

A PRACTICE OF STREAM RESTORATION PROJECT IN URBAN AREA AND ITS EVALUATION

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This study reports on a progressive stream restoration project and its evaluation from the ecological aspect by investigating fish population condition in an urban stream in Japan. From the results of field survey, it is revealed that fish species richness and physical environment variety are remarkably improved. These results showed that the Kamisaigo River restoration project succeeded in ecological aspect.

1 INTRODUCTION

River management work is turning from hard engineering methods to ecologically-based restoration methods in order to improve river environment worldwide [1]. River environments in urban streams are degraded due to excessive hard covered revetment work, loss of longitudinal connectivity and many other influences [2]. Thus stream restoration work in urban area is one of the most important issues for river management.

This study reports on a progressive stream restoration project and its evaluation in terms of fish ecological condition in an urban stream in Japan. The project site is the Kamisaigo River, which runs through urbanized areas. The major purposes of the project are restoration of ecological environment and flood control. In this study, an overview of Kamisaigo river restoration project is introduced and effect of the restoration project was evaluated from environmental aspect.

2 OVERVIEW OF THE PROJECT

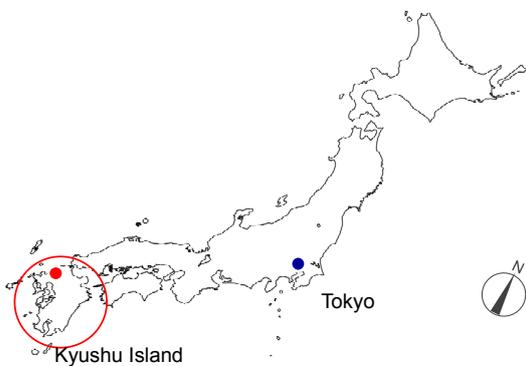


Figure 1. Location of the project site.

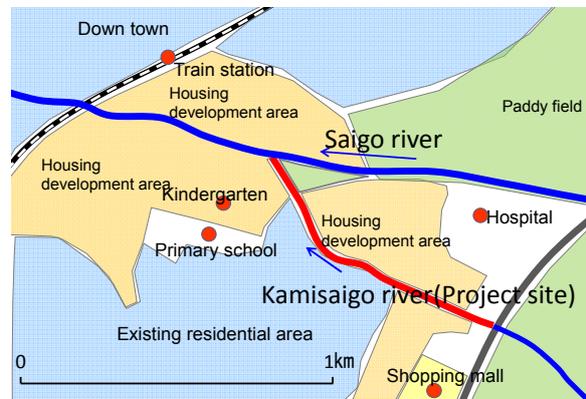


Figure 2. Aerial view of the project site.



Figure 3. Landscape of pre-restoration.



Figure 4. Landscape of post-restoration.

The project site is in northern part of Kyushu Island, located in the south west part of Japan (Figure 1). The Kamisaigo River runs through urbanized areas as one of the tributaries of the Saigo River (the Saigo River is shown by the blue line in Figure 2). The Kamisaigo River is a small urban stream, being 3.3 km long from its headwaters to confluence with the Saigo River, and with a 3.3 km² catchment area. The Catchment is heavily developed for agriculture (paddy fields) and housing. The proportional coverage of paddy fields is progressively decreasing due to urbanization. The project site is located on the middle reach of the Kamisaigo River. The site is approximately 1 km long (shown by red line on Fig.2). The river bed gradient of the site is 1/500~1/350.

The Kamisaigo River had several issues prior to the river restoration works. Figure 3 shows the pre-restoration landscape of the site. The most important issue for residents was flood control. The river did not have enough capacity to convey storm water caused by one in three year flood events. Although the river would have flooded naturally prior to development, the increase in catchment impervious area and constriction of the channel (Figure 3) had increased the extent of flooding, and residential properties often suffered from inundation. On the other hand, revetment of the project site meant that it was covered with concrete, and that environmental condition was degraded. Vegetation on the water's edge was poor and stream flow variability was also poor. For the reasons above, the Kamisaigo River was a concern for local residents. Under natural circumstances, the river would have flooded every year or every second year in natural condition. But many residents are living around the Kamisaigo river that this project should have concerned about interrelationship between human livelihoods and nature restoration.

Because of those issues, the Kamisaigo river restoration project was started in 2008. Three main objectives form the basis of this restoration project. One is flood control; flood capacity of the restored stream will be improved to prevent flooding for ten year flood discharges (46 m³/s). The second objective is to restore the natural river environment. The third objective is to restore the relationship among the river and residents.

To accomplish those objectives, many restoration actions are being implemented, such as broadening the river channel to twice the width as pre-restoration, removing the concrete revetment, removing concrete weirs to restore longitudinal connectivity, and installing small-scale structures for riffle and pool habitat restoration. To develop the restoration plan, river restoration workshops were held with residents and scientists. All of the issues and plans for restoring them were discussed in the workshop. Via these processes, the final restoration plan was decided, and construction work was completed in 2013 (Figure 4).

3 METHODS

3.1 Evaluation survey

A fish sampling survey, physical environment survey, and transition of stream flow survey were conducted to evaluate the effect of the restoration project. Surveys were conducted every autumn from 2009 (pre-restoration) to 2013 (post-restoration). The survey design is shown in Figure 5.

3.1.1 Fish sampling survey

Fish sampling was conducted in every autumn from 2009 to 2013 (except for 2010: because of construction works). Five survey stations of 50 m length were established at the study site (50 m is almost one meander length of the Kamisaigo River). Each survey station was established by screening the reach with fish blocking net. Most of the fish are captured at each station by using standard electrofishing methods (Backpack mounted). All the captured fish are released after identifying the species and measuring its length.

3.1.2 Physical environment survey

Water depth and velocity are measured to characterize the physical environment. A survey cross section line for physical environment was installed every five meters (this interval is similar to the average water width of the project site). Five measuring points are set in every cross section. Additional measuring points are added depending on the stream flow conditions. Physical environment surveys were conducted in 2009, 2012 and 2013.

3.1.3 Transition of Stream flow and riparian vegetation

To confirm the transition of stream flow from the landscape view, habitat mapping surveys were conducted in every autumn from 2009 to 2013. Stream flow is classified into six habitat categories (riffle, run, glide, scoured pool, dammed pool, back water) by its flow characteristics. This classification refers to former research in Japan

[3] and flow characteristics of the Kamisaigo river. Habitat area was measured for every habitat type in every station. Also, ecological condition of riparian vegetation (which works as habitat of juvenile fish) was evaluated by measuring the longitudinal length of water edge that was covered with riparian vegetation in every station.

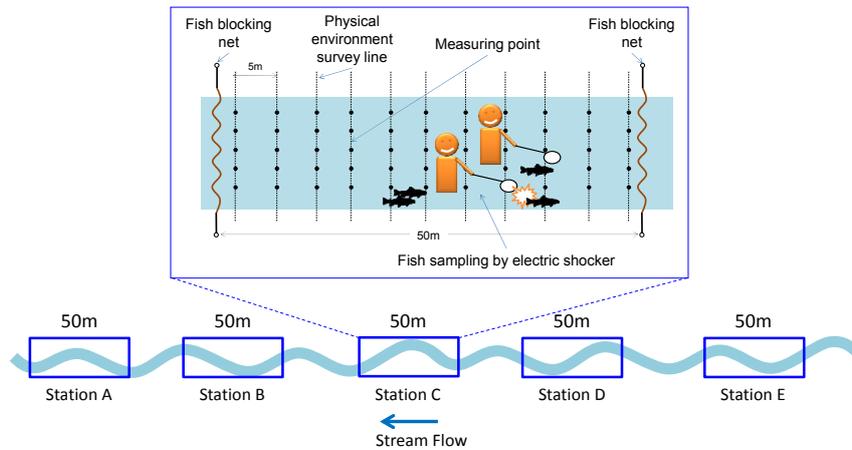


Figure 5. Evaluation survey design in the project site.

4 RESULTS

4.1 Fish sampling survey

Over the five year survey, a total 6572 individuals of 17 species were captured. Captured fish list is shown in Table 1. Some endangered species are included. The transition of fish appearance over time is shown in Figure 6. The blue bar shows average abundance captured at each station, and the dark blue plot shows average species richness. Both of these indicate that fish species richness and abundance are remarkably improved year by year.

4.2 Physical environment survey

Measured water depth and velocity are plotted in Figure 7, with a total of 1562 points. The vertical axis shows water depth, and horizontal axis shows water velocity. Comparing these results, physical environment heterogeneity has been significantly improved following restoration works. The spread of depth and velocity on Figure 7 indicates that flow conditions became more diverse through the restoration work. Especially, deep, slow-flowing points are increased.

4.3 Transition of Stream flow and riparian vegetation

Figure 8 shows the result of the habitat mapping survey. The area of dammed pools was drastically decreased from 2009 to 2011 due to restoration work, and other kinds of habitat are increased. In particular, back water habitat, an important habitat for spawning [4], is newly established after restoration work. Longitudinal length of water edge covered with riparian vegetation is also significantly increased.

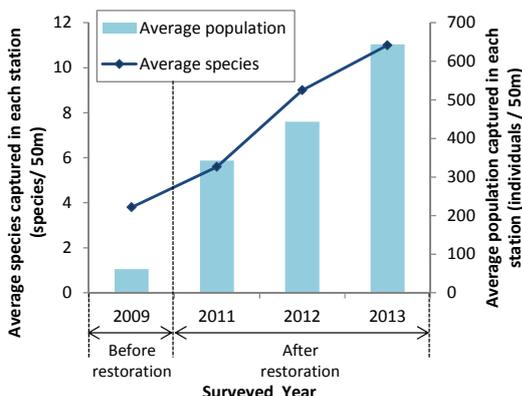


Figure 6. Transition of fish appearance.

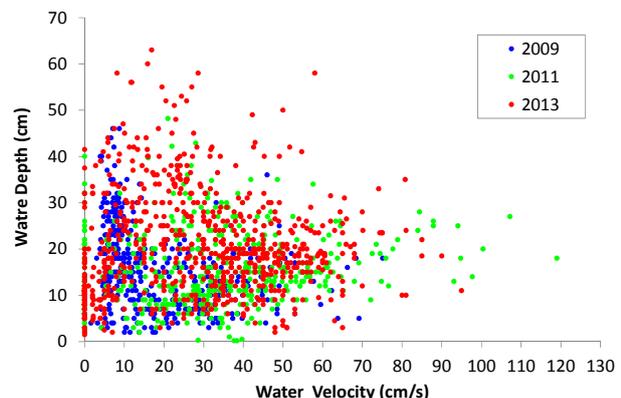


Figure 7. Relationship between water depth and velocity.

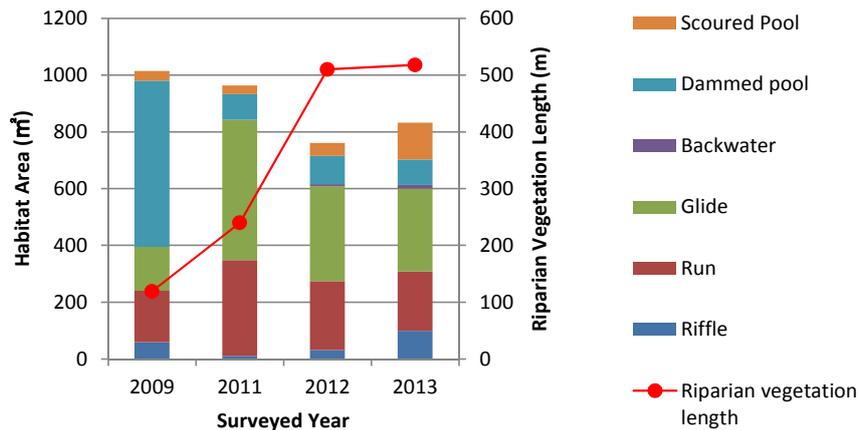


Figure 8. Transition of stream flow and riparian vegetation.

Table 1. Captured fish list.

Japanese name	Scientific name	2009	2011	2012	2013
Ukigori	<i>Gymnogobius urotaenia</i>		○		○
Unagi*	<i>Anguilla japonica</i>				○
Oikawa	<i>Zacco platypus</i>	○	○	○	○
Ookinbuna	<i>Carassius auratus buergeri</i>				○
Kamatsuka	<i>Pseudogobio esocinus</i>		○	○	○
Kawamutsu	<i>Zacco temminckii</i>	○		○	○
Gingbuna	<i>Carassius auratus langsdorfii</i>		○	○	○
Koi	<i>Cyprinus carpio</i>	○		○	○
Gourakuhaze	<i>Rhinogobius giurinus</i>			○	○
Shimayoshinobori	<i>Rhinogobius sp. CB</i>	○	○	○	○
Sumiukigori	<i>Gymnogobius petschiliensis</i>		○	○	○
Takahaya	<i>Phoxinus oxycephalus jouyi</i>		○		
Touyoshinobori	<i>Rhinogobius sp. OR</i>	○	○		○
Dojou	<i>Misgurnus anguillicaudatus</i>	○		○	
Donko	<i>Odontobutis obscura</i>	○	○	○	○
Minami-medaka*	<i>Oryzias latipes</i>				○
Yamatoshimadojo*	<i>Cobitis matsubarae</i>	○	○	○	○
Total Number of Species		8	10	11	15
Total Population		307	1714	1330	3221

*Ranked as endangered species by Ministry of the Environment in Japan

5 CONCLUSION

From the evaluation survey, it is revealed that fish species richness and physical environment variety are remarkably improved by the Kamisaigo river restoration project. These results showed that Kamisaigo river restoration project succeeded in ecological aspect. In addition, we can see many of residents using the river for strolling, environmental education, recreation (fishing, playing in the water) and other activities.

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