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Fish Community Structure and Ecological Health Assessment of the Shuaishui River Basin, China

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ABSTRACT

The Shuaishui River originates from the southern mountainous area of Anhui Province and is an important water source for local residents. The ecological environment of this basin has been seriously damaged because of the effects of human disturbance. In August 2016, a field study of five units of the Shuaishui River Basin was conducted to understand the fish community structure and assess the ecological health status. A total of 43 fish species were collected from the entire river basin, and they belonged to 4 Orders, 10 Families, and 31 Genera. The maximum number of species belonged to the family Cyprinidae, and the main trophic guild was omnivorous fish. Among the five units, species number was the highest in unit 2 (27 species) and the lowest in unit 3 (12 species). The dominant species in the five units were mainly typical mountain-stream fish, such as *Zacco platypus*, *Acrossocheilus fasciatus*, and *Vanmanenia stenosoma*. In some areas, *Varicorhinus barbatulus* or *Rhinogobius cliffordpopei* also showed great dominance because of the impacts of the local habitat conditions. Redundancy analysis showed that altitude, water velocity, stream order, and water surface width were the main factors that influenced the distribution and species composition of the fish. Eigenvalues of the first two axes were 0.183 and 0.082 and explained 40.9% and 18.3% of the species-environment relationship variables, respectively. The ecological health of the five units and the entire basin was assessed based on the arithmetic mean of three indicators, namely, number of classification units, Shannon-Wiener index, and Berger-Parker dominance index. The results indicated that the ecological health status was relatively poor in unit 3, general in units 1 and 5, and good in units of 2 and 4. The status of the entire basin was general. To the best of our knowledge, this is the first comprehensive assessment of the ecological health of the Shuaishui River Basin, and it has great significance for the ecological management and protection of this basin.

INTRODUCTION

China has the most amount of island waters worldwide (Wan 2016). However, most watersheds in China are experiencing various degrees of water pollution, decline in species diversity, ecosystem degradation, and other problems because of the rapid development of the economy, irrational use of water resources, and increased discharge of sewage. The ecological health of watershed ecosystems has become one of the most important factors that restrict sustainable development of the socio-economy (Department of Nature and Ecology Conservation, Ministry of Environmental Protection of China 2014). To effectively assess the ecological health of watershed ecosystems, physical, chemical, and biological methods have been used by some researchers in China (Wan 2016). Recently, the biological assessment methods have become one of the most commonly used methods because of their unique advantages, and fish and macrozoobenthos are usually been selected as the main evaluation groups (Tang et al. 2002). Species diversity, population, and community characteristics of fish play important roles in indicating the ecological health of a watershed (Karr 1986). Besides, fish generally have a longer life history and wider movement range, which can reflect long-term and large-scale changes in the water environment (Karr 1981). The pressures caused by stress factors in the water environment can be reflected in the physiological, morphological, or behavioural characteristics of fish (Barbour et al. 1999). However, most watershed ecological health assessment studies in China were conducted in large rivers or plain rivers, and there are relatively few studies on mountain rivers. Fish communities are more sensitive and vulnerable to environmental changes in mountain rivers than in other rivers because of the complex geological and climatic conditions, and they are at a higher risk of endangerment and extinction (Wan 2016).

Therefore, it is important to assess the ecological health of watersheds of mountain rivers.

The Shuaishui River is located in Huangshan City, and it originates from the southern mountainous area of Anhui Province. It is the source of three important rivers in China, namely, Xin'an, Fuchun, and Qiantang Rivers, and it is an important water source for Huangshan City. The total length of the mainstream is 148.2 km, and the watershed area is about 1,522 km^2. On the basis of its topographical features, the whole river can be divided into three sections. The upper reaches, with deep water and rapid flow in the channel, can be found above Xikou Town; the middle reaches, from Xikou Town to Yuetan Village; and the lower reaches, with shallow water and slow velocity in the channel, below Yuetan Village. The Shuaishui River Basin belongs to the north subtropical monsoon climatic zone, with four distinct seasons and abundant rainfall. The annual average temperature is 16.2°C, and the annual average rainfall is 1613.7 mm. Recently, the ecological health of Shuaishui River has been seriously damaged because of disorderly sand mining, sluice and dam construction, and unreasonable land use. However, assessment of the ecological health of this watershed has not yet been reported.

In August 2016, a field study was conducted to understand the species diversity and community characteristics of fish resources and assess the ecological health of the Shuaishui River Basin. To facilitate ecological management, we first divided the Shuaishui River Basin into different units based on the watershed standard in China (Department of Nature and Ecology Conservation, Ministry of Environmental Protection of China 2014) and then analysed each unit and the whole river basin. The main objectives of our study were to (1) understand the species diversity and community characteristics of fish in the Shuaishui River Basin and different units; (2) identify the main factors that affect the spatial distribution of fish in the Shuaishui River Basin; and (3) assess the ecological health of the different units and whole river basin by using the fish data. The results of this study are not only of great significance for the protection and restoration of fish resources but also provide a scientific basis for the ecological management of the Shuaishui River Basin.

MATERIALS AND METHODS

Field Sampling

In August 2016, fishes in the Shuaishui River Basin were surveyed. According to the river network complexity and field reachability, a total of 38 sampling points were set in the whole basin (Fig. 1). At each sampling point, the fish were collected using an electric fishing device by one person. The collection time was 30 min, and the sampling length was 100 m. The fishing area included different habitats, such as deep pools, shallow waters, and rapid waters that can be waded. The collected specimens were identified in the fresh state, and individual number and weight (accurate to 0.1 g) of different species were measured. Species that could not be identified in the field were fixed with 10% formaldehyde and brought back to the laboratory for identification.

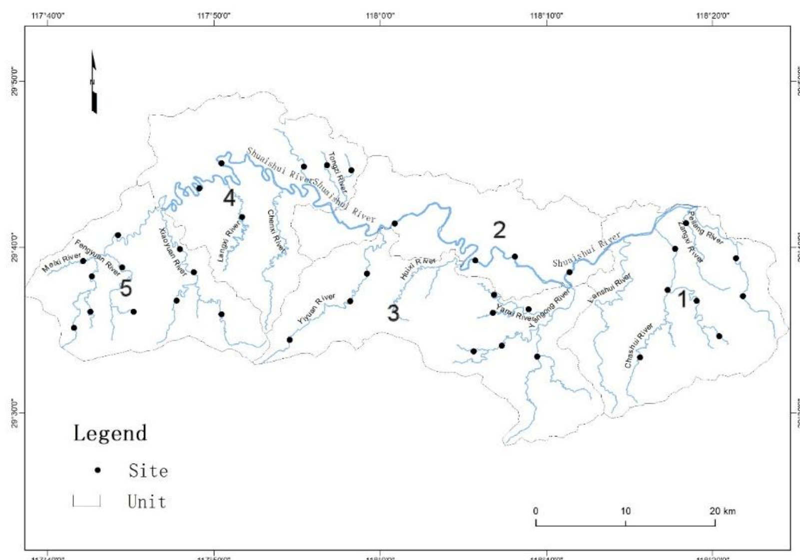

Fig. 1: Location of the sampling sites in different units in the Shuaishui River basin.

Measurement of Environmental Parameters

Local habitat parameters, physicochemical parameters, and stream levels were measured at each sampling point. The local habitat parameters were altitude, water surface width, channel width, water velocity, water temperature and substrate type, and physiochemical parameters were pH, salinity, dissolved oxygen and electrical conductivity. The altitude was measured using a handheld GPS (Garmin etrex type), water surface width and channel width were measured with a laser rangefinder (Trupulse 200), and water velocity was measured using a portable flow meter (Global FP211). The sediment type was determined with a visual scoring method and divided into six levels: 1 (<0.06 mm), 2 (0.06-1 mm), 3 (2-5 mm), 4 (15-63 mm), 5 (64-256 mm), and 6 (>256 mm) (Zhang et al. 2017). The water temperature was measured with a digital thermometer, and dissolved oxygen, electrical conductivity, and turbidity were measured using a portable dissolved oxygen meter (YSI 550A), electrical conductivity meter (YSI Pro 30), and turbidity meter (Rex WZS-185 type), respectively. The stream order was divided using a previously described method (Strahler 1957). The smallest tributary is called the first-order stream; the confluence of two streams with the same stream order causes an increase in the stream order. When a low-level stream flows into a high-level stream, its influence on stream order is ignored (Kuehne 1962).

Data Analysis

To facilitate the assessment and management of the watershed, the Shuaishui River Basin was divided into five different units based on the similarity of the natural conditions and administrative division (Department of Nature and Ecology Conservation, Ministry of Environmental Protection of China 2014). The five units are shown in Fig. 1. One-way analysis of variance (ANOVA) was used to test the differences in the environmental parameters. If a significant variance was detected, Tukey's honest significant difference multiple comparisons were conducted to further examine the differences between groups (Zhang et al. 2015). Based on different trophic guilds, all the collected fish were classified as herbivorous, carnivorous, and omnivorous fish; according to the different tolerances to pollution, all the fish were divided into three levels: sensitive, general, and tolerant. To determine the dominant fish species, the relative importance index (IRI%) was calculated:

$$IRI\% = \left\{ \frac{(W_i\% + N_i\%) \times F_i\%}{\sum_{i=1}^{n} (W_i\% + N_i\%) \times F_i\%} \right\} \times 100\%$$

Where, $W_i\%$ is the weight per cent of the *i*-th species in the catch, $N_i\%$ is the individual number per cent of the *i*-th species in the catch, and $F_i\%$ is the occurrence frequency of the *i*-th species.

The relationship between the fish and environmental parameters was analysed by the CANOCO software. The species matrix was constructed using the individual number data for fish. To satisfy the assumption of homogeneity and normal distribution, log (x+1) was used to transform the data. Then, detrended correspondence analysis was performed to evaluate the response model. Because the gradient value was less than 3, redundancy analysis (RDA) was performed to determine the relationships between the species and environmental parameters. To assess the ecological health, the following three indexes were used (Department of Nature and Ecology Conservation, Ministry of Environmental Protection of China 2014):

1. **Number of classification units (S):** The number of classification units of fish present at a sampling point.
2. **Shannon–Wiener index (H):** The formula is $H' = -\Sigma (P_i)(\log_2 P_i)$, where P_i is the individual proportion of the i-th species.
3. **Berger–Parker dominance index (D):** The formula is $D = N_{max}/N$, where N_{max} is the individual number of the most dominant species at a sampling point, and N is the total individual number at a sampling point.

The three indexes were standardized, and then the arithmetic mean values of the three indexes were calculated. The ecological health was assessed according to the following grades: excellent ($0.8 \leq N < 1$), good ($0.6 \leq N < 0.8$), general ($0.4 \leq N < 0.6$), relatively poor ($0.2 \leq N < 0.4$), and poor ($0 \leq N < 0.2$) (Department of Nature and Ecology Conservation, Ministry of Environmental Protection of China 2014).

RESULTS

Environmental Parameters

The environmental parameters of the five units in the Shuaishui River Basin are listed in Table 1. One-way ANOVA showed that, except for sediment types, water velocity, and pH, significant differences were observed among the environmental parameters ($P < 0.05$). Unit 2 had the lowest average altitude and the highest channel width, water surface width, and water temperature, whereas unit 5 had the highest average altitude and lowest channel width, water surface width, and water temperature. No significant differences were found among units 1, 3 and 4 (Table 1).

Table 1: Environmental parameters of the five units in the Shuaishui River Basin (mean ± SD). The different superscript letters in the table indicate significant differences ($P < 0.05$).

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Altitude (m)	242.0 ± 159.7^{ab}	161.8 ± 20.0^{a}	214.8 ± 58.6^{ab}	212.3 ± 41.6^{ab}	337.5 ± 86.8^{b}
Substrate type	4.5 ± 0.4	3.7 ± 0.9	4.7 ± 0.7	4.3 ± 0.8	4.2 ± 0.6
Water velocity (cm/s)	15.3 ± 7.1	19.0 ± 15.7	12.4 ± 7.5	19.2 ± 9.0	22.1 ± 11.4
Channel width (m)	23.6±22.5^{a}	115.6 ± 42.2^{b}	24.9±10.4^{a}	36.0 ± 39.8^{a}	23.4±9.3^{a}
Water surface width (m)	10.0 ± 5.0^{a}	59.4± 28.1^{b}	14.4 ± 7.1^{a}	18.1 ± 22.2^{a}	7.6 ± 5.5^{a}
Water temperature (℃)	29.1 ± 3.7^{ab}	32.7 ± 1.7^{b}	27.7 ± 2.3^{a}	28.4 ± 4.0^{ab}	26.4 ± 1.6^{a}
pH	8.40 ± 0.41	8.31 ± 0.44	8.09 ± 0.42	8.17 ± 0.38	8.44 ± 0.65
Dissolved oxygen (mg/L)	11.86 ± 0.81^{a}	10.03 ± 1.23^{b}	10.98 ± 0.92^{ab}	10.80 ± 0.84^{ab}	11.14 ± 1.14^{ab}
Conductivity (μS/cm)	61.01 ± 13.41^{a}	40.78± 7.34^{b}	33.42± 9.97^{b}	45.61 ± 3.72^{b}	34.55 ± 6.18^{b}
Salinity (ppt)	0.033 ± 0.010^{a}	0.023± 0.005^{b}	0.014 ± 0.007^{b}	0.002 ± 0.000^{b}	0.018 ± 0.004^{b}

Species Composition

A total of 2579 individuals were collected from the entire Shuaishui River Basin, with a total weight of 9182.46 g. A total of 43 species were identified, and they belonged to 4 Orders, 10 Families and 31 Genera (Table 2). Cyprinidae was the dominant family (33 species) and accounted for 76.7% of the total species, followed by Siluriformes (five species) and Perciformes (four species), which accounted for 11.6% and 9.3% of the total species, respectively. Only one species that belonged to the order Synbranchiformes, *Monopterus alba*, was found, and it accounted for 2.3% of the total species. Among the five units, unit 2 had the largest species number (27 species), followed by unit 4 (26 species); units 5 and 1 had 22 and 21 species, respectively; and unit 3 had only 12 species.

With respect to the three trophic guilds, the maximum number of species were omnivores (25 species), accounting for 58.1% of the total species; 7 and 11 species were herbivorous and carnivorous and accounted for 16.3% and 25.6% of the total species, respectively. With respect to the tolerance of pollution, *Acrossocheilus fasciatus*, *Rhynchocypris oxycephalus*, *Opsariichthys bidens*, *Botia superciliaris*, *Leptobotia taeniops*, *Vanmanenia stenosoma*, *Pseudobagrus ondon*, and *Liobagrus styani* were sensitive species; *Pseudorasbora parva*, *Monopterus alba*, *Cyprinus carpio*, *Misgurnus anguillicaudatus*, and *Carassius*

Table 2: Species composition in the five units of the Shuaishui River Basin (mean ± SD).

Species	Code	Tolerance	Trophic guild	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Cypriniformes								
Cyprinidae								
Zacco platypus	Zac-pla	General	O	+	+	+	+	+
Acrossocheilus fasciatus	Acr-fas	Sensitive	H	+	+	+	+	+
Phoxinus oxycephalus	Pho-oxy	Sensitive	O	+		+		+
Carassius auratus	Car-aur	Tolerant	O		+		+	
Hemiculter leucisculus	Hem-leu	General	O		+			
Pseudorasbora parva	Pse-par	Tolerant	O	+	+			
Pseudorasbora elongata	Pse-elo	General	O		+			
Cyprinus carpio	Cyp-car	Tolerant	O		+			
Hemibarbus labeo	Hem-lab	General	C		+			
Opsariichthys bidens	Ops-bid	Sensitive	C	+			+	+
Microphysogobio fukiensis	Mic-fuk	General	O		+		+	+
Platysmacheilus exiguus	Pla-exi	General	O					+
Microphysogobio tafangensis	Mic-taf	General	O					+

Table Cont....

Species	Code	Tolerance	Trophic guild	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Microphysogobio kiatingensis	Mic-kia	General	O		+		+	+
Squalidus intermedius	Squ-int	General	O		+	+	+	+
Squalidus wolterstorffi	Squ-wol	General	O	+			+	
Aphyocypris chinensis	Aph-chi	General	O	+				
Gnathopogon taeniellus	Gna-tae	General	O				+	
Rhodeus ocellatus	Rho-oce	General	H				+	+
Rhodeus fangi	Rho-fan	General	H			+	+	
Rhodeus sinensis	Rho-sin	General	H	+	+	+	+	
Acheilognathus sp.	Ach-eil	General	H		+		+	
Acheilognathus barbatulus	Ach-bar	General	H		+			
Acheilognathus gracilis	Ach-gra	General	H		+			
Sarcocheilichthys nigripinnis	Sar-nig	General	O	+				
Sarcocheilichthys parvus	Sar-par	General	O	+	+		+	+
Varicorhinus barbatulus	Var-bar	General	O			+	+	+
Cobitidae								
Cobitis sinensis	Cob-sin	General	O	+	+	+	+	+
Botia superciliaris	Bot-sup	Sensitive	C		+			
Misgurnus anguillicaudatus	Mis-ang	Tolerant	O	+	+	+	+	+
Leptobotia taeniops	Lep-tae	Sensitive	C	+				+
Mastacembelidae								
Mastacembelus aculeatus	Mas-acu	General	C	+	+			
Homalopteridae								
Vanmanenia stenosoma	Van-ste	Sensitive	O	+	+	+	+	+
Perciformes								
Gobiidae								
Rhinogobius cliffordpopei	Rhi-cli	General	C	+	+	+	+	+
Rhinogobius sp.	Rhi-nog	General	C	+	+		+	+
Rhinogobius giurinus	Rhi-giu	General	C	+	+			
Serranidae								
Siniperca undulata	Sin-und	General	C		+		+	
Eleotridae								
Odontobutis obscurus	Odo-obs	General	C	+	+	+	+	+
Siluriformes								
Amblycipitidae								
Liobagrus styani	Lio-sty	Sensitive	C				+	
Bagridae								
Pelteobagrus eupogon	Pel-eup	General	O		+			
Pseudobagrus pralli	Pse-pra	Sensitive	O				+	+
Pseudobagrus ondon	Pse-ond	Sensitive	O	+			+	+
Synbranchiformes								
Synbranchidae								
Monopterus alba	Mon-alb	Tolerant	O	+			+	+

auratus were tolerant species; and the others were general species.

Dominant Species

In this study, species with IRI higher than 5% were regarded as the dominant species. The number of dominant species in the five units was 5, 7, 3, 5, and 4 species (Table 3). *Acrossocheilus fasciatus*, *Vanmanenia stenosoma*, *Zacco platypus* were the three main dominant species in the entire Shuaishui River Basin.

Main Influencing Factors

The RDA and Monte Carlo permutation tests indicated that the altitude, water velocity, stream order, and water surface width had significant effects on the spatial distribution of the fish. Fig. 2 shows the two-dimensional RDA bioplots for the species-environmental variables. The eigenvalues of the first two axes were 0.183 and 0.082 and contributed to 40.9% and 18.3% of the total variance, respectively. The water surface width mainly contributed to the first axis; water velocity, second axis; and altitude and stream order, both axes.

Ecological Health Assessment

The assessment results based on the arithmetic mean values of the three evaluation indexes are listed in Table 4. The mean values of the five units (from 1 to 5) are 0.48, 0.70, 0.29, 0.64, and 0.57, respectively. Based on the set level, unit 3 was relatively poor, units 1 and 5 were general, and units 2 and 4 were good. The mean value of the entire Shuaishui River Basin was 0.51, and the health status was general.

Table 3: Dominant species in the five units of the Shuaishui River Basin.

Dominant species	Weight (g)	Per cent weight (%)	Individual number	Per cent individual number (%)	IRI (%)
Unit 1					
Zacco platypus	198.5	11.2	51	10.4	11.90
Acrossocheilus fasciatus	630.2	35.5	132	27.0	41.29
Phoxinus oxycephalus	295.1	16.6	71	14.5	6.86
Vanmanenia stenosoma	213.4	12.0	75	15.3	15.06
Rhinogobius cliffordpopei	69.5	3.9	71	14.5	12.17
Unit 2					
Zacco platypus	25.5	7.0	8	5.5	8.70
Acrossocheilus fasciatus	33.6	9.2	4	2.8	8.32
Sarcocheilichthys parvus	76.1	20.9	33	22.8	30.32
Botia superciliaris	28.3	7.8	8	5.5	9.23
Misgurnus anguillicaudatus	33.7	9.3	7	4.8	6.52
Vanmanenia stenosoma	47.1	12.9	16	11.0	5.55
Rhinogobius cliffordpopei	18.5	5.1	22	15.2	14.06
Unit 3					
Acrossocheilus fasciatus	1481.5	45.4	233	38.1	62.51
Varicorhinus barbatulus	813.4	24.9	112	18.3	7.19
Vanmanenia stenosoma	669.2	20.5	180	29.5	24.93
Unit 4					
Zacco platypus	326	19.2	122	21.0	26.35
Acrossocheilus fasciatus	520.2	30.6	127	21.8	34.41
Acheilognathus sp.	154.9	9.1	106	18.2	10.76
Misgurnus anguillicaudatus	148.8	8.8	28	4.8	7.12
Vanmanenia stenosoma	159.9	9.4	66	11.3	10.90
Unit 5					
Zacco platypus	272.7	13.1	86	11.4	12.51
Acrossocheilus fasciatus	674.1	32.3	183	24.3	35.34
Vanmanenia stenosoma	514.5	24.7	190	25.3	31.14
Rhinogobius sp.	125.4	6.0	138	18.4	11.05

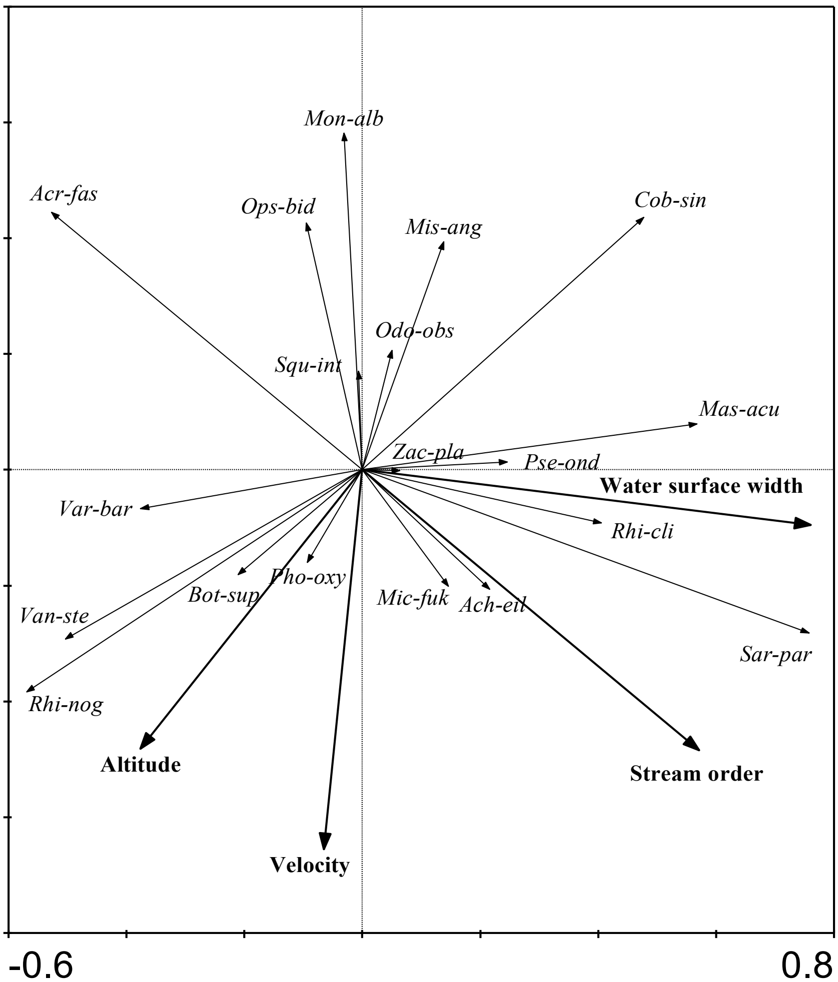

Fig. 2: Redundancy analysis for the correlation between fish distribution and environmental parameters (the abbreviations have been defined in Table 2).

Table 4: River health assessment of the five units of the Shuaishui River Basin.

	Number of classification unit (S)	Shannon-Wiener index（H）	Berger-Parker dominance index (D)	Arithmetic mean	Health status
Unit 1	0.44	0.34	0.66	0.48	General
Unit 2	0.75	0.48	0.87	0.70	Good
Unit 3	0.17	0.27	0.43	0.29	Relatively poor
Unit 4	0.64	0.51	0.76	0.64	Good
Unit 5	0.45	0.49	0.77	0.57	General

DISCUSSION

Species Composition and Spatial Distribution

Many studies have shown that artificial changes to the natural habitat of mountain rivers decrease the suitability of locally sensitive fish while increasing the suitability of tolerant fish (Scott & Helfman 2001); usually, this causes the fish that originally inhabited the downstream regions to invade the upstream regions successfully (Rahel 2002). In this study, a total of 43 species of fish were collected from the Shuaishui River Basin, and the number of species is significantly lower than that in the adjacent Qingyi River Basin (57 species) in mountainous areas of Anhui

Province (Xiang 2011). This indicates that the ecological environment of the Shuaishui River Basin may have changed greatly. Some pollution-tolerant species that are usually distributed in stationary or slow-flowing waters (such as *Carassius auratus, Pseudorasbora parva, Rhodeus ocellatus, Misgurnus anguillicaudatus,* and *Monoperus alba*) were found upstream of the Shuaishui River Basin. A large number of small dams (mainly low-head dams) in the Shuaishui River Basin may be the main cause for this phenomenon. For agricultural irrigation and domestic water use, small dams were built everywhere in the Shuaishui River Basin, which changed local habitat parameters such as water velocity, water temperature, and sediment type and inevitably caused changes to the fish community structure and species diversity (Zhang et al. 2017).

In addition, an alien invasive species, *Lepomis auritus*, has been reported in other mountain rivers of Anhui Province (Wan et al. 2015). In the present study, no alien invasive fish were found, except for *Procambarus clarkii*, were found in the Shuaishui River Basin. *Procambarus clarkii*, a crayfish, belongs to the order Decapoda and family Cambaridae and it is native to northern Mexico and the southern United States. It is widely distributed in many countries worldwide because of its strong adaptability. The occurrence of this species in the Shuaishui River Basin also indicates that the ecological environment has undergone major changes. Some species that are endemic to China were found in this basin, namely, *Pseudorasbora elongata*, *Phoxinus oxycephalus*, *Microphysogobio tafangensis*, and *Microphysogobio kiatingensis*, but the population sizes were small.

Among the five units, species number was the lowest in unit 3 and the highest in unit 2. Differences in the natural environment and anthropogenic disturbances may be the main reasons for this phenomenon. The altitude of unit 2 is the lowest of the five units, and most sampling sites in this unit were located in fourth-order streams. According to Matthews (1986), species diversity usually increased with an increase in stream order because of increased spatial heterogeneity. The reason for the minimum species number in unit 3 may be mainly related to the relatively serious fishing activities in this region.

Main Influencing Factors and Health Assessment

In general, biotic, abiotic, and historical factors (such as species formation and extinction) have important filtering roles in local fish communities and affect the species composition, community structure, and spatial distribution of fish at different spatial scales (Dauwalter et al. 2008). Previous studies in China have shown that the fish community structure in mountain rivers is mainly influenced by the local habitat environment and spatial river position. The local habitat environment includes altitude, water velocity, sediment type, conductivity, water temperature, and water depth, and spatial river position mainly includes stream order, link, and downstream link (Yan et al. 2011, Li et al. 2015). In this study, the RDA showed that the main parameters that affected the spatial distribution of fish were altitude, water velocity, water surface width, and stream order, which is consistent with the above-mentioned conclusions. Altitude has always been regarded as an important environmental factor because environmental factors such as water temperature and water velocity will change correspondingly with a decrease in altitude. The RDA sequence diagram showed that *Phoxinus oxycephalus* and *Vanmanenia stenosoma* are mainly distributed in water bodies with a high altitude and water velocity, whereas *Misgurnus anguillicaudatus*, *Monopterus alba*, *Mastacembelus aculeatus,* and *Odontobutis obscurus* are distributed in waters with a low altitude and water velocity. The stream order and water surface width also had significant effects on the fish community, and this may be mainly because the diversity and complexity of the habitat increased as the stream order and water surface width increased. The RDA sequence diagram showed that *Sarcocheilichthys parvus* and *Microphysogobio fukiensis* are mainly distributed in streams with a higher stream order and large water surface width, whereas *Acrossocheilus fasciatus* and *Opsariichthys biden*s are mainly distributed in streams with lower stream order.

The ecological health of the Shuaishui River, an important river in the mountainous area of Anhui Province, is related to the sustainable development of the regional economy. The ecological health assessment results showed that units 1 and 5 were general, units 2 and 4 were good, and unit 3 was relatively poor. This indicated that the health status of the different units in the Shuaishui River Basin varied greatly, and the main reason may be related to the different economic levels and anthropogenic disturbances. To protect and manage the Shuaishui River Basin, it is necessary to perform targeted management of the different units. We suggest (1) increased monitoring of the water environment and fish resources and control of the polluted waters; (2) improved fishery administration, implementation of a no-fishing system, and restoration of the natural habitat of fish in the Shuaishui River Basin; (3) enhancement of artificial fisheries to increase fishery resources and species diversity in the Shuaishui River Basin; and (4) evaluation of the impacts of dams on fish resources in this basin and establishment of scientific and rational dam-control strategies.

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