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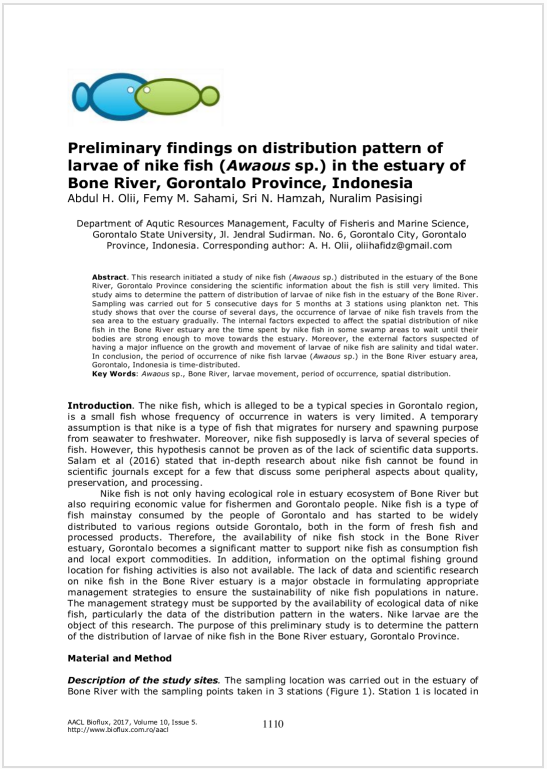

Preliminary findings on distribution pattern of larvae of nike fish (*Awaous* sp.) in the estuary of Bone River, Gorontalo Province, Indonesia

Abdul H. Olii, Femy M. Sahami, Sri N. Hamzah, Nuralim Pasisingi

Department of Aqutic Resources Management, Faculty of Fisheris and Marine Science, Gorontalo State University, Jl. Jendral Sudirman. No. 6, Gorontalo City, Gorontalo Province, Indonesia. Corresponding author: A. H. Olii, oliihafidz@gmail.com

Abstract. This research initiated a study of nike fish (*Awaous* sp.) distributed in the estuary of the Bone River, Gorontalo Province considering the scientific information about the fish is still very limited. This study aims to determine the pattern of distribution of larvae of nike fish in the estuary of the Bone River. Sampling was carried out for 5 consecutive days for 5 months at 3 stations using plankton net. This study shows that over the course of several days, the occurrence of larvae of nike fish travels from the sea area to the estuary gradually. The internal factors expected to affect the spatial distribution of nike fish in the Bone River estuary are the time spent by nike fish in some swamp areas to wait until their bodies are strong enough to move towards the estuary. Moreover, the external factors suspected of having a major influence on the growth and movement of larvae of nike fish are salinity and tidal water. In conclusion, the period of occurrence of nike fish larvae (*Awaous* sp.) in the Bone River estuary area, Gorontalo, Indonesia is time-distributed.
Key Words: *Awaous* sp., Bone River, larvae movement, period of occurrence, spatial distribution.

Introduction. The nike fish, which is alleged to be a typical species in Gorontalo region, is a small fish whose frequency of occurrence in waters is very limited. A temporary assumption is that nike is a type of fish that migrates for nursery and spawning purpose from seawater to freshwater. Moreover, nike fish supposedly is larva of several species of fish. However, this hypothesis cannot be proven as of the lack of scientific data supports. Salam et al (2016) stated that in-depth research about nike fish cannot be found in scientific journals except for a few that discuss some peripheral aspects about quality, preservation, and processing.

Nike fish is not only having ecological role in estuary ecosystem of Bone River but also requiring economic value for fishermen and Gorontalo people. Nike fish is a type of fish mainstay consumed by the people of Gorontalo and has started to be widely distributed to various regions outside Gorontalo, both in the form of fresh fish and processed products. Therefore, the availability of nike fish stock in the Bone River estuary, Gorontalo becomes a significant matter to support nike fish as consumption fish and local export commodities. In addition, information on the optimal fishing ground location for fishing activities is also not available. The lack of data and scientific research on nike fish in the Bone River estuary is a major obstacle in formulating appropriate management strategies to ensure the sustainability of nike fish populations in nature. The management strategy must be supported by the availability of ecological data of nike fish, particularly the data of the distribution pattern in the waters. Nike larvae are the object of this research. The purpose of this preliminary study is to determine the pattern of the distribution of larvae of nike fish in the Bone River estuary, Gorontalo Province.

Material and Method

Description of the study sites. The sampling location was carried out in the estuary of Bone River with the sampling points taken in 3 stations (Figure 1). Station 1 is located in

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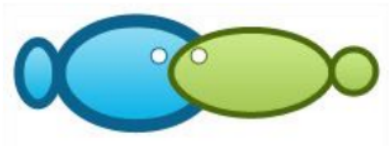

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Material and Method

Description of the study sites. The sampling location was carried out in the estuary of Bone River with the sampling points taken in 3 stations (Figure 1). Station 1 is located in

the coastal area, administrative area of North Leato Village (00°30'52.284"N and 123° 003'39.919"E), station 2 is located in the mouth of the river, administrative area of Talumolo Sub-district (00°30'05.124" N and 123°003'57.469" E), and station 3 is located in the river body, administrative area of Pabean Village (00°31'35.850" N and 123°003' 53.295" E).

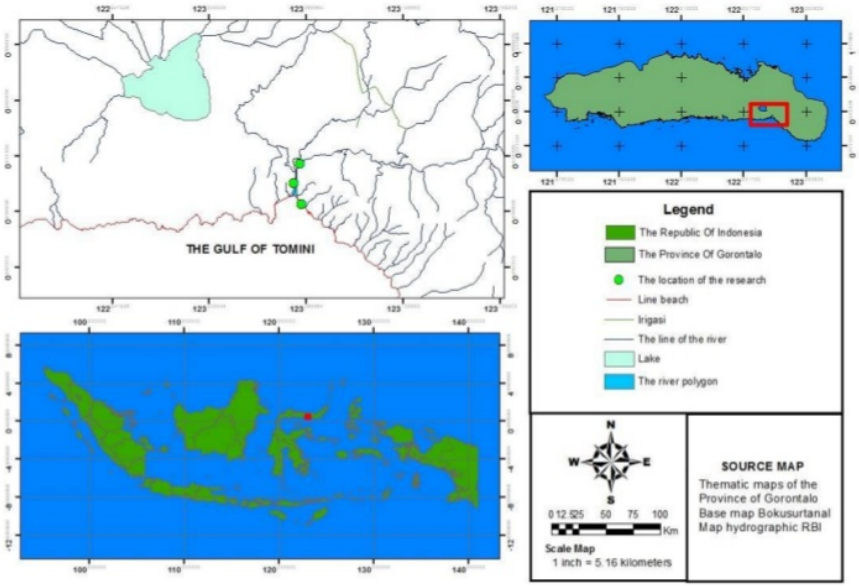

Figure 1. Map of the study area showing the locations of stations: station 1 in coastal area, station 2 in estuary area, station 3 in river area.

Larvae sampling. The study was conducted for three months (March, April, and May 2017) to obtain samples of larvae and five months (March, April, May, June and July 2017) to observe the appearance of nike fish larvae in water, where sampling for five consecutive days in each month with the consideration that nike fish appear in the waters only at the beginning of the month. Nike fish larva was collected using plankton net (diameter of mouth opening 20 cm, length 50 cm). Sampling process was done by means of embedded net at a depth of 1 meter and silenced for 15 minutes and then pulled vertically.

Data analysis. The number of fish caught is identified, calculated and the data obtained is compiled in the data sheet to be analyzed descriptively. Interviews with fishermen conducting nike fishing were also conducted to support information on the distribution of nike fish in the estuary of Bone River.

Results

General description of nike fish larvae in the Bone-River estuary. Nike fish larva in the waters cannot always be caught by fishermen yet only once a month during the year due to the limitation of its presence in the waters. Based on information obtained through interviews with local fishermen, nike fish larvae appear only once a month for approximately 5 days at the beginning of the new lunar-month and then the fish disappear in the waters until the next lunar-month. Nike fish larvae welded together in a thin membrane packet which, when it encountered sea water, would split and the larvae spread in the waters for several days.

Nike fish larvae are caught by traditional fishermen once in every month in the confluence of freshwater and marine waters in the estuary of the Bone River. According to information from fishermen, nike fish larvae are found in the waters during the new lunar-month, and the time of fishing activity is often through at night. Sukimin (2008) mentions that the catch of nike fish larvae by fishermen around Bone River day by day is very abundant and fishing activity is at the beginning of lunar-month. After the fifth day of the lunar-month larvae of nike fish are no longer found in the waters both in the sea and estuary.

Sero, cone-shaped webs or pockets with open net mouths using frames made of bamboo or rattan or metal, is the main fishing gear used to catch nike fish using the help of lamps placed on a boat. Nike fish larvae caught are generally small, 1-2 cm in length, with transparent body color.

The research (unpublished research) conducted by a team of researchers from the Faculty of Fisheries and Marine Science, Gorontalo State University, Gorontalo City, Indonesia in September-November 2015 on observation of length growth and behavior of larvae of nike fish from the Estuary of Bone River in a container of maintenance showed that the increase of larval length of nike fish since 60 days of maintenance has not changed much. Nike fish larvae make only one or two movements, and generally more silent at the bottom of the container. Nike fish larvae while on the surface of the water often make a jumping motion. Figure 2 shows the larvae of the nike fish larvae maintained in a container.

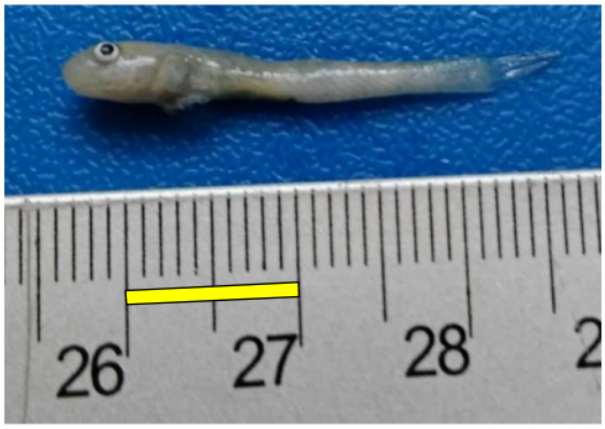

Figure 2. Nike fish larvae (=1 cm).

Abundance and distribution of nike fish larvae (Awaous sp.) in the Bone-River estuary. Data on the distribution of nike fish larvae abundance for 5 days observation for 3 months (March, April, May 2017) showed various data. The abundance of individuals in the Bone River estuary was highest observed in March, while the lowest abundance was observed in April.

Based on data in March (Figure 3), the highest occurrence of nike fish larvae was found to be in the station 1 on the first day of observation with an abundance value of nearly 250 individuals. The lowest abundance was found at station 2 on the fourth observation day with the number of less than 40 individuals, even some stations on a certain observation day found no larvae of nike fish in the waters.

Figure 3 also shows varying information regarding the emergence and abundance of nike fish larvae in the waters. Observations at station 1, nike fish larvae were found only on the first day and the second day of the observation. The emergence of fish at station 2 is only found on the third and fourth day, with an abundance of less than 50 individuals. Furthermore at Station 3, the larvae of nike fish appear only on the fourth and fifth day observations with an abundance of less than 40 individuals. On the fifth

day, the larvae of nike fish were found only in station 3 with an abundance of less than 40 individuals and were not found in the other two stations.

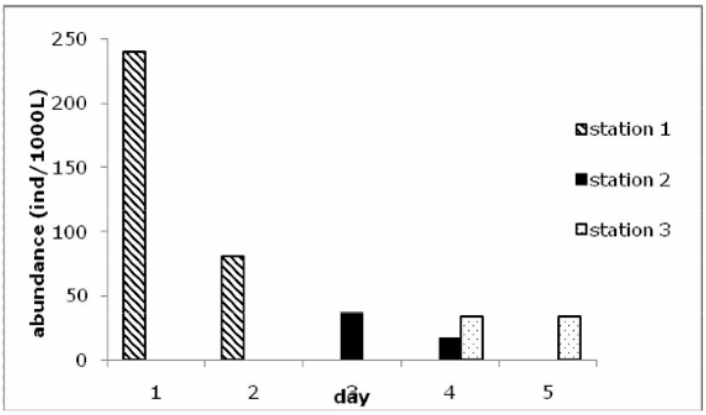

Figure 3. Distribution of larvae of *Awaous* sp. during March.

Observations in April (Figure 4) show that the highest abundance of larvae of nike fish is found at station 3 on the fourth day with an abundance of 45 individuals, while the lowest abundance is at station 2 on the fourth observation day with an abundance of 5 individuals.

Based on the emergence of fish in waters in April, it can be seen from Figure 4 that the larvae of nike fish on the first and second day were distributed only at station 1, whereas at the third day of observation, the larvae were found scattered at stations 1 and 2 with the number of fish at station 2 lower than the number of fish larvae found at station 1. On observation of the fourth day, the larvae of the nike fish were not found at station 1, but appear at stations 2 and 3. In this fourth day observation, the abundance of nike fish larvae was higher in station 3 compared to the abundance of larvae at station 2, 6 and 44 individuals respectively for stations 2 and 3. As for the fifth day of observation, in all water stations, there were no nike fish larvae.

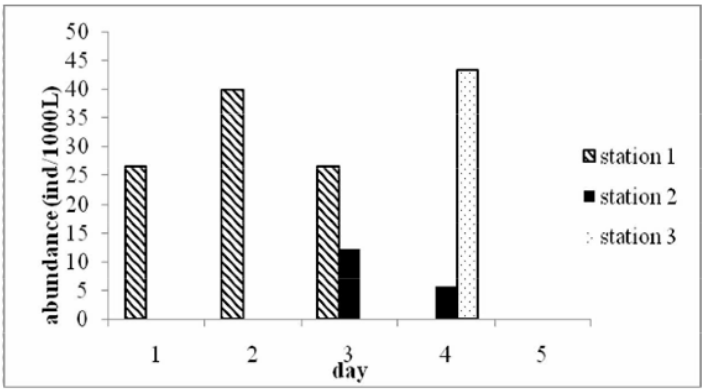

Figure 4. Distribution of larva of *Awaous* sp. during April.

The abundance of nike fish larvae in the Bone River estuary during the five days of observation in May indicated in Figure 5, reaching 84 individuals. Based on the period of occurrence in the waters, the nike larvae, on the first and second day were found only in station 1. On the third day observations, the nike larvae were found in two stations: stations 1 and 2 with an abundance of less than 40 individuals. Further on the fourth day observation, the only nike larvae found distributed at stations 2 and 3 with abundance

values at each station were 6 and 84 individuals, respectively. On the fifth day of observation at all stations, no nike fish larvae were found in the waters.

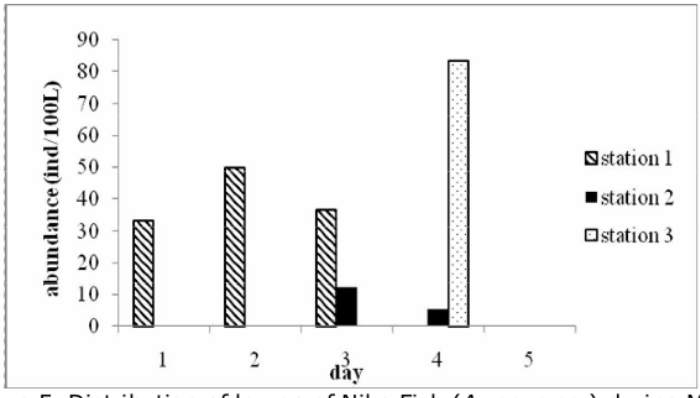

Figure 5. Distribution of larvae of Nike Fish (*Awaous* sp.) during May.

The occurrence of nike fish larvae in the Bone River estuary in 3 sampling stations in 5 days observation for 3 months showed a uniformly tendentious pattern. Based on the average abundance data for 3 months observation found the trend that the larvae on the first and second day only appeared in station 1 next on the third day abundance at station 1 decreased and fish larvae also appeared in station 2. On the fourth day, larvae of nike fish no longer found in station 1, but found in stations 2 and 3 with the larvae abundance at station 2 decreased compared to this of the previous observation day. On this fourth day, the larvae of nike fish appeared at station 3 with relatively having a high abundance. Further on the fifth day, the number of larvae abundance which were found only in station 3 was lower compared to the abundance of the previous day, even in April and May, no nike fish larvae were found in the waters

In general, information on the pattern of the occurrence period of nike fish larvae in Bone River estuary at 3 stations which has different salinity condition during 5 days observation for five months is presented in the Figures 6, 7, and 8.

In March and April, the larvae of nike fish were not seen on several days at station 1, then on the fourth and fifth day the larvae appeared at stations 2 and 3. This was allegedly because the spawning process was not maximized followed by environmental changes ahead of the change season from west to east season. Communities call the phenomenon of non-occurrence of larvae of nike fish in waters as "nike not so". The same situation also occurred in May and June, where no nike larvae were found for several days at some certain stations.

The pattern of occurrence of nike fish larvae was very different in July. Visible on station 1 occurrence of nike larvae occurred from the first day until fifth day. Based on observations, the occurrence of larvae of nike fish in this month occurred around 10 p.m Furthermore, at station 2 the nike fish larvae were not found and at station 3. They were found only on the fifth day. This phenomenon is supposedly influenced by the pattern of the west season followed by the high tide of the river so that nike fish larvae cannot reach the estuary. In addition, the very high catching activity in the coastal region occurred this month. The existence of the nike fish larvae on the fifth day at station 3 is suspected of being a very complicated journey. After that nike is no longer visible in the territorial waters of the estuary and coastal.

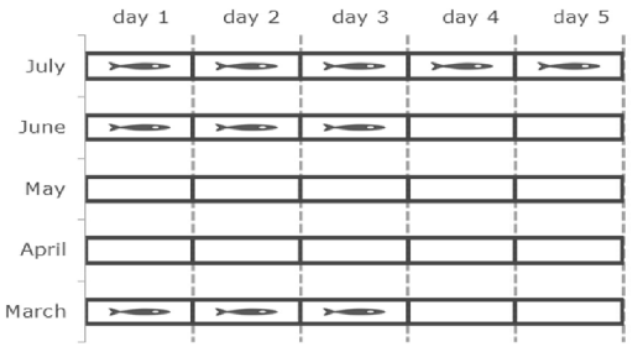

Figure 6. The pattern of existence of nike fish larvae for 5 days 1 during 5 months at station 1 (Sea Area).

Notes:

: Nike fish larvae appear in the water;
: Nike fish larvae do not appear in the water.

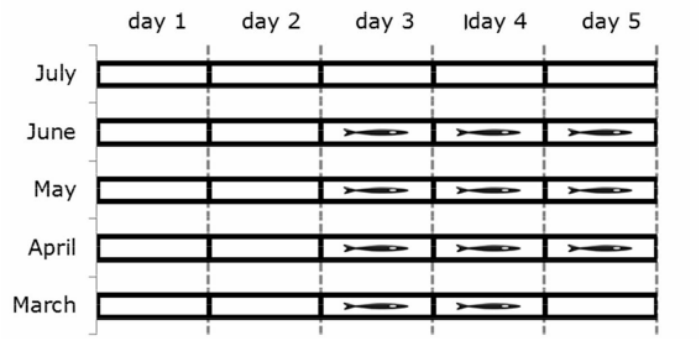

Figure 7. The pattern of existence of *Awaous* sp. larvae for 5 days during 5 months at station 2 (Estuary Area).

Notes:

: Nike fish larvae appear in the water;
: Nike fish larvae do not appear in the water.

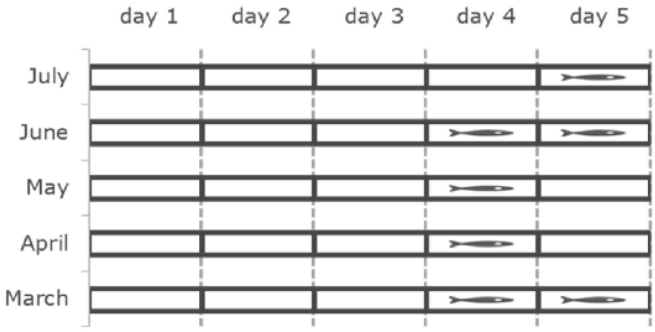

Figure 8. The pattern of existence of *Awaous* sp. larvae for 5 days during 5 months at station 3 (River Area).

Notes:

: Nike fish larvae appear in the water;
: Nike fish larvae do not appear in the water.

Discussion. Small-sized fish found in the waters of the Bone River estuary called nike by the Gorontalo people are larvae of the *Awaous* sp. species. *Awaous* is a genus of fish from Gobidae family belonging to amphidromous fish (Yamasaki et al 2011). Freshwater gobies of tropical islands are amphidromous (Lagarde et al 2017). Amphidromy is a diadromous life history pattern where fish spawn in freshwater, and their larvae drift downstream to the sea; the larvae mature in marine environments then wander back in rivers to grow and reproduce (Pezold et al 2016; Iida et al 2017). In tropical rivers, amphidromous fish species are the immense contributor to the diversity of communities in system (Tabouret et al 2014; Lejeune et al 2016).

In this study, the larvae of nike fish were suspected to migrate for several days. The suspicion of this phenomenon is supported by the observation data of fish emergence in Figures 6, 7, and 8 which show a gradual shifting pattern from the sea area (station 1) to the direction of the river (station 3). The duration of the movement of the nike larvae to the spawning areas in the upper reaches of the Bone River lasts for approximately five days in the new lunar-month by night-time. Larvae of amphidromous fishes spawned in freshwater streams on Okinawa Island fright to drift soon after hatching at dusk and complete their exit from freshwater areas into the estuary and sea by midnight (Maeda & Tachihara 2010).

The five-day period is the prone time experienced by the nike fish larval population due to very high pressures derived from environmental and human factors. In *Awaous stamineus*, successful dispersal can enhance both the individual fitness and population persistence, but the process of dispersal is often inherently risky (Hogan et al 2014). Nike fish larvae require high energy to make adaptation efforts to changes in water salinity as a migration path area. The high salinity appears to require more energy for larval osmoregulation, resulting in the acceleration of yolk depletion and reduced growth of the notochord. Increasing the osmoregulation cost during the yolk-sac stage resulted in the faster induction of a state of starvation. Seawater is considered to have an adverse effect on the survival of newly hatched larvae, as it lowers the efficiency of foraging and predator avoidance due to an energetic tradeoff (Iguchi & Takeshima 2011). Amphidromous migrations conferred both of these risks and advantages. Amphidromous species run risks of dispersion and expatriation while at sea and, with that, difficulties in returning to freshwater habitats (McDowall 2007). Amphidromous gobies living in the rivers of tropical islands display a high continuous reproductive effort in response to environmental unpredictability (Teichert et al 2015). In addition, fishing activities that occurred in this 5-day period also threaten the survival and availability of nike fish in nature.

In adult phase, nike fish suspected spawn in the upstream area, then their larvae are thought to be drifting into the estuary area of the Bone River and Tomini Bay. Furthermore, in the larval phase they will return to the freshwater to become mature again. This phenomenon is supported by Larson (2001) which said that in *Awaous*, the adults breed in freshwater with the larvae being swept down to the sea, whereupon post-larvae and juveniles migrate upstream some months later.

Internal factors suspected to affect the spatial distribution of nike fish in the Bone River estuary are the time spent by nike fish in some swamp areas to wait until their bodies are strong enough to move towards the estuary. Physical changes, especially in some *Awaous* species, tend to occur when these fish move from the river to the estuary (Larson 2001). The study on morphological changes of amphidromous goby larvae, *Sicyopterus lagocephalus* reveals that in sea water, larvae remain in a vertical position, their head is oriented downwards, and keep on migrating up and down alternatively. However, they also progressively spend more time horizontally (i.e. up to 50% of their time), after their mouth opens, showing the sudden accelerations in their swimming behavior (Ellien et al 2016).

The phase change of fish from eggs, larvae and juveniles as well as the direction of fish movement in the waters is determined by some external factors derived from the aquatic environment. In this study, two major environmental factors suspected of having a major influence on the growth and movement of larvae of nike fish are salinity and tidal water.

Observation of location condition of study indicates that at the time of estuary of Bone River tend to flat, hence influence of sea water is not far, so fresh water tends to accumulate well and dominates estuary of Bone River so give influence far enough (reach 100 km toward the sea) to salinity of estuary. Low salinity water acts as a trigger of metamorphosis as well as a guide line for migrating nike fish to the upper area.

Tides are also suspected to be another major factor contributing to the distribution pattern of larvae of nike fish in the waters of the Bone River estuary. Larva use tides as a means of transport to successfully enter the river, a behavior known as selective tidal stream transport (STST) as the mechanism by which a fish ascends into the direction of the column and the transporting tide is in the direction and descends to the bottom to maintain its position in the opposing tidal current (Huisman et al 2016). This naturally occurring mechanism is thought to aid the movement of nike fish in the waters. This phenomenon takes place in the estuary where mixing currents occur. When there is no STST behavior mechanism, nike fish larvae will bounce deep into the sea and even die from exhaustion.

Conclusions. To sum up, the period of occurrence of nike fish larvae (*Awaous* sp.) in the Bone River estuary area, Gorontalo is time-distributed. Gradually, for five days, the appearance of larva emerges in the sea (station 1) and move towards the estuary (station 2) then to river area (station 3). The duration of the movement of the nike larvae to the spawning areas in the upper reaches of the Bone River lasts for approximately five days in the new lunar-month by night-time. Moreover, the five-day period is the prone time experienced by the nike fish larval population due to very high pressures derived from environmental and human factors.

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Authors:
Abdul Hafidz Olii, Department of Aquatic Resources Management, Gorontalo State University, Jl. Jendral Sudirman, No.6, 96128, Gorontalo City, Indonesia, e-mail: oliihafidz@gmail.com
Femy M. Sahami, Department of Aquatic Resources Management, Gorontalo State University, Jl. Jendral Sudirman, No.6, 96128, Gorontalo City, Indonesia, e-mail: femysahami@yahoo.co.id
Sri Nuryatin Hamzah, Department of Aquatic Resources Management, Gorontalo State University, Jl. Jendral Sudirman, No.6, 96128, Gorontalo City, Indonesia, e-mail: ieen_ers@yahoo.com
Nuralim Pasisingi, Department of Aquatic Resources Management, Gorontalo State University, Jl. Jendral Sudirman, No.6, 96128, Gorontalo City, Indonesia, e-mail: pasisinginuralim@gmail.com

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