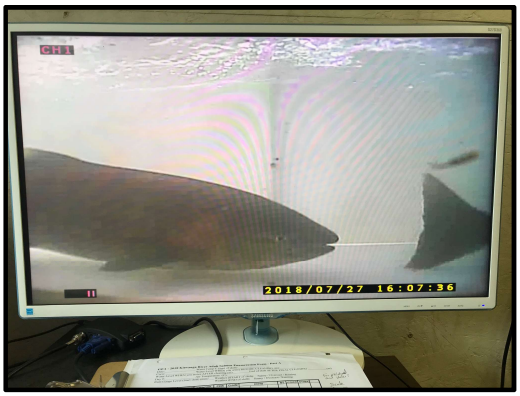
Gitanyow *Fisheries* Authority

Kitwanga River Salmon Enumeration Facility (KSEF) – 2018 Annual Report



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Abstract

In 2018, the Gitanyow Fisheries Authority (GFA) operated the Kitwanga River Salmon Enumeration Facility (KSEF) for the 16th consecutive year to count and biologically sample Pacific salmon returning to the Kitwanga River. The fence was operational from July 10th to November 13th, 2018 under very low water conditions for most of the season. Overall, the average water level was 28% lower than the long-term average (2003-2017), and as much as 44% lower on some days. Low water most likely played a large role in the late returns of salmon to the Kitwanga River in 2018. GFA counted 1,434 sockeye, 618 Chinook, 18 jack chinook, 2,736 pink, 273 chum, and 551 coho through the KSEF (and KsF) in 2018.

The 2018 sockeye return of 1,434 fish was below the long-term average of 4,299 (2003-2017). Overall the run was late, with the majority of the fish coming after the first of October; coinciding with a precipitation event at the time. Of the 57 sockeye tagged and tracked in 2018, only 19 (32%) made it to Gitanyow Lakes spawning locations. The extremely low flow conditions observed in 2018, provided opportunities for beavers to construct dams on the mainstem of the Kitwanga River, that had not been observed in past years. High mortality rates were seen in association with these beaver dams, which were identified through tracking of the 57-tagged sockeye. Given the high on-route mortality seen for Kitwanga sockeye between the KSEF and Gitanyow Lake, the actual escapement may be closer to 460 adults given the radio tracking results seen in 2018 (1,434*32%).

The 2018 chinook return of 618 fish was 55% below the running average from 2003 to 2017 of 1,381 fish/year, and is slightly down from the more recent average from 2009 to 2017 of 792. The 2018 run compares to a minimum return of 586 fish in 2017 and a maximum return of 3,225 in 2007. Overall, the chinook run was approximately a week later in 2018 compared to the long-term timing average (2003-2017), with a bi-modal timing distribution.

The 2018 Kitwanga even-year pink run of 2,736 fish was well below the running even-year average of 30,562 fish (2004– 2016) and was the lowest recorded at the KSEF. This return originated from the 2016 brood year, which had an escapement of 19,700 fish, indicating the 2018 return was about 86% below replacement value for the stock. The 2018 even-year pink run compares to a minimum even-year return of 4,245 fish in 2008 and a maximum return of 75,416 in 2014. Overall the even-year pink run was approximately a week later in 2018 compared to the even-year long-term timing average (2004-2016).

A total of 273 chum salmon returned to the Kitwanga River in 2018. The 2018 run compares to a minimum return of 150 fish in 2008 and a maximum return of 1,862 in 2005. This year's estimate for chum escapement was 61% below the running average of 701 fish recorded from 2003-2017 and seems to be in line with the lower stable average seen from 2010 to 2015 and 2017 (411).

A total of 551 coho salmon returned to the KSEF in 2018. This was by far the lowest adult coho escapement recorded through the KSEF and is 86% below the running average from 2003 to 2017 (3,908 fish/year). The 2018 escapement total represents the fourth year in a row of a noted coho declines. Overall run timing in 2018, when compared to 2003-2015[1], was approximately two months later.

[1] Note KSEF was shut down on September 1st in 2016 and on September 11 in 2017.

Acknowledgements

Gitanyow Fisheries Authority (GFA) would like to thank the Gitanyow Hereditary Chiefs Office for their continued leadership and support for the GFA program. In 2018 the project funders were: Pacific Salmon Commission (PSC), Fisheries and Oceans Canada and the Gitanyow Huwilp Sustainability Fund. GFA would also like to acknowledge our field staff that make the project possible year after year. GFA staff are often required to work long hours, sometimes under short notice in adverse weather conditions and for this we are very grateful for their continued commitment to the project. In 2018 GFA technicians included: Les McLean, Earl McLean, Vernon Russell, Phillip Johnson, Brenton Williams, Morgan Douse, Johnny Martin, and Melissa Shirey. A special thanks to Dean Miller for his expertise on the sockeye telemetry study and for his invaluable work on getting the fence panels automated and adding the new counting chute and surveillance cameras. We are thankful DFO employees Rob Dams for lending us a digital video camera recorder (DVR) for our new salmon counting chute, and Shaun Davies for helping us secure the additional funds required to operate the KSEF into November to enumerate late arriving coho salmon. Mike McCarthy and Dustin Gray were also helpful in adding their professionalism when we needed them. GFA leads included: Mark Cleveland, Jordan Beblow and Gregory Rush.

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1. INTRODUCTION AND BACKGROUND

Historically, the Gitanyow fished salmon in the Kitwanga River for section 35 purposes where sockeye was the main species of choice. In the early 1900's sockeye stocks were thriving and Gitanyow Elders spoke of the lakeshores of Gitanyow Lake turning red every fall as the sockeye congregated to spawn on their respective spawning grounds.

Fish weir on the Kitwanga River, note basket traps on far shore.
Louis Shotridge, 1918 (CMC, 71-8442).

However, by the 1960's the Elders talked of the noticeable declines in the returns of the Kitwanga sockeye and by the 1970's most fishing sites along the Kitwanga River were voluntarily abandoned by the Gitanyow due to conservation concerns for the stock (Cleveland 2005, Kingston 2013).

Over fishing in mixed stock fisheries in the ocean are thought to be the leading cause for the declines. Historical exploitation rates on Kitwanga sockeye have been shown through DFO fishery reconstructions to be very high through most of the 1900's, averaging between 50-70%. Other factors likely contributed to the decline. They include the degradation of spawning and rearing habitats in and around Gitanyow Lake due to poor forest harvesting practices (Cleveland 2006, Kingston 2013).

Historical DFO Salmon Escapement Data (SEDS) records for Kitwanga sockeye prior to the implementation of the KSEF are very limited. In most years, stream escapement counts were not completed and even when they were, the results were likely inaccurate because Kitwanga sockeye are exclusively lakeshore spawners. GFA observations over the last 16 plus years have found that conducting lakeshore counts is very difficult and almost always under estimate the true annual escapements by a large margin.

In 1999, GFA initiated studies on Kitwanga sockeye to conserve, protect and recover the stock. As part of the of Kitwanga sockeye salmon recovery plan, which was initiated in 2006 (Cleveland et al 2006), two of the highest priority projects has included the accurate annual assessment of adult and smolt production. Adult sockeye escapement data has been collected continuously since 2000 through the operations of a temporary weir (2000-2003) and then through the operations of the KSEF (2003-2018). Smolt production from Gitanyow Lake has been accurately assessed continuously since 2008, when the Kitwanga River Smolt Facility (KsF) was constructed.

In conjunction with counting fences, GFA has conducted lakeshore spawning assessments, habitat rehabilitation works, egg-to-fry survival studies and limnological assessments on Gitanyow Lake. In an effort to boost egg-to-fry survival, a two-year small scale pilot hatchery program was also conducted in 2006/07 and in 2007/08 (Cleveland 2007 & 2009, Kingston 2008 & 2009, McCarthy and Cleveland 2012). In addition, an overall reduction in the exploitation rate (ER) on adult Kitwanga sockeye has been implemented since 2009 in most years, where averages ER have been reduced to about 22%. These compare positively to the more historical exploitation rates which were double and triple these values. All of these works have had a positive effect on Kitwanga sockeye and we have seen some modest rebuilding of the stock in reason years.

The KSEF not only provides fishery management benefits for the Kitwanga sockeye salmon recovery plan, but it is also used as a middle Skeena salmon

index to gauge the annual escapements of Kitwanga chinook, pink, chum and coho salmon. The information collected at the KSEF is relied upon in-season and post-season by DFO and First Nation fisheries managers that use the index to help manage Skeena salmon fisheries.

In 2018, the KSEF was operated with funds provided by the Pacific Salmon Commission, DFO's Stock Assessment and Aboriginal Fisheries Strategy programs and from the Gitanyow Huwilp Sustainability Fund. This report summarizes the sampling results and findings for the KSEF program in 2018. Kitwanga salmon escapement data obtained by GFA in 2000, 2001 and 2002 from the operations of the temporary Kitwanga River weir, through stream walks and aerial flights prior to the construction of the KSEF will not be included in this report for comparison purposes, but those results are available in other annual reports produced by GFA.

2. DESCRIPTION OF THE STUDY AREA

The Kitwanga River (BC Watershed Code 400-364900) is a fifth order stream that drains into the Skeena River about 250 km northeast of Prince Rupert, B.C. It supports all six species of Pacific salmon including pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*O. keta*), chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), and steelhead trout (*O. mykiss*). The Kitwanga River supports populations of resident rainbow trout (*O. mykiss*), cutthroat trout (*O. clarki*), Dolly Varden char (*Salvelinus malma*), bull trout char (*S. confluentus*), mountain whitefish (*Prosopium williamsoni*) and various other species of coarse fish (BC Fisheries Information Summary System, or FISS).

The drainage encompasses an area of about 83,000 hectares and has a total mainstem length of approximately 59 kilometers (Cleveland 2000). Gitanyow Lake (gazetted name Kitwanga Lake) separates the Upper and the Lower Kitwanga River. The Upper Kitwanga is located directly north of Gitanyow Lake and has a main stem length of about 23 km. The Lower Kitwanga River flows

south for about 36 km between Gitanyow Lake and the Skeena River. The Lower Kitwanga River has four major gazetted tributaries: Tea Creek, Deuce Creek, Kitwancool Creek and Moonlit Creek. The Upper Kitwanga River has no major tributaries and exhibits a multi-channel meandering configuration with intensive beaver activity along its lower reaches.

The KSEF is located on the Kitwanga River about 4 km upstream from its confluence with the Skeena River (Figure 1). It is situated on private property and a long-term Statutory Right of Way permit has been granted for the site and the access road to the GFA salmon research facility. Most of the Kitwanga River is within the Traditional Territory of the Gitanyow, however the KSEF site itself is located on the traditional territory of the Gitksan or Gitwangak Wilp. Gitwangak Wilp member(s) are employed annually on the KSEF project to keep them involved in the project and help foster continued relationships between the nations.

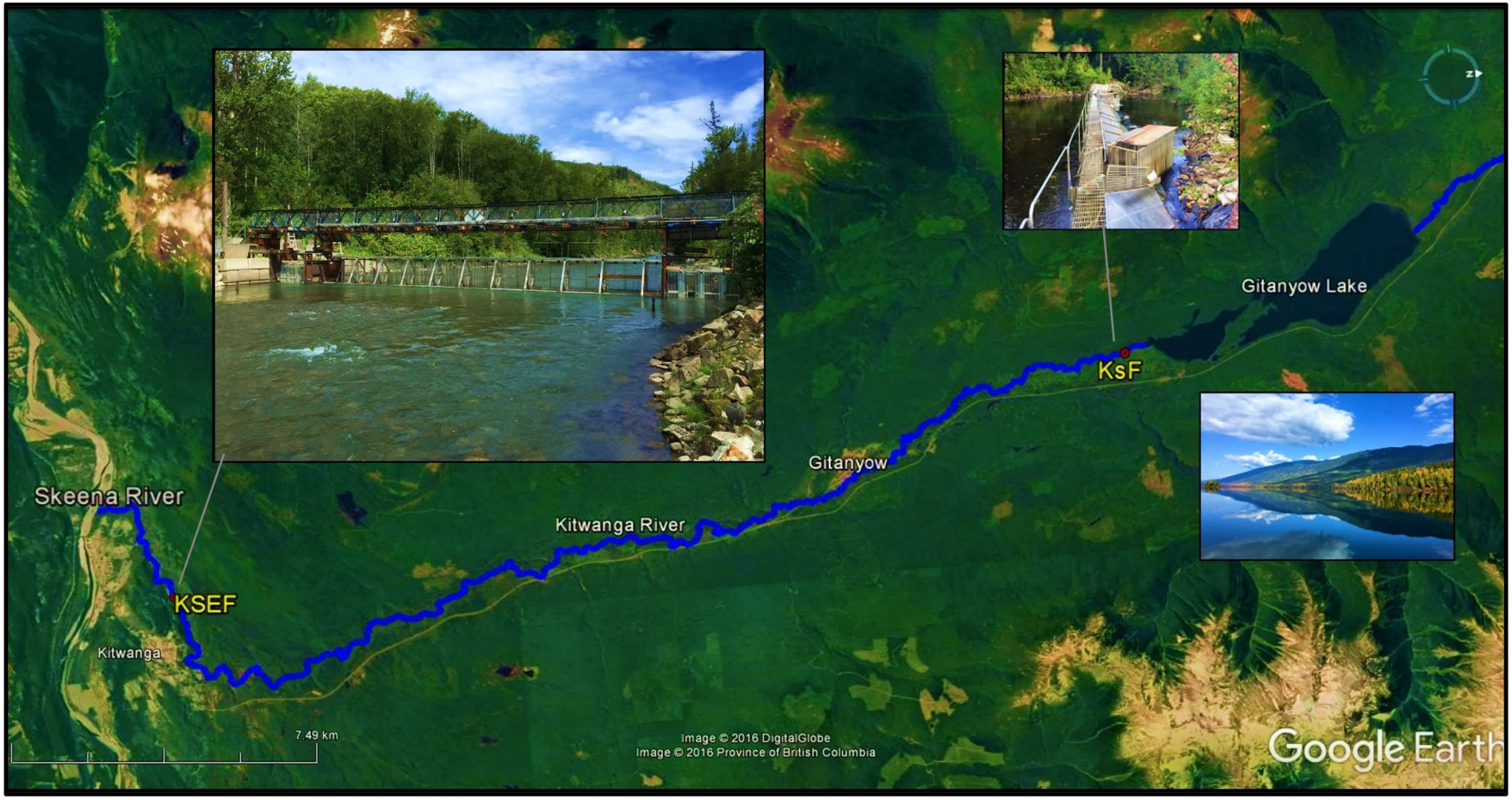

Figure 1: Google Earth image of the Skeena River (far left) and the Kitwanga Watershed including photos of the KSEF, KsF and Gitanyow Lake.

3. KSEF DESIGN AND OPERATING METHODS

The KSEF counting fence is located on the Kitwanga River about 4 Km upstream from the confluence of the Kitwanga and Skeena Rivers and downstream of most Kitwanga salmon spawning areas (Cleveland, 2004). The KSEF operates during the summer and fall months and uses aluminum panels to funnel fish into counting stations located on the left and right banks of the Kitwanga River (Figure 2; photo series of KSEF design). From late fall through to the following summer, fence panels and counting boxes are removed allowing fish unimpeded movement past the site when it is not in operation. The Kitwanga River at the KSEF site is about 30m wide and the facility spans perpendicular to the rivers flow.

Based on a temporary test panel design that was tested during the regular fence operations in 2013 and 2014, the GFA upgraded the entire fence section to a rotating panel design in 2015. GFA acquired financial assistance from the Pacific Salmon Commission (PSC) to complete the 2015 fence design and fabrication (Kingston, 2015). The rotating panel design provides a much safer platform for the staff working at the facility, allowing them to safely and efficiently remove debris buildup during the fall floods.

The rotating panel design consists of a series of nine aluminum transoms that support the aluminum rotating panels and an associated walkway. Annually, the transoms and walkway are mounted to nine steel base plates that are permanently bolted onto the existing cement crump. There are two rotating fence panels in between each transom and there is a total of 21 rotating panels that span the entire river and block fish passage. Each rotating panel is made from 3/4" schedule 40 aluminum bars that are welded to ¼" thick 4" X 4" aluminum square tubing at each end. The panel spacing between each aluminum bar is 1" to block adult salmon from swimming upstream through the panels. The rotating panels are 40" wide and 72" tall. Each aluminum fence panel rotates on 2" steel balls that are permanently secured in the river onto a

continuous steel base plate. A lower nylon bushing was fastened to the base of each rotating panel and the bushings were machined to fit the 2" steel balls. At the top of each rotating panel a steel bracket was welded with an upright 1 ½" steel shaft and a nylon bearing that could be fastened to a cross brace between each transom. Each steel bracket had a 1 ¼" Hex head bolt machined into the top of the bracket to aid in turning each panel with a large T-bar to remove leaf litter, woody debris and expired salmon carcasses from the fence panels.

Automated Cleaning System

In 2018, the KSEF fence was retrofitted with an electro pneumatic cleaning system controlled by a programmable logic controller (PLC). The previous cleaning system required GFA staff to operate it manually to remove organic debris build-up (e.g. leaves, wood, expired salmon carcasses, etc.), which proved to be very labour intensive and logistically very challenging during large and extended precipitation events. GFA staff cleaned panels by pulling a locking pin on a particular panel and rotating it at least 120 degrees using a large T-bar. The river current would then wash away accumulated debris downstream and the panel would be rotated back and locked back into place.

The automated cleaning system installed in 2018 utilized a custom engineered mechanical system, powered by a pneumatic cylinder that opened each panel 120 to 130 degrees to clean off debris in the same manner as the manual system (Figure 2). Air was supplied to the pneumatic cylinder of each panel via a 12-volt electric/air solenoid mounted near the panel and connected to an air manifold and a central air compressor. Panels were individually controlled via electrical circuits from the solenoids to the PLC mounted inside the fisheries trailer (Figure 2). The PLC allowed for both manual control of each panel via individual control switches or programmed control utilizing a timer function allowing panels to be cleaned when no crew were present such as at night.

Figure 2: Photo on left shows automated panels and photo on right shows PLC panel where automation parameters can be set.

An aluminum walkway is installed annually on top of the transoms, which allows workers access to each rotating panel from above. By rotating panels regularly, it clears off debris that clogs up the fence during regular operations.

The rotating panels and transoms are designed to be taken out after the adult salmon migration is complete, and the only portion remaining in the river is the concrete slabs thereby allowing other fish to migrate past the survey site unimpeded at all other times of the year (Figure 3; photo series of KSEF design).

Figure 3: Photo series of installation of the KSEF structure.

Once the aluminum rotating panels and walkways are secured into the middle section of the river, the left and right bank counting stations are installed so that all fish movement through the site can be controlled. This allows for easy salmon identification to the species level and biologically sampling to take place as they migrate past the facility. Each trap box has two counting chutes so that counting technicians can direct fish into one of two large holding pens, where they can be examined more closely as necessary, and sampled as instructed in the annual biological sampling protocol. A white Teflon reflective background is used on the bottom of both counting chutes to make the visual identification of fish easier. A floating plexiglass-bottomed viewing box is also used on the water surface to reduce glare and improve fish visibility. Counting chute bottoms are designed to be raised or lowered as necessary to allow adequate water levels in the chutes to make fish identification possible at times when water clarity is not ideal.

In 2018, a portion of the salmon migrating through the KSEF was randomly sampled to acquire a full range of fish sizes and scales were collected for aging purposes. For fish sampling purposes, sampled fish are dipnetted out of the holding boxes, placed in a "V" trough equipped with a hose and electric pump which provided a constant supply of fresh river water during sampling (Figure 4; Photo series showing scale sampling). Samples are taken from all species except pink salmon and GFA staff strive to sample 5-10% of the annual returns in any

given year. Fish are also visually inspected to identify the presence of marks (e.g. adipose fin clip), measured for fork length and inspected for sex, ripeness and overall physical condition. Scale samples are collected for aging and the results are presented in this report using the European age method. This method presents ages using a two-number sequence with the first number representing the fresh water occupation period and the second number representing the salt-water occupation period. All scales are sent to the DFO Pacific Biological Station in Nanaimo, except for sockeye. Sockeye scales are sent to a private lab (Birkenhead Scale Analysis) annually for age analysis.

Figure 4: Scale sampling.

GFA fisheries staff are instructed in proper fish handling techniques to reduce the stress on the fish. Crews of two fisheries technicians visually enumerate and count salmon daily as they swim through each counting chute. One GFA technician would work on the right bank counting station and the other on the left during each shift. The hours of fence operation are during daylight hours only[2]. The KSEF is closed nightly preventing upstream migration between dusk and dawn.

[2] Exceptions for high water events where staff are present to keep the panels clear of debris.

A permanently erected stage gauge is used annually to manually measure river levels throughout the operating period. GFA staff record river levels four times daily. The manual stage gauge was established at the KSEF in 2004 and is used to compare water levels and flood events from year to year. Daily water temperatures, rain gauge measurements and air temperature were also recorded throughout the operating period in 2018.

As a pilot project for 2018, GFA installed and operated a new salmon counting chute on one of the KSEF panels bringing our counting facility up to 3 counting areas (Figure 5). The new chute was equipped with a digital video camera recorder (DVR)[3]. The DVR was in place and operational from July 24, 2018 to the dismantle of the fence on November 13, 2018.

Figure 5: Photo shows counting chute (equipped with a DVR).

In 2018, GFA also installed, a water level alarm to alert senior staff when a high water event is reached, as well as surveillance cameras to monitor the environmental conditions at the site, maintain staff safety and to protect the site investments. Both the water alarm and camera system worked off cell phone towers and provided information through smart phones in real-time.

[3] Special thanks to DFO and Rob Dams for lending the equipment.

Bank Erosion Repairs

In the fall of 2016 and 2017, high water events at the end of August and early September, resulted in damage to the KSEF in terms of bank stability. In March of 2018, work was conducted to stabilize the right bank with new drain rock, rip-rap and tying in and connecting all lock-blocs. Figure 6 shows photo examples of the high water event and the subsequent remediation works conducted.

Figure 6: Photo on top left - taken during normal operating flow and photo on top right on September 11th, 2017, during extremely high flow, with yellow oval highlight right bank overflow. Photo on bottom left, right bank stabilization in process (March, 2018) and bottom right, finished work.

4. RESULTS

The operation of the KSEF in 2018 marked the 16th consecutive year that the facility was used to enumerate salmon in the Kitwanga River. The KSEF was operation from July 10TH to November 13TH, 2018 (2 weeks longer than normal). Operations were continuous with no breaches and water levels were below average for the entire season. More specifically, overall the average water level was 28% lower than the long-term average (2004-2017) and as much as 44% lower on some days (Figure 7).

Water temperatures were higher than the long term range for July through to early September (2011-2017) and generally lower from mid to late September till the program ended in mid-November (Figure 8). While temperatures did approach 20^{0}C later in the day for periods in late July and early August, overall water temperatures were considered adequate for salmon survival during the operations of the KSEF in 2018.

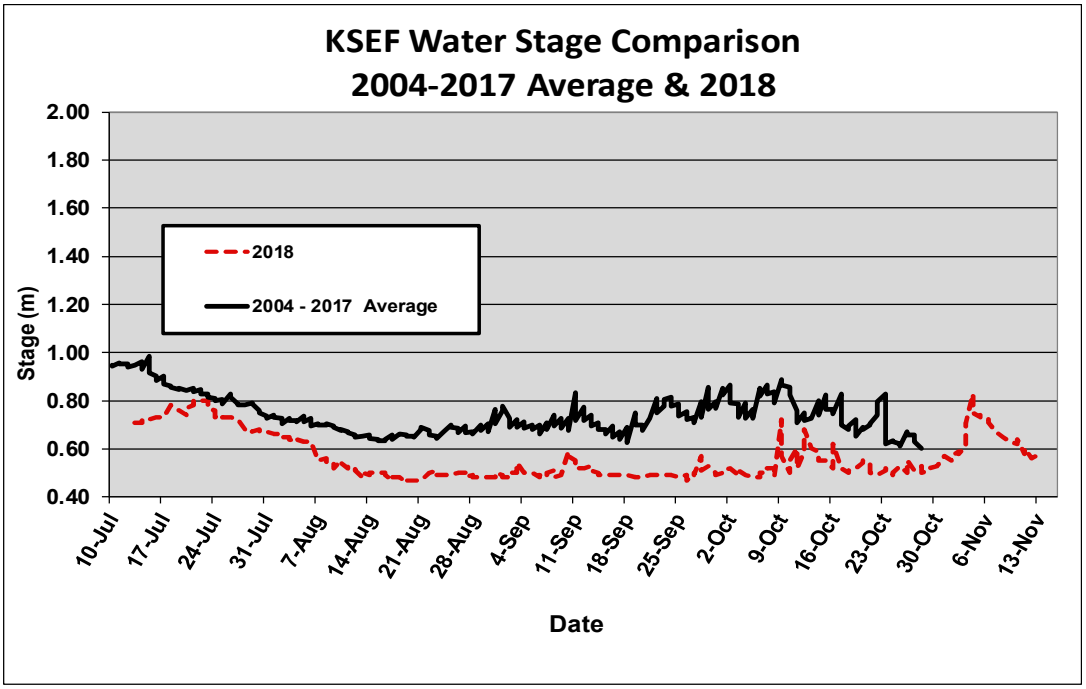

Figure 7: Average stage recordings at the KSEF (2004-2017) vs. 2018 results.

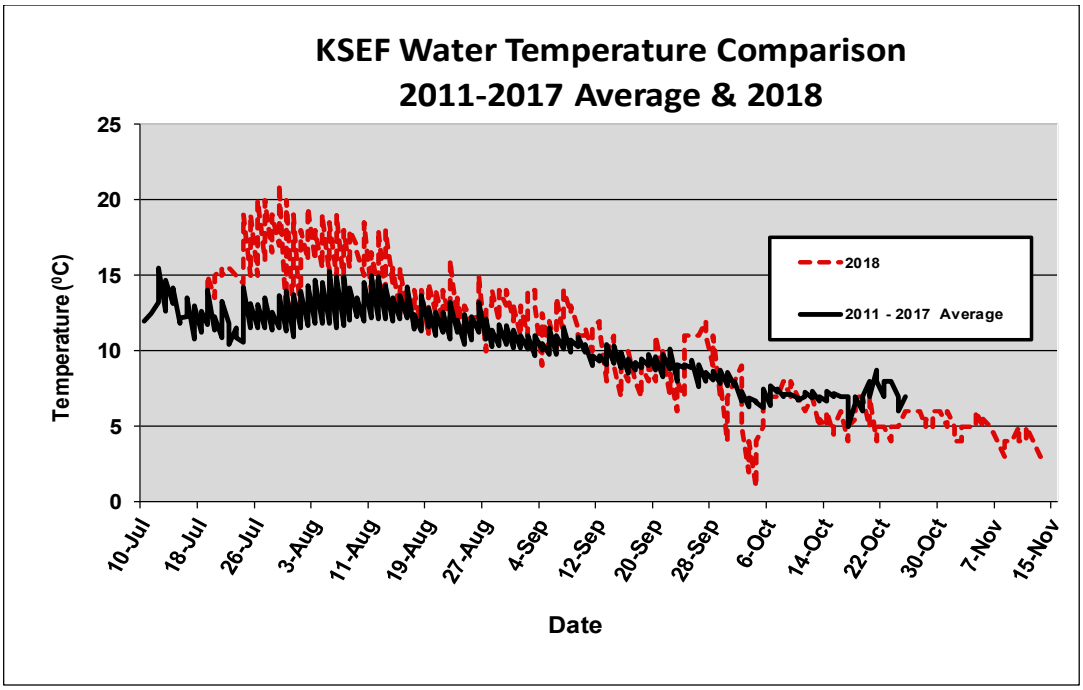

Figure 8: Average water temperature at the KSEF (2011-2017) vs. 2018 results

Total counts, run timing, historical run numbers, size, age and sex ratios, are described for sockeye, chinook, pink, chum and coho salmon in the following sections; 4.1 to 4.5.

4.1 Sockeye

In 2018, while GFA was operating the KsF in the Upper Kitwanga River to count smolts emigrating from Gitanyow Lake, adult sockeye show up below the KsF starting on July 3. In total 69 adult sockeye were counted through the KsF between July 3 and July 18. These fish would have passed the lower river adult fence (KSEF) site prior to it being installed for the year. Because GFA has never seen adult sockeye at the KsF site this early in the season, the smolt fence was used to enumerate adult salmon moving upstream after the KsF was usually pulled for the year. Specifically, the KsF was kept operational for two weeks longer than normal and 9 days after the KSEF was rendered operational in the lower river. On July 19, GFA conducted stream walks below the KsF for a distance of approximately 6km (between the KsF and Moonlit Creek) and an additional 35 adult sockeye were counted holding in this section of the river (most within 1km of the KsF). Therefore, when the KsF was pulled on July 19, 2018

GFA estimated that a total of 104 sockeye likely passed the KSEF prior to its installation and these fish were added to the total sockeye escapement count for 2018. GFA believes that this estimate is fairly accurate given that no sockeye passed the KSEF between July 10-17 and fish would have likely moved through the river to the KsF site with ease given that water levels were quite good for that period (~0.75m and <15^{0}C).

A total of 1,434 sockeye were estimated to have return through the KSEF and the KsF fences in 2018.

Sockeye returns to the Kitwanga in 2018 rebounded slightly after poor returns in 2016 and 2017. Since 2003 Kitwanga sockeye returns have averaged 4,299, with the lowest recorded of 240 (2007) and the highest of 20,804 in 2010 (Figure 9).

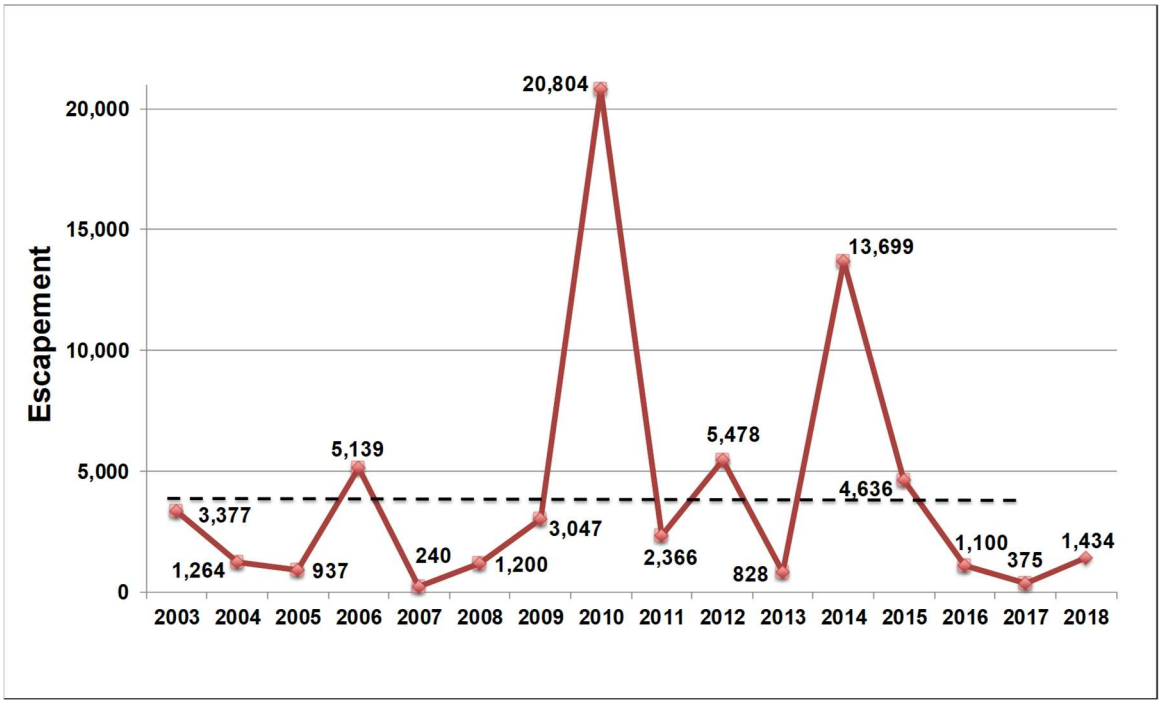

Figure 9: Annual Sockeye escapement into the Kitwanga River through the KSEF from 2003 to 2018 - Dashed line is average from 2003 to 2017.

Once the KSEF was installed and rendered fish tight on July 10, the first sockeye passed the site on July 17. Overall the run was late in 2018 with only ~41% of it

migrating passed the site by the first of October, where in previous years (2003-2015) 91% of the run would have been past the site by this time[4]. Also of note is that over a third of the run migrated past the site in one event in early October (Figure 10). The overall later arrival likely coincides with the very low water conditions we experienced in the area in 2018. Most sockeye did not start moving in until water levels started to rise after some rains in the middle of October. These extended low water conditions likely played a significant role in terms of delaying sockeye entry into the Kitwanga River.

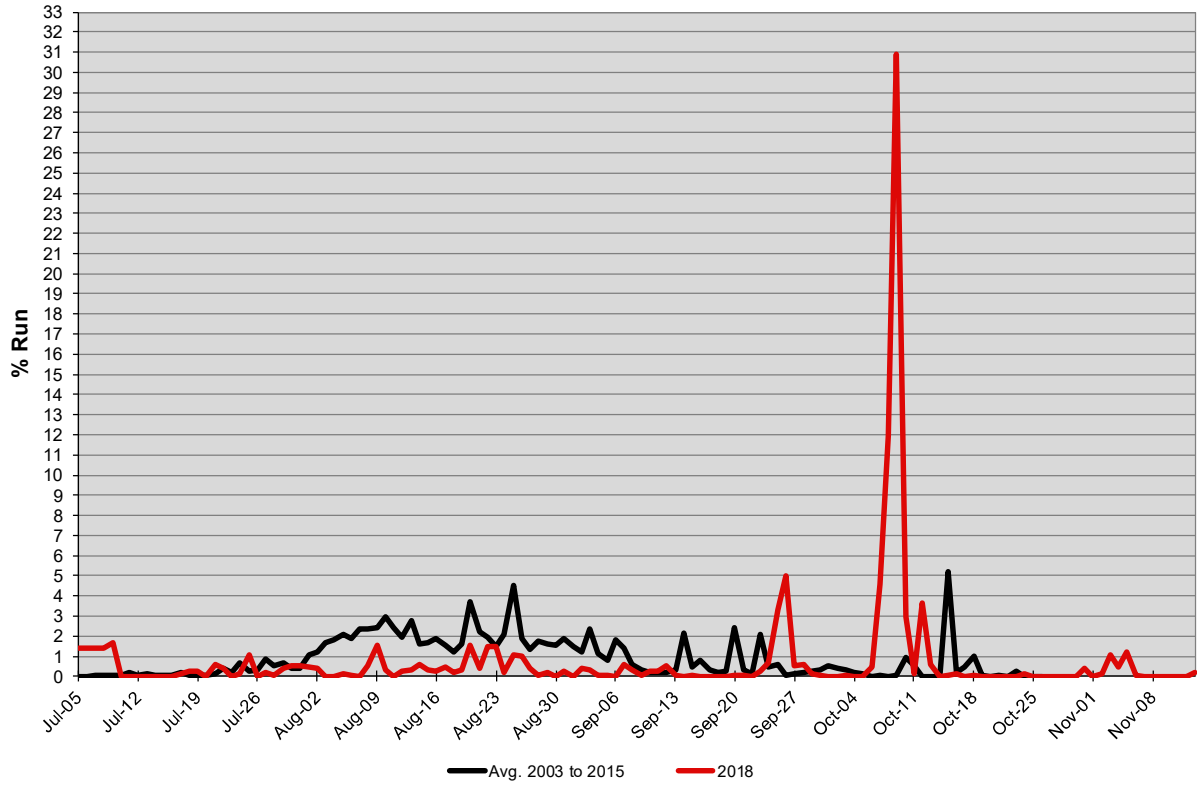

Figure 10: Kitwanga River sockeye salmon average run timing (daily run percent) for 2003-2015 vs. run timing for 2018 at the KSEF.

Preliminary fishery exploitation rates for 2018 reported by DFO in December of 2018 were estimated at 19% (3% Alaskan Marine, 11% Canadian Marine – including in-river demonstration fisheries, and 5% In-river FSC) (pers. comm. Steve Cox-Rogers, 2019; Figure 11). Without exploitation (estimated 336 sockeye

[4] Note KSEF was shut down on September 1st in 2016 and on September 11 in 2017.

removed), the estimated total return for 2018 would have been approximately 1,770 sockeye.

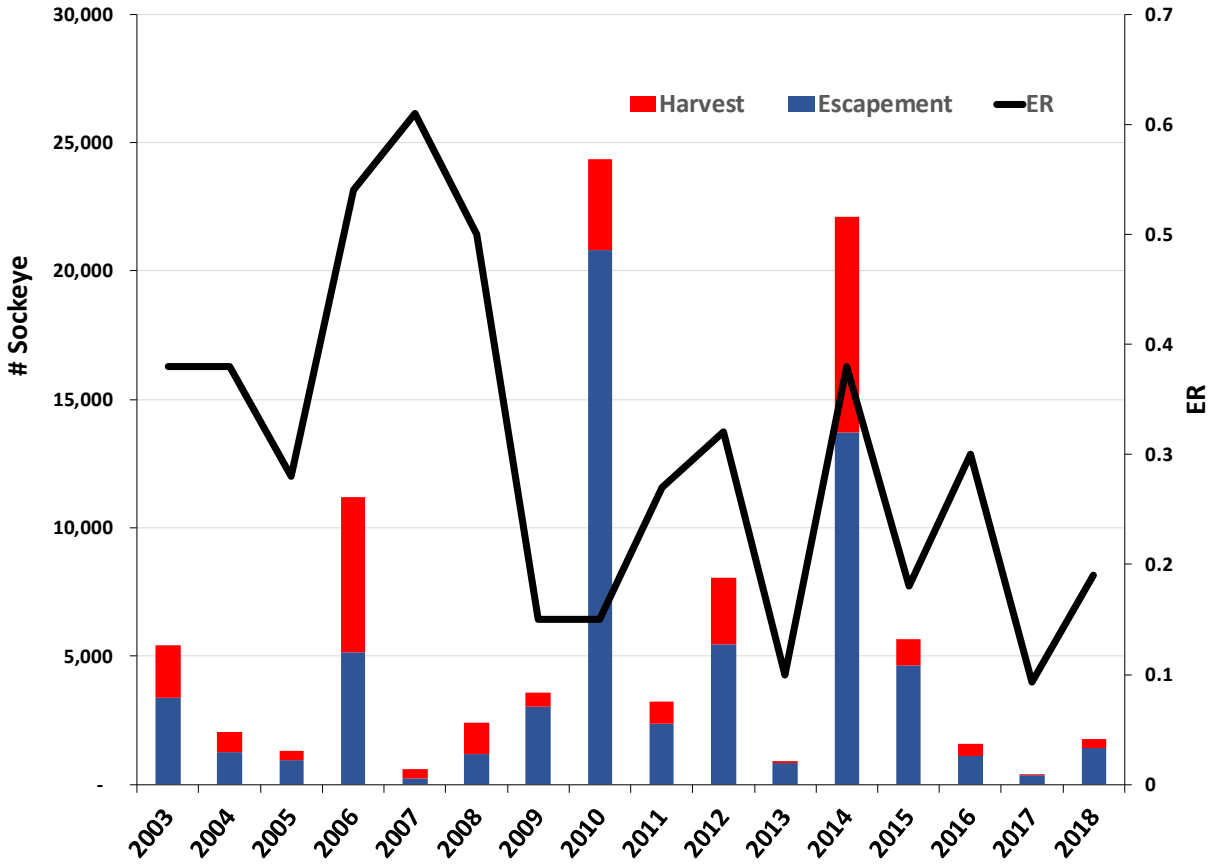

Figure 11: Kitwanga River sockeye salmon escapement and exploitation 2003-2018.

Complete fork length measurements, age and sex data were collected from 145 sockeye (~10% of the run) in 2018. Female composition comprised 54% (n=77) and males 46% (n=65)[5], which is within the normal sex ratio distribution observed previously. Average fork lengths were slightly greater for males and showed a wider range in size than females (Table 1). Size class (5 cm) histogram for combined sexes showed a uni-modal distribution, dominated by fish in the 56 to 60 cm size class (90%) followed by fish in the 51 to 55 cm and 61 to 65 cm size classes (5% each; Figure 12). When male and female average length was

[5]Sex was not determined for three sampled sockeye

compared to previous years, the 2018 results fell within the historical range (Table 1). Average length recorded since 2003 were similar and within a narrow 5 cm size range for females (53 to 57 cm), and males (52 to 59 cm) (Table 2).

Table 1: Sockeye salmon fork length (cm) statistics at the KSEF in 2018.

	Female	Male	Combined
Mean	54	56	55
Min	45	47	45
Max	59	63	63
Count	77	65	142

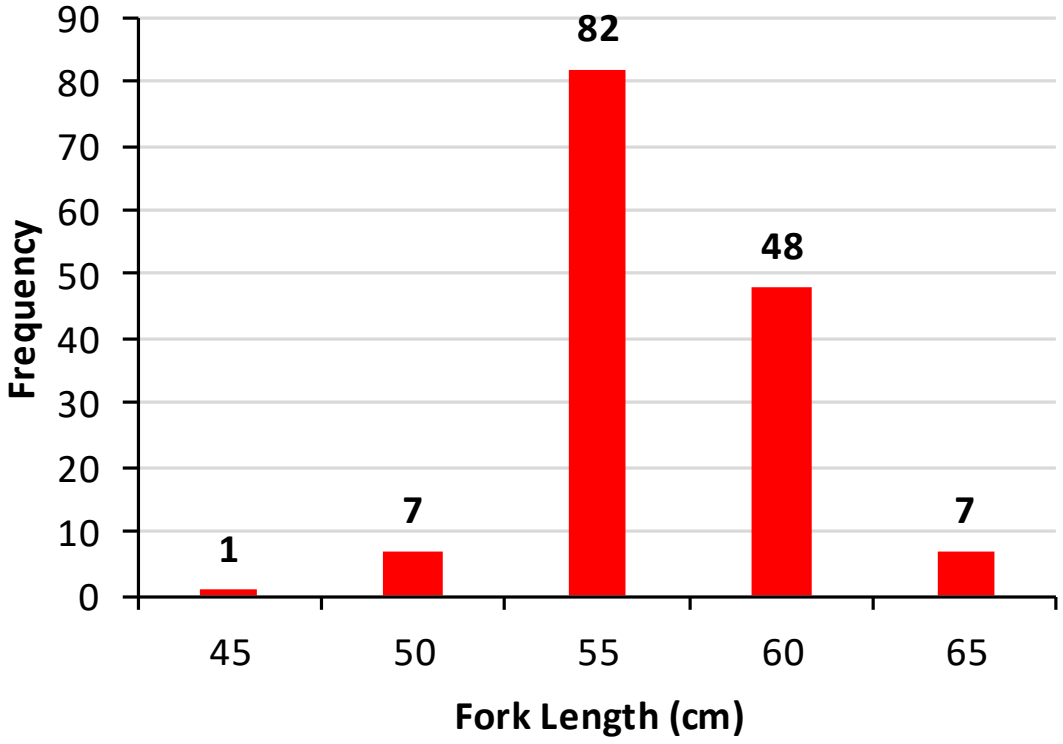

Figure 12: Fork length distribution for sockeye salmon in 2018 (n=145). X axis labels are 5 cm length class upper boundaries.

Table 2: Average length (cm) for sockeye female, male and combined Sexes from 2003 to 2018.

Year	Female	Male	Total
2003	55.3	58.8	56.6
2004	56.4	58.3	57.1
2005	57.2	57.5	57.4
2006	52.6	55.3	53.8
2007	53.5	52.2	53.3
2008	54.9	58.3	56.3
2009	54.3	57.4	55.8
2010	53.9	56.5	55.3
2011	56	59	57.5
2012	55	58	56
2013	54	58	57
2014	52.6	55.9	54.2
2015	53.7	56.3	55
2016	55	57	56
2017	56	58	57
2018	54	56	55

In 2018, scale samples were collected from adult sockeye complete with sex and length data and submitted to Birkenhead Scales Analysis for age determination. A total of 110 samples were confidently readable providing an 8% sample of the total run (60 females, 48 males and 2 unknowns). In 2018, Kitwanga sockeye were 100% 4-year-old fish (aged 1.2; or 1 year in fresh water post hatch and 2 years in salt water post-hatch). Given that the escapement of adult sockeye to the Kitwanga River in 2014 was 13,699, the 2018 return was only about 10% of its replacement value. Mean size for age 4 fish differed slightly for females and males at 54 and 56 cm respectively. Table 3 shows the ages class distribution from 2004 to 2018.

Table 3: Age class distribution (%) for sockeye salmon from 2004 to 2018.

Species	Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Sockeye	3 yr	1%	NA	NA	11%	3%	0%	0%	1%	0%	0%	1%	0%	3%	0%	0%
	4 yr	40%	NA	NA	22%	**95%**	**88%**	**99%**	**65%**	**95%**	**66%**	**96%**	**67%**	**89%**	**51%**	**100%**
	5 yr	**42%**	NA	NA	**67%**	2%	12%	1%	34%	5%	34%	3%	33%	8%	49%	0%
	6 yr	17%	NA	NA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Total sampled	99	NA	NA	240	65	323	323	238	240	105	360	303	38	45	110

4.2 Chinook Salmon

A total of 618 Chinook were counted at the KSEF in 2018. This is less than half of the long-term escapement average of 1,381 from 2003 to 2017 (Figure 13). In 2018, the first Chinook salmon was counted at the KSEF on July 19th and the last on September 17th (Figure 14). Overall the run was approximately a week later in 2018 with a bi-modal distribution. More specifically, over a third of the run was early with 37% of the run having passed the fence by the end of July, which compares to 18% (average between 2003-2017) seen previously to this date. By the end of August, 79% of the run had passed through the fence, compared to the long-term (2003-2017) run timing average of 97% for the same period.

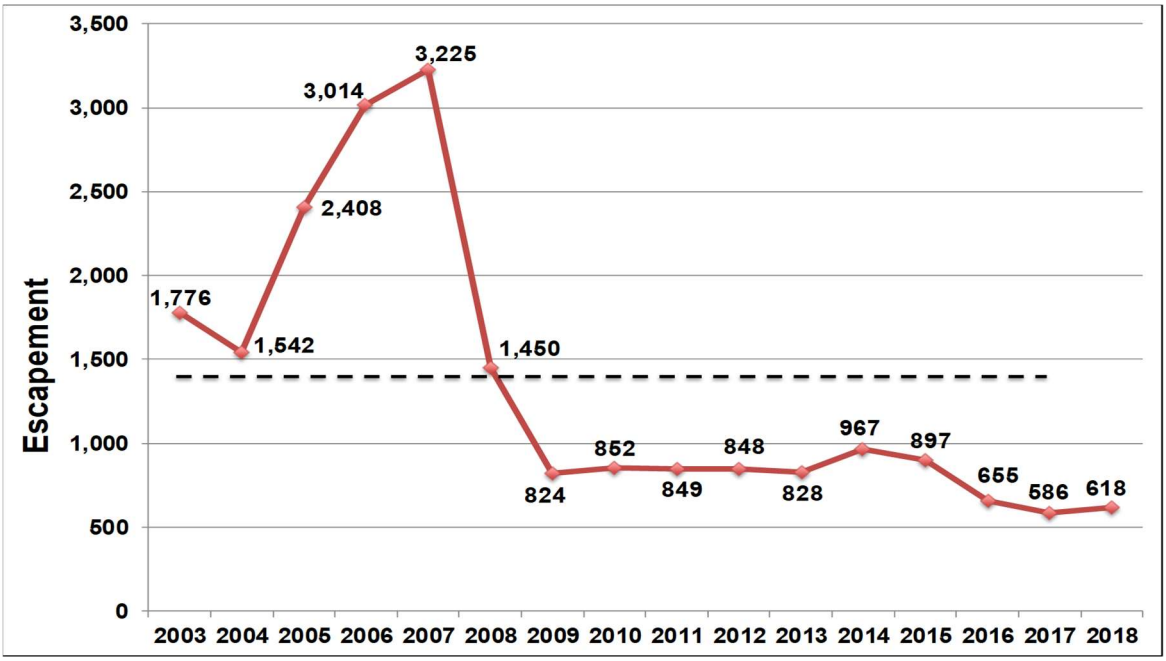

Figure 13: Annual Chinook escapement into the Kitwanga River through the KSEF from 2003 to 2018 - Dashed line is average from 2003 to 2017.

Length, age, and sex data was collected from 53 Chinook salmon (~9% of the total run) in 2018. Male and female sex ratios were 57 and 43 percent respectively falling within the parameters of what has been seen previously and within a healthy sex ratio breakdown for salmon populations. Fork length histogram (5cm intervals) showed a uni-modal distribution, dominated by fish in

76 to 80cm class (21%), 81 to 85cm class (23%), and to a lesser extent fish in the 71 to 75cm class (15%; Figure 15). Average fork length of the total sample was 79 cm and males and females were 76 and 82cm respectively (Table 4). The 2018 length results showed that female Chinook sampled in 2018 were slightly smaller when compared to results observed since 2008, but overall sampled Chinook fell within the normal range (Table 5).

Age results for the 2018 Chinook samples were not available for inclusion in this report but will be presented in the 2019 KSEF Annual Report.

Table 6 shows age class distribution for Kitwanga Chinook salmon from 2008-2017.

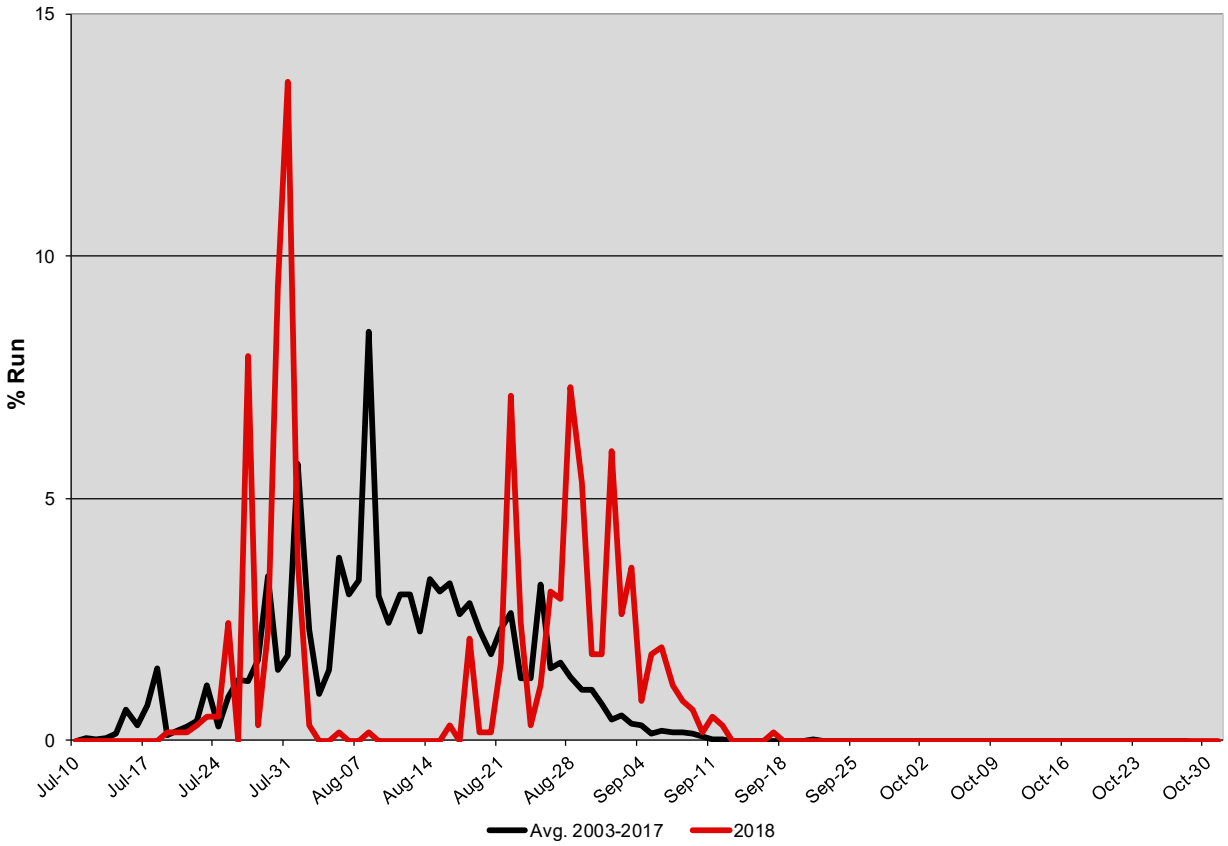

Figure 14: Kitwanga River Chinook salmon average run timing (daily run percent) for 2003-2017 vs. run timing for 2018 at the KSEF.

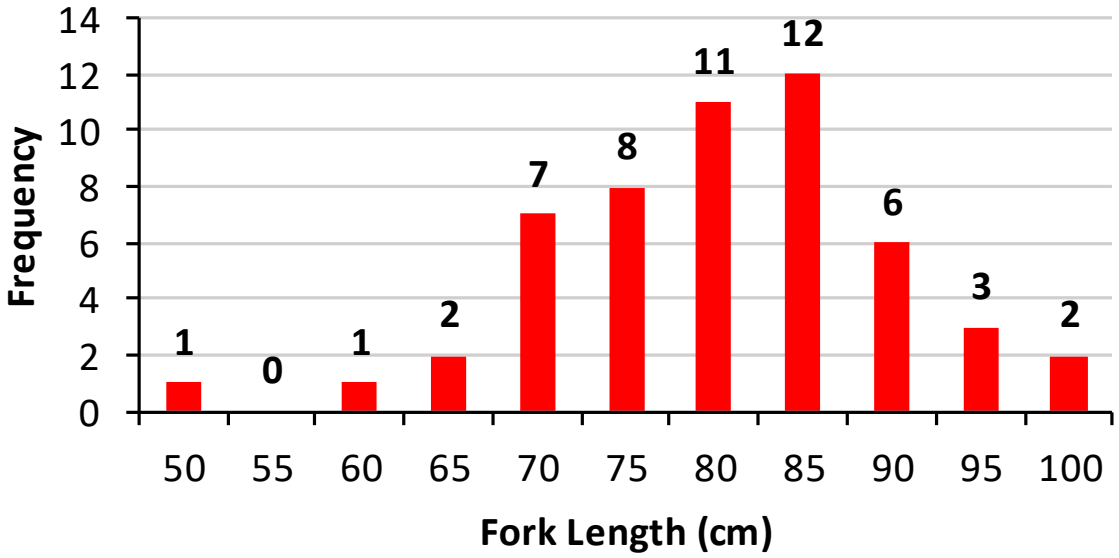

Figure 15: Fork length distribution for Chinook salmon in 2018 (n=53); X axis labels are 5 cm length class upper boundaries.

Table 4: Chinook salmon fork length (cm) statistics at the KSEF in 2018.

	Male	Female	Combined
Mean	76	82	79
Min	50	69	50
Max	93	97	97
Count	30	23	53

Table 5: Average length (cm) for Chinook female, male and combined sexes from 2008 to 2018.

Year	Male	Female	Combined
2008	87.8	92.3	89.2
2009	83.6	88.6	85.6
2010	74.6	87.5	80.7
2011	76.0	86.0	80.1
2012	77.0	84.0	80.0
2013	79.0	84.8	81.3
2014	79.6	84.8	81.3
2015	74.9	86.2	79.9
2016	83.1	84.9	83.9
2017	80.2	84.4	82.3
2018	76.0	82.0	79.0

Table 6: Age class distribution (%) for Chinook salmon from 2008 to 2017.

Species	Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chinook	3 yr	0%	0%	2%	2%	17%	1%	0%	2%	0%	13%
	4 yr	38%	26%	**46%**	28%	32%	30%	**48%**	44%	32%	24%
	5 yr	**53%**	**62%**	25%	**65%**	**48%**	**60%**	38%	**49%**	**62%**	**57%**
	6 yr	9%	12%	27%	5%	3%	9%	14%	5%	6%	6%
	Total sampled	66	84	48	127	90	70	21	101	63	54

4.3 Pink Salmon

A total of 2,736 even-year pink were counted at the KSEF in 2018. This is well below the long-term even-year average of 30,562 from 2004 to 2016 (Figure 13), and is the lowest even-year return ever recorded at the KSEF.

The 2018 pink return originated from the 2016 brood year, which had an escapement of 19,700 fish, indicating the 2018 return was about 86% below replacement value for the stock (Figure 16).

The majority of the pinks counted in 2018 migrated through the KSEF from late August until the middle of September (Figure 17). Peak counts occurred on August 26th (n=328), September 2nd (n=250) and September 7th (n=230), which when combined represented 30% of the total run. The run timing in 2018 was about one week later than observed in previous even years (2004-2016) with the peak of the run arriving later than normal as well.

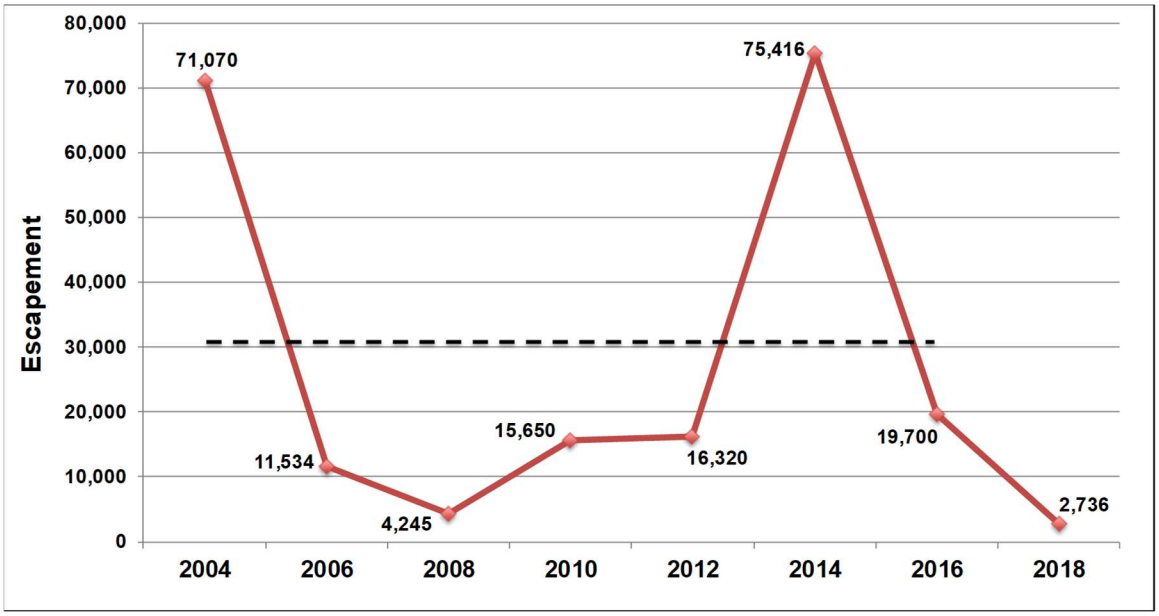

Figure 16: Annual escapement for even-year pink runs at the KSEF from 2004 to 2018 - Dashed line is average even year from 2004 to 2016.

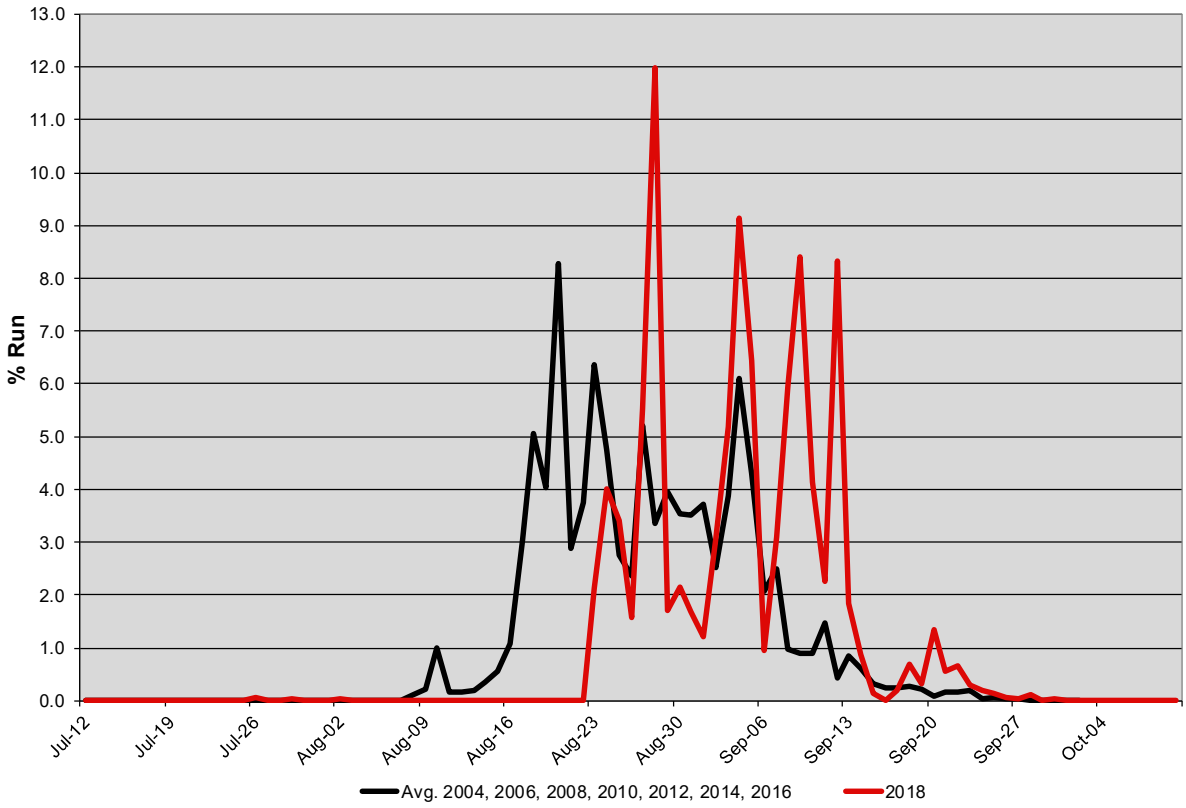

Figure 17: Run timing for pink salmon (daily run %) in 2018 vs. average even-year run from 2004 to 2016.

4.4 Chum Salmon

A total of 273 chum were counted at the KSEF in 2018. This is below the long-term average of 701 from 2003 to 2017 (Figure 18). The 2018 run compares to a maximum return of 1,862 fish in 2005 and a minimum of 150 in 2008. The 2018 escapement estimate was 61% below the average escapement of 701 fish recorded from 2003-2017 and seems to be in line with lower stable average seen from 2010 to 2015 and 2017 (n=411).

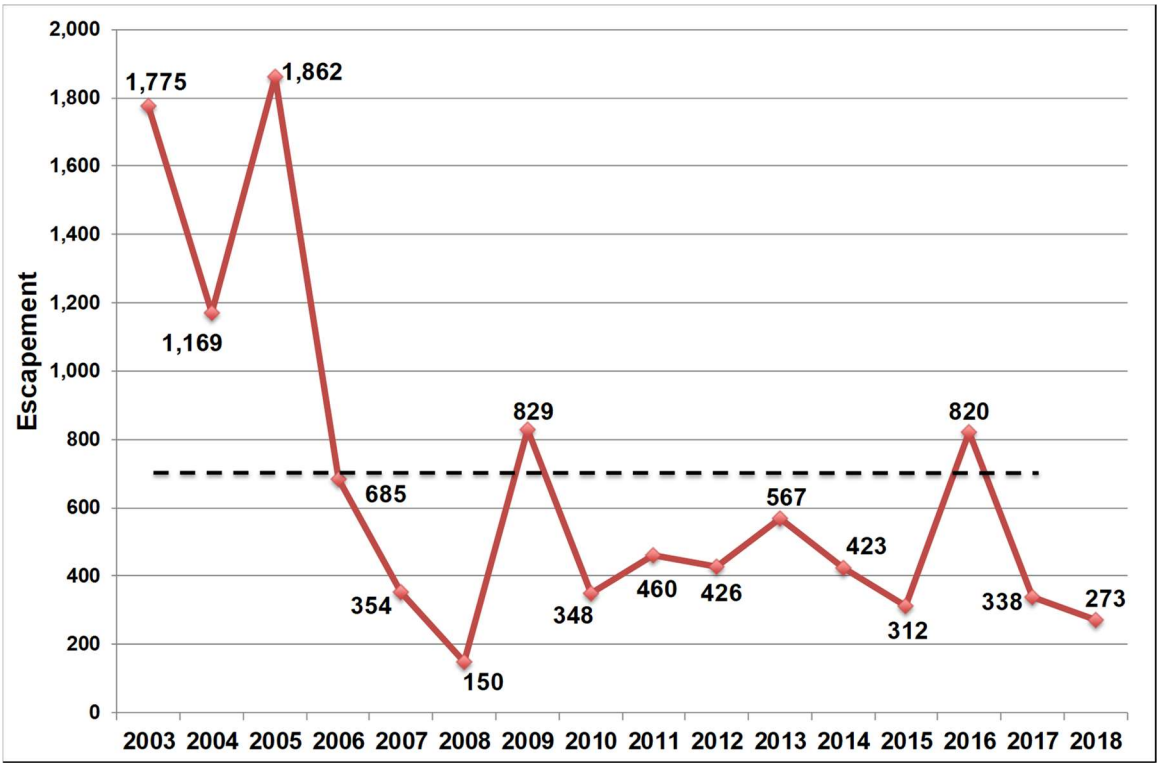

Figure 18: Annual escapement for chum salmon at the KSEF from 2003 to 2018 - Dashed line is average from 2003 to 2017.

In 2018, the first chum salmon was counted at the KSEF on August 1st and the last counted on October 9th. In general, two main pulses of chum returns were noted throughout the sampling period; one in late August/early September and the other in mid-September (Figure 19). Figure 19 shows that the 2018 chum run timing, was approximately two week later than observed in previous years. This could be a result of the low water levels observed in August and September of 2018.

Fork length, sex and age data was collected from 37 chum salmon in 2018 (14% of the run). Male to female sex ratio were approximately 50% and on average, females were bigger than males (73 and 69cm respectively; Table 7). In contrast, since 2008, males have measured the larger of the sexes sampled. The 2018 length samples were overall, at the smaller end of the range of average size results observed since 2008 (Table 8).

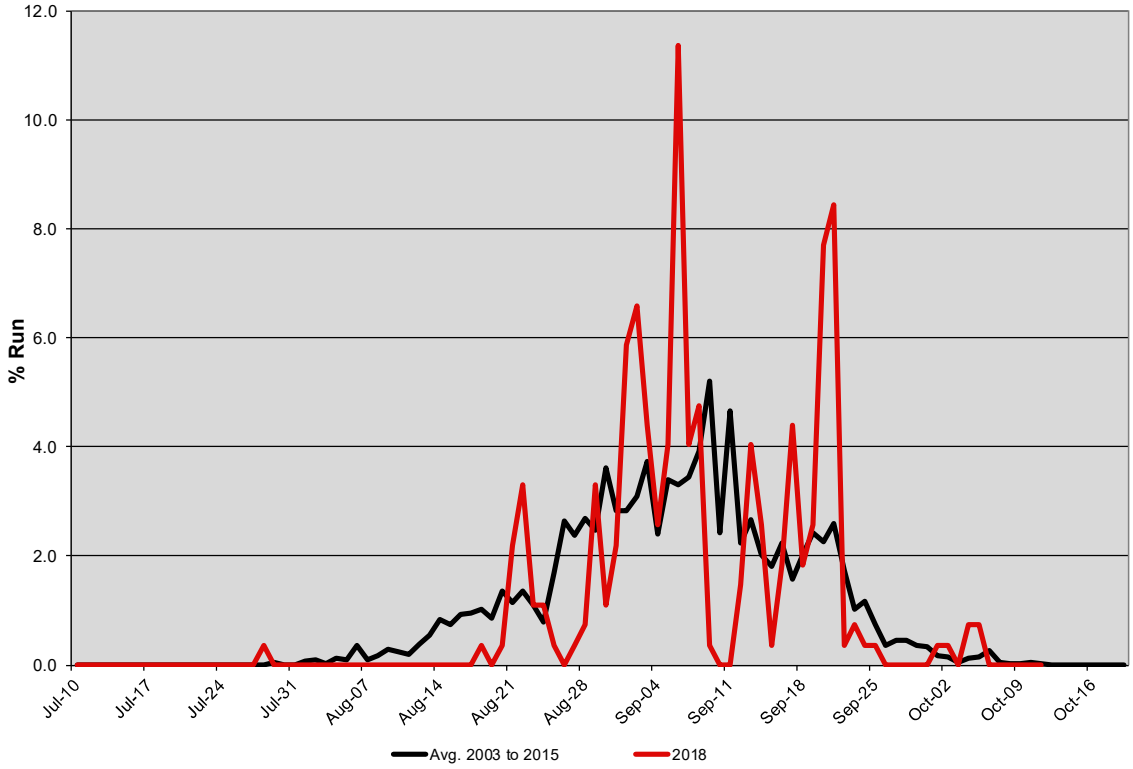

Figure 19: Kitwanga River chum salmon average run timing (daily run %) for 2003-2015[6] vs. run timing for 2018 at the KSEF.

Table 7: Chum salmon fork length (cm) statistics at the KSEF in 2018.

	Male	Female	Combined
Mean	69	73	71
Min	53	62	53
Max	83	80	83
Count	18	18	36

[6] Note KSEF was shut down on September 1st in 2016 and on September 11 in 2017.

Table 8: Average length (cm) for chum female, male and combined sexes from 2008 to 2018.

Year	Male	Female	Combined
2008	77.0	70.3	75.0
2009	76.1	72.0	73.7
2010	76.5	73.9	75.1
2011	71.0	70.0	70.7
2012	80.0	77.0	78.0
2013	76.8	74.3	75.4
2014	72.1	72.0	72.1
2015	75.9	75.3	75.5
2016	80.3	74.4	77.3
2017	77.9	77.0	77.5
2018	68.9	72.8	70.8

Age results for the 2018 chum samples were not available for inclusion in this report but will be presented in the 2019 KSEF Annual Report.

Table 9 shows age class distribution for Kitwanga chum salmon from 2005-2017.

Table 9: Age class distribution (%) for chum salmon from 2005 to 2017.

Species	Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chum	3 yr	4%	NA	NA	**57%**	1%	3%	2%	7%	4%	5%	7%	6%	7%
	4 yr	**88%**	NA	NA	29%	**96%**	**82%**	**95%**	19%	**91%**	**92%**	**74%**	**65%**	**50%**
	5 yr	6%	NA	NA	14%	3%	15%	3%	**73%**	4%	3%	19%	29%	43%
	6 yr	2%	NA	NA	0%	0%	0%	0%	1%	1%	0%	0%	0%	0
	Total sampled	NA	NA	NA	7	205	99	98	80	105	39	74	17	54

4.5 Coho Salmon

A total of 551 coho were counted at the KSEF in 2018. This is by far the worse Kitwanga adult coho escapement ever recorded through the KSEF and well below the long-term average of 3,908 from 2003 to 2017 (Figure 20). This poor escapement may have been partly due to the very low water conditions seen in 2018. By the end of October, we had only counted 75 adults through the KSEF, so the program was extended to the middle of November to capture coho thought to be waiting for higher waters to move into the Kitwanga River. The KSEF operation extension was made possible through additional funding provided by DFO in October of 2018. An additional 476 adults did finally move

pass the KSEF by November 13, when the facility was decommissioned for the year. Overall, the run as about a month late when compared to previous years run timings (Figure 21; 2003-2015). It should be noted that coho were still migrating into the system in small numbers when the fence was finally pulled on November 13, 2018. The KSEF was pulled because of funding constraints and it is possible that there were still some coho holding outside of the system at time of closure. However, given how late in the season it was when the project was decommissioned for the year, it is not predicted that these later escapements would have changed the overall escapement numbers by large bounds.

The 2018 return was well below the highest return of 12,080 coho in 2009 and 86% below the running average from 2003 to 2017, which is 3,908 fish/year. As Figure 20 demonstrates, Kitwanga coho returns have been variable for the study period, with a noticeable decline in the last four years.

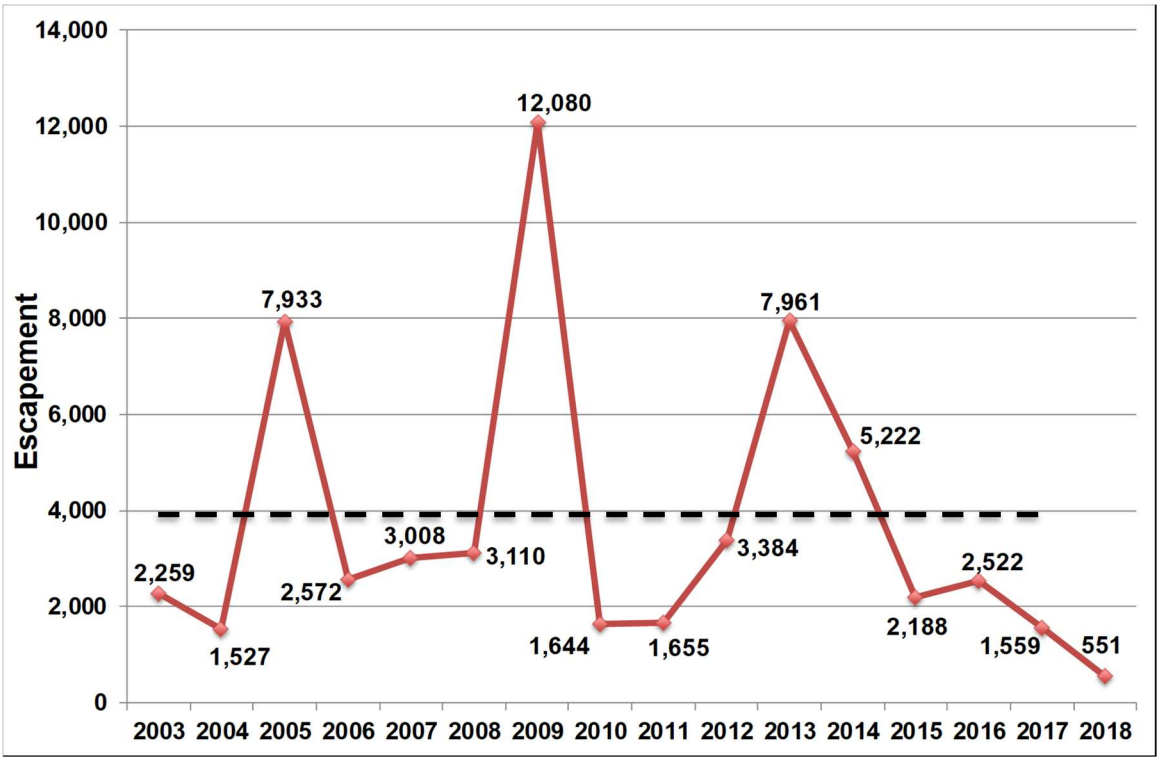

Figure 20: Annual escapement for coho salmon from 2003 to 2018 at the KSEF - Dashed line is average from 2003 to 2017.

Length, age, and sex data was collected from 45 coho salmon in 2018 (8% of the total run). Male and female coho sex ratios from the samples were 36% and 63% respectively falling within the parameters of what has been seen previously on the Kitwanga River. Average fork length for males and females were 69 and 67cm respectively (Table 10). Fork length histogram (5cm intervals) showed a bi-modal distribution, dominated by fish in the 66 to 70cm and 71 to 76cm size classes (69% - Figure 22), with a small group in the 46 to 50cm size class (4%). The 2018 length results were on average, the largest sample group recorded since 2010 (Table 11).

Age results for the 2018 coho samples were not available for inclusion in this report but will be presented in the 2019 KSEF Annual Report. Table 12 shows age class distribution for Kitwanga coho salmon from 2010-2017.

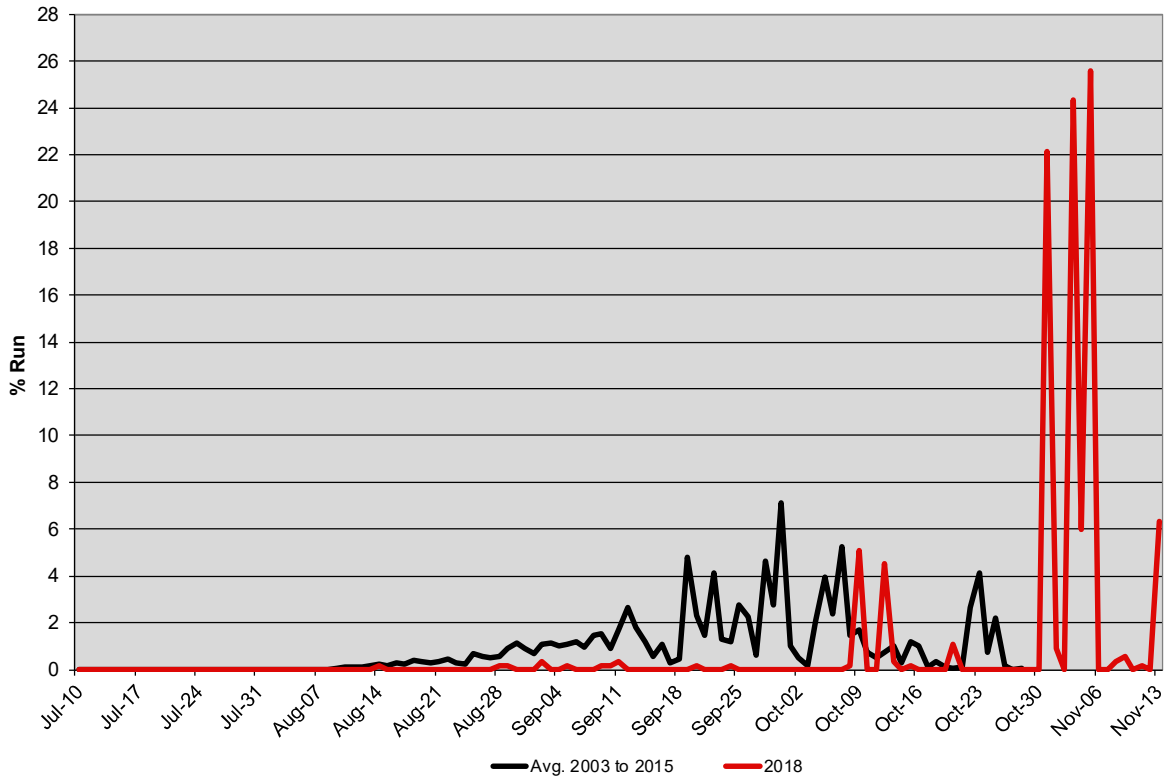

Figure 21: Kitwanga River coho salmon average run timing (daily run %) for 2003-2015[7] vs. run timing for 2018 at the KSEF and through the KsF.

[7] Note KSEF was shut down on September 1st in 2016 and on September 11 in 2017.

Table 10: Coho salmon fork length (cm) statistics at the KSEF in 2018.

	Male	Female	Combined
Mean	69	67	68
Min	40	51	40
Max	77	73	77
Count	16	28	44

One coho was sampled with the sex undetermined (fork length – 47 cm)

Table 11: Average length (cm) for coho female, male and combined sexes from 2010 to 2018.

Year	Male	Female	Combined
2010	65.3	64.2	64.8
2011	60.8	62.5	61.4
2012	62.3	60.7	61.2
2013	63.7	60.4	62.7
2014	63.6	62.9	63.4
2015	56.8	61.0	58.1
2016	65.1	63.9	64.8
2017	63.2	63.3	63.2
2018	68.9	66.8	67.9

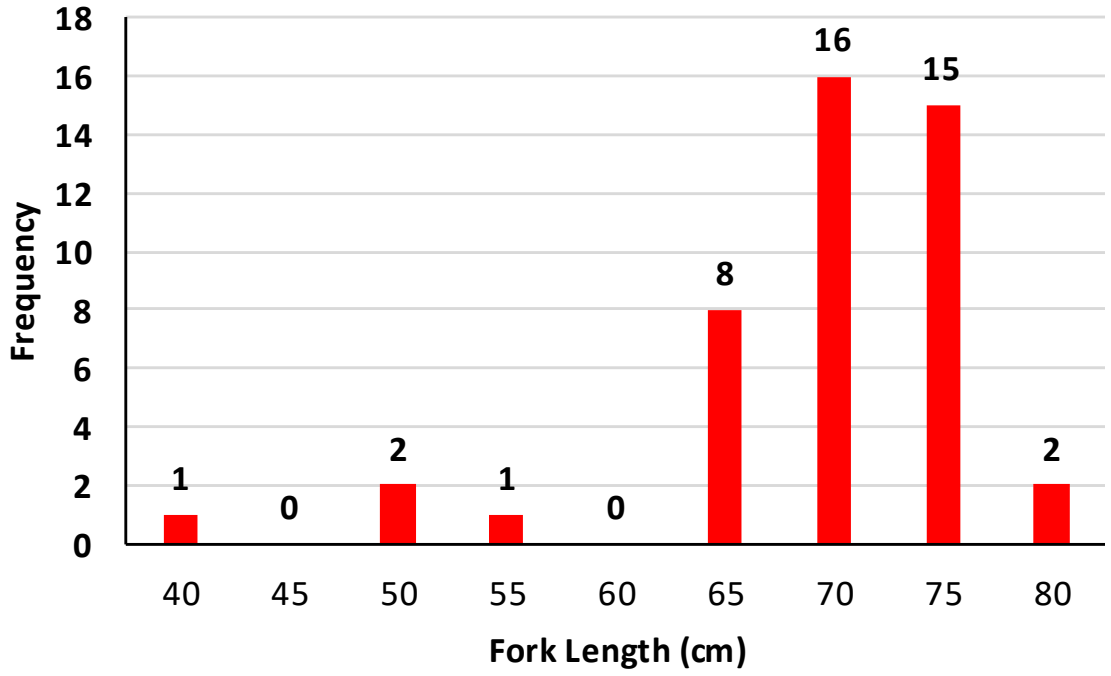

Figure 22: Fork length distribution for coho salmon in 2018 (n=45); X axis labels are 5 cm length class upper boundaries.

Table 12: Age class distribution (%) for coho salmon from 2010 to 2017.

Age	2010	2011	2012	2013	2014	2015	2016	2017
3 yr	**72%**	**72%**	**85%**	**82%**	**89%**	**81%**	**88%**	**83**
4 yr	28%	28%	15%	18%	11%	19%	12%	11
5 yr	0%	0%	0%	0%	0%	0%	0%	6
Total sampled	94	154	52	230	55	37	25	18

In the spring of 2017, GFA applied 3,236 CWT's to coho smolts at the KsF, which is located at the outlet of Gitanyow Lake. Most coho smolts (including CWT implanted fish) generally return to the KSEF 18 months later. The majority of 2017 CWT smolts were expected to return as adults in the fall of 2018. A total of 71 CWT fish out of 488 examined fish were counted through the KSEF in 2018. Extrapolating to the total run, an estimated 80 tagged fish passed through the fence in 2018 (2.5% survival). Kitwanga Coho CWT results and information related to where they were caught and their overall ocean survival will be reported on in a separate report and not discussed here.

5. DISCUSSION AND RECOMMENDATIONS

Since the KSEF became operational in 2003, GFA has collected accurate and invaluable stock assessment information on Kitwanga River salmon stocks. The information is used annually to gauge the health of the Kitwanga River and other Skeena River salmon stocks. GFA operated the KSEF to enumerate and collect biological information for sockeye, chinook, chum, pink and coho salmon returning to the Kitwanga River.

In 2018, the Kitwanga River, like many watersheds in northern BC, experienced drought conditions. Figure 23 shows a table from the British Columbia Drought Information Portal[8], which includes the Skeena-Nass basin. The area had dry to extremely dry conditions from June 14 to November 8 in 2018. In particular, the Kitwanga River had drought like conditions from late August to November 1st,

[8]https://governmentofbc.maps.arcgis.com/apps/MapSeries/index.html?appid=838d533d8062411c820eef50b08f7ebc

which likely effected fish movement into spawning areas. On the Kitwanga River, water levels were below the 2004-2017 averages (15 years) for all months the fence was in operation in 2018. The average water level was 28% lower than the 2004-2017 average for August to October, and as much as 44% lower for periods in late September and early October. These historically low water levels clearly delayed some run timing components of all five species of salmon counted through the KSEF in 2018, and likely has detrimental effects on their spawning abilities.

2018 DROUGHT LEVELS AT A GLANCE

Drought Levels:	1	Normal	2	Dry	3	Very Dry	4	Extremely Dry					

BASINS	14-Jun	28-Jun	12-Jul	26-Jul	09-Aug	14-Aug	17-Aug	21-Aug	23-Aug	06-Sep	20-Sep	04-Oct	18-Oct	01-Nov	08-Nov
Northeast	2	1	1	2	3	3	3	3	4	3	2	2	2	1	1
East Peace	2	1	1	1	1	1	1	1	2	2	1	1	1	1	1
Peace	2	1	2	2	2	2	3	3	3	3	2	3	3	3	3
Northwest	2	2	2	3	3	3	3	3	4	3	3	3	3	2	1
Stikine	2	2	2	3	3	3	3	3	4	4	4	4	4	4	2
Skeena-Nass	2	2	2	3	3	3	3	3	4	4	4	4	4	4	3
Nechako	1	1	1	1	2	2	2	2	3	3	2	3	3	3	3
Upper Fraser West	1	1	1	1	2	2	3	3	3	3	3	3	3	3	2
Upper Fraser East	2	1	1	1	2	2	3	3	3	3	2	3	3	3	1
Upper Columbia	2	1	1	2	2	2	2	2	2	2	2	1	1	1	1
Lower Columbia	2	1	1	2	2	2	2	2	3	3	2	1	1	1	1
West Kootenay	2	1	2	2	2	2	2	2	3	3	2	1	1	1	1
East Kootenay	2	1	2	2	2	2	2	2	3	3	3	2	2	2	1
Middle Fraser	2	1	1	2	2	2	2	2	3	3	3	3	3	2	1
North Thompson	1	1	1	2	2	2	2	2	2	2	1	1	1	1	1
South Thompson	1	1	1	2	2	2	2	2	3	3	2	1	1	1	1
- Salmon River Basin	2	2	1	2	2	2	2	2	3	3	2	1	1	1	1
Nicola	2	1	1	2	2	2	2	3	3	3	2	1	1	1	1
- Coldwater River Basin	2	2	2	2	2	2	2	3	3	3	2	1	1	1	1
Similkameen	2	1	1	2	2	2	2	2	2	2	2	1	1	1	1
Okanagan	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1
Kettle	1	1	1	2	2	2	3	3	3	3	2	1	1	1	1
Skagit	2	1	1	2	2	2	2	2	3	3	2	1	1	1	1
Lower Fraser	2	2	2	3	3	3	3	3	3	3	2	1	1	1	1
South Coast	2	2	2	3	3	3	3	3	3	3	2	1	1	1	1
Central Coast	2	1	1	3	3	3	3	3	3	3	3	3	3	2	1
West Vancouver Island	1	1	1	3	3	3	3	3	4	4	2	1	1	1	1
East Vancouver Island	2	2	2	3	3	4	4	4	4	4	2	1	1	1	1
Haida Gwaii	1	1	2	3	3	3	3	3	3	3	2	2	2	1	1

Prepared By: Water Management Branch - Ministry of Forests, Lands, Natural Resource Operations and Rural Development

BC Drought Levels - November 8th, 2018

Figure 23: Drought levels in British Columbia for the summer and fall – 2018 (British Columbia Drought Information Portal).

Sockeye escapement in 2018 was 1,434, which is lower than the long-term (2003-2017) average of 4,299, but an increase from the past two years. Low numbers were expected for the entire Skeena River for 2018 (645,000), but the total return estimates were better than expected on the Skeena as a whole at ~1.78 million (Cox-Roger 2018). Overall, the exploitation rate on Kitwanga sockeye has remained relatively in recent years and again in 2018 at ~19%. Poor overall

survival to age has been attributed to poor marine survival in the last years at sea for age 5 sockeye, which is consistent from poor age 4 survival in 2017. In contrast to ocean conditions from 2013 to 2016, where the potential effects of the ocean 'blob,' a mass of warmer water was thought to be contributing to smaller-size-at-age, reduced body condition factor and later run timing, 2018 was thought to have more favorable ocean conditions for ocean migration (Cox-Rogers 2018). That being said, the 'son of Blob' moved into circulation late in 2018 and may disrupt future sockeye run timing patterns (Cox-Rogers 2018). Body size (fork length) have remained relatively unchanged over the last sixteen years, where the average fork length from 2003 to 2017 is 56mm compared with the 2018 average fork length of 55mm and the sex ratio for 2018 was almost even.

Overall the run was late in 2018 with only ~41% migrating passed the site by the first of October, where in previous years (2003-2015), 91% of the run has passed by during the same period. The run also peaked strongly during a three-day period from October 8 to 10, where 46% of the run passed through. This later arrival likely coincides with the very low water conditions we experienced in the area in 2018. Most sockeye did not start moving in until water levels started to rise after some rains in the middle of October. These extended low water conditions likely played a significant role in terms of delaying sockeye entry into the Kitwanga River.

In 2017, GFA initiated a sockeye telemetry study with the primary objectives to confirm and identify any new spawning locations and to see if on-route mortality was observed. Although under much different water conditions when compared to 2018, in 2017, of the 22 sockeye radio tagged at the KSEF, 14 (64%) entered Gitanyow Lake and were tracked to two known sockeye spawning areas. In 2018, another 57 sockeye were tagged and tracked and only 19 (32%) made it to Gitanyow Lakes spawning locations. The extremely low flow conditions observed in 2018, provided opportunities for beavers to construct dams on the mainstem of the Kitwanga River, that had not been observed in

past years. High mortality rates were seen in association with these beaver dams, which were identified through tracking of the 57-tagged sockeye. Further details from the 2018 radio tagging study will be available in a separate report. Given the high on-route mortality seen for Kitwanga sockeye between the KSEF and Gitanyow Lake the actual escapement may be closer to 460 adults given the radio tracking results seen in 2018 (1,434*32%).

The recent downward trend in production for sockeye should be cause of concern for fisheries managers and more emphasis should be put into finding out why recent production is not performing as expected. This illustrates the importance of continuing the KSEF program to: 1) acquire long-term, accurate escapement numbers which can be highly variable from year to year; 2) obtain exploitation rates on the sockeye stock; 3) provide in-season salmon forecasts to DFO Fisheries managers so the information can help implement more sustainable fisheries; and 4) continue to develop and update Kitwanga sockeye rebuilding plans. In addition to continuing with the KSEF program, GFA have plans to continue to study the limnological parameters in Gitanyow Lake in order to assess potential limiting factors to adults and juveniles as well as to continue the radio telemetry study on sockeye salmon to help identify on-route migration mortality and continued monitoring of spawning locations on Gitanyow Lake. In early 2019, GFA will be updating our Kitwanga sockeye salmon recovery plan, originally completed in 2006 (Cleveland et al 2006), and expect further directed studies to come from the revised strategy.

Chinook salmon in 2018 (n=618) have declined from higher abundances seen in the earlier 2000's. The escapements have somewhat stabilized at lower levels with a slight downwards dip over the last three years, which is a cause for concern. Overall, sex ratios in 2018 were in line with previous years and a healthy population. The average length of sampled Chinook (79mm) in 2018 were slightly smaller overall compared to the 2008-2017 average length of 82.4mm. Overall the Chinook run was approximately a week later in 2018 compared to the long-term timing average (2003-2017).

A total of 2,736 adult even-year pink salmon returned to the KSEF in 2018. This return was well down from the running even-year average of 30,562 fish (2004 – 2016) and the poorest even-year return ever recorded at the KSEF. Overall, Skeena River pink salmon returns were thought to be very poor throughout the watershed in 2018 and the KSEF count provided a good index to support those findings. The run timing for even-year pink in 2018 looks to have arrived about one week later than previous even-years (2004-2016) with the peak of the run arriving later than normal as well.

A total of 273 adult chum salmon returned to the Kitwanga River in 2018 and compares to a minimum return of 150 fish in 2008. Overall, sex ratios in 2018 were in line with previous years for chum salmon. Since 2008, males have measured the larger of the sexes sampled, but in 2018, on average, females were bigger than males (72.8 and 68.9cm respectively). The 2018 length samples were overall, at the smaller end of the range of average size results observed since 2008 (70.8mm in 2018 and 75.0mm from 2008-2017). The 2018 chum run timing, was approximately two week later than observed in previous years.

A total of 551 adult coho were counted at the KSEF in 2018; by far the lowest adult coho escapement ever recorded through the KSEF and well below the long-term average of 3,908 from 2003 to 2017. As seen with the other four salmon species, very low water conditions in 2018 likely attributed to the low escapement numbers seen in 2018. Overall, sex ratios in 2018 were in line with previous years. The 2018 length results were on average, the largest fish sampled since 2010 (67.9mm in 2018 versus 62.4mm from 2010-2017). By the end of October, only 75 adults had been counted through the KSEF, with an additional 476 counted through by the time the fence was decommissioned in mid-November. Overall run timing, when compared to 2003-2015, was approximately two months later.

Improvements made to the KSEF in 2018, included:

- **Bank stabilization** – the bank stabilization work was completed in March of 2018 (Figure 24). During the operation of the fence in 2018, we did not witness the high flows observed in 2017 and 2016. The integrity of the KSEF structure has been improved due the bank stabilization work conducted in 2018.
- **New counting chute, equipped with a digital video camera recorder (DVR)** - the new chute successfully passed all salmon species, and overall, fish seemed more comfortable moving through the camera box than through our regular sample box areas. More than half of the fish enumerated through the KSEF in 2018 were counted through the DVR camera box.
- **24hr. video surveillance –** allowed senior staff to successfully monitor environmental conditions (i.e., flow conditions during heavy precipitation, debris on fence), provided additional safety for staff and some overall protection for the site investments .
- **Automatic self-cleaning rotating panels** – were successfully installed and were a key tool in keeping the fence clear of debris in a safe and timely manner. The automation also provided relief for future KSEF operations, for potential high flow events; having the ability to regulate water level quickly and safely.

All of these site improvements were very beneficial to the KSEF operation in 2018 and it is recommended that these additions continue into the future.

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