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Reproductive Biology of Striped Snakehead (*Channa striata*, Bloch, 1793) in Floodplain of Lubuk Lampam, South Sumatra

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ABSTRACT

Striped Snakehead (Channa striata) is one of the fish species inhabiting the flooded floodplain. Currently, the striped snakehead fish population in the Lubuk Lampam floodplain is undergoing a significant decline due to continuous and unregulated fishing activities. To prevent this population decline, there is a need for comprehensive efforts in managing their reproduction. The objective of this study was to investigate the reproductive behavior of striped snakehead fish in the floodplain of Lubuk Lampam, South Sumatra. The research spanned five months, from December 2022 to April 2023, and involved the collection of fish samples from four different floodplain types: river, lebung, lebak kumpei, and rawang. A total of 284 striped snakehead fish were examined, and measurements of length- weight and their reproductive biology were observed. The findings revealed that the sex ratio of striped snakehead fish was skewed toward females, with a ratio of 1:1.7 (females to males). The size at which female striped snakehead fish reach maturity was determined to be 28.5 cm, while male striped snakehead fish matured at 29.30 cm. The peak spawning season for striped snakehead fish occurred in December, coinciding with the rainy season. The spawning grounds for striped snakehead fish were predominantly located in the lebung station in the upper reaches of the Lubuk Lampam Floodplain. Striped Snakehead fish exhibited a partial spawning behavior. Furthermore, these fish demonstrated a relatively high reproductive potential, with fecundity ranging from 5,859 to 30,321 eggs.

Keywords: Striped snakehead, reproductive biology, floodplain area

INTRODUCTION

Striped snakehead, known as Channa striata, inhabit various environments such as floodplains, muddy watersheds, rice fields, and brackish water, and and it is a fish species that is particularly localized in Indonesian aquatic ecosystems. (Iqbal 2011, Widyastuti *et al.* 2017). The Striped Snakehead's distribution spans across several Indonesian islands, including Sumatra, Kalimantan, Java, and various other islands. (Mujiatami. 2015). According to (Selviana *et al*. 2020; Iqbal. 2020), the Striped Snakehead's range encompasses a broad geographical area, extending from China, India, Sri Lanka, the Philippines, Nepal, Burma, Pakistan, Bangladesh, Singapore, Malaysia, and Indonesia.(Sumatra, Kalimantan and Java).

Striped Snakehead boasts a rich nutritional profile, boasting a protein content that can reach up to 30%. Beyond its nutritional value, striped snakehead fish offers a range of benefits, including

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its potential to aid in wound healing due to its abundance of omega-3 and omega-6 fatty acids. (Andrie *et al*. 2018; Nofriyanti *et al*. 2020). In the region of South Sumatra, striped snakehead fish holds significant economic importance and is extensively utilized in processed products such as crackers, pempek, and salted fish, contributing to its high commercial value (Iqbal *et al*. 2018). According to Gustiano et al. (2019), Striped Snakehead serves as a primary ingredient for producing crackers and pempek. At the South Sumatra Market, Striped Snakehead is typically available for sale at prices ranging from IDR 45,000 to IDR 100,000 per kilogram. In Indonesia, economically speaking, C. striata holds significant value as a commodity, with a price range of IDR 30,000 to IDR 60,000/kg (Rahayu *et al*. 2021).

Among various fish species, the catch of Strped Snakehead in public waters accounts for the largest share, constituting approximately 14.2% of the total catch. (Kartamihardja, 2014). In South Sumatra, floodplains serve as significant production hubs for the capture of Striped Snakehead. An illustrative instance of such a flooded swamp area is the Lubuk Lampam Floodplain. Lubuk Lampam is a crucial region for fisheries and is situated within the Lebak Ogan Komering Ilir area. From 2019 to 2020, the catch of Striped Snakehead in the Lubuk Lampam Floodplain of South Sumatra decreased, going from 492 tons to 341 tons. Over the past five years, there has been a growing demand for Striped Snakehead in South Sumatra. This escalating demand has led to uncontrolled exploitation of Striped Snakehead in the waters of Lubuk Lampam, posing a serious threat to the population of this species in the area, which is expected to experience a significant decline in numbers as a consequence. To prevent the decline in population, it is essential to implement management strategies that focus on the comprehensive understanding of the reproductive aspects of Striped Snakehead. Currently, there is a lack of available information regarding the reproductive biology of Striped Snakehead in the floodplains of Lubuk Lampam.

Understanding the reproductive biology of fish is a critical element in the management and sustainable exploitation of fisheries resources. Reproductive infromation plays a pivotal role in bolstering the success of breeding programs. Achieving successful fisheries management hinges on the precision of fecundity assessments, which provide valuable insights into the potential for fish populations to rebound and recover. (Ath-thar *et al*. 2017; Saputra *et al*. 2017). It is known that the development of gonad maturity levels can be related to the size of the fish, specifically the length at which the gonads initially become mature. This information can serve as a foundation for establishing regulations on the types of fishing gear permissible for use in floodplain areas. Additionally, this information can also be used as a basis for population management and fishing management in Floodplain Lubuk Lampam. To fully support these endeavors, it is crucial to gather information about the reproductive behavior of Striped Snakehead in the Lubuk Lampam Floodplain. Ideally, this information should be comprehensive and thorough. Hence, conducting research on the reproductive patterns of Striped Snakehead (*Channa striata*) is imperative as a fundamental step in managing Striped Snakehead populations in the Floodplain of Lubuk Lampam, South Sumatra.

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The studies conducted in this study covered various aspects of fish reproduction, including sex ratio, gonadal maturity level, gonadal maturity index, size at first maturity (Lm), spawning season, spawning type, spawning site and reproductive potential. The data obtained from this research study can serve as a foundation for the management of striped snakehead fish in the floodplain. The purpose of this study was to study the reproductive biology of Striped Snakehead (*Channa striata*, Bloch, 1793) in the Floodplain of Lubuk Lampam, South Sumatra.

MATERIALS AND METHODS

Location and Time of Research

The research was conducted in the Lubuk Lampam Floodplain, situated within the Ogan Komering Ilir Regency of South Sumatra Province. The process of fish sampling extended over a span of five months, ranging from December 2022 to April 2023. Fish sampling stations were established in four distinct floodplain types within Lubuk Lampam, including: 1) Lebak kumpei type; 2) Rawang; 3) Lebung; 4) River.

The field observation procedure involved several steps. Initially, the length and weight of the sampled fish were measured. Subsequently, the fish were dissected using a dissecting set. This surgical procedure aimed to determine the sex and assess the maturity level of the fish's gonads. The method of determination is detailed in Table 1 and Table 2 for reference. Both male and female snakehead gonads were weighed using digital scales with a precision of 0.001 g. Subsequently, the gonads of female Striped Snakehead were placed into sample bottles, preserved with a 4% formalin solution, and labeled for identification and storage.

Table 1. Gonadal maturity level (GML) of female Striped Snakehead based on morphological characters (Efendie (1979); Karmon (2011)).

GML	Description
I	In young fish, the gonads resemble a pair of thread-like structures extending along the lateral sides of the peritoneal cavity towards the front. They exhibit a transparent color and possess a smooth surface
II	As they mature, the gonads become larger, exhibiting a yellowish-white coloration. At this stage, individual eggs cannot be discerned with the naked eye of the fish.
III	In adult fish, the gonads occupy nearly half of the peritoneal cavity. At this stage, the eggs become visible to the naked eye, appearing as fine grains. Additionally, the color of the gonads shifts to a greenish-yellow hue.
IV	The peritoneal cavity is predominantly occupied by fully mature gonads that have a brownish and very dark appearance. In comparison to GML III, it is evident that the eggs of GML IV are larger in size.

Table 2. Gonadal maturity level (GML) of male Striped Snakehead based on morphological characters (Efendie (1979); Karmon (2011)).

GML	Description
I	The gonads are in the form of a pair of threads, but they are notably shorter than the ovaries of female fish at the same developmental stage. They are also transparent in color.
II	The gonads are milky white in color and look larger than the first-grade gonads.

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III	Gonads occupy almost half of the peritoneal cavity, displaying a milky white color and taking up the majority of the peritoneum.
IV	The gonads are larger and denser, milky white in color and fill most of the peritoneum

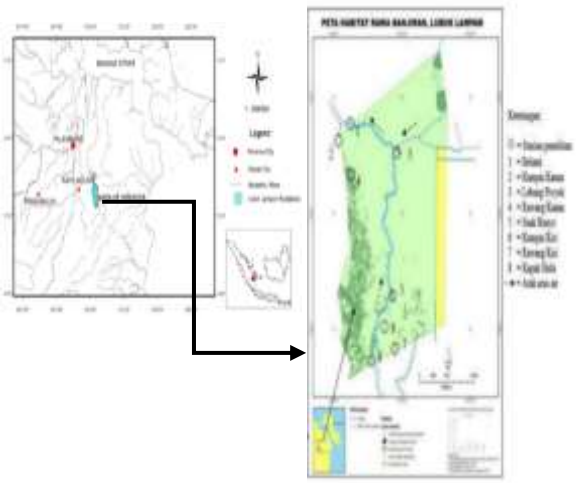

Figure 1. Map of the striped Snakehead Fish Research Area (*Channa striata,* Bloch, 1793) in Lubuk Lampam, South Sumatra.

Laboratory Analysis

Laboratory examinations involve the assessment of parameters such as fecundity and egg diameter. Fecundity observations were carried out on 53 GML IV female Striped Snakehead. The gonad weight of the GML IV female Striped Snakehead was taken 10% of the total gonad weight in the anterior, middle and posterior parts, then the number of eggs was counted to determine the value of fecundity.

A total of 53 gonad samples were collected from female cork fish at Gonadal Maturity Level (GML) IV, and their fecundity values were computed. Subsequently, the diameter of the eggs was measured as part of the study. From each gonad sample, 150 eggs were taken, with 50 eggs taken from each of the anterior, middle, and posterior sections. This resulted in a total of 7,950 eggs whose diameters were observed in the study. Egg diameter was measured under a microscope equipped with an ocular micro-meter. The measured egg diameter is the longest recorded size. The acquired data is initially transformed by multiplying it by a conversion factor of 0.025.

Fish Sampling

Taking fish samples can represent the biological conditions of Striped Snakehead in Floodplain Lubuk Lampam. The collection of fish samples was carried out using the Simple Random Sampling Technique (PCAS) with an interval of one month. The sample fish were obtained from fishermen's catches using various types of fishing gear (multifishing gear), both selective and non-selective fishing gear. Fish samples obtained from fishermen were alive, then grouped based on station and time.

Data analysis

• Sex ratio

According to Steel & Torrie (1980) in Karmon (2011), sex ratio can be calculated using the formula:

$$X=J/B$$

Description =
X = Sex ratio
J = Number of male fish (tail)
B = Number of female fish (tail)

- **Spawning Season**

Spawning season can be determined by plotting the Gonad Maturity Level (GML) and Gonad Maturity Index (GMI) values. To determine the percentage analysis for each Gonad Maturity Level (% GML) using the formula employed by Wudneh. (1998):

$$MSi\% = \frac{MS}{\sum_{i=1}^{s} MSi} x\ 100$$

Description:
MSi % = percentage of gonad maturity at grade i

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MSi = number of gonadal mature fish at i level
$\sum_{i=1}^{s}$ MSi = number of fish from all stages of gonad maturity

To calculate the Gonad Maturity Index (GMI) and the proportion of the percentage of the number of fish for each level of gonadal maturity, the formula used by Wudneh (1998) and Bandpel, et al. (2011) was applied:

$$\text{GSI (GMI)\%} = \frac{\text{Bg}}{\text{Bt-Bg}} \text{ x } 100$$

Description:
GMI = Gonad Maturity index (%)
Bg = gonad weight (g)
Bt = fish weight (g)

- **Size at First Maturity of Gonads (Lm)**

Data analysis to determine the size at first maturity (Lm) was estimated using the Spearman-Karber method (Udupa, 1986). The formula used is as follows:
M = (Xk + X/Z) – (X, ∑pi)
The length range is estimated by the equation:

Antilog [m ± 1,96 $\sqrt{(var(m))}$]
Nilai var (m) = $(X)^2$ x ∑[(pixqi)/(ni – 1)]

Description:
Lm = the length of the fish when the gonads first mature is antilog m
m = log length of fish at first gonad maturity
Xk = log of the median length class for the last time the gonads matured

- **Reproductive Potential**

The reproductive potential of striped snakehead fish is based on its Fecundity value. In accordance with Efendie (1992), the total fecundity calculation involves the utilization of the gravimetric method. Initially, all gonads that contain eggs were air-dried. Subsequently, the weight of the entire dried gonads was measured, along with the weight of a portion of the dried gonads, using the following formula:

$$\text{F} = \left(\frac{G}{g}\right) \text{x n}$$

Description:
F = Total number of eggs contained in the gonads (fecundity)
G = gonad weight per fish
g = The weight of a section of the gonad (sample) for each individual fish
n = Quantity of eggs derived from the sampled portion of the gonad

- **Spawning Type**

Spawning type of Striped Snakehead (*Channa striata*) was determined using data on the diameter of the eggs.

- **Spawning Places**

The identification of spawning sites for Striped Snakehead was accomplished by assessing the number of fish with mature gonads (GML IV) captured and comparing this with the highest Gonadal Maturity Index (GMI) values among the sampling stations during the study. The station with the highest number of mature fish and the highest GMI value was considered as the spawning ground for Striped Snakehead in the Floodplain of Lubuk Lampam.

RESULTS AND DISCUSSION

Sex Ratio

The number of Striped Snakehead samples during the study was 284 consisting of 179 females and 105 males. The sex ratio of Striped Snakehead at GML IV was 1:1.7 (female). This comparison value shows that a fish population in a waters is not balanced. A ratio of 1:1.7 suggests a potential need for a higher number of females for successful spawning, even though it's possible that the Striped Snakehead group reproduces with a 1:1 sex ratio. The results of *Selviana et al.* (2020). pattern 1: 1 (Jacob.

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2015). Deviations in the sex ratio of the pattern (1:1) can arise from various factors which include differences in distribution, activity and movement of fish (Turkmen *et al*. 2002), male and female sexual turnover and variation in growth period, mortality and length of life Deviances from the 1:1 sex ratio pattern can result from various factors, including disparities in fish distribution, activity, and movement (Turkmen et al. 2002), turnover rates of male and female individuals, variations in growth periods, mortality rates, and lifespan lengths (Simanjuntak. 2007).

Other data showing a balanced sex ratio with a ratio of 1:1.14 reported by Makmur *et al*. (2003), 1:1.16 (Mian *et al*. 2017), 1:1.33 (Prased *et al*. 2011), 1:1.05 (Gogoi *et al.* 2016). The sex ratio data is essential for estimating the population equilibrium in water bodies.

Size at first maturity of gonads

Data regarding the level of gonad maturity, as correlated with the total length of the Striped Snakehead, is presented in Figure 2 and Figure 3. According to the calculations using the Spearman-Karber method based on the data from Figure 2 and Figure 3, it is determined that the size at which male Striped Snakehead gonads mature is approximately 29.30 cm, while the size at first maturity for female Striped Snakehead is approximately 28.5 cm. This data indicates that the size at which female Striped Snakehead's gonads mature is smaller than that of the male Striped Snakehead. Prianto (2015) noted that the gonad maturity size typically occurs at a faster rate in female fish compared to male fish. The rate of maturity in female fish is believed to be closely associated with environmental factors in the Floodplain of Lubuk Lampam.

In a separate study conducted by Selviana *et al*. (2020) on Striped Snakehead in the Floodplain of the Sebangau River, it was found that the size of first gonad maturity for female Striped Snakehead was 27.5 cm, while for male Striped Snakehead, it was 32.17 cm. As reported by Irhamsyah *et al.* (2018), in their research conducted in the Upper South River of Central Kalimantan, they found that female Striped Snakehead first matured at a size of 27.8 cm, while male Striped Snakehead matured at 32.3 cm. The size at first maturity (Lm) for female Striped Snakehead in Sempor Reservoir is 28.5 cm while for male Striped Snakehead, it is 30.5 cm. (Purnawan, 2021). According to Karmon (2011), in their research conducted in the Musi Swamp Watershed, the size of the first gonad maturity for male Striped Snakehead was 24.4 cm, while for female Striped Snakehead, it was 27.7 cm

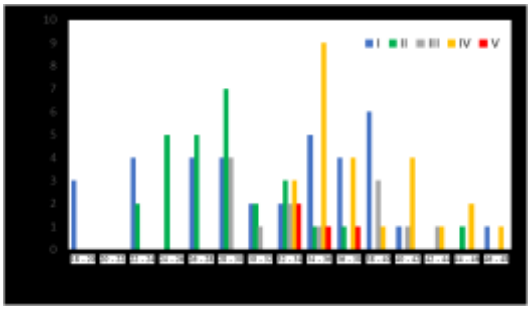

Figure 2. Gonadal maturity level (GML) of male fish.

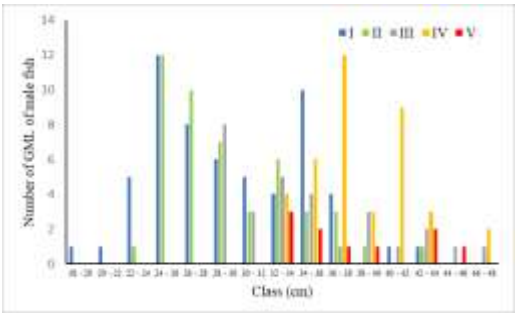

Figure 3. Gonadal maturity level (GML) of female fish

Spawning Season

The data regarding the gonadal maturity levels of male and female Striped Snakehead, categorized by the month of observation, can be observed in

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Figure 4. Meanwhile, data on the average GMI of male and female Striped Snakehead categorized by the month of observation, can be observed in Figure 5. Based on Figure 4, it is evident that GML IV (gonad maturity level) for both male and female Striped Snakehead is most frequently observed in December and January. Similarly, Figure 5 indicates that the average Gonad Maturity Index (GMI) falls within the range of 7.52% to 9.3% for females and 3.05% to 4.22% for males. The gonad maturity level of Striped Snakehead (GML I – GML V) is always obtained every month, this indicates that Striped Snakehead can spawn throughout the year (Figure 4). According to Tamsil (2016), the consistent presence of fish at GML V every month not only suggests that these fish are capable of spawning on a monthly basis but also indicates that spawning occurs throughout the year.

In December, the highest Gonad Maturity Index (GMI) values were recorded for female Striped Snakehead at 9.3% and for male Striped Snakehead at 4.22%. In contrast, GMI values for the other months exhibited relatively fluctuating patterns. Based on GML IV and GMI data (Figures 4 and 5) for both male and female Striped Snakehead, it is suspected that the spawning season for Striped Snakehead occurs in December - January and peaks in December when the rainy season begins. According to Selviana *et al*. (2020), the peak of the Striped Snakehead spawning in the Sebangau River Floodplain flow occurs in October (rainy). Makmur & Prasetyo (2006), Striped Snakehead fish the waters of the Sambujur River sanctuary spawn all year round with spawning peaks in the rainy season, namely October - December and have GMI values ranging from 0.01 - 4.83%. Based on Prianto *et al.* (2015), most of the fish in flooded swamps spawn during the rainy season. According to Welcome (1985), in tropical river ecosystems, the prime time for spawning in most fish species occurs during periods of river water overflow or flooding. Additionally, Lagler (1972) noted that fluctuations in water levels can influence and potentially trigger fish reproduction. Furthermore, there is an increased availability of food as the fish and other creatures that serve as the Striped Snakehead's prey also thrive and reproduce.

Based on findings from another study by Puspaningdah (2014) concerning the Gonadal Maturity Level (GML) of Striped Snakehead in Rawa Pening, it was observed that both female and male Striped Snakehead were predominantly in GML II, with a gonadal maturity index ranging from 0.04% to 4.32% for females and 0.06% to 0.29% for males.

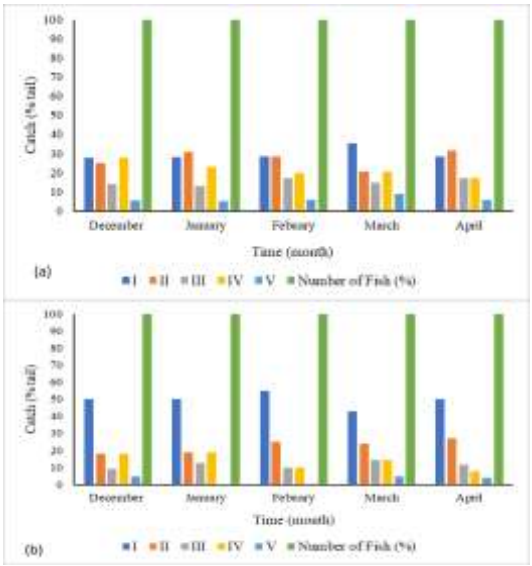

Figure 4. Gonad Maturity Level (GML) of Striped Snakehead (a) female and (b) male based on the month of observation.

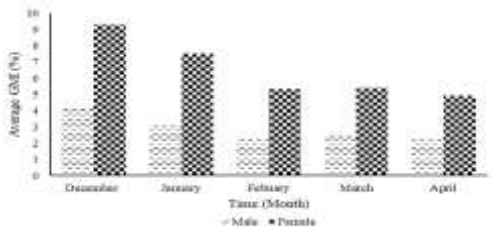

Figure 5. Average Male and Female GMI

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Spawning Place

Figure 6 presents the data illustrating the gonadal maturity levels of both male and female Striped Snakehead at each station. The research data depicted in Figure 6 shows that the spawning grounds for Striped Snakehead are located at the lebung station in the upper reaches of the Floodplain Lubuk Lampam. At this particular location, there is a significant presence of mature male and female Striped Snakehead in gonads

According to Figure 6, it's evident that there were only a small number of Striped Snakehead observed at the River Station and Floodplain Station that had reached gonadal maturity. According to Selviana *et al*, (2020), said that Striped Snakehead is not suitable for living in current and shallow waters.

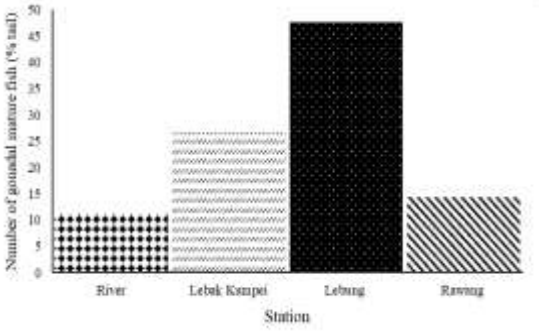

Figure 6. Number of Gonad Ripe Striped Snakehead (GML IV) at each Observation Station

Spawning Type of Snakehead Fish

Data on the distribution of egg diameter values are presented in Figure 7. The egg diameter data collected in this research aligns with the egg diameter of Striped Snakehead found in the Sambujur River reserve, which falls within the average range of 0.65 to 0.75 mm, as reported by Makmur and Prasetyo (2006). This measurement is larger than the findings of Selviana et al. (2020), who reported an average egg diameter of 0.55 mm for Striped Snakehead eggs in the Sebangau River Floodplain. Saikia's research in 2013 obtained an average egg diameter of 0.34 mm.

According to Figure 7, the egg diameter for GML IV cork fish was 35.53% in the range of 0.75 to 0.85 mm and 28.04% in the range of 0.53 to 0.63 mm. Based on the grouping, the graph displays a notable dispersion with two distinct peaks, indicating that the Striped Snakehead in the Floodplain of Lubuk Lampam exhibited a pattern of partial spawning or a prolonged spawning pattern. As stated by Susilawati (2012), fish displaying a partial spawning pattern have a lengthy spawning period, often spanning several days. This is evident from the presence of various sizes of eggs in their ovaries. Fish that exhibit a partial spawning pattern typically belong to a category of fish with relatively large egg diameters. (Kartamihardja (2014).

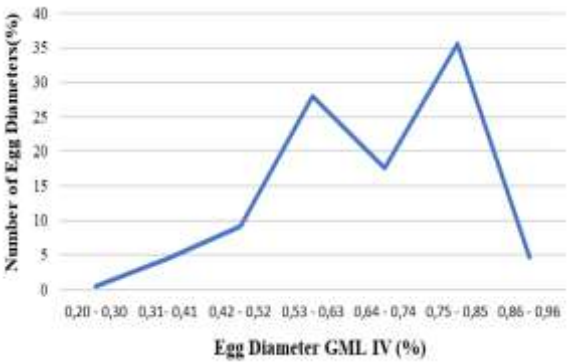

Figure 7. Distribution of Striped Snakehead Egg Diameters by Size Group

Reproductive Potential

The fecundity values observed in this study for Striped Snakehead ranged from 5,859 to 30,321 eggs. (Table 3). The fluctuating fecundity of Striped Snakehead in this study may be attributed to the variability in the age of the fish sampled. Generally, younger fish that are spawning for the first time tend to have lower fecundity compared to relatively older fish that have experienced multiple spawning events. Furthermore, fluctuations in fecundity can also attributed to by differences in the size of the collected fish as larger fish typically

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have a higher fecundity compared to smaller ones.

The research conducted by Sangedighi and Umnoumoh (2011) reported a fecundity range of 1,813 to 18,195 eggs for Striped Snakehead. Ferdausi *et al.* (2015) discovered that the highest fecundity for C. striata was recorded in June, with 22,783 eggs, while the lowest fecundity was observed in September, with 6,158 eggs. Main *et al*. (2017) obtained fecundity ranging from 2,538 – 23,987 eggs. Selviana (2020) found a fecundity ranging from 4,341-35,507. Based on Harianti's research data (2013), the fecundity of Striped Snakehead in Lake Tempe, Wajo Regency ranges from 1,062 – 27,200 eggs. Based on the the findings of this study and literature data, it was revealed that the reproductive potential of Striped Snakehead in the Floadplain of Lubuk Lampam is quite high due to its considerably high fecundity value.

Table 3. Fecundity value of Striped Snakehead from December 2022 – April 2023.

Month	Number of Sampel (N)	Fecundity (eggs)	
		Range	Average
December	6	7.235 – 8.833	8.034
January	8	5.686 – 14.889	9.171
Febuary	8	2.859 – 10.191	5.322
March	9	4.992 – 30.321	10.612
April	7	3.845 – 7.179	5.629

CONCLUSION

Striped Snakehead (*Channa striata*) in the Floodplain of Lubuk Lampam, South Sumatra, has a sex ratio of 1:1.7 (females). The size at first maturity of female Striped Snakehead is 28.5 cm and male Striped Snakehead is 29.30 cm. The peak spawning season for Striped Snakehead occurs in December coinciding with the onset of the rainy season. The spawning area for Striped Snakehead is located at the lebung station in the upper sections of the Floodplain Lubuk Lampam. The Striped Snakehead exhibits a partial spawning pattern, characterized by an extended duration of the spawning process. Striped Snakehead has a fairly high reproductive potential with fecundity ranging from 5,859 – 30,321 eggs.

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REFERENCES

Andrie, M., Sihombing, D. 2017. Efektivitas Sedian Salep yang Mengandung Ekstrak Ikan Gabus (*Channa striata*) Pada Proses Penyembuhan Luka Akut pada Stadium II Terbuka Pada Tikus Jantan Galur Wistar. https://scholarhub.ui.ac.id/psr/vol4/iss2/4/ ; https://doi.org/10.7454/psr.v4i2.3602.

Ath-thar, M.H.F., Gustiano, R., Kusmini, I.I., Prakoso, V.A. dan Putri, F.P. 2017. Induksi hormonal maturasi ikan gabus (*Channa striata)*. *Jurnal Riset Akuakultur*, 12, pp. 9-20.

Bandpei, A., M.A.M. M aghhor. S.H., Abdulmaleki, H., Najafpour and

p-ISSN 1829 586X
e-ISSN 2581-0170

A.A. Janbaz. 2011. The Environmental Effect on Spawning Time Length at Maturity and Fecundity of Kutum (*Rutilus frisii kutum*, Kamensky, 1901) in Southem Part of Caspian Sea, Iran. *Iranica Journal of Energy and Environment*, 2(4): 374-381.

Effendi, M.I. 1979. *Metode Biologi Perikanan*. Bogor: Yayasan Dewi Sri.

Effendi, M.I. 1992. *Metode Biologi Perikanan*. Edisi Revisi. Bogor: Yayasan Dewi Sri.

Ferduasi, Jannatul, H, Chandra, R.N., Jannatul, F.M., Amzad, H.M., Mehedi, H.M., Das, T.B., Sohel, M., Igbal, Mahbub, M., Bodrul, M.M., Hossain, Mosarof, M. 2015. Reproductive Biology of Striped Snakehead (*Channa striata*) from Natural Wetlands of Sylhet, Bangladesh. *Journal Avas*. 2(6): 162-169.

Gogoi, N., Hazarika, L.P., Biswas, S.P. 2016. Studies on the Reproductive Biology and Captive Breeding of *Channa aurantimaculata*, an Endemic Fish from Assam. *Journal of Environmental Biology*. 37(3):369-374.

Gustiano, R., Ath-thar, M.H. F., Kusmini. I.I. 2019. Diversiti, Biologi Reproduksi dan Manajemen Induk Ikan Gabus (Bogor: IPB Press) p 104.

Harianti. 2013. Fekunditas dan Diameter Telur Ikan (*Channa striata* Bloch, 1793) di Danau Tempe, Kabupaten Wajo. *Jurnal Saintek Perikanan*. 8(2): 18-24.

Iqbal 2004. Invetarisasi Daerah Penting Bagi Ikan di Sumatera Selatan

Iqbal. 2011. Ikan-ikan di hutan rawa gambut Merang-Kepayang.

Iqbal et al. 2018. Ikan-ikan di Sungai Musi dan pesisir timur Sumatera Selatan.

Iqbal et al. 2020. Ikan-ikan Air Tawar Sembilang Dangku

Irhamsyah dan Agustiana 2018. Bio-Fishing Technique Study of Snakehead (Channa striata) in Swamp Water. *Prosiding Seminar Nasional Lingkungan Lahan Basah*. Volume 3 Nomor 1 Halaman 287-292.

Jacob PK. 2015. Studies on Some Aspects of Reproduction of female *Anabas Testudineus* (Bloch). Departen of Marine Biology, Microbiology and Bioloy. Cochin University of Science and Teknology India. Thesis. P.261.

Karmon. 2011. Pertumbuhan dan Reproduksi Ikan Gabus *(Channa striata);* Kaitannya dengan Kondisi Habitat Rawa Banjiran Daerah Aliran Sungai (DAS) Musi Sumatera Selatan. Tesis. Bogor (ID): Institut Pertanian Bogor.

Kartamihardja, E.S. 2014. Biologi reproduksi populasi ikan gabus (*Channa striata)* di Waduk Kedungombo. *Jurnal Penelitian Perikanan Darat*. 12(2): 113-119.

Lagler, K.F. 1972. *Freshwater Fishery Biology*. Dubuque: Second Edition. W. M.C. Brown Company Publishers.

p-ISSN 1829 586X
e-ISSN 2581-0170

Makmur, 2003. *Biologi Reproduksi dan Pertumbuhan Ikan Gabus (Channa striata Bloch 1793) di Daerah Banjiran Sungai Musi Sumatera Selatan*. Tesis. Institut Pertanian Bogor. 59 hal.

Makmur S, Prasetyo D. 2006. Kebiasaan Makan Tingkat Kematangan Gonad dan Fekunditas Ikan Haruan (*Channa striata* Bloch, 1793) Di Suaka Perikanan Sungai Sambujur DAS Barito Kalimantan Selatan. *Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia*. 13(1): 27–31.

Mian, S., Hossain, M.A., Shah, A.W. 2017. Sex Ratio, Fecundity and Gonado Somatic Index of Spotted Snakehead, *Channa punctatus* (Channidae) from a Lentic Ecosystem. Poland. *Journal of Fisheries and Aquatic Studies*. 5(1): 360-363.

Mudjiatami, E. 2015. *Naskah Akademik Ikan gabus haruan* (*Channa striata* Bloch 1793) Hasil Domestikasi. Balai Perikanan Budidaya Air Tawar Mandiangin. Hal 6-7.

Nofriyanti, Sinata, N., Mistawati, A. 2020. Formulasi Dan Uji Aktivitas Emulgel Minyak Ikan Gabus (*Channa striata*) Sebagai Penyembuh Luka Bakar. https://bestjournal.untad.ac.id/index.php/Galenika

Olurin, K.B., Savage, O.D. 2011. Reproductive Biology, Length-Weight Relationship and Condition Factor of The Affrican Snake Head, *Parachanna obscura*, from River Oshun, South-west Nigeria. *Journal of Fisheries and Aquaculture*. 3(8): 146-150.

Puspaningdiah, 2014. Aspek Biology Ikan Gabus (*Ophiocephalus striatus*) di Perairan Rawa Pening, Kaabupaten Semarang. Ponerogo *Journal of Maquares Management of Aquatic Resources*.3(4):75-82.

Prased, L., Arvind, K., Dwivedi, Vineet, K., Dubey, Serajuddin, M. 2011. Reproductive Biology of Freswater Murrel, *Channa punctatus* (Bloch, 1793) from River Varuna (A tributary of Ganga River) in India. *Journal Ecophysiol Occup*. 63(3):69-80.

Prianto, E., 2015. Aspek Reproduksi dan Dinamika Larva Ikan Sebagai Dasar Pengelolaan Sumberdaya Ikan di Paparan Banjran Lubuk Lampam Provinsi Sumatera Selatan. Sekolah Pascasarjana Institut Pertanian Bogor. Disertasi. 120 hal.

Purnawan. 2021. Aspek Biologi Reproduksi Ikan Gabus (*Channa striata* Bloch, 1973) di Waduk Sempor Kebumen. Sekolah Pascaserjana Universitas Sudirman Purwakerto Jawa Tengah. *Tesis* 80 hal.

Rahayu, G.K., Solihin, D.D., Nursila, A. 2021. Keragaman populasi ikan gabus, *Channa striata* (Bloch, 1793) dari Bekasi, Jawa Barat dan Barito Kuala, Kalimantan Selatan menggunakan gen Cytochrome B. *Jurnal Iktiologi Indonesia* 21(1): 61-73 DOI: https://dx.doi.org/10.32491/jii.v21i1.552.

Saikia, A.K., Abujam, S., Biswas, S.P. 2013. Reproductive Biology of Channa punctatus (Bloch) from Paddy Field of Sivasagar, Assam.

p-ISSN 1829 586X
e-ISSN 2581-0170

Journal of Current Research. 5(5): 542-546.

Sangedighi, Umoumoh I.A. 2011. Some Aspect of The Reproductive Biology of African Snakehead-*Parachanna obscura* in Itu-Cross River System, Nigerian *Journal of Agriculture, Food and Environment*. 7(4): 19-30.

Saputra, A., Ath-thar, M.F.F., Samsudin, R., Putri, F.P., Prakoso, V.A. 2017. Biologi Reproduksi Ikan Gabus (*Channa striata* Bloch, 1973) di Bogor dan Bekasi, Jawa Barat. *Jurnal Ilmu Hayati. LIPI*. Volume 16 Nomor 3, Desember 2017. Hal 309-314.

Selviana, E., Affandi, R., Kamal, M.M. 2020. Aspek Reproduksi Ikan Gabus (*Channa sriata*) di Rawa Banjiran Aliran Sungai Sebangau, Palangkaraya. *Jurnal Ilmu Pertanian Indonesia (JIPI*), Januari 2020. Vol. 25 (1): 10–18.

Simanjuntak CPH. 2007. Reproduksi Ikan Selais, *Ompok hypopthalmus* (Bleeker) Berkaitan Dengan Perubahan Hidromorfologi Perairan di Rawa Banjiran Sungai Kampar Kiri. Tesis. Bogor. Program Pascasarjana. Institut Pertanian Bogor.

Susilawati, R. 2012. Aspek Biologi Reproduksi, Makanan dan Pola pertumbuhan Ikan Biji Nangka (*Upeneus moluccensis* Blkr) di Perairan Teluk Labuan, Jawa Barat. Tesis Program Pascasarjana. Institut Pertanian Bogor.

Tamsil, A. 2016. Studi Beberapa Karakteristik Reproduksi Prapemijahan dan Kemungkinan Pemijahan Buatan Ikan Bungo (*Glossogobius aureus*) di Danau Tempe dan Danau Sindereng Sulawesi Selatan. Disertasi Program Pascasarjana Institut Pertanian Bogor.

Turkmen M, Erdogan O., Yildirim A., Akhyurt I. 2002. Reproductive tactics, age and Growth of *Capoeta capoeta* umla Heckel 1843 from the Askale Region of the Karasu River, Turkey, *Journal Fish Res* 54:317-328.

Udupa, K.S. 1986. Statistical Method of Estimating the Size at First Maturity in Fishes. Fishbyte. 4(2): 8–10.

Welcomme, R.L. 1985. River Fisheries.United Nations, No. Report no. 262, Rome, Italy.

Widyastuti, Y.R., Prihardi T.H., Taufik, I., Pamungkas, B.A., Das, S.K. 2017. Ecological Intensification: A New Paragon for Sustainable Aquaculture. IOP Conf. Series: Earth and Environmental Science 521 (2020) 012017. doi:10.1088/1755-1315/521/1/012017: 1- 6.

Wudneh, T. 1998. Biology and Management of fish stocks in Bahir Dar Gulf, Lake Tana, Ethopia. PhD Thesis, fish Culture and fisheries group Wageningen Institute of Animal Sciense. Wageningen Agriculture University Netherlands. 144 p

p-ISSN 1829 586X
e-ISSN 2581-0170