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Diversity and distribution freshwater ichthyofaunal of West Sulawesi

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Diversity and distribution freshwater ichthyofaunal of West Sulawesi

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Abstract. The diversity of ichthyofauna species is very interesting to study, especially in terms of species inventory as an effort to reveal the biodiversity of aquatic species. Sulawesi is one of the locations in the Wallacea region which is the location with the most species diversity and the location where most of the endemic species found in Indonesia are found. This study purpose to determine the diversity and distribution of ichthyofaunal species in the waters of West Sulawesi, and evaluate the status of conservation based on data from the International Union for Conservation of Nature to determine the level of utilization of species in West Sulawesi. The study was conducted in February 2018 to May 2019, samples were collected from eight rivers from the estuary area to the upper stream of the waters of West Sulawesi. The number of samples that were collected was 771 fish samples consisting of 31 species of fish and from 10 families including, Family Ambassidae, Anguillidae, Gobiidae, Eleotridae, Mugilidae, Gerreidae, Apogonidae, Terapontidae, Lutjanidae, and Leiognathidae. From the total species found, the highest number of species was found from the Gobiidae family, where species from the Gobiidae family dominated at each research station. The conservation status of the fish obtained is in the data deficient status with three species, least concern with 28 species, and near threatened with one species. Distribution of species in the waters of West Sulawesi is spread throughout the Indonesian waters, and some of them are endemic to Sulawesi.

1. Introduction

Inventory of fish resources or freshwater ichthyofaunal in Indonesia has been carried out since the 19th century by researchers such as [1,2] and other researchers from which the exploration efforts of the species have succeeded in identifying and revealing species that it has not been reported before in terms of distribution of taxonomic aspects. The status of Indonesian freshwater fish resources reported by [3] which recorded that 1218 species were consisting of 84 families including 1172 of which were native species from 79 families and 630 species of fish were endemic.

Sulawesi Island is one of the locations included in the Wallacea region and is known as an area that has the abundant potential of ichthyofaunal and is the location with the highest number of endemic species,



especially in freshwater fish [2–4]. Furthermore, [5] states that in the freshwater waters of Sulawesi Island there are 68 endemic freshwater fish species consisting of seven families, namely Adrianichthyidae (19 species), Telmatherinidae (16 species), Zenarchopteridae (15 species), Gobiidae (14 species), Anguillidae (1 species), Eleotridae (2 species), and Terapontidae (1 species).

West Sulawesi has a diversity of aquatic species that is quite abundant, but the existence of aquatic species is still not clearly known because until now, there is no information related to fish species found in the waters of West Sulawesi, especially freshwater fish species, so it is necessary to conduct research aimed to identify freshwater fish species as an effort to determine diversity and distribution, as well as the conservation status of ichthyofaunal in the waters of West Sulawesi.

2. Materials and Methods

The study was conducted in February 2018 to May 2019 in the waters of West Sulawesi (Figure 1) by sampling from the estuary to the upper reaches of the river at each location. Fish were sampled by gill nets, hand nets, electro shocker and using clove oil. Fish specimens collected were fixed in a 10% formalin solution and transferred to a 70% ethanol solution. Fish were identified using references to fish identification according to [2,6,7], in addition to knowing information related to distribution and conservation status refer.

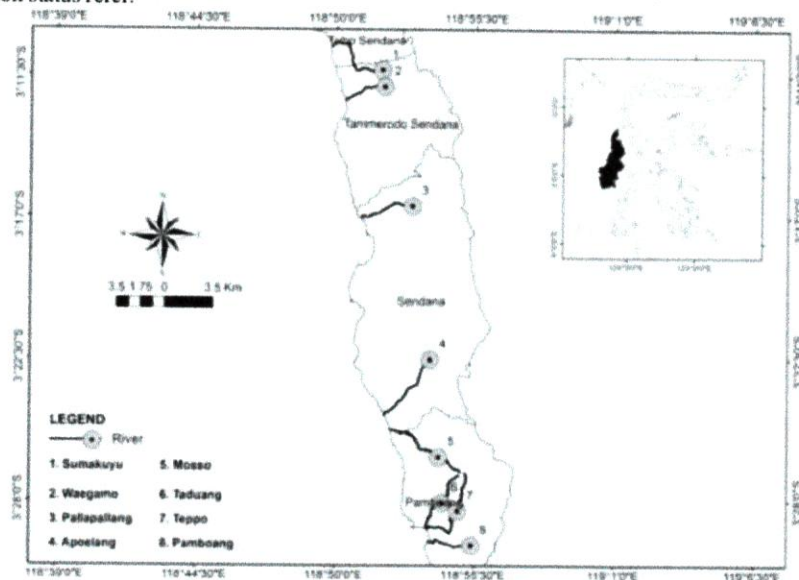


Figure 1. View of West Sulawesi and sampling stations.

3. Results

A total of 31 freshwater fish species from 10 families were found during study of the eight sites in waters of West Sulawesi (table 1) and Gobiidae family has the highest number of species (Figure 2) and has a percentage of about 49% of other fish groups in West Sulawesi Waters.

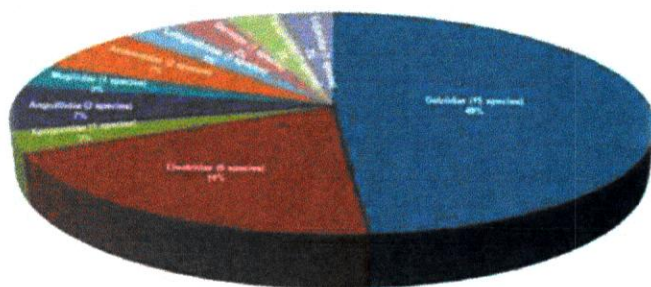


Figure 2. Fish composition of West Sulawesi

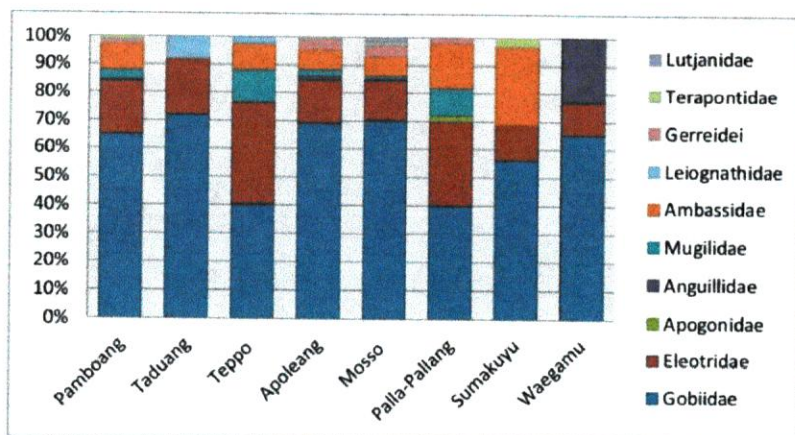


Figure 3. Abundance of freshwater fish based on location.

Species distribution found in the waters of West Sulawesi (Table 1) linked to distribution information via www.fishbase.com shows that in general fish found in the waters of West Sulawesi are known to be scattered throughout Indonesian waters, except for some species that are declared endemic to Sulawesi only found in freshwaters of Sulawesi.

Table 1. Checklist, distribution, and conservation status of fishes in the waters of West Sulawesi.

Family	Species	N	Distribution	IUCN Status
Gobiidae	<i>Sicyopterus lagocephalus</i>	71	Indo-Pacific: Comoros Islands (East Africa) to Austral Island (French Polynesia). In the Indian Ocean, from Comoros to Mascarene Is. and in the Pacific Ocean, from Japan to French Polynesia, New Caledonia and Vanuatu	LC ¹⁸
	<i>Sicyopterus longifilis</i>	28	Asia: Philippines and Indonesia. Reported from New Guinea	LC
	<i>Sicyopterus cynocephalus</i>	5	Asia: Philippines and Indonesia. Oceania: Papua New Guinea	LC
	<i>Stiphodon semoni</i>	55	Asia and Oceania: Indonesia, Philippines, New Guinea and Solomon Islands	LC
	<i>Stiphodon atropurpureus</i>	5	Northwest Pacific: tropical and subtropical; Japan, Taiwan, Malaysia, Philippines and the mainland of South China.	LC
	<i>Stiphodon atratus</i>	7	Asia and Oceania: occurs in Indonesia, on the northern coast of New Guinea, Admiralty Islands, Halmahera Island, Bismark Archipelago, Bougainville, Vanuatu and New Caledonia	LC
	<i>Sicyopus zosterophorus</i>	172	Asia: Japan, Philippines, and Indonesia and China. Oceania: Papua New Guinea, Palau Solomon Islands, New Caledonia and Vanuatu	LC
	<i>Smilosicyopus leprurus</i>	3	Asia: Indonesia, Ryukyu Islands, Oceania: Mariana Islands	DD
	<i>Butis</i> sp.	6	Asia and Oceania: Japan southward to the Philippines, Indonesia, New Guinea and Australia. Reported from Africa: south to Coffee Bay, South and Seychelles.	-
			Widely distributed over the West tropical Pacific, from Japan to the Philippines, Indonesia, New-Guinea, North of Australia, Vanuatu and New Caledonia	
	<i>Glossogobius celebius</i>	3	Asia and Oceania: Ryukyu Islands in Japan, Taiwan, Philippines, Indonesia, Solomon Islands, New Guinea and northern Australia. Reported from Palau, Fiji, New Caledonia and Vanuatu.	LC
	<i>Schismatogobius saurii</i>	2	Asia: Sumatra, Java, Bali, Lombok, Ambon dan Panay Indonesia, Japan	DD
	<i>Schismatogobius</i> sp.	13	-	-
	Eleotridae	<i>Awaous grammepomus</i>	58	Asia: Sri Lanka to New Guinea
<i>Awaous ocellaris</i>		33	Asia: India to the Philippines and north to Japan. Oceania: Fiji, French Polynesia and New Caledonia and Vanuatu.	LC
<i>Stenogobius genivittatus</i>		14	Indo-West Pacific: east African coast and offshore islands to Indonesia and western Pacific. Reported from French Polynesia	LC
<i>Giuris margaritaceae</i>		47	Africa to Oceania: Madagascar to New Guinea. Australia and other islands of Melanesia.	-
<i>Giuris</i> sp.		11	-	-

<i>Belobranchius belobranchius</i>	7	Asia and Oceania: Indonesia, Philippines, and New Guinea. Also from Japan	DD
<i>Ophiocara porocephala</i>	2	Indo-West Pacific: East Africa to the Philippines, north to the Ryukyu Islands, south to Australia and New Caledonia	LC
<i>Eleotris fusca</i>	64	Indo-West Pacific: East Africa to French Polynesia.	LC
<i>Eleotris melanosoma</i>	23	Africa, Asia and Oceania: East Africa to Society Islands, north of Japan, Vanuatu.	LC
<i>Yarica hyalosoma</i>	1	Africa, Asia and Oceania: East Africa to Papua New Guinea. Recorded from New Caledonia and Micronesia	LC
<i>Anguilla marmorata</i>	3	Indo-Pacific: East Africa, inland Mozambique and lower Zambezi River to French Polynesia, north to southern Japan.	LC
<i>Anguilla celebesensis</i>	7	Western Pacific: Indonesia to the Philippines and New Guinea. Reported from Western and American Samoa	NT
<i>Mugil cephalus</i>	31	Cosmopolitan in coastal waters of the tropical, subtropical and temperate zones of all seas. Eastern Pacific: California, USA to Chile. Western Pacific: Japan to Australia. Western Indian Ocean: from India to South. Western Atlantic: Nova Scotia, Canada to Brazil, Cape Cod to southern Gulf of Mexico. Eastern Atlantic: Bay of Biscay to South Africa, including the Mediterranean Sea and Black Sea. Reported in Sea of Okhotsk.	LC
<i>Ambassis miops</i>	42	Indo-West Pacific: India to New Guinea and New Caledonia, north to the Ryukyu Islands. Reported from Samoa	LC
<i>Ambassis interrupta</i>	26	Asia: Indo-Australian Archipelago, including Indonesia, the Philippines, Borneo, Java, New Guinea, Vanuatu, New Caledonia, to northern Australia and the Andaman Sea. Reported from Palau and the Ryukyu Islands.	LC
<i>Aurigequula fasciata</i>	5	Indo-West Pacific: Red Sea and East Africa to Samoa and Fiji, north to Japan, south to northeastern Australia.	LC
<i>Gerres filamentosus</i>	18	Indo-Pacific: East Africa and Madagascar to Japan and Australia; New Caledonia and Vanuatu. Enters rivers and lakes in Madagascar and the east coast of Africa.	LC
<i>Terapon jarbua</i>	6	Indo-Pacific: Red Sea and East Africa to Samoa, north to southern Japan, south to the Arafura Sea, Australia, and Lord Howe Island.	LC
<i>Lutjanus argentimaculatus</i>	3	Indo-West Pacific: East Africa to Samoa and the Line Islands, north to the Ryukyu Islands, south to Australia.	LC

DD= Data Deficient LC = Least Concern NT = Near Threatened

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4. Discussion

In the waters of West Sulawesi had varied freshwater fish species and some common species include *Awaous ocellaris*, *Eleotris fusca*, *Giuris margaritacea*, *Sicyopterus lagocephalus*, *Sicyopterus longifilis*, *Stiphodon semoni*, *Sicyopus zosterophorus*, *Stenogobius genivittatus*, *Schismatogobius* spp., *Mugil cephalus*, *Ambassis interrupta*, dan *Ambassis miops*. Besides, from the eight research stations, the number of fish species from the Gobiidae family dominated each study station figure 3.

The results of research conducted by [3] found results, where species of the Gobiidae with 52 species dominate the waters in the Wallacea Region, especially in Sulawesi Waters, whereas for the Sunda Region it is dominated by the Cyprinidae with 132 species and the Sahul Region is dominated by Melanotaeniidae with 47 species. In addition, [3] stated that for the species of the Gobiidae spread over the Wallacea region, it consists of 52 species and 23 of them are endemic species that are only found in the Wallacea Region and generally in Indonesian waters, family Gobiidae is the second-largest group of fish after the family Cyprinidae. [27] states that from the taxonomic aspect it is known that the family Gobiidae is the group of fish with the largest number of species in the world with a number of species around 212 genera and 1,875 species that have been identified and their existence can be found in various types of waters in general [6,8].

Fish species that are only found in the downstream area are species from the genus *Ambassis*, *Mugil cephalus*, *Lutjanus argentimaculatus*, *Gerres filamentosus*, *Terapon jarbua*, *Aurigequula fasciata*, dan *Yarica hyalosoma*. While other species are scattered along the river flow, especially species from the Gobiidae which are spread from upstream to downstream in various types of river habitats, this is inseparable from the adaptation by several species of the Gobiidae that have the ability to immerse themselves in sand like species in the genus *Awaous* that live on sandy substrate, the ability to camouflage habitat by species of the genus *Schismatogobius* that live in rock crevices in rocky sand substrate and the ability to climb and pass fast-flowing rivers such as species in the subfamily Sicydiinae (e.g. *Sicyopterus*, *Sicyopus*, *Stiphodon*, *Smilosicyopus*) are generally found in upstream areas. Based on habitat distribution reported by [7] states that species of the genus *Sicyopus*, *Smilosicyopus*, *Lentipes*, and *Akihito* are only found in the middle course to upper course, whereas for species of the genus *Stiphodon* can only be found in the lower course to middle course and genus *Sicyopterus* can be found from lower course to upper course.

One of morphological adaptation to the species of the family Gobiidae is the modification of the pelvic fin that resembles a sucker to attach to rocks in a river and climb at waterfall through which it reaches the upper course. Sucker formed from pelvic fins united is a vital organ for amphidromous species because it is used to climb waterfalls and specifically for *Sicyopterus* as herbivore fish that consume algae attached to the rock surface is very helpful during the dredging process of algae to remain attached to the rock surface and in general, fish from the Gobiidae have sucker as adaptations for living in fast-flowing river [9–11].

The conservation status of fishes found in the waters of West Sulawesi is mostly in the least concern status considering deficient of studies related to bioecological aspects as supporting data to determine the conservation status of species in general. In addition to near threatened status species *Anguilla celebesensis* or commonly known as eel is an endemic species of Sulawesi known as one of the catadromous migratory fishes in the ocean during the spawning season and the larvae will return to the river until the adult. In addition to eel fish, other fish that are known as migratory fish are some species from the Gobiidae and species of the Eleotridae and that migrate amphidromous and to species of the migratory Gobiidae and also from the family Eleotridae are generally called as *amphidromous goby* fish.

In the waters of West Sulawesi, it is often found a group of goby fish postlarva which migrate very large numbers into the river and sometimes followed by a group of larvae of the eel fish that migrate at the same time, the people of West Sulawesi called it a Penja fish for the goby fish postlarvae and masapi fish for eel larvae. the migration incident made the local community make the process of fishing for migration a routine activity during the new moon. Data Deficient status is a species that has not been studied at all such as species *B. belobranchus*, *Smilosicyopus leprurus*, and *S. saurii*, specifically for *S.*

saurii species which were only discovered as new species in 2017 [12] and there are only information is available relating to taxonomic, distribution and DNA information as supporting data.

5. Conclusion

Overall, a total 771 individuals of freshwater fish consisting of 31 species from 10 families were found during study of the eight sites in waters of West Sulawesi including Ambassidae, Anguillidae, Gobiidae, Eleotridae, Mugilidae, Gerreidae, Apogonidae, Terapontidae, Lutjanidae, and Leiognathidae. The species of the Gobiidae family dominates at each research location in the waters of West Sulawesi and has a percentage of 49% of the total species obtained. The conservation status of the fish obtained is in the status of data deficient with 3 species, least concern with 28 species, and near threatened with 1 species. Distribution of fishes in the waters of West Sulawesi is spread throughout the Indonesian waters, and some of them are endemic to Sulawesi.

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