Lakelse Sockeye Adult Monitoring

Fry Outplant Project

Williams Creek Sockeye Return 2018

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EXECUTIVE SUMMARY

For the fifth consecutive year, Hidden River Environmental Management (HREM) was contracted by the Department of Fisheries and Oceans Canada (DFO) to determine the ratio of wild to enhanced (hatchery) sockeye salmon adults returning to spawn in Williams Creek during the 2018 run, and to estimate the total population. The population estimate was calculated using the Lincoln-Peterson Index. Fish were marked at the mouth of the creek during seining and subsequently recaptured gillnetting further upstream during the peak spawning period. The total 2018 Williams Creek estimated sockeye escapement was 4,201 (excluding jacks). That hatchery contribution to this number was 75 fish. This was derived from a weighted average from marks (no adipose fin) captured both seining and gillnetting. The ratio of returned hatchery sockeye altered weekly.

The Fry Outplant Project showed a variety of results. A weighted average was calculated for each year of the project span (2014-2018) to determine the amount of hatchery sockeye that returned. A year-to-year synopsis determined that 1,968 hatchery sockeye from the Fry Outplant Project were projected to have returned to Williams Creek over the course of five years.

Figure 1. Hidden River Environmental Management (HREM) employee, Summer Schulte, holding a male sockeye.

INTRODUCTION

Background

The Lakelse Lake sockeye salmon (*Oncorhynchus nerka*) stock have been recognized as species of concern for over one decade (DFO et al., 2005; and Gottesfeld et al., 2002). The Lakelse Lake sockeye salmon are an economically, culturally, recreationally, and environmentally integral species to the local area. A drastic 92% decline in the Lakelse Lake stock was recorded from the years 1992 to 2004 (DFO et al., 2005). Due to their significance and drastically declining numbers, multiple government agencies, local societies, and the Kitselas band of The Tsimshian First Nation have been determined to identify the factors impacting the sockeye population and to establish recovery strategies.

One of the outcomes proposed from DFO and other parties was the development of the *Lakelse Lake Sockeye Recovery Plan* (LLRSP) in 2005, outlining the issues impacting the sockeye and give direction for research, enhancement, habitat restoration, and stock assessment related to Lakelse sockeye recovery. The LLRSP described and ranked multiple recovery strategies in order of feasibility, effectiveness, timeframe, and costs. The Lakelse Lake Sockeye Fry Outplant Project was rated as a high priority recovery strategy.

As a part of the LLRSP, the Lakelse Sockeye Fry Outplant Project was implemented to enhance low sockeye escapement numbers. Brood stock was obtained from lower Williams Creek in August each year from 2006 – 2013 (excluding 2009, owing to lack of funding), and the eggs and sperm were flown to Snootli Creek Hatchery in Bella Coola for fertilization, incubation, rearing, and adipose fin clipping (to physically differentiate from wild sockeye). When the weights of the sockeye fry were between 0.7 grams and 0.9 grams in the spring, the fry were flown back and released into both lower Williams Creek as well as upstream in a newly constructed backchannel (Drewes and Kujat, 2014).

In order to monitor the success of the Fry Outplant Project, a sockeye seining program was developed and carried out annually since 2014 to determine the ratio of enhanced (hatchery) to wild returns, thereby determining the success of the brood releases, returning in three, four, and five-year-old age classes. As data was collected during the seining and gillnetting sampling season for hatchery versus wild returns, the population estimate was also calculated through mark-recapture methodology. The 2018 seining program monitored the last sockeye returns from the 2013 brood year (now five-year-olds).

Study Location

Williams Creek is the largest of four primary tributaries (the others being Schulbuckhand, Clearwater, and Hatchery Creeks) that drain into Lakelse Lake. The lake drains into the Lakelse River and subsequently into the Skeena River, towards the Pacific Ocean. As much as 80% of the Lakelse sockeye use Williams Creek for spawning (Coburn and Bilton, 1967; and DFO et al., 2005). The lower reaches of Williams Creek contain optimal conditions for spawning sockeye. The medium course gravels, cold water temperatures, and sufficient shading offer optimal habitat conducive to spawning. Sockeye salmon within the Lakelse Lake watershed comprise one of approximately 28 wild stocks in the Skeena River drainage system (DFO 2005 and Gottesfeld *et al.* 2002). Sockeye enter Lakelse Lake from the Pacific Ocean approximately mid-June and hold between one and two months in the lake prior to entering the tributaries (Coburn and Bilton, 1967; Cox-Rogers et al., 2004; DFO et al., 2005; Gottesfeld et al., 2002; and Kokelj, 2003).

Figure 2. Satellite image of the Williams Creek flowing into Lakelse Lake. Credit: Bing Maps 2018.

METHODOLOGY

Population Estimate through Mark-Recapture

To determine the enhanced (absence of adipose fin) to wild (presence of adipose fin) sockeye ratio, seine sets were completed to obtain sub-samples of the population. Also, the Lincoln-Peterson Index mark-recapture method was applied during data analysis to estimate the sockeye salmon population returns. In a mark-recapture study design, a percentage of the population is captured and marked, then released and resampled to determine what percentage of the population carries the given markings (Krebs 1989). Multiple seining and gillnetting sampling sets were completed to gather a sufficient portion of the population.

To obtain a substantial enough sample size of the Williams Creek sockeye population while incorporating the Lincoln-Peterson Index, the study design took place on multiple sampling dates and at different locations. Characteristically, the Lincoln-Peterson Index only includes one marking (clipping) session and one recapture session. All fish seined were added together to make up the initial marking session and all fish gillnetted were summed to comprise the recapture session. No fish caught that were previously marked, were double counted in either seining or gillnetting sessions.

The three variables, *K, n,* and *k* were then entered the Lincoln-Peterson equation (Figure 3) for the Williams Creek sockeye population estimate.

$$N = \frac{Kn}{k}$$

where,

N = Number of sockeye in the population
K = Number of new sockeye seined
n = Total number of new sockeye gillnetted
k = Number of right side recaptured gillnetted

Figure 3. Lincoln-Peterson index formula used to determine the population estimate return.

The variables were specifically calculated prior to using the equation. During the seining sets, each new sockeye seined were given a right opercular clip, which represents *K* (the amount of sockeye captured and marked). Recaptured sockeye during subsequent seining sessions were not included in the equation as they had already been previously counted and were no longer new to the population. The recapture sets included all of the gillnetting sampling sessions, excluding sockeye marked with left opercular clips because they represented individuals during the *recapture* session that were previously captured and counted. The total amount of sockeye captured during the recapture session, or *n*, included all new and right recaptured sockeye. The total number of recaptures, or *k*, included only right recapture sockeye in the recapture sets during gillnetting.

Figure 4. A left opercular clip in a female sockeye from a gillnet set.

Figure 5. A right opercular clip on a female sockeye from a seine set.

Seining

Prior to each set, a stop net was placed across the creek (east to west) near the mouth of Williams Creek to prevent sockeye escaping downstream during the seine set (Figure 6). After the stop net was positioned, a second seine net, 50 metres long with three-inch mesh sized holes was transported approximately 300 metres upstream in a jet boat passed a deep pool where sockeye are known to hold. The seine net deployed by the jet boat across the creek was then brought downstream towards the stop net by hand. Participants would splash the water to encourage the sockeye to swim into the purse of the seine net while it was brought downstream. Once near the stop net, the east side of the pursed seine net was conveyed west towards the shoreline, creating a crescent moon shape with the seine net. The pursed seine net would then have the fish entrapped along the sand and shallow water near the mouth of Williams Creek.

Immediately after the seine net was brought downstream and pursed, participants gently released entangled sockeye from the net. Participants marked sockeye with a single hole, using a hole-punch, on the right operculum. The marked sockeye were released outside of the pursed seine net directly after contact and the following characteristics were communicated to the data collector: wild/hatchery (adipose fin presence or absence), sex, jack (distinct phenotypic features), recapture (opercula clip presence or absence), or other species of fish (all other species of fish were immediately released and not marked). The pursed seine net was brought in as the fish were processed to reduce the pursed area.

Figure 6. Satellite image of the location of the stop net and seine net on Williams Creek. Map credit: Google Earth 2016.


Figure 7. Participants clipping a sockeye on the right operculum with a hole punch.

Gillnetting

Gillnetting occurred in two sets, downstream (Gillnet A) and upstream (Gillnet B) of the Highway 37 Williams Creek Bridge (Figure 9). Gillnet set A occurred 300 metres downstream of the Williams Creek bridge. The net was placed across the width of the creek and slowly brought downstream by two technicians towards a line of participants standing in the water attempting to "spook" the fish into the gillnet by splashing the water's surface. The gillnet was brought downstream for approximately 100 metres, spanning the stream, and the south end of the gillnet would be brought north towards the shoreline to be secured in place for handling the fish. During gillnetting, female sockeye were removed immediately to prevent stress and release of their eggs. Newly captured sockeye were marked by clipping the left operculum. Participants communicated to the data collector the sex of the fish, whether it was wild or enhanced, new or recaptured (opercular clip absence or presence on the right, left, or both sides), or if a jack or other species was captured. Fish were released outside of the gillnet after being processed. Gillnet set B occurred immediately after Gillnet set A approximately 200 metres upstream from the Williams Creek bridge.

Figure 8. Location of gillnetting sites A (downstream of HWY 37) and B (upstream of HWY 37). Map credit: Google 2016.

Figure 9. Participants stand in a line across Williams Creek for Gillnet set A.

RESULTS

Seining

The amount of sockeye captured while seining, excluding recaptures, totaled 952. This consisted of 513 males, 439 females, and 6 jacks captured. This has been the lowest amount of sockeye captured seining during the span of the project. The highest daily total was 301 sockeye salmon on August 24th. Hatchery stock comprised 1.90% of the sockeye sampled (1.89% including jacks).

Males were prevalent in both the wild and hatchery sockeye captured. The Operational Sex Ratio (OSR) for wild sockeye was 1.15 (not including jacks), meaning that for every one female there was an average of 1.15 males. However, for hatchery sockeye there was an OSR of 1.57.

The total by-catch from the seven sets of seining included one cutthroat trout (*Oncorhynchus clarkii*), one coho salmon (*Oncorhynchus kisutch*), and two white suckers (*Catostomus comersoni).*

An evident increase and decrease of hatchery sockeye returns altered weekly. During the third and fourth week of August, there was an increase of hatchery stock. On August 15th (the third week of August), eight hatchery sockeye were captured, seven male and one female; this comprised 44% of the total hatchery sockeye captured while seining in 2018. On August 20th and August 24th (the fourth week of August) eight hatchery sockeye were captured, four male and three female; this encompassed 39% of the total hatchery sockeye captured while seining in 2018. Certain weeks during sampling may have contained a higher abundance of hatchery fish then other due to the coinciding timing of the brood stock collection dates.

Figure 10. Participants helping to bring the pursed seine towards the mouth of Williams Creek.

Gillnetting

During gillnetting, 262 sockeye were handled over the course four days (eight sets overall) consisting of 151 males and 111 females. No jacks were captured during any gillnetting sampling dates. In total, 59 of the gillnetted sockeye were recaptures from the seining sets and three were hatchery fish. Gillnet captures (including right recaptures) show an OSR of 1.36 which, when separated by wild versus hatchery, is calculated to be 1.35 for wild sockeye and 2.00 for hatchery sockeye. The highest amount of sockeye in a one day was on September 7th, during Set A, with 60 sockeye. On August 24th, a human error was made bringing the gillnet downstream. The net twisted which allowed for fish to escape. Only eight sockeye were captured during Set B. Only one other by-catch species was captured during all gillnetting sets, one dolly varden char (*Salvelinus malma*). This could be due to the larger mesh size of the gillnet making it easier for smaller fish to escape.

Only two new hatchery sockeye and one previously seined hatchery sockeye were captured during the four days of gillnetting. One female hatchery sockeye was caught on August 20th, during Gillnet B. Two male hatchery sockeye, one new and one recaptured from seining, were captured in the gillnet during Gillnet A on August 31st.

Figure 11. Participants and volunteers removing sockeye from the gillnet.

Population Estimate

The estimated population size was 4,228 adult sockeye, including jacks, and 4,201, excluding jacks, based on the 952 new sockeye seined, 262 gillnetted, and 59 gillnetted fish that were seining recaptures (Figure 12). Calculations excluded right recaptures recorded during seining and left recaptures during gillnetting in order to eliminate duplicating counts for individuals, as indicated by Krebs *et al.* 1989. As well, on August 24th during Gillnet B and August 31st during Gillnet A, the gillnet malfunctioned during the sets which resulted in fewer fish captured.

K = all new male, female [and jack] sockeye from seining sessions

n = all new and right recapture male, female [and jack] sockeye from gillnetting sessions

k = all right recapture male, female [and jack] sockeye from gillnetting sessions

$$N = \frac{(952)(262)}{59}$$

$$N = 4{,}228$$

Population estimate including jacks.

$$N = \frac{(946)(262)}{59}$$

$$N = 4{,}201$$

Population estimate excluding jacks.

Figure 12. The Lincoln-Peterson Index used to determine the population estimates including and excluding jacks.

DISCUSSION

The sockeye sampled during the 2018 sampling season were the least amount captured over the last five years of the Lakelse Adult Sockeye Monitoring in Williams Creek. As this was the final year of returns (only five-year-olds) from the Fry Outplant Project, low hatchery return numbers were anticipated (Table 1). Though the amount of sockeye captured were noticeably lower overall, many new sockeye were captured during the final seining and gillnetting sets. This is why the 2018 population estimate is greater than the 2017 estimate, even though more fish were handled in 2017. Steady influxes of new sockeye were captured during the final seining and gillnetting dates. Of the total sockeye, 80% (754 of 946) (excluding jacks) seined were captured during the final three seining dates (August 20th, 24th, and 31st). During the final two gillnetting days (August 31st and September 7th), 53% (139 of 262) of new sockeye were captured. It is likely that the 2018 sockeye return may have had a stronger later component, meaning that the population estimate could be greater as more sockeye could have arrived after the last seining session, as shown by the percentage of new sockeye in the last day of gillnetting.

Improvements that were implemented in 2016, continued throughout the remainder of the project. From 2016 to 2018, sockeye were marked with only one clip per right and/or left operculum, whereas in 2014 and 2015 repeated clips were incorporated for each fish recaptured. The single clipping method allowed for less stress to the sockeye as each recaptured fish was handled less.

Table 1. Comparison of the Fry Outplant Project's statistics for each year of the program. Estimates and percentages were

determined with jacks omitted from the calculations. Hatchery percentages are believed to vary between seining and gillnetting locations and timing.

Assessment Year	Population Estimate	% Hatchery During Seining	% Hatchery During Gillnetting	Weighted Average % Hatchery	Estimated Number of Hatchery in Population Estimate
2014	6,682	3.30	4.77	3.63	243
2015	11,598	7.20	6.26	7.11	825
2016	11,137	4.15	3.34	4.06	452
2017	3,668	10.44	7.73	10.18	373
2018	4,201	1.90	1.15	1.79	75
					1,968

Over the course of the five-year project looking at sockeye returns in Williams Creek, 1,968 hatchery sockeye were recaptured (Table 1). The estimated percentage of hatchery sockeye recorded in Williams Creek from the Fry Outplant Project is 5.3% from 2014-2018. It is also interesting to note that the wild population size was significantly reduced in 2017 and 2018 in comparison to previous years. It is difficult to determine the factors that could have contributed to these reduced numbers.

As seen in Table 1, the percentage-calculation method was used to calculate the number of hatchery fish in the population, by multiplying the weighted average percentage of hatchery fish by the overall population estimate. The 2018 hatchery return population was calculated as follows: (0.0179)(4,201) = 75, showing a total of 75 hatchery fish in the total population estimate for Williams Creek.

When using the Lincoln-Peterson Index, the estimated hatchery population for 2018 was 54 adults, which is 21 individuals less than in the percentage-calculation method. As a fewer amount of hatchery sockeye were handled during sampling, the percentage-calculation method is considered to provide a relatively more accurate estimate of the number of hatchery fish within the population when compared to the Lincoln-Peterson Index. The discrepancy between these two methods used for calculating the hatchery fish population size may be due to assumptions made in the percentage-calculation method which are not met in the Lincoln-Peterson Index. These assumptions are what likely accounts for the discrepancy between the two estimates. Thus, a population of 75 using the percentage-calculation method is a valid estimate of the number of hatchery sockeye present in the Williams Creek spawning system.

As previously mentioned, Williams Creek receives approximately 80% of all the Lakelse watershed sockeye escapements during spawning season (DFO et al., 2005). Using this estimate, we can determine an approximate estimate of the returned sockeye population in the entire Lakelse Lake watershed. Using the Lincoln-Peterson Index (4,201 ÷ 0.80), it was determined that the entire 2018 Lakelse Lake sockeye escapement was approximately 5,251 fish.

However, the Williams Creek and Lakelse Lake population calculations may be underestimated as it is probable that additional new sockeye entered Williams Creek after the seining and gillnetting was completed. Thus, they would not have been included in the Williams Creek population estimate.

RECOMMENDATIONS

Although the Fry Outlplant Program has come to an end, a continuation of the mark-recapture population estimate program in Williams Creek would contribute to the consistency of determining sockeye escapements for this stream. Should mark-recapture studies continue, it is recommended to extend the seining and gillnetting dates further into September to obtain a more accurate sample size, as a large portion of new sockeye entered the Williams Creek system near the end of the sampling period in 2018.

To compound knowledge gathered throughout the duration of this project, it is also recommended that the data from the entire project be analyzed as a whole in order to determine trends not previously noted. For example, analyzing associations between egg takes and hatchery returns or between spawning times and flood events in relation to egg development. Also, looking at the 2015 and 2016 escapements and trying to determine what made them so successful. These analyses may lead to understanding the future success and/or declines of this sockeye population.

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Should you require any further information or have any questions or concerns, please feel free to contact us.

Sincerely,

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APPENDIX

Table 1. Raw data taken from all seining sets

Date	Activity	Wild Male	Wild Female	Hatchery Male	Hatchery Female	Recapture Male	Recapture Female	Recap Hatchery Male	Recap Hatchery Female	Jack	Other	Total	Notes
03-Aug-18	Seining	7	5							2	2	16	Other spp = 1 cutthroat; 1 sucker
07-Aug-18	Seining	8	3		2		1				1	15	Other spp= 1 sucker
10-Aug-18	Seining	35	26			3	1		2			67	
15-Aug-18	Seining	62	36	7	1	7	9	1				123	
20-Aug-18	Seining	158	99	3	2	18	11	1				292	
24-Aug-18	Seining	116	126	1	1	36	17			4		301	
31-Aug-18	Seining	110	137		1	23	14		1		1	287	Other spp = 1 coho
TOTAL		**496**	**432**	**11**	**7**	**87**	**53**	**2**	**3**	**6**	**4**	**1101**	

Table 2. Raw data taken from all gillnetting sets

Date	Activity	Wild Male	Wild Female	Hatchery Male	Hatchery Female	Recapture Male			Recapture Female			Recapture Hatchery Male			Recapture Hatchery Female			Jack	Other	Total	Notes
						Left	Right	Left/Right	Left	Right	Left/Right	Left	Right	Left/Right	Left	Right	Left/Right				
20-Aug-18	Gillnetting Set A	5	3				5			1										14	
20-Aug-18	Gillnetting Set B	18	10		1		3			4										36	
24-Aug-18	Gillnetting Set A	15	10			2	7	3		4	1	1			1					44	
24-Aug-18	Gillnetting Set B	2	1						3	1	1									8	
31-Aug-18	Gillnetting Set A	12	7	1		4	2	2	5	1			1							35	
31-Aug-18	Gillnetting Set B	17	23			1	5		1	2										49	
07-Sep-18	Gillnetting Set A	21	21			1	6	1	4	5	1								1	61	Other spp = 1 Dolly Varden
07-Sep-18	Gillnetting Set B	25	11			2	6	2	2	6	1									55	
TOTALS		**115**	**86**	**1**	**1**	**10**	**34**	**8**	**15**	**24**	**4**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**302**	