Exxon Valdez Oil Spill
Restoration Project Final Report

In Stream Habitat and Stock Restoration for Salmon
Shrode Creek Barrier Bypass Subproject

Restoration Project 94139-B2
Final Report

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Study History: Restoration Project 94139-B2 was initiated from Restoration Project 93063, Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Anadromous Fish, draft report 1993 by K.L. Wedemeyer. This report identified the Shrode Creek fishway repair opportunity to resolve a fishway deterioration problem.

Abstract: In 1994, repair was made to a deteriorating concrete weir at the Shrode Creek fishway. The stream flows into Long Bay, Culross Passage, Prince William Sound. Repairs were made through use of three types of polymer resins to obtain information and experience in applicability and effectiveness of these resins as applied to fishway repair.

Key Words: *Onchorhynchus*, fishway, weir, *Exxon Valdez*, salmon, Prince William Sound.

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EXECUTIVE SUMMARY

Shrode Creek, located within the Chugach National Forest, flows into Long Bay, Culross Passage, Prince William Sound. Long Bay is immediately adjacent to areas which received heavy amounts of oil from the 1989 *Exxon Valdez* oil spill. Shrode Creek supports runs of pink salmon (*Onchorhynchus gorbuscha*), coho salmon (*Onchorhynchus kisutch*), sockeye salmon (*Onchorhynchus nerka*), chum salmon (*Onchorhynchus keta)* and Dolly Varden char (*Salvelinus malma*). Pink salmon, sockeye salmon, and Dolly Varden were species injured by the *Exxon Valdez* oil spill.

A fishway was constructed in 1962 to allow salmon passage around a 10 foot barrier falls. In 1993, the lower concrete weir to this fishway was determined to be deteriorating and posed a high risk of failure. Failure of this weir would stop further upstream migration of salmon. In 1994, the Forest Service successfully repaired the weir using polymer resin panels constructed off-site then transported to the field. The panels were bolted onto the failing wall to armor it and stop further deterioration of the worn concrete.

The method used to repair the concrete wall was considered effective and eliminated the need to haul quantities of concrete into the remote field location.

INTRODUCTION

Shrode Creek, located within the Chugach National Forest, flows into Long Bay, Culross Passage, Prince William Sound. Long Bay is immediately adjacent to areas which received heavy amounts of oil from the 1989 *Exxon Valdez* oil spill. The stream supports runs of pink salmon (*Onchorhynchus gorbuscha*), coho salmon (*Onchorhynchus kisutch*), sockeye salmon (*Onchorhynchus nerka*), chum salmon (*Onchorhynchus keta)* and Dolly Varden char (*Salvelinus malma*). Pink salmon, sockeye salmon, and Dolly Varden were species injured by the *Exxon Valdez* oil spill.

The Shrode Creek fishway was constructed in 1962 to bypass a 10 foot barrier falls and provide salmon access to the stream habitat above the falls, Shrode Lake, and two small unnamed lakes. The fishway is a series of concrete weirs and gabions. Habitat above the fishway is utilized by sockeye, coho, pink, and chum salmon, as well as Dolly Varden char. After construction, the fishway was modified in 1965-1967. This fishway has required substantial maintenance, performed by the Forest Service, since the 1980's. A 1992 inspection indicated the need for immediate replacement of the gabion baskets armoring the downstream side of the lower weir as many salmon were impaled and gilled by the deteriorating gabions. Inspection during 1993, when the gabions were replaced, revealed that the concrete weir above the gabions was undercut and in need of reconstruction as the potential for it's failure was high.

OBJECTIVES

The project objective was to evaluate and repair a seriously deteriorating concrete wall critical to the function of the Shrode Creek fishway.

METHODS

A field camp was set up near the fishway. The fishway repair was made between June 20 and July 18, 1994 by a field crew of 7 individuals.

The repair involved the use of three types of polymer concrete products (trade name Thermo-Chem), including an underwater curing resin (filler resin) used as a filler material (Thermo-Chem product # 312), a fibrous mortar resin used in the panel construction (Thermo-Chem product # 306), and an injection resin for crack repair (Thermo-Chem product # 2).

Ten panels 2 feet (′) by 4′ by one inch (") thick, weighing approximately 70 pounds each, were pre-cast, in Anchorage, of fibrous mortar resin and transported to the site for construction. The purpose of the panels was to armor the outsides walls of the existing weir in a sandwich-like manners to provide added strength and stop the continued deterioration of the concrete structure. The existing concrete weir is a notched wall spanning 19′, 4′ high, 1.5′ wide with the notch 31 inches (") wide by 18" deep for fish passage.

Prior to repair of the wall, water flow to the fishway was shut off at the up-stream head-wall and a coffer dam constructed on the downstream side of the lowest wall. The fishway was de-watered and the old gabions that were placed below the wall as a temporary repair were removed.

The precast panels acted both as forms to rebuild undercut walls and as final armoring to the eroded surfaces of the wall. The bottom row of panels were scribed to fit along the base of the wall and anchor pilot holes were drilled into the wall. The panels were removed and anchor holes were drilled to a

minimum depth of 6" and 3/4" all-thread was grouted into the holes with filler resin. The first row of panels were hung on these studs and bolted in place. To seal the base of the panels to the new foundation and existing bed rock, a sandbag form was laid along the base and a footing was poured with filler resin. The voids behind the panels were filled with chips from the scribe-fit panels and filler resin.

After this installation of the lower panels had set, the upper row of panels were bolted to the wall with a 3/16" gap. Filler resin was poured in to fill the void and bond the panels to the wall.

RESULTS

A closer inspection of the wall after the channel was de-watered revealed much more extensive damage than was evident when the wall was last inspected the previous field season. Upon removing the gabions from the downstream side of the weir, it was discovered that nearly a third of the submerged portion of the wall was undercut and water flowed freely under at least half it's length.

Only two sections on either end of the upstream side of the wall rested on bedrock (approximately 20% of the wall). The rest of the downstream edge of the wall rested on unconsolidated materials with no foundation. The downstream side of the wall had several large cavities, rotten concrete and exposed rebar and aggregate. Several large cracks had developed that ran completely through the wall, with only the rebar reinforcements holding the sections together. The upstream side of the wall was also undermined but the damage was less extensive.

Serious consideration was given whether to abandon the project, as there were inadequate materials on hand to complete repairs which were more extensive than originally planned. We determined however, that further delay in repair of the wall threatened failure of the entire wall and that immediate repair, including securing additional supplies, was the most efficient means of preserving and repairing the wall.

Repair of the wall began by removing loose concrete initially with pneumatic scaling tools. As a result of the poor condition of the concrete and minimal materials to fill voids, the preparation was completed with hand tools to avoid further loss of material in the wall. The base on the downstream side of the wall was excavated to solid bedrock and a new foundation poured of filler resin mixed with silica sand. Bedrock under two sections of the wall, less than one linear foot, was not located. Originally it was planned to use only panel chips and filler resin to fill the space between the bottom of the wall and the new foundation. However, the area was so large it was impractical to use only resin and the limited chips available from fitting the precast panels. Consequently the void was filled with washed rocks and filler resin poured into the space between the rocks to bind them together.

Panels were bolted onto the front and back of the wall with some difficulty. Some panels had to be scribed and cut multiple times to a proper fit onto the all-thread attachment bolts. The panels eventually fit into place as designed.

The weir notch was lined with filler resin and the top of the wall capped with 5 star structural concrete repair mortar to complete the project.

On August 13, 1994, the fish pass construction was inspected. All repairs were determined to be in good shape and holding well.

DISCUSSION and CONCLUSIONS

The repair is expected to extend the life of the lower weir of this fishpass and eliminate the need for major repairs in the next 5 years. Observation during the return of adult sockeye salmon revealed the fish were passing successfully through the repaired wall of the lower weir.

The repair of the wall required twice the original estimate of materials and four additional days of labor by the 7 person crew. During that time, however, the crew was also able to clear boulders and rocks from the intermediate pools in the fish pass which is expected to improve passage for pink salmon.

Although the fibrous mortar resin panels and filler resin were colored to blend into the natural landscape, the filler resin around the bolts and between the panels does not blend in well. Painting the panels installed on the lower wall a dark neutral color will make them blend in more naturally with the environment, improving the visual esthetics in the Wilderness Study Area surroundings.

The polymer resins performed irregularly during the project. The resins are a two part product in liquid form which harden when mixed. The rate of chemical reaction is dependent on temperature. Weather was cool and wet on site during use. Often the resins did not set up quickly enough and flowed through any opening in the forms and was lost. The injected resin was difficult to hold in place for a period long enough for it to set up unless it was injected down a vertical hole or crack with no way for it to escape. Rough irregular surfaces at the project site added to the difficulty of use. This was the first time the crew had used the resins and it is most likely that further experience with these products would solve most difficulties encountered. It is recommended that the products be tested and experimented with prior to field application by those who would be using such products. This will allow the user more familiarity as to the capabilities of the product.

It is recommended that a complete structural review of the entire fishway be performed by qualified engineers to determine current structural integrity and life expectancy under the current maintenance regime.

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