BONNEVILLE POWER ADMINISTRATION

Grande Ronde Model Watershed Project

Catherine Creek Swim-thru Fishway Field Test

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Grande Ronde Model Watershed Project

Catherine Creek Swim-thru Fishway Field Test

Completion Report

Performance Period
March 21, 2005 to September 30, 2005

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Introduction

Numerous fish passage projects have been implemented by the Grande Ronde Model Watershed Program and its partners over the last decade, providing access to habitat for ESA listed fish in the Grande Ronde Subbasin. Despite that effort, substantial passage obstacles remain, many of which will be extremely expensive to remove and replace.

The GRMWP in cooperation with Swim Thru Fishway, Inc. (STF), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), BOR, USFWS and NOAA Fisheries tested an innovative fish passage technology at the Catherine Creek Adult Collection Facility (CCACF) operated by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The CCACF site was selected because it offered a secure location where the device could be installed and monitored by CTUIR staff in conjunction with their adult chinook collection activities.

STF developed the rotary valve system. The prototype used in the test was built by Everett Engineering. It was tested extensively at the Bureau of Reclamation Water Resources Research Laboratory in Denver, CO. Preliminary testing indicated the STF technology could be a cost effective means of improving fish passage without compromising the function of many of the essential regional structures that create obstacles (irrigation diversion, road culverts, flow control devices, etc.) This field testing was proposed to determine whether fish would use the rotary valve under actual stream conditions. Field testing was considered a key step toward development of necessary, affordable fish passage technology.

Description of the Project Area

The trap was operated at the Catherine Creek Adult Collection Facility (CCACF), located on the mainstem Catherine Creek at River Mile 32, about 3 miles east of the town of Union, OR. The CCACF is a structure used to collect adult chinook salmon and steelhead as they migrate upstream to spawning grounds. The CCACF structure is part of an irrigation diversion where Catherine Creek spills over a series of notched spillways, dropping about 6 feet in elevation from the upstream portion of the structure to the downstream portion (total of about 100 ft). See Figure 1 at end of report. The downstream end of the notched spillways serves as a weir for a fish trap which blocks upstream passage. When in use, it redirects migrating adult steelhead and chinook to a specially designed fish ladder located adjacent to the main stream. Fish blocked by the weir enter a fish ladder and swim up to a fyked headgate about 30 ft from the ladder entrance. Once the fish swim into the fyke, they cannot swim back out. At the same time, another headgate located toward the upstream exit of the fish ladder prevents them from leaving the ladder. In effect, once fish enter the fyked headgate they confined and can be processed by CTUIR personnel.

Trained CTUIR staff process adult fish that enter the trap according to procedures agreed to by the co-managers of the basin (CTUIR, Oregon Department of Fish and Wildlife, Nez Perce Tribe and the U.S. Fish and Wildlife Service. Selected wild and hatchery fish are allowed to continue upstream. Other fish are removed for transportation by tank truck

to either a related hatchery or to one or more streams that are separate from Catherine Creek. At times fish may also be removed to be used for Tribal purposes.

The trapping facility is accessible by locked, private road and is quite secure. It is attended by CTUIR staff 24 hours a day during the chinook and steelhead migration season, which covers the period from April through September. CTUIR staff indicated that it was possible to conduct research evaluation of the Swim-Thru Fishway rotary valve system at the facility, if testing was carefully scheduled and coordinated with the workload of the facility.

Proposal

The proposed research was intended to confirm basic safety and functionality of the STF rotary valve. Because the facility has a hoist and on-site staff to install and remove the valve, tests could be conducted as often as necessary to work out problems that could be encountered, as long as they were coordinated with the primary work of the facility. Tests could be conducted with all species, at any time of day, in varying turbidity conditions. Staff could record the behavior of fish, via video cameras as they approached the valve. Tests could be done during a variety of water flow levels.

Research results were to be recorded by trained CTUIR staff and the underwater video equipment. All results could be logged with time correlations pertaining to time of test, length of test, safety outcomes, observed failures, if any, etc.

Project Goal: Determine the operational feasibility of the rotary valve system during real-time use and the acceptance of the system by multiple fish species and multiple fish life stages during times of testing.

Project Objectives

1. Determine whether the system can be operated during normal stream conditions.
2. Determine whether fish migrating upstream in Catherine Creek will accept the system as a viable passage method.
3. Determine whether fish (usually juveniles) migrating downstream will accept the system as a viable passage method.

The rotary valve equipment was to be placed in the fish ladder immediately above where the fyked headgate is normally positioned. The fyked headgate was installed just above the upstream outlet of the STF valve. Five tests were planned for periods as described below. Start time depended on how soon permits could be obtained and equipment manufactured and delivered to the site. Between test periods the equipment would be completely removed from the stream. At any time during testing if the migration of fish appeared to be impeded (no fish in trap above equipment), the equipment would be removed from the stream and attempts made to modify and correct the configuration of the entrance.

The following testing schedule was proposed. Tests would commence as soon as the STF was delivered to the site. The August test period was tentative depending on availability of personnel, water conditions and necessity, ie. results of July test period.

Test 1: Week of 18 April
Duration: 3-5 days.
Species: Adult summer steelhead and resident rainbow trout.
Results: Measuring the number of fish entering trap prior to installation of trap, number of fish entering trap during use of valve, and number of fish entering the trap after removal of valve will be the determination of success. Passage through the valve will be timed. Use of underwater video monitoring of equipment and inspection of fish for injuries after passing valve will occur.

Test 2: Week of 23 May.
Duration: 3-5 days.
Species: Adult spring chinook salmon, resident rainbow trout, bull trout, sucker spp.
Results: Measuring the number of fish entering trap prior to installation of trap, number of fish entering trap during use of valve, and number of fish entering the trap after removal of valve will be the determination of success. Passage through the valve will be timed. Use of underwater video monitoring of equipment and inspection of fish for injuries after passing valve will occur.

Test 3: Week of 20 June.
Duration: 3-5 days.
Species: Adult spring chinook salmon, and sucker spp.
Results: Measuring the number of fish entering trap prior to installation of trap, number of fish entering trap during use of valve, and number of fish entering the trap after removal of valve will be the determination of success. Passage through the valve will be timed. Use of underwater video monitoring of equipment and inspection of fish for injuries after passing valve will occur.

Test 4: Week of 25 July.
Duration: 3-5 days.
Species: Juvenile spring chinook salmon, and O. mykiss.
Results: Downstream migration of juveniles past the valve will be the determination of success. Passage through the valve will be timed. Use of underwater video monitoring of equipment and inspection of fish for injuries after passing valve will occur.

Test 5: Week of 22 August.
Duration: 3-5 days.
Species: Juvenile spring chinook salmon, and O. mykiss.
Results: Downstream migration of juveniles past the valve will be the determination of success. Passage through the valve will be timed. Use of underwater video monitoring of equipment and inspection of fish for injuries after passing valve will occur.

The CCACF is designed to regulate and withstand the downstream flow of water-bourn debris. The rotary valve was similarly designed. It was expected that the series of tests would include testing when debris was present, and CTUIR staff would measure and report debris resistance or failure along with their other observations.

Scheduling, staffing and reporting: All of the foregoing was proposed for 2005, to commence as soon as permits and funding were in place and the equipment constructed and delivered to the site.

Materials and Methods

The STF rotary valve internal design includes three revolving veins similar to a revolving door. The design allows fish to enter on the downstream side, rotate around to the upstream side, and exit through an opening. The veins are driven by a worm gear, operated either by an electric motor or a water wheel. The veins are made of aluminum with a rubber strip on the top, sides, and bottom. The rubber strips were installed to keep fish from moving to and from each vein. The external structure, made of machined aluminum, is approximately four feet in length by six feet wide, with a depth of two feet The top of the device had three portal windows to allow observation of fish moving through the valve.

Delays in delivery of the valve and permitting precluded testing during the first proposed test week beginning April 18 for summer steelhead, etal., and the second period May 23 for spring chinook, etal.

Upon delivery, the rotary valve had to be adapted to fit inside the fishway. A plywood wall was attached on the upstream side to the device to build up a head of water and to control the flow of water through the machine. Attractant flow was provided by screened pipes, regulated by knife gates. Water entered the pipes on the upstream end and exited near the downstream entrance to the valve. The upstream valve exit had three, one-inch diameter pickets acting as a one-way door, so once fish swam through they were unable to return downstream. Installation of the device in this configuration could only test upstream capabilities for adult fish, although fish smaller than the space between the fyke bars could enter the valve from the upstream side.

The STF valve was first installed on June 1 at 2:00 pm**.** The water wheel, which was to power the valve, did not function properly due to lack of pressure through a 1 ½" hose. The valve was pulled out and an electric backup motor was installed. The video cameras were installed viewing the entrance to valve and the fyke at the outlet. On June 2nd the passage device was fully operational. The positioning of the camera was adjusted during the tests to best view the entrance and exit. Video tape segments were about 12 hours each and ran from 8 PM to 8AM and 8:00 AM to 8:00 PM. Nearly all of the Catherine Creek chinook entered the CTUIR trap during periods of low-light or darkness. CTUIR personnel normally began processing fish about 8:00 AM so the number of fish reported for dates listed in Table 1 are for a period that began at 8 PM of the preceding day.

Results

Testing began at 2:45 PM June 2. The video cameras where started at this point. During the first 20 hours of operation 3 adult chinook and 1 large mouth sucker passed through the valve. Videotape for daylight hours during this period showed that the chinook would test the entrance then back downstream before re-entering the device. The suckers would face downstream positioned below the fyke. Suckers were not observed going into the trap, although they did pass through during the night. On the morning of June 3rd the motor shut down and had to be removed. To continue testing a 4" diameter PVC pipe with a 90-degree elbow was installed to run the water wheel. The motor was sent in for repairs.

Testing resumed the afternoon of June 3rd using the water wheel to drive the valve. The June 4 AM trap check reveled 4 adult chinook and 3 largemouth suckers had successfully passed through the valve. No behavioral observations at the entrance via the video were made due to the poor video quality. During the resetting of the flows for the device a problem with the rotation of the gates was discovered. The gates would slow at a certain point every revolution. To correct this, a piece of rubber was installed on the elbow increasing the flow of water on the water wheel.

Testing resumed the afternoon of June 4. The June 5 AM trap check resulted in 10 adult chinook and 8 large mouth suckers successfully passing through the trap. However an adult chinook, 639 mm in length, was found impinged between one of the gates and the exit portal of the device. Due to the inability of the video to monitor fish movement inside the valve, it is not known how the fish became impinged. Also during this test period a bull trout, 354 mm in length, was found dead, caught in the grating covering the exit of one of the flow attractant pipes. As specified under Special Terms and Conditions in the USFWS recovery permit under Section 10(a)(1)(A) limiting injury or mortality to one bull trout, testing was terminated.

Table 1 lists the date, species, sex, fin-clip and size of fish that passed through the rotary valve and were collected in the holding area above the valve.

Table 1

Fish #	Dated	Species	Sex	Fin-Clip	Fork Length (mm)
1	6-3-05	LMS	N/A	UN	390
2	6-3-05	CHS	M	AD	623
3	6-3-05	CHS	M	AD	849
4	6-3-05	CHS	M	UN	858
5	6-4-05	CHS	M	AD	705
6	6-4-05	CHS	F	AD	741
7	6-4-05	CHS	F	AD	738
8	6-4-05	CHS	F	UN	695
9	6-4-05	LMS	N/A	UN	431
10	6-4-05	LMS	N/A	UN	312
11	6-4-05	LMS	N/A	UN	322

Fish #	Dated	Species	Sex	Fin-Clip	Fork Length (mm)
12	6-5-05	CHS	M	AD	821
13	6-5-05	CHS	F	AD	790
14	6-5-05	CHS	F	AD	735
15	6-5-05	CHS	F	AD	871
16	6-5-05	CHS	M	AD	706
17	6-5-05	CHS	F	AD	763
18	6-5-05	CHS	M	AD	766
19	6-5-05	CHS	M	AD	654
20	6-5-05	CHS	M	UN	662
21	6-5-05	CHS	F	AD	779
22	6-5-05	CHS	M	AD	639 dead
23	6-5-05	BT	N/A	UN	354 dead
24	6-5-05	LMS	N/A	UN	413
25	6-5-05	LMS	N/A	UN	354
26	6-5-05	LMS	N/A	UN	360
27	6-5-05	LMS	N/A	UN	404
28	6-5-05	LMS	N/A	UN	415
29	6-5-05	LMS	N/A	UN	368
30	6-5-05	LMS	N/A	UN	471
31	6-5-05	LMS	N/A	UN	400

Discussion

A total of 17 adult chinook, ranging in size from 623-871 mm, successfully passed through the rotary valve during 3 test periods. Twelve large mouth suckers also passed through the valve. The chinook mortality, at 639 mm, was actually one of the smaller chinook to use the valve. Video documentation of fish passing through the valve is not sufficient to determine the behavior of fish inside the valve. Most fish passed through during periods of low, or no light. It is not known what behavioral pattern caused the adult chinook to become impinged by the valve vane at the exit portal. The fish was caught just behind the gills and pinned between the vane and the valve structure. There is speculation, based on pre- post-test video of adult chinook approaching the fyke (after the valve was removed), that the fish may have approached the fyke at the valve exit to test it and then became impinged as it retreated back into the valve. This behavior was observed clearly during video monitoring of the fyke at the lower end of the CTUIR trap after the STF had been removed. An adult chinook was observed moving up to the fyke, backing downstream, and then a minute or so later quickly passing through the fyke.

The bull trout mortality was result of a combination of a design flaw and bad karma. Evidently the fish attempted to enter the flow attractant pipe which was screened by vertical bars. The bars happened to be spaced at just the right width to allow the fish to partially enter but then become gilled as it tried to back downstream.

Summary and Conclusions

The project goal was to determine the operational feasibility of the rotary valve system during real-time use and the acceptance of the system by multiple fish species and multiple fish life stages during times of testing.

Field testing partially met this goal. It did determine the feasibility of using the rotary valve system. Due to the limited duration of the testing the trial was not able to test the acceptance of the system by multiple fish species and life stages. Adult chinook and largemouth suckers were the only species, positively identified, to pass through the valve.

The project objectives were:

1. Determine whether the system can be operated during normal stream conditions.
2. Determine whether fish migrating upstream in Catherine Creek will accept the system as a viable passage method.
3. Determine whether fish (usually juveniles) migrating downstream will accept the system as a viable passage method.

Objective were also partially met. Field tests verified the operability of the valve under controlled flow conditions. Modifications of the setup of the valve could likely be made if the unit were installed under conditions where flow might be subject to change. Adult chinook and largemouth suckers did accept the valve and pass through it. The valve was not tested on juveniles migrating downstream.

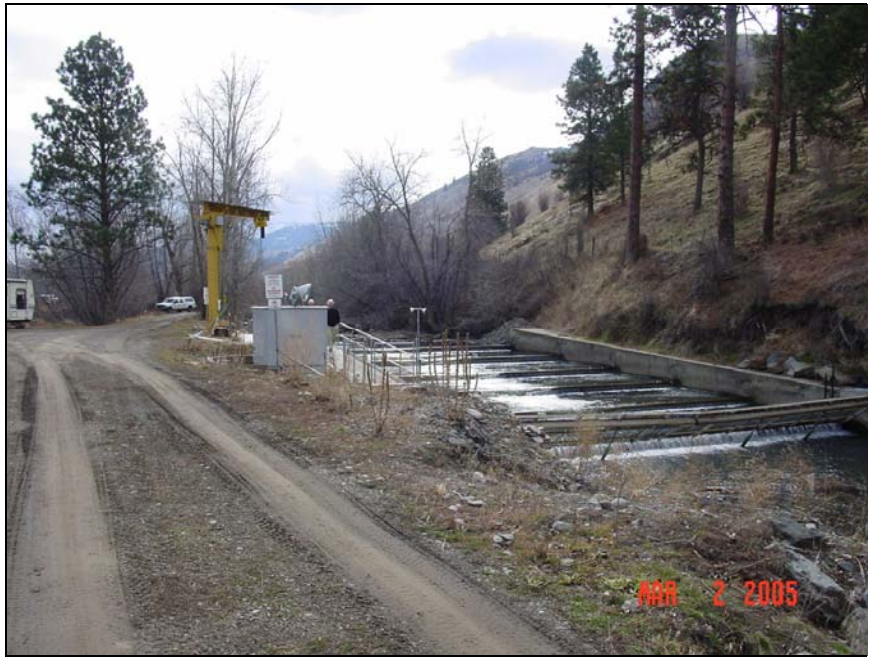
Although the STF rotary valve successfully passed 17 adult chinook salmon there needs to be further development and design changes before this prototype or another version can be tested on ESA listed fish. Testing on unlisted fish under variable conditions would be a good place to start. We believe the concept still has the potential to be a viable, economic technology to provide fish passage under certain conditions.

It did not appear that the placement of the valve at the CTUIR collection site inhibited adult chinook movement into the CTUIR fish trap until, during the 3rd day of testing, when the valve rotation was totally stopped by the impinged fish. A larger more continuous fish migration however is needed to verify the effect on migration pattern. It is not known if the artificial lighting, to enable video monitoring had an effect on fish movement or behavior. It is unlikely that it had a significant effect since 11 adult chinook moved through the valve during the last test period, most under cover of darkness, with artificial light in place.

Further testing, if undertaken, should include better video monitoring, including the ability to observe fish behavior within the valve. Had this been in place we might have a better idea of how the chinook mortality occurred. Additionally, better screening of flow attractant pipes could keep smaller fish from suffering the fate of the bull trout.

Budget Summary

Activity	Total Budgeted	Total Expended	Difference
Rotary valve fabrication and delivery	$22,250	$24,920	+$2,670
Installation & materials (fabrication, steel, pipe)	$3,200	$1,530	-$1,670
Underwater monitoring equipment	$1,000	0	-$1,000
Prepare field test report	$2,000	0	$2,000
Contract administration	$500	$500	-
Total	$28,950	$26,950	+$2,000



CCACF Site

CTUIR Fish Trap, STF Placed in this structure