Lakelse Sockeye Adult Monitoring

Fry Outplant Project

Williams Creek Sockeye Return 2017 – Year Four of a Five-Year Program

Prepared for:
Lana Miller, Department of Fisheries and Oceans Canada

Submitted by:
Alison Grover, B.Sc., Hidden River Environmental Management

Table of Contents

*Title page photo by Korby Holzapfel

Executive Summary

For the fourth 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 Williams Creek during the 2017 spawning run, and to undertake an adult sockeye population assessment for 2017. The population estimate was calculated by marking fish at the mouth of the creek during seining, and subsequently gillnetting farther upstream during the peak spawning period to assess recapture rates. Of the total 2017 Williams Creek sockeye escapement, enhanced/hatchery (no adipose fin) fish made up 10.06% of fish seined and 7.71% of fish gillnetted. A total population estimate of approximately 3,668 sockeye adults was determined for the 2017 Williams Creek spawning run.

Figure 1: Participants handling and marking sockeye in the seine net at the mouth of Williams Creek. Photo credit: Mitch Drewes.

Introduction

Background

Over the last decade, DFO and the local community have recognized Lakelse sockeye salmon as a population of concern (DFO et al., 2005; and Gottesfeld et al., 2002). Compared to historical numbers, the Lakelse sockeye population has been severely reduced. From 1992 to 2004, the population decreased by 92% (DFO et al., 2005). Luckily, the sockeye of Lakelse have not been without extensive study and documentation. Historical data includes stream walks and other visual counting methods. This data collection has allowed groups such as government agencies (i.e. Ministry of Water, Land and Air Protection; Fisheries and Oceans Canada), the Kitselas band of the Tsimshian First Nation, and local concerned societies (Lakelse Watershed Stewards Society, Terrace Salmonid Enhancement Society) to determine potential factors impacting the sockeye numbers, and identify recovery strategies for the sockeye of Lakelse Lake.

Lakelse Lake and its watershed have faced extensive human presence and development since the 1950s. Activities include logging, highway and linear development, residential zoning and expansion, recreational lake and stream use, and many others (DFO et al., 2005). The accumulation of these activities has led to stream degradation in the way of erosion, changes in stream dynamics such as depth and velocity, modification of stream confluence fans, and declines in water quality. In 2001, a stream assessment of Williams Creek and its surrounding watershed rated the channel, fish habitat, and riparian conditions to be poor (Reese-Hansen, 2001).

As a result of the increase in concern for Lakelse sockeye numbers, in 2005 the *Recovering Lakelse Lake Sockeye Salmon–Lakelse Lake Sockeye Recovery Plan* (LLSRP) was developed by DFO and partners in order to provide identification of impacts to sockeye populations and give direction for research, enhancement, habitat restoration, and stock assessment related to Lakelse sockeye recovery. Following the creation of the Recovery Plan, funding was provided via the Pacific Salmon Commission for projects related to Lakelse sockeye rehabilitation, restoration, and enumeration. The document identified a number of recovery plans including habitat, enhancement, and assessment strategies, and ranked them in order of feasibility, effectiveness, timeframe, and cost. One of the highest priority recovery strategies determined by the LLSRP is the Lakelse Sockeye Fry Outplant Project.

As a part of the Recovery Plan, the Lakelse Sockeye Fry Outplant Project was implemented to enhance low sockeye escapement numbers. Each year, from 2006 to 2013 (excluding 2009, owing to lack of funding), brood stock was taken from sockeye in Williams Creek and transported to the Snootli Creek Hatchery in Bella Coola for fertilization, incubation, rearing, and adipose fin clipping. After reaching between 0.7g and 0.9g the following spring, fry were released back into both Williams Creek and a newly created backchannel to Williams Creek (Drewes and Kujat, 2014). In order to monitor the success of the Outplant Project, a sockeye seining program has been carried

out annually since 2014 to determine the ratio of enhanced versus wild returns, thereby determining the success of the brood releases, returning in three, four, and five year old age classes. In conjunction with collecting data on enhanced vs. wild return ratios, population estimates have also been calculated through a mark-recapture program implemented during the seining work.

The 2017 seining program monitored sockeye returns from 2012 (now five-year-olds), 2013 (now four-year-olds), and 2014 (now three-year-olds, aka jacks). There were no three-year-old hatchery fish in Williams Creek this year because the Fry Outplant program ended during the final brood stock collection in 2013; those fry were released in 2014 which are four-year-old returns this year.

Study Area

Upon returning from the ocean in mid to late June via the Skeena-Lakelse river systems, sockeye spend one to two months holding in Lakelse Lake before making their way up the various tributaries to spawn (Coburn and Bilton, 1967; and DFO et al., 2005). Williams Creek, along with Schulbuckhand, Clearwater and Hatchery Creeks, are the four main tributaries out of the 28 tributaries of Lakelse Lake, and provide the vast majority of spawning habitat for Lakelse sockeye. Williams Creek, in particular, is estimated to receive about 80% of Lakelse sockeye spawners each year (Coburn and Bilton, 1967; Cox-Rogers et al., 2004; DFO et al., 2005; Gottesfeld et al., 2002; and Kokelj, 2003).

Figure 2: Location of the Williams Creek tributary and alluvial fan draining into Lakelse Lake. Credit: Google Earth 2016.

Methods

Figure 3: James Powell, DFO, holds female sockeye as volunteer Jennifer Drewes performs a right opercular clip. Photo credit Mitch Drewes.

Seining

Prior to seining, a stop net was placed and secured along the width of Williams Creek (100 meters upstream of the mouth) in order to prevent fish from escaping capture by swimming downstream. Following placement of the stop net, a 50 meter-long seine net with three inch mesh size was taken 300 meters upstream from the mouth of the creek above a deep pool, where the majority of sockeye were known to hold. The seine net was fed across the creek from the west to east using a jet boat, and was then gradually pulled south down Williams Creek towards the stop net. Upon reaching the stop net, the far east end of the seine net was brought in along the stop net to the west end of the sein net, entrapping fish in the purse along a sandy beach on the west side of the creek's outlet (Figure 4). Participants, wearing wool gloves, removed entrapped fish from the seine net, and designated crew members clipped the right operculum of each sockeye. Marks were small holes in the operculum that were made by using a hand-operated single-hole punch. Marked fish were then released. During handling, participants indicated to the data collector whether the sockeye was a jack/male/female, hatchery/wild (presence or lack of adipose fin), and new/recapture (presence or absence of existing right opercular clip). As fish were processed and the quantity of individuals within the seine net decreased, float lines were brought in to decrease the

size of the pursed area. Once all fish were marked and released, the seine net and stop nets were taken out of the water and stored.

Figure 4: Location of stop and seine nets on Williams Creek. Photo credit Google Earth 2016.


Figure 5: Stop net and seine net in place near the mouth of Williams Creek. Photo credit Mitch Drewes.

Gillnetting

Gillnetting was undertaken both upstream and downstream of the Highway 37 Williams Creek bridge, making up two sets: Gillnet A and Gillnet B (Figure 6). At set A, the gillnet was fed 300 meters downstream of the Williams Creek bridge from north to south across the width of the creek and a human line of 'spookers' were positioned downstream. As the gillnet made its way down, directed by a technician at each end, participants in the spooker line splashed the surface water to deter fish from swimming downstream and to encourage them to swim upstream and enter the gillnet. After drifting 100 meters downstream, the south end of the gill net came down and across the creek to the north shore, where the entire net was secured and handling took place. Ripe females were removed from the net first in order to limit spawning stress. Gillnetted fish were marked with a left opercular clip. Handlers indicated to the data collector whether the sockeye was a jack/male/female, hatchery/wild (presence or lack of adipose fin), and if it was a new/recapture (presence or absence of opercular clip on the left and/or right side). The location of pre-existing clips (left, right, or both opercula) was indicated to the data recorder along with the other data. Once processed, fish were released outside of the net line. Gillnet B followed the same procedures as Gillnet A, except that it took place 200 meters upstream of the bridge crossing (Figure 6).

Figure 6: Location of gillnetting sites A (downstream of Hwy 37) and B (upstream of Hwy 37). Photo credit Google Earth 2016.

Figure 7: Participants forming a spooker line as Gillnet B is brought down from upstream. Photo credit: Alison Grover

Population Estimate through Mark-Recapture

To determine a population estimate and a hatchery/wild ratio for the Williams Creek Sockeye escapement, the Lincoln-Peterson (Figure 8) mark-recapture method was applied to the data collected during seining and gillnetting. 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 sample carries the given markings (Krebs, 1989). Using a hand-held hole-punch, individual sockeye were clipped in the **right** operculum during seining/initial capture (Figure 9 and 10), and were marked with a **left** opercular clip during later gillnetting/recapture. Initial marking (right clip) of sockeye took place through seining on August 3, 7, 11, 14, 17, 25, and 30 from 9:30AM to 11:30AM, and recapture upstream using a gillnet occurred on August 17 and 25, and September 1 and 8, from 9:00am to 11:00am.

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

where,

N = number of Sockeye in the population
K = Number of new Sockeye seined
n = Total Number of Sockeye gillnetted
k = Number of recaptures gillnetted

Figure 8: Lincoln-Peterson formula used for Williams Creek sockeye population estimate.

Figure 9: New right opercular clip in female.

Figure 10: Recaptured male with pre-existing right opercular clip.

Because the sockeye population is in fact a moving population (moving upstream in Williams Creek), we attempted to avoid violating the Lincoln-Peterson assumption of a closed population by incorporating different creek locations in the sampling. Within the entire Williams Creek sub-basin the population is considered closed, and taking this into account we gillnetted upstream of the mouth of the creek at two of the best spawning locations to better sample the entire population. However, the nature of spawning salmon includes a high death rate following reproduction, as well as a constant influx of new adults into the stream system (essentially mimicking births into the population). Because of this, it is likely that the Lincoln-Peterson assumption of no deaths and no births in the population during sampling was not met. Since this is unavoidable when sampling spawning sockeye, we are confident that our methods will provide the most accurate population estimate available for this species.

In order to get a significant sample size of the population in Williams Creek, a method was devised to sample a large number of Sockeye in multiple occasions and locations that could still be usable in the classic, simplified Lincoln-Peterson algorithm. Since the classic sampling method only incorporates one *mark* session and one *recapture* session, all seining occasions were lumped together as the initial *mark* session, and all gillnetting occasions were lumped together as the *recapture* session. The individuals in the seining/*mark* sessions representing *K* (the number of individuals captured and marked) included all of the new captures throughout the seining sessions, which were given a right opercular clip. Recaptures during the seining sessions were not counted in the equation, since these were simply new individuals during the *mark* session that were handled more than once. During the *recapture* session, which was all of the gillnetting occasions, any sockeye with left recapture clips were not counted because, like in the seining, they represented individuals during the *recapture* session that were handled more than once. The total number of fish caught during the *recapture* session, or *n*, included all new and right recapture sockeye. The total number of recaptures, or *k*, included only right recapture sockeye in the *recapture* session. These three variables, *K, n,* and *k,* were then entered into the Lincoln-Peterson equation (Figure 8) for the Williams Creek sockeye population estimate.

Figure 11. Volunteers remove and mark sockeye from Gillnet A. Photo credit Olivia Gray.

Results

Seining

As shown in Table 2 in Appendix A there were nearly equal male and female wild sockeye captured during seining. Specifically, the Operational Sex Ratio (OSR) was 1.03 (not including Jacks), which means that for every female there is an average of 1.03 males. There were generally more male than female hatchery sockeye in each set, with an OSR of 1.30 for hatchery sockeye. In total, 2,376 sockeye were sampled over the seven seining events, which consisted of 1,161 males, 1,128 females, and 87 jacks. This does not include recaptured sockeye as these were already handled in one or more previous seining sessions. The highest daily total of fish caught was 688 on August 3rd. Enhanced stock (hatchery) comprised 10.44% of the sampled sockeye (10.06% if wild jacks are included). No hatchery jacks were caught during the sampling season. To better compare this data to the extensive streamwalk data collected throughout the 1900s and early 2000s, calculations will be made primarily without jack data. Bycatch included two rainbow trout (*Onchorhynchus mykiss)*, one coho (*Onchorhynchus kisutch)*, and one sucker species, which was tentatively identified as a white sucker (*Catostomus comersoni)*.

Generally, three year olds (jacks) make up a very small portion of returns into the Lakelse system each year (Mitch Drewes, pers. Comm.). The number of jacks sampled this year was much higher than in previous years. For example, last year's sampling recorded a total of nine jacks in a seining sample size of 4,643 sockeye. This calculates to a percentage of (9 / 4643) * 100 = 0.19% of the sampled sockeye being jacks. This year, 87 jacks (not including recaptured jacks) were recorded in a seining sample size of 3,142 sockeye. Therefore, this year's jacks comprised (87 / 3142) * 100 = 2.77% of the sample and, through extrapolation, the population. This is more than a ten-fold increase in jack proportions from 2016 to 2017. Gillnetting sample sizes were not included in the calculation because only one jack was caught during gillnetting this year, and none in 2016. This is because of the large mesh size of the gillnet, which jacks can easily swim through and therefore evade capture.

Gillnetting

Gillnet captures (including right recaptures, since these were not handled yet in a gillnetting session) show an OSR of 1.48 (without jacks), which, when separated by wild vs hatchery, is calculated to be 1.53 for wild sockeye and 1.07 for hatchery sockeye. A total of 376 sockeye were sampled during the four days of gillnetting sessions, which consisted of 224 males, 151 females, and one jack (shown in Table 3 in Appendix A). Of this total, 7.73% were enhanced stock, or hatchery fish (7.71% with jacks). Overall, 234 sockeye were recaptures from the previous seining sessions (right opercular clip). The largest sample was 78 fish during Set A on Aug 25. By-catch included one Rocky Mountain whitefish (*Prosopium williamsoni)*.

Population Estimate

The population size is estimated at 3,668 adult sockeye (not including jacks), based on the 2,289 new sockeye seined, 375 gillnetted, and 234 gillnetted fish that were seining recaptures. If jacks are included, the population would be estimated at 3,818. 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.

N = number of sockeye in the population

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

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

$$N = \frac{(2389)(375)}{234}$$

$$N = 3668.3$$

Discussion

The 2017 Lakelse adult sockeye monitoring in Williams Creek was an overall success. Improvements were made to the program this year as well as in 2016 by marking the right/left operculum with only one clip instead of repeating clips for every subsequent catch of the same fish, since this method did not provide any further useful data. As a result, handling time/stress of the recaptured fish decreased, and overall residence time in the nets was reduced for all individuals.

Table 1. Comparison of this year's descriptive statistics to those of the previous years of the program. Estimates and percentages were determined with jacks omitted from the calculations. Hatchery percentages are believed to vary between seining and gillnetting purely from sampling variation, which does not represent a change in the true hatchery proportions between seining and gillnetting locations and timing.

Assessment Year	Population Estimate	% Hatchery during Seining	% Hatchery during Gillnetting	Weighted Average % Hatchery	Estimate number of hatchery in population
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

The assessment provided useful information on the estimated population of sockeye returning to Williams Creek, as well as the percentage of hatchery stock that comprised the escapement. The population size is significantly reduced to previous years, and it is difficult to determine what factors may be at play. Since sockeye return to Lakelse Lake in three, four and five year age classes, many of the potential factors limiting sockeye success would show impact in previous (and future) sampling years as well. Sampling in the coming year may shed light on the potential trends that could have impacted this year's population size.

The hatchery estimate calculated in Table 1, using the percentage-calculation method, was determined by multiplying the weighted average percentage of hatchery fish to the overall population estimate. For 2017, the hatchery population was calculated as follows: (0.1018) * (3,668) = 373 hatchery fish in the William's Creek spawning population. This estimate can also be calculated using the Lincoln-Peterson equation for marked and recaptured hatchery fish collected during the sampling season. Using this method, the estimated hatchery population for 2017 is 408 adults, which is only 35 individuals more than in the percentage-calculation method. Because of the large number of sockeye handled during sampling, the percentage-calculation method is considered to provide a relatively accurate estimate, whereas because some assumptions may not have been met in the Lincoln-Peterson method, this estimate is considered to be potentially less accurate, which likely accounts for the discrepancy between the two estimates. Therefore, we consider 373 hatchery sockeye to be a valid estimate of hatchery sockeye present in the William's Creek spawning system.

The high jack percentage in the population this year may be due to a number of factors. The survival of 2014's brood offspring may have been higher than average, resulting in a multitude of jacks returning after one year in the ocean. Jacks often take the role of a "sneak" in the reproducing population, whereby they can sneak in while a female sockeye releases her eggs and fertilize the eggs before an adult male has a chance to do so (Foote et al., 1997). Because of the relatively small sockeye return this year, jacks may have returned this year due to the perceived reduction in resource, and possibly even reproductive, competition in Williams Creek. Generally, large proportions of jacks have been widely accepted as an indicator of a strong sockeye run in the year to come (Cass et al., 2006; Mitch Drewes, pers. comm.).

According to the Lakelse Lake Sockeye Recovery Program (DFO et al., 2005), Williams Creek receives, on average, 80% of all Lakelse escapements during spawning season. With this statistic we can calculate a rough estimate of the entire adult sockeye population in the Lakelse system using our Lincoln-Peterson estimate of the William's Creek population. The entire Lakelse escapement return in 2017 is therefore estimated to be 3,668 / 0.80 = 4,585 adult sockeye. It is possible that further sockeye entered the William's Creek system after the sampling season was over, which means that they would not have been included in the William's Creek population estimate. Therefore, the Lakelse escapement calculation may be an underestimate.

As shown in Table 1, the proportion of hatchery fish in the population this year is the highest (so far) in this 5-year program. The decrease in population size coupled with the increased proportion of enhanced fish in the population suggests that the wild population may have experienced an event such as heavy rainfall that reduced the survival rate of the wild sockeye in their spawning, incubation, or rearing life stages, before the enhanced sockeye were returned to the system. This hypothesis may be useful to consider in future efforts towards population recovery. Overall, the substantial proportion of the population consisting of hatchery enhanced sockeye indicates that the Fry Outplant Project is showing a positive, significant contribution to the population.

Next year, the final year in the five-year project, will mark the final returns from enhanced sockeye stocks. With this data we will be able to look at an overall trend in sockeye population changes within the Williams Creek system, and determine the short- and long-term benefits of the Fry Outplant Program.

Figure 12. Who doesn't love sockeye!

Acknowledgements

We would sincerely like to thank the following groups/individuals who contributed to the success of the project

Mike Jacubowski, DFO – use of the seine nets
Wade Larson, DFO – use of the boat
Lana Miller, DFO
Rob Dams, DFO
James Powell, DFO
Sandy Devcic, DFO
Summer Schulte, HREM
Megan Rogers, HREM
Olivia Gray, HREM
Andrea Komlos
LWSS Volunteers
Terrace Rod and Gun Club
And all other volunteers!

Should you require any further information or have any questions or concerns, please do not hesitate to contact me.

Alison Grover, B.Sc.

Ph: (250) 254-2848
Email: agrover@ualberta.ca

Reviewed by
Mitch Drewes, RB Tech

Ph: 250 641 3173
Email: hrem@telus.net

Reviewed by
Olivia Gray, B.Sc.

Ph: 604 366 5552
Email: olivia.hrem@gmail.com

References

Cass, A., Folkes, M., Parken, C., and Wood, C., 2006. Pre-season run size forecasts for Fraser River sockeye for 2006. *Canadian Science Advisory Secretariat of Fisheries and Oceans Canada.*

Coburn, A.S and Bilton, H.T. 1967. The age, size and sex composition of sockeye in the escapements to Schulbuckhand and Williams Creeks, Lakelse Lake, B.C. in 1965 and 1966. *Fisheries Research Board of Canada*.

Cox-Rogers, S. F., Hume, J. M. B., & Shortreed, K. S. 2004. Stock status and lake based production relationships for wild Skeena River sockeye salmon. *Canadian Science Advisory Secretariat of Fisheries and Oceans Canada*.

DFO, BC Ministry of Water Land and Air Protection, BC Timber Sales, Lakelse Watershed Society, Kitselas First Nation, and Terrace Salmonid Enhancement Society. 2005. Recovering Lakelse Lake Sockeye Salmon. *Lakelse Lake Sockeye Recovery Plan.*

Drewes, M. and Kujat, M. 2014. Lakelse Lake Sockeye Salmon Fry Outplant Program 2013-2014. *Prepared for the Department of Fisheries and Oceans & The Pacific Salmon Commission.*

Foote, C. J., Brown, G. S., and Wood, C. C. 1997. Spawning success of males using alternative mating tactics in sockeye salmon *Oncorhynchus nerka*. *Canadian Journal of Fisheries and Aquatic Sciences* 13, 1785-1795. DOI: 10.1139/f97-080

Gottesfeld, A. S., Rabnett, K. A., & Hall, P. E. 2002. Conserving Skeena fish populations and their habitat. *Skeena Fisheries Commission, Hazelton BC.*

Kokelj, J. 2003. Lakelse Lake draft management plan. Prepared for Lakelse Watershed Society. *Ministry of Water, Land and Air Protection*, Skeena Region. Smithers, BC.

Krebs, C. J. 1989. Ecological methodology. No. QH541. 15. S72. K74 199. New York: Harper & Row.

Reese-Hansen, L. 2001. Interim restoration plans for nine watersheds in the central Kalum Forest District. *Kitsumkalum Band Council*, Terrace, BC.

Appendix A

Table 2. Raw data from all 2017 seining occasions.

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-17	Seining	383	224	50	30					1		688	
07-Aug-17	Seining	100	87	26	20	76	47	10	7	3		376	
11-Aug-17	Seining	166	180	22	14	119	67	5	9	19	1	602	1 Rainbow
14-Aug-17	Seining	125	236	21	19	57	67	4	12	27		568	
17-Aug-17	Seining	109	170	9	16	76	113	6	9	25		533	Jacks: 19 = wild, 6 = recap
25-Aug-17	Seining	102	94	6	4	38	32	6	7	4	1	294	Jacks: All = wild; Other = Rainbow
30-Aug-17	Seining	41	33	1	1	19	11	1		16	2	125	Jacks: 14 = Wild, 2 = Recap; Other = one Coho, one Sucker
TOTAL		**1026**	**1024**	**135**	**104**	**385**	**337**	**32**	**44**	**95**	**4**	**3186**	

Table 3. Raw data from all 2017 gillnetting occasions.

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				
17-Aug-17	Gillnetting A	3	7	2	1		22			13			1			1		1		51	
17-Aug-17	Gillnetting B	4	5	1			14			4										28	
25-Aug-17	Gillnetting A	13	11	1	1		21	3	3	15	7		1			1			1	78	Other = Rocky Mountain Whitefish
25-Aug-17	Gillnetting B	10	7				26		1	14			3			2				63	
01-Sep-17	Gillnetting A	12	8		3	3	27	2	2	7	5		2							71	
01-Sep-17	Gillnetting B	11	8			2	17		1	10	1		1			1				52	
08-Sep-17	Gillnetting A	8	7	1	2	3	10	2	5	5	2	2				2				49	
08-Sep-17	Gillnetting B	6	9			1	5	3		7	3		2		1					37	
TOTALS		**67**	**62**	**5**	**7**	**9**	**142**	**10**	**12**	**75**	**18**	**2**	**10**	**0**	**1**	**7**	**0**	**1**	**1**	**429**	