Mapping the Distribution of Fish Caught in the Jatigede Reservoir, Indonesia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final
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ABSTRACT

This research aims to map the structure of the fish community living in the floodplain of the Jatigede reservoir based on the catch. This research uses the field observation method, taking fish samples every 14 days and doing 6 times. The results of the survey show that the number of fish caught during the survey was 799 individuals, and the fish species identified at 6 stations of Jatigede Reservoir consisted of 9 families of 18 species. The fish species with the highest abundance was *Parambassis siamensis* at station 1. At stations 2, 3, 4, and 5, the fish with the highest abundance was *Hampala macrolepidota* and at station 6, the fish with the greatest abundance was *Oxyeleotris marmorata*. The distribution of native fish is more dominant than introduced fish with a comparison of 11 native fish species and 7 introduced fish species. The water quality at each station still meets the requirements of environmental quality standards according to Government Regulation (Indonesia) No. 22 of 2021 on Water Quality Standards and is suitable for fish life.

1. INTRODUCTION

The water of the Jatigede reservoir was undergoing an ecosystem change from a river ecosystem with running waters (Lotic) to a reservoir ecosystem with standing waters (Lentic) at the time of its flooding in 2015. The shift from a lotic ecosystem to a lentic ecosystem

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can affect changes in the abundance and composition of fish species and impact fish habitat, behavior, feeding habits, hiding from predators and fish reproduction will be disturbed. Riverine fish, especially diadromous fish, which are fish species that regularly move between fresh and marine waters, will lose their habitat or lose the opportunity to complete their entire life cycle [1]. This is consistent with Jubaedah's (2006) statement that changes in the ecosystem from flowing to flooded are likely to cause changes in species and fish population composition [2].

From 2015 to 2017, 19.750.600 fish have been stocked in the Jatigede reservoir. The types of fish stocked consisted of *Oreochromis niloticus*, *Osteochilus vittatus*, *Barbodes gonionotus*, *Barbodes orphoides*, *Barbodes baleroides*, *Cyprinus carpio*, *Tor duoronensis*, *Ctenopharyngodon idella*, *Chanos chanos*, *Pangasius hypophthalamus*, *Helostoma teminkii*, *Trichogaster pectoralis*, and *Macrobrachium rosenbergii*. The types of fish that are stocked are different each time they carry out activities. Based on Herawati's research (2017), 11 families of fish caught and identified in Jatigede Reservoir consisted of 25 species, namely *Barbodes baleroides, Diplocheilichthys pleurotaenia, Hampala macrolepidota, Mystacoleucus marginatus, Osteochilus vittatus, Osteochilus sp, Rasbora argyrotaenia, Barbodes gonionotus, Oreochromis niloticus, Oreochromis mossambicus, Trichogaster pectoralis, Chana striata, Liposarcus pardalis, Pangasius hypophthalamus, Mystus gulio, Chanos chanos, Mastacembelus erythrotaenia, Dermogenys maxillus, Barbodes scwanenfeldii, Barbodes orphoides, Clarias batrachus, Cyprinus carpio, Colossoma macropomum, Parachromis managuensis,* and *Amphilophus citrinellus* [3].

At the beginning of the flooding of the original fish species of the Cimanuk River, which increased in quantity and spread evenly, namely B. baleroides and H. macrolepidota. Catches in 2016 reached 25 kg to 50 kg per day, according to fishermen. In 2017, it has now dropped from 2 kg to 3 kg per day. The decrease in catches was due to the increase in the number of fishermen, the number and type of catches and the lack of institutions regulating fishing activities in Jatigede reservoir [4]. If excessive fishing continues and the catch resources are not managed, the fish in the Jatigede reservoir will eventually become extinct.

In order to support trap fishing activities, it is necessary to manage natural fisheries through stocking, introduction of fish and conservation. This management is one of efforts to increase the stock of caught fish to be stocked in the waters of Jatigede Reservoir. However, management to add fish stocks cannot be done haphazardly as the presence of new fish or introduced fish has no direct beneficial impact on Indonesia's aquatic ecosystems. This introduced fish is known to be aggressive and potentially invasive to native Indonesian fish [5].

Based on these conditions, it is necessary to study the distribution of fish through mapping. The mapping analysis required a system called the Geographic Information System (GIS). Arcview is one of the GIS tools that can visualize, examine (explore), answer (query), and analyze data geographically related to spatial and nonspatial data. The combination of GIS and studies on several ecological aspects of the fish community, such as distribution patterns, composition of fish species and structure of fish community, will be very useful to provide information on fish existence and sustainability [6]. Consistent with this statement, this research aims to map the structure of the fish community living in the floodplain of the Jatigede reservoir based on the catch.

2. MATERIALS AND METHODS

2.1 Time and Place

This research was conducted from August to October 2021 in Jatigede reservoir with fish sampling intervals every 14 days, 6 samples were taken, sampling was performed at 6 stations (Fig. 1).

2.2 Research Methods

The research method used in sampling fish is a field observation method with a targeted sampling technique. Fish caught were descriptively identified to provide a complete description of each fish species at each station.

2.3 Data Analysis

The data analysis used the quantitative-descriptive method by providing an overview of the species and abundance of fish. In addition, the data from the analysis is displayed on a map using the ArcMap GIS 10.3 software and Microsoft Excel. Catch composition analyses, water quality measurements and physical and

chemical measurements such as temperature, light transparency, carbon dioxide (CO_2), acidity (pH) and dissolved oxygen (DO) were carried out in Jatigede reservoir. For fish identification and chemical measurements, ammonia (NH_3) was analyzed at the Laboratory of Water Resources Management, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

3. RESULTS AND DISCUSSION

The composition of fish caught in the Jatigede Reservoir was 799 individuals, covering 18 species from 9 families. The following is the composition of caught fish during the research (Table 1).

The results showed that the distribution of native fish in Jatigede Reservoir was more dominant

than that of introduced fish in Jatigede Reservoir, identifying a ratio of 11 native fish species and 7 introduced fish species. 18 species of fish are caught at all stations, the fish included in Red List status were *O. marmorata*, *M. Singaringan*, *M. marginatus*, *R. argyrotaenia*, *P. siamensis*, *L. pardalis*, *O. niloticus*, *H. macrolepidota*, *B. baleroides*, *P. hypophthalamus*, *M. nigriceps*, *P. managuensis*, *A. citrinellus*, *H. nemurus* and *G. giuris* with the Least Concern (LC) category. Meanwhile, *C. carpio* and *O. mossambicus* are included in the *Vulnerable* (VU) category and *D. maxillus* are included in the *Data Deficient* (DD) category.

The LC category is a category for species that have been assessed but do not fall into any category. While the VU category is Vulnerable or Near Vulnerable, this category is given to
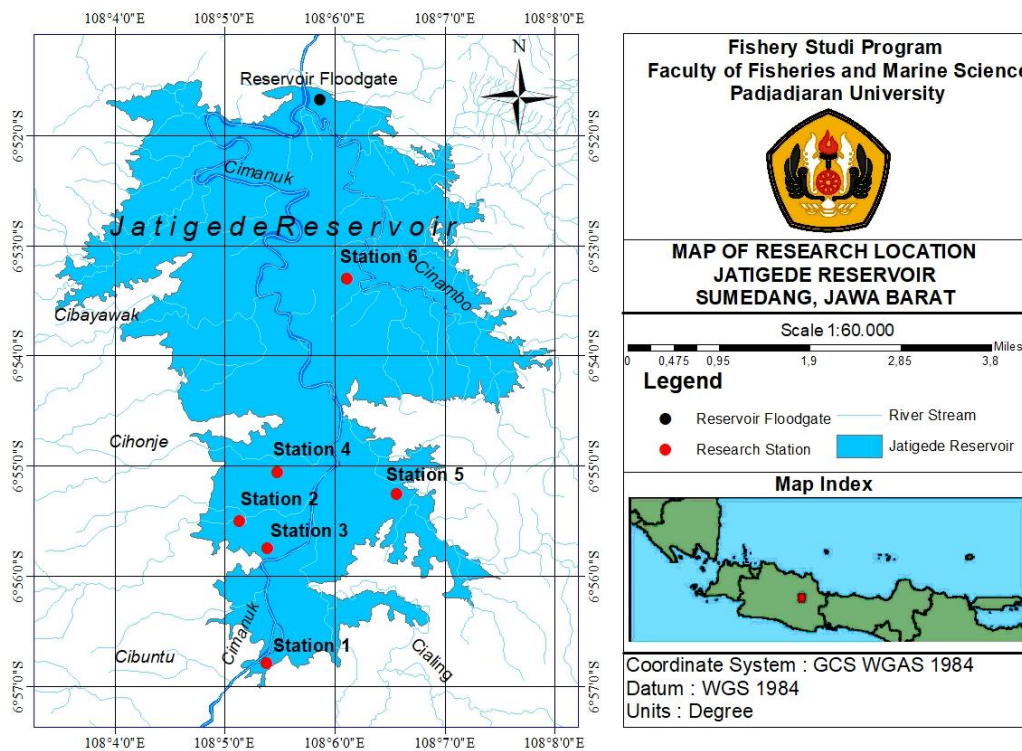

Fig. 1. Research Location Map

Station 1:	The main inlet is sourced from the Cimanuk River, this station is a riverine zone. With coordinates 6°55'48,9"S & 108°5'24,0"E
Station 2:	The riverine zone that flows from the cialing river. With coordinates 6°55'50,2"S & 108°5'42,3"E
Station 3:	The location where water comes from two small rivers, namely the Cimuja River and the Cijajaway River. This station is *riverine zone*. With coordinates 6°55'59,3"S & 108°5'01,2"E
Station 4:	The transition zone with water supply comes from the Cihonje River, Cimuja River, and Cacaban River. At station 4 there is a catch fishery activity. With coordinates 6°55'02,9"S & 108°5'28,3"E
Station 5:	The estuary of the Cacaban River and the beginning enter the flooded zone. At station 5 there are fishing activities using gillnets. With coordinates 6°55'18,0"S & 108°6'45,6"E
Station 6:	The location of station 6 is a flooded zone. At this station, there is rarely catch fishery activity because of the strong winds. with coordinates 6°54'23,6"S & 108°6'19,9"E

Table 1. Types of fish caught in Jatigede Reservoir

Family	Local Name	Common Name	Scientific Name	Based On Origin			Based On Biodiversity		Station					
				Native	Introduced	Invasive	Protected	Prohibited	1	2	3	4	5	6
Cyprinidae	Genggehek	*Beardless barb*	*Mystacoleucus marginatus* (Valenciennes, 1842)	√			√LC		1					
	Paray	*Silver rasbora*	*Rasbora argyrotaenia* (Hubbs & Brittan, 1954)	√			√LC		1					
	Goldfish	*Common carp*	*Cyprinus carpio* (Linnaeus, 1758)		√	√VU			5		3	4	8	
	Hampal	*Hampala barb*	*Hampala macrolepidota* (Kuhl & Van Hasselt, 1823)	√			√LC		43	30	17	30	65	
	Lalawak	*Barbodes / Java barb*	*Barbodes baleroides* (Valenciennes, 1842)	√			√LC		27	17	12	6	21	
Cichlidae	Nila	*Nile tilapia*	*Oreochromis niloticus* (Linnaeus, 1758)		√	√LC			3	1	5	3		
	Mujair	*Mozambique Tilapia*	*Oreochromis mossambicus* (Peters, 1852)		√	√VU			5			4		
	Marinir	*Jaguar guapote*	*Parachromis managuensis* (Gunther, 1867)		√	√LC			1			3		
	Oscar	*Midas cichlid*	*Amphilophus citrinellus* (Gunther, 1864)		√	√LC			5		1	4	4	
Bagridae	Senggaringan	*Bagrus singaringan*	*Mystus Singaringan* (Bleeker, 1846)	√			√LC		1				1	
	Keting	*Twospot catfish*	*Mystus nigriceps* (Valenciennes, 1840)	√			√LC		5					
	Tagih	*Asian redtail catfish*	*Hemibagrus nemurus* (Valenciennes, 1840)	√			√LC		3			2	2	
Eleotridae	Boboso	*Marble goby*	*Oxyeleotris marmorata* (Bleeker, 1852)	√			√LC		13			1		12
Gobiidae	Bungo	*Tank goby*	*Glossogobius Giuris* (Hamilton, 1822)	√			√LC		136					1
Ambassidae	Pepetek	*Ponyfishes*	*Parambassis siamensis* (Fowler, 1937)	√			√LC		233			1		
Loricariidae	Sapu-Sapu	*Common pleco*	*Liposarcus pardalis* (Castelnau, 1855)		√			√LC	32	4	4	6	2	
Pangasiidae	Patin	*Silver catfish*	*Pangasius hypophthalamus* (Valenciennes, 1840)		√	√LC			1		3	3	3	
Hemiramphidae	Julung-Julung	*Wrestling half beak*	*Dermogenys maxillus* (Kuhl & Van Hasselt, 1823)	√			√DD		1					
Presentase (%)				61%	39%	33%	61%	6%						

Source: IUCN Redlist and Fishbase.org
Description: LC= Least Concern, VU= Vulnerable, DD= Data Deficient

species that are threatened with future extinction in the wild. And the DD category is a taxon that is declared "uninformed" when the available information is insufficient to estimate its risk of extinction based on the distribution and status of the population [7].

3.1 Fish Abundance

The abundance of fish at each station in the waters of the Jatigede Reservoir during the research can be seen in Fig. 2.

The fish with the highest frequency at Station 1 was *P. siamensis*, Stations 2, 3, 4 and 5 were H. macrolepidota, and at Station 6 O. marmorata. Fish species that have a high abundance value rely on their ability to adapt to the environment and use the potential of existing resources to meet their living needs. According to Gonawi (2009), Individuals who are in groups or *schools* and have large numbers can affect the high frequency, since they are usually found in very abundant amounts with each identification [8].

3.2 Mapping the Distribution of Fish Species

The mapping of the distribution of fish species in the Jatigede Reservoir based on fish abundance can be seen in (Fig. 3).

The distribution of fish species in Jatigede Reservoir can be distinguished based on origin, namely native fish (indigenous) and introduced fish, and differentiated based on protected fish species based on data from the IUCN (International Union for Conservation of Nature and Natural Resources) Redlist The results showed that the distribution of native fish in the Jatigede Reservoir was more dominant than the introduced fish in the Jatigede Reservoir with a ratio of 11 native fish species and 7 introduced fish species.

At Station 1, the fish identified were *O. marmorata*, *M. Singaringan*, *M. marginatus*, *R. argyrotaenia*, *P. siamensis*, *L. pardalis*, *O. niloticus*, *C. carpio*, *H. macrolepidota*, *B. baleroides*, *P. hypophthalamus*, *M. nigriceps*, *O. mossambicus*, *P. managuensis*, *A. citrinellus*, *H. nemurus*, *P. siamensis*, *G. giuris*, and *D. maxillus*. There are 11 native fish species and 7 introduced fish. At Station 2, the identified fish were *H. macrolepidota*, *B. baleroides*, *O. niloticus* and *L. pardalis*. There are 2 native fish species and 2 introduced fish. At Station 3, the
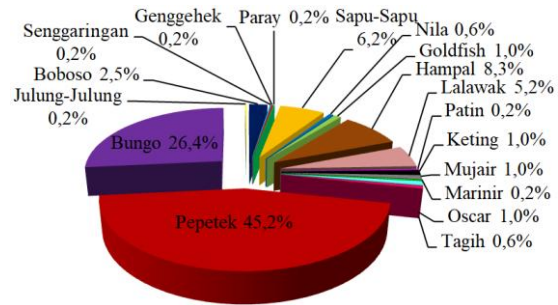
identified fish were *H. macrolepidota*, *O. niloticus*, *C. carpio*, *A. citrinellus*, *P. hypophthalamus*, *B. baleroides*, and *L. pardalis*. There are 2 native fish species and 5 introduced fish. At Station 4, the identified fish were *H. macrolepidota*, *B. baleroides*, *O. niloticus*, *P. managuensis*, *O. marmorata*, *L. pardalis*, *P. hypophthalamus*, *A. citrinellus*, *C. carpio*, *O. mossambicus*, *H. nemurus*, and *P. siamensis*. There are 5 native fish species and 7 introduced fish. At Station 5, the identified fish were *H. macrolepidota*, *B. baleroides*, *C. carpio*, *A. citrinellus*, *M. Singaringan*, *L. pardalis*, *P. hypophthalamus*, and *H. nemurus*. There are 4 native fish species and 4 introduced fish species. At Station 6, the identified fish were *O. marmorata* and *G. giuris*. There are 2 native fish species.
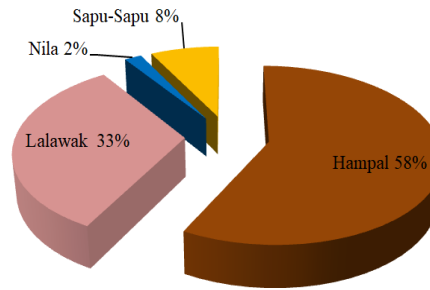
3.3 Water Quality of Jatigede Reservoir

The results of observations of physical and chemical parameters can be seen in (Table 2).

The results of the temperature measurements in the Jatigede reservoir were between 28.0^{o}C and 28.6^{o}C. The temperature range showed that the Jatigede reservoir's water conditions were still good to support fish life. Aquatic organisms such as fish and shrimp can live well in the temperature range between 20°C and 30°C [9]. The range of temperature values is in accordance with Government Decree No. 22 of 2021, the temperature value in class II and III waters is a deviation of 3. Thus, the temperature value in Jatigede reservoir has met the water quality standards. The results of measuring the light transmittance in the Jatigede reservoir ranged from 43 cm to 81 cm. The level of transparency is affected by suspended matter in the form of fine particles and colloids that can cause turbidity and a lack of light entering the water. High turbidity can cause disturbances in the osmoregulation system such as respiration and disrupt the life of fish when foraging due to visual impairment and cause stress and even death of fish.
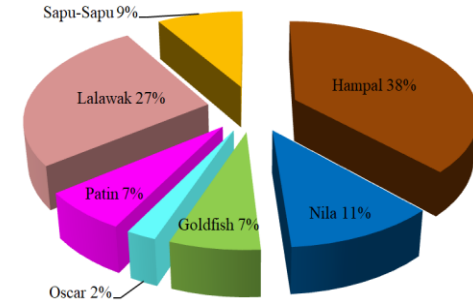
The results of the pH measurements in the Jatigede reservoir were between 6.0 and 7.1. The pH achieved in the water of the Jatigede reservoir is still good enough to support the life of aquatic organisms such as fish. According to the Government Decree No. 22 of 2021, the pH in class II and III waters is 6 to 9. Thus, the pH in Jatigede reservoir has met the quality standard for fisheries. The results of the CO_2 measurements in the Jatigede reservoir at each
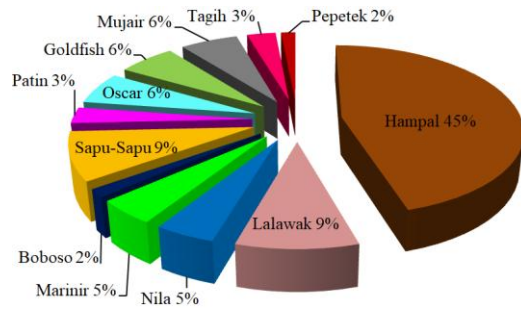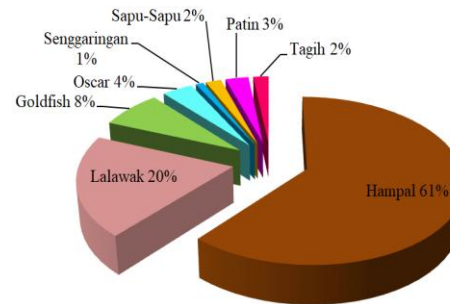
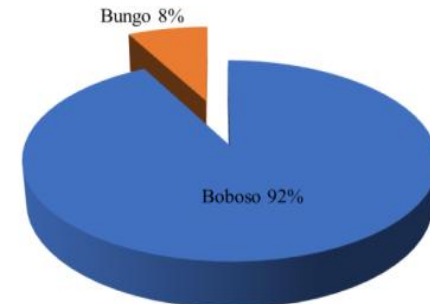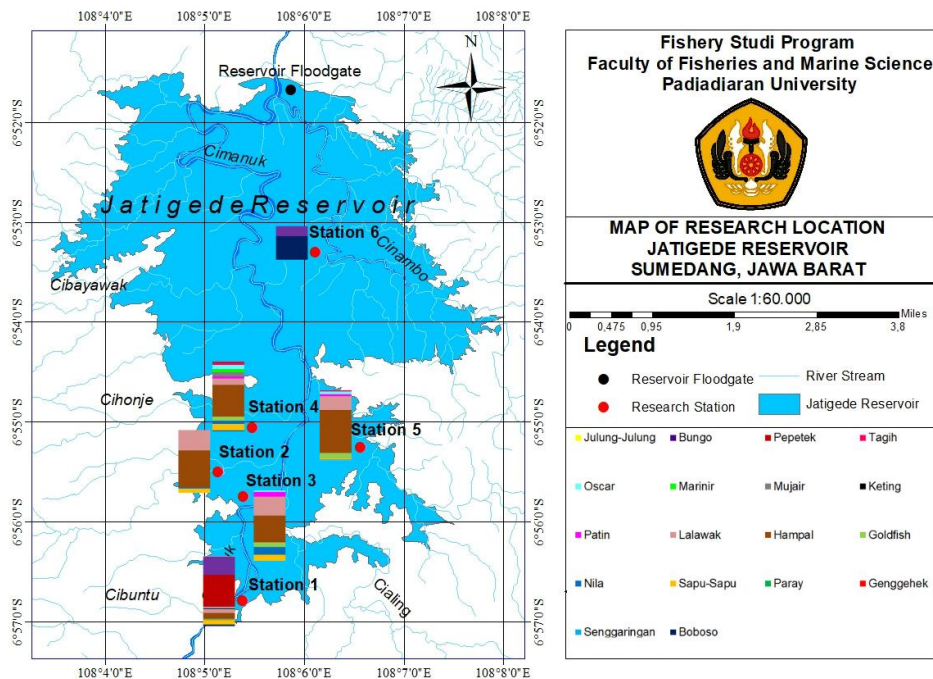**Fig. 2. Graph of Fish Abundance Caught at Stations 1,2,3,4,5, and 6**

Fig. 3. Map of Fish Species Distribution of Jatigede Reservoir

Table 2. Water quality parameters

Parameters	Unit	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Class II*	Class III*
Physical									
Temperature	^{o}C	28.0	28.3	28.4	28.2	28.4	28.6	Dev 3	Dev 3
Light transparency	cm	45	47	43	65	69	81	-	-
Chemical									
pH	-	6.0	6.6	7.1	6.8	6.1	6.3	6-9	6-9
CO_2	mg/L	33.3	23.3	23.3	20.0	26.7	20.0	-	-
DO	mg/L	5.50	4.63	5.13	5.43	4.53	5,53	4	3
NH_3	mg/L	0.0025	0.0023	0.0030	0.0025	0.0018	0.0028	0,2	0,5

station ranged from 20.0 to 33.3 mg/L. In general, the carbon dioxide level in the water is between 10 and 30 mg/L, this range is very good for aquatic plants and not harmful for fish. However, if when it is more, it become very dangerous because it inhibits the binding of oxygen (O_2), and when the CO_2 level exceeds 40 mg/L, the fish die [10]. The range of CO_2 values in the water of the Jatigede reservoir is therefore still quite good for aquatic organisms such as fish.

The results of measuring the dissolved oxygen in the Jatigede reservoir at each station ranged from 4.53 to 5.53 mg/L. When the concentration of dissolved oxygen decreases, it affects aquatic organisms, especially organisms like fish. According to Government Decree No. 22 of 2021, the DO value in Class II waters is 4 mg/L and Class III is 3 mg/L. So the DO value in

Jatigede reservoir at each station still meets the fish life quality standards. The results of the analysis showed that the ammonia level in the water of the Jatigede reservoir was between 0.0018 and 0.0030 mg/L. This value is determined by the water quality standards according to the Government Decree no. 22 In 2021, the ammonia value in class II water is 0.2 mg/L and class III is 0.5 mg/L. Thus, the ammonia levels in the water of the Jatigede reservoir at each station still meet the quality standards for fish life. According to Makmur *et al.* (2012) Ammonia in the aquatic environment generally originates from the decomposition of organic matter and the results of fish metabolism [11]. The higher the organic matter in the water, the higher the concentration of ammonia in the water. High levels of ammonia can damage fish organ systems and damage fish gill tissues [12].

27

4. CONCLUSION

Fish species identified at 6 stations in Jatigede Reservoir consisted of 9 families, namely Cyprinidae, Cichlidae, Bagridae, Eleotridae, Ambassidae, Loricariidae, Pangasiidae, Gobiidae, and hemiramphidae which consisted of 18 species. The distribution of native fish in the Jatigede Reservoir is more dominant than the introduced fish in the Jatigede Reservoir with a ratio of 11 native fish species and 7 introduced fish species. The water quality at each station still meets the requirements of environmental quality standards based on Government Regulation No. 22 of 2021 concerning water quality standards and is suitable for fish life.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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