Repair of the Lower Diversion Weir at Frazer Lake, 2003

by

Nicholas H. Sagalkin

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AUTHOR

Nicholas H. Sagalkin is a Region IV Finfish Research Biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 211 Mission Road, Kodiak, Alaska.

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ABSTRACT

The Frazer Lake fish pass was built in1962 and went through modifications in 1971, 1972, and 1979. No repairs have been made to the concrete structure built in the 1960s and 1970s (up to 40+ years old). Due to corrosion and the lack of maintenance, several parts of the fish pass were deteriorating. In particular, the weir that diverts fish into the fish ladder was structurally weakened due to rotten wood and rusted and bent steel. In addition, the entrance chute (wood) and the upper sampling platform (wood) were deteriorating and in need of repair. Repair plans were sketched in 1999; however, lack of funding prevented any long-term repairs in 2001 or 2002. Funds were acquired in the fall of 2002 to make repairs. Following a site visit by Rob Baer in the summer of 2002, it was determined that the diversion weir required more substantial repair than originally estimated. Materials for the repair were purchased in the winter of 2002. In the spring of 2002, materials were transported to Stockholm Point in Olga Bay via the R/V K-Hi-C and then shuttled to Frazer Lake using a chartered DeHavilland Beaver floatplane. Materials were transported from the lake to the fish pass with a tractor and trailer. A crew of three people were transported to Frazer Lake on 5 June 2003 and repaired the fish pass through 19 June 2003. Substantial improvements were made to the diversion weir, entrance chute, upper sampling deck, and fish pass covers.

INTRODUCTION

Frazer Lake is the second largest lake in the Kodiak Archipelago. A 9-m barrier falls located on Dog Salmon Creek, approximately 0.9 km below the outlet of Frazer Lake, prevented anadromous salmon from naturally accessing the lake (Sagalkin 1999). Sockeye salmon *Oncorhynchus nerka* were introduced into Frazer Lake with egg plants beginning in 1951 by the Alaska Department of Fish and Game (ADF&G; Blackett 1979). Stocking continued through 1978, and adult returns began in 1956 (6 adult sockeye salmon). From 1956 through 1961 returning adults were backpacked over the falls and in 1962 a fish pass was built to allow fish to circumvent the falls (Figure 1; Blackett 1987).

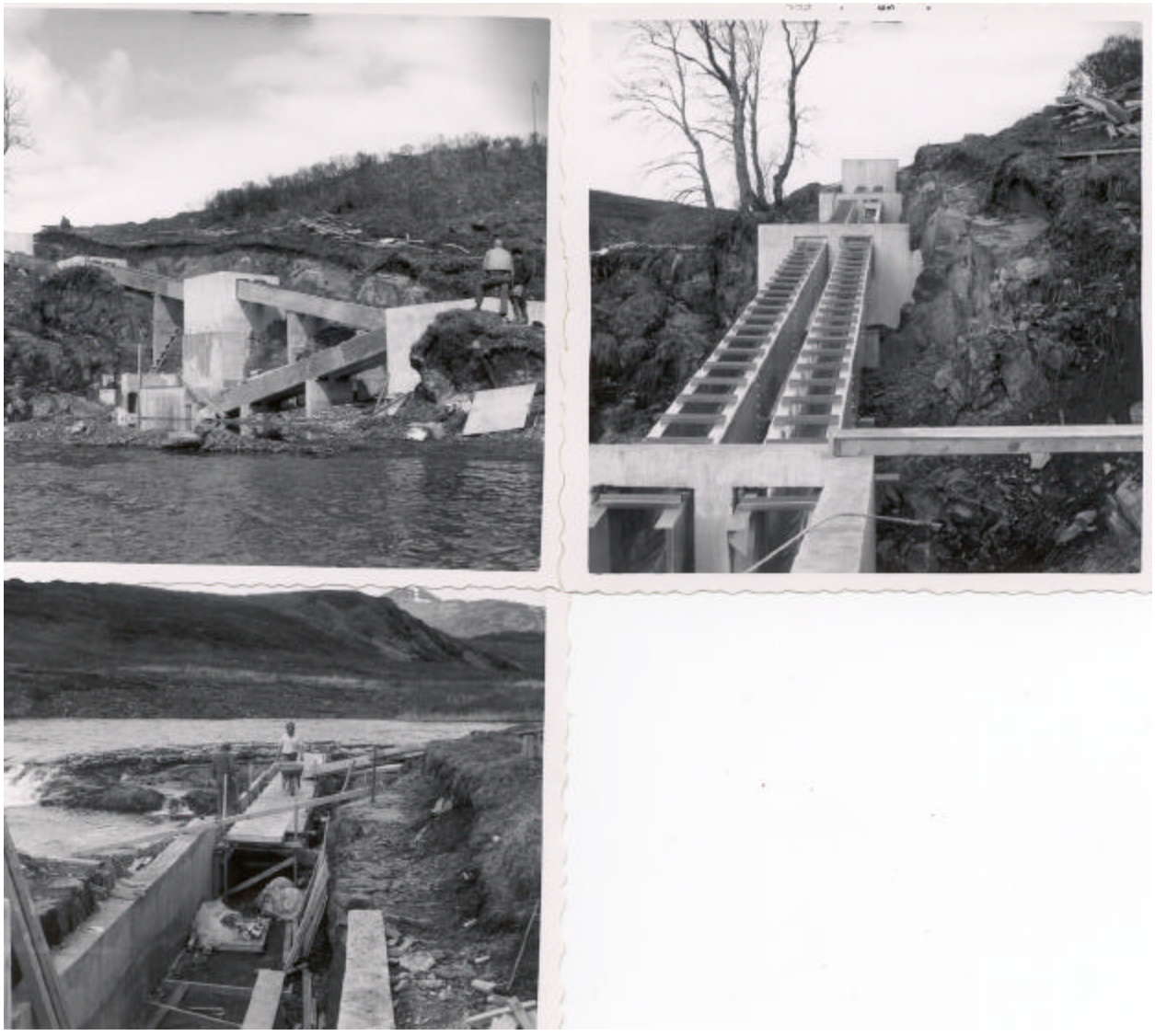

Figure 1. Frazer Lake fish pass construction, 1962.

Fish Pass Modifications

The entrance for the fish pass, built in 1962, was at the base of the falls, and fish had a difficult time finding the entrance (Figure 2).

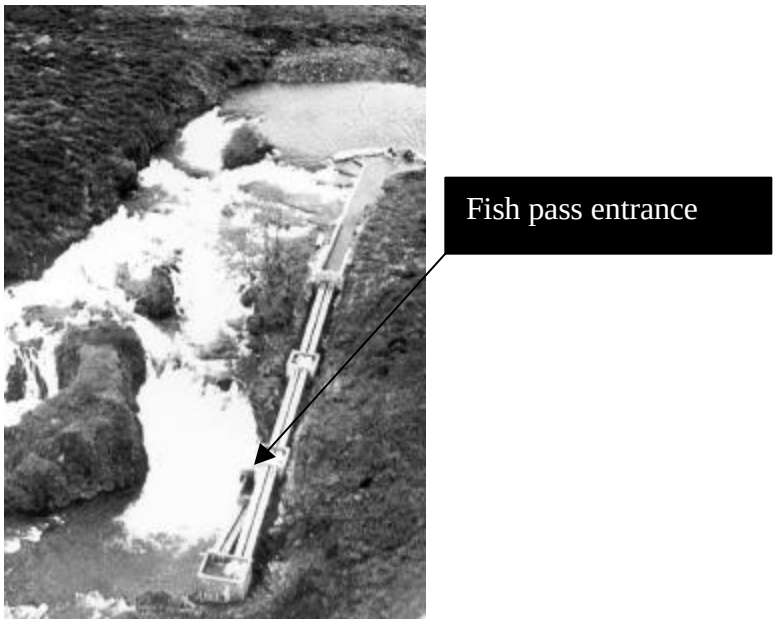

Figure 2. Frazer Lake fish pass, 1962.

In 1971 and 1972, the fish pass was modified by extending the entrance downstream of the falls and a weir (diversion weir) was built to guide the salmon to the entrance (Blackett 1987; Figure 3).

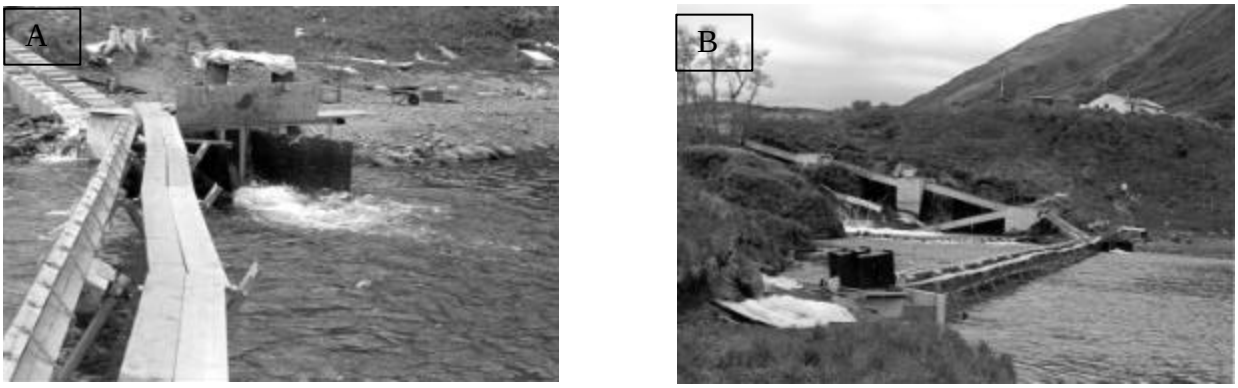

Figure 3. Frazer Lake fish pass entrance downstream of falls (A) and the new diversion weir (B), 1972.

In the late 1970s the Frazer Lake sockeye salmon run had increased substantially, with a record escapement of 141,981 in 1978. New research suggested implementing a much higher escapement goal for the system than originally established (Blackett 1979). As a result, a second fish pass (NEW) was built in 1979 to increase the passage rate (Figure 4).

Figure 4. Construction of the second (NEW) fish pass at Frazer Lake, 1979.

Subsequent research demonstrated that the higher escapement goal was impacting the forage base, and the escapement goal was lowered (Kyle et al. 1988). After the escapement goal was lowered, only one fish pass was needed. The older fish pass, with more resting pools, worked better than the new fish pass. Since 1979, few modifications or improvements have been made to the fish passes with the exception of discontinuing operation of the new fish pass (Figure 5).

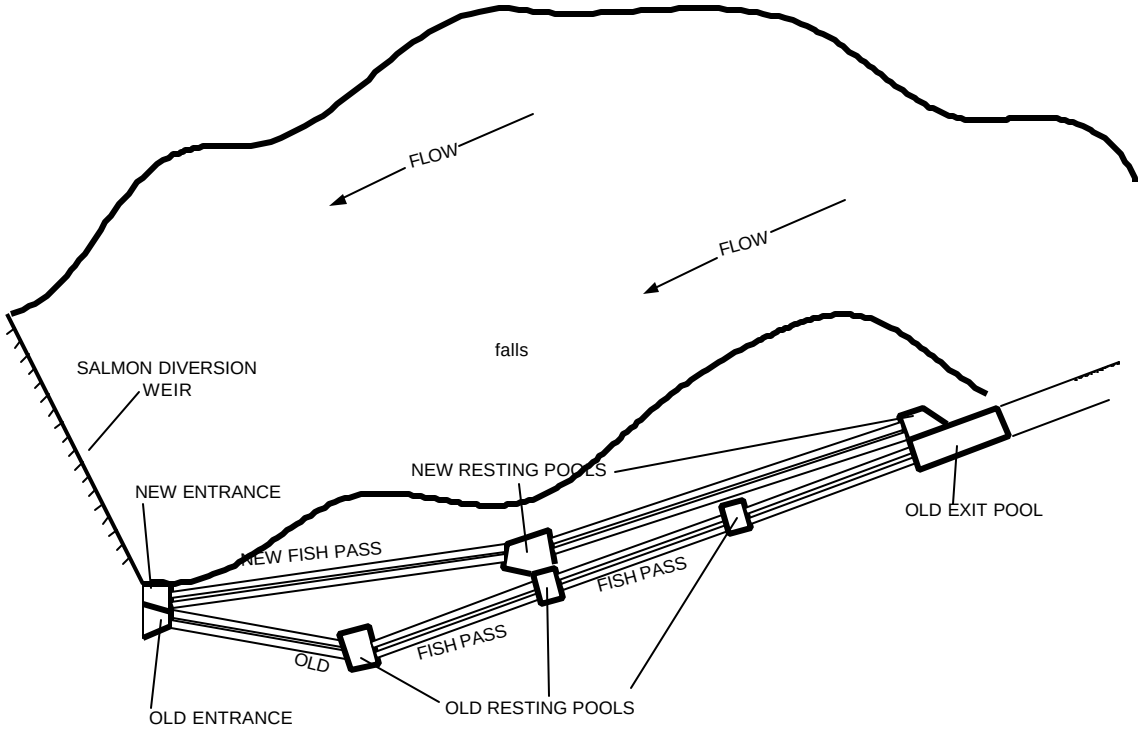

Figure 5. Schematic of the Frazer Lake fish pass and diversion weir, 2002.

Diversion Weir

The diversion weir has essentially remained unchanged from 1972 through 2002. The diversion weir is integral to fish passage because migrating fish would otherwise miss the fish pass entrance and get trapped at the falls. The diversion weir is 55 m long and constructed across the stream at a 40° angle to the fish pass entrance.

During original construction, the weir was anchored in place by a series of ¼" iron I-beams that were driven into the riverbed with a portable pile driver approximately every 10 feet (Larry Malloy, Kodiak Regional Aquaculture Association, Kodiak, personal communication; Figure 6).

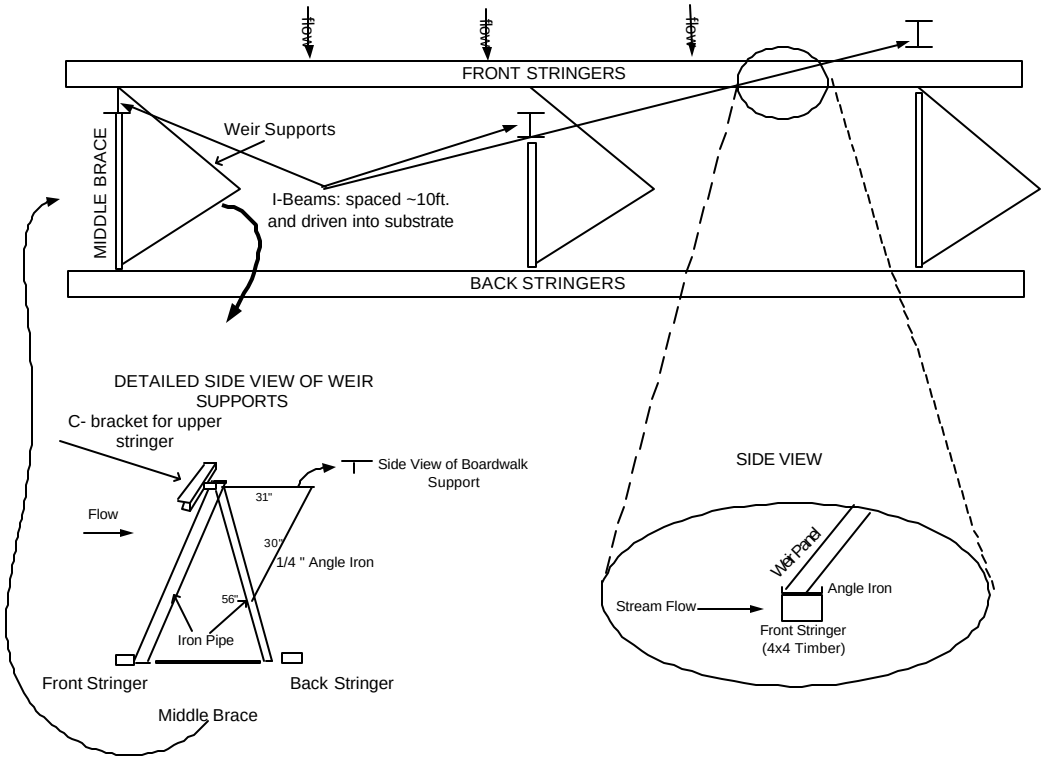

Figure 6. Schematic of the Frazer Lake diversion weir with details of the weir bipods and front stringer, 2002.

Due to the rocky streambed, the I-beams were not located in a straight line from bank to bank. Many of the I-beams were twisted or angled. Stringers (4"x4" spruce) were fastened to the I-beams on the upstream side of the weir (front stringers). These stringers from bank to bank. A second set of stringers were placed parallel to the front stringers (back stringers). Front and back stringers were braced against each other, generally at the I-beams, by a 4"x4" running perpendicular to the front and back stringers (middle brace). The front stringers have two pieces of angle iron bolted on top of them forming a groove that held the bottom of the weir panels.

The weir supports were constructed with steel bipods (1/4" steel pipe; Figure 7). The front and back legs of the bipods were connected to the front and back stringers with steel plates and bolts. The primary lateral support for the bipods were 4"x4" stringers connected to the top of the bipod with a C-bracket. This upper stringer also provided the support for the top of the weir panels. Steel supports for a catwalk (2"x12" spruce planks) were connected to the back leg of the bipod.

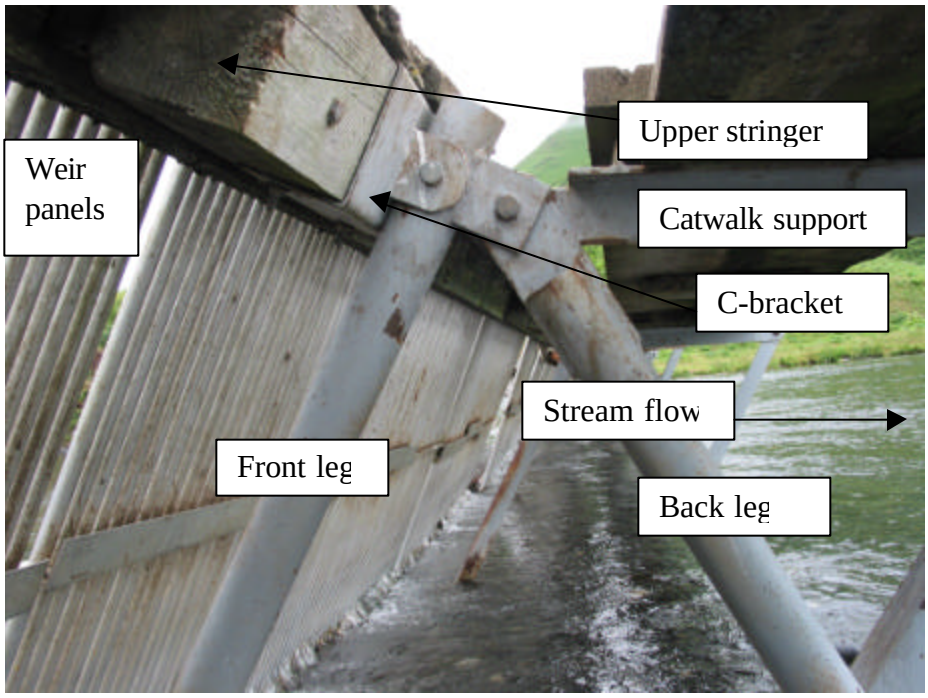

Figure 7. Diversion weir bipods, 2001.

Annually, weir panels were installed along the diversion weir when the first fish were counted through the Dog Salmon weir (approximately 15 June). The Dog Salmon weir is located on the Frazer Lake system 482 meters from saltwater and 14.5 km down river from the fish pass. Weir panels on the diversion weir were then removed when the fish pass was closed down (mid-August). The remainder of the weir, including the bipods and catwalk, remain in the stream year-round. By 1999 significant deterioration of the diversion weir had been noted by the ADF&G field crew stationed at Frazer Lake.

The Frazer Lake crew began having difficulties maintaining the weir in 1999. In the fall of 2000, Steve Honnold, Dale Johnson, and Nick Sagalkin visited Frazer Lake for one day to examine the weir supports. At that time, the major problem identified was the angle iron falling off the timbers of the front stringer, which allowed bears to easily dislodge the weir panels. Plans were made to repair the angle iron, the entrance chute, and the sample platform the following year. Due to funding priorities, the Frazer Lake diversion weir was not repaired the following year. A proposal to repair fish passes at Frazer Lake and the Perenosa system using capital improvement money (CIP) was granted in 2001. In the summer of 2002, Rob Baer visited Frazer Lake and noted substantial damage to the steel bipod legs, which would require further repairs.

Needed Repairs

Diversion Weir. Weather, brown bears, and time have taken their toll on the diversion weir. The front stringer was still in good shape; however, most of the angle iron that held the weir panels had fallen off the front stringer by 2002 (Figure 8).

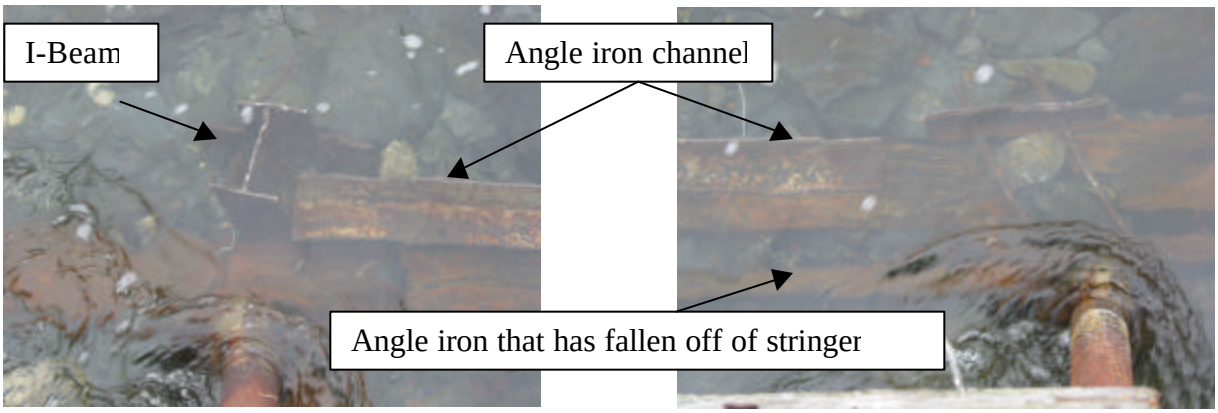

Figure 8. Pictures of angle iron used to hold the bottom of the weir panels, Frazer Lake, 2001.

The angle iron was still useable, but the bolts that held the angle iron to the stringer were rusted. Without the angle iron, it was very difficult to keep the weir fish tight. The upper stringer, connecting the bipods, was rotted in many places, weakening the lateral support for the weir (Figure 9).

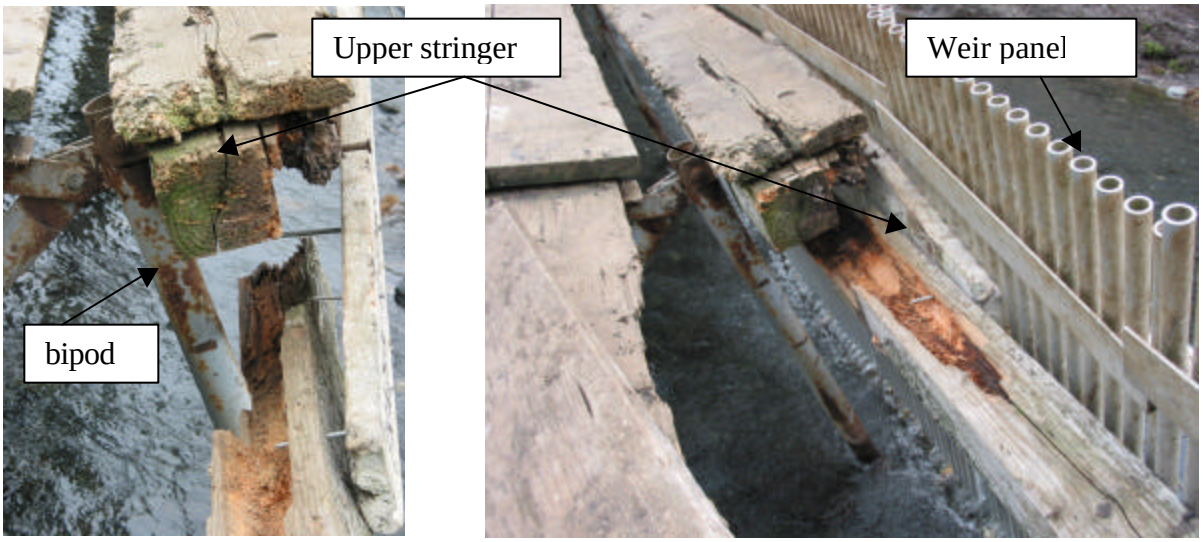

Figure 9. Broken pieces on upper stringer on lower diversion weir, Frazer Lake, 2001.

Many of the bipods were bent making the entire weir out of alignment, and many of the bolts connecting the pieces of bipod together were heavily rusted (Figure 10).

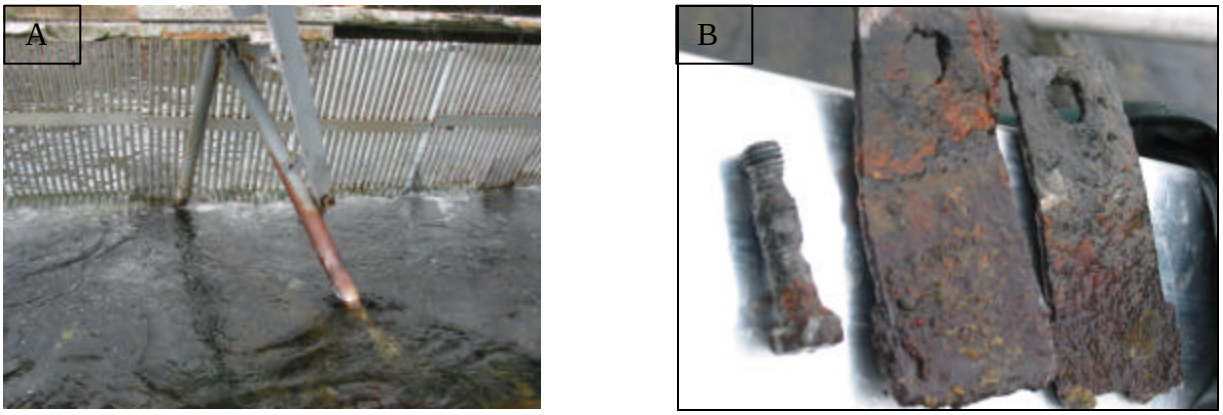

Figure 10. Upstream view of weir bipod showing the bent back leg, Frazer Lake, 2001 (A) and rusted bolt and brackets removed from the bipod, Frazer Lake, 2003 during the remodel (B).

Catwalk. The catwalk was made of 2"x12" rough cut planks and was heavily abused by weather and bears (Figure 11). While the catwalk provided very little structural support to the weir, it was important to the operation of the fish pass because it allowed the crew to inspect the weir for gaps. The damaged planks were also a safety issue because the crew could have easily broken a plank and fallen into the stream.

Figure 11. Frazer Lake catwalk, 2001.

Fish Pass Entrance. The Frazer Lake fish pass originally had difficulty attracting sockeye salmon into the ladder. After the entrance to the fish pass was moved further downstream of the falls, sockeye salmon would enter the ladder and then 'drop out' (Blackett 1987). Consequently, chutes were installed at the entry of the fish pass to increase passage into the fish pass and decrease the fish

dropout rate (Blackett 1987). These chutes were heavily abused by the weather and bears (Figure 12).

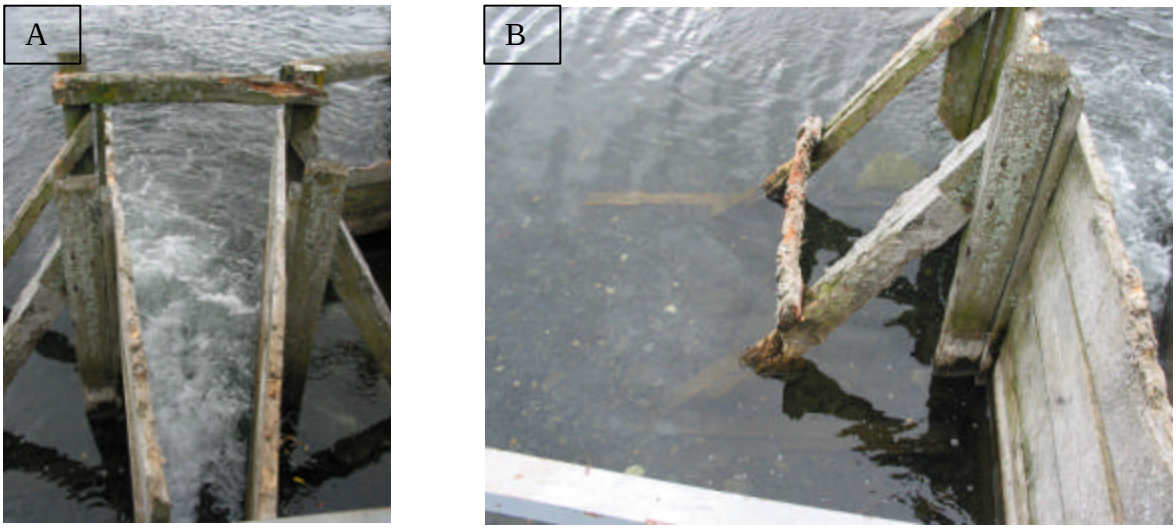

Figure 12. Chute to the Frazer Lake fish pass (A) and braces for the chute (B), 2001.

Fish Pass Covers. The bottom and sides of the fish pass were made of aluminum (Blackett 1987). The top of the fish pass had aluminum cross braces spaced approximately every 16 cm. Between these braces the fish pass was open. Openings were covered with plywood to prevent fish from falling out and to allow personnel to walk up the fish pass. Many of the plywood covers had rotted or were broken by bears (Figure 13). Some of the openings were already replaced by aluminum; however, many more covers needed to be replaced.

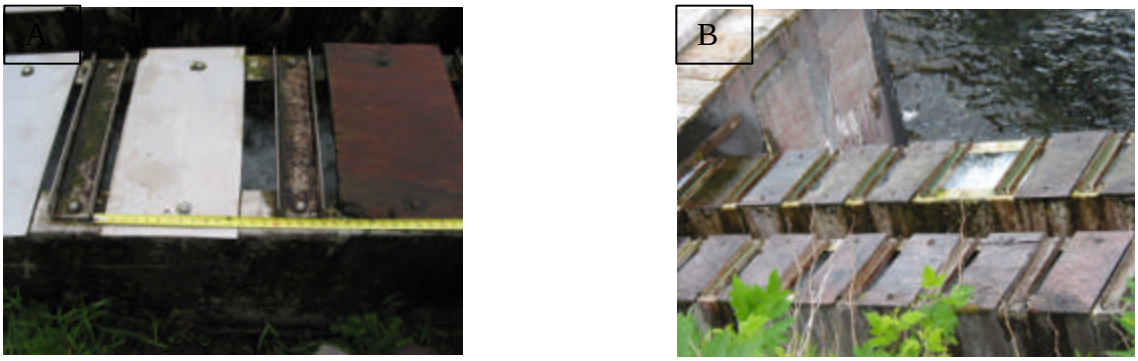

Figure 13. Aluminum and plywood fish pass covers (A), and missing plywood cover (B), Frazer Lake fish pass, 2001.

Sample Platform and Walkway. Fish were sampled at the top of the fish pass on a wooden sample platform. The sample platform, made of dimensional lumber and plywood, was rotting, creating safety problems (Figure 14). The walkway to the sample platform crossed over the upper holding tank. This walkway was rotten and was also a safety issue.

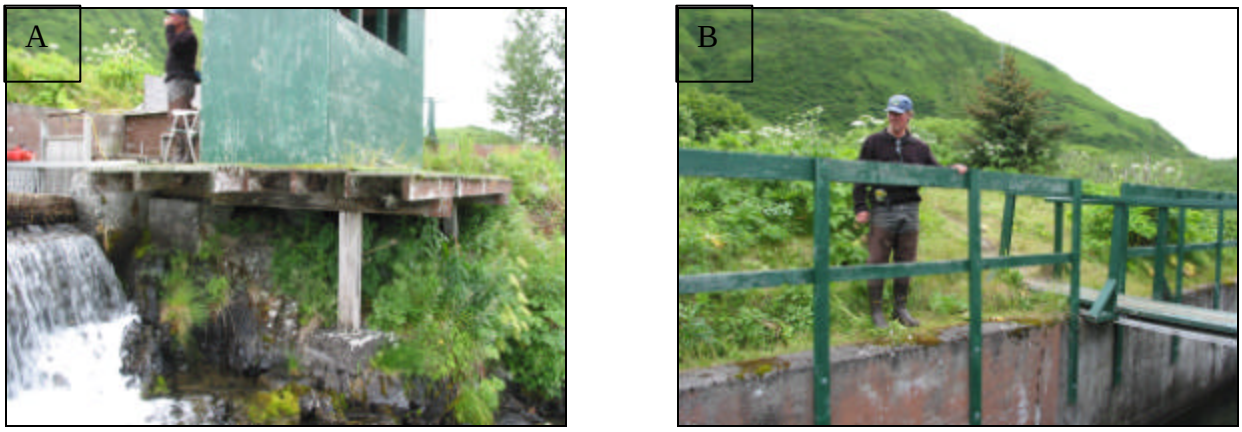

Figure 14. Sample platform (A) and walkway across the upper holding tank (B), Frazer Lake, 2001.

METHODS and RESULTS

In 2002, the Frazer Lake crew made schematic drawings of the diversion weir and sent in a bipod. The tentative plan was to replace the upper wood stringer with aluminum tube, fabricate six new bipods to replace damaged ones, replace damaged underwater stringers (front and back) with rough cut 4"x4" timbers, and replace all the bolts. The entrance chute was to be reconstructed out of aluminum. In addition to these modifications, a galvanized steel grating was purchased for catwalk material. The steel catwalk was selected in an effort to improve safety of the crew, increase structural support for the weir, and reduce the need for frequent replacement.

Materials for the reconstruction were purchased in the winter of 2002. The R/V K-Hi-C was scheduled to transport the material from Kodiak to Stockholm Point on June 2, 2003. SeaHawk airlines was contracted to shuttle the materials from Stockholm Point to Frazer Lake. The shuttle flights were difficult because the aluminum tube was 20 feet long, the catwalk pieces were 10'x2', and the aluminum sheets were 10'x4'x3/8" (Figure 15).

Figure 15. Unloading catwalk for the Frazer Lake fish pass repairs, 2003.

Although repair plans were made prior to the project, most of the engineering decisions had to be made onsite because it was difficult to know the status of all the existing materials and structures in advance.

Diversion Weir

The entrance chute, diversion weir catwalk, and diversion weir upper stringer were dismantled 5 to 6 June 2003 (Figure 16).

Figure 16. Dismantling the Frazer Lake diversion weir catwalk and upper stringer, 2003.

The biggest constraint in repairing the diversion weir were the I-beams that were driven into the substrate. The I-beams secured the weir to the riverbed; however, the I-beams were not in a straight line. As a result, pieces that connected to the I-beam had to be shimmed to make a straight line.

Bolts were disconnected underwater and bipods were realigned (Figure 17). The bipods were placed in 10-foot intervals; although, some bipods were spaced slightly more than 10 feet and others were spaced slightly less than 10 feet due to the I-beam placement. Replacing the upper stringer with aluminum required that bipods be placed exactly 10-feet apart in order to connect them to the c-brackets (Figure 18). All-thread (5/8" zinc plated) was used to attach the aluminum tube to the brackets.

Figure 17. Dale Johnson and Rob Baer disconnecting an underwater bolt, Frazer Lake, 2003.

Figure 18. New aluminum tube replacing the wood on the diversion weir, Frazer Lake, 2003.

A 2”x6” rough cut board was fastened to the front of the aluminum tube. This board allowed weir panels to be fastened to the weir with screws.

Angle iron was re-fastened to the front stringer using lag bolts (Figure 19).

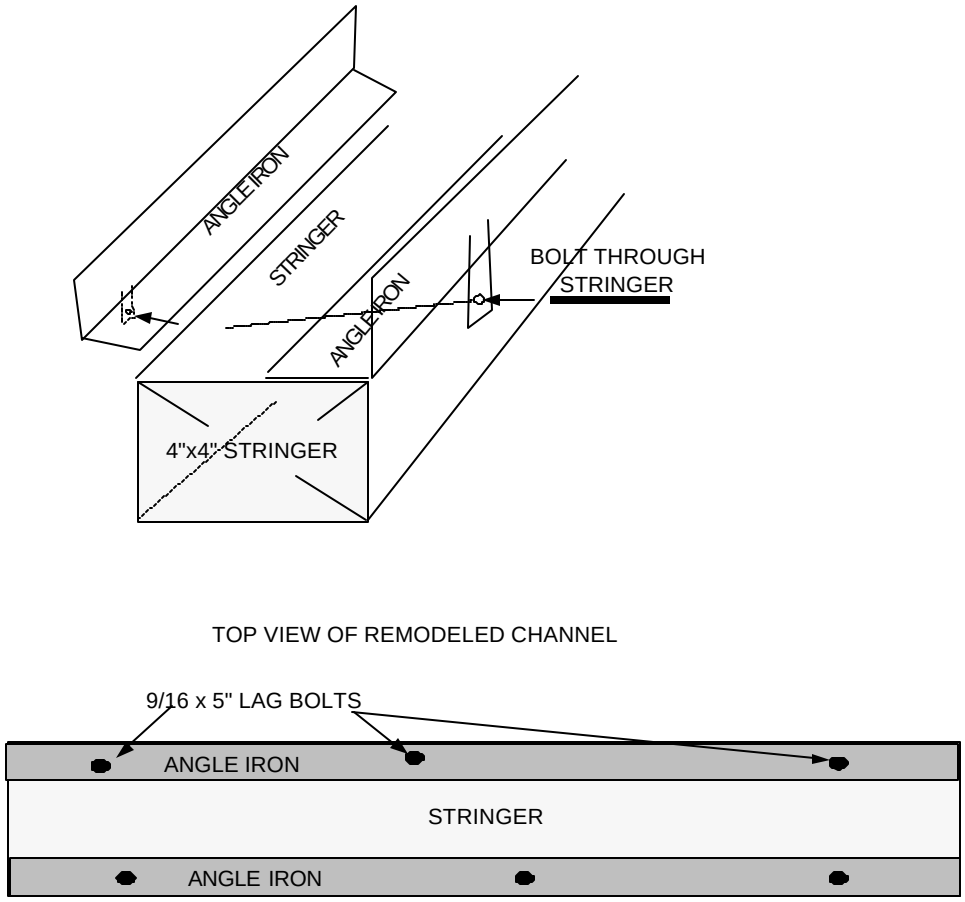

Figure 19. Angle iron attachment to the front stringer of the diversion weir, Frazer Lake, 2003.

To prevent bears from tipping over weir panels, aluminum flat stock (1/2”x1”x10’) were secured to the board attached to the aluminum tube, ‘sandwiching’ the weir panel in between (Figure 20).

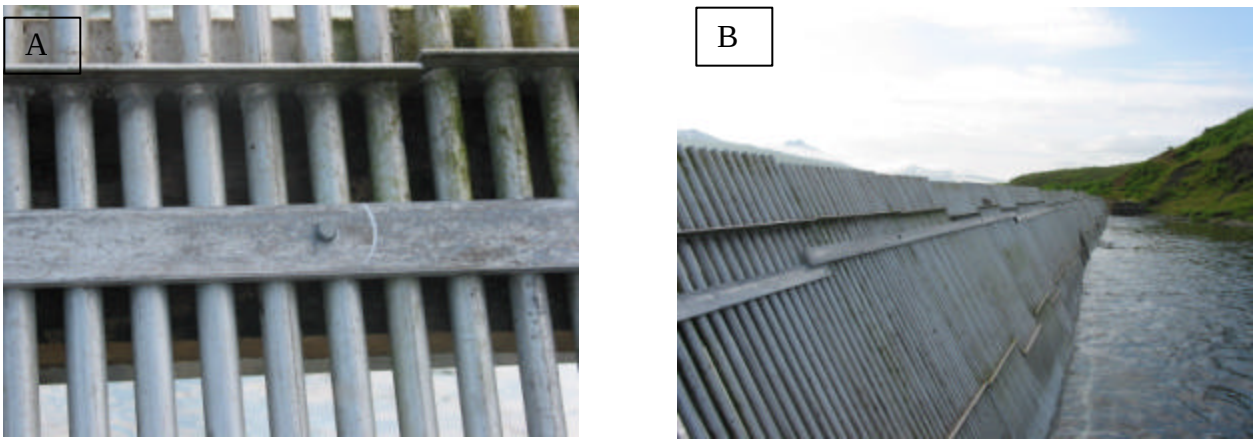

Figure 20. Close up of aluminum flat stock securing the weir panel to the weir (A), and wide angle view of the weir showing the flat stock securing the weir panels (B).

Catwalk

The catwalk was replaced with galvanized steel Grip-strut©. Grip-strut© was mounted on top of 4”x4” rough cut spruce (Figure 21). The Grip-strut© was fastened to the 4x4s with 6” lag bolts. A stairway was also built on the edge of the entrance tank to access the catwalk.

Figure 21. Frazer Lake diversion weir catwalk, 2003.

Fish Pass Entrance

The wooden fish pass chute was replaced with 3/8” aluminum. The new chute has a notched bottom that fits in the groove created by the entrance tank (Figure 22). The old chute was eight feet long and the new chute is 10 feet long. A hinged lid was added that tapers down toward the water line to prevent bears from blocking the entrance (Figure 23). The hinge allows the crew to access the chute to clean or make repairs.

Figure 22. Notched bottom of the new entrance chute (A) and new chute under construction (B), Frazer Lake, 2003.

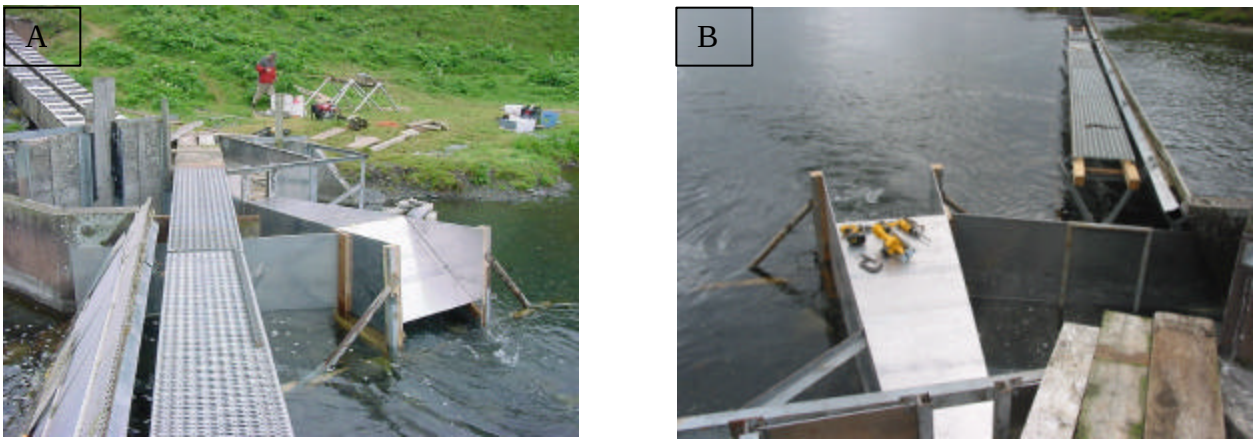

Figure 23. The new entrance chute with the hinged lid (A,B), Frazer Lake, 2003.

Fish Pass Covers

New fish pass covers were made out of 3/8" aluminum. New covers were made for the operational fish pass where they were missing.

Sample Platform and Walkway

The wood from the old sampling platform and walkway were rotten. The new sampling platform and walkway were made from treated (AWWF) wood (Figure 24).

Figure 24. New Frazer Lake sampling platform (A), and walkway across the holding tank (B), Frazer Lake, 2003.

FUTURE MAINTENANCE NEEDS

Despite all of the recent maintenance at the Frazer Lake fish pass facility, there are still a number of structures that need repair.

Upper Holding Tank

The upper holding tank is primarily made of concrete and is in good shape. However, one side of the tank is made of plywood and is rotten. The plywood acts as a railing to prevent crew from falling into the tank. The frame for the exit tank is made of wood and is rotten. Finally, the wood surrounding the trap of the exit tank is not rotten, but heavily weathered and should be replaced soon (Figure 25). Recently (summer 2003), bears have begun breaking the gates allowing fish to swim out of the holding tank without being counted.

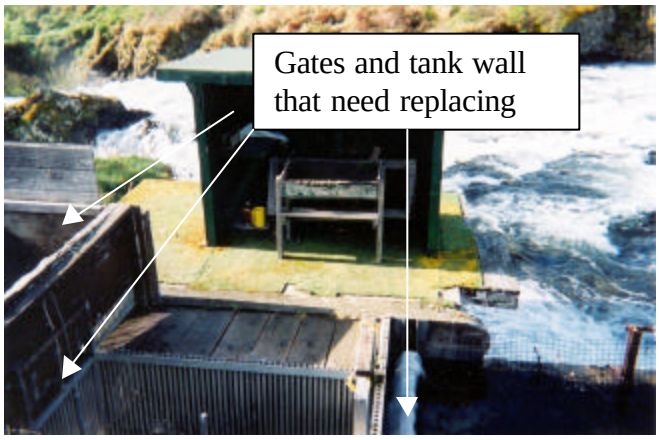

Figure 25. Sample platform area showing the gates and holding tank wall that need to be replaced, Frazer Lake 2000.

Cabin Windows, Doors, and Siding

The current cabin has wooden frame windows that do not open. For safety reasons, the windows in the bedrooms should open and be large enough for people to exit in case of fire. The doors are wooden and in poor condition and should be replaced. The cabin siding is old and made of asbestos and should also be replaced.

Fuel Lines

The refrigerator, stove, and lights run off of propane. Currently, there are propane tanks on the side, back and front of the cabin. None of these tanks are properly secured, and the lines enter through the cabin wall creating the potential for moisture to enter as well. For safety, maintenance, and convenience, all of the propane tanks should be located on the front deck. New propane lines should run under the cabin and come up through the cabin floor.

SUGGESTED IMPROVEMENTS

In addition to maintenance needs, there are several projects that would improve the Frazer Lake facility.

Workshop

There are currently three sheds at the Frazer Lake facility (Figure 26). One shed is used for tools, and storing the tractor, one is used for fuel, and one is used for miscellaneous items. While these sheds are adequate for the project, it would be better, if there was one large shed that utilized the space more efficiently.

Figure 26. The storage sheds used at Frazer Lake, 2003.

Wind and Hydro Generated Power

Currently, one battery is always left at the Frazer Lake camp, and one battery is brought to town to be charged at the beginning of the season. During the season, the batteries are charged with a solar panel. There are two large radio towers on the compound that could easily be used to mount a small wind-generator. In addition, the Frazer Lake waterfall is an ideal situation for hydropower. In fact, the original designs for the ladder incorporated a hydropower system. It would be helpful to continuously charge the batteries that are left at the camp to prevent them from freezing or draining from lack of use. This would prolong the life of the batteries (a large triennial expense) and provide an inseason source of power.

Smolt Bypass and Monitoring System

Emigrating smolt currently have to navigate the waterfalls as they leave Frazer Lake. These waterfalls likely cause mortality. Emigrating smolt are currently estimated through a mark-recapture project that uses an incline plane trap. Due to funding constraints, funds are becoming less available to operate the smolt project. It would be beneficial to investigate developing a bypass system similar to the one used at Spiridon Lake to pass smolt over the waterfalls to decrease mortality and increase return potential. It would also be possible to incorporate a counter so that complete (and automated) counts of the emigration were obtained. The general plan would be to use the NEW fish pass (currently not used), and divert all of the smolt down a pipeline within the pass. Smolt could be enumerated using a Smith-Root (SR-1601) fish counter. Personnel costs would be required to setup the smolt bypass system, and weekly one-day visits to check the pipeline.

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