

2019 Summary Report for the Silver Salmon River Sockeye Access Improvement Project



Prepared For:
Taku River Tlingit Fisheries
Atlin BC

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Executive Summary:

Silver Salmon River is a migration corridor for sockeye salmon destined for Kuthai Lake. Kuthai sockeye escapement has been low for numerous years and does not seem to be recovering. Since 2007 returns to Kuthai Lake have been markedly lower than the long term average. The Kuthai stock is known to have early run timing, passing the lower Taku River in latter June, arriving at the confluence of the Nakina and Silver Salmon Rivers in early to mid-July. Peak enumeration into Kuthai Lake has historically been latter July to early August. The lower 700 meters of Silver Salmon River is a canyon reach with a number of boulder obstructions that pose jump height and velocity/turbulence challenges to upstream migration. Previous work and long term observations by TRT Fisheries has noted that the passage obstructions in the canyon are the main cause of these reduced returns. The TRT and the Pacific Salmon Commission are collaborating on this study to explore the cause of reduced returns to Kuthai Lake and to undertake careful mitigation. Those assessments have resulted in the ranking of specific sites for passage difficulty. Project activities for 2019 included two site visits, an April site visit to conduct further rock shaping at the two most problematic canyon jumps (SR3-3 and SR3-5) and a July visit to monitor jump attempts, collect hydrometric data and conduct beaver dam management.

Acknowledgements:

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Introduction:

The Taku River Tlingit (TRT) and the Department of Fisheries and Oceans (DFO) have been working collaboratively to mitigate adult fish passage issues in the Silver Salmon canyon since 2015. After several years of assessment a mitigation approach has been developed to remediate fish passage at several locations in the Silver Salmon canyon. In 2018 and 2019 the project was granted a Change Approval (#6001882) to conduct the work at the migration challenges identified in the assessment phase. The mitigation works were implemented in the October 2018 low flow period and during the spring of 2019.

2018 was a very low flow year in the Silver Salmon watershed which resulted in poor returns to Kuthai Lake and the virtual loss of the 2018 year class (a total of 13 sockeye reached the lake). The poor returns were, in part, a function of the stage dependency of the target obstacle (site SR3-3) whereby extremely low flows are problematic for staging pool and “landing pad” migration hydraulics. The specific issues here were two fold;

1. The staging pool below the upstream plunge was obstructed with a rubble pile of boulders that did not allow for adequate jump heights to be achieved by migrating sockeye;
2. Observations during the migration period indicated that fish were attempting to stage from river left which caused them to approach the “landing pad” at the upper crest at an oblique angle to the flow which resulted in many failed attempts when the migrants hit the crest and were spun around parallel to the flow. Fish were not able to reach the upper crest head-on since the rubble pile caused them to stage from too far away to reach the crest.

In their review of the 2018 project activities the Trans-boundary Technical Committee expressed an interest in expediting the mitigation work in the Silver Salmon in order to be certain that a second, consecutive year class failure, does not occur. The project approach has been to address fish passage challenges in an upstream direction starting at the Nakina confluence and proceeding up to the head of the canyon. Using this approach the project team re-visited the site in mid-April 2019 to conduct more rock shaping at the two uppermost migration obstacles. Results during the 2019 migration period were more positive in that significantly more fish arrived at Kuthai Lake although the jump attempt monitoring indicates that there is more passage improvement potential at these two locations.

2019 Project Summary:

Field Scope of Work:

Fieldwork for the 2019 project implementation included the following;

1. A site visit was conducted between April 15th and 21st to expand the rock work at SR3-3 and SR3-5, conduct spring time flow gauging and low water recon of the Silver Salmon canyon.
2. A site visit was undertaken between July 22nd and 29th to capture video jump attempt data, conduct hydrometric gauging and beaver dam management between the Silver Salmon canyon and Kuthai Lake;

2019 Results:

Field Work Results:

Spring Site Visit:

A spring site visit was conducted between April 15th and 21th. The site visit was conducted to take advantage of low water in order to achieve the following objectives;

1. Reconnaissance of the canyon migration challenges from the Nakina confluence to the top of the canyon;
2. Continue the rock shaping to deepen the cuts at SR3-3 and SR3-5;
3. Conduct hydrometric surveying.

The canyon was traversed from top to bottom to assess the previously identified migration obstacles. Water quality was excellent during this recon which allowed for good visibility in the channel. The reconnaissance of the lower canyon revealed two channel step changes. The changes were the result of the movement of a log from the staging pool in the “Angle Pool” (SR1-3) down to the spill point on the next downstream step, the “foam Pool” (SR1-2). It appears that this change will improve staging conditions in the “Angle Pool” since this log was lodged below the spill there. The log has relocated to the spill point above the “Foam Pool” which may increase the overall jump height but it does not appear to be reducing passage based on a limited number of checks from the top of the canyon during the summer and the fact that fish were making it up to SR3-3. The log appears not significantly lodged in place so we expect it may continue downstream in a stepwise fashion during subsequent high flows.



Photo 1: The relocated LWD at the "Foam Pool" spill point as of April 2019.

Rock Work:

SR3-3:

Rock shaping work conducted during the spring site visit included deepening and widening of the river left side of the channel at the lower obstacle (SR3-3, photo 2 below).



Photo 2: The SR3-3 site after the spill point was widened and deepened. (Photo date April 20th, 2019)

The chert bedrock is very hard, with a hardness of 7 on the Mohs scale, (diamond is ranked at 10 on the scale) making the rock shaping rate of progress slow. The hardness resulted in rapid wear of the diamond blades used in the rock saw. Nonetheless the rock shaping both widened and deepened the rock cut and low flow notch.

SR3-5 (the Mushroom):

The Mushroom is formed by a large chert boulder lodged at the spill crest of the furthest upstream pool in the canyon. Flows, prior to shaping, were dispersive across the convex surface of the boulder creating poor attraction flows and minimal low flow depth. Rock work at the SR3-5 site involved the following;

- A 25 cm wide, 1.5 meter long notch was cut to increase attraction flows and provide a deeper landing pad for better traction;
- The staging pool was also backwatered by manually infilling the downstream crest of the pool;
- The upstream edge of the boulder, at the notch inlet, was infilled with cobble and small boulders to reduce flow losses.

Photo 3 shows the results of the rock shaping and the new, deeper, laminar flow of the landing pad. The passage dimensions of the spill and staging pool were surveyed post work, Table 1 below details the key passage dimensions;

Table 1: SR3-5 Passage Survey	
Staging pool depth	0.95 m
Rock notch length	1.5 m
Rock notch width	0.25 m
Rock notch gradient (total head / total length)	18%
Jump height (water surface to the trailing edge of the landing pad)	1.3 m
Total length (rock notch plus landing pad)	2.5 m

The resulting alignment provides a more focussed attraction flow, laminar landing pad and slightly deeper staging pool (see photo below).



Photo 3: The Mushroom (SR3-5) during the summer migration period. (Photo Date July 22nd, 2019)

July Site Visit:

During the July site visit activities included the observation of jump attempts and a beaver dam notching program. On July 21, 2019 a reconnaissance aerial survey provided for the observation 13 beaver dams between Kuthai Lake and the Silver Salmon canyon. On July 25, 2019 the project and weir crew breached 6 of those dams i.e. those that were not open and could potentially restrict sockeye salmon access. A summary of the jump attempt results is included in Table 1 below. Following completion of the jump attempt monitoring the crews from the Nakina weir and the Kuthai weir conducted a beaver dam notch program to open up passage through the series of dams between the top of the canyon and Kuthai Lake. All the dams in this reach were notched which resulted in a pulse of sockeye passing through the weir.

Analysis

Hydrology:

Several sites were gauged during the site visits. Table 3 is a summary of the sites gauged during 2019.

Table 2: Nakina Silver Salmon Gauging Summary, 2019.			
Date	Site	Discharge)m³/s	Notes
April 20 th	Nakina above silver Salmon	4.47	Extreme low flow. Moved gauging section upstream to the pool below camp
July 24 th	Nakina above Silver Salmon	16.565	Compares to 15.22 m³/s on July 11, 2015, and 9.811 m³/s on July 30, 2018

The staff gauge located at the bottom of the Silver Salmon canyon continues to function well as a means to estimate the relative stage between years. Gauge checks were undertaken four times during the July site visit in 2019 (between July 22nd and 26th) and 4 times in 2018 (between July 28th and August 2nd). While the dates are not exactly overlapping they do indicate the relative difference in stage between the two years. The average stage for 2018 was 0.322 m in comparison to average stage in 2019 of 0.325 m. This indicates that the stages during the two successive years was very similar with 2018 average stage only 3 mm lower than the 2019 average.

Jump Attempt Monitoring:

Jump attempt monitoring was conducted on July 22nd and 23rd. Results are included in Table 1 above. The jump success in 2019 was somewhat improved in that successful jumps were observed but the overall success rate is still too low.

Table 3: Summary of 2019 Jump Attempt Monitoring				
Date	Site	Jump Rate (per second)	Observation Time (seconds)	Attempts /Success
July 22	SR3-3	0.31	900	274/1
July 22	SR3-3	0.13	191	25/0
July 23	SR3-3	0.28	1383	383/3
July 23	SR3-3	0.33	30	10/0
July 23	SR3-3	0.44	410	180/2
July 23	SR3-3	0.13	54	6/1
July 23	SR3-5	0.03	1200	36/1

Performance Measures:

Performance measures are necessary to gauge the relative success of the passage mitigation. Measures included here include the following;

- Mid Return Date: This measure tracks the migration delay imposed by instream obstacles and assumes that some of the Lake arrival time is due to migration delays in the canyon;
- Total Return: This measures provides an inter-annual measure of success based on the total return;
- Jump Attempt Success Rate: This measure is an estimate of the rate of successful jumps at the two obstacles observed during the summer migration period.

We recognize that there are confounding factors in these performance measures that affect the performance results, namely river stage inter-annual differences in the timing of peak and low flows and other migration corridor obstacles that may impose migration delays. Nonetheless taking these confounding factors into account the performance measures are a reasonable means of assessing

mitigation performance. The stage difference between 2018 and 2019 (as measured at the Silver Salmon staff gauge) indicates that the migration period stage was very similar over these two years so the performance measures may be more representative for the 2018/2019 comparison. The following is a summary of the performance measures being used to assess the results of passage mitigation;

Mid return date:

Mid return date refers to the mid-point of the total run past the weir at Kuthai Lake. The number is determined from the weir numbers as they pass through the counting weir. The measure assumes that the migration delay imposed by the obstacles in the canyon will be reflected in the overall weir arrival times and that mitigation of the migration obstacles will result in earlier mid return dates. Plot 1 is a summary of the mid return dates from 1993 to 2019. Mid return dates are calculated as the number of days past July 1st that 50% of the total run has passed through the weir at Kuthai.

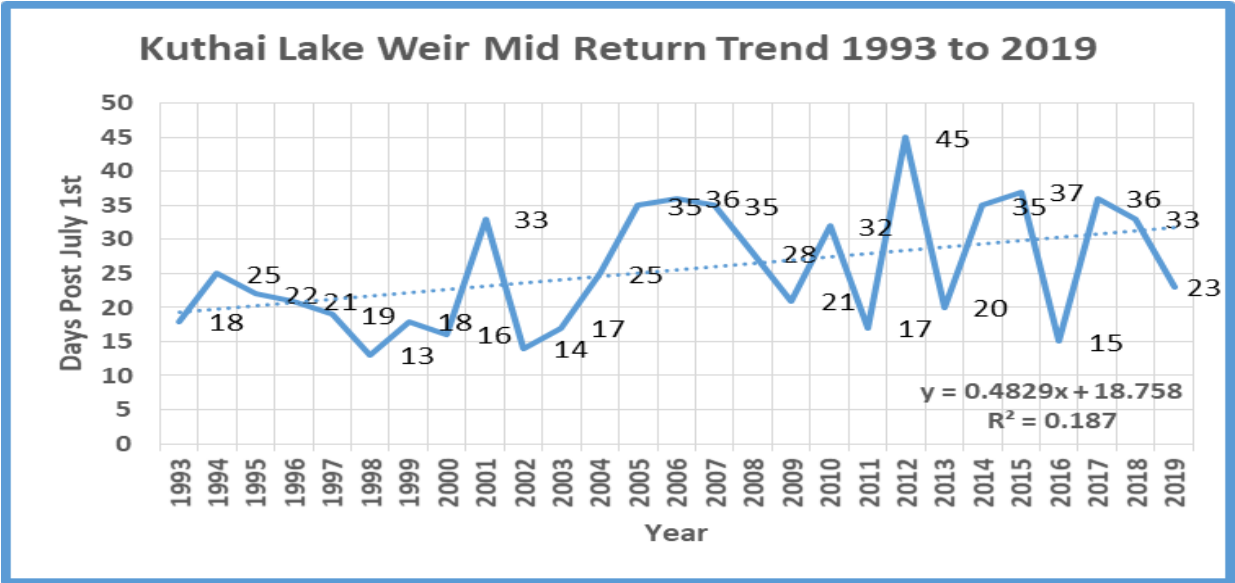


Figure 1: A summary of the mid return dates for Kuthai sockeye passing the weir at Kuthai Lake.

The plot shows a trend line over the data period of increasing mid return date. The mid return date for 2019 is 23 which is the 50th percentile of the dataset indicating that the mid return date is at the average for the data period.

Total Return:

Total Return for the 2019 season was 605 individuals past the weir. This compares to 13 past the weir in 2018 under similar river stage. This suggests some positive results from the rock shaping in 2018 and spring 2019. The 2019 return ranks at the 47th percentile of total returns between 2006 and 2019 making it approximately an average return for the period. The 2019 lake escapement of 605 came primarily from the 2014 brood (parent) year escapement of only 204. However, the 2018 lake escapement of only 13 sockeye came from the 2013 brood (parent) year escapement of 1,195. This provides further indication that the 2019 mitigation works provided improved access.

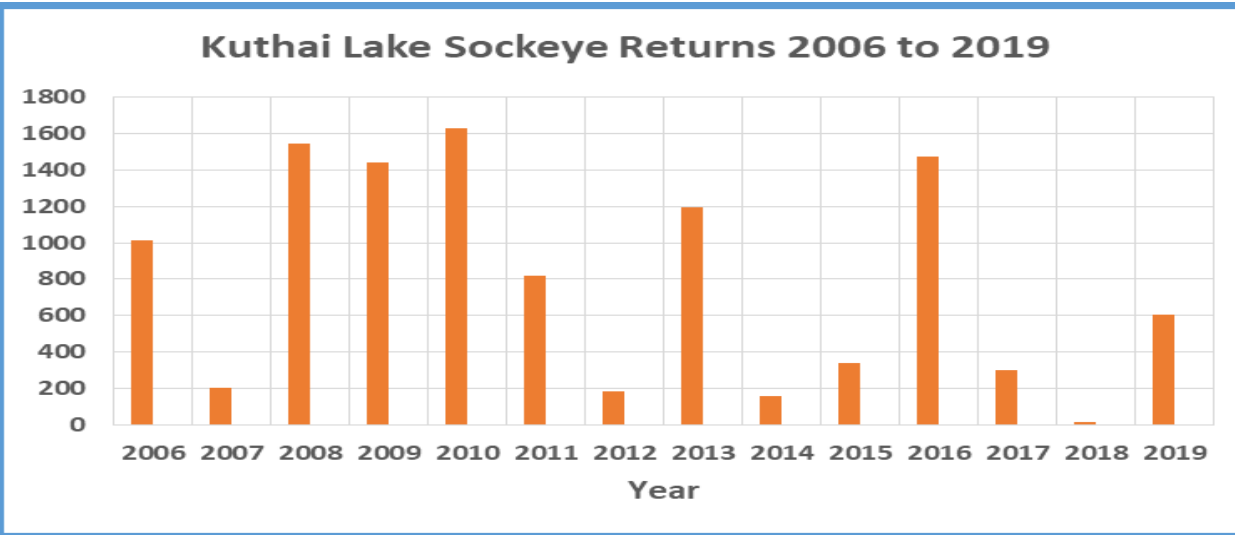


Figure 2: A plot of total returns to the Kuthai weir between 2006 and 2019. The 2019 total is ranked at the 47th percentile of returns for the period, an average year.

Jump Attempt Success Rate:

Jump attempt success rate is perhaps the best performance measure of the two migration obstacles. As Table 3 shows there were successful jumps observed during the 2019 migration period observations which is an improvement over 2018. However the total measured success rate at the lower obstacle (SR3-3) was just below 1% which is still too low. This rate represents an average of 9.7 successful migrations per hour. For SR3-5 there were also successful attempts observed at 2.8% (approximately 2 per hour) although the period of observation was much less due to bears at the observation point. The video was reviewed to assess the percentage of the well aligned, good height jump attempts that were directed at the river right side of SR3-3 and which were directed toward the river left side (the side with the rock shaping works). This reviewed indicates that 60% of the well aligned jump attempts were directed at the river right side of the spill point. This suggests that there is still insufficient attraction flow on the river left side of the spill crest.

Discussion:

The results of the 2019 Program indicate that there has been some positive mitigation results but that there is room for improvement. All three of the performance measures show some level of improvement but the results are not where they need to be to rebuild the stock. The video monitoring of the jump attempts also indicates that migrating sockeye are almost exclusively using the passage options that are being worked on. The monitoring also indicates that sockeye are avoiding the use of options that are accessible to bears that might otherwise be passable. Migration path choices may be different during the nighttime hours although the bears also fish at night. Jump attempt monitoring at night is not possible. What the work also shows is that the focus of the 2020 program should be the following;

- Increase the attraction flow at SR3-3 on the river left side of the spill point;
- Decrease the overall jump height on the river left side of SR3-3;
- Continue the rock shaping at SR3-5 to provide a deeper “landing pad” and reduce the overall jump height.

Proposed 2020 Works:

SR3-3

Proposed work for 2020 includes a further rock shaping effort to achieve the above objectives. Increasing the attraction flow on the river left side of the SR3-3 spill point means further rock shaping to divert more water to the left side of the spill. Given the durability of the bedrock we are looking at utilizing expanding epoxy to increase the hydraulic inlet cross sectional area to the left side passage option. We are proposing to cut a deeper notch at the upstream inlet to the left side to bring the total left side flow closer to 50% of the total flow as opposed to the 80 / 20 split as it is now. From the as built survey we can see that the elevation difference between the river left (modified) channel and the natural thalweg on river right is approximately 0.35 meters so the proposed rock notch will need to be about that deep to achieve the objective attraction flow increase. Appendix 3 shows the location of the proposed rock notch. The chert bedrock has natural weaknesses and the tendency to fracture with a conchoidal fracture pattern so the outline of the notch will need to be pre-drilled and kerfed with the rock saw to contain the epoxy fracture pattern. We will use the rock saw to cut an outline of the notch and provide good seating for the hammer drill. A tight drill pattern will be used to form the outside edge of the notch. A pilot hole will then be drill horizontally down the length of the notch which will create a void to insert the expanding epoxy. The objective is to achieve a rock notch with the following design;

Table 4: SR3-3 rock notch dimensions	
Notch length	1.5 meters
Average depth	0.35 meters
Gradient	20%
Average width	0.5 meters

SR3-5:

The objective for SR3-5 is decrease the overall jump height and increase the depth of flow for the landing pad. This site is a single boulder so it is risky to attempt blasting or to use expanding epoxy, so we are proposing to use only the rock saw to deepen the landing pad and reduce the overall jump height.



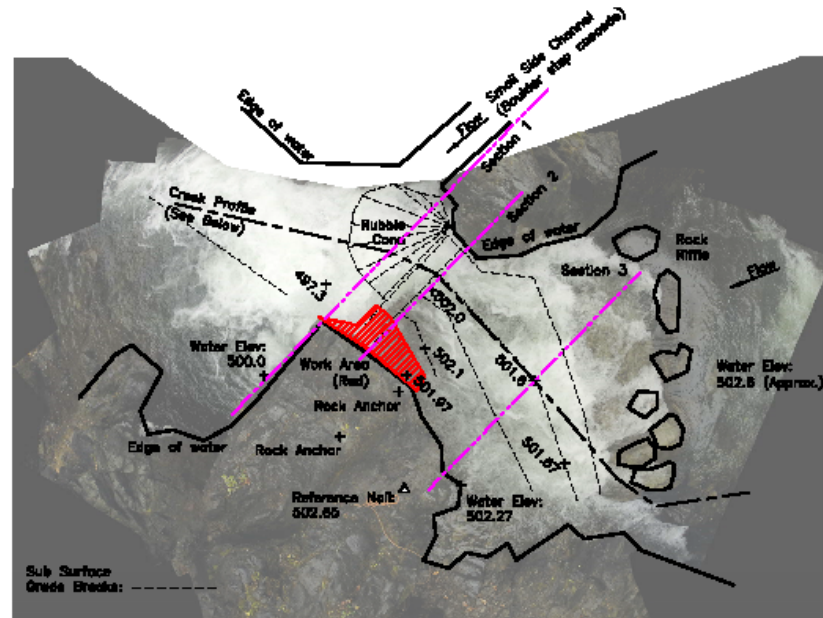
Photo 4: Proposed rock shaping works for site SR3-5.

In addition to the above, the proposed 2020 field work includes a summer site visit to facilitate follow up monitoring (i.e. jump attempts) and continue with the beaver dam mitigation efforts.

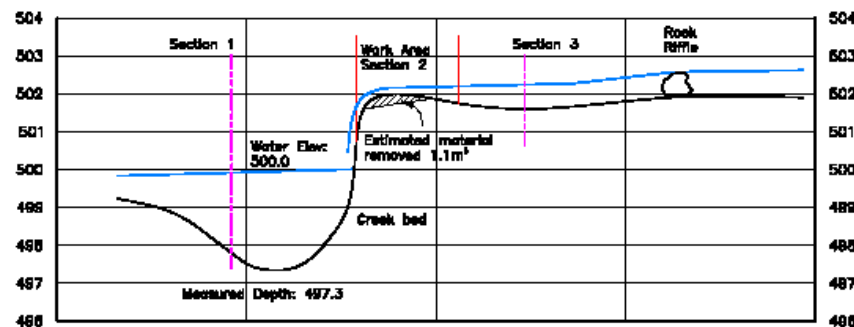
Appendix 1: Overview mosaic of the Upper Canyon



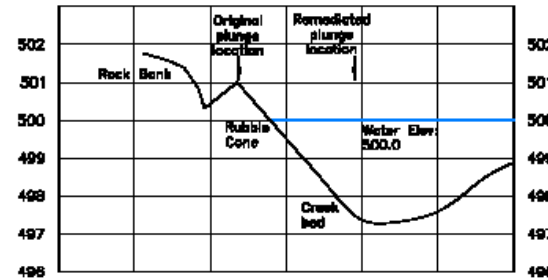
Appendix 2: SR3=5 As-built Survey



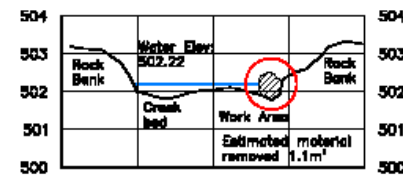
Site SR3-3 Sketch



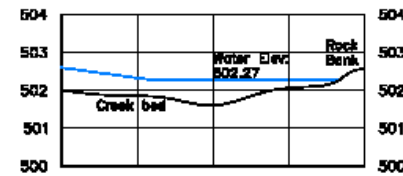
Silver Salmon Creek Profile
Through Confluence of Creek



Section 1
Plunge Pool



Section 2
Crest of Falls



Section 3
Upper Run

UTM COORDINATES:

NAD 83 (CSRS) (2002.0), Zone 8		
Site	Northing	Easting
SR3-3	8554712.0	614260.0

As-built Survey By: Hydrologic Inc.
As-built Survey Date: Oct 13, 2016
Drawn By: HBH Land Surveying Inc.

Plan, Profile and Sections
As-built Survey of Passage
Remediation Works
Silver Salmon Creek
Site SR3-3

Appendix 3: Proposed rock notch SR3-3

