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Fish pass using baffle effects of water flow without plates

Masaaki Ishikawa * and Jyunji Shirai

National Institute of Technology, Kisarazu College, Kisarazu, Chiba, 292-0041, Japan
* Correspondence: d028201@gmail.com or cisikawa@inc.kisarazu.ac.jp; Tel.: +81-438-30-4154

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Introduction

Fish passes are structures constructed on artificial barriers that facilitate the natural migration of diadromous fishes [1,2]. In this study, we propose a fish pass that uses the baffle effects of water flow without baffle plates (hereafter referred to as a water flow fish pass, WFP).

The WFP consists of a fish pass and reservoirs. The fish pass section is a simple channel without baffle plates. The reservoirs are set up on both sides of the channel. Water from the upstream area flows into the reservoirs. A weir plate is located at the downstream end of the reservoirs, and water levels are equalized in the reservoirs upstream of the channel. In practical applications of the WFP, the weir plate will be detachable, enabling soil, driftwood, and debris piled up in reservoir to be removed rapidly. Along the inclination of the fish pass channel bed, there are orifices in the reservoir sidewall. As the depth of reservoir increases in the downstream direction, runoff from each orifice becomes stronger. Water flow from the orifices hits the main current of the fish pass, dampening the power of the water flow in the channel (Fig. 1).

Materials and methods

Based on the conceptual diagram of the WFP (Fig. 1), we constructed a fish pass unit (length: 1.82 m, width: 0.42 m, height: 0.459 m). Figure 2 shows the design plan of the constructed fish pass unit. For simplicity, we made the fish pass unit from waterproof plywood. Figure 3 shows a three-dimensional image of the fish pass unit. There is a difference in water level between the reservoirs and fish pass channel because of the presence of the weir plates at the end of the reservoirs. According to the water level difference, water flows out from the sidewall orifices into the fish pass channel. We installed this fish pass unit in an indoor experimental channel (length: 10.0 m, width: 0.8 m, height: 0.8 m). Water from the upstream area flowed into the fish pass unit using an exclusive mounting plate. It supplied water pumped up from a water tank under the ground

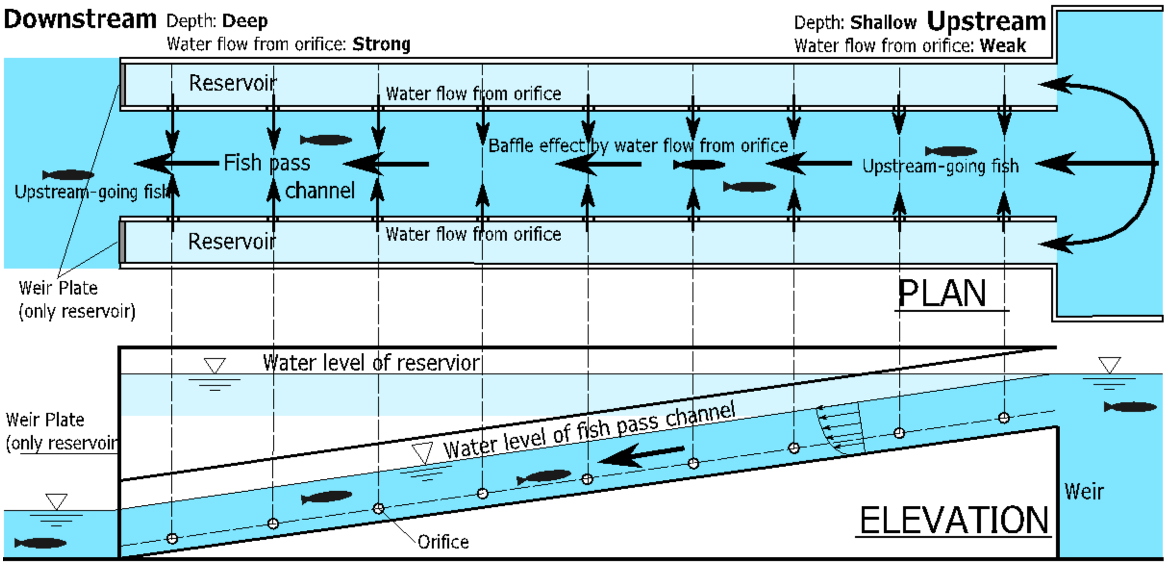

Fig. 1 Schematic diagram of the proposed water flow fish pass.

via an electromagnetic pump with an inverter control to the experimental channel. After flowing down the experimental channel, the water returned to a water tank. In this experiment, we assumed a discharge of Q = 0.030 m^3/s. Using this discharge, we calculated the orifice diameter and setting height as a test. We measured the flow speed of the fish pass channel using a small propeller-type current meter (CR-7, KOSUMO RIKEN). The measurements were taken at a height of 0.021 m from the channel bed. Figures 4 and 5 show all of the flow speed measurement locations.

Results

Figure 4 shows the water flow velocity planer distribution vector. We confirmed that the flow speed at the center (Y = 0.13 m) was slower than that at either side (Y = 0.07, 0.19 m). Figure 5 shows the cross-sectional water flow velocity. The results confirmed that the central flow velocity was relatively slow. Based on these experiments, we confirmed that a relatively slow velocity of continuous flow occurred in the cross-sectional central area of the fish pass.

Discussion

Photo 1 shows an image of the state of the flow in the fish pass channel. The orifice runoff conflicted with water flow of fish pass channel, resulting in large fluctuations in the surface of the water. To determine the changes in flow in the fish pass channel with different orifice vertical positions, further experiments are necessary. In the future, we will perform an experiment using real fish, we observe the number of fish able to run up and their route. This will help confirm the utility of the WFP.

Acknowledgements

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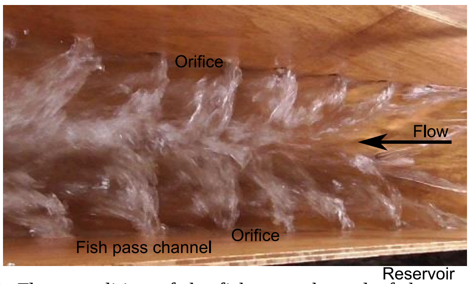

Photo 1. Flow condition of the fish pass channel of the water flow fish pass.

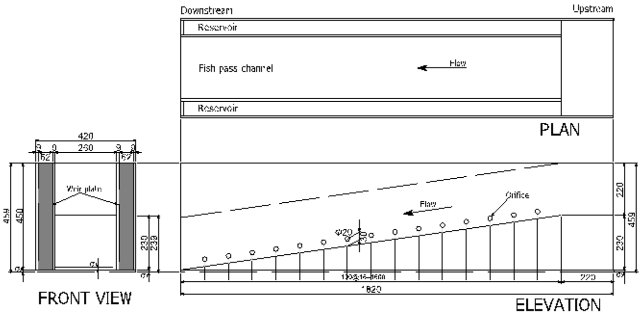

Fig. 2 Design plan of the water flow fish pass unit.

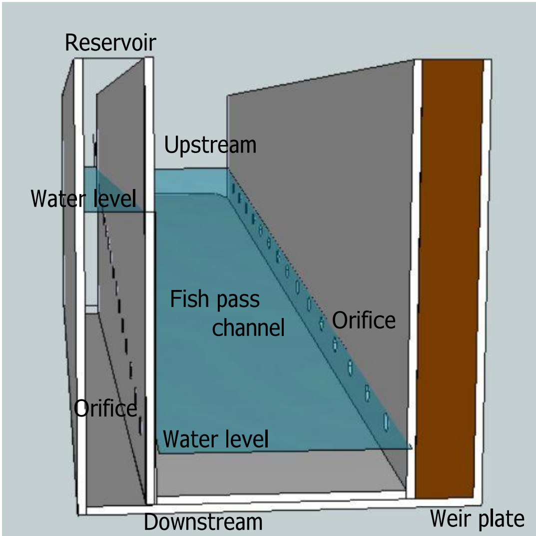

Fig. 3 Three-dimensional drawing of the water flow fish pass unit as viewed from downstream.

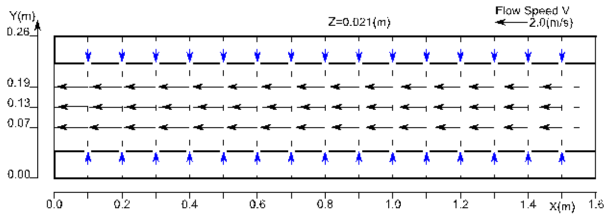

Fig. 4 Water flow velocity planar distribution of the water flow fish pass.

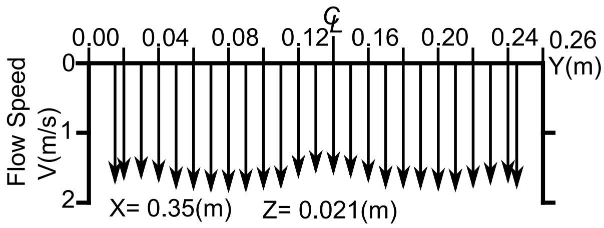

Fig. 5 Water flow velocity cross sectional distribution (X = 0.35 m).

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