Gitanyow *Fisheries* Authority

Kitwanga River Salmon Enumeration Facility (KSEF) – 2019 Annual Report

Submitted to: Gitanyow Hereditary Chiefs,
Fisheries and Oceans, Canada,
Pacific Salmon Commission

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Abstract

In 2019, the Gitanyow Fisheries Authority (GFA) operated the Kitwanga River Salmon Enumeration Facility (KSEF) for the 17th consecutive year to count and biologically sample Pacific salmon returning to the Kitwanga River. The fence was operational from July 11th to October 31st. Water levels were below average (2004-2017)[1] for most of the season. GFA counted 125 sockeye, 654 Chinook, 52,644 pink, 492 chum, and 1,647 coho in 2019.

Sockeye escapement in 2019 was 125, which was the lowest recorded since accurate annual enumeration was initiated in 2003, and well below the long-term (2003-2018) average of 4,120. With very few sockeye through the fence, inferences on average size and age are difficult. Only six sockeye were aged in 2019, of which five were age 4 fish (83%) and one was age 5 (17%). These ages fall within the long-term average (2003-2018) of 80% age 4, 19% age 5 and 1% age 3 fish. Body size (fork length) have remained relatively unchanged over the last 17 years, where the average fork length from 2003 to 2018 was 56cm compared with the 2019 average fork length of 55mm. The sex ratio for 2019 was even and run timing was similar when compared to the 2003-2015 average.

A total of 654 Chinook were counted at the KSEF in 2019. This is less than half of the long-term escapement average of 1,334 from 2003 to 2018. Chinook salmon in 2019 (n=654) have declined from higher abundances seen in the earlier 2000's, and seem to be part of the second lower tier of escapement number seen in the Kitwanga since 2003. From 2003 to 2008, the average escapement was 2,235 and from 2009 to 2015 the average escapement was 866. During the last four years (2016-2019), the average escapement has dropped to 628. The 2019 length results showed that female Chinook sampled in 2019 were very similar when compared to results observed since 2008 and males were the largest observed since 2008. Overall the peak of run in 2019 was earlier when compared with the 2003-2018 average run timing, with 77% of the run having passed the fence by August 9. This compares to 50% (average between 2003-2018) seen previously to this date. This early run timing may be the result of using the two camera's in 2019, as Chinook in particular, seemed to be more comfortable moving through the camera chutes versus the traditional counting areas located on both sides of the river.

A total of 52,644 adult pink salmon migrated past the KSEF in 2019 which is well below the running odd-year average of 223,124 fish (2003 – 2017). The 2019 pink return originated from the 2017 brood year, which had an escapement of 179,071 fish, indicating the 2019 return was about 71% below replacement value for the stock. The run timing in 2019 was about five days later than observed in previous odd years (2003-2017) with the peak of the run arriving approximately two week earlier.

[1] Note did not include 2018 in with long term average, as it was a very low flow year; lowest on record.

A total of 492 adult chum salmon returned to the Kitwanga River in 2019, which was the largest return since 820 in 2016. The 2019 escapement estimate was 27% below the average escapement of 674 fish recorded from 2003-2018 and seems to be in line with a lower stable average seen from 2010 to 2015 and 2017, 2018 (n=393). Sex ratios in 2019 were 50/50 which was in line with previous years for chum salmon and males and females were also similar in size. The 2019 chum run timing was approximately two weeks later than observed in previous years and concluded about one week earlier.

A total of 1,647 adult coho were counted at the KSEF in 2019, which was less than half the long-term average of 3,698 from 2003 to 2018. Overall, sex ratios in 2019 were in line with previous years. Overall, run timing for coho in 2019 was similar to the 2003-2015[2] average run timing.

In 2019 GFA successfully operated the KSEF for the entire season free of any breaches. Given this and taking into account the average salmon run timing through the KSEF (2003-2018), GFA is confident that all or most of the salmon returning to the Kitwanga River would have been enumerated in 2019.
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[2] Note KSEF was shut down on September 1st in 2016 and on September 11 in 2017, and 2018 had record low water levels which influenced run timing.

Acknowledgements

Gitanyow Fisheries Authority would like to thank the Gitanyow Hereditary Chiefs Office for their continued leadership and support for the GFA program. In 2019 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. They often are 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 2019 GFA technicians included: Les McLean, Earl McLean, Vernon Russell, Phillip Johnson, Brenton Williams, Morgan Douse, Melissa Shirey, and Johnny Martin. A special thanks to Senior technician Dean Miller for his invaluable work in setting up two new underwater cameras / counting chutes and to Les McLean for his professionalism and commitment in maintaining the fence and collecting quality data in all weather conditions. GFA Guardians Dustin Gray and Greg Johnson were also involved in the project and we thank them for their technical help in 2019. 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 is thought to be one of the leading cause for the Kitwanga sockeye declines. Historical exploitation rates on them 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 20 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 (2003-2019). Smolt production from Gitanyow Lake has been accurately assessed continuously since 2008, when the Kitwanga River Smolt Facility (KsF) was constructed. In 2019/2020, the Kitwanga Sockeye Salmon Recovery Plan was updated to compile and summarize the data collected and the rebuilding efforts conducted by GFA and DFO since 2006 (KSRP - 2020). The goal of the KSRP-2020 is to confirm and prioritize current monitoring works and to develop and prioritize a new direction as deemed necessary to recover Kitwanga sockeye to more historical levels.

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%.

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 2019, 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 2019. 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.

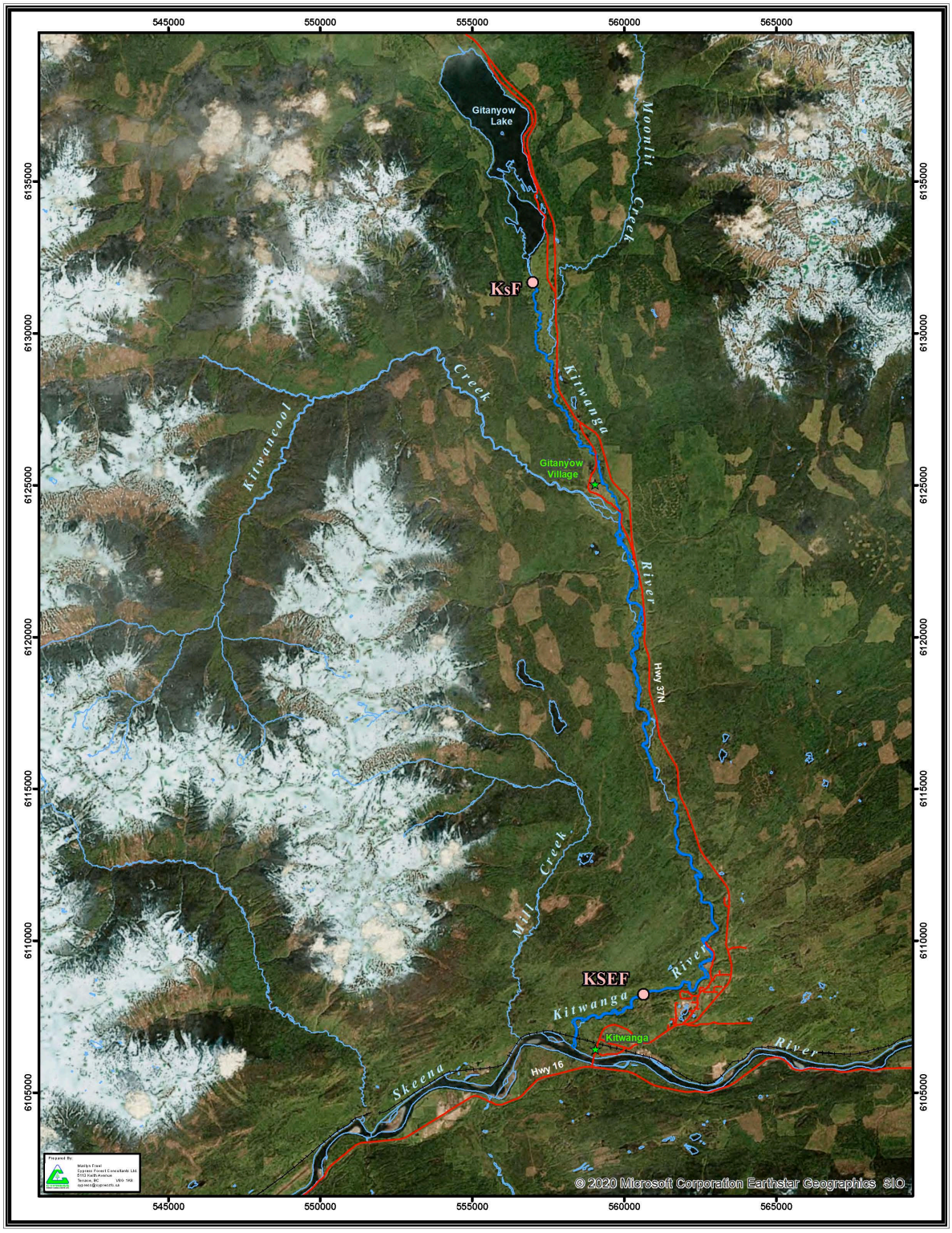

Figure 1: Skeena River and the lower Kitwanga Watershed including the KSEF, KsF and Gitanyow Lake.

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).

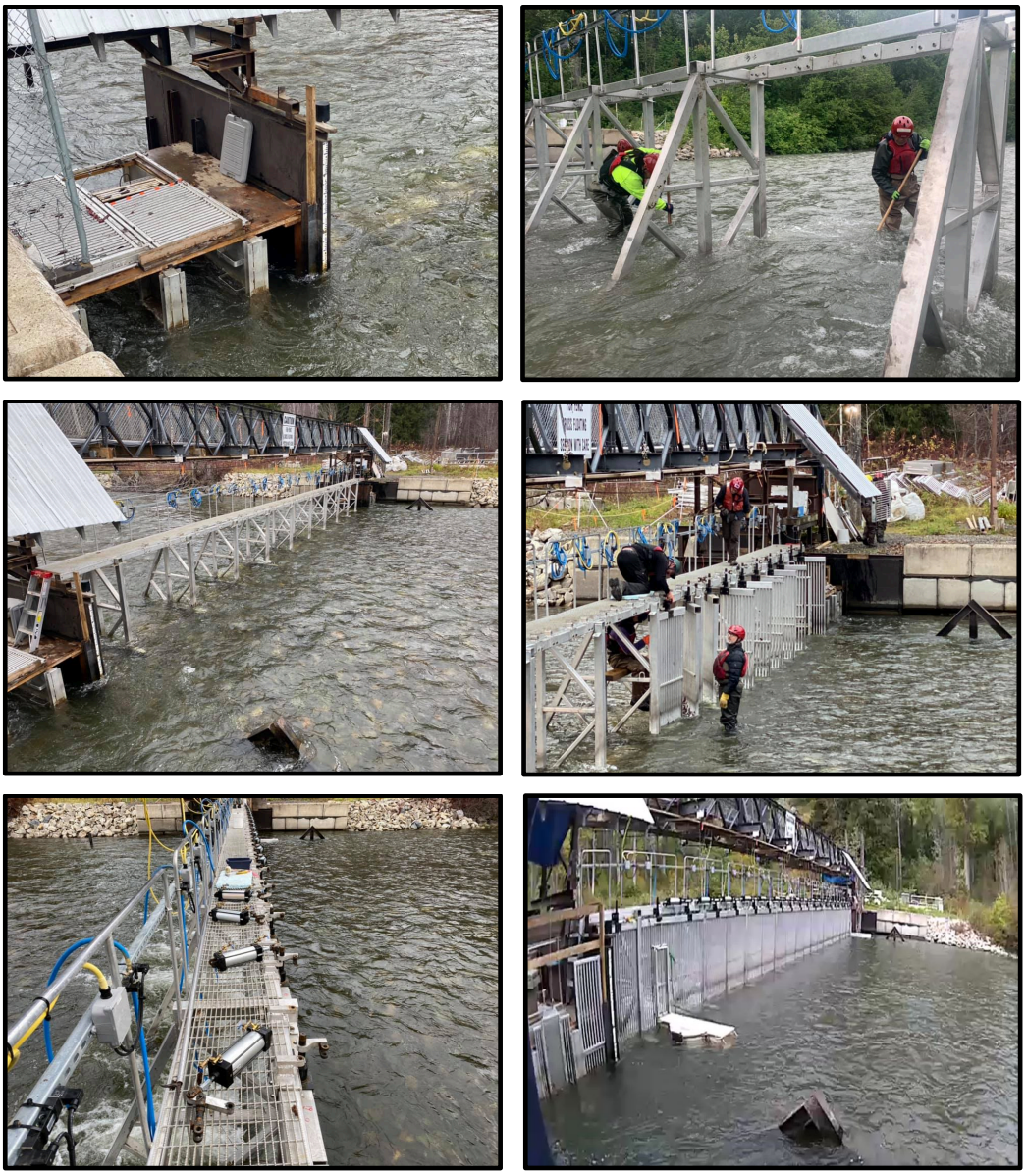

Figure 3: Photo series of installation of the KSEF structure.

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 2019, 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: Photo series of 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[3]. The KSEF is closed nightly preventing upstream migration between dusk and dawn.

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 2019.

In 2018, GFA had installed and successfully operated a salmon counting chute on one of the KSEF panels. The counting chute was installed again in 2019 and a second counting chute was added to river right on the fence (Figure 5). Both chutes were equipped with digital video camera recorders (DVR).

Figure 5: Photo on left shows counting chute on river left and photo on right overhead view of second counting chute added in 2019 on river right.

In 2019, 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

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

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.

4. RESULTS

The operation of the KSEF in 2019 marked the 17th consecutive year that the facility was used to enumerate salmon in the Kitwanga River. The KSEF was operational from July 11th to October 31st, 2019. Operations were continuous with no breaches. Water levels were below average (2004-2017)[4] for July to mid-October, with the exception of a ten-day period at the end of August where water levels were above average (Figure 6). Water levels during the last half of October were above average.

Water temperatures were higher than the long-term range for July through to early August (2011-2017) and generally lower from late September until the program ended at the end of October (Figure 7). Overall water temperatures were considered adequate for salmon survival during the operations of the KSEF in 2019.

[4] Note did not include 2018 in with long term average, as it was a very low flow year; lowest on record.

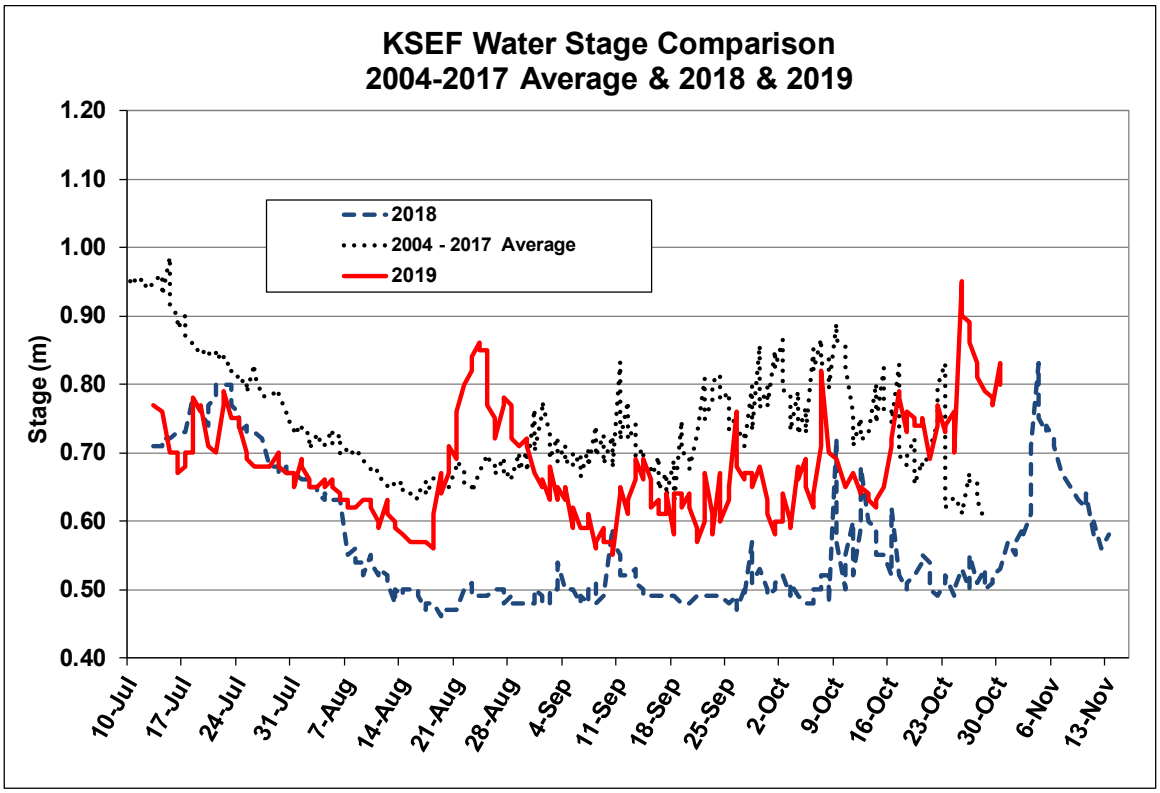

Figure 6: Average stage recordings at the KSEF (2004-2017, 2018) vs. 2019 results.

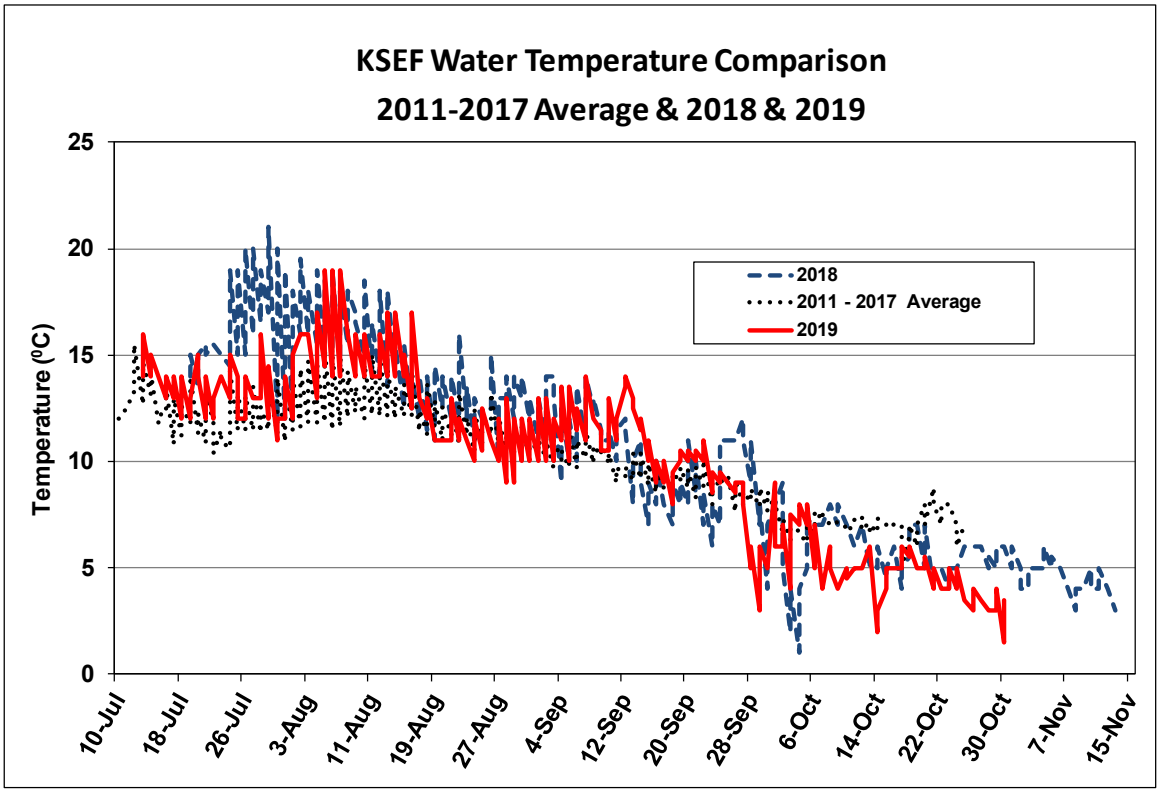

Figure 7: Average water temperature at the KSEF (2011-2017, 2018) vs. 2019 results

In 2019, GFA once again operated a digital video camera recorder (DVR). The DVR camera box was in place and operational on July 17, 2019 and passed all species successfully. A second camera box was added to the right bank side of our fence in August and provided additional fish passing capabilities. As a result, more than half of the fish enumerated through the KSEF in 2019 were counted through the DVR camera boxes.

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

A total of 125 sockeye were counted through the KSEF in 2019 (Figure 8). This escapement is well below the long-term (2003-2018) average of 4,120, and is the lowest recorded since the fence was first installed in 2003.

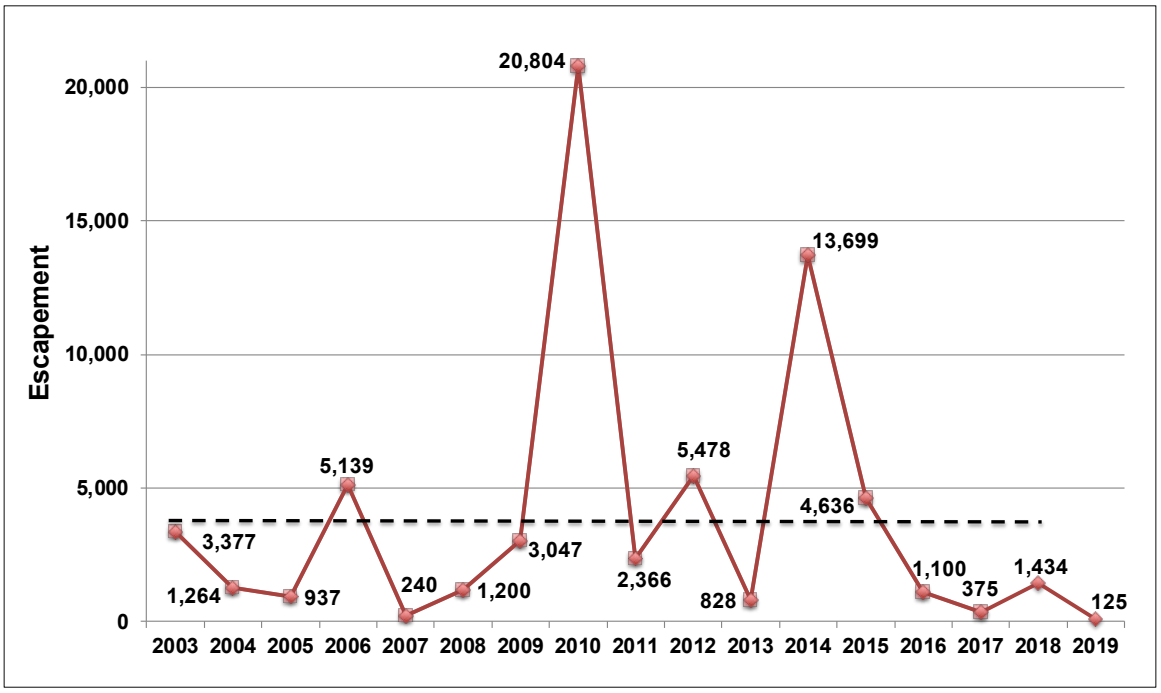

Figure 8: Annual Sockeye escapement into the Kitwanga River through the KSEF from 2003 to 2019 - Dashed line is average from 2003 to 2018.

Once the KSEF was installed and rendered fish tight on July 11, the first sockeye passed the site on July 27. The run timing was consistent with what has been document previously between 2003-2015[5] (Figure 9).

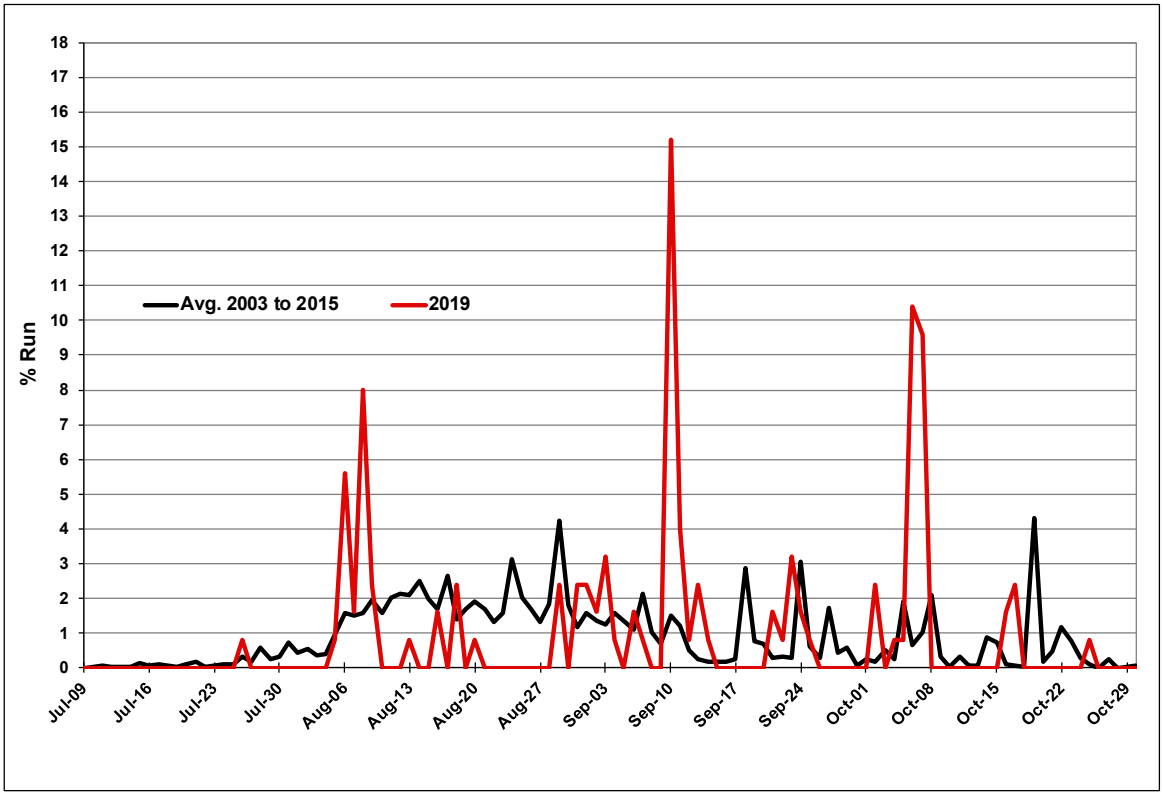

Figure 9: Kitwanga River sockeye salmon average run timing (daily run percent) for 2003-2015 vs. run timing for 2019 at the KSEF.

Preliminary fishery exploitation rates for 2019 reported by DFO in 2020 were estimated at 23% (18% Alaskan Marine, 0% Canadian Marine – including in-river demonstration fisheries, and 5% In-river FSC) (pers. comm. Steve Cox-Rogers, 2020; Figure 10). Without exploitation (estimated 37 sockeye removed), the estimated total return for 2019 would have been approximately 162 sockeye.

[5] Note KSEF was shut down too early in both 2016 and 2017 to use those years for run timing comparison, 2018 was screened out as well because that year had record low water levels which likely influenced run timing.

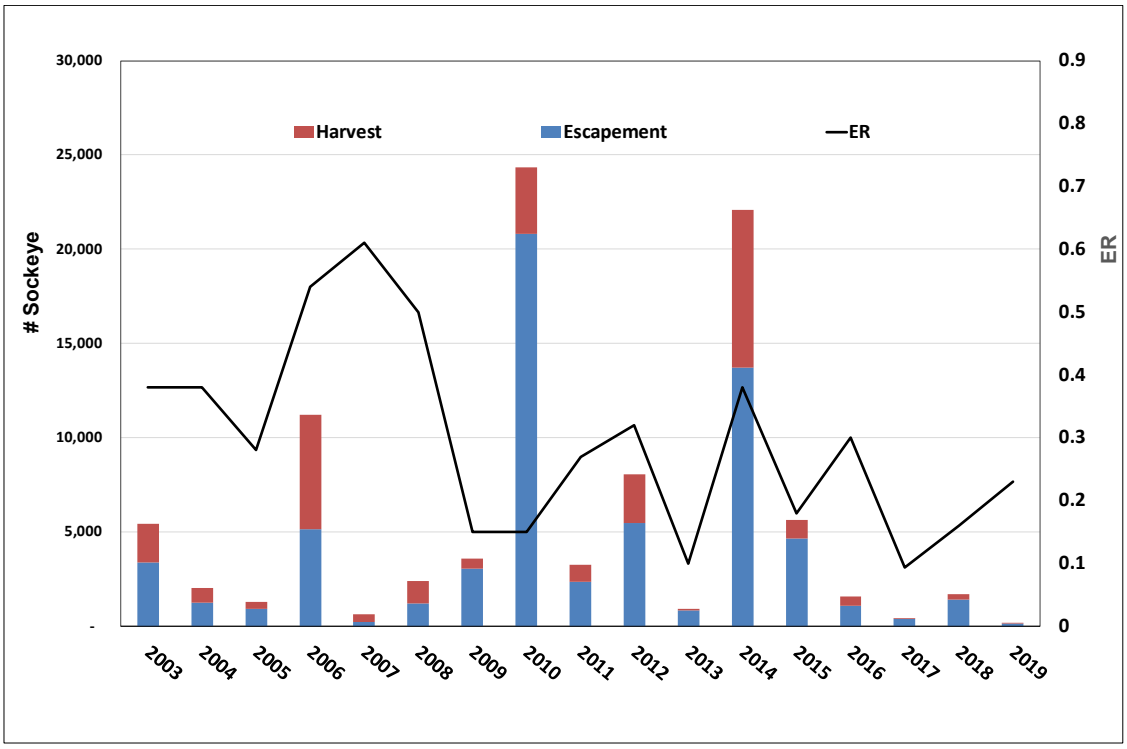

Figure 10: Kitwanga River sockeye salmon escapement and exploitation 2003-2019.

Complete fork length measurements, age and sex data were collected from 8 sockeye (~5% of the run) in 2019. Female composition comprised 50% (n=4) and males 50% (n=4), 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). When male and female average length was compared to previous years, the 2019 results fell within the historical range (Table 2). Average lengths 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 2019.

	Female	Male	Combined
Mean	53	57	55
Min	51	53	51
Max	57	62	62
Count	4	4	8

Table 2: Average length (cm) for sockeye female, male and combined Sexes from 2003 to 2019.

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
2019	53	57	55

In 2019, 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 6 samples were confidently readable providing a 5% age sample of the escapement. In 2019, Kitwanga sockeye were 83% 4-year-old fish (aged 1.2; or 1 year in fresh water post hatch and 2 years in salt water post-hatch) and 17% five-year old fish. Given that the escapement of adult sockeye to the Kitwanga River in 2015 was 4,636 and most of the return was four year olds, the 2019 return was only about 3% of its replacement value. Mean size for age 4 fish were the same for females and males at 53 cm. On average (2003-2019), 4-year-olds have comprised 80% of the run, with 5-year olds at 19% and 3-year olds at about 1%. Notable exceptions occurred in 2007 when age 5 fish dominated the sample and in 2017 when age 4 and 5 fish were roughly similar in percentage.

Table 3 shows the average fork length (cm) for age and sex for brood years 2004 to 2015. Over this time period the lengths have remained relatively consistent

with fork length standard deviations for ages 3, 4 and 5 of 3.6 (n=15), 1.2 (n=1,809) and 2.4 (n=354) respectively.

Table 3: Average fork length (cm) for age class, and sex for sockeye salmon - brood years 2004 to 2015.

Brood Yr	3yr olds			4yr olds			5yr olds		
	Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)	
		F	M		F	M		F	M
2004	2007	41	40	2008	55	60	2009	58	61
2005	2008		39	2009	54	57	2010		63
2006	2009	42	NA	2010	54	57	2011	59	61
2007	2010		NA	2011	55	59	2012	60	61
2008	2011	50	44	2012	55	57	2013	58	62
2009	2012			2013	53	56	2014	59	61
2010	2013			2014	52	56	2015	56	58
2011	2014	40	NA	2015	53	55	2016		61
2012	2015			2016	55	57	2017	58	59
2013	2016		41	2017	54	57	2018		
2014	2017			2018	54	56	2019		62
2015	2018			2019	53	53			

4.2 Chinook Salmon

A total of 654 Chinook were counted at the KSEF in 2019. This is less than half of the long-term escapement average of 1,334 from 2003 to 2018 (Figure 11). In 2019, the first Chinook salmon were counted at the KSEF on July 15th and the last on September 11th (Figure 12). Overall the peak of run occurred earlier when compared with the 2003-2018 average run timing, with 77% of the run having passed the fence by August 9. This compares to 50% (average between 2003-2018) seen previously to this date. This early run timing may be the result of using the two camera's in 2019, as Chinook in particular, seemed be more comfortable using the camera chutes versus the traditional counting areas located on both sides of the KSEF. By the end of August, 95% of the run had passed through the fence, compared to the long-term (2003-2018) run timing average of 97% for the same period.

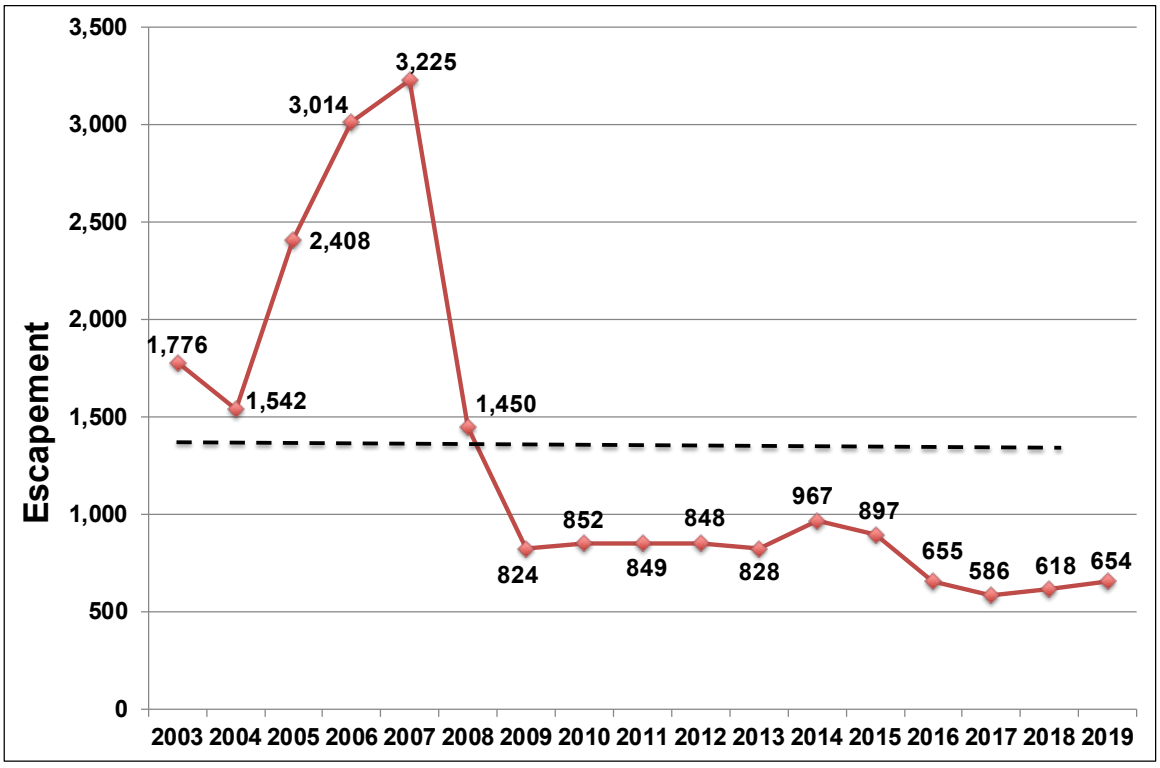

Figure 11: Annual Chinook escapement into the Kitwanga River through the KSEF from 2003 to 2019 - Dashed line is average from 2003 to 2018.

Length, age, and sex data was collected from 35 Chinook salmon (~5% of the total run) in 2019. Male and female sex ratios were 49 and 51 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 the 81 to 85cm class (23%), and 86 to 90cm class (73%; Figure 13). Average fork length of the total sample was 86 cm and males and females were 87 and 85cm respectively (Table 4). The 2019 length results showed that female Chinook sampled in 2019 were very similar when compared to results observed since 2008 and males were the largest observed since 2008 (Table 5). In 2019, it was the first year on record that males were on average larger than females.

Age results for the 2019 Chinook samples were not available for inclusion in this report but will be presented in the 2020 KSEF Annual Report. Age results for 2018

that were not available in 2018 are presented below (Table 6). Of the readable scales from 2018 (36 samples out of a run total of 618 fish, or 6% of the 2018 run), the majority of fish (52.8%) were 4-year old's originating from the 2014 broodyear followed by 5-year old's (38.9%) originating from the 2013 broodyear and 6-year old's (5.6%) originating from the 2012 broodyear. The remaining were 3-year old's (2.8%) originating from the 2015 broodyear.

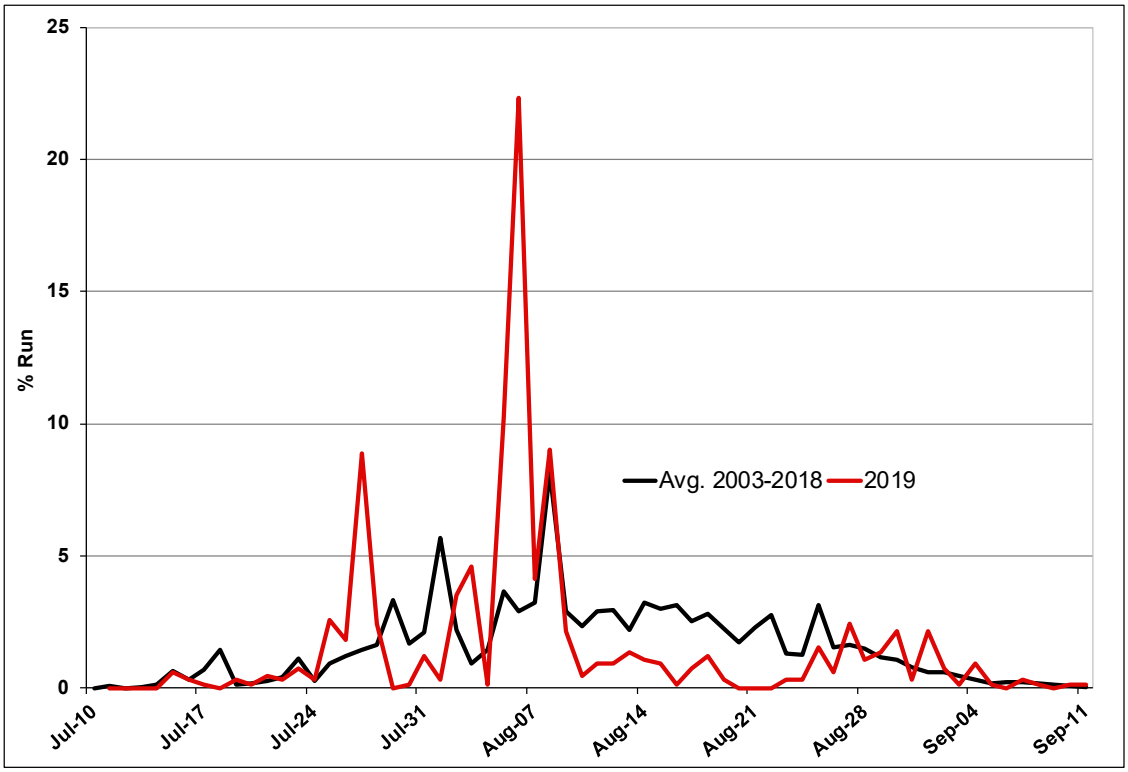

Figure 12: Kitwanga River Chinook salmon average run timing (daily run percent) for 2003-2018 vs. run timing for 2019 at the KSEF.

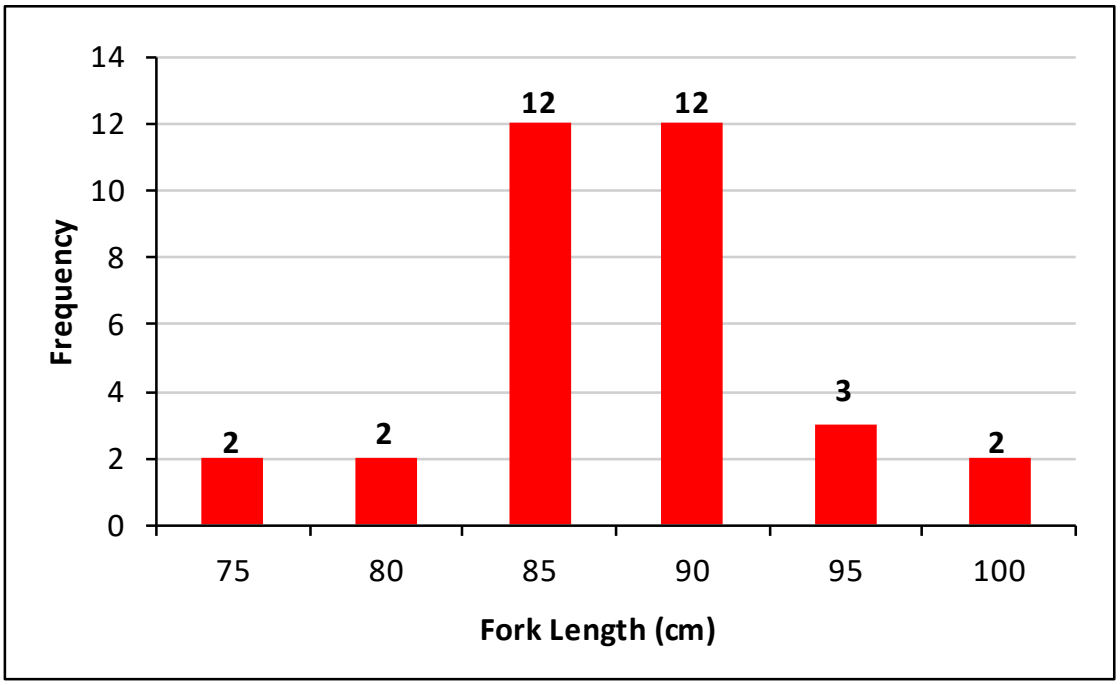

Figure 13: Fork length distribution for Chinook salmon in 2019 (n=33); X axis labels are 5 cm length class upper boundaries.

Table 4: Chinook salmon fork length (cm) statistics at the KSEF in 2019.

	Male	Female	Combined
Mean	87	85	86
Min	72	78	72
Max	99	92	99
Count	15*	18	33

Lengths for two of the males were not available

Table 5: Average length (cm) for Chinook female, male and combined sexes from 2008 to 2019.

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
2019	86.7	85.4	86.0

Table 6:Age distribution for Chinook salmon sampled in 2018 at the KSEF.

European	Gilbert-Rich	Brood Yr.	Frequency	Percent
14	62	**2012**	2	5.6%
13	52	**2013**	14	38.9%
12	42	**2014**	19	52.8%
11	32	**2015**	1	2.8%
		Total	36	100%

On average (2008-2018), 5-year-olds have comprised 51% of the run, with 4-year olds at 36%, 6-year olds at 9% and 3-year olds at 3%. Notable exceptions occurred in 2010, 2014 and 2018 when age 4 fish dominated the run; although in each of these three years, the total Chinook sampled were the lowest for 2008-2018.

Table 7 shows the average fork length (cm) for age and sex for brood years 2005 to 2015. Over this time period the lengths have remained relatively consistent with fork length standard deviations for ages 3, 4, 5, and 6 of 10.1, 5.6, 2.5 and 4.7 respectively.

Table 7: Average fork length (cm) for age class, and sex for Chinook salmon - brood years 2005 to 2015

Brood Yr	3yr olds			4yr olds			5yr olds			6yr olds		
	Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)	
		F	M		F	M		F	M		F	M
2005	2008			2009			2010			2011	-	97.0
2006	2009			2010			2011	86.3	83.8	2012	-	90.2
2007	2010			2011	66.5	68.1	2012	85.9	84.0	2013	-	95.5
2008	2011	-	58.8	2012	69.7	70.9	2013	84.2	85.8	2014	95.0	83.0
2009	2012	-	64.3	2013	74.5	71.3	2014	87.8	82.5	2015	90.6	-
2010	2013	-	45.2	2014	82.5	72.0	2015	87.1	86.0	2016	85.0	-
2011	2014	-	-	2015	78.3	71.4	2016	82.6	84.0	2017	88.7	-
2012	2015	-	52.5	2016	81.8	78.2	2017	83.4	84.0	2018	90.0	-
2013	2016	-	-	2017	86.5	76.1	2018	77.5	87.3	2019		
2014	2017	-	42.4	2018	78.3	74.8	2019					
2015	2018	-	67.0	2019								

4.3 Pink Salmon

A total of 52,644 odd-year pink were counted at the KSEF in 2019. This is well below the long-term odd-year average of 223,124 from 2003 to 2017 (Figure 16), and is the lowest odd-year return ever recorded at the KSEF.

The 2019 pink returns originated from the 2017 brood year, which had an escapement of 179,071 fish, indicating the 2019 return was about 71% below replacement value for the stock (Figure 14).

The majority of the pinks counted in 2019 migrated through the KSEF from the second week of August until mid-September (Figure 15). Peak counts occurred on August 8th (n=4,932), August 9th (n=5,699), September 1st (n=2,516) and September 4th (n=2,620), which when these days are combined represents 30% of the escapement. The run timing through the KSEF in 2019 was about five days later than observed in previous odd years (2003-2017) with the peak of the run arriving approximately two week earlier.

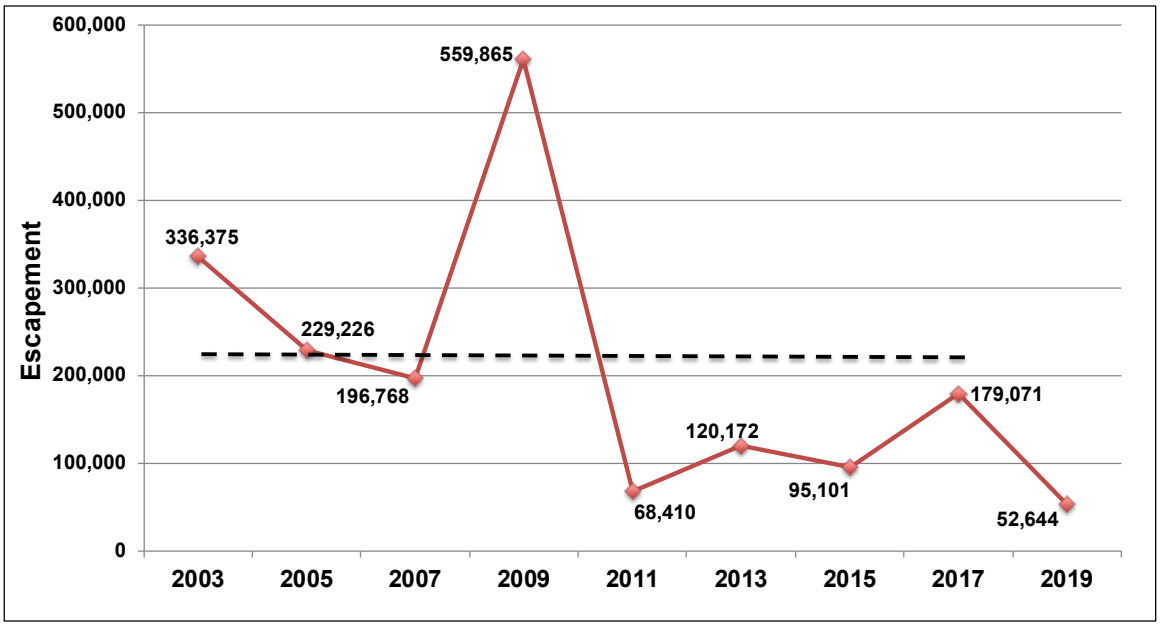

Figure 14: Annual escapement for odd-year pink runs at the KSEF from 2003 to 2019 - Dashed line is average odd year from 2003 to 2017.

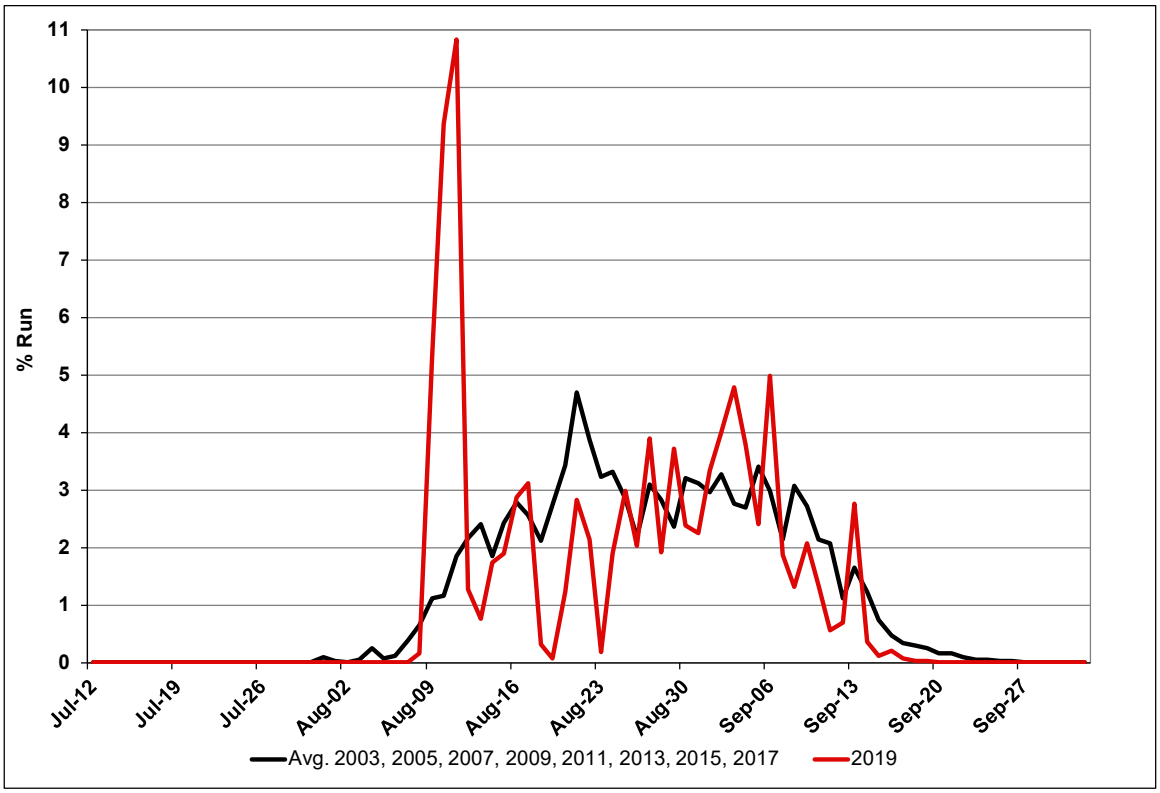

Figure 15: Run timing for pink salmon (daily run %) in 2019 vs. average odd-year run from 2003 to 2017.

4.4 Chum Salmon

A total of 492 chum were counted through the KSEF in 2019. This is below the long-term average of 674 from 2003 to 2018 (Figure 16). The 2019 run compares to a maximum return of 1,862 fish in 2005 and a minimum of 150 in 2008. The 2019 escapement estimate was 27% below the average escapement of 674 fish recorded from 2003-2018 and seems to be in line with lower stable average seen from 2010 to 2015 and 2017, 2018 (n=393).

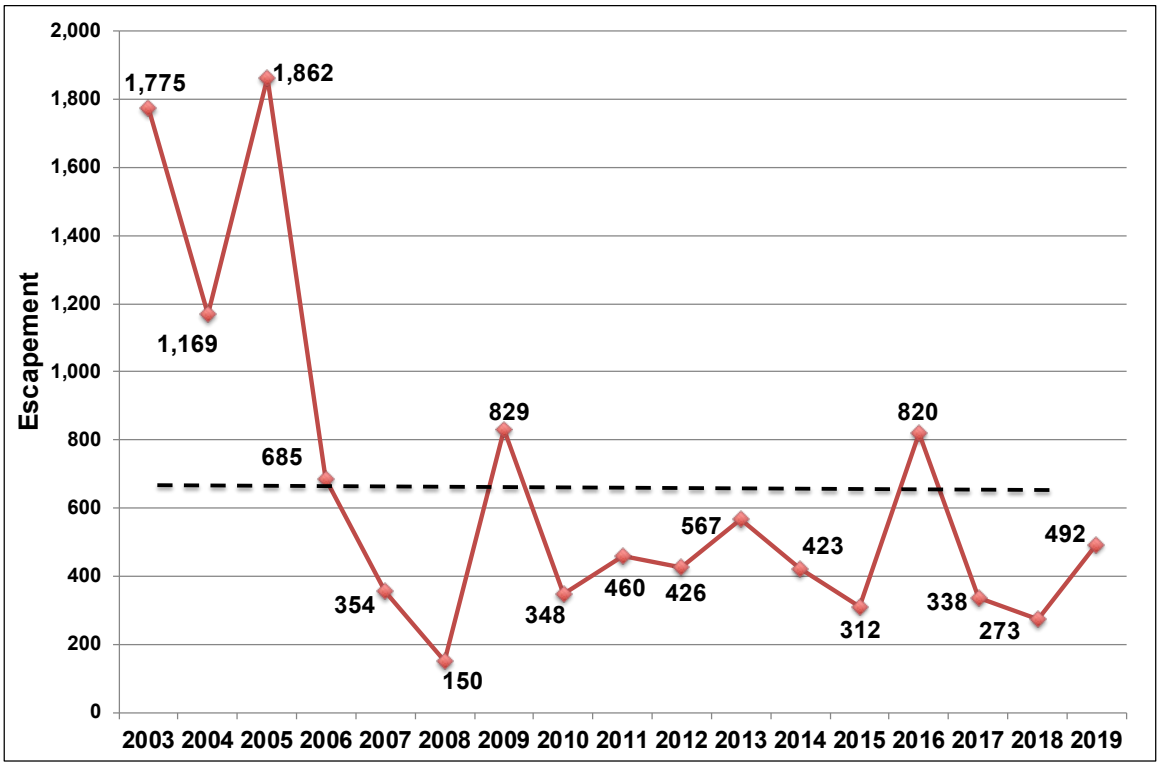

Figure 16: Annual escapement for chum salmon at the KSEF from 2003 to 2019 - Dashed line is average from 2003 to 2018.

In 2019, the first chum salmon was counted at the KSEF on August 19th and the last counted on September 25th. In general, a steady pulse of chum returns were noted from August 31st to September 12th, when 73% of the run passed the fence. Figure 17 shows that the 2019 chum run timing, was approximately two week later than observed in previous years and concluded about one week earlier.

Fork length, sex and age data was collected from 61 chum salmon in 2019 (13% of the run). Male to female sex ratio were approximately 50% and on average, females and males were similar in size (76cm respectively; Table 8). The 2019 length samples were overall, in the range of average size results observed since 2008 (Table 9).

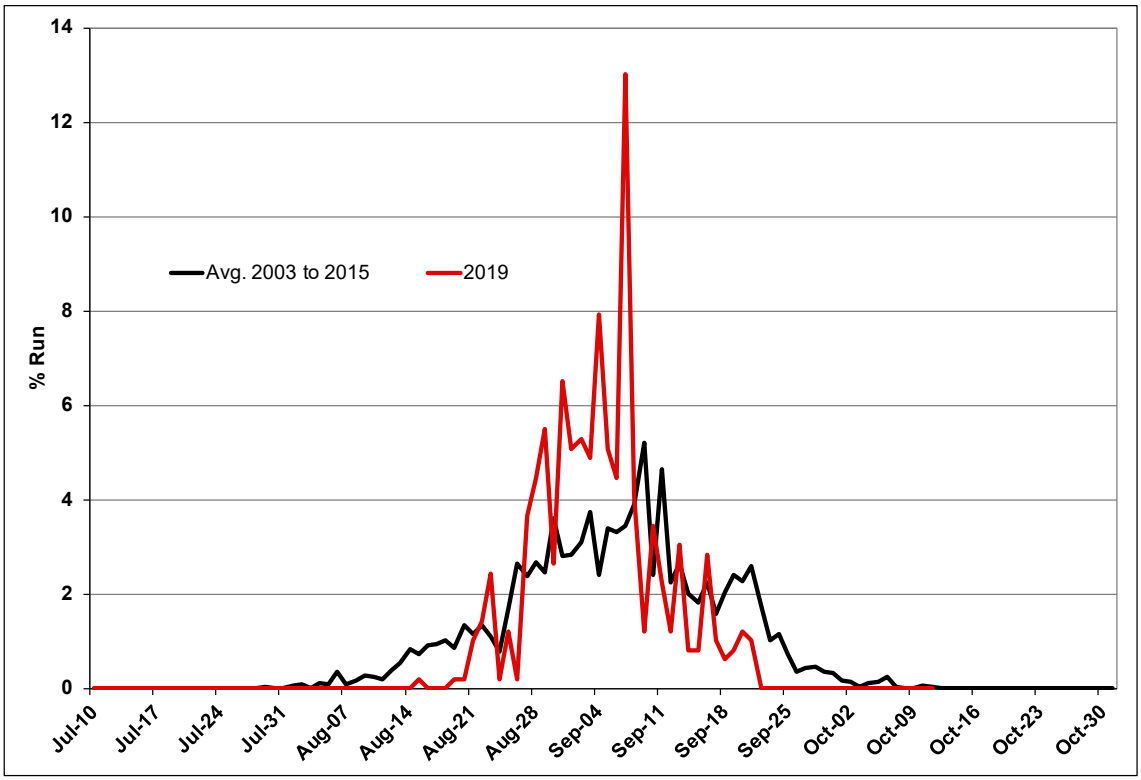

Figure 17: Kitwanga River chum salmon average run timing (daily run %) for 2003-2015[6] vs. run timing for 2019 at the KSEF.

Table 8: Chum salmon fork length (cm) statistics at the KSEF in 2019.

	Male	Female	Combined
Mean	76	76	76
Min	59	64	59
Max	88	85	88
Count	31	30	61

Table 9: Average length (cm) for chum female, male and combined sexes from 2008 to 2019.

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

[6] Note the KSEF was shut down too early in both 2016 and 2017 to use those years for run timing comparison, 2018 was screened out as well because that year had record low water levels which likely influenced run timing.

Year	Male	Female	Combined
2017	77.9	77.0	77.5
2018	68.9	72.8	70.8
2019	76.2	75.9	76.1

Age results for the 2019 chum samples were not available for inclusion in this report but will be presented in the 2020 KSEF Annual Report. Age results for 2018 that were not available in 2018 are presented below (Table 9). Of the readable scales from 2018 (37 samples out of a run total of 273 fish, or 14% of the 2018 run), the majority of fish (56.8%) were 4-year old's originating from the 2014 broodyear and 3-year old's (43.2%) originating from the 2015 broodyear (Table 10).

Table 10: Age distribution for chum salmon sampled in 2018 at the KSEF.

European	Gilbert-Rich	Brood Yr.	Frequency	Percent
03	41	**2014**	21	56.8%
02	31	**2015**	16	43.2%
		Total	37	100%

On average (2008-2018), 4-year-olds have comprised 68% of the run, with 5-year olds at 19%, and 3-year olds at 13%. A notable exception occurred in 2012 when age 5 fish dominated the run (73%).

Table 11 shows the average fork length (cm) for age and sex for brood years 2006 to 2015. Over this time period the lengths have remained relatively consistent with fork length standard deviations for ages 3, 4, and 5, of 2.9, 2.8, and 3.9 respectively. There was only one year of data with age 6 chum (2013).

Table 11: Average fork length (cm) for age class, and sex for chum salmon - brood years 2006 to 2015

Brood Yr	3yr olds			4yr olds			5yr olds			6yr olds		
	Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)	
		F	M		F	M		F	M		F	M
2006	2009			2010			2011	71.5	78.0	2012		
2007	2010			2011	70.2	70.8	2012	77.9	81.8	2013	-	78.0
2008	2011	68.0	72.0	2012	76.9	78.1	2013	78.0	81.3	2014		
2009	2012	70.0	72.2	2013	74.4	77.1	2014	-	73.0	2015		
2010	2013	68.5	63.5	2014	70.5	73.2	2015	78.0	82.5	2016		
2011	2014	-	65.0	2015	74.5	75.6	2016	78.0	84.7	2017		
2012	2015	71.0	71.5	2016	74.0	77.0	2017	78.4	84.2	2018		
2013	2016	70.0	-	2017	75.6	76.4	2018	-	-	2019		
2014	2017	72.0	71.5	2018	74.1	76.6	2019					
2015	2018	66.0	65.9	2019								

4.5 Coho Salmon

A total of 1,647 coho were counted at the KSEF in 2019. This was an increase in numbers recorded over the last two years, but less than half the long-term average of 3,698 from 2003 to 2018 (Figure 18). As Figure 18 demonstrates, Kitwanga coho returns have been variable for the study period.

Overall, run timing for coho in 2019 was similar to the 2003-2015 (Figure 19).

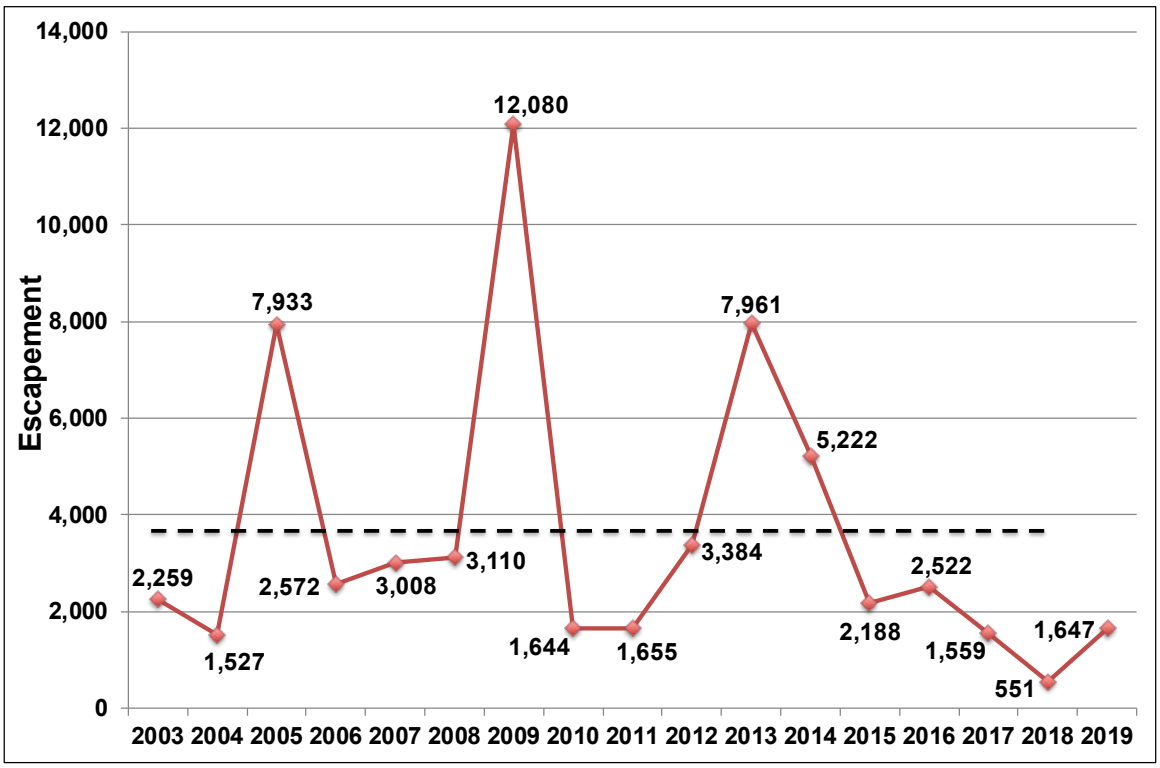

Figure 18: Annual escapement for coho salmon from 2003 to 2019 at the KSEF - Dashed line is average from 2003 to 2018.

Length, age, and sex data was collected from 49 coho salmon in 2019 (3% of the total run). Male and female coho sex ratios from the samples were 71% and 29% respectively falling within the parameters of what has been seen previously on the Kitwanga River. Average fork length for males and females were 62cm and 60cm respectively (Table 12). The 2019 length samples were overall, in the range of average size results observed since 2010 (Table 13). Fork length histogram (5cm intervals) showed a uni-modal distribution, dominated by fish in the 61cm to 65cm size class (35% - Figure 20).

Age results for the 2019 coho samples were not available for inclusion in this report but will be presented in the 2020 KSEF Annual Report. Age results for 2018 that were not available in 2019 are presented below (Table 14). Of the readable scales from 2018 (35 samples out of a run total of 551 fish, or 6% of the 2018 run), the majority of fish (60.0%) were 3-year old's originating from the 2015 broodyear and 4-year old's (40.0%) originating from the 2014 broodyear (Table 14).

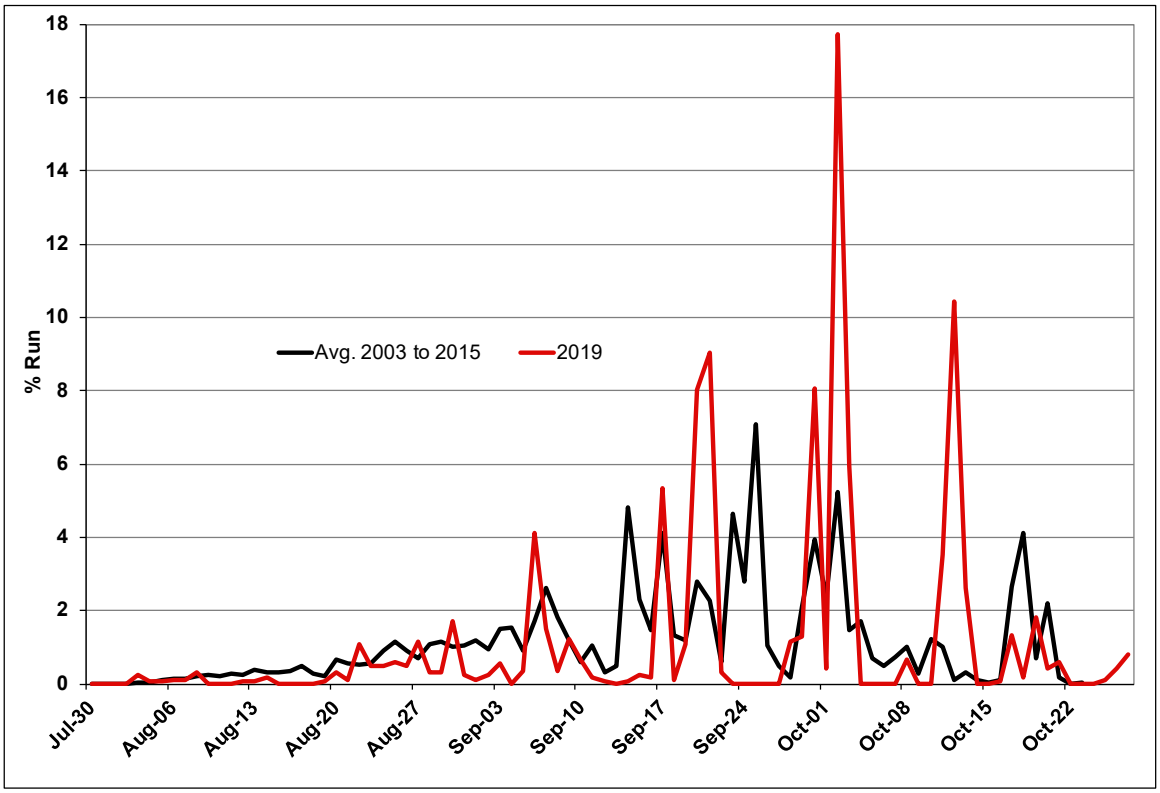

Figure 19: Kitwanga River coho salmon average run timing (daily run %) for 2003-2015[7] vs. run timing for 2019 at the KSEF.

Table 12: Coho salmon fork length (cm) statistics at the KSEF in 2019.

	Male	Female	Combined
Mean	62	60	61
Min	39	40	39
Max	75	69	75
Count	35	14	49

[7] Note KSEF was shut down on September 1st in 2016 and on September 11 in 2017, and 2018 had record low water levels which influenced run timing.

Table 13: Average length (cm) for coho female, male and combined sexes from 2010 to 2019.

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
2019	61.8	60.1	60.9

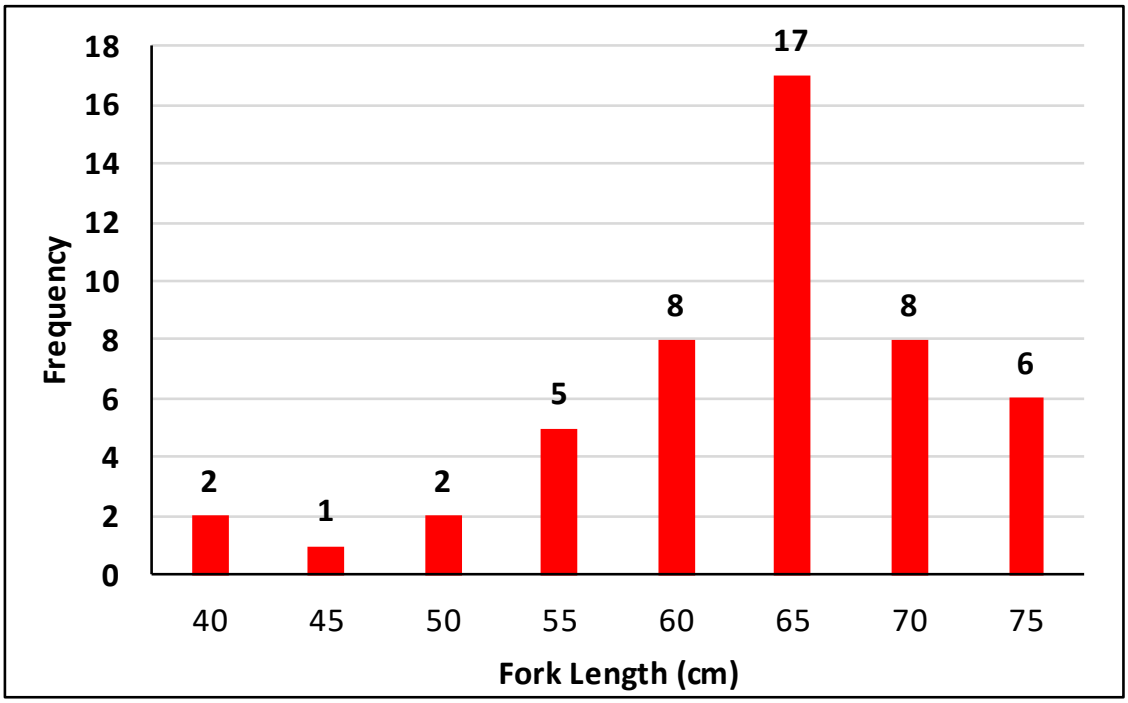

Figure 20: Fork length distribution for coho salmon in 2019 (n=49); X axis labels are 5 cm length class upper boundaries.

Table 14: Age distribution for coho salmon sampled in 2018 at the KSEF.

European	Gilbert-Rich	Brood Yr.	Frequency	Percent
21	43	**2014**	14	40.0%
11	32	**2015**	21	60.0%
		Total	35	100%

On average (2010-2018), 3-year-olds have comprised 79% of the run, with 4-year olds at 20%, and 5-year olds at 1%.

Table 15 shows the average fork length (cm) for age and sex for brood years 2006 to 2015. Over this time period the lengths have remained relatively consistent with fork length standard deviations for ages 3 and 4 of 3.4, 3.2 respectively. There was only one year of data with age 5 coho (2017).

Table 15: Average fork length (cm) for age class, and sex for coho salmon - brood years 2006 to 2015

Brood Yr	3yr olds			4yr olds			5yr olds		
	Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)		Return Yr	Avg Fork Length (cm)	
		F	M		F	M		F	M
2006	2009			2010	68.2	65.9	2011	-	-
2007	2010	64.3	65.6	2011	63.8	61.1	2012	-	-
2008	2011	61.4	60.8	2012	63.0	65.0	2013	-	-
2009	2012	60.4	62.5	2013	60.5	65.4	2014	-	-
2010	2013	60.1	64.0	2014	65.0	63.3	2015	-	-
2011	2014	62.1	62.7	2015	-	56.6	2016	-	-
2012	2015	60.2	57.1	2016	61.0	65.0	2017	70.0	-
2013	2016	66.0	65.3	2017	-	60.5	2018	-	-
2014	2017	64.0	63.9	2018	66.4	69.2	2019		
2015	2018	67.0	72.2	2019					

In the spring of 2018, GFA applied 5,863 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. A good portion of 2018 CWT smolts were expected to return as adults in the fall of 2019. A total of 103 CWT fish out of 1,322 examined fish were counted through the KSEF in 2019. Extrapolating to the total run, an estimated 129 tagged fish passed through the fence in 2019 (2.2% 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.

Sockeye escapement in 2019 was 125, which is the lowest recorded since the fence was first installed at the current location in 2003, and well below the long-term (2003-2018) average of 4,120. Overall, the exploitation rate on Kitwanga sockeye has remained relatively low in recent years and again in 2019 at ~23%. Overall, the 2019 is likely one of the lowest sockeye returns to the Kitwanga River and a deep cause of concern. Poor overall salmon survival has been attributed to poor marine survival for over a decade. The potential effects of the ocean 'blob,' a mass of warmer water thought to be contributing to smaller-size-at-age fish, reduced body condition factor and later run timing (Cox-Rogers and Carr-Harris 2019) is likely impacting salmon success. The 'son of the Blob' another warm water mass moved into circulation late in 2018 and may disrupt future sockeye run timing patterns (Cox-Rogers 2018).
With such a small escapement and subsequent biological sample size in 2019, the results for body lengths, sex ratios, age should be viewed with great caution. However, for what it is worth the 2019 results showed that Kitwanga sockeye body lengths were similar to what has been seen previously in the last 17 years, sex ratios were even and age results showed that most fish were 4 year olds with smaller percentage of 5's.

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 2019 and early 2020, GFA updated our Kitwanga sockeye salmon recovery plan (Cleveland et al 2020), originally completed in 2006 (Cleveland et al 2006), with additional directed studies to come from the revised strategy.

A total of 654 Chinook were counted at the KSEF in 2019. This is less than half of the long-term escapement average of 1,334 from 2003 to 2018. Chinook salmon in 2019 (n=654) have declined from higher abundances seen in the earlier 2000's, and seem to be part of the second lower tier of escapement number seen in the Kitwanga since 2003. From 2003 to 2008, the average escapement was 2,235 and from 2009 to 2015 the average escapement was 866. During the last four years (2016-2019), the average escapement has dropped to 628, which is cause for concern. Overall, sex ratios in 2019 were in line with previous years and a healthy population. The 2019 length results showed that female Chinook sampled in 2019 were very similar when compared to results observed since 2008 and males were the largest observed since 2008. In 2019, it was the first year on record that males were on average larger than females. Overall the peak of run timing in 2019 was earlier when compared with the 2003-2018 average run timing, with 77% of the run having passed the fence by August 9. This compares to 50% (average between 2003-2018) seen previously to this date. This early run timing may be the result of using the two camera's in 2019, as Chinook in particular, seemed to be more comfortable using the camera chutes versus the traditional counting areas located on both sides of the river.

A total of 52,644 adult pink salmon migrated past the KSEF in 2019 which is well below the running odd-year average of 223,124 fish (2003 – 2017). In the Kitwanga watershed odd year runs normally dominate over even year runs. The 2019 pink return originated from the 2017 brood year, which had an escapement of 179,071 fish, indicating the 2019 return was about 71% below replacement

value for the stock. The run timing in 2019 was about five days later than normal (2003-2017) with the peak of the run arriving approximately two weeks earlier.

A total of 492 adult chum salmon returned to the Kitwanga River in 2019, which was the largest return since 2016 (n=820). The 2019 escapement estimate was 27% below the average escapement of 674 fish recorded from 2003-2018 and seems to be in line with a lower stable average seen from 2010 to 2015 and 2017, 2018 (n=393). Sex ratios in 2019 were even which was in line with previous years for chum salmon and males and females were also similar in size. The 2019 chum run timing was approximately two weeks later than normal and concluded about one week earlier.

A total of 1,647 adult coho were counted at the KSEF in 2019, which was less than half the long-term average of 3,698 from 2003 to 2018. Overall, sex ratios in 2019 were biased towards males, which is a little bit concerning but in line with what has been seen in previous years (10-year average is 61% males and 39% females). The 2019 coho length samples were overall, in the range of average size results observed since 2010. Overall, run timing for coho in 2019 was on time compared to previous years (2003-2015[8]) average run timing. The fence was closed on October 31st and during the last stream walk downstream from the fence, GFA technicians counted 13 coho, which were added to the total of 1,647. Leading up to this stream walk, a total of 9 coho had passed through the fence over a 1-week period. Prior to 2018, which was a very low flow year and equated to late arriving sockeye and coho, 100% of the coho have passed through the fence by October 31st.

[8] Note the KSEF was shut down too early in both 2016 and 2017 to use those years for run timing comparison, 2018 was screened out as well because that year had record low water levels which likely influenced run timing.

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