Advances in Tropical Biodiversity and Environmental Sciences
7(3): 87-92, October, 2023
e-ISSN:2622-0628
DOI: 10.24843/ATBES.2023.v07.i03.p01
Available online at: https://ojs.unud.ac.id/index.php/ATBES/article/view/231

Relationship Between Length and Weight and Habitat Conditions of Several Fish Species in Tondano Lake, Minahasa, North Sulawesi

Rosenta Sipayung, Helen Joan Lawalata, Iriani Setyawati*, Livana Dethris Rawung, and Rievo Handry Djarang

Departement of Biology, Faculty of Mathematics, natural and Earth Science, Universitas Negeri Manado
South Tondano, Minahasa, North Sulawesi, Indonesia
*Corresponding author: irianisetyawati@unima.ac.id

Abstract. The snake-head gudgeon or payangka fish (*Ophieleotris aporos*), tilapia fish or mujair (*Oreochromis mossambicus),* and marble goby or betutu fish (*Oxyeleotris marmorata*) are economically important fish in Lake Tondano. However, numerous community activities can disrupt aquatic biodiversity, declining Lake Tondano environmental conditions, and other factors. This study aimed to determine the relationship between length and weight and the habitat conditions of *Ophieleotris aporos*, *Oreochromis mossambicus*, and *Oxyeleotris marmorata*. The method used in this study was purposive sampling with research stations located at Remboken (station 1), Kakas (station 2), and Tondano Estuary (station 3). Sampling was carried out 5 times in every 10 days. The weight and length of the fishes caught in Lake Tondano were 2-60 g and 1-8 cm (*Ophieleotris aporos*); 9-180 g and 6-25.5 cm (*Oreochromis mossambicus*); and 16-30 g and 2.6-26.5 cm (*Oxyeletotris marmorata*), all of them have an allometric growth pattern. *Oreochromis mossambicus* is the most commonly caught fish in all research stations. The research station with the best level of water fertility is Remboken Station. The habitat characteristic of Lake Tondano was 25-29^{0}C of water temperature; brightness of 1.34-2.66 m; depth of 4.23-11.8 m; pH of 6.7-7.8; and dissolved oxygen of 2.27-6.31 mg/L, which still supports the well-being of the fish.

Keywords: allometric**;** fish length; fish weight; habitat; Lake Tondano.

I. INTRODUCTION

Lake Tondano is the upper reaches of the Tondano River. It is the largest lake in North Sulawesi Province. Geographically, the Lake Tondano watershed is located between 10º6'06"-01º20'25"N (north latitude) and 124º45'04"-124º58'20" E (east longitude) extending from south to north, and located in Minahasa Regency [1].

The snake-head gudgeon or payangka fish (*Ophieleotris aporos*) is a type of fish found in Lake Tondano. This fish belongs to the Eleotridae family and is an economically important fish in Lake Tondano. Tilapia fish or mujair (*Oreochromis mossambicus)* easily live and breed in various conditions such as water conditions with high salt content and low salinity levels. Marble goby or betutu fish (*Oxyeleotris marmorata*) has the characteristics of an elongated body, a cylindrical front, and a flat back; total length 5-6 times the body height; flat head, length of the body ⅓-¼ of total length; tapered muzzle; the lower jaw is more forward than the upper jaw; the teeth consist of several rows, the outer row being larger in size; some of the teeth resemble tusks (no obvious canines) [1].

This study aimed to determine the differences in length and body weight of *Ophieleotris aporos, Oreochromis mossambicus,* and *Oxyeleotris marmorata* as well as habitat conditions in the waters of Lake Tondano, Minahasa, North Sulawesi.

II. METHOD

This research was conducted in Lake Tondano, Minahasa, North Sulawesi, from December 2022 to January 2023. Fish and sediment samples were obtained from the three stations (Figure 1). Station 1 (Remboken) is located at N 01°13.958'E 124°52.266', which is a hot spring, fishing, and tourism area (Sumaru Endo). Station 2 (Kakas) is located at N 01°11.836'E 124°52.223' and is an area of rice fields, fishing, and many aquatic plants such as water hyacinth and hydrilla with a sandy mud bottom. Station 3 (Tondano estuary) is located at S01°16.833'E 124°54.769', there is a lot of bamboo stuck into the water to dispel the water hyacinth from covering the Tondano estuary.

Advances in Tropical Biodiversity and Environmental Sciences 7(3): 87-92, October, 2023 e-ISSN:2622-0628
DOI: 10.24843/ATBES.2023.v07.i03.p01 Available online at:
https://ojs.unud.ac.id/index.php/ATBES/article/view/23188

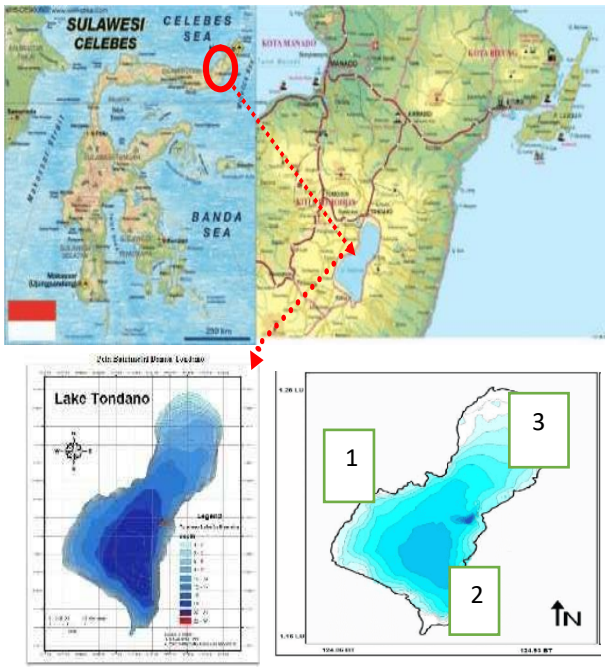

Fig. 1. Map of research sites: North Sulawesi Province at Sulawesi island (top-left); North Minahasa district (top-right); Tondano Lake (bottom); sampling stations (bottom-right) namely 1. Remboken, 2. Kakas, and 3. Tondano estuary.

Research Methods

The methods used in this research were purposive sampling and survey-exploratory methods by selecting certain areas as stations. The purposive sampling method is a deliberate sampling technique in accordance with the required sample requirements. The survey-explorative method is collecting data and information on a primary and secondary basis.

Research Procedure

Parameters of Fish Length and Weight

Fish caught were measured for total length (mm) and weight (g) using a ruler and digital scales with an accuracy of 0.1 mm and 0.01 grams. Fish samples were documented with the camera facing left. Measurement of the total length of the fish is measured by the distance between the leading edge of the head and the rear caudal end [2].

Habitat Condition Parameters

Physical and chemical parameters of water observed on-site at each station include current, temperature, pH, brightness, and dissolved oxygen. The current was measured using a floating draught, temperature was measured using a digital thermometer, and pH was measured using a pH meter. Brightness was measured using a Secchi disk and dissolved oxygen was measured using a DO (Dissolved Oxygen) Meter.

III. RESULTS AND DISCUSSION

The Number of Fish Caught in Lake Tondano

The number of fish caught in Lake Tondano at five sampling times, with a period of 10 days can be seen in Figure 2. The number of *Ophieleotris aporos*, caught in each sampling ranged from 1-12 individuals. Most *Oreocromis mossambicus* were found at the Remboken station (2-12 individuals) from sampling 4.

Oxyeleotris marmorata was rarely found during fishing and was not even found at the estuary station in the 2nd, 4th, and 5th sampling, and the last one that is found the least is *Oxyeletotris marmorata*. These results were slightly different from research in 2016 where the composition of the number of fish caught in Lake Tondano with the highest number was *Ophieleotris aporos*, then *Oxyeleotris marmorata* and the least was *Oreochromis mossambicus* [1].

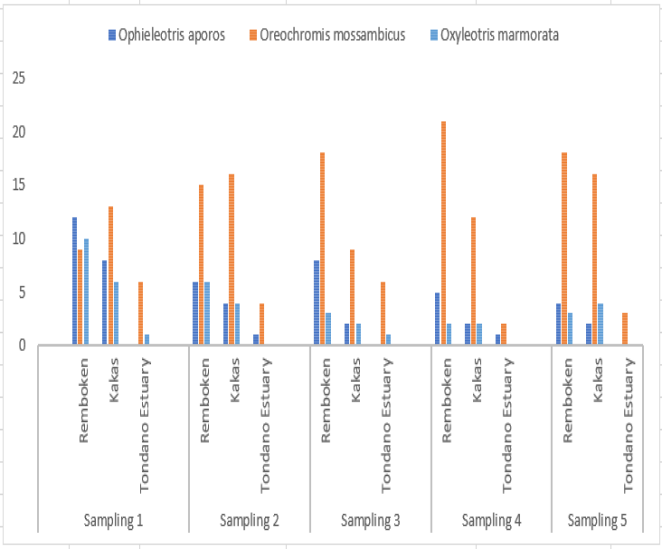

Fig. 2. Number of Catches of Fish at Each Station.

Oreochromis mossambicus is the most commonly caught fish due to the large number of cages from fishermen who raise *Oreochromis mossambicus* around the research site. Their eggs kept in cages can get out into the waters of the lake. These eggs then grow and develop so that the number of these species increases.

The many *Oreochromis mossambicus* around Lake Tondano are caused by many community activities, namely agriculture in the form of rice fields. The remaining fertilizer from the rice fields flows into Lake Tondano and makes many *Oreochromis mossambicus* around Lake Tondano.

Ophieleotris aporos have the ability to survive in competition with other fish which are very tough and even dominate local fish. This is due to the ability of the

TABLE 1.
WEIGHT, TOTAL LENGTH AND GROWTH PATTERN OF LAKE TONDANO FISH (*Ophieleotris aporos*, *Oreochromis mossambicus*, AND *Oxyeletotris marmorata*).

Fish Species	Times	Station	N	Weight (g)	Length (cm)	Growth Patterns
Ophieleotris aporos	Sampling 1	1	12	10 – 60	11,7 – 17,3	Allometric
		2	8	10 – 40	6 – 12	Allometric
		3	0	0	0	–
	Sampling 2	1	6	5 – 21	2,5 – 12	Allometric
		2	4	5 – 11	2,5 – 7	Allometric
		3	1	3	3,2	Allometric
	Sampling 3	1	8	8 – 16	2,4 – 7	Allometric
		2	2	2 – 10	1 – 6	Allometric
		3	0	0	0	–
	Sampling 4	1	5	10 – 18	6,5 – 18	Allometric
		2	2	10 – 16	4 – 12	Allometric
		3	1	9	3,6	Allometric
	Sampling 5	1	4	10 – 12	6,5 – 12	Allometric
		2	2	10 – 12	6,4 – 11	Allometric
		3	0	0	0	–
Oreochromis mossambicus	Sampling 1	1	9	29 – 172	11,7 – 17,3	Allometric
		2	13	20 – 120	6 – 12	Allometric
		3	6	22 – 120	12 – 18	Allometric
	Sampling 2	1	15	31 – 180	12,3 – 24,2	Allometric
		2	16	29 – 155	13,5 – 20	Allometric
		3	4	21 – 85	12 – 24	Allometric
	Sampling 3	1	18	20 – 115	13 – 22,5	Allometric
		2	9	29 – 40	12,4 – 24,5	Allometric
		3	6	20 – 22	12 – 14,5	Allometric
	Sampling 4	1	21	30 – 145	13,5 – 25,5	Allometric
		2	12	15 – 32	9,8 – 18	Allometric
		3	2	16 – 21	12,4 – 15,2	Allometric
	Sampling 5	1	18	26 – 110	13 – 21,2	Allometric
		2	16	18 – 87	13 – 19,4	Allometric
		3	3	9 – 16	10,2 – 13,5	Allometric
Oxyeletotris marmorata	Sampling 1	1	10	20 – 25	12,8 – 26,5	Allometric
		2	6	20 – 24	3,2 – 24,5	Allometric
		3	1	22	6,5	Allometric
	Sampling 2	1	6	20 – 30	2,6 – 12	Allometric
		2	4	20 – 24	6,2 – 13	Allometric
		3	0	0	0	–
	Sampling 3	1	3	18 – 22	4,3 – 8,3	Allometric
		2	2	18 – 20	12,5 – 17,3	Allometric
		3	1	20	2,16	Allometric
	Sampling 4	1	2	20 – 24	5,5 – 6,5	Allometric
		2	2	20 – 23	5,7 – 10,2	Allometric
		3	0	0	0	–
	Sampling 5	1	3	16 – 25	2,6 – 6,3	Allometric
		2	4	20 – 22	4,4 – 8,2	Allometric
		3	0	0	0	–

Ophieleotris aporos to survive, due to the wide variety of their food [1]. However, several things can threaten the life of the *Ophieleotris aporos*, including environmental degradation of Lake Tondano, and the introduction of foreign species and exotic species that have the same niches, for example, food similarities and other bioecological needs as well as predatory species. Another thing that has the most influence is that every spawning season, the local people compete to catch the *Ophieleotris aporos* fry, known as nike fish, because of their soft flesh and delicious taste. This has caused a decrease in the *Ophieleotris aporos* population since 2016, compared to the *Oreochromis mossambicus* [1].

The lowest number of *Oxyeleotris marmorata* caught is due to their habitat, which always lives on the bottom of the lake so only a few are caught when caught using nets. All species of fish are caught at least at the Tondano estuary station because there are no cages around the Tondano estuary, and also there are community activities that can interfere with the growth and development of fish species, including washing clothes and fishing.

The Relationship between the Fish Length and Weight

The results of the regression analysis and the graph of the relationship between the length and weight of the *Ophieleotris aporos*, which has a regression equation of $y= -0.0083x^2+0.748x+0.6412$ with a coefficient of

Advances in Tropical Biodiversity and Environmental Sciences 7(3): 87-92, October, 2023 e-ISSN:2622-0628
DOI: 10.24843/ATBES.2023.v07.i03.p01 Available online at:
https://ojs.unud.ac.id/index.php/ATBES/article/view/23190

determination of R^2 = 0.7564. This means that 75.6% of the body weight gain of *Ophieleotris aporos*, occurs due to the increase in the body length of the fish, while 24.4% of the fish weight gain is caused by other factors such as environmental factors and age (Figure 3).

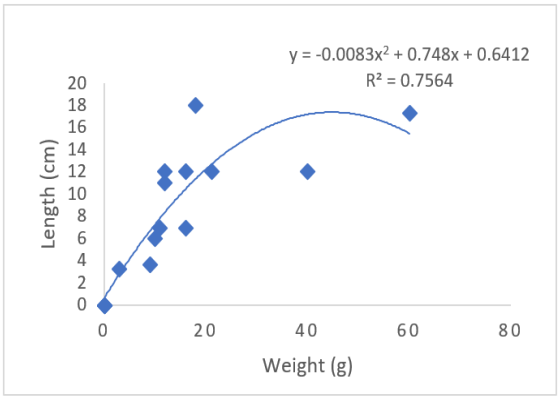

Fig. 3. Relationship of length and weight of *Ophieleotris aporos* at all stations.

Figure 4 shows the regression analysis results and the graph relationship between the length and weight of *Oreochromis mossambicus* has a regression equation y = 2.4166 + 8.9525 with a coefficient of determination R2 = 0.2211. This means that 2.21% of *Oreochromis mossambicus* body weight gain occurs due to the increase in body length of the fish, while 97.7% of fish weight gain is caused by other factors such as environmental factors and age.

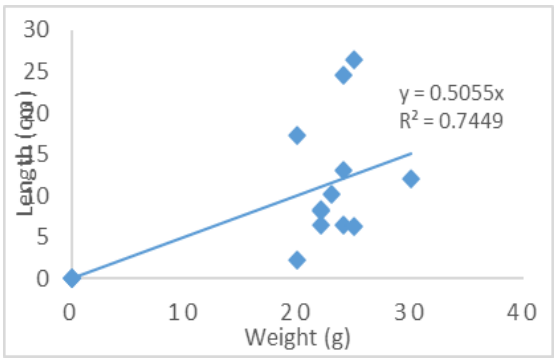

Fig. 4. Relationship of length and weight of *Oreochromis mossambicus* at all stations.

Figure 5 shows the results of the regression analysis and the graph of the relationship between the length and weight of the *Oxyeleotris marmorata* which has a regression equation of y = 0.5055× with a coefficient of determination of R2 = 0.3866. This means that 38.6% of the increase in body weight of the *Oxyeleotris marmorata* occurs due to the increase in body length of the fish, while 61.4% of the increase in fish weight is caused by other factors such as environmental factors and age [3].

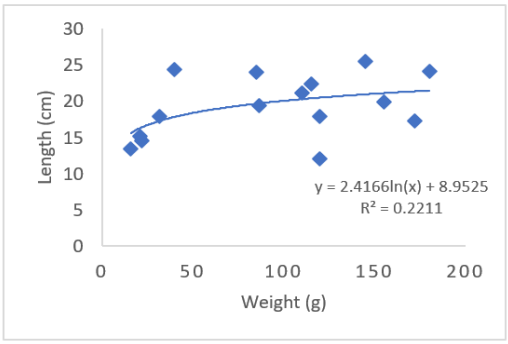

Fig. 5. Relationship of length and weight of *Oxyeleotris marmorata* at all stations.

The growth patterns of *Ophieleotris aporos*, *Oreochromis mossambicus*, and *Oxyeleotris marmorata* in Lake Tondano are an allometric pattern, or the growth in length and weight is not the same or unbalanced. This value will affect the length and weight of the fish, the pattern of fish growth can change depending on environmental conditions. *Ophieleotris aporos*, *Oreochromis mossambicus*, and *Oxyeleotris marmorata* have allometric growth characteristics, meaning that the length of the fish increases faster or slower than the growth of body weight [3].

Differences in growth patterns are not only due to differences in the level of fish maturity, there are also differences in seasons and water fertility levels related to the abundance and type of food available [4]. *Ophieleotris aporos* have a high reproductive ability. This fish can reproduce throughout the year. The peak of reproduction occurs in June, September, and December, with an average egg production of around 30,000-60,000 eggs per head.

Based on BPPPU research [1], food for *Ophieleotris aporos*, and *Oxyeleotris marmorata* are small shrimp still abundant in Lake Tondano's waters. These shrimp live in shallow waters in littoral areas with aquatic plants. The shrimp population is highly dependent on the presence of aquatic plants such as water hyacinth, hydrilla, and other species, this also has a major effect on the population of *Ophieleotris aporos*, *Oxyeleotris marmorata*, and other fish in Lake Tondano. While young *Oreochromis mossambicus* eat plankton or small animals, as adults, tilapia will eat moss, leaves, small insects, worms, or small fish. There are differences in each season and the availability of different food is obtained for each station which causes *Ophieleotris aporos*, *Oreochromis mossambicus*, and *Oxyeleotris marmorata* each station has a different weight and length.

In 2016, it was seen that the *Ophieleotris aporos* weighed 10.30-61.15 g with a total length of 11.7-20.3 cm, *Oreochromis mossambicus* weighed 6.71-914.4 g

with a total length of 13.5-165 cm, while the *Oxyeleotris marmorata* weight 16.34-214.5 g with a total length of 2.16-26.5 cm [6]. In this study it was seen that *Ophieleotris aporos* weighed 2-60 g with a total length of 1-17.3 cm, *Oreochromis mossambicus* weighed 9-172 g with a total length of 2-24.2 cm, while *Oxyeleotris marmorata* weight 16 -25 g for a total length of 2.16-25.5 cm. The decrease in the total length and weight of *Ophieleotris aporos*, *Oreochromis mossambicus*, and *Oxyeleotris marmorata* is due to the growth of macrophytes in lake waters (semi-aquatic), free-floating aquatic plants, floating and rooted at the bottom.

Three types of aquatic plants are commonly found and found in almost all areas on the outskirts of the lake, namely water hyacinth *Eichhornia crassipes*, *Hydrilla verticillata*, and *Ceratophylum demersum* [5].

The Habitat Characteristics

Several parameters of the aquatic environment of Lake Tondano show values that are still within tolerance limits for the life of aquatic organisms including fish. Parameter measurements of habitat conditions were carried out at each station (Remboken, Kakas, and Tondano estuary) at each fish sampling.

Figure 6 shows some of the water parameters of Lake Tondano based on observation time. From Figure 6 we can see that temperature showed a fluctuation among stations in three times of sampling. Station 3 shows the lowest value of pH, brightness, and depth value. In sampling 1 and 2, station 3 shows the highest value of dissolved oxygen.

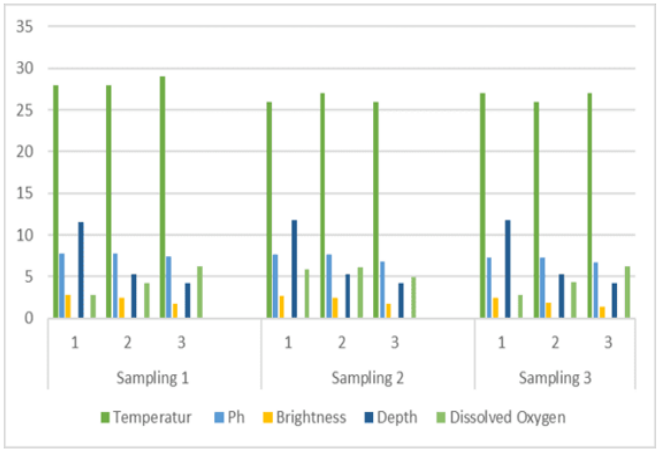

Fig. 6. Temperature, pH, brightness, depth, and dissolved oxygen of water at three stations in Lake Tondano (Remboken, Kakas, and Tondano estuary) in December 2022 and January 2023.

The first measurement in Lake Tondano showed the water temperatures were 28^{0}C at stations 1 and 2, and 29^{0}C at station 3. The second measurement showed the water temperatures were 26^{0}C at stations 1 and 3, and 27^{0}C at station 2. The third measurement showed the water temperatures were 27^{0}C at stations 1 and 3, and 26^{0}C at station 2. In Government Regulation No. 82 of 2001 Management of Water Quality and Control of Water Quality Pollution in Division 3, the maximum temperature limit is about 30^{0}C (Figure 6). So it is still in normal conditions.

The first measurement revealed that the pH value was 7.8 at stations 1 and 2, and 7.4 at station 3. The second measurement showed pH values were 7.6, 7.7, and 6.8 at stations 1, 2, and 3, respectively. The third measurement showed pH values of 7.3 at stations 1 and 2, and 6.7 at station 3.

The first measurement showed brightness values of 2.8, 2.5, and 1.79 at stations 1, 2, and 3, respectively. The second measurement showed brightness values of 2.66, 2.4, and 1.77 at stations 1, 2, and 3, respectively. The third measurement showed brightness values of 2.5, 1.87, and 1.34 at stations 1, 2, and 3, respectively (Figure 6).

The three times measurements showed range values of depth namely 11.6-11.8; 5.26-5.27; and 4.23-4.24 meters at stations 1, 2, and 3, respectively (Figure 6). The depth of Lake Tondano influences water circulation which in turn affects water quality. The pollutants tend to settle in deep water in the northern and eastern parts of the lake [5].

A water hyacinth (*Eichhornia crassipes*) blooming in all stations except in the middle of the lake affects the water's brightness. The percentage area of water hyacinth in Lake Tondano increased from 2.82% in 2006 to 6.32% in 2011, and the growth ratio was 32.38 ha annually [7].

The first measurement showed DO values of 2.75, 4.32, and 6.28 mg/L at stations 1, 2, and 3, respectively. The second measurement showed DO values of 5.89, 6.09, and 4.93 at stations 1, 2, and 3, respectively. The third measurement showed brightness values of 2.75, 4.32, and 6.28 at stations 1, 2, and 3, respectively (Figure 6).

Station 1 had a high density of cages, station 2 had a low density of cages, and there was no activity of floating cages at station 3. According to research in 2006, Lake Tondano had approximately 3500 units of floating fish cages. The latest inventory in 2014 showed an increase in the number, reaching 10,874 units [6]. These conditions affected the water parameter quality of Lake Tondano, not only the pH and dissolved oxygen values of the water but also the brightness and depth of the lake.

According to Government Regulation No 82, 2002, the DO value exceeded the pollution threshold of first-class

water (6 mg/L). The water of Lake Tondano was categorized as second-class water, which is suitable for use in recreation, fisheries, animal husbandry, irrigation, and other utilization with similar standards of water quality [5].

Based on the habitat characteristic measurements, the habitat conditions at the three stations still support the growth of the three species in this research. However, the best habitat condition for *Ophieleotris aporos* is Remboken station. The three stations' habitat conditions still support *Oreochromis mossambicus* growth, while *Oxyeletotris marmorata* is better supported by the habitat of the Remboken and Kakas stations.

A good habitat condition supports the availability of phytoplanktons, as good bioindicators. The community of phytoplankton shows water quality as a quick response to environmental quality degradation [8]. Phytoplankton plays an important role in energy transfer in the lake ecosystem [9]. In Lake Tondano, the phytoplankton was dominated by Navicula and Nitzschia while the zooplankton group was dominated by Asplachna and Nauplius. The number of species was evenly distributed in the group of benthos. The presence of Navicula as the dominant phytoplankton in Lake Tondano indicated low-moderate pollution [5].

IV. CONCLUSION

The weight and length of fish caught in Lake Tondano ranged from 2-60 g and 1-8 cm (*Ophieleotris aporos*); 9-180 and 6-25.5 cm (*Oreochromis mossambicus*); and 16-30 g and 2.6-26 cm (*Oxyeletotris marmorata*). They all have an allometric growth pattern. Habitat characteristics at the three stations in Tondano Lake still support the growth of the fish.

REFERENCES

[1] Balai Penelitian Perikanan Perairan Umum (BPPPU). 2016. Kajian Stok sebagai Dasar untuk Pengelolaan Sumberdaya Ikan Danau Tondano Sulawesi Utara, Laporan Teknis Penelitian 2016.

[2] Suryati, Y.D., I. Setyawati, dan D.S. Yusup. 2023. Analisis Aspek Morfometri dan Biologi Reproduksi Tongkol Lisong (*Auxis rochei*) yang Didaratkan Di PPI Kedonganan Bali, *Metamorfosa: Journal of Biological Sciences* 10(1): 28-39.

[3] Effendi, M.I. 2002. Biologi Perikanan. Yayasan Pustaka Nusantara, Bogor.

[4] Makmur, S., D. Arfiati., G. Bintoro., and A.W. Ekawati. 2014. Habitat Characteristics, Biology, Fishing and Population Dynamics as Management Basis of Hampala (Hampala macrolepidota Kuhl& Van Hasselt 1823) in Ranau Lake, South Sumatera and Lampung. Dissertation Doctoral Program of Fisheries Marine Science, Indonesia: University of Brawijaya.

[5] Setyono, P., and W. Himawan. 2018. Analyses of Bioindicators and Physicochemical Parameters of Water of Lake Tondano, North Sulawesi Province, Indonesia, *Biodiversitas* 19(3): 867-874.

[6] Kusen, D.J., Marsoedi, Z. Kusuma, and Z. Tamod. 2014. Environmental Friendly Foods in the Cultivation of Floated Net Cages at Tondano Lake in North Sulawesi Province. *Scholars Acad J Biosci* 2 (12A): 877-881.

[7] Turangan, T.M.B, A.S. Leksono, Soemarno, and D. Arfiati. 2014. Innovation of *water hyacinth* (*Eichhornia crassipes*) in the Surface Water of Tondano Lake. *Intl J Curr Res* 6 (3): 5470-5476.

[8] Jindal, R., R.K. Thakur, U.B. Singh, and A.S. Ahluwalia. 2014. Phytoplankton Dynamics and Water Quality of Prashar Lake, Himachal Pradesh India. *Sustain Water Quality Ecol* 3(4): 101-113.

[9] Darchambeau, F., H. Sarmento, and J.P. Descy. 2014. Primary Production in a Tropical Large Lake: The Role of Phytoplankton Composition. *Sci Total Environ* 473-474: 178-188.