barumun River for one year are presented in Figure 5.

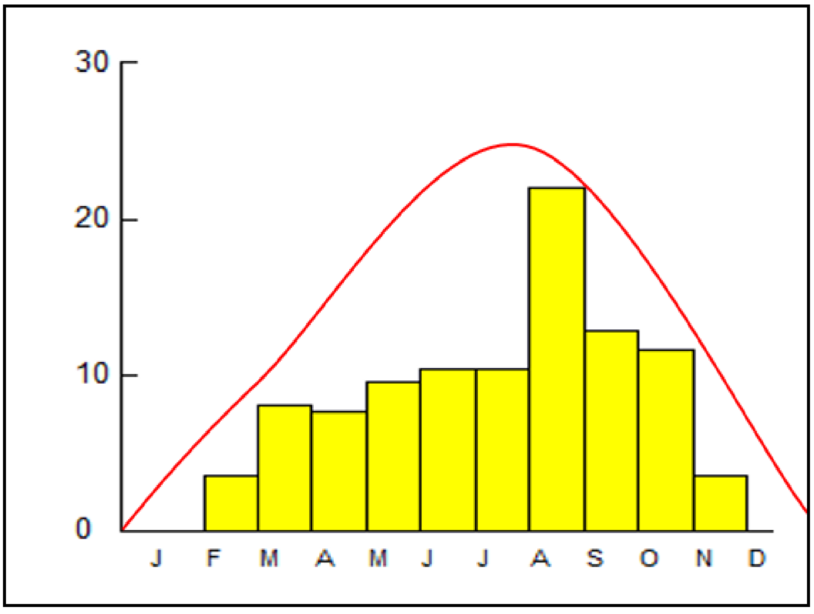

Figure 4. *Helostoma temmincki* recruitment pattern in the swampy waters of Barumun River, Indonesia.

Based on the results of FISAT II analysis, the highest recruitment peak occurred in August, probably because the month coincides with the peak spawning season. According to Hopkins (1971), the blue gourami (*Trichogaster trichopterus*) spawning season occurs in August. According to Edison (1997), the maximum value that can be exploited is half of the fish populations available.

Natural mortality. Data from field sampling measurements shows that the average temperature of swampy waters of Barumun River is 27.8°C. Based on the growth parameters (L_∞=20.55 cm, K=0.84 per year) and T=27.8°C, the natural mortality value (M) was 1.76. Z's estimated value is 3.38 per year. The estimated value of M is 1.76 per year and the estimated mortality value due to arrest (F) is 0.41 per year.

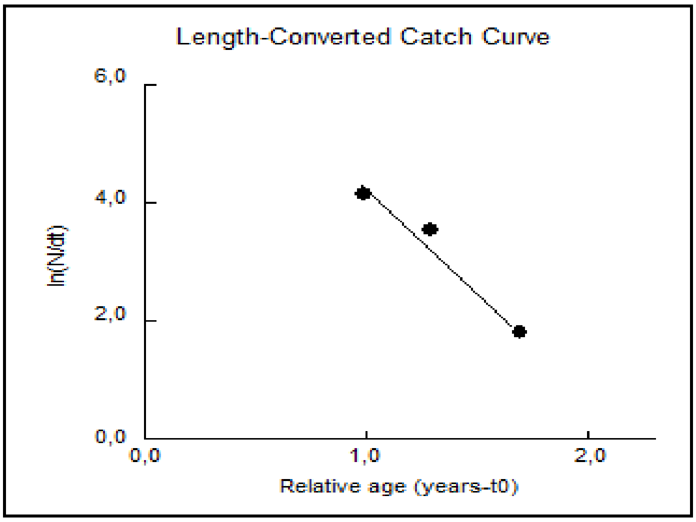

Figure 5. *Helostoma temminckii* catch curve in the swampy waters of Barumun River, Indonesia.

Based on the catch curve, the *H. temminckii* known Z is 3.38 per year and M is 1.76. Based on the results of this study, it is suspected that there has been an overfishing of *H. temminckii* in the study area. Fishermen make massive *H. temminckii* catches during the rainy season (Tarigan et al 2015). Sudirman et al (1997) suggested that fast-growing fish generally have high natural mortality, while slow-growing fish have low natural mortality. In relation to reproduction, Sparre & Venema (1998) suggested that fish that have high natural mortality value will mature faster gonad so that their reproduction is faster. This is likely due to natural population recovery efforts to maintain population size stability (Ongkers 2008).

Conclusions. The results of research on the population dynamics of *H. temminckii* in swampy waters of Barumun river are known to have been declining population. This is thought to be due to over-capture and has reduced its natural habitat. It is necessary to make massive efforts to prevent capture and habitat conservation efforts by relevant government agencies, so that the genetic resources of kissing gourami (*H. temminckii*) remain sustainable.

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