Gitanyow Fisheries Authority

Kitwanga River Salmon Enumeration Facility (KSEF) – 2016 Annual Report




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Abstract

In 2016, the Gitanyow Fisheries Authority (GFA) operated the Kitwanga River Salmon Enumeration Facility (KSEF) for the 14th consecutive year to count and biologically sample Pacific salmon returning to the Kitwanga River. The fence stayed operational from July 5th to September 1st, 2016 under lower than normal water conditions for part of July and most of August. On the morning of September 1st, the KSEF was breached due to extremely high water levels, which forced the closure of the project approximately two months earlier than anticipated. Within 30 hours of the KSEF going down, GFA staff were able to set-up and modify the KsF (Upper smolt Fence) just below Gitanyow Lake to count adult sockeye from September 2nd to November 2nd, 2016. A total of 1,100 sockeye, 655 chinook, 33 jack chinook, 19,597 pink, 820 chum, and 2,522 coho salmon were enumerated and sampled through the KSEF and KsF.

At the KSEF, 348 sockeye were counted and an additional 970 were counted through the KsF for a total of 1,318. GFA does not believe any sockeye were missed between when the KSEF went down and the KsF was rendered operational. However, some sockeye may have been double counted so the total escapement for 2016 is likely within a range of 970 to 1,318, with an estimate total return of 1,100. The 2016 sockeye return of 1,100 fish was well below the highest recorded of 20,804 in 2010, above the lowest return of 240 fish in 2007, and below the running average of 4,865 fish per year (2003-2015).

The 2016 chinook return of 655 fish was 44% below the running average from 2003 to 2015 of 1,493 fish/year and marked the 8th consecutive year of counts below 1,000 fish compared to the range of 1,450 to 3,225 fish observed from 2003 to 2008. The 2016 return is the lowest on record since accurate annual enumeration was initiated in 2003.

The 2016 pink run of 19,597 fish was below the running even-year average of 32,373 fish (2004 – 2014). The 2016 pink return originated from the 2014 brood year, which had an escapement of 75,416 fish, indicating the 2016 return was 74% below replacement.

A total of 820 adult chum salmon returned to the Kitwanga River in 2016. The 2016 chum run compares to a maximum return of 1,862 fish in 2005 and a minimum of 150 in 2008. The 2016 chum escapement estimate was 12% above the average escapement of 720 fish recorded from 2003-2015 with potential signs of recovery to the 1,000+ returns encountered between years 2003 and 2005.

It is estimated that a total of 2,214 adult coho salmon returned to the Kitwanga River in 2016. The 2016 return is well below the highest return of 12,080 coho in 2009 and 47% below the running average from 2003 to 2015, which was 4,196 fish/year.

Acknowledgements

Gitanyow Fisheries Authority (GFA) would like to thank the Gitanyow Hereditary Chiefs (GHC) for their continued leadership and support for the GFA program. In 2016 the project funders were: Fisheries and Oceans Canada (Prince Rupert Stock Assessment and AFS Program), Pacific Salmon Commission (PSC), and the Gitanyow Huwilp Sustainability Fund. GFA gratefully acknowledges their field staff that make the project possible. GFA staff are often required to work long shifts under short notice in adverse weather conditions and for this we are very grateful for their continued commitment to the project. In 2016 GFA technicians included: Les McLean, Earl McLean, Vernon Russell, Phillip Johnson, Brenton Williams, Owen Russell, Johnny Martin, Morgan Douse, Melissa Shirey, Taylor Russell, Eva Martin. GFA lead staff included: Mark Cleveland, Jordan Beblow, Gregory Rush and Kevin Koch. A special thanks too former GFA biologist and master welder Derek Kingston for all his valued work on the fence from 2003-2016.

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1. INTRODUCTION AND BACKGROUND

Historically, the Gitanyow fished salmon in the Kitwanga River for food, social and ceremonial purposes with sockeye being the main salmon 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. 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 of the stocks collapsed. Past fishery re-constructions for the last 50 years show an average exploitation on Kitwanga sockeye of over 50% and reaching as high as 70% in some years (Cox-Rogers, DFO, Pers. comm., 2010 in Kingston 2016). Other factors likely contributed to the decline. They include the degradation of spawning and rearing habitat 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 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 15 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. One 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 when the Kitwanga River Salmon Enumeration Facility (KSEF) was constructed. 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 spawning assessment and habitat rehabilitation works and small pilot hatchery programs to try and boost egg to fry survival (Cleveland 2007 & 2009, Kingston 2008 & 2009, McCarthy and Cleveland 2012). In addition, an

overall reduction in the exploitation rate on Kitwanga sockeye has been implemented in the last 8 years where averages have been about 23%. 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 benefits for the Kitwanga sockeye rebuilding program, but it is also used as a middle Skeena salmon index because it also collects annual escapement data on chinook, pink, chum and coho salmon. The information collected at the KSEF is relied upon in-season and post-season by fisheries managers that use this index tool to help manage all Skeena salmon fisheries.

The 2016 season marks the 14th year that the KSEF has been in operation. Kitwanga salmon escapement data from 2000 to 2002 obtained from a temporary weir, stream walks and aerial flights prior to the construction of the KSEF and presented in previous reports are not included in this report.

In 2016, the KSEF was operated with funding contributions from Fisheries and Oceans Canada - Stock Assessment and Aboriginal Fisheries Strategy programs, Pacific Salmon Commission – Northern Fund, and Gitanyow Hereditary Chiefs Huwilp Sustainability Fund. This report summarizes the sampling results and findings for the KSEF program in 2016.

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 Statutory Right of Way permit has been granted for the site and the access road to the Gitanyow Fisheries Authority for salmon research until 2036. Because the KSEF site is on the traditional territory of the Gitxsan (Gitwangak), fishery personnel from Gitwangak house groups are trained and employed annually by GFA to help operate the facility.

Figure 1: Google Earth image of the Kitwanga Watershed including the KSEF and the KsF

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 one of two 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. Nine steel base plates were also bolted onto the existing cement crump weir to secure the aluminum transoms that spanned the entire width of the river. The steel base plates were fastened with Hilti bolts at 2m intervals across the width of the river and parallel to the rivers flow. 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" – 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 bushing was machined to fit a 2" steel ball. 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 and woody debris from the fence panels.

An aluminum walkway was installed on top of the transoms that allowed the workers to access each rotating panel from above and rotate the panel to clear off the debris that has been held up by the fence. A row of plywood with Styrofoam secured to the underside were placed along the back of the entire fence to prevent salmon from jumping on the fence prior to swimming through the counting chutes (Photo 1).

Photo 1: View towards right bank of KSEF, with Styrofoam secured underneath plywood and aligned along downstream end of fence, in order to mitigate salmon from injuring themselves while jumping

The rotating panels and transoms are designed to be taken out after the adult salmon migration so that 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 2; photo series of KSEF design).

Figure 2: Photo series of 2016 installation of the KSEF structure

Once the aluminum rotating panels and walkways were secured into the middle section of the river, the left and right bank counting stations were installed so that all fish can be identified to the species level and biologically sampled as they migrate past the fence. 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, and sampled as depicted by the pre-season biological sampling protocol. A white Teflon reflective background is used on the bottom of the 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 were 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 2016, 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 (Photo 2). For fish sampling purposes, sampled fish were 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 3; Photo series showing sampling station and scale sampling). Samples were taken from all species except from pink salmon and GFA staff strive to sample 5-10% of the annual returns in any given year. Fish were 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 condition. Scale samples were collected for aging and the results are presented in this report using the European 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.

Photo 2: View of sockeye holding downstream of the fence

GFA fisheries staff were instructed in proper fish handling techniques to reduce the stress on the fish. Crews of two fisheries technicians visually enumerated and counted salmon daily as they swam 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 operation were during daylight hours only. The KSEF is closed nightly preventing upstream migration between dusk and dawn.

A permanently erected stage gauge was used to manually measure river levels throughout the operating period. GFA staff recorded 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 2016.

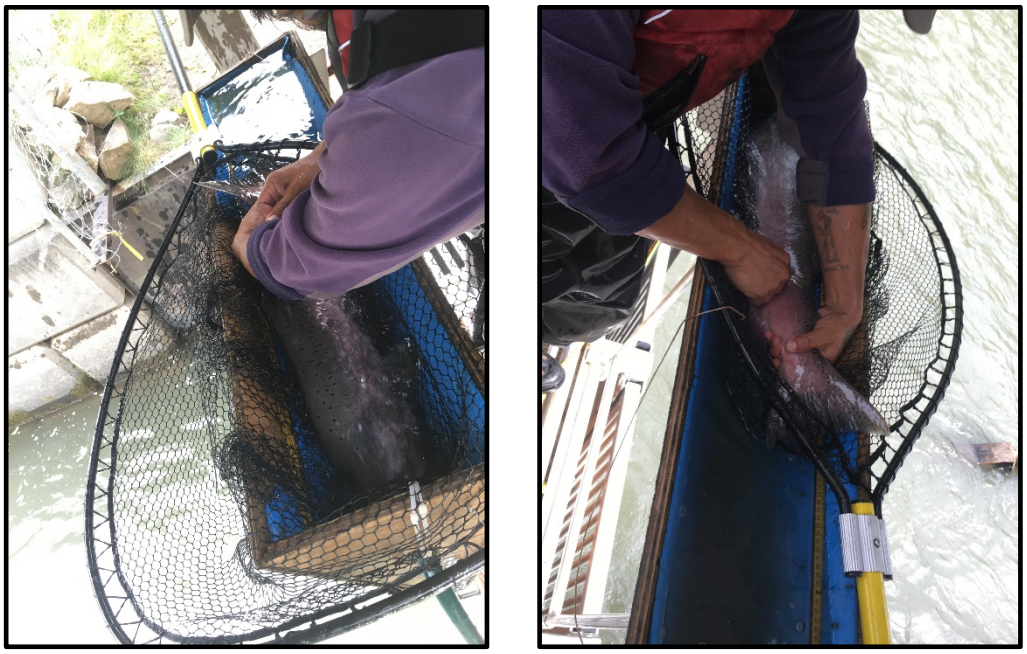

Figure 3: Photo series of counting and sampling stations used at the KSEF

4. RESULTS

The operation of the KSEF in 2016 marked the 14th consecutive year. The project was operated at the KSEF site for a total of 59 days in 2016, from July 5th to September 1st. Normal operations at the KSEF would see the project continue operations to the end of October, when most of the returning salmon would have passed the site. However, the project was closed for the season at this site on September 1st, 2016 because the site experienced extreme high water flooding after several days of intense rain. The decision to end the project two months early was made by the head fisheries biologist overseeing the project because water levels were so high that is was felt that it was no longer safe for GFA staff to man the site and damage to the facility was likely because river levels were continuing to rise. Therefore, all the fence panels were left open to relieve pressure on the structure and to prevent the facility from sustaining damage. All the panels were opened when water levels reached 1.80m in height and the river was still rising. After all the panels were opened at the KSEF, the water level dropped below 1.0m, as the open panels allowed more flow through the site. During the flooding, leaf litter and wood debris was building up on the panels at an accelerated rate and the GFA crew were not able to spin them effectively and quick enough to keep them clear (Figure 4).

Because it was obvious that water levels in the river would not be receding for some time, GFA decided to try and continue to count sockeye through the operation of the Kitwanga River smolt fence (KsF) which was located approximately 25km upstream. Within 30 hours of the KSEF being shut down in the lower part of the river, GFA staff were able to set-up and render the KsF fish tight just below Gitanyow Lake to continue to count adult sockeye and coho returns for the remainder of the year. The KsF was also temporarily modified to allow for adult counting and sampling from its current smolt sampling design (Figure 5). The KsF remained operational from September 2nd to November 2nd, 2016, another 62 days. It should be noted that the operation of the KsF would only provide escapement information for all sockeye and a portion of the coho returns for 2016, because all sockeye spawn above the KsF while only a portion of the coho run spawned above the site (~10-20%). In most years, the majority of chinook, pink and chum salmon spawn between the KSEF and KsF and in 2016 none were counted through the KsF site.

Figure 4: Photo series of the high water event and breaching of the fence on September 1, 2016 that that made for unsafe conditions and potential wash-out of fence

Figure 5: Photo series of installation of upper sockeye (KSF) and sampling

Overall, the average water levels recorded in 2016 at the KSEF for most of the operating period were some of the lowest ever recorded at the site (2004-2015). For example, from July 18 to August 29, the average flow was only 0.60m compared to 0.73m for the same period between 2004-2015. Furthermore, water levels in the Kitwanga River below Gitanyow Lake were also very low, so low that on August 26, during a stream walk, GFA crews found a 1.2km section of the Kitwanga River, between Gitanyow Lake and Moonlit Creek completely dry (Figure 6).

The highest water levels occurred on September 1st, when the fence was shut down, with water levels reaching 1.80m at the KSEF site, which was a significant rise from the previous day's level of 0.98m (Figure 7).

Figure 6: Photos showing dry section of Kitwanga River

Water temperatures ranged from 10^0C to a high of 18^0C at the KSEF and from 7^0C at the end of counting on November 2 to a high of 19^0C on September 3 at the KsF. Water temperatures were within the normal range recorded in previous years and overall considered adequate for salmon survival during the operations of the KSEF and the KsF.

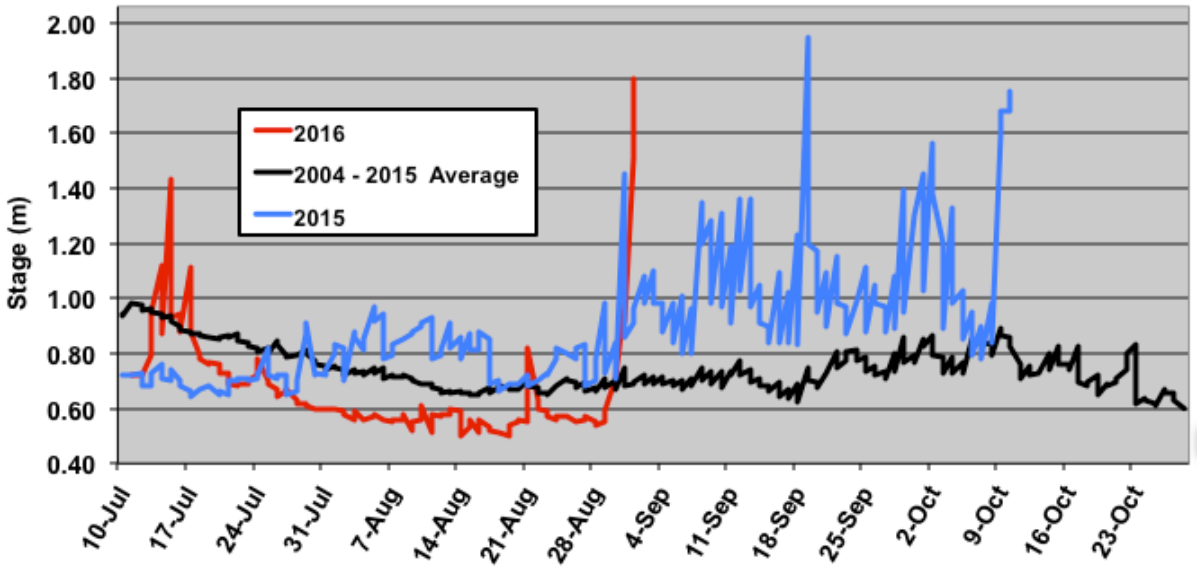

Figure 7: Water Stage at the KSEF, 2004-2015 average and 2016 recordings. Note: in 2016, KSEF was shut down on September 1

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

4.1 Sockeye

A total of 1,100 sockeye were estimated to have return through the KSEF and KsF fences in 2016. At the KSEF, 348 sockeye were counted between July 5 and September 1 and an additional 970 were counted through the KsF between September 3 and November 3, 2016 for a total of 1,318 sockeye. GFA staff do not believe any sockeye were missed in 2016 because there was only a 30-hour period when either the KSEF or the KsF were operational and impeding fish movement. Given that any fish migrating in-river during flooding period in early September would have had to cover a distance of approximately 25km under extremely high water conditions, it is unlikely that sockeye would have been missed. For example, studies have shown that Skeena sockeye only travel an average of 16-19 km per day under normal water conditions (Brett 1995) and it is fairly well documented that salmon in general move upstream at reduced speeds when travelling in high water conditions.

That said, some Kitwanga sockeye may have been double counted through the two facilities in 2016 so it is not appropriate to simply combine the two counts from the KSEF and the KsF. Therefore, in 2016 GFA will present the total Kitwanga sockeye escapement as a range of 970 to 1,318. However, using our professional judgment and considering that ~10-20% of the sockeye

would have likely had time to move through the KsF site into Gitanyow Lake between the time when they would have been counted through the KSEF and when the KsF was installed, GFA estimates that the total return would have likely been approximately 1,100 in 2016. For stock assessment purposes and future reference, the total Kitwanga sockeye escapement from 2016 will be reported as 1,100 sockeye.

Sockeye escapement in 2016 were among some of the lowest observed in recent years and only about a fifth of the replacement value considering most of the 2016 sockeye were 4-year-olds (ages will be reported upon below) originated from a 2012 broodyear escapement of 5,478 adults. This compares to the lowest escapement ever recorded between 2003-2015 of 240 in 2007 and the highest of 20,804 in 2010 (Figure 8). Figure 8 shows that over the study period Kitwanga sockeye trends in abundance show low but somewhat stable escapement abundances with two good years of returns. However, based on production forecasts generated in the pre-season by GFA and DFO using smolt outputs by age class and average ocean survival rates, we were predicting a return of more than double that realized in 2016. This recent downward trend in production 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.

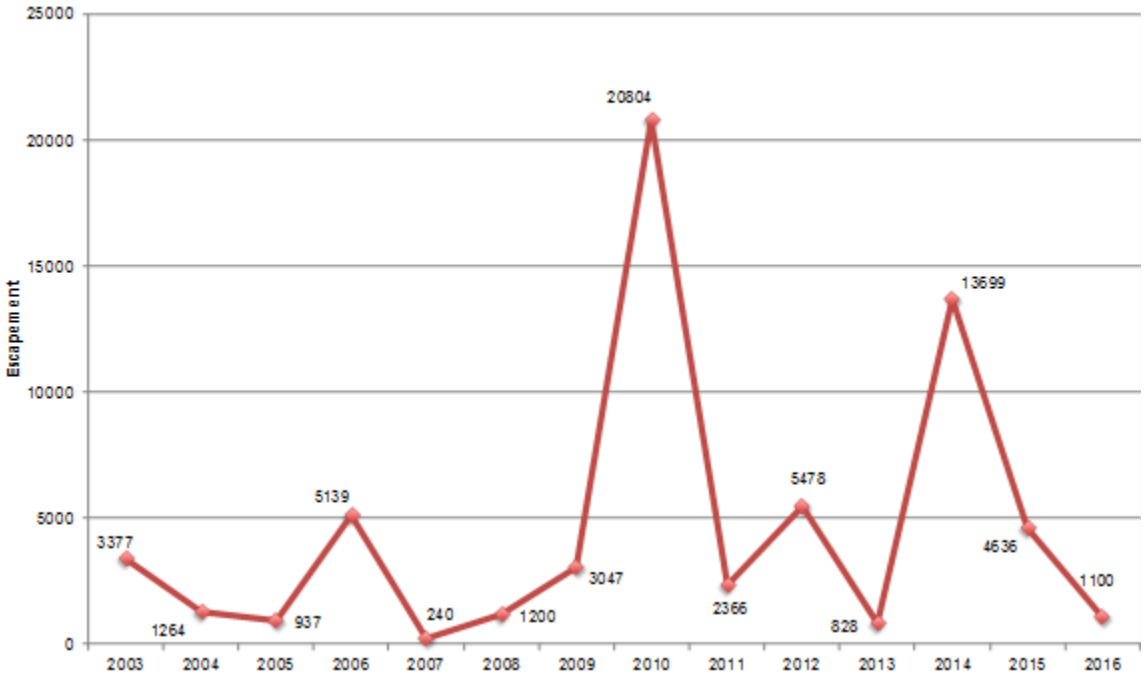

Figure 8: Annual Sockeye escapement into the Kitwanga River through the KSEF from 2003 to 2016

In 2016, the first sockeye passed through the KSEF on July 21st, which was approximately 10 days later than normal historical timing of first entry. Furthermore, although it is not possible to compare overall run timing from 2016 to historical run timing between 2003-2015 because the KSEF was only operational for roughly half the season, it would appear that overall the 2016 sockeye run was approximately 2 weeks later than normal. Also, inspections of all known lakeshore spawning grounds showed delayed entry to Gitanyow Lake occurred in 2016, and may be attributable to observed lower than normal low water levels in 2016 or the late arrival of the run. Detailed Kitwanga sockeye spawning activity in 2016 is not reported upon in this report but can be referenced in a separate report, yet to be authored, which will be titled *Gitanyow (Kitwanga) Lake Assessment, 2016* and available from the GFA by June, 2017. Most of the sockeye run was spread out over a 7-week period from August 20th to October 6th. Significantly higher counts of sockeye were observed at the KsF on September 19th (n=229), September 25th (n=183) and October 6th (n=291), and when combined accounted for 54% of the total run.

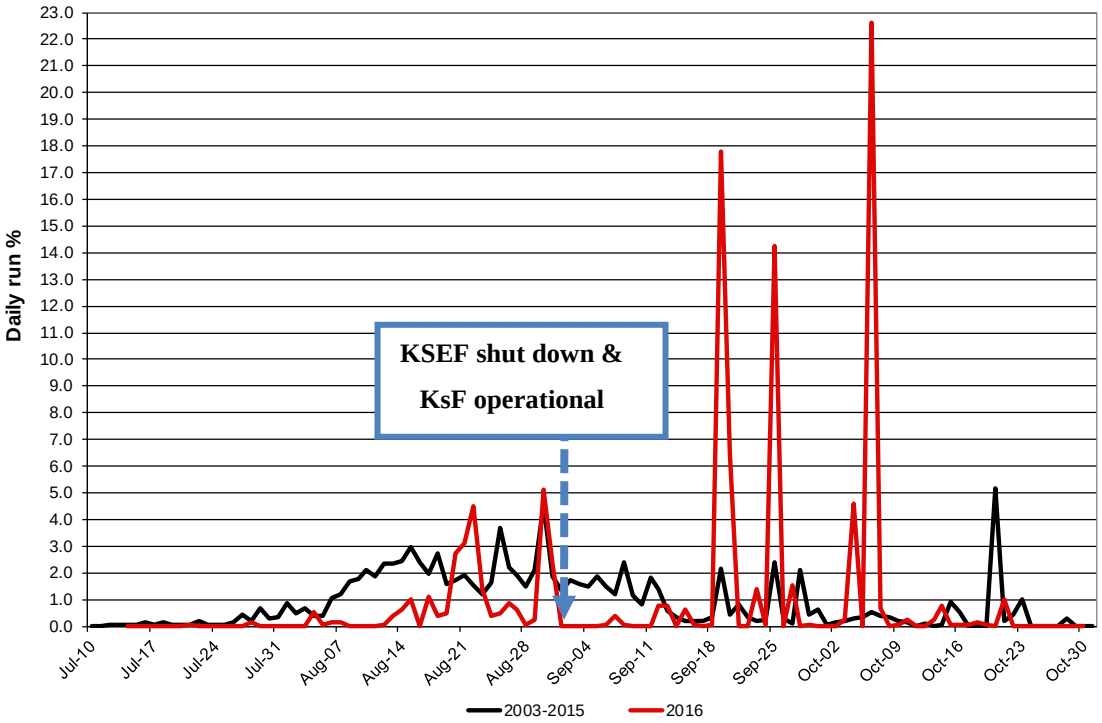

Figure 9: Kitwanga River sockeye salmon average run timing (daily run percent) for 2003-2015 vs. run timing for 2016 at the KSEF

Preliminary fishery exploitation rates for 2016 reported by DFO in December of 2016 were estimated at 30 percent (14% Alaskan Marine, 9-11% Canadian Marine – including in-river demonstration fisheries, and 5% In-river FSC) (pers. comm. Steve Cox-Rogers, 2016; Figure 10). Without exploitation (estimated 330 sockeye removed), the estimated total return for 2016 would have been approximately 1,430 sockeye.

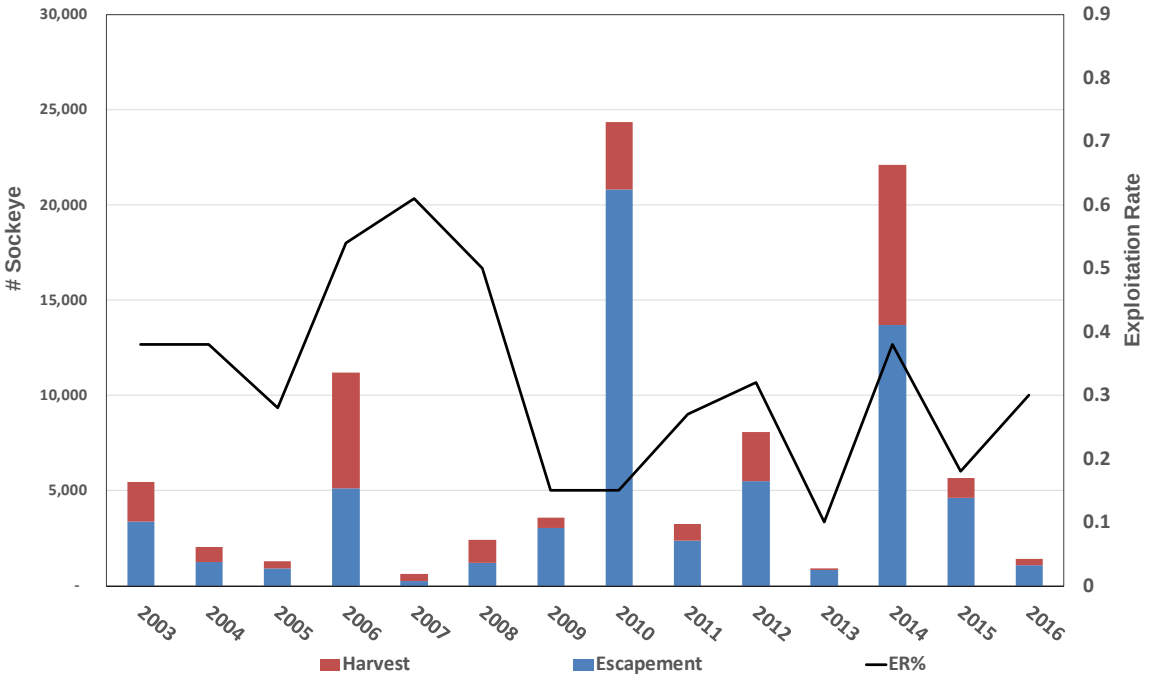

Figure 10: Kitwanga River sockeye salmon escapement and exploitation 2003-2016

Complete fork length measurements, age and sex data were collected from 43 sockeye (3.9% of the run) in 2016. Female composition comprised 40.5% (n=17) and males 59.5% (n=25)[1], which is within the normal sex ratio distribution observed previously. Average fork lengths were slightly greater for males and females showed a wider range in size than males (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 (40%) followed by fish in the 51 to 55 cm size class (33%; Figure 11). When male and female average length was compared to previous years, the 2016 results fell within the historical range (Table 2). Average length recorded since 2003 were similar and within a narrow 5 cm size range for males (55 to 59 cm), and females (52 to 57 cm) (Table 2).

[1]Sex was not determined for one sampled sockeye

Table 1: Sockeye salmon fork length (cm) statistics at the KSEF in 2016

	Female	Male	Combined
Mean	55	57	56
Min	49	41	41
Max	62	68	68
Count	17	25	42

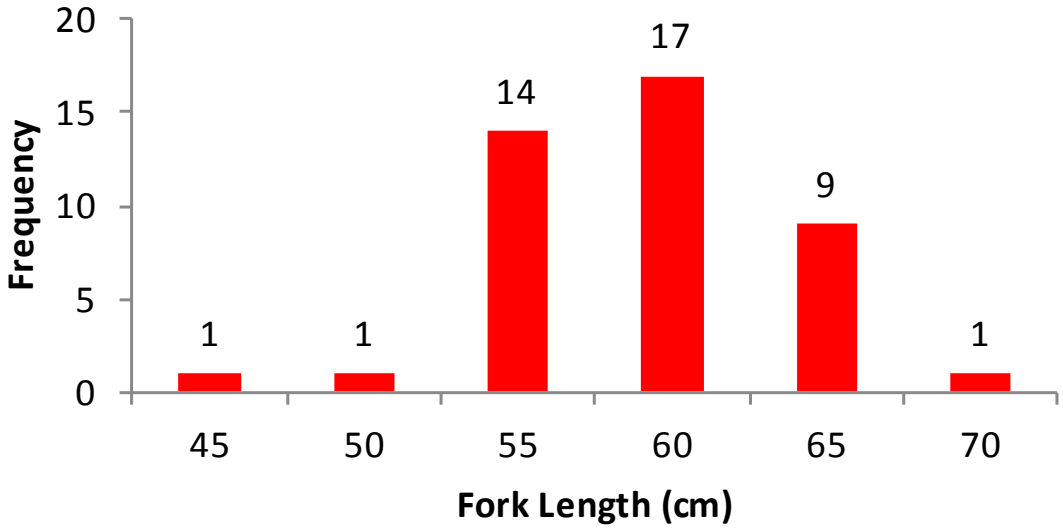

Figure 11: Fork length distribution for sockeye salmon in 2016 (n=43). X axis labels are 5 cm length class upper boundaries

Table 2: Average length (cm) for sockeye female, male and combined sexes from 2003 to 2016

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

In 2016, scale samples were collected from adult sockeye complete with sex and length data and submitted to Carol Lidstone of Birkenhead Scales Analysis for age determination. A total of 38 samples were confidently readable providing a 3.4% sample of the total run (17 females and 20 males). Age 4 fish (aged 1.2; or 1 year in fresh water post hatch and 2 years in salt water post-hatch), originating from the 2012 broodyear, were the dominant age class for both females (100%) and males (80%). Mean size for age 4 fish differed slightly for females and males at 55 and 57 cm respectively. The remaining sockeye sampled were three 5-year old fish (all males, 61cm average length) originating from the 2011 broodyear and one male 3-year old (41cm fork length) originating from the 2013 broodyear. Therefore, overall 2016 Kitwanga sockeye were 89% 4 old, 8% 5-year-old and 3% 3-year-old fish.

4.2 Chinook Salmon

When the fence went down on September 1st 2016, a total of 642 chinook salmon had gone through the KSEF. Based on average run timing through the KSEF from 2003-2015, GFA predicts that approximately 98% of the chinook returns would have migrated past the site in 2016. Based on this, we can extrapolate that the total escapement of adult chinook salmon in 2016 would have been about 655 large and 33 jack chinook salmon. The 2016 return is the lowest ever counted through the KSEF, well below the highest return of 3,225 chinook in 2007 and marks the eighth consecutive year of chinook counts below 1000 fish (Figure 12). The 2016 chinook return is 44% below the running average from 2003 to 2015 of 1,493 fish/year. At the time this report was authored, the ages for 2016 Kitwanga chinook were not available, however given that in most years Kitwanga chinook are made-up of mostly four and five-year-old fish, we can predict that most fish would have originated from the 2011 and 2012 broodyears which seen average returns of ~850 adults. Given this the 2016 chinook return was only about 75% of the replacement value for the stock. Figure 12 shows that Kitwanga chinook have declined from a higher abundance and have somewhat stabilized at lower levels with a slight dip in 2016, which may be cause for concern. Given this, fisheries managers in future years should consider protection measures to prevent further decline or the stock.

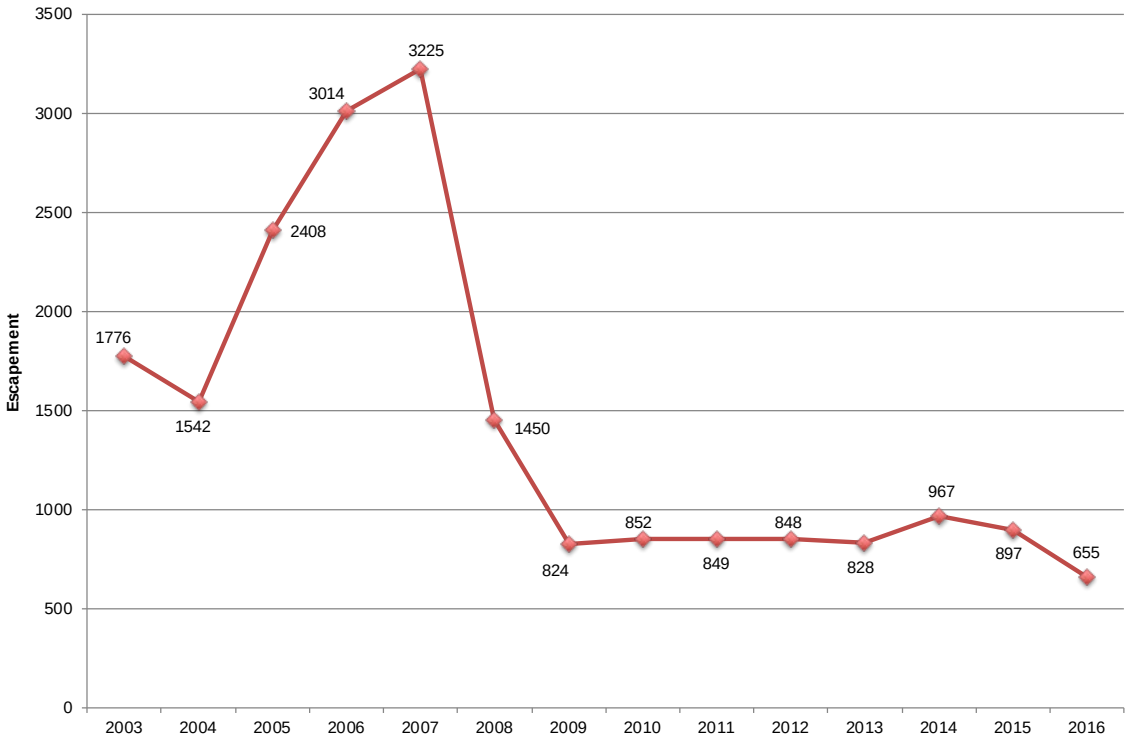

Figure 12: Annual Chinook escapement into the Kitwanga River through the KSEF from 2003 to 2016

In 2016, the first chinook salmon was counted at the KSEF on July 16th and the last on August 31st. The 2016 main run timing range was from July 28th to August 26th (92% of the total run). Relatively high counts were observed on three dates: August 15th (n=61), August 21st (n=128), and August 22nd (n=63). When combined these three dates represented 39% of the total run (Figure 13). The 2016 run timing was very similar to the historical run timing observed through the KSEF from 2003-2015.

Length, age, and sex data was collected from 89 chinook salmon (13.6% of the total run) in 2016. Male and female sex ratios were 52 and 48 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 81 to 85cm class (28%) and followed by the 76 to 80cm class (26%; Figure 14). Average fork length of the total sample was 85cm and males and females were 83 and 85cm respectively (Table 3). The 2016 length results fell within the normal range of results observed since 2008 (Table 4).

Age results for the 2016 chinook samples were not available for inclusion in this report but will be presented in the 2017 KSEF Annual Report. However, age results for 2015 that were not available in 2015 are presented below (Table 5). Of the readable scales from 2015 (101 samples out of a run total of 897 fish, or 11.3% of the 2015 run), the majority of fish (49.5%) were 5-year old's originating from the 2010 broodyear followed by 4-year old's (43.5%) originating from the 2011 broodyear.

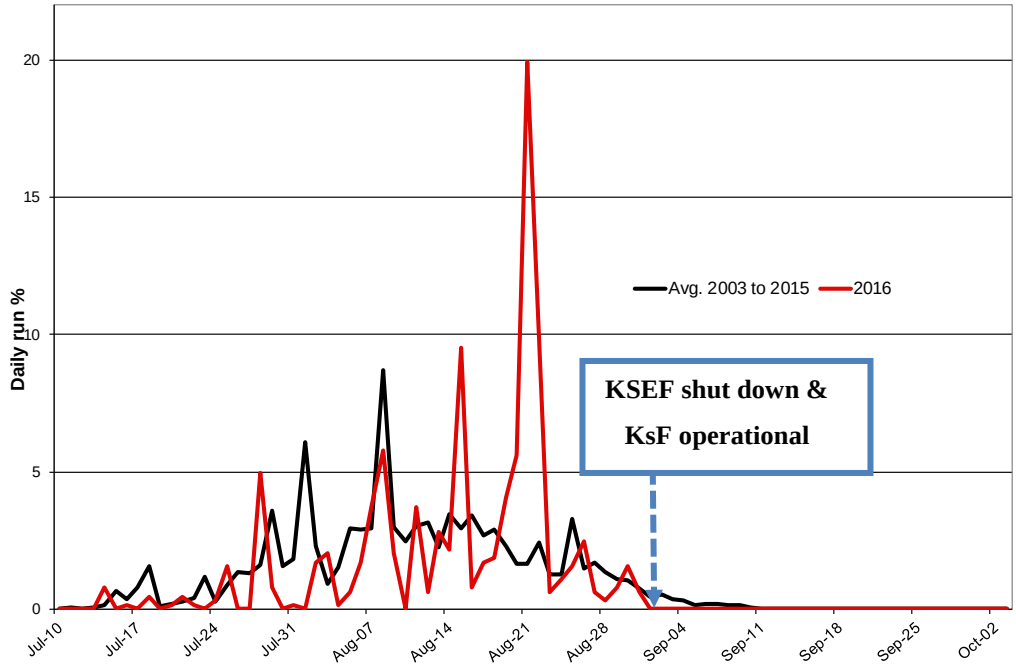

Figure 13: Kitwanga River chinook salmon average run timing (daily run percent) for 2003-2015 vs. run timing for 2016 at the KSEF

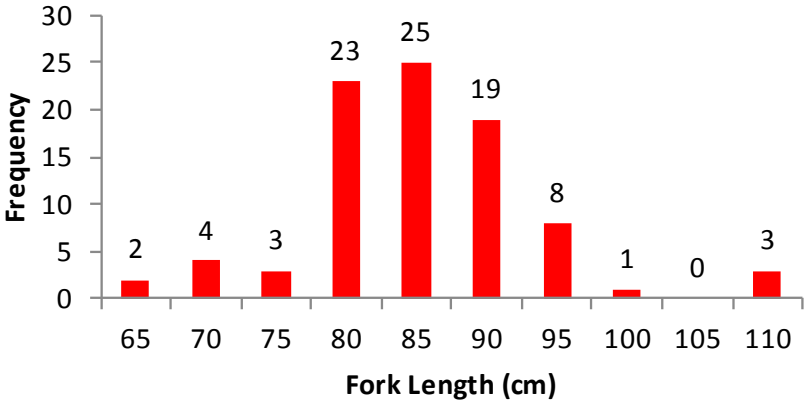

Figure 14: Fork length distribution for chinook salmon in 2016 (n=89); X axis labels are 5 cm length class upper boundaries – Note there was also one 160 cm female chinook in 156-160 length class which is not shown on the graph

Table 3: Chinook salmon fork length (cm) statistics at the KSEF in 2016

	Male	Female	Unknown	Combined
Mean	83	85	87	85
Min	62	73	87	62
Max	106	160	87	160
Count	46	42	1	89

Table 4: Average length (cm) for chinook female, male and combined sexes from 2008 to 2016

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

Table 5: Age distribution for Chinook salmon sampled in 2015 at the KSEF

Species	European	Gilbert-Rich	Brood Yr	Frequency	Percent
Chinook	14	62	2009	5	5%
Chinook	13	52	2010	50	49%
Chinook	12	42	2011	44	44%
Chinook	02	31	2012	1	1%
Chinook	11	32	2012	1	1%
			Total	101	100%

4.3 Pink Salmon

When the fence went down on September 1st, a total of 12,150 pink salmon had gone through the KSEF. Based on average run timing through the KSEF from 2003-2015, GFA predicts that approximately 62% of the even year pink returns would have migrated past the site in 2016. Based on this, we can extrapolate that the total escapement of even year pink salmon in 2016 would have been about 19,597. This return was well below the running even-year average of 32,373 fish (2004 – 2014). The 2016 pink return originated from the 2014 brood year, which had an escapement of 75,416 fish, indicating the 2016 return was only about 26% of the replacement value for the stock (Figure 15). However, given that we predicted that only about two-thirds of

the run would have migrated through the KSEF when the project was discontinued for the year these results should be interpreted with some caution. Overall, Figure 15 shows that Kitwanga even-year pink salmon show typical Skeena pink salmon variability in trend abundance.

The majority of the pinks counted in 2016 migrated through the KSEF over a 2-week period between August 13th and August 31st (62% of the run; Figure 16). Peak counts occurred on August 21st (n=4,032), August 22nd (n=3,304) and August 29th (n=1,535), which when combined represented 44% of the total run. The run timing in 2016 may have been a few days later than normal but overall based on the run timing observed it would appear that it was similar to what has been observed in other even year returns.

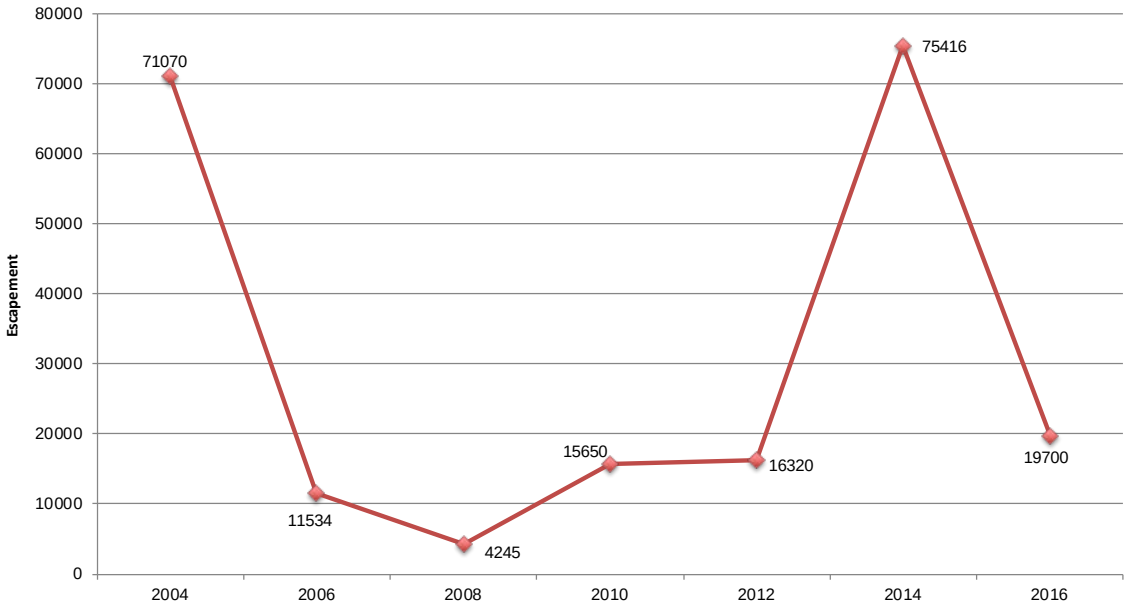

Figure 15: Annual escapement for even-year pink runs at the KSEF from 2004 to 2016

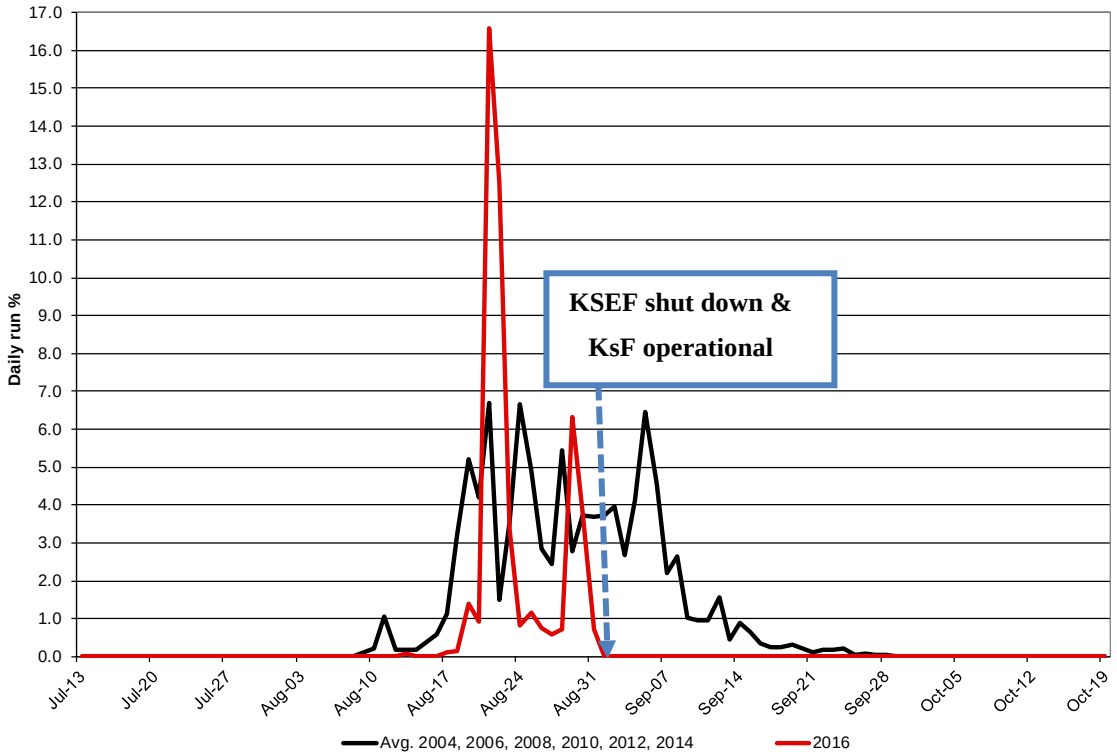

Figure 16: Run timing for pink salmon (daily run %) in 2016 vs. average even year run from 2004 to 2014. Note that daily run percentages only reflect fish that were actually counted in 2016 therefore their daily values cannot be compared to long-term trends because they do not incorporate the later part of the run which would reduce the 2016 values

4.4 Chum Salmon

When the fence went down on September 1st, a total of 285 chum salmon had gone through the KSEF. Based on average run timing through the KSEF from 2003-2015, GFA predicts that approximately 35% of the chum returns would have migrated past the site in 2016. Based on this, we can extrapolate that the total escapement of adult chum salmon in 2016 would have been about 820. However, it should be noted that this reported escapement value should be valued as an approximate value given that only about a third of the run usually has returned to the Kitwanga River by September 1st in any given year (2003-2015). That said, historical run timing values for Kitwanga chum salmon from year to years do not show much variability, therefore GFA believes that reporting the estimated chum escapement for 2016 from extrapolated run timing poses some value. The 2016 run compares to a maximum return of 829 fish in 2009 and a minimum of 150 in 2008 (Figure 17). The 2016 chum escapement estimate was 12% above the average escapement of 720 fish recorded from 2003-2015 with potential signs of recovery to the 1,000+ returns seen between years 2003 and 2005. Although we do not have the age data for 2016 chum returns, on

average the stock composition is mostly made-up of 4 and 5-year-old fish, which would have originated from the 2011 and 2012 broodyears which seen average returns of ~443 adults. Given this the 2016 chum return was about 85% above the replacement value for the stock. However, given that we predicted that only about one-third of the run would have migrated through the KSEF when the project was discontinued for the year, these results should be interpreted with caution. Figure 17 shows that Kitwanga chum salmon have declined from previously higher abundances but have appeared to have stabilized at lower levels.

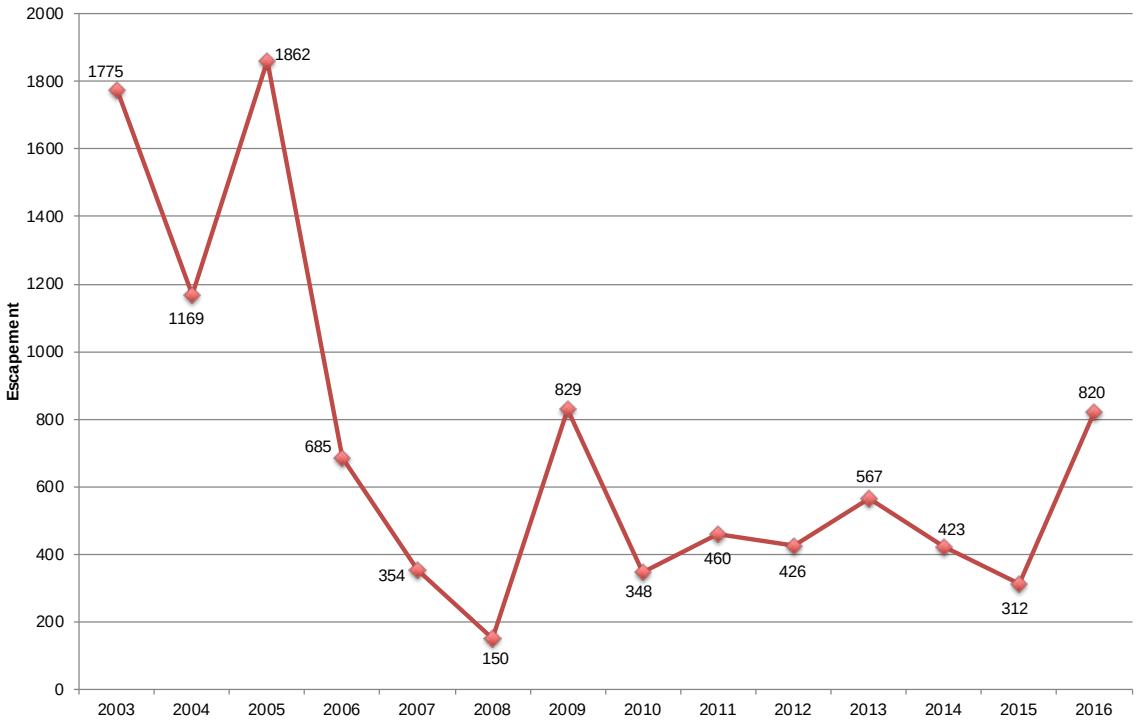

Figure 17: Annual escapement for chum salmon at the KSEF from 2003 to 2016

In 2016, the first chum salmon was counted at the KSEF on August 4th and the last counted on August 31st. In general, chum returns were spread evenly throughout the sampling period with no distinct run pulse observed during the operation of the KSEF (Figure 18). Figure 18 shows that the 2016 chum run timing, for at least the first third of the run, was very similar to what has been observed in previous years.

Fork length, sex and age data was collected from 17 chum salmon in 2016 (2% of the run). Male and female sex ratios were 41% and 59% respectively, falling within the parameters of what has been seen previously and within a healthy sex breakdown for salmon populations. On average,

males were only slightly larger than females (80 and 74 cm respectively; Table 6). The 2016 length results fell within the normal range of results observed since 2008 (Table 7).

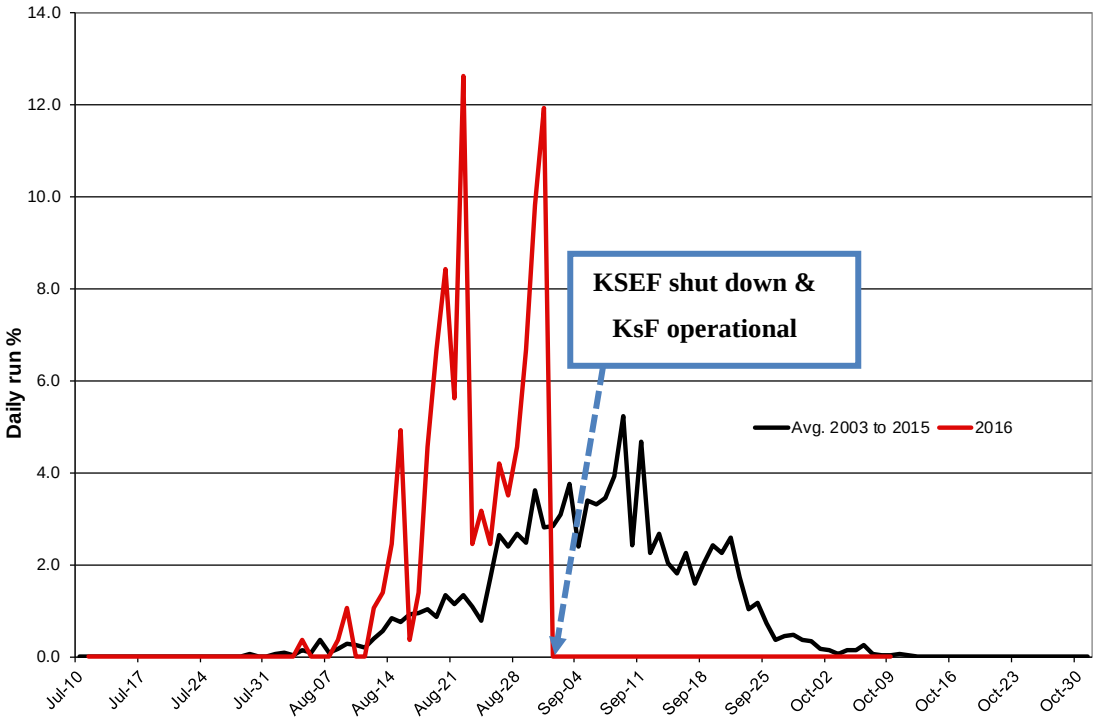

Figure 18: Kitwanga River chum salmon average run timing (daily run %) for 2003-2015 vs. run timing for 2016 at the KSEF. Note that daily run percentages only reflect fish that were actually counted in 2016 therefore their daily values cannot be compared to long-term trends because they do not incorporate the later part of the run which would reduce the 2016 values

Table 6: Chum salmon fork length (cm) statistics at the KSEF in 2016

	Male	Female	Combined
Mean	80	74	77
Min	74	69	69
Max	89	83	89
Count	7	10	17

Table 7: Average length (cm) for chum female, male and combined sexes from 2008 to 2016

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

Year	Male	Female	Combined
2014	72.1	72.0	72.1
2015	75.9	75.3	75.5
2016	80.3	74.4	77.3

Age results for 2016 chum salmon returns were not available for this report but will be included in the 2017 KSEF Annual Report. However, age results for 2015 are presented below (Table 8). Of the readable scales from the 2015 aging sample (74 samples out of a run total of 312 fish, or 24% of the 2015 run), the majority of fish (74.3%) were 4-year old's originating from the 2011 broodyear.

Table 8: Age distribution for chum salmon sampled in 2015 at the KSEF

Species	European	Gilbert-Rich	Brood Yr	Frequency	Percent
Chum	04	51	2010	14	19%
Chum	03	41	2011	55	74%
Chum	02	31	2012	5	7%
			Total	74	100%

4.5 Coho Salmon

When the fence went down on September 1st 2016, a total of 232 coho salmon had gone through the KSEF. The first coho salmon was counted at the KSEF on August 6th (n=1) and the last on August 31st (n=28). Based on average run timing through the KSEF from 2003-2015, GFA predicts that only about 10% of the coho returns would have migrated past the site when the KSEF was closed on September 1, 2016. Based on this, we can extrapolate that the total escapement of adult coho salmon in 2016 would have been approximately 2,320 coho, but there is much uncertainty in this estimate given that a very small percentage of the run was actually enumerated. Therefore, in an attempt to verify the relative accuracy of this estimate, GFA conducted several stream counts in late October and early November of all know coho spawning sites. The counts were performed during the peak of the Kitwanga coho spawning activities. The result was a peak count of live and dead coho of 1,471 adults (including observer efficiency correction factor of 10%) below the KsF. On that date an additional 636 coho had already migrated upstream through the KsF, so the overall stream / KsF count of coho salmon in 2016 was estimated at 2,107. Given that the two estimates are fairly close in values we will report the average escapement count of 2,214 for the 2016 escapement.

The 2016 return is well below the highest return of 12,080 coho in 2009 and 47% below the running average from 2003 to 2015, which was 4,196 fish/year. As Figure 19 demonstrates, Kitwanga coho returns have been variable for the study period, with a noticeable decline in the last two years.

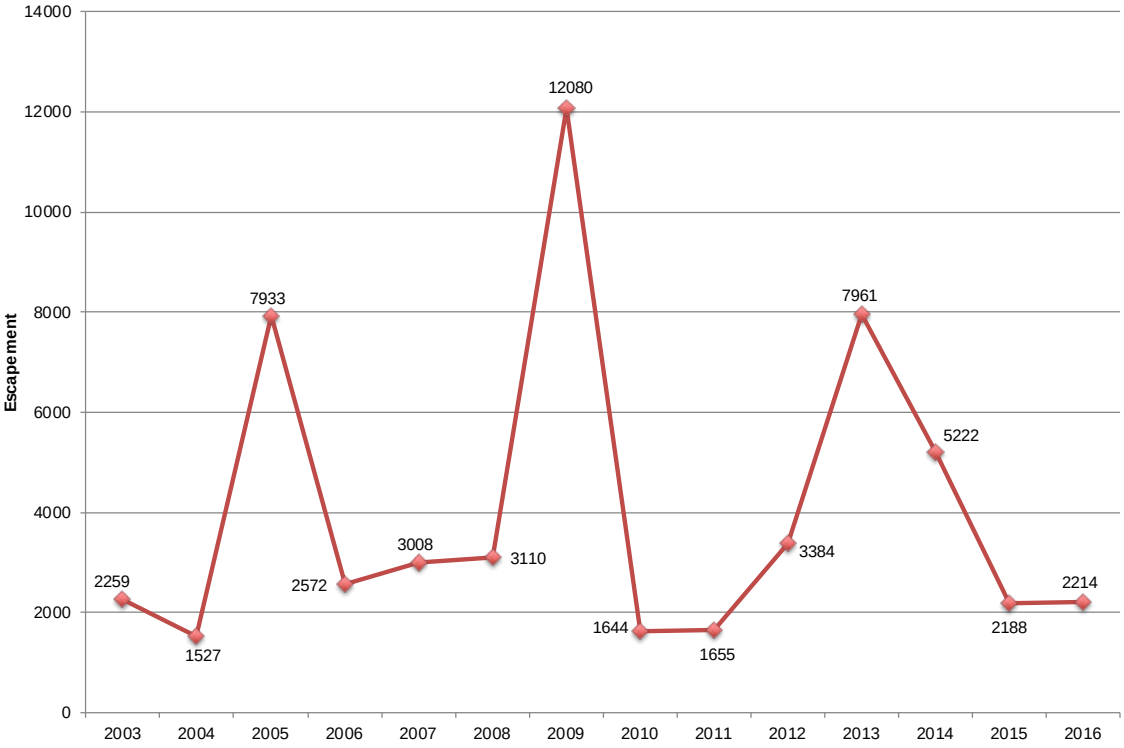

Figure 19: Annual escapement for coho salmon from 2003 to 2016 at the KSEF

Length, age, and sex data was collected from 34 coho salmon in 2016 (1.3% of the total run). Male and female sex ratios from the samples were 76% and 24% respectively falling within the parameters of what has been seen previously on the Kitwanga River. Average fork length for males and females were similar at 65 and 64cm respectively (Table 9). Fork length histogram (5cm intervals) showed a bi-modal distribution, dominated by fish in the 66 to 70cm size class (30%) and 51 to 55cm size class (24% of the sample; Figure 21). The 2016 length results fell within the normal range of results observed since 2010 (Table 10).

Age results for 2016 coho salmon returns were not available at the time of this report but will be included in the 2017 KSEF Annual Report. However, age distribution for coho salmon sampled in 2015 are presented below (Table 11). Of the 37 readable scales from the 2015 aging samples

(1.7% of the 2015 run of 2,188 fish), the majority of fish were 3-year old returns (81.1%) followed by 4-year old returns (18.9%).

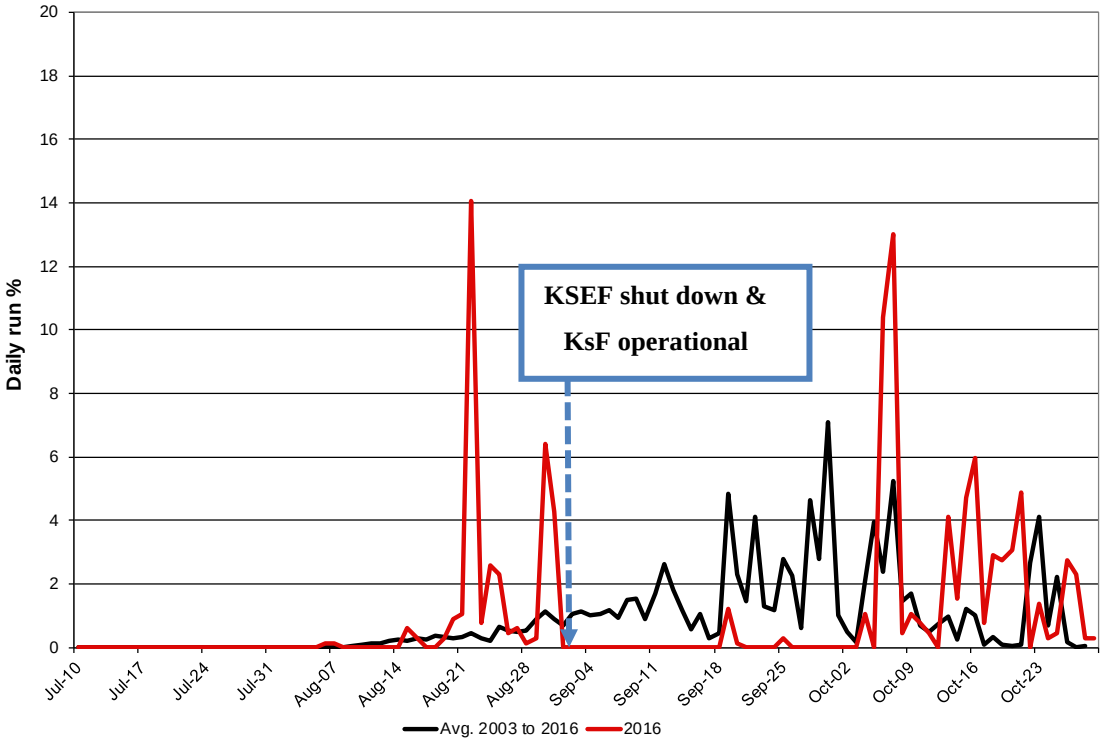

Figure 20: Kitwanga River coho salmon average run timing (daily run %) for 2003-2015 vs. run timing for 2016 at the KSEF and through the KsF (2016)

Table 9: Coho salmon fork length (cm) statistics at the KSEF in 2016

	Male	Female	Combined
Mean	65	64	65
Min	47	51	47
Max	80	85	85
Count	26	8	34

Table 10: Average length (cm) for coho female, male and combined sexes from 2010 to 2016

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

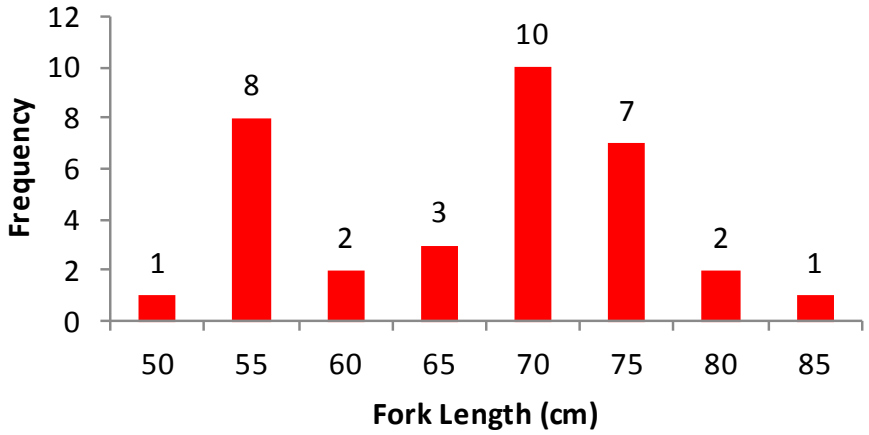

Figure 21: Fork length distribution for coho salmon in 2016 (n=34); X axis labels are 5 cm length classes. X axis labels are 5 cm length class upper boundaries

Table 11: Age distribution for coho salmon sampled in 2015 at the KSEF

Species	European	Gilbert-Rich	Brood Yr	Frequency	Percent
Coho	21	43	2011	7	19%
Coho	11	32	2012	30	81%
			Total	37	100%

In the spring of 2015, GFA applied 3,500 CWT's to coho smolts at the Kitwanga Smolt Facility, 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 2015 CWT smolts were expected to return as adults in the fall of 2016. A total of 42 CWT fish out of 687 examined fish were counted through the KSEF in 2016. Extrapolating to the total run, an estimated 154 tagged fish passed through the fence in 2016 (4.4% recovery). The complete coho CWT results will be reported upon at a later date by GFA in a separate report which will be available in March, 2017.

5. DISCUSSION AND RECOMMENDATIONS

Since the KSEF became operational in 2003, GFA has collected accurate and invaluable information on Kitwanga River salmon stocks where now the information is used annually to gauge the health of other Skeena River salmon stocks. In 2016, under lower than normal water levels for much of July and August, GFA operated the KSEF to enumerate and collect biological information for sockeye, chinook, chum, pink and coho salmon returning to the Kitwanga River. The Skeena River was at record low water during this period (Gottesfeld, SFC, Pers. comm., 2016). On the Kitwanga River, from July 18 to August 29, the 2016 average water levels over this period were only 0.60m, compared to a mean of 0.73m for the 2004-2015 period. On August 26, during a stream walk, GFA crews found a 1.2km section of the Kitwanga River completely dry.

The KSEF project closed on September 1, 2016, due to extreme high flows, which threatened the safety of the GFA staff and risked damage to the facility. Within 30 hours of the KSEF being shut down, GFA staff were able to set-up and modify the KsF (smolt Fence) just below Gitanyow Lake to continue to count adult sockeye and coho from September 2nd to November 2nd, 2016. As a result, total escapement numbers for chinook, pink, chum and coho were scaled upwards accordingly to account for missed fish counts. Scaling was based on historical run timing for salmon passing through the KSEF by September 1 from 2003 – 2015. This was not done for sockeye because a complete count was maintained throughout the sampling period through the operations of the KSEF and the subsequent operation of the KsF. Also, because so few coho had passed the KSEF by the project end data, coho stream walks were performed to verify and complement the coho KSEF estimate in 2016.

In 2016, GFA replaced the left and right bank counting boxes because both were damaged beyond repair during flooding in the fall of 2015. A bridge was also installed at the upstream end of the diversion channel on river left, which was established when the KSEF was originally installed in 2003 (Figure 22). The bridge was installed because the existing culvert was impeding water flow in the diversion channel. While this helped to divert a portion of the mainstem river flow away from the KSEF, there were still problems with debris build-up on the panels that contributed to the project being closed pre-maturely.

Figure 22: Photo series of installation of bridge over diversion channel

A total of 1,100 sockeye were estimated to return through the KSEF and the KsF in 2016 (Table 12). GFA does not believe any sockeye were missed in 2016. However, some may have been double counted and a range of 970 to 1,318 is estimated, with an overall estimated return of 1,100. Sockeye escapement in 2016 were the lowest since 2013, when the count totaled 828. The current running average escapement from 2003 to 2016 now stands at 4,580 sockeye, which is down from the 4,865 sockeye per year average calculated for years 2003 to 2015. Low water levels in the Skeena and Kitwanga Rivers in July and August, likely had an effect on sockeye run timing and potential survival overall for sockeye in 2016.

Since 2010, there has been a slow but positive increase in Kitwanga sockeye numbers with 2013 and 2016 being the exception. 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 and 3: provide in-season salmon forecasts to DFO Fisheries managers so the information can help implement more sustainable fisheries, 4: continue to develop and update Kitwanga sockeye rebuilding plans.

The 2016 chinook salmon run of 655 fish is considered low compared to relatively high returns observed from 2003 to 2008 (1,450 - 3,225 fish). Chinook salmon numbers in 2016 were 44% below the running average (2003-2015) and marks the 8th consecutive year of counts below 1,000 fish. Kitwanga chinook have declined from a higher abundance and have somewhat stabilized at lower levels with a slight dip in 2016, which may be cause for concern. Given this, fisheries managers in future years should consider protection measures to prevent further decline or the stock.

A total of 19,597 adult even-year pink salmon returned to the KSEF in 2016. This return was below the running even-year average of 32,373 fish (2004 – 2014). In the Kitwanga watershed, even-year runs are normally the small run in comparison to odd-year runs. The 2016 pink return originated from the 2014 brood year, which had an escapement of 75,416 fish, indicating the 2016 return was 74% below replacement.

A total of 820 adult chum salmon are estimated to have returned to the Kitwanga River in 2016. The 2016 run compares to a maximum return of 1,862 fish in 2005. The 2016 chum escapement estimate was 12% above the average escapement of 720 fish recorded from 2003-2015 with potential signs of recovery to the 1,000+ returns encountered between years 2003 and 2005.

A total of 2,214 adult coho salmon were estimated to have returned to the KSEF in 2016. The 2016 return is well below the highest return of 12,080 coho in 2009. The 2016 coho return was 47% below the running average from 2003 to 2015, which was 4,196 fish/year.

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