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ZONATION OF ENDEMIC ICHTHYOFAUNA CONSERVATION AREA IN ANCIENT LAKE TOWUTI, SOUTH SULAWESI-INDONESIA

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ABSTRACT

Lake Towuti is a tectonic-oligotrophic (A= 56000 ha) located in Malili Complex, South Sulawesi and has been designated as a recreation park. This lake is one of the ancient lakes in Sulawesi. There are 29 fish species from 13 families in Lake Towuti, 19 species are endemic. All of the endemic fishes are recently utilized by people around the lake for consumption (fresh fish, dry fish and salty fish). On the other side the fast growth of fishing activities especially used a dipnet ("bagan") namely instrument unfriendly environmental increases number, in 2007 totaled 19 and in 2009 had reached 30 piece. An increasing number of dipnet that are operating in the waters of this indicates a threat to fish populations endemic. There are indications that Lake Towuti has been biologically contaminated. Considering potential threats against endemic ichthyofauna of Lake Towuti enough redoubted, then information about the ecological parameters already collected should be used to designate and map conservation area zoning endemic ichthyofauna. This research was conducted in Lake Towuti from 2009 to 2011 at two zones (Kawatang and Tominanga) at six stations respectively. Fish sampling using experimental gill net with four mesh sizes. Making zoning map using ArcGIS 9.2 programme. Thematic map obtained of endemic ichthyofauna ecological side of value-based score of endemic biota. Based on the results of the scoring against the distribution of endemic ichthyofauna in Kawatang zone, the station that has the highest score (five) is in the Kawatang downstream, while in Tominanga zone is in Cape of Bintu.

Keywords: zonation, conservation area, endemic ichthyofauna, ancient lake, Lake Towuti

ABSTRAK

Danau Towuti adalah danau tektonik-oligotrofik (A= 56000 ha) yang terdapat di Kompleks Malili, Sulawesi Selatan dan telah ditetapkan sebagai Taman Wisata Alam. Danau ini merupakan salah satu danau purba di sulawesi. Terdapat 29 spesies ikan dari 13 famili (Wirjoatmodjo et al., 2003). Dari 29 spesies ikan tersebut terdapat 19 spesies ikan endemik. Seluruh ikan endemik ini dimanfaatkan oleh penduduk di sekitar danau untuk konsumsi (ikan segar, ikan kering, dan ikan asin). Disisi lain terjadi peningkatan pesat kegiatan penangkapan menggunakan alat tangkap bagan (dipnet) yang termasuk alat yang tidak ramah lingkungan, pada 2007 berjumlah 19 dan pada 2009 telah mencapai 30 bagan. Peningkatan jumlah bagan yang beroperasi di perairan ini memberikan ancaman untuk populasi ikan endemik. Ada indikasi bahwa Danau Towuti telah tercemar secara biologis. Mengingat potensi ancaman terhadap iktiofauna endemik dari Danau Towuti cukup mengkhawatirkan, maka informasi tentang parameter ekologis yang sudah dikumpulkan harus digunakan untuk menetapkan peta zonasi kawasan konservasi iktiofauna endemik. Penelitian ini dilakukan di Danau Towuti dari 2009-2011 di dua zona (Kawatang dan Tominanga) masing-masing di enam stasiun. Sampling ikan menggunakan eksperimental gill net dengan empat ukuran mata jaring. Pembuatan peta zonasi menggunakan program ArcGIS 9.2. Diperoleh peta tematik iktiofauna endemic dari sisi ekologi berdasarkan nilai skor biota endemik. Berdasarkan hasil penilaian terhadap distribusi iktiofauna endemik di zona Kawatang, stasiun yang memiliki nilai tertinggi (lima) adalah di Muara Sungai Kawatang, sedangkan di zona Tominanga adalah di Tanjung Bintu.

Kata kunci: Zonasi, kawasan konservasi, iktiofauna endemik, danau purba, Danau Towuti

INTRODUCTION

Lake Towuti is a tectonic-oligotrophic (A= 56000 ha) located in Malili Complex, South Sulawesi and has been designated as a recreation park according to Agriculture Minister Decree No. 274/Kpts/Um/1979. This lake sustains the life of several endemic fish resources. There are 29 species of fish from 13 families (Wirjoatmodjo et al. 2003). Of the 29 species of fish there are 19 species of endemic fish that are listed in the IUCN (IUCN, 2003 and Froese and Pauly, 2004). As well as utilized for various human purposes i.e. hydroelectric power plant, capture fishery, navigation, ecotourism and source of water for domestic uses (Nasution, 2006).

According to Nasution (2008), that the number of dipnet recommended operating no more than 19 pieces of the dipnet and operated for 10 days in the dark. On the other side prolific growth of fishing activities with dipnet on endemic fish species in the lake, already indicate a situation threatening the population. In addition to the above problems, there are indications that the polluted waters of Lake Towuti has been biologically characterized the entry of exotic fish species namely Tilapia (Oreochromis *niloticus*), Goldfish (*Cyprinus carpio*), Mujair (*Oreochromis mosambicus*), Osang or Betok (*Anabas testudineus*), Cork (*Channa striata*) and Golden sanil (Nasution, *et al.* 2009).

Conservation based on the inland waters of indonesian culture which is defined as integrated synergy all the nation ability to utilize (utilisation), protect (protection), prevent (mitigation) and repairing the damage (rehabilitation) inland waters in order to fulfill the needs and aspiration of present and future generations (Hartoto, 2008). The activity of natural resources conservation to be an order in society in such a way that all components and capabilities of the nation can synergize in integrative to reach a goal that is mutually agreed.

Until now the attention of a government to the endemic biota that inhabit the Lake Towuti in conserve, manage and exploit it in polite and wise still not enough attention.

This research aims to reveal the endemic ichthyofauna conservation area zoning to Lake Towuti presented in a thematic map of the distribution of endemic ichthyofauna. This result is expected to be beneficial to the conservation area zoning designation of endemic biota. The results of this research are some of scientific foundations for the development of conservation system of fish resources that is mandated by Governmental Regulation No 60 of 2007, in this regulation a conservation area should be managed through development of zonation system.

MATERIAL AND METHODS

This research was conducted in Lake Towuti, East Luwu Regency of South Sulawesi Province. The method used is a descriptive method. Based on the results of the assessment of the station which has endemic biota and environmental conditions are good, most stations have obtained endemic biota and environmental conditions are good in Kawatang and Tominanga station (Table 1).

From Table 1, set two zone are Tominanga zone and Kawatang zone. There are six stations in the Kawatang zone as follows: Cape of Mongi (KW1); Cape of Teteu (KW2); Kawatang downstream (KW3); Cape of Mea (KW4); Uno-uno (KW5) and Cape of Lengkobale (KW6). There are six stations in the Tominanga zone as follows: Cape of Bakara (TMG1); Cape of Batu (TMG2); Saone (TMG3); Cape of Tominanga (TMG4); Tominanga downstream (TMG5) and Cape of Bintu (TMG6). The determination of the sampling locations are determined using Geographic Positioning System (GPS). Location of research can be seen on Figure 1.

Fish samples were collected from using experimental gillnet with mesh sized ¾, 1, 1¼ and 1½ inches. The total length of the net is 200 m (4 x 50 each mesh size). Net equipped with the float at top and sinker at the bottom. Net is positioned vertical to the coastline in each station (Nasution et al. 2007). Fish samples preserved using 4% formalin solution then soaked in 70% alcohol solution. To determine the type of fish species identified using Weber and Beaufort (1913), Weber and Beaufort (1916), Weber and Beaufort (1922) and Kottelat et al. (1993).

Stages in determining score to choose zoning conservation area of endemic ichthyofauna in Lake Towuti includes:

1. There are facts in the field
2. There are table parameters criteria in determining zoning conservation area that refers to Hartoto et al. (2009)
3. Calculated based on the average score of each criterion parameter are being made

The assessment is done by making the distribution of endemic ichthyofauna interval class (divided into five classes) and given a score from 1 to 5. Abundance distribution of endemic biota criteria

Table 1. The assessment station have biota endemic and good environmental conditions

Endemic biota and good environmental condition	Station						
	Tominanga	Cape of Manu	Loeha Island	Hola-hola downstream	Kawatang downstream	Beau	Cape of Bakara
Ichthyofauna	√	-	-	√	√	√	-
Carcinofauna	-	-	-	-	√	-	-
Malacofauna	√	-	-	-	-	√	-
Rriparian vegetation (*allochtonous*)	√	√	√	√	√	-	√
Water macrophyte	-	-	-	-	-	√	-
Water quality	√	√	√	√	√	-	√

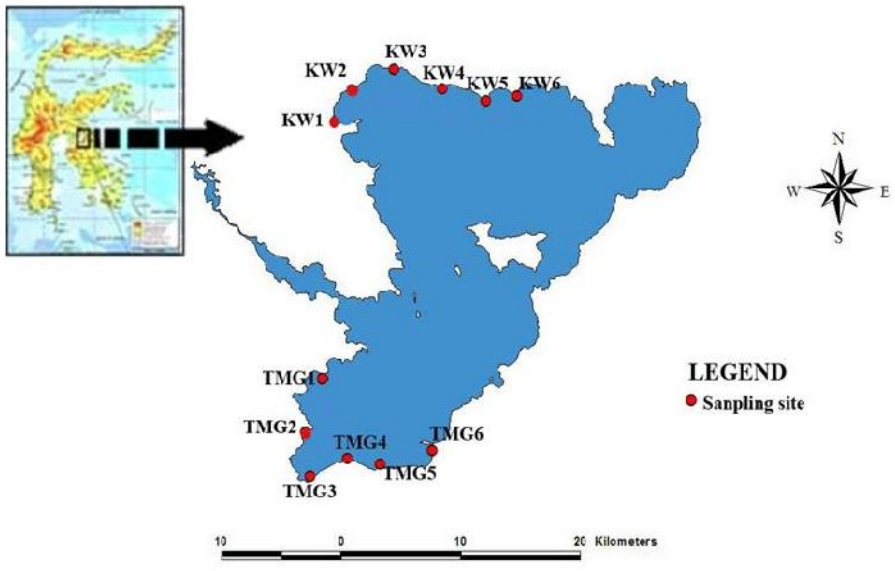

Figure 1. Research station in Lake Towuti

namely: score 1 = less abundance, score 2 = medium abundance, score 3 = abundance is high enough, score 4 = abundance of high and score 5 = abundance very high. Subsequently incorporated into the tables and for easy presented also in form of zoning map of the dominant endemic ichthyofauna distribution and total individual distribution in each station's in Kawatang and Tominanga zones.

The stage of making zoning map using ArcGIS 9.2 program:

1. Input the coordinates of point sampling into Excell program by formatting a decimal-degrees (DD) with a value score of each criteria
2. Save the file into form of files dbf
3. Input file dbf into the ArcGIS 9.2 program
4. Change the file dbf into shapefile in accordance with criteria
5. Projected data from the geographic coordinates of Datum WGS84 projection to UTM Zone 51 S
6. Interpolation of data to get raster data
7. Changing raster data to vector data by changing the file format be shapefile
8. Do the steps above for the other criteria until all criteria of registered
9. Do the cutting process or clipping data interpolation with maps of Lake Towuti

RESULT

In conducting a mapping zoning conservation area endemic ichthyofauna in Lake Towuti will be used parameters criteria who had been given score. Granting score done of various parameters of every station made using ArcGIS program. On this research to choose zoning conservation area endemic ichthyofauna, seen from a map to distribution endemic ichthyofauna.

Ichthyofauna that caught in four (4) stations of the Kawatang zone can be seen in Table 2. The seven species of fish found in this region and all species of fish including endemic fish. Species of fish was Pangkilang (*Telmatherina celebensis*), Bonti-bonti blue (*Paratherina striata*), Bonti-bonti red fins (*P. cyanea*), Butini (*Glossogobius matanensis*), Bungo (*G. flvipinnis*), Anggori (*G. celebius*) and Dui-dui (*Dermogenys megarhamphus*). Endemic species of fish which is not caught in this research are Red Pangkilang (*Tominanga* sp.) and Rice fish (*Oryzias marmoratus*) (Nasution, 2008).

Similarly not found Cork fish (*Canna striata*) which is competitors Butini fish (*Glossogobius matanensis*) which is endemic fish in Lake Towuti. Exotic fish as Tilapia (*Oreochromis niloticus*) Mujair (*O. mosambicus*), Osang or Betok (*Anabas testudineus*) and Goldfish (*Cyprinus carpio*) found also in the zone of Kawatang.

Table 2. Species and abundance of endemic ichthyofauna in Kawatang zone in Lake Towuti

No	Fish species		Station					
	Local name	Scientific name	KW1	KW2	KW3	KW4	KW5	KW6
1	Pangkilang	*Telmatherina celebensis*	50	20	225	23	95	24
2	Bonti-bonti blue	*Paratherina striata*	1	2	22	9	8	1
3	Bonti-bonti red fins	*P. cyanea*	0	1	1	3	4	5
4	Butini	*Glossogobius matanensis*	2	4	11	0	4	0
5	Bungo	*G. flavipinnis*	0	5	8	0	12	9
6	Anggori	*G.celebius*	0	5	33	0	11	30
7	Dui-dui	*Dermogenys* sp.	0	0	0	1	0	0
	Total individuals		53	37	300	36	134	69
	Total species		3	6	6	4	6	5

Description:
KW1 = Cape of Mongi; KW2 = Cape of Teteu; KW3 = Kawatang downstream; KW4 = Cape of Mea; KW5 = Uno-uno dan KW6 = Cape of Lengkobale

Seven species of fish found in this zone and all species of fish including endemic fish. This species of fish is Pangkilang (*Telmatherina celebensis*), Bonti-bonti blue (*Paratherina striata*), Bonti-bonti red fins (*P. cyanea*), Butini (*Glossogobius matanensis*), Bungo (*G. flvipinnis*) and Anggori (*G. celebius*). *T. celebensis* has the highest abundances as many as 111 fish found in Saone station (TMG3) (Table 3).

fish species. There are three dominant fish species, namely *T.celebensis, Paratherina striata* dan *G. celebius* are viewed based on abundance at every station. Then made class to determine the criteria of its abundance and each fish was given scoring (Table 4 and 5). From those results is presented in form of tables and pictures of fish distribution map. These three types of fish were found with the highest score (5) at the Kawatang

Table 3. Species and abundance of endemic ichthyofauna in Tominanga zone in Lake Towuti

No	Fish species		Station					
	Local name	Scientific name	TMG1	TMG2	TMG3	TMG4	TMG5	TMG6
1	Pangkilang	*Telmatherina celebensis*	6	50	111	35	56	34
2	Bonti-bonti	*Paratherina striata*	0	3	1	1	0	0
3	Bonti-bonti	*P. cyanea*	0	0	0	1	1	0
4	Butini	*Glossogobius matanensis*	0	0	0	0	0	10
5	Bungo	*G. flavipinnis*	5	4	3	0	3	21
6	Anggori	*G.celebius*	6	5	0	0	2	20
	Total Individuals		17	62	115	37	62	85
	Total species		3	4	3	3	4	4

Description:
TMG1 = Cape of Bakara; TMG2 = Cape of Batu; TMG3 = Saone; TMG6 = Cape of Tominanga; TMG5 = Tominanga downstream dan TMG6 = Cape of Bintu

DISCUSSION

Abundance of fish individual total found in Kawatang downstream station of highest as many as 300 fish (Table 2). This station of the source material that gets input of nutrients and source of allochthonous for feed of fish taht carried through the river into the lake. Most pelagic species of *Telmatherina celebensis* are many found at Kawatang downstream station, whereas the benthic species is *Glossogobius celebius* found in Kawatang downstream station Cape of Lengkobale stations. *T.celebensis* spread at all stations in the Kawatang zone.

Fish species that are caught are generally endemic fish, so that in the determination or electoral zoning conservation area based on endemic fish to distribution of species in every station. To know the distribution of the fish, then made ichthyofauna classification for dominant

downstream station (Table 4 and 5; Figure 2a, 2b and 2c) Similarly the abundance of individuals total, the highest score be found in Kawatang downstream station (Table 6 and Figure 3).

Based on classification and scoring on each dominant species in station in Tominanga zone, shows that *Telmatherina celebensis* has highest scores in Saone station, while *G. flvipinnis* and *G. celebius* has the highest score at Cape of Bintu station (Table 7 and 8, Figure 4a,4b and 4c). Classification of ichthyofauna based on the abundance of the individual's total each station in Tominanga zone (Table 9 and Figure 5) to see that the abundance has highest (score 5) found in Saone and Cape of Bintu station. Suggested core zone in Tominanga zone is Cape of Bintu station where the habitat conditions area at the Cape of Bintu where riparian vegetation is still good, a lot of a submerged wood, a substrate

composed of gravel to boulders (on the edge). Found also macrophyte (Ottelia mesenterium) as a place of shelter put fish eggs and place of sticking it a source of feed on leaves. In addition the condition of water quality intact with a score of 4 (Nasution et al. 2009).

Table 4. Ichthyofauna classification based on the dominant fish species in Kawatang zone in Lake Towuti

No	Fish species	Class				
1	*Telmatherina celebensis*	<40	40-80	81-120	121-161	> 161
2	*Paratherina striata*	<4	4 s/d 8	9 s/d 12	13 s/d 16	>16
3	*Glossogobius celebius*	<1	1 s/d 6	6 s/d 12	13 s/d 18	>18
	Score	1	2	3	4	5
	Fish abundance	less	medium	quite high	high	very high

Table 5. Scoring results of ichthyofauna for each station in Kawatang zone in Lake Towuti

No	Station	KW1	KW2	KW3	KW 4	KW5	KW6
1	*Telmatherina celebensis*	2	1	5	1	3	1
2	*Paratherina striata*	1	1	5	3	2	1
3	*G.celebius*	1	2	5	1	3	5

Table 6. Classification ichthyofauna based on total of individual abundance every station in Kawatang zone in Lake Towuti

Class:	< 50	50-100	101-151	152-202	>202	
Score classes	1	2	3	4	5	
Abundance	less	medium	quite high	high	very high	
Station	KW1	KW2	KW3	KW4	KW5	KW6
Abundance score	2	1	5	1	3	2

Table 7. Ichthyofauna classification based on the dominant fish species in Tominanga zone in Lake Towuti

No	Fish species	Class				
1	*Telmatherina celebensis*	<6	6 s/d 27	28 s/d 49	50 s/d 79	>79
2	*Glossogobius flavipinnis*	<3	3 s/d 6	7 s/d 10	11 s/d 14	>14
3	*G.celebius*	<2	2 s/d 6	7 s/d 10	11 s/d 14	>14
	Score	1	2	3	4	5
	Fish abundance	less	medium	quite high	high	very high

Table 8. Scoring results of ichthyofauna for each station in Tominanga zone in Lake Towuti

No.	Station	TMG1	TMG2	TMG3	TMG4	TMG5	TMG6
1	*Telmatherina celebensis*	1	3	5	3	4	3
2	*Glossogobius flavipinnis*	2	2	2	1	2	5
3	*G.celebius*	2	2	1	1	1	5

Table 9. Classification ichthyofauna based on total of individual abundance every station in Tominanga zone in Lake Towuti

Class:	<20	20-40	41-61	62-82	>82	
Score classes	1	2	3	4	5	
Abundance	less	medium	quite high	high	very high	
Station	TMG1	TMG2	TMG3	TMG4	TMG5	TMG6
Abundance score	1	4	5	2	4	5

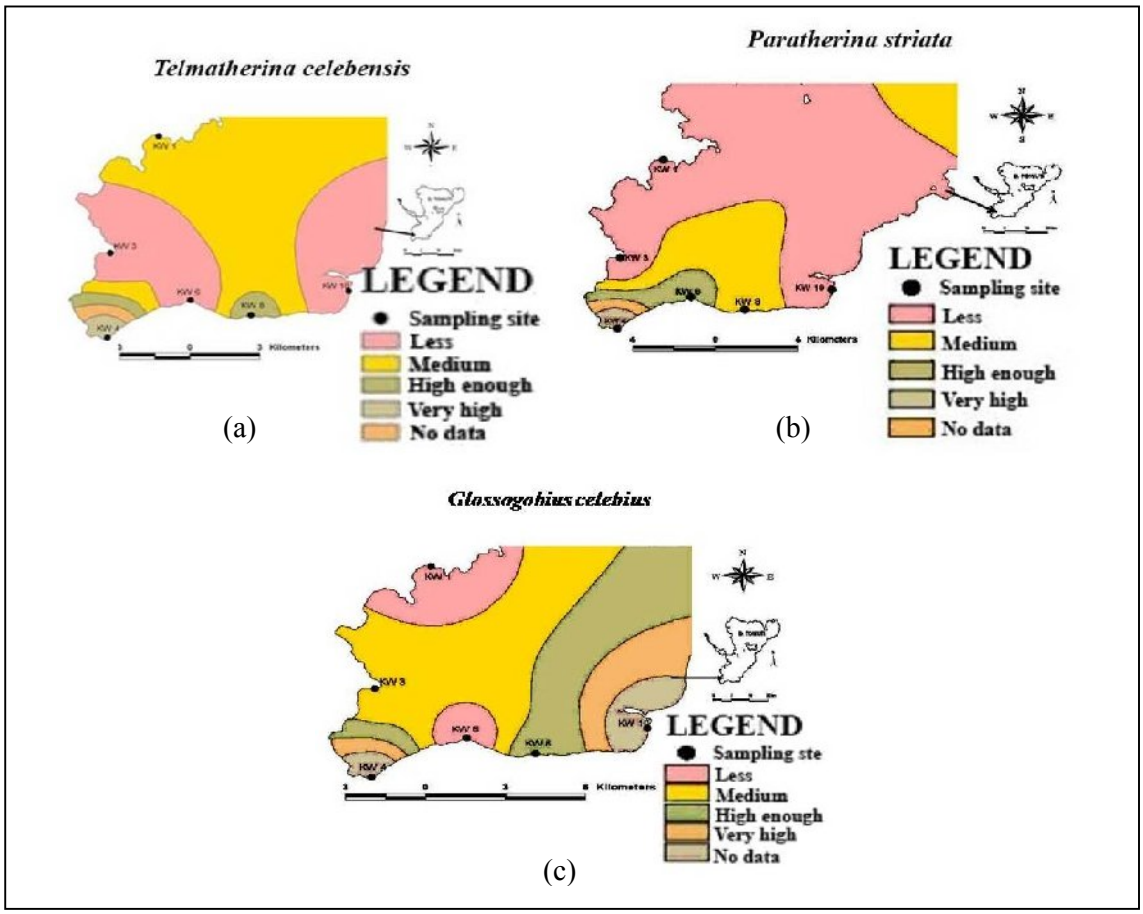

Figure 2. Thematic maps of distribution of endemic fish *Telmatherina celebensis* (a), *Paratherina striata* (b) and *Glossogobius celebius* (c) of Kawatang zone in Lake Towuti

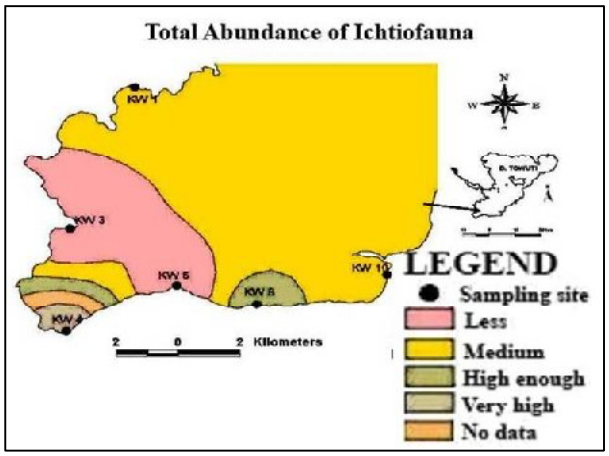

Figure 3. Thematic maps of ichthyofauna distribution based on total individual abundance every station in Kawatang zone in Lake Towuti

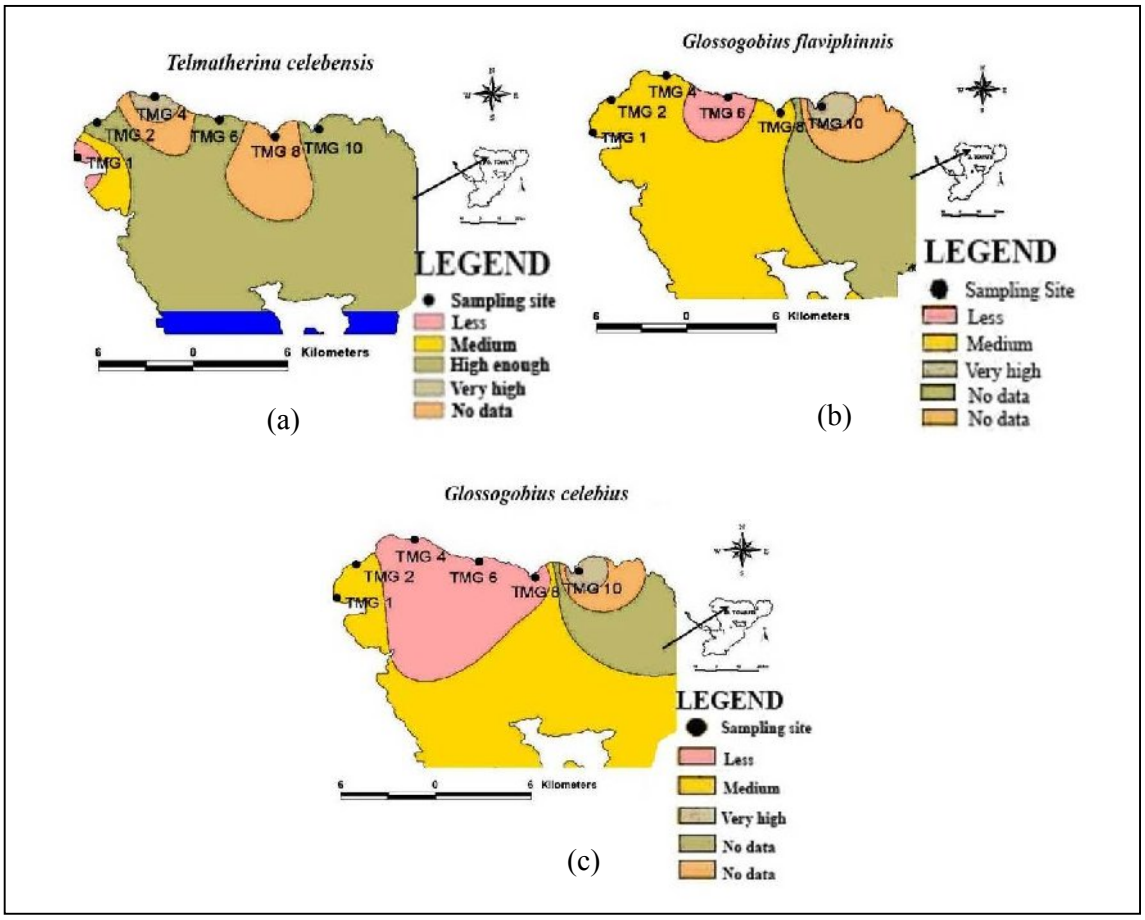

Figure 4. Thematic maps of distribution of endemic fish *Telmatherina celebensis* (a), *Glossogobius flavipinnis* (c) and *Glossogobius celebius* (c) in Tominanga zone in Lake Towuti

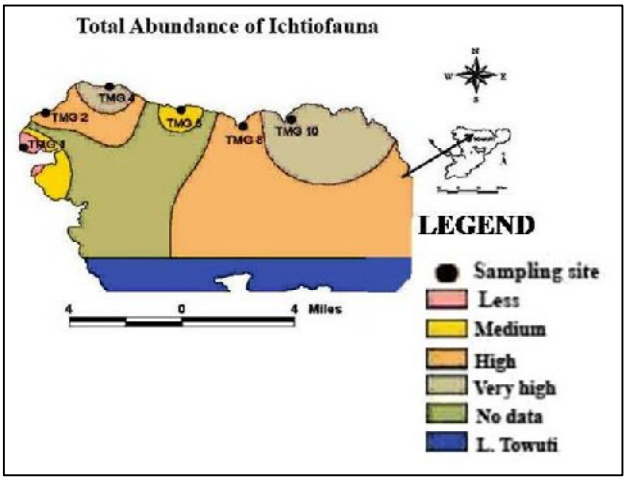

Figure 5. Thematic maps of ichthyofauna distribution based on total individual abundance every station in Tominanga zone in Lake Towuti

CONCLUSION

Zonation of endemic ichthyofauna conservation area in ancient Lake (Towuti Lake), South Sulawesi-Indonesia based on result of the scoring has the highest score (five) in Kawatang zone is Kawatang downstream and in Tominanga zone is in Bintu Cape.

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