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The Guild Composition for Modelling Fish Community in Banjaran River, Purwokerto

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Abstract

Over exploitation of consumed fishes causes declining of targeted fish populations that will lead to a cascade effect to the guild compositions. The change of carnivorous, omnivorous and herbivorous fish populations drives to the food chain destructions and unstable ecosystems. The objective of this study was to build fish community modelling based on guild compositions. This study was conducted on fish communities in the Banjaran River. The data collected were species richness, the abundance of fish and the guild composition among carnivore, herbivore, and omnivore. Survey and purposive random sampling technique were applied and Banjaran River was divided into five sites based on the physical characteristics of the environment and fishing activities. Species richness data were analyzed by ANOVA, the composition of the carnivorous, omnivorous and herbivorous fish was analyzed descriptively based on the guild pyramides. About 115 individuals consist of 17 species belong to 5 families were found. The species richness in the five sites in was relatively similar ($P > 0.05$ ($P = 0.269$)). The fish community in site 3 had the balanced composition which was composed by 3% carnivores, 21.2% omnivores and 75.8% of herbivores. This fish community modelling could be an an alternative way to manage fish community. By controlling the carnivorous fish population, the natural resource especially fish as food resource will sustain and the species loss will be prevent.

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INTRODUCTION

Fishing activity in rivers is one of the threats to fish community. The exploitation of commercial fish will drive a decline in targeted fish population. The further consequence is the change of composition of the fish community or known as guild composition based on their feeding preference (herbivore, carnivore and omnivore). For example is the ratio of *Clarias batrachus* and *Poecilia reticulata* as the predator and prey in Bureng River, Gendanglegi Sub-district, Malang Regency that was 1:55 causing imbalances in both population sizes and fish community (Mahendra *et al.,* 2013)? Also, the dominance of predators up to 87% causing imbalance fish community in the Penjalin Reservoir, Central Java (Hedianto *et al.*, 2013). A predator mostly is carnivorous fishthat will destruct the food chain and drive to unstable ecosystems. The same case could happen in Banjaran River, therefore, modelling the fish community which requires an information of species richness and the composition of fish community based on the guild of each species (the carnivore, omnivore, and herbivore) is urgently required.

The guild composition of fish community is often more stable in time rather than the species composition of community. Since the species within a guild can take over each other functional role following the fluctuation community. The use of ecological function groups or guilds of fish have been recognized (Elliot & Whitfield, 2011; Mourao *et al.,* 2014) and known to be able to provide a better understanding of assemblages of fish community and as a useful tool to describe ecosystem service, assessing the anthropogenic pressure which threat the fish diversity.

The Banjaran River requires more attention since the human population increases and human activity becomes more intensive which often affect the freshwater fish diversity. As a tributary of Logawa River, this river is occupied by 35 species, some of them are predator fish (*Channa gachua*, *Channa striata,* and *Mystus microchantus*) (Lestari, 2004). However, there is no further information about the ratio of the carnivorouses, omnivorous, and herbivorous fish in Banjaran River. Thus, this research was conducted to evaluate: the species richness (S), the compositions of carnivorous, omnivorous, and herbivorous fish and to build a fish community modelling. A model of fish community management can be constructed based on this guild composition. This model of fish community management is needed for preventing fish extinction and maintaining the freshwater fish diversity toward sustainability of natural resources.

METHODS

The objects of this research were fish and water samples from Banjaran River. The sampling method was performed with two different kinds of nets i.e. 2.0 x 2.0 cm^2 and 1.5 x 1.5 cm^2. The nets were chosen based on their ability to be used in more favorable conditions in term of depths and extension of sites. During the fish collection, the nets were set in a random configuration with 10 trawls for approximately 100 minutes (Lestari, 2009). The specimens of fish were collected during day time only (07:00 AM until 04.00 PM). Then the collected fish was identified using Saanin (1984); Kottelat *et al.*, (1993). The specimens were identified based on morphological characteristics and then the name of species was verified by comparing to the information in http://www.fishbase.org (Fishbase, 2017).

The environmental condition of the Banjaran River was determined by measuring physical and chemical parameters employed APHA standard procedure (APHA, 2012). Depth, light, current, water temperature and substrates were measured *in situ.* The chemical parameters such as pH, DO (Dissolved Oxygen) and BOD (Biological Oxygen Demand) were assessed in the Ecology Laboratory, Faculty of Biology, Universitas Jenderal Soedirman.

Study Site

This research was conducted in the Banjaran River by surveying and applying purposive random sampling technique. The Banjaran River was divided into five sites based on differences in physical characteristics and estimation number of fisherman (Table 1). Each site was observed four times with two weeks interval.

For each site, the number of fish species was reported in term of an absolute species richness (S) (Magurran, 2004; Krebs, 2009). The fish species richness obtained by calculating a total number of species captured in each site The guild composition constructed by counting of all the carnivorous, omnivorous, and herbivorous fish.

The guilds of fish were observed based on morphology and digestive tract particularly tooth types, gill filter, and ratio length of the intestine (Burhanuddin, 2014). Most of carnivorous fish possess a canine type of teeth which are long, harp and shaped like a cone or curved. The herbivorous fish have a molar type of teeth which are broad and flat. (Florida Museum, 2017). The length of the intestine is related to the trophic sta-

Table 1. Description of Study Sites

Site	Description	Fishing Activity	Coordinate
1	The width of water body was 24.00 m with a swift current. The composition of substrate is 85% large rocks and 15% gravel. The surrounding areas consist of 75% agriculture, 10% settlement, and 15% open land.	Fishing activity by ± 3 peoples a day	07°22'072'' S 109°13'216'' E
2	The width of the water body is 17.20 m with fast current. The composition of substrate is 65% large rocks, 25% gravel, and 10% sand. The surrounding areas consist of 50% agriculture and 50% settlement.	Fishing activity by ± 6 peoples a day and fish cultivation ponds	07°23'664'' S 109°13'393 E
3	The width of the water body is 18.60 m with a slightly fast current. The composition of substrate is 50% stones and 50% gravel. The surrounding areas consist of 5% agriculture and 95% settlement	Fishing activity by ± 4 peoples a day, fish cultivation ponds and fish market.	07°25'055'' S 109°13'393 E
4	The width of the water body is 22.50 m with slow current. The composition of substrate is 50% medium stone, 30% gravel and 20% mud The surrounding areas consist of 10% agriculture, 80% settlement and 10% open land	Fishing activity by ± 8 peoples a day	07°26'209'' S 109°12'947'' E
5	The width of the water body is 34.00 m with the very slow current. The composition of substrate is 40% gravel, and 60% mud. The surrounding areas consist of 65% agriculture and 35% settlement.	Fishing activity by ± 5 peoples a day, fish cultivation ponds and center of seed cultivation	07°27'466'' S 109°12'836'' E

tus of the species and the lengths are ordered as follows carnivorous < omnivorous < herbivorous < detritivorous fish (Wagner et.al, 2009)

Data Analysis

Differences in the number of fish species or species richness (S) in each site were statistically analyzed by Analysis of Variance (ANOVA) test using SPSS software. The composition of the guild in each site was analyzed descriptively in the form of a pyramid chart. The water quality parameters were analyzed descriptively as habitat requirement of fish.

RESULTS AND DISCUSSION

Species Richness of Fish in the Banjaran River

The results showed that 115 individuals of 17 fish species were captured from Banjaran River. These species belong to 5 families: Bagridae, Channidae, Cichlidae, Cyprinidae, and Loricariidae, and dominated by Cyprinidae with 10 species (Table 2). The domination of Cyprinidae was also reported by previous studies i.e. by Nuryanto *et al*. (2016) and Lestari (2004). This family composed by 6 species in Cijalu River, Cilacap, and 7 species in Logawa River, Banyumas, Central Java. Data of this study showed that Banjaran River had more Cyprinid fish compared to the other two studies mentioned before. . Among those 10 species of cyprinid, four species *Puntius orphoides*, *Osteochillus vittatus*, *Cyprinus carpio* and *Barbonymus gonionotus* are well known as common domesticated fish (Susatyo *et al.*, 2016 & Seetyaningrum *et al.*, 2017)

The species richness (S) in 5 sites of Banjaran River was relatively similar with $P > 0.05$ ($P = 0.269$). Among 5 sites, site 2 and 3 had the highest species richness with 8 species, and the lowest species richness was reported from site 5

that only 5 species was recorded. The most possible cause of this condition is related to the fishing activities. In site 5, more frequently people come for capturing fish that causing the overexploitation of *Osteochillus vittatus* and *Channa striata*. Over exploitation a certain species in Kampar Kiri River resulted in significantly decreased of fishery production (Simanjuntak *et al.*, 2006)

O vittatus, B gonionotus, Oreochromis sp *and R. argyrotaenia* were common species. These species well adapted to current, they can live rift and pool part. The same results were recorded *B. gonionotus* and *O. niloticus* were common in in Gajah Mungkur Reservoir, Wonogiri (Sriwidodo *et al.*, 2013) and *O. vittatus* and *R. Argyrotaenia* were common species in Cijalu River, Cilacap, Central Java (Nuryanto *et al.,* 2016). Meanwhile, *H. nemurus, C. carpio, O. hasselti, C. auratus, C. striata*, and *O. mossambicus* were rare species, due to these species are targeted by the peoples. Even, *H. nemurus, O. hasselti, C. striata* were the most targeted fish in Kampar Kiri River (Simanjuntak *et al.*, 2006).

The Guild Compositions of Fish Community

The sevenfteen fish species found composed of 3 carnivores, 7omnivores, and 7 herbivores (Table 3 and Figure 1). The abundance of carnivores, omnivores, herbivores, were 3, 49, and 63 individuals respectively. Species with the highest abundance was herbivores by 55%, this was a result of plant abundance in this river (Schmitz, 2009). The herbivores was dominated by *O. vittatus* with 35 individuals and omnivores was dominated by *R. argyrotaenia* with 24 individuals. Kow *et al.* (2016), reported that both species have the capability to adapt to changes of water quality in Madek, Mengkibol, Dengar, and Ulu Dengar Rivers, Johor, Malaysia.

Figure 1 demonstrates that fish community in the Banjaran River was dominated by herbivores (55 %). Refers to Schmitz (2009), the fish community should consists of more herbivore than carnivore in trophic level. The same result was obtained by Hussain *et al*. (2016), in Indus River, Pakistan that collected 42% herbivore, and both of omnivore and carnivore were 28%. Ko-

Table 2. Species Richness of Fish in Banjaran River

Species	Site					Total
	1	2	3	4	5	
Bagridae						
Hemibagrus nemurus	1	-	-	-	-	1
Channidae						
Channa striata	-	-	-	1	-	1
Cichlidae						
Oreochromis mossambicus	-	-	-	-	1	1
Oreochromis sp.	-	7	7	1	5	20
Cyprinidae						
Barbonymus gonionotus	1	6	2	1	1	11
Carrasius auratus	-	-	1	-	-	1
Cyprinus carpio	-	1	-	-	-	1
Osteochilus hasselti	-	-	2	-	-	2
Osteochilus vittatus	3	4	15	10	3	35
Puntius binotatus	4	1	-	-	-	5
Puntius orphoides	-	1	1	-	-	2
Rasbora argyrotaenia	5	4	4	11	-	24
Rasbora lateristriata	3	-	-	1	-	4
Tor tambroides	1	3	-	-	-	4
Loricariidae						
Pterygoplichthys pardalis	-	-	1	1	1	3
Total Individuals	18	27	33	26	11	115
Total Species	7	8	8	7	5	15

Table 3. The Guild Composition of Fish Community in Banjaran River

Guild	Species	Individuals	Total
	Channa striata	1	
Carnivore	*Hemibagrus nemurus*	1	3
	Oreochromis sp.	1	
	Carrasius auratus	1	
	Oreochromis sp.	9	
	Puntius binotatus	5	
Omnivore	*Puntius orphoides*	2	49
	Rasbora argyrotaenia	24	
	Rasbora lateristriata	4	
	Tor tambroides	4	
	Barbonymus gonionotus	11	
	Cyprinus carpio	1	
	Pterygoplichthys pardalis	3	
Herbivore	*Oreochromis mossambicus*	1	63
	Oreochromis sp.	10	
	Osteochilus hasselti	2	
	Osteochilus vittatus	35	

enigstein *et al.*, (2016) considered that the predator-prey interaction are a primary determinant of fish community assemblage. 1. The change of predator population in size will effect triggered by impacting directly on elements of food web. Therefore, controlling predator population size can be apply in top-down fish community management.

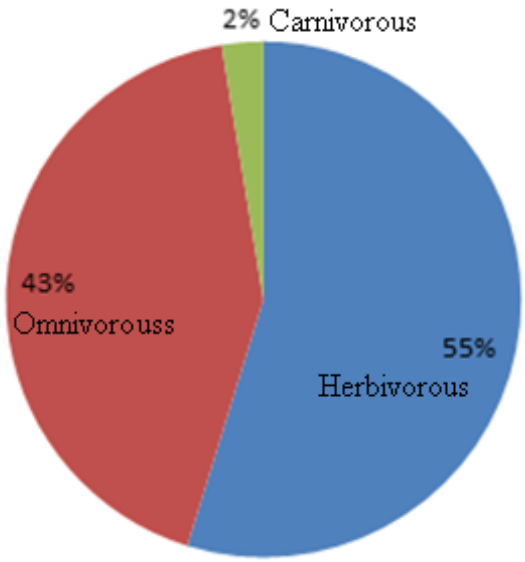

Figure 1. The Guild Composition of Fish Community in Banjaran River

The compositions of carnivore, omnivore, and herbivore are not only related to the food web but also to trophic levels. Mostly, 10% of energy was transferred to the higher trophic level and only 1% of transferred energy was received (Campbell *et al.*, 2012). Concerning of these amount of energy, the compositions of carnivore, omnivore, and herbivore fish in Banjaran Rivers seems to be a healthy composition

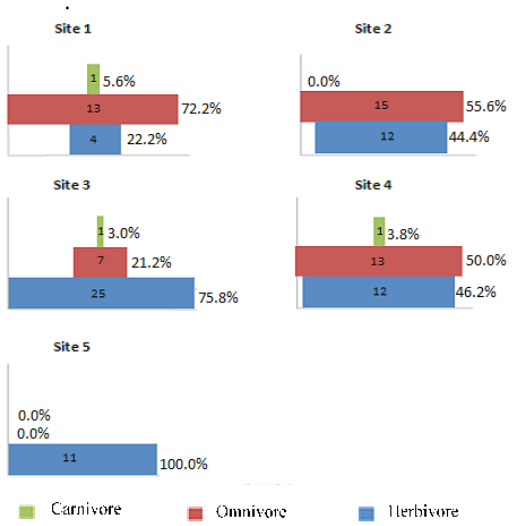

Figure 2. Comparison of Guild Compositions in 5 Sites of Banjaran River

The Figure 2 shown that the balanced guild composition was found in site 3. This fish

community composited by 3% carnivore, 21.2%, omnivore, and 75.8% herbivore. While, imbalanced compositions were detected in site 2 and 5 due to an absence of predator in both sites and an absence of omnivore in site 5. The reason for this phenomenon was the sampling was performed after people went fishing. Usually, people prefer to get *Osteochillus vittatus*, *Oreochromis* sp and *Channa striata*. The carnivorous fish such as *H nemurus and C striata* (Simanjuntak et.al*.,* 2006) and omnivorous fish such as *Oreochromis* sp. and *P. Orphoides* (Hadisusanto & Suryaningsih, 2011) are the most wanted species in order to fulfill the domestic needsThe numbers of omnivorous fish were higher than herbivorous fish in site 1 and 4. The omnivorous fish are able to utilizes plants and animal food resources (Albrecht *et al.*, 2009). This lead to them to be able to occupy a higher or lower trophic levels. So, fish communities in these sites seem to be in unbalanced compositions. The portrait of guild composition in site 3 consider to be promoted as a good model of fish community in Banjaran River. The management of fish community can be conducted by controlling the number of carnivores since this guild will regulate the number of omnivore and herbivores.

Scheme 1 demonstrates that the stability of fish community will remain if the community composited by 3 guilds. In this case, one individual of carnivorous fish (3%) was supported at least by 7 individuals of omnivorous fish or 21.2%. Then the omnivorous fish needed 25 individuals of herbivorous fish (75.8%) for live. In scheme 2, if carnivorous fish increases by 0.8%, this guild group should supported by 50% of omnivores for living. Then, as a result, the herbivorous fish decreases 46.5%. On the other hand, the absence of carnivorous fish leads to omnivores increases up to 55.6% and herbivores decreases up to 44. %.(Scheme 3). It is obvious that the stability fish community can be manage by controlling carnivorous fish population (Figure 3).

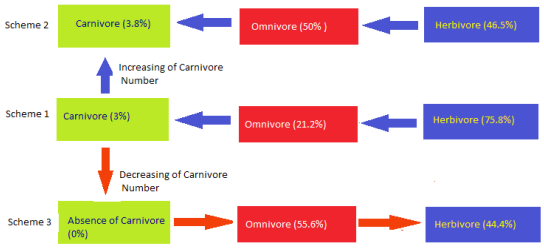

Figure 3. The Management Model of Fish Community in the Banjaran River.

The Water Quality of Banjaran River.

The results of physical and chemical parameters measurement in Banjaran River are presented in Table 2.

Liboriusen *et al.* (2005) stated that an ideal light penetration for aquatic organisms is >45 cm. According to Evans (1999), the suitable water temperature of fish is 25-30°C, so that the Banjaran River provides suitable habitat for fish. The others study also reported in Juwana Pati River with depth of 90-110 cm, light penetration of 12-34 cm, and temperature of 24-29°C (Purwanto *et al.*, 2014) and in Banjaran River with light penetration of 20-63 cm (Amelia *et al.*, 2014) fish can survive. The other studies also reported that fish survive lives in rivers. Such as in Juwana Pati River with depth of 90-110 cm, light penetration of 12-34 cm and temperature of 24 -29 °C (Purwanto *et al.*, 2014) and in Banjaran River with light penetration of 20-63 cm (Amelia *et al.*, 2014). The pH in the study sites ranged from 6.83 to 7.63 which seems to be optimal condition for fish as reported by Evans (1999). This result is relatively similar to pH of Cikaro River Bandung (6-7.5) (Permana *et al.,* 2015). The BOD level was 0.07-2.89 ppm while the DO was 4.44-12.72 ppm. This indicated that Banjaran River already receives sufficient organic matter. For living, fishneeds DO at least 3.00 ppm (Haryono, 2004). Based on those water quality parameters, the Banjaran Ri-

Table 2. Physical and Chemical Parameters of Banjaran River

Site	Parameter						
	Depth	Light Penetration	Current	Water Temperature	pH	DO	BOD
	(cm)	(cm)	m/s	°C	(unit)	(ppm)	(ppm)
1	80.00-93.00	16.50-93.00	0.55-1.11	22.00	6.83-7.46	5.32-12.72	0.33-2.89
2	56.00-89.00	40.00-80.00	0.38-1.42	24.00-27.00	7.19-7.50	4.44-6.96	0.49-2.19
3	55.00-83.00	44.00-64.00	0.76-1.25	24.00-27.00	7.30-7.63	5.08-7.60	0.05-1.50
4	75.00-100.00	21.50-49.50	0.60-1.11	25.00-26.00	7.13-7.44	4.56-7.60	0.09-1.81
5	41.00-60.00	14.50-44.00	0.66-0.83	24.00-26.00	7.15-7.47	6.18-8.16	0.07-1.86
Range	41.00-100.00	14.50-93.00	0.38-1.42	22.00-27.00	6.83-7.63	4.44-12.72	0.07-2.89

ver provides suitable habitat for fish.

The fish community modelling based on guild compositions is an alternative way to manage fish community. The advantage of this model is by controlling population of the carnivorous fish, the natural resources especially fish as food resource will be sustain and the species loss will be prevent.

CONCLUSION

There were 115 fish individuals which consistend of 17 species and belonged to 5 families were captured from Banjaran River and dominated by Cyprinidae with 10 species. Fish community in Banjaran River has normal composition of carnivorous, omnivorous and herbivorous fish. The fish community modelling based on guild composition can be apply for maintaining sustainable fish resources and preventing species loss.

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