

The spatial heterogeneity of mesohabitat for species diversity at the reach in mountain stream

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1. INTRODUCTION

Generally rivers are drawn as lines in the map, but they are composed of diverse spaces and areas in the real environment. These spaces can be defined as hierarchically organized systems, for example fall, cascade, riffle, run and pool under categories of faster or slow water (C.A.Frissell *et al.*, 1986; C.P.Hawkins *et al.*, 1993; I.Maddock, 1999). There are a lot of reason that researcher distinguish stream spaces, one of them is because each unit reflects physical environments as habitat for plants and animals (I. Maddock, 1999). Physical environments are recognized as important factors that can influence on the life of aquatic living as basic elements of river ecosystem (C.A. Extence, et al., 1999; R. Bartley and I. Rutherford, 2005). The physical environments are responded and make balance against environmental changes around them. Especially artificial changes like dam construction make the stream is changed quickly. Sabo dam is one of structures to defend sudden debris flow in a mountain area. The main purpose of the dam is to convert a slope of river bottom by impounded sediments. However, in the respect of ecosystem, dams of vertical wall type interrupt the fish's movement to upstream and a large amount of sediment influences the habitats for various aquatic living. Therefore, now, lots of sabo dam are opened as one or two slits. This research is about the effects of sabo dam on spatial heterogeneity of small habitat like riffle, run and pool in the cases of full and opened dams. Therefore the purposes of research are to investigate a range of physical parameter on each habitat around sabo dams, and to analyze differences of the range as species diversity.

2. STUDY AREA AND METHOD OF ANALYSIS

Study areas are up and downstream reach of each five dam in two second order streams, Oiawa and Wasada stream in Yamagata, totally 10 sites. One river, Oisawa stream, is second order and flows 7.2km with 1.3 sinuosity, 0.030m/m slope and 21.8km² catchments. There are three sabo dam and two dams of were partly opened with slot shape in 2004, 2007. Another stream, Wasada, is also second order and flow 8km distance with

1.2 sinuosity, 0.034m/m slope and catchment area is 25.6km², and has two full sabo dams. In field, current velocity and particle size of substrate as physical parameter was measured and invertebrate benthos was sampled to calculate species diversity at the small scale habitat like riffle, run and pool. Defines of each geomorphic units were referred to Channel geomorphic units(CGUs)(C.P.Hawkins *et al.*, 1993; I.Maddock, 1999). Sampled benthos were classified and then species diversity was calculated using the method of Shannon-diversity (H') as a kind of species diversity.

$$\text{Shannon diversity index} = H = -\sum_{i=1}^s P_i \ln P_i$$

(Where P_i is the proportion of each species)

Next, the results of Shannon diversity were categorized by the values using cluster analysis. To calculate heterogeneity of physical parameter on mesohabitat, we used One-way ANOVA that can analyze the differences of average values of each parameter on riffle, run and pool unit within the clustered groups. Post-hoc analysis was carried by Scheffe method.

3. RESULTS AND DISCUSSION

The distributions of velocity were about 0.75-0.95m/s on riffle, 0.3-0.5m/s on run, 0.05-0.2m/s. The ranges of velocity were significant different on each habitat unit. The ranges of average particle size at riffle habitats were wide from 1.5 to 4mm and some range overlap with that of run (1.25-5mm)(fig1).

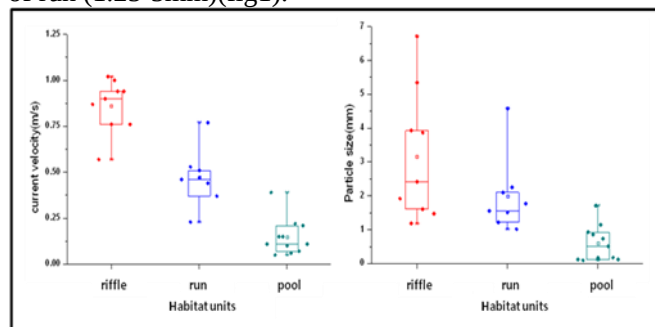


Fig 1. The range of physical parameter as velocity and particle size on each unit

The values of Shannon-diversity were calculated in the range from 0.5 to 1.36. In the figure 2A, both sites as E, F that have passed long time after dam slit, have high values.

Key words: River ecosystem, Mountain stream, Sabo dam, Spatial heterogeneity, Species diversity

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While upsides(G,I) of full dam had low species diversities, the value of A site was high. Even if A was also upside of full dam, we could find various habitats in this site than others. It may be that various habitat type can be formed by different velocity on site A because the stream is meandering and particle size is big(Kang, J.H. *et al.*, 2010). As the result of Shannon-diversity, three groups were made(Fig 2B). The six sites were grouped together with high values over than 1.2 as first group. Site G was classified as third group, only one. Environment of site G was simple and composed of only pool habitat. It was not reservoir, but current velocity was slow(0.29m/s) therefore particle size was also very fine(0.10mm).

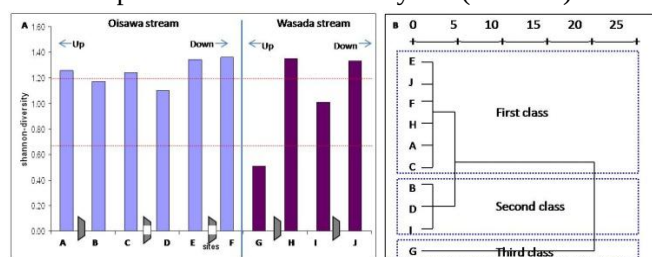


Fig2. (A) Shannon-diversity on each reach site, (B) categorized groups by Shannon-diversity using cluster analysis (average linkage_between groups)

Table 1. The result on difference of average values of physical factors using One-way ANOVA (A=riffle, B=run, C=pool, D=statistic difference, the mean difference is significant at the .05 level)

Source		F-value	Sig.	Diff	Post Hoc Test(scheffe)	
					Sig.	Diff
Velocity	First class	44.4	.000 < .05	O	AB = .01 <.05 AC = .00 <.05 BC = .00 <.05	O O O
	Second class	27.3	.002 < .05	O	AB = .01 <.05 AC = .00 <.05 BC = .11 >.05	O O x
	Third class			X		
Particle size	First class	5.3	.021 < .05	O	AB = .64 >.05 AC = .02 <.05 BC = .20 >.05	X O X
	Second class	0.4	.701 > .05	X		
	Third class			X		

Next is about the result of One-way ANOVA analysis. We started it with the results of cluster analysis. Third class was included only one site, we considered that habitats of site G is same, not different. As the results of One-way ANOVA, current velocity had significant difference in both first and second group. However there was no difference between run and pool habitats within second group in the result of post hoc test. In the analysis

of particle size, there was significant difference in first group but no in second group, and we could confirm that this difference was from that between riffle and pool after post hoc test. However second group had not significant difference among of each habitat, in other words, the particle sizes are similar(table 1).

4. CONCLUSIONS

In this research, we could confirm that species diversity as one of the biodiversity is affected by the physical characters. Specially, low species diversity was found on upsides of dam where were composed of simple habitat with slow velocity and small particle size. It may be because simple habitat can not supply good environment for various species. The meaning of simple habitat is similar that heterogeneity of habitat is also low. Therefore we got the results that if the heterogeneities of physical factors are reduced, various invertebrates can not live. We think that it is a problem of sabo dam for ecosystem. However, if some place is keeping various habitats like site A, even if the place is upside of dam, high species diversity can be kept. Generally macroinvertebrates are affected by environment and very sensitive by environmental change and they have preferred physical environment. Therefore if habitat is composed of diverse environment, various species which can survive in optimal spaces can be found. Therefore to expect species diversity, habitat diversity or heterogeneity is secured, to begin with.

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