Breeding striped snakehead (*Channa striata*) using the concrete tank method in the Cangkringan Area, Special Region of Yogyakarta

Kurniawan Wahyu Hidayat and Dwi Amelia

Polytechnic of Marine and Fisheries Pangandaran.

The striped snakehead (*Channa striata*) is a species of swamp fish that has a high economic value. To fulfill the increasing demand for striped snakeheads, the intensity of the capture of this fish in the wild has also increased. Intensive fishing has reduced the wild populations of striped snakehead.

In Indonesia, especially in Sumatra, Kalimantan, and Java, the striped snakehead has many uses, both economically and for health purposes. Initially, the striped snakehead was known as a pest or predator that feeds on small fish living in freshwater and brackish water such as in swamps or channels. Today, the striped snakehead is known as a food fish and an ornamental fish.

The striped snakehead is a nutritious species that can be utilised as a source of antioxidants and contains around 25.2 g of protein per 100 g of flesh.

Efforts to domesticate the striped snakehead from the wild in a controlled environment (aquaculture) have been conducted. The striped snakehead can live in waters poor in oxygen. This is advantageous in the culture of striped snakeheads.

In China, the striped snakehead has been cultured in large numbers using styrofoam boxes for spawning with a male to female ratio of 1:1. The fertilised eggs are then transferred to concrete ponds filled with zooplankton. After the hatchlings are 3-5 cm long, they are fed pellets.

Having biological and economic advantages, the striped snakehead is suitable for breeding and producing seed that are ready to be released to the wild as an effort to conserve fish resources and increase the natural population. In addition, striped snakehead seed from hatcheries can be used in controlled aquaculture businesses.

Below we describe a protocol we used for controlled spawning and hatchery operations for striped snakehead.

Fish fecundity is determined using the gravimetric method with the following equation:

$$F = \frac{Bg}{Bs} \text{ x } Fs$$

Where:

F = Total number of eggs
Bg = Weight of the entire gonad (g)
Bs = Weight of a small part of the gonad (g)
Fs = The number of eggs in part of the gonad

Fecundity is related to the fish's body length and weight using regression analysis.

To determine the fertilisation rate of the fish eggs, the following equation is used:

$$FR\ (\%) = \frac{Po}{P} x100\%$$

Where:

FR = Egg fertilisation rate (%)
P = Number of egg samples
Po = Number of fertilised eggs

The hatching rate (HR) is affected by the egg movement, temperature change, light intensity, and dissolved oxygen. The equation used to calculate the hatching rate is:

$$HR = \frac{\text{The number of eggs hatched}}{\text{The number of eggs fertilised}} \text{ x } 100\%$$

Growth rate can be calculated using the following equation:

$$GR = \frac{Wt - Wo}{t}$$

Where:

GR = Growth rate (g/day)
Wt = Final average weight (g)
Wo = Initial average weight (g)
t = Maintenance duration (days)

The specific growth rate can be calculated using the following equation:

$$SGR = \frac{(\ln Wt - \ln Wo)}{t} \times 100\%$$

Where:

SGR = Percentage of average weight (% g/day)
Wt = Final average weight (g)
Wo = Initial average weight (g)
t = Maintenance duration (days)

The survival rate can be calculated using the following equation:

$$SR = \frac{Nt}{No} x100\%$$

SR = The fish's survival rate (%)
Nt = The number of fish at the end of the study (individuals)
No = The number of fish at the beginning of the study (individuals)

The breeding technique of striped snakehead included a few processes. Broodfish were maintained in a permanent pond of 3 x 3 x 1 m. Pond preparation prior to stocking included draining, cleaning, rinsing, and filling it with water. The pond was cleaned by brushing the walls and floor to dislodge dirt, algae, and feed debris on the pond walls.

The pond was filled with aquatic plants such as water hyacinths to emulate the fish's natural habitat. The broodfish released in the ponds were at least 8-12 months old and weighed 150-200 g/individual.

The process of producing high-quality striped snakehead seed begins with high-quality broodfish. One of the factors that affect broodfish quality is feed. The type of feed given to the striped snakehead broodfish was artificial feed in the shape of 4 mm pellets. The nutritional content of the feed for striped snakehead broodfish can be seen in Table 1.

The striped snakehead broodfish were fed twice a day, once in the morning at 8 AM and once in the afternoon at 3 PM. However, the feeding frequency in the semi-intensive and intensive culture systems is 4 - 6 times a day. This is done to provide a greater opportunity for the fish to feed at any time of the day, and thus ensure that their nutritional needs are always fulfilled.

Because maintaining feed quality is very important, feed must be stored properly. Properly stored feed will not easily get moldy. In Cangkringan, the fish feed was stored in a

feed warehouse. The feed sacks were neatly stacked using wooden boards as the base. This was done to prevent mold from growing on the feed, especially during the rainy season when the floor was damp. Feed must be stored in a dry condition with low moisture content (10-12%) to prevent the growth of mold. In the storage area, the feed sacks must be placed on a base to prevent direct contact with the floor. As a base, wooden girders of 10 x 10 cm size can be used at an interval of 10 – 20 cm. Wooden boards are then placed on the base to provide a space between the stack of feed sacks and the floor. If there are any damaged feed sacks, they must be placed on the outer part of the stack so that they are used first.

Another factor that influences fish survival is water quality. The water quality does not need to be checked daily; once a month is sufficient. However, the water needs to be monitored daily. The water quality parameters that need to be checked include the pH, temperature, salinity, and dissolved oxygen.

The results of the water quality parameter measurements in the broodfish striped snakehead raising ponds can be seen in Table 2.

Spawning ponds were prepared by draining and drying. The ponds need to be completely dried to minimise the presence of pests and diseases in the pond. After the ponds had been dried out, they were filled with water to the depth of 40 cm, planted with water hyacinth to provide a place for the striped snakehead eggs to attach and to emulate the fish's natural habitat, and had pieces of pipe were placed in them to provide a place for the fish to hide.

Selection of male and female broodfish is the determining factor of the spawning success because high-quality seed are produced by high-quality broodfish. The broodfish to be spawned were at least 10-12 months old and weighed at least 150-200 g/individual. The broodfish selected to be spawned were also healthy, with no wounds or defects, exhibited lively movements, and were gonad-mature.

In the wild, striped snakehead spawning occurs at the beginning of the rainy season. After the water level slowly rises, striped snakehead will spawn by building a nest near water hyacinths in the perimeter of shallow waters with a weak current. Striped snakehead spawning can occur 2-3 times in a single spawning season and even occurs at the end of the rainy season. Out of several reproductive parameters observed, it was found that the change in water depth had a strong correlation with the egg diameter.

Natural spawning was conducted in concrete ponds of 3 x 3 x 1 m^3 size. Before being placed in the pond, the male and female broodfish were weighed to determine the initial weight before spawning and final weight after spawning. The data for male and female broodfish weight before and after spawning can be seen in Table 3.

The natural striped snakehead spawning was done at a ratio of 1:1 based on the number of fish in each pond. After they were placed in the pond, the fish were left to spawn on their own. Once the eggs were laid, the broodfish were not immediately moved to the broodfish maintenance pond because striped snakeheads will look after their eggs until they hatch. Striped snakehead eggs float on the surface of the water, so to determine whether the fish have spawned, the ponds were monitored daily. Spawning occurs at night and begins with chasing between the male broodfish and the female broodfish. This is followed by the female broodfish turning around while releasing the eggs and at the same time the male releases its sperm. The process will be repeated several times until all the eggs are released. The following morning, the fertilised eggs will be translucent and the unfertilised eggs colored. The fertilised eggs will hatch in 48 hours with aeration.

Fecundity is the broodfish's ability to produce eggs based on the fish's weight. The method for determining the striped snakehead broodfish fecundity was by weighing the broodfish before and after the spawning and calculating the difference. After that, 100 eggs were collected as a sample, weighed, and the average calculated. The equation for calculating the fecundity of striped snakeheads can be seen below. Before spawning, the weight of the female fish was 640 g, after spawning it was 620 g, while the male's weight remained 500 g.

The female gonad weight : 20 g

$$F = \frac{\text{Gonad weight}}{\text{Average egg weight}}$$

$$F = \frac{20}{0.002}$$

= 10,000 eggs

So the fecundity of the striped snakehead was around 10,000 eggs.

Table 1. The nutritional content of broodfish feed.

Nutrient	Percentage(%)
Protein	44-46
Fat	Min 12.0
Crude fibre	Max 3.0
Ash	Max 15.0
Moisture	Max 11.0

Table 2. Water quality parameter measurements in the broodfish raising ponds.

Parameter	Result	Optimum range
Dissolved oxygen	2.8 ppm	>3 ppm
Temperature	29.9°C	26-28°C
pH	8.3	4-9

Table 3. Weight of male and female broodfish before and after spawning.

Broodfish	Before spawning (g)	After spawning (g)	Gonad weight (g)
Male	500	-	-
Female	660	640	20

Table 4. The characteristics of fertilised and unfertilised eggs.

Fertilised egg	Unfertilised egg
The egg cell begins to divide into two cells	The egg remains a single cell
The egg is bright yellow, and then the egg cell will divide	The egg is opaque white and dead
Two cells divide into four and so forth until the egg hatches	
The egg is translucent	

Table 5. The nutritional content of powdered feed.

Nutrient	Amount (%)
Protein (min)	43
Calcium (min-max)	1.5-2.5
Phosphorous (min-max)	1.5-2.0
Amino acids (min)	2.6
Total fat (min-max)	5-10

Source: feed packaging.

Table 6. The results of water quality measurements in the first stage nursery.

Parameter	Amount	Optimum range
Dissolved oxygen	2.4 ppm	2.0-3.7 ppm
Temperature (C)	30.50C	25.50 - 32.70
pH	8.3	4-9

The fecundity of each female individual depends on the age, size, species, and environmental condition (availability of feed, water temperature, and season). Fecundity is influenced by feed, fish size, and environmental condition, and could also be affected by egg diameter. Striped snakehead brood-fish weighed 60-640 g and had a fecundity of around 1,100-16,500 eggs and had a gonad weight range of 1.15-21.4 g.

After the fecundity was calculated, the egg fertilisation rate was calculated. For this, a sample of 100 striped snakehead eggs was collected randomly. From the sample collected, the number of fertilised eggs was 92 and the unfertilised eggs 8. Therefore, the number of fertilised eggs was estimated to be 9,200. The characteristics of fertilised and unfertilised eggs can be seen in Table 4.

Striped snakehead eggs were hatched in the 3 x 3 x 1 m spawning pond. The percentage of hatched eggs was 94%; therefore, the number of hatchlings was around 8,600. The fecundity of striped snakehead usually ranges between 1,000 and 57,000 eggs.

The survival rate of the larvae reared for one week was calculated by comparing the number of live fish larvae at the end of the rearing period to the number of the fish larvae that hatched. The calculation was done when the larvae were about to be released into the first stage nursery pond. The larvae harvesting was conducted in the morning by collecting the larvae using a fine scoop net and placing them in a bucket then counting the harvest results manually. The number of larvae harvested was 8,129 with an SR of 93.9%.

The purpose of the nursery is to raise the newly hatched striped snakehead larvae that have used up all their yolk in the yolk sac in ponds to obtain striped snakeheads that are ready to become prospective broodfish. The nursery phase is usually divided into two sub-phases: first stage nursery and second stage nursery.

The first stage nursery of the striped snakehead was conducted in a semi-permanent pond sized 10 x 5 m with a depth of 1.5 m. The first stage nursery medium preparation began with pond draining, application of lime, fertilisation, and refilling.

Feed management in the nursery phase is very important because it is needed to guarantee that the striped snake-heads receive adequate nutrients for their growth. On the first day, the larvae were not fed because they still have food stored as egg yolk. After two days, the larvae were given additional feed in the form of tubifex worms for two weeks, providing feed around the clock. The worms were first weighed and then observation was conducted to determine how many days it took to finish the worms to determine how many worms were needed by the striped snakehead larvae during the rearing period. After the larvae entered the color-change phase from yellow to black, they were fed powdered artificial feed and after 3 weeks, when the larvae became seed, they were fed pellets. Feeding additional artificial feed is difficult because striped snakeheads are predominantly carnivorous and require special treatment during feeding. The nutritional content of the powdered feed can be seen in Table 5.

The larvae were fed twice a day manually by sprinkling the feed around the periphery of the pond so that the feed was evenly distributed. The feed was given using the ad libitum method. Before the feed was given, it was first weighed to determine the amount of feed consumed daily and to reduce the possibility of wastage. The remaining feed was weighed afterward.

In the first nursery phase, the water quality was not checked daily but instead it was done once a month because striped snakehead can survive in less than optimum water conditions. The water quality parameters measured included dissolved oxygen, salinity, temperature, and pH. The results of the water quality measurements in the first stage nursery phase can be seen in Table 6.

Sampling was conducted to determine the average growth in terms of length and weight. Sampling was done once a week to determine the striped snakehead seed's growth. Samples were collected using a wooden lift net because this species is easily stressed, necessitating careful and gentle handling. The number of fish observed at each sampling was 10 individuals. The measurements taken were the weight using a digital scale and the total length using a ruler.

The larval growth rate in this study was 0.019 g/day. This was higher than the results in the study by Astria et al. (2013) which was 0.0063-0.0072 g/day

The specific growth rate (SGR) or specific daily growth rate is defined as the change in the fish's weight, size, and volume. The SGR during this study was 15%.

In the cultured of striped snakeheads in ponds, the main source of pests in the nursery ponds is the water source which may bring in wild fish, freshwater mussels and crabs, whereas pests that come from land are snakes and frogs. To prevent the entry of fish and crabs when filling the ponds with water, a filter was fastened to the pond inlet. There were no special treatments for pests; they were removed manually during harvest.

The first stage nursery activity lasted 45 days with an initial stock of 8,129 hatchlings. After the seed were 45 days old, they were harvested and moved to the second stage nursery to grow into fingerlings. The harvest was conducted in the morning by draining the water in the pond. The striped snakehead seed were then herded toward the pond outlet. The seed in the outlet were quickly collected using a fine-meshed scoop net and placed in a bucket.

The total harvest of the striped snakeheads from first nursery was 3,112, which means the survival rate of the seed was 38%, which was suspected to reflect a degree of cannibalism.