EFFECTS OF DOWN SLOPE OF BOTTOM IN POOL-AND-WEIR FISHWAY ON MIGRATION RATE OF *NIPPONOCYPRIS TEMMINCKII*

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ABSTRACT

1.INTRODUCTION

River structures such as dam prevent fish from migrating. Therefore, fishway is constructed in these river to make it easier for fish to migrate. The elucidation of the most suitable geometric and flow conditions in fishway is tried. The geometric conditions that affect migration rate of fish in pool-and-weir fishway which is adopted all over the world [1] are the drop between the pools [2], the shape of the notch [3], the length and depth of the pool [4]. These experiments were performed under the condition that the bottom of the pool is level. However, the gradient of the bottom of the pool is not examined well. Onitsuka *et al*. [5] showed that when the bottom slope was set down slope toward upstream side, the migration rate became high value. Still, his experiment was performed in only one case that the angle of down slope of the bottom is 40°. So, the most suitable value of the angle of down slope of the bottom is not unravel. In this study, effects of down slope of the bottom in pool-and-weir fishway on migration rate of Kawamutsu (*Nipponocypris temminckii*) are investigated by changing the value of the angle of down slope toward upstream side and discharge.

2.EXPERIMENTAL SETUP AND METHOD

Figure 1 shows pool-and-weir fishway. Pool length (L) is 0.9m, width (B) is 0.8m and 3 pools are connected in a staircase pattern. The thickness of the partition wall (Δx) is 0.2m, the drop between the pools (Δy) is 0.15m, the width of the notch (Δz) is 0.16m, the height from the bottom of the pool to the bottom of the notch (H) is 0.3m and the notch is R shape. x axis is taken in the downstream direction, y axis is vertical direction and z axis is transverse direction. **Figure 2** shows the schematic of down slope toward upstream side. **Table 2** shows experimental case. The angles of down slope of the bottom (I) are 0, 1/10, 2/10 and 3/10. The discharge (Q) are 1, 3 and 5(l/s). 12 cases are performed in total. The used fish is Kawamutsu (*Nipponocypris temminckii*) and the number of fish (N) is 30. Averaged body length ($\overline{B_L}$) is 70mm.
In each case, fish are put into the middle pool. After it is confirmed that Kawamutsu settle down, the swimming behaviors of fish in the middle pool are recorded with the aid of two sets of digital video cameras for 30 minutes. In addition, the number of fish which migrate to the upstream pool (n_u) and swimming position are analyzed.

3.RESULTS AND DISCUTION

Figure 3 shows migration rate (n_u/N) of Kawamutsu according to discharge (Q). As the angles of down slope of the bottom (I) increase, migration rates show higher value.

Figure 4 shows the contour figure of existing probabilities ($\overline{n_m}/N$) that it was calculated by locating the swimming position of Kawamutsu with every 10s for the case of Q=1 and 5(l/s), I=0 and 3/10. **Figure 4(a)**~**(d)** show contour figure of existing probabilities in horizontal section. The domains which indicate high existing probabilities approach the left bank and upstream side with the increase of the angles of down slope of the bottom (I). **Figure 4(e)**~**(h)** show contour figure of existing probabilities in vertical section. In the case of I=0, Kawamutsu are distributed on the downstream side and the bottom of the pool. In the case of I=3/10, the areas of distribution are narrower and the positions of it approach upstream side than the case of I=0.
Judging from these results, migration rates show higher value because the distance between the positions of Kawamutsu and the notch become shorter with the increase of the angles of down slope of the bottom

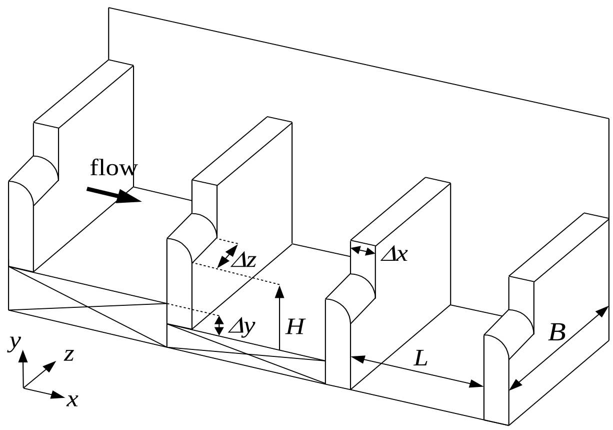


Figure 1 Pool-and-weir fishway

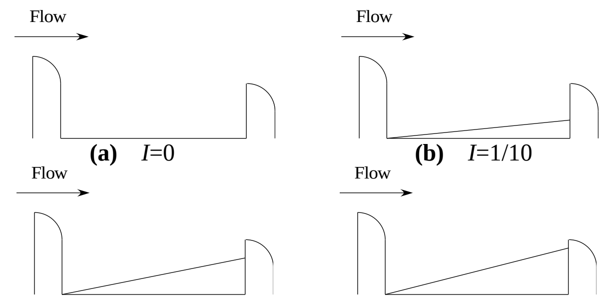


Figure 2 Schematic of down slope

Table 1 Experimental case

Q (l/s)	angle of down slope of bottom			
	I =0	*I* =1/10	*I* =2/10	*I* =3/10
1	0-Q1	1-Q1	2-Q1	3-Q1
3	0-Q3	1-Q3	2-Q3	3-Q3
5	0-Q5	1-Q5	2-Q5	3-Q5

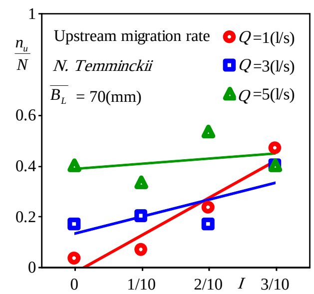
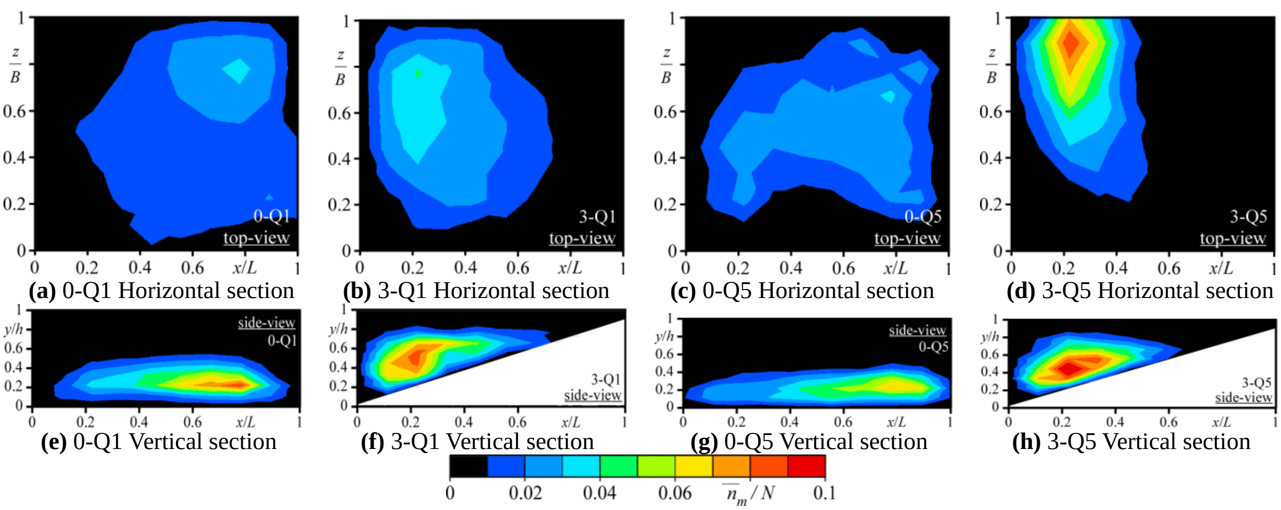


Figure 3 Upstream migration rate of Kawamutsu



(a) 0-Q1 Horizontal section **(b)** 3-Q1 Horizontal section **(c)** 0-Q5 Horizontal section **(d)** 3-Q5 Horizontal section

(e) 0-Q1 Vertical section **(f)** 3-Q1 Vertical section **(g)** 0-Q5 Vertical section **(h)** 3-Q5 Vertical section

Figure 4 Contour figure of existing probability

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