

A hydraulic Fishheart fishway

Fish are attracted into the dual chamber Fishheart with a combination of internal and external attraction flows. As the image detection identifies a fish inside the unit the elevation process is initiated. The direction of the attraction water flow is automatically changed by the logic and fish are elevated over the dam by the combined impact of the siphoning effect and the master pump. Simultaneously the other chamber continues to attract fish, and the process continues. As the Fishheart fishway is a floating system, it can be installed again and again, until the best possible position to the entry of the fishway has been found. It suits all species of fish, it is remarkably water efficient, and it represents an affordable investment compared to traditional solutions.

Mika Sohlberg

1 Introduction

Fishheart Ltd. was founded in February 2016. Fishheart Ltd. has developed a Fishheart fishway, a hydraulic floating fishway to enable fish migration in built rivers. The Fishheart fishway suits all species of fish, it is remarkably water efficient, and it represents an affordable investment compared to traditional solutions. Other products of the company are the Smoltheart for downward smolt migration, Satelliteheart, which is a floating additional entry to the Fishheart fishway and the award winning, biodegradable Eco Egg Box for stocking fish eggs.

The first Fishheart fishway was assembled during summer 2019 at Taivalkoski hydropower plant Kemijoki River, Finland. In addition, the patented solution is now operated at the Lepikoski dam, Oulujoki river system, Finland. EU water directive demands member countries to arrange fishways in built rivers. With traditional fish passages this comes expensive. At many plants, there is also not space enough to build well-functioning passages and a vast majority of the fish passages are suitable only for a limited number of species. Further, most fish passages are far from energy efficient. The hydraulic Fishheart fishway can be installed at hydropower plants with limited space, high ascent, or long transfer distances. Due to the siphon effect the Fishheart water usage is less than 0.3 m³/s. As the fish transfer is done by reversing the direction of the water flow, the Fishheart suits also weakly swimming species like whitefish, lamprey, and eel.

2 Principle of the hydraulic Fishheart fishway

The floating Fishheart unit is designed to be installed on the downstream side of a dam. It connects to tubes passing over the dam with inlet and outlet lines. Using the siphoning effect, water from upstream of the dam is fed into the tubing through the inlet line. An attraction flow tubing atop Fishheart also runs on siphoned water. The Fishheart control unit operates the system remotely 24/7. The control unit is situated inside a separate container, containing electrical hardware and monitors. The water collection tubing can be con-

nected to the separate Smoltheart downstream migration solution if desired. The floating solution enables positioning and repositioning the Fishheart to find the best possible fish migration route.

3 How does the Fishheart operate technically?

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4 Fishheart fishway set up

Figure 1 shows a set-up of the hydraulic Fishheart fishway. Number 4 is the siphon water pipeline which is used to take water to the system from the upper reservoir. Water runs to the Fishheart unit (number 1) via the master pump (number 5). The pump is bypassed by an attraction water line (number 6). Once the fish is inside the Fishheart unit and the elevation starts, it takes the fish safely over the dam inside pipeline (number 3). The whole system is steered by the control unit (number 2), and the system is operated remotely as default.

Synopsis

- The Fishheart fishway is a floating system, situated downstream of dams.
- The fishes are detected and elevated with water through a pipeline system.

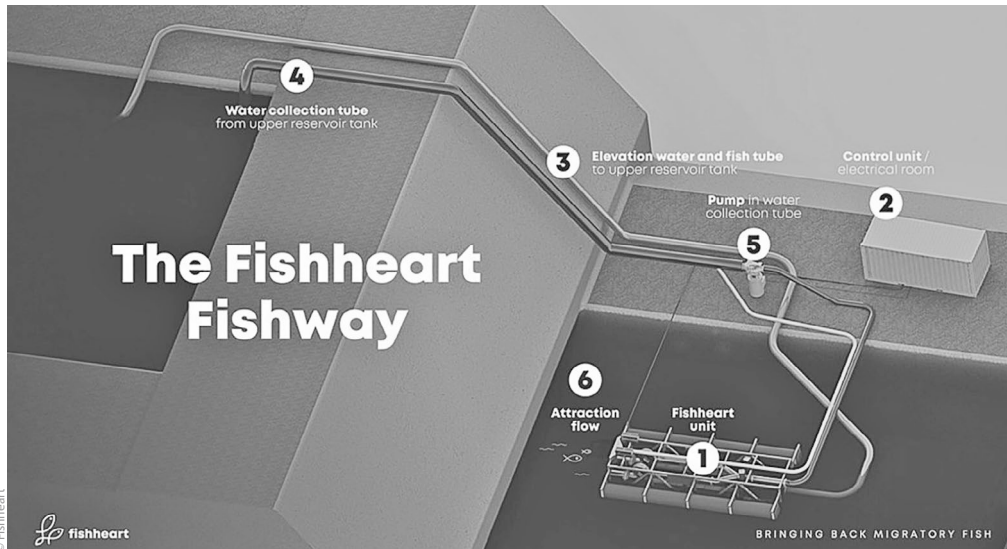


Figure 1: A set-up illustration of the hydraulic Fishheart fishway

5 How does the hydraulic Fishheart fishway attract fish?

Fish approaching hydropower plants tend to swim towards the turbine outlets, these generate the strongest current in the area. Entries of traditional fish passages, situated at the banks or further downstream are easily missed. Eventually fish struggling in the outlet currents need rest, and they position themselves in the close by eddy between the power station and the turbine. This is where the floating and movable Fishheart unit is positioned (**Figure 2**). Resting fish detect the waterfall attraction and approach the unit.



Figure 2: The outer attraction

6 How does the Fishheart elevate fish?

As fish approach the waterfall attraction, they notice the underwater attraction flow coming from inside the unit. This causes them to swim into the Fishheart. There AI detects the fish, takes photos and videos (**Figures 3 to 5**). Information is passed on to the logic and depending on logic settings the automation to elevate fish is started.

7 Satelliteheart

Satelliteheart is a floating additional entry to the Fishheart fishway meant for the larger rivers. It helps the fish to find the Fishheart fishway quickly, to pass several hydropower plants and to reach the spawning areas in time before the spawning starts.

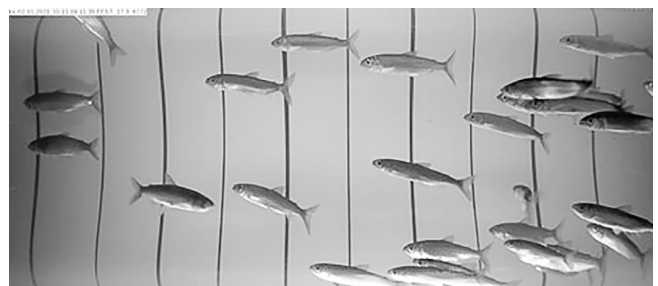


Figure 3: A school of vendace



Figure 4: A whitefish inside the Fishheart



Figure 5: A brown trout inside the Fishheart

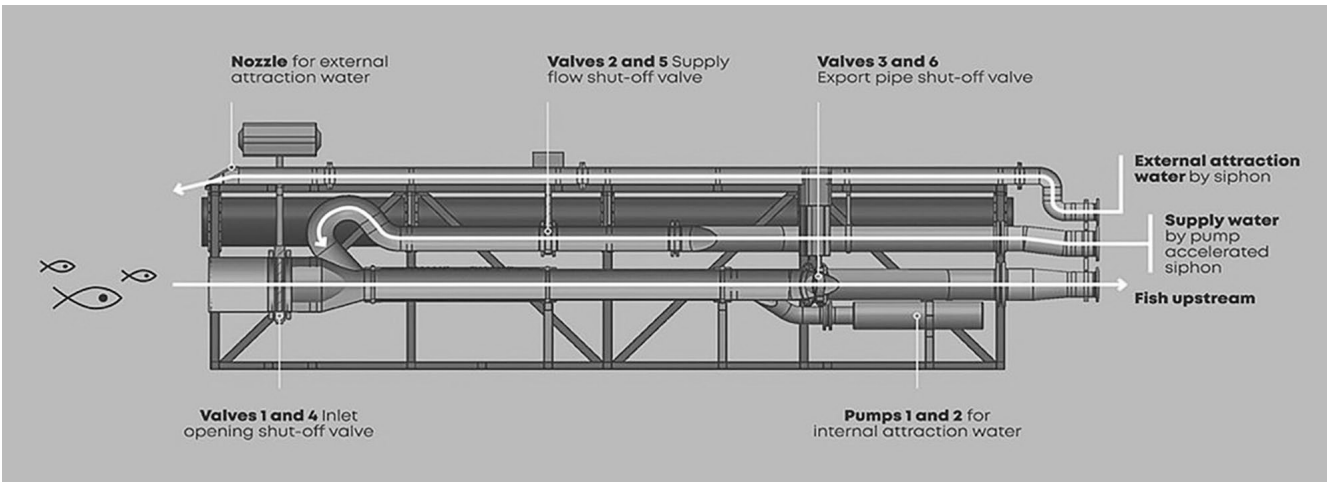


Figure 6: The Fishheart Unit

It can be assembled into different locations downstream of the dam, to areas which are the best for fish migration at different water temperatures and turbine settings. Satellitheart is connected to the Fishheart fishway with a floating pipeline. Same innovation can also be used to improve the functionality of existing badly working technical fishways.

When a fish is to be elevated (species/size/health etc. are as desired) the process initiates automatically (Figure 6). A valve (1 or 4) behind the fish closes, another valve in front of the fish opens (2 or 3) and a third valve (5 or 6) above the fish opens. The

direction of the water is altered, and fish pass over the dam with the combined impact of the siphon effect and the master pump.

Fish will travel safely over the dam as they are constantly surrounded by water during the elevation. They arrive through the pipeline to the upstream in perfect condition and are ready to swim to the next Fishheart unit, or to start spawning.

Results and effectiveness

Fishheart has been granted a hydraulic fishway status by the Regional State Administrative Agency of Northern Finland (AVI). Random sample studies conducted in 2020 by LUKE (Natural resources institute Finland) showed no health impact whatsoever on the salmonids passing through the Fishheart. Further studies in 2021 indicated that the number of Salmonids finding the entrance of the Fishheart is significantly higher than for traditional fish passages in the same river system. The Fishheart suits all species of fish, including eel, whitefish, grayling, and lamprey.

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Die Fishheart-Fischaufstiegsanlage

Bei der Fishheart-Fischaufstiegsanlage werden die Fische durch eine spezielle Leitströmung in das Zweikammer-System geführt. Sobald die Bilderkennung einen Fisch im Inneren des Geräts identifiziert, wird der Aufstiegsvorgang eingeleitet. Die Steuerung ändert automatisch die Richtung des Leitstroms und die Fische werden durch die kombinierte Wirkung des Siphoneffekts und der Hauptpumpe über ein Rohrleitungssystem über den Damm gehoben. Gleichzeitig werden in der anderen Kammer weiterhin Fische angelockt und der Vorgang wird fortgesetzt. Da es sich um ein schwimmendes System handelt, kann es immer wieder neu ausgerichtet werden, bis die bestmögliche Position für den Einstieg gefunden ist. Diese Fischaufstiegsanlage eignet sich für alle Fischarten, ist bemerkenswert wassersparend und stellt im Vergleich zu herkömmlichen Lösungen eine kostengünstige Investition dar.