

# **OHRC testing of Swim-Thru Fishway**

April 2012

Summary: The U.S. Bureau of Reclamation provided funding to the Oregon Department of Fish and Wildlife (ODFW) to build and test the Swim-Thru Fishway. The testing was conducted at the Oregon Hatchery Research Center in February and March, 2012. The results of this test are reported below.

Oregon Hatchery Research Center: ([www.dfw.state.or.us/OHRC](http://www.dfw.state.or.us/OHRC)) The Oregon Hatchery Research Center is a state-of-the-art research facility that allows scientists to study native fish recovery and hatchery programs. The Center is owned by the Oregon Department of Fish and Wildlife, and is jointly operated by ODFW and Oregon State University's Department of Fisheries and Wildlife.

The Center's fish-rearing facilities enable researchers to study both natural and hatchery environments. Facilities include four artificial streams that replicate natural channels and allow scientists to alter substrate, cover, shade and water flow to mimic a variety of natural conditions; four raceways to produce fish under traditional hatchery conditions for comparison with wild fish; and a tank farm with approximately 40 tanks for rearing groups of fish.

Testing for this experiment was done by trained ODFW staff working at the OHRC. All staff members are trained fish culturists with backgrounds in fish husbandry and collectively have over 30 years of fish culture experience.

Swim-Thru Fishway, Inc.: Swim-Thru Fishway has a U.S. patent for a fish passage system that may be used at dams and other stream obstructions to allow fish to pass in an upstream direction. Prior to 2012, a scaled-down version of its system had been tested under the auspices of the U.S. Forest Service at a facility maintained by James Madison University in Virginia. The testing done at the OHRC is the first full scale test of the system.

The basic system is a fish passage pipe that has a set of valves at its lower (entry) end. It is designed to attract fish that are otherwise unable to continue upstream due to the presence of a dam or other stream obstruction. By entering the pipe, passing through the valves and then continuing upstream within the slowly moving stream of water within the pipe, fish may surmount such obstructions, at least in theory. The OHRC test was designed to assess the potential of the system and the functionality of its components.

OHRC Test Site: The four raceways at the OHRC are approximately 80' long x 12' wide x 5' deep. During the Swim-Thru test one of these two sets of raceways was used. Water from Fall Creek, a tributary of the Alsea River, was used for this experiment. Water from the water intake is gravity fed throughout the facility including the raceways. One raceway was used for the "test" raceway in which the Swim-Thru Fishway device was placed. The adjacent raceway was filled with water and acted as the "capture" or

“recovery” tank. The pipe was elevated over one raceway, spilling into another require the fish to ascend 8.5’ during passage.

Swim-Thru Equipment: The equipment that was tested at the OHRC was placed in the left raceway. It consisted of a 20’ valve section and a 60’ passage pipe. The upstream end of the passage pipe spilled over into the adjacent raceway, such that fish that swam through the system spilled over into this adjoining raceway for collection and recovery.

The lower end valve section consisted of three elements: (1) a fish attraction/fish entry and pinch valve connected to (2) an opaque, tubular fish passage pipe with light ports, a fish sensor and a camera, connected to (3) a second pinch valve. The valves and pipes were 12” diameter. It is planned that the subsequent, commercial version of this design would have a larger, 18”-24” diameter.

Pinch Valves: As stated, the Swim-Thru system uses pinch valves to slow the velocity of water flowing from upstream down through the fish passage so that fish can swim upward. These valves were provided by the Red Valve Company of Pennsylvania. The valves are Type A Pinch Valves actuated by compressed air. Their closure and opening is accomplished by inflation and deflation of a flexible rubber sleeve within the valve body. This sleeve can close and open slowly and is therefore regarded as being fish-friendly. <http://www.redvalve.com/rv/index.php/content/view/24/87/>

Sensors: The Swim-Thru system uses fish sensors designed to notice the entry of fish through the first valve, closing that valve after the fish are past. The sensors are Ultrasonic Distance sensors from Automation Direct with an adjustable range from 100 to 600 mm, IP67 waterproof rating. During the OHRC testing, it took several tries to get the sensors adjusted properly.

Once fish pass the first valve and are seen by the sensors, the software in the system then opens the second valve to allow the fish to pass beyond it. A second set of sensors notice that the fish have passed and close the second valve. At that point the fish were free to swim upward to the end of the passage pipe.

In addition to opening and closing under the direction of the sensors, the software is also able to open and close the valves according to elapsed time. Thus the system can cycle itself, opening and closing periodically even if the sensors do not detect the presence of fish within the pipe.

The system also had a Jetview CM30 Underwater CCD color video camera designed for fishing and exploration. During the test the camera allowed us to view the fish within one small section of pipe, however, the LED lights seemed to deter fish from moving upstream within the pipe. With the LED lights turned off, lighting in the device was minimal and function of the camera system was not utilized or efficient. Infar-red lighting is often preferred for fish research projects.

Fish Attraction: The system is designed to utilize upstream water flowing through a separate pipe, merging into the valve area and rushing out to attract fish into the passage pipe. The velocity of this water depends on the height differential between the upstream inlet and the downstream valve section. (Stream flow within the Swim-Thru system is reduced to allow easy upstream passage, and thus is not entirely suited to fish attraction.)

During the OHRC test a pump was to supply water into the upper end of the pipe, as well as a lower attraction flow port. Water was pumped up out of one of the bays and then directed down into the fish attraction section, as though it was coming from upstream. Water flow was set and maintained at 1 cubic foot per second (cfs). A Crowder (12' wide and 30" high, aluminum frame with plastic mesh screen) was installed and utilized to direct the fish toward the opening of the pipe. Fish did move in voluntarily, however it appeared to be the cover they were seeking rather than upstream migration. This conclusion is based on fish utilizing the lower end of the pipe while the flow was turned off. The crowder was critical in directing the fish toward the opening of the pipe. A piece of fabric shade cloth was also placed over the crowder system near the opening of the device to provide shade and protection for the fish near the entrance. For the initial testing to verify that the sensors and valves worked, OHRC staff used the crowder to completely eliminate the holding area and force the fish into the pipe. In the first test, the 12' x 6' holding area was constricted to 6' x 6' by use of the crowder. In subsequent tests documented below, fish were allowed to utilize the entire 12' x 6' holding area.

Fish for this Test: For this experiment, a total of 21 Alsea Stock Winter Steelhead (*Oncorhynchus mykiss*) were used. The adult steelhead ranged in age from 2 to 3 years. Their weight ranged from 2.7 to 3.6 kilograms and length from 56 to 64 cm. The sex ratio was near 50:50 with 10 females and 11 males. Winter Steelhead were chosen for this experiment based on their availability and timing. All fish were transferred from Alsea Fish Hatchery, located on the North Fork Alsea and operated by the Oregon Department of Fish and Wildlife.

Observations from the Test: On February 23, 2012 OHRC staff set up the device in a concrete raceway. Both valves and sensors were tested and seemed to be functioning. Six adult winter steelhead were placed in the holding area below the device, and allowed to acclimate overnight. Water was supplied through the raceway, however no water was flowing through the fishway. The following morning the pumps were turned on to supply water to the fishway as well as attraction water. Fish moved into the fishway, however the sensors did not function properly (later found out to be a secondary pressure sensor) and the system did not function in "Fish Mode" which allows automatic function of the valves triggered by the fish sensors. Early in the afternoon of February 24, 2012, the system was turned to "Manual" and OHRC staff manually changed the position of both valves from open to closed throughout the afternoon to allow fish passage. The system was operated for a total of 19 ½ hours. The following morning, 4 of the 6 fish were found in the recovery raceway. All four of the fish moved during the night/dark hours as no fish passage was observed during daylight hours for any of the tests.

The second test started on February 27, 2012. Five fish were placed in the holding area of the test raceway. The system was again placed in “Fish Mode,” after OHRC staff readjusted the fish sensors. The system ran for 14 hours and no fish passage occurred. Due to the faulty fish sensors (or pressure sensors) the valves did not properly function by opening and closing when triggered by a fish.

The third test started on February 29, 2012. Five fish were placed into the holding area of the experimental raceway. Due to the sensors not functioning properly, the system was placed in “Auto Mode” where the valves open and close every 90 seconds. The system was operated for 15.5 hours. One fish passed into the recovery raceway. The fish moved during night/dark hours as no fish passage was observed during daylight hours.

On March 22, 2012 Tom Sage, the project engineer, was onsite and made some modifications to the system to fix the sensor issue we had in tests one and two. He was able to by-pass the pressure sensors allowing the system to operate properly. The operating pressure was lowered to 8psi to allow attraction flow when either valve was in the closed position. Any higher pressure would completely restrict flow. The pressure sensors were much less sensitive (20-100psi) so they were by-passed, or removed from the system. The pressure sensors acted as a redundant check to verify the valves had closed. Again, due to the low operating pressure to allow adequate flow, the sensors were not functioning properly.

The fourth and final test started on March 26, 2012. Five fish were placed in the holding area of the experimental raceway. The system was now again placed in “Fish Mode.” The system was operated for 13 hours. No fish were observed passing into the recovery raceway. Fish were observed in the fishway and the sensors and valves were functioning properly.

<b>Total Time (hours)</b>	<b># of Fish</b>	<b># of Fish Passed</b>	<b>% Passed</b>	<b>Fish/Hour</b>
19.5	6	4	66.67%	0.21
14.0	5	0	0.00%	0.00
15.5	5	1	20.00%	0.06
13.0	5	0	0.00%	0.00
		<b>Fish Passage</b>	<b>23.81%</b>	
		<b>Fish per Hour</b>	<b>0.08</b>	

All five fish that did pass through the device did so during dark hours. While fish were observed in the device during daylight hours, no passage occurred.

Velocity of Flow Within the Passage Pipe: The compressed air operated pinch valves, when fully pressurized, can close almost completely. When less than fully pressurized they leave a central opening through which water can flow. For fish that are swimming upward, at least some minimum flow is thought to be needed to indicate the upstream direction. At the same time, the less flow there is, the easier it may be for fish to swim upward. One aim of the test was to assess the rate of flow that best meets the needs of the

fish. The measured flow rate was 1cfs and the operating pressure for the system was set at 8psi to allow flow when the valves are closed.

Light Within the System: The valve section and the passage pipe were built with light ports to admit ambient light. After observing that light in the pipe seemed to be inhibiting fish from entering, the ports were covered and fish seemed more inclined to enter. Similarly, the underwater camera came equipped with bright LED lighting. This had to be turned off when it seemed that it made the fish uncomfortable.

Fish Safety: A prime concern in conducting the test was ensuring the safety of the fish involved. The system was built with smooth internal surfaces and the pinch valves were programmed to open and close slowly so as not to harm the fish in any way. And in fact no fish were harmed.

Ambient Noise: There were at least two sources of noise within the system: the sound created by the operation of the pinch valves and the pump sound of the fish attraction flow pump. Neither seemed to be an issue for the test fish. In subsequent testing, if it were to happen on an actual stream, stream water could be used for fish attraction but the sound of the pinch valve bladders opening and closing would remain a constant.