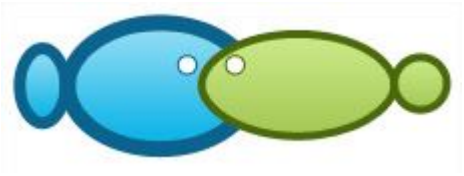

Species composition of *Telmatherina* caught in the vegetated and rocky habitats in Matano Lake, South Celebes, Indonesia

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Abstract. *Telmatherina* is a genus of endemic fish of South Sulawesi. The aim of this research was to observe the fish composition and dominant catches of the *Telmatherina* in two different habitats, vegetated and rocky habitats. This research was conducted for 2 months, in July and in November 2017, in Matano Lake at two sampling sites in Salonsa Beach and around Petea River. The sampling was taken using multi-filament nets with 0.5 inch of mesh size. The fish was identified and counted the number of the cathes in terms of its percentage. According to the result, the fish composition consists of 6 species i.e. *Telmatherina prognatha, T. abendanoni, T. opudi, T. wahjui, T. sarasinorum* and *T. antoniae*. The dominant species in vegetated habitat are *T. antoniae* and *T. prognatha* (24.56%), while the rocky habitat is dominated by *T. antoniae* (35.66%).
Key Words: endemic fish, Matano Lake, South Celebes, *Telmatherina*.

Introduction. The number of fish species inhabiting waters in Indonesia is estimated to be approximately 6,000 species distributed in various regions (Omar 2012). Fish distribution in Indonesia is influenced by both geographical and geological aspects. The distribution area consists of Sunda Shelf (Sumatra, Java, Bali and Borneo), as a part of the Asia, Wallacea region (Nusa Tenggara and Celebes), and Sahul Shelf which previously belonged to Papua New Guinea and linked to Australia (Rahardjo et al 2011). The biota living in the Wallacea region has its own uniqueness as it is a transitioning area between Asia and Australia (Omar 2012).

Celebes, located in the side of Wallacea Line, was formed millions of years ago due to a tectonic activity. This makes Celebes Island having unique ecological conditions and high endemicity. Bio-geographically, Celebes is the end of the Asian (oriental) fauna distributions and the evolution zone separating Southeast Asian fauna and flora from those of Australia (Roy 2006). Wallacea Line is the crossing boundary of the western biota. This condition makes Celebes owning diverse fish species in Southeast Asia including endemic families Adrianichctyidae and Telmatherinidae (Kottelat 1991; Kottelat et al 1993). Telmatherinidae family consists of three genera i.e. *Paratherina*, *Tominanga* and *Telmatherina* (Kottelat et al 1993).

Telmatherina is an endemic genus discovered in Matano Lake. There are nine species inhabiting Lake Matano covering *Telmatherina abendanoni, T. antoniae, T. bonti, T. celebensis, T. obscura, T. opudi, T. prognatha, T. sarasinorum,* and *T. wahjui* (Hadiaty & Wirjoatmodjo 2002), and a recently discovered species, *Telmatherina albolabiosus* (Tantu & Nilawati 2008). *Telmatherina* is known by the community as the opudi fish. In Mataono Lake, the fish distribution from this genus has quite large coverage; however, it is still small in number. According to IUCN (2008), *Telmatherina* is a vulnerable genus whose existence must be protected.

The present condition of Lake Manato is increasingly threatened by the ultimate threats coming from the land-based pollution, land conversion to agriculture, mining and settlement. In accordance with Ridwansyah's study (2017), during the period of 1997-2016, approximately 1,149.1 ha of land around Lake Matano had undergone functional changes into pepper fields. The transfer of function around Matano Lake may have an impact on riparian areas. This condition leads to abrasion and reduces vegetation coverage (Sulastri et al 2017) primarily affecting the life of *Telmatherina* fish inhabiting the Matano Lake.

The habitat in Matano Lake has riparian vegetation and water plants. Riparian vegetation functions as the protection area and food supplier, as well as the habitat quality indicator between littoral area and disturbance around the banks (Kaufmann et al 2014). In addition, vegetation has an important role as a source of both organic material inputs and food for aquatic organisms like fish (Nasution et al 2015).

Tambewa (*Kjelbergerdendron celebicum*), a species of aquatic plant discovered in this lake, is endemic in Matano and the Malili lakes (Sulastri et al 2017). *Telmatherina* inhabits the littoral zone both on riparian and stone and gravel zones. *Telmatherina* usually lay eggs on a substrate either on the sides of riparian roots or among the rocks and gravel with no aquatic plants.

Differences in two habitats in Matano Lake can affect the composition types of the inhabiting fish. However, the insufficient information led to this research aiming to determine the composition of caught fish species and its dominance in the two habitats, namely, vegetated and rocky habitat as base for fisheries management in the area.

Mataerial and Method. Determination of the research stations was based on several considerations: the stations considered to represent vegetated and rocky habitats and the condition of the station allowing the operation of the fishing gear used in Lake Matano that is around the Petea River and Salonsa Beach (Figure 1).

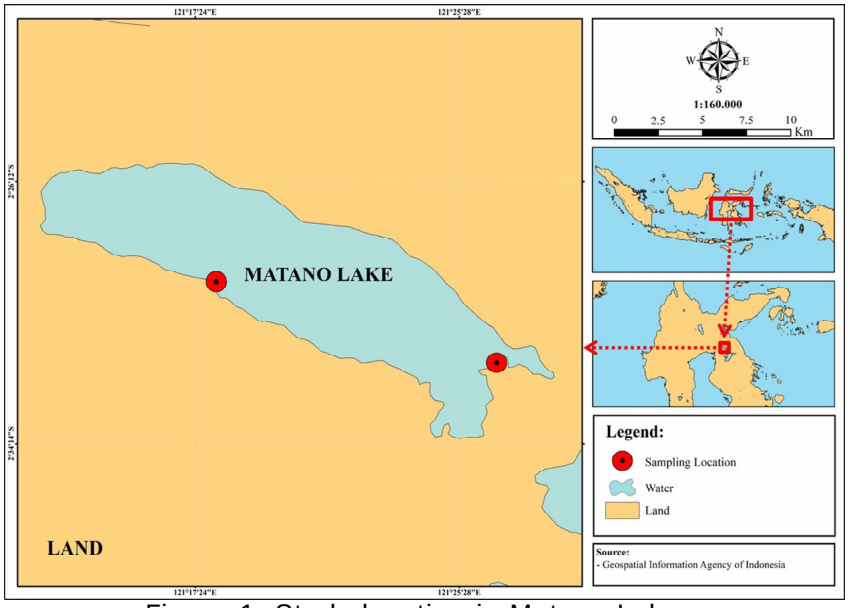


Figure 1. Study location in Matano Lake.

The materials used in this research were samples of the caught fish, formalin (10%) and ethanol (70%) as fish sample preservatives. The tools used were multi-filament nets. For measuring the total length of sample fish we used 0.5 mm gap and the weight of the fish is weighed with electronic balance DJ Series (Mode DJ1002C, Capacity: 1000g, Accuracy: 0.01 g.

Fish sampling method. Fish sample collection was conducted using a rectangular net, designed from the fisherman nets (3 m longth, 1 m width with mesh size of 0.5 inch multifilament type). The net was stretched out on the water bottom by two fishermen,

each netted the end of the net; then, one person snorkling lead the fish into the net and the net was pulled simultaneously and lifted up to the water surface.

Sample observation. The caught fish samples were inserted into the sample plastic bag attached with a date label and sampling station and were given 10% formalin. Furthermore, the fish was washed with clean water and sorted by species. Once sorted, the fish was incorporated into 80% ethanol. Thus, after 24 hours, the fish sample was inserted into the new ethanol. Moreover, the sample of *Telmatherina* was identified. Fish identification was performed in accordance with Kottelat (1991) and Kottelat et al (1993). Subsequently, the fish sample was then measured in length and weight using 0.01 mm gap of a detailed caliper and an analytic scale with 0.01 g of accuracy.

Data analysis. The data used in determining species composition of both vegetated and rocky habitats were the data of the catches of each *Telmatherina* fish species, and their number was distinguished based on *Telmatherina* fish species. Afterwards, a diagram was made, and the difference in the percentage of fish caught in each species in vegetated and rocky habitat can be identified covering the largest to the least number of fish caught.

Results and Discussion. In this research, the sampling was conducted in two different habitats i.e. in vegetated habitat and rocky habitat. Based on the sampling results, the number of *Telmatherina* caught in Lake Matano reached 415 in total. The caught fish consisted of 6 species of *Telmatherina*, i.e. *T. prognatha, T. abendadoni, T. opudi, T. wahjui, T. sarasinorum* and *T. antoniae*. Table 1 shows the composition of *Telmatherina* species caught in Lake Matano in vegetated and rocky habitats.
The catches in Table 1 were dominated by two species i.e. 129 *T. antoniae* and 80 *T. sarasinorum,* followed by 67 *T. prognatha,* 62 *T. wahjui,* and 59 *T. opudi.* Meanwhile, *T. abendedoni* reached 18 tails in total. Figure 2 presents the *Telmatherina* species caught on both vegetated and rocky habitats. *T. bonti, T. obscura* and *T. albolabiosus* species were not identified in this research.

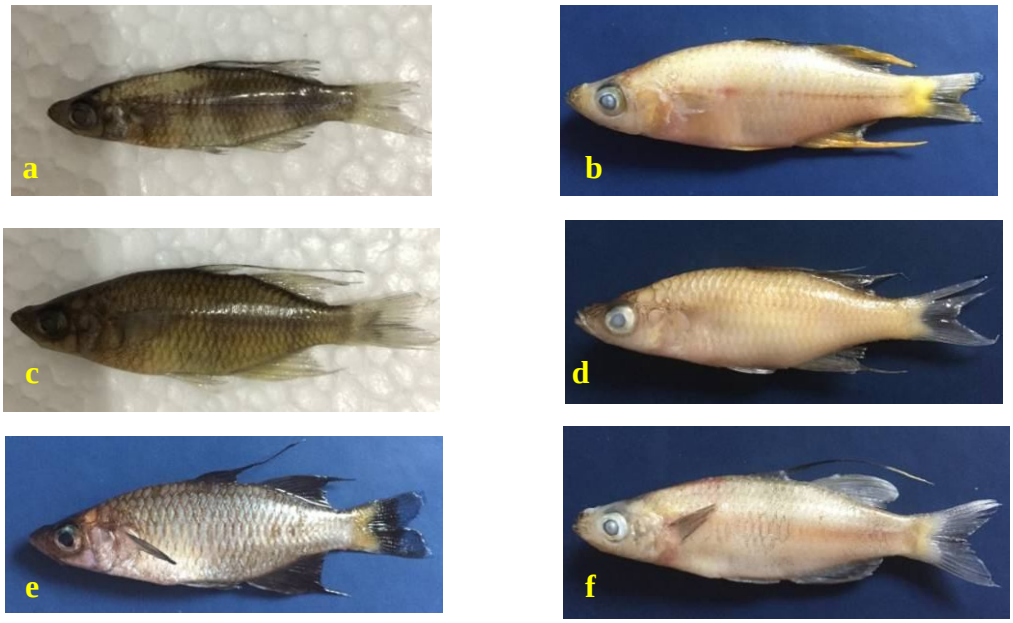


Figure 2. *Telmatherina* fish caught in Matano Lake; (a) *T. prognatha*, (b) *T. abendanoni*, (c) *T. opudi*, (d) *T. wahjui*, (e) *T. sarasinorum*, (f) *T. antoniae.*

Table 1

Caught fish species composition in Matano Lake

No	*Species*	*Total*	*%*
1	*T. prognatha*	67	16.14
2	*T. abendanoni*	18	4.34
3	*T. opudi*	59	14.22
4	*T. wahjui*	62	14.94
5	*T. sarasinorum*	80	19.28
6	*T. antoniae*	129	31.08
	Total	415	

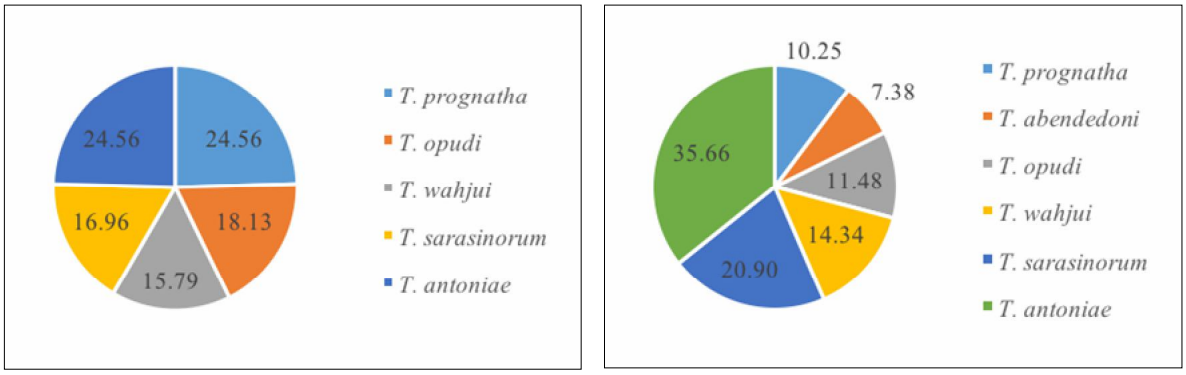
Table 2 highlights the number of *Telmatherina* fish caught in different habitats in Matano Lake. Vegetated and rocky habitats provide sun protection and shade for *Telmatherina* fish. Its distribution in these two habitats is due to its egg-spawning on roots or trunks of the fallen trees and on the rocks.

Table 2

Telmatherina fish composition caught in different habitats

No	*Species*	*Total*	
		Vegetated habitat	*Rocky habitat*
1	*T. prognatha*	42	25
2	*T. abendanoni*	0	18
3	*T. opudi*	31	28
4	*T. wahjui*	27	35
5	*T. sarasinorum*	29	51
6	*T. antoniae*	42	87
	Total	171	244

The number of fish caught in habitat with vegetation and water plants was 171 individuals, which is less than that caught in the rocky habitat with a total of 244 individuals (Table 2). *T. antoniae* and *T. prognatha* caught from the vegetated habitat had the same percentage of 24.56%, followed by *T. opudi* of 18.13%, *T. sarasinorum* of 16.96%, and *T. wahjui* of 15.79% (Figure 3a). In the rocky habitat, the respective percentages of the caught fish are as follows: *T. antoniae* of 35.66%, *T. sarasinorum* of 20.90%, *T. wahjui* 14.34%, *T. opudi* 11.48%, *T. prognatha* of 10.25% and *T. abendanoni* of 7.38% (Figure 3b).



(a) (b)

Figure 3. The percentage of *Telmatherina* caught in (a) vegetated habitat and (b) rocky habitat in Matano Lake.

Measurements on the length and weight of fish caught were also conducted in this study and the results obtained varied widely. Table 3 shows the total length range and weight of *Telmatherina* fish caught in the Lake Matano. In terms of size, the number of fish caught in the vegetated habitat was smaller than that in the rocky habitat (Table 3). It is presumed that the large-sized fish is scattered in more opened areas.

Table 3

The length and weight of *Telmatherina* fish caught in Matano Lake

No	Species	*Vegetated habitat*				*Rocky habitat*			
		Length (mm)		*Weight (g)*		*Length (mm)*		*Weight (g)*	
		Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
1	*T. prognatha*	40.21	62.01	0.75	2.88	47.62	82.96	0.90	5.80
2	*T. abendanoni*	-	-	-	-	50.5	80.47	0.91	5.04
3	*T. opudi*	48.62	75.40	1.08	5.49	48.61	64.96	1.08	2.92
4	*T. wahjui*	38.47	76.25	1.03	5.38	50.81	65.60	1.26	2.93
5	*T. sarasinorum*	53.10	78.84	2.06	5.15	50.69	82.16	1.40	6.59
6	*T. antoniae*	50.17	79.64	1.03	5.55	20.38	86.02	1.23	7.38

This study only found six species of *Telmatherina* spread in the two habitats in which *T. antoniae* was the most caught, followed by *T. sarasinorum* (Table 1). Based on the study by Sulastri (2017), it is suggested that *T. antoniae* is also the most widely spread species in Matano Lake compared to other *Telmatherina* species. In reference to the research conducted by Hadiaty & Wirjoatmodjo (2002), *T. bonti* is a species that is not widely spread, i.e. only in one sampling station out of the 12 stations around the inlet of Matano Lake.

The distribution of *Telmatherina* fish in Matano Lake is influenced by several important factors such as biotic (food) and abiotic (environmental condition). *Telmatherina* fish spread in two habitats i.e. in vegetated and rocky habitats in the littoral zone although there are differences in numbers and types caught in both habitats (Table 2). *Telmatherina* fish spreads in the littoral zone for feeding and spawning. Due to the condition of Matano Lake as an oligotrophic lake, habitat utilization is usually confined to the littoral and limnetic zone surfaces. Its status plays an important role in species abundance and diversity (Haffner et al 2006).

All species of fish are scattered in different habitats in the waters. Habitat utilization is usually influenced by the presence of competitors, habitat structure and food availability (Duncan et al 2011). In addition, the movement and distribution patterns of fish in the lake are affected by the physical condition of the habitat (Gerig et al 2011). Food availability and habitat for fish are not comparable in shallow littoral zone, even low anthropogenic disorders can disrupt the food chain (Hampton et al 2011). The condition of Matano Lake is currently vulnerable to anthropogenic disruption due to the large opening of plantations surrounding the lake that can cause disturbance to the fish inhabiting the littoral area.

Based on the research conducted by Tantu et al (2012), almost all species of *Telmatherina* spread in the littoral area as their habitat. In addition, *Telmatherina* fish also inhabit basic habitat with little or no vegetation. The spread of *Telmatherina* fish in the two habitats in Matano Lake indicates an utilization of littoral areas as their habitat and in open areas in clear and shallow waters with a depth of approximately 0.5 m (Soeroto et al 2004), up to 10 m (Gray & McKinnon 2006).

The distribution of these fishes in two habitats is also related to reproduction activity in which spawning is conducted on sandy substrates, rocks and sometimes on large boulders and vegetation. According to Nilawati et al (2010), *T. sarasinorum* utilizes two habitats to spawn i.e. in root and rocky habitats. The eggs of *Telmatherina* fish are placed at the bottom of the water (Gray & McKinnon 2006), between rocks, gravel or sand with no aquatic plants (Soeroto et al 2004).

Selection of different habitats, especially in the spawning season, is due to the presence of *Telmatherina* species as an egg predator i. e. *T. celebensis* and *T. sarasinorum* (Gray & McKinnon 2006). Another factor that determines the fish distribution in the waters is the food. *Telmatherina* fish prey on arthopods and fish (Herder et al 2008) being a carnivorous fish. In addition, its complementary food is litter (Sulistiono et al 2006). It is also one cause that not only small-sized *Telmatherina* inhabits the vegetated habitat for shelter but also adult *Telmatherina* fish is in this area for feeding.

T. prognatha is scattered in two habitats although the percentage is small (Figure 4). This is in accordance with the results of the research conducted by Herder et al (2008); Herder & Schliewen (2010) argued that *T. prognatha* usually inhabits a steep habitat characterized by rocks, especially the shallow areas that provide protection from riparian vegetation. *T. wahjui* is also found in the two habitats. This is presumably due to the sampling location located near the outlet of Matano Lake as an area with a rapid flow of water. The results of Gray & McKinnon's study (2006) suggest that *T. wahjui* is found only in Matano Lake outlet as it has strong currents entering the Patea River. *T. abendanoni* is found only in vegetated habitat and none is found in the rocky habitat.

This is similar to the research result conducted by Sulastri et al (2017) stating that *T. abendanoni* is caught in the riparian area although the number is small. The results of Nasution et al (2007) show that the spread of *T. celebensis* in Towuti Lake is widely distributed in waters ranging between the littoral area and the middle lake with varying sizes on habitats that have aquatic plants and those that do not.

The same habitat utilizations on different species indicate a sign of healthy competition both by intra-species and by inter-species (Duncan et al 2011). To overcome the environmental changes and optimize habitat utilization, fish perform adaptation and seek for suitable environment for them to survive.

In general, the fish size in the vegetated habitat is smaller than that in the rocky habitat. This is in line with Gbaguidi et al (2016) stating that large-sized fish generally spread in open waters; while the smaller fish (juvenile) spreads around habitat with aquatic plants. As the larger fish dominates and utilizes the littoral habitat, smaller fish and fish larva utilize most of pelagic and littoral habitats (Rechencq et al 2014).

Differences in length and weight of fish in the two habitats can be affected by both biotic and abiotic factors. Abiotic environmental conditions affect the fish distribution, particularly related to water temperature. Water temperature is one factor for habitat selection, as some species of fish can maximize growth at warm temperatures (Paradis et al 2014). Vegetated habitats tend to be more protected from exposure to sunlight compared to rocky habitats.

Differences in the distribution, habitat utilization and size of caught fish indicate a relationship between fish and its micro-habitat. Environmental changes, either because of land use, changes in water patterns flowing into lakes due to dam construction, habitat fragmentation, or fish introduction into the lake are threats to the health and sustainability of fish resources. Land use on the banks of the lake and changes of water discharge can eliminate spawning habitat and protection for fish inhabiting the littoral area that has aquatic plants and make some areas become dry. Meanwhile, fish introduction can have an impact on competitions both for food and habitat. There are numbers of introduced fish with the same food niches as the native fish. This matter can pressurize the native fish since they have difficulties to compete with the other fishes in obtaining food.

Conclusions. There are 6 species of *Telmatherina* caught in total in this study i.e. *T. prognatha, T. abendanoni, T. opudi, T. wahjui, T. sarasinorum* and *T. antoniae*. The dominant species of *Telmatherina* fish caught in a vegetated habitat include *T. antoniae* and *T. prognatha* (24.56%), while *T. antoniae* (35.66%) was caught in the rocky habitat. The largest size of *Telmatherina* fish caught in the rocky habitat is *T. antoniae* with a maximum total length of 86.02 mm and a maximum weight of 7.38 g; while the smallest *T. antoniae* is 20.38 mm with a minimum weight of 1.23 g. In the vegetated habitat, the largest fish caught is again *T. antoniae* with a maximum total length of 79.64 mm and a

maximum weight of 5.55 g; while the smallest one is *T. wahjui* with a minimum total length of 38.47 mm and a minimum weight of 1.03 g.

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