Evaluating Aquatic Habitats of an Agricultural Waterway Network Improved for Recreational Use of Local Residents

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Abstract

In this study, the authors conducted habitat evaluation of aquatic organisms in a waterway network in the town of Koura, the Shiga Prefecture, Japan, where the environmental improvement was practiced to promote recreational use of local residents. The Japanese fish habitability evaluation program was applied to sampled biological (fishes and crustaceans) and physical data . As the results, the model generated by the program showed high suitability (0.80 to fishes, 0.76 to crustaceans), and the program is applicable to a waterway network including various types of watercourses. The characteristics of the high-scored canals by the program included 1) wider canal width, 2) deeper water depth, 3) higher water velocity for fish and lower water velocity for crustaceans, 4) higher vegetation coverage, and 5) gravel riverbed. The water parks developed by the environmental improvement and the drainage canals tended to have these characteristics. Therefore, our findings suggest that developing water parks in a waterway network and conserving the connectivity of drainage canals, which were practiced as the environmental improvement, contributes not only to promote recreational use but also to habitat conservation.

Introduction

Green infrastructure is defined as '*a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services*' in both rural and urban settings.

Agricultural waterways for irrigation have been historically developed in rice-farming regions. Such waterways were traditionally used not only for irrigation but also fisheries, recreation, and domestic use.

However, recent modernization of agricultural landscapes and infrastructures modified only for efficient agricultural production and accelerates to use as grey infrastructure. Thus, improving irrigation infrastructures as green infrastructure based on sustainable ecosystem service use is a recent fundamental challenge.

A waterway network in the town of Koura, the Shiga Prefecture, Japan, where the environmental improvement was practiced to promote recreational use of local residents. However, it is not known that such modification for recreational use benefit to restoring ecosystem services. In restoration practice, considering habitability of aquatic organism is key for availability of wider ecosystem services.

Objectives

To evaluate aquatic species habitability of the agricultural waterways modified for recreational use.

Methodology

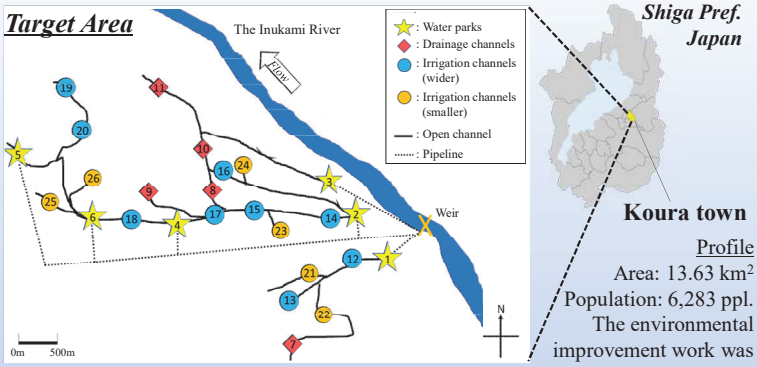


Fig. 1 Locations of 26 survey sites

Profile
Area: 13.63 km^2
Population: 6,283 ppl.
The environmental improvement work was practiced in 1989.

Data collection and analysis

Biological (fishes and crustaceans) and physical data were collected in August 2018.

Data type	Survey items
Physical data	width of channel, width of sandbank, water depth, water velocity, vegetation coverage
Bed materials	ratio of concrete, sand (<2mm), pebble (2-64mm), cobble (>64mm)
Biological data	species and the number of fishes and crustaceans

Analysis

"The Japanese Fish Habitability Evaluation Program" (JP.)

- The tool developed for non-expert users[1)]
- Creates a model that has a positive correlation with the number of species, using physical data as variables.
- Species habitability of each site is scored from 1 (low) to 5 (high)

Results and Discussion

Results of survey

[Fishes]

Species	Population	Number of sites	
N. Sieboldii	351	12	46.2%
R. l. steindachneri	22	5	19.2%
Oryzias sp.	59	3	11.5%
Rhinogobius spp.	153	10	38.5%
Cobitis sp. BIWAE type B	1	1	3.8%
O. Obscura	3	3	11.5%
O. Platypus	22	3	11.5%
P. Altivelis	24	7	26.9%
M. Anguillicaudatus	14	4	15.4%
N. temminckii	3	2	7.7%
P. o. jouyi	1	1	3.8%
P. esocinus ecosinus	3	1	3.8%
T. hakonensis	1	1	3.8%

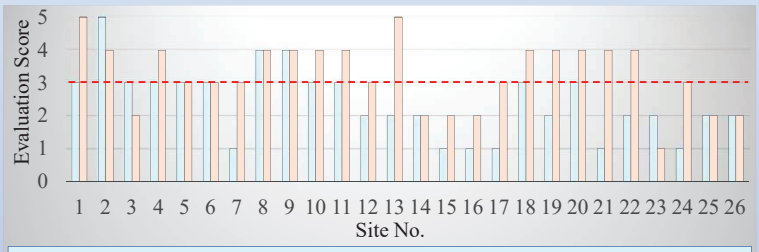
[Crustaceans]

Species	Population	Number of sites	
G. dehaani	211	15	57.7%
P. clarkii	163	10	38.5%
P. compressa	3,630	21	80.8%
P. Paucidens	35	7	26.9%

[Physical characteristics]

Physical conditions	Average ± SD
water width (cm)	184.5 ± 118.7
sandbank width (cm)	15.5 ± 9.7
water depth (cm)	15.6 ± 10.6
water velocity (cm/s)	12 ± 11
vegetation coverage (%)	16 ± 18

Habitat evaluation by JP.



[Fishes] $y=0.929+0.034x_1+0.021x_2-0.018x_3+0.014x_4+0.020x_5$

x_1: water depth, x_2:water velocity, x_3:sandbank, x_4:vegetation, x_5:ratio of sands in riverbed

[Crustaceans] $y=4.760-0.046x_1-0.049x_2-0.005x_3+0.022x_4-0.015x_5$

x_1:water depth, x_2: water velocity, x_3:sandbank, x_4:vegetation, x_5:ratio of sands in riverbed

Fig. 2 The model generated by JP. and the evaluation score at each site

Table 1 The suitability of the models

	Model suitability	Correlation coefficient of evaluation score and Shannon Index *H'*
Fishes	0.80	0.63**
Crustaceans	0.74	0.37

The program showed high suitability, which implies the program is applicable to a waterway network including various types of watercourses.

Table 2 The evaluation scores and H' by watercourse type

Type of watercourses	The number of sites	Fishes		Crustaceans	
		Score	H'	Score	H'
Water parks	6	**3.3**	**1.2**	**3.5**	**0.8**
Drainage channels	5	**3.0**	**1.0**	**3.8**	**0.4**
Irrigation channels (wider)	9	1.9	0.3	3.2	0.3
Irrigation channels (smaller)	6	1.7	0.3	2.7	0.2
All waterways	26	2.4	0.6	3.3	0.4

Conclusion

The water parks developed by the environmental improvement and the drainage canals tended to have these characteristics. Therefore, our findings suggest that developing water parks in a waterway network and conserving the connectivity of drainage canals, which were practiced as the environmental improvement, contributes not only to promote recreational use but also to habitat conservation.

References: 1) Watabe, K. et al., 2018. Evaluation method for fish habitats in agricultural drainage canals. Bulletin of the NARO, Rural Engineering, 2, 111-119.