Gitanyow *Fisheries* Authority

Kitwanga River Salmon Enumeration Facility (KSEF) – 2021 Annual Report

Submitted to: Gitanyow Hereditary Chiefs,
Fisheries and Oceans, Canada,
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Abstract

In 2021, the Gitanyow Fisheries Authority (GFA) operated the Kitwanga River Salmon Enumeration Facility (KSEF) for the 19th consecutive year to count and biologically sample Pacific salmon returning to the Kitwanga River. The KSEF was operational from July 15th to September 21st. Water levels were higher than the long term averages recorded between 2004 to 2019, but not up to 2020 water levels. Higher water levels again made operations particularly challenging when in the early morning of September 21, after heavy rainfall and flooding on the Kitwanga River, all the panels had to be left opened to relieve pressure on the KSEF to prevent permanent damage to the facility. The river discharge increased over 40 m^3/s over a 13-hour period. During this period large logs and other debris were carried down the river and were lodged on the fence. Beginning on August 7, GFA had set-up the Kitwanga smolt fence (KsF) below Gitanyow Lake (30km upstream) to be used as a secondary adult salmon counting facility, primarily to count sockeye and coho. Since the remote telemetry underwater digital video camera recorder (DVR) system at the KsF was in place prior to the time that the KSEF was breached, GFA is confident that no sockeye or coho would have passed the KsF site undetected. Many salmon spawn between the KSEF and KsF but all the sockeye and about half of the coho spawn above the KsF site. The KsF was operated from August 7 - November 8, 2021.

Sockeye escapement in 2021 was 290, which was well below the long-term (2003-2020) average of 3,694. Overall, the exploitation rate on Kitwanga sockeye had remained relatively low in recent years (average of 16%) but was much higher in 2021 at 48%, primarily through catches from the Alaskan Marine Fisheries (43%). Fork length measurements, age and sex data were collected from 34 sockeye (~12% of the run) in 2021. Numbers of females and males were equal, which is within the normal sex ratio distribution observed previously. Sockeye lengths collected in 2021 were similar to the long-term average (52 to 59cm). Age results for the 2021 sockeye samples were not available for inclusion in this report but on average (2003-2020), 4-year-olds have comprised 81% of the run, with 5-year olds at 18% and 3-year olds at about 1%.

A total of 544 Chinook were counted at the KSEF in 2021. This is less than half of the long-term escapement average of 1,294 from 2003 to 2019. Chinook salmon in 2021 (n=544) 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)[1], the average escapement has dropped to 628, which is cause for concern. Overall, Chinook arrived later to the fence in 2021, but the peak of run timing was earlier when compared with the 2003-2019 average run timing, with 78% of the run passing through the KSEF by August 14. Which compares to 63% (average between 2003-2019) seen previously to this date.

[1] Note we did not get an overall escapement for 2020, with a minimum of 119 counted through the fence.

Overall, sex ratios in 2021 were in line with previous years and a healthy population. The 2021 length results showed that female Chinook sampled in 2021 were very similar when compared to results observed since 2008 and male Chinook sampled in 2021 were the smallest on record (average) when compared to results observed since 2008.

A total of 179,967 adult pink salmon migrated past the KSEF in 2021 which is in the range of the odd-year average of 204,181 from 2003 to 2019. The 2021 pink return originated from the 2019 brood year, which had an escapement of 52,644 fish, indicating the 2021 return was well above replacement value for the stock. The run timing in 2021 was in line with previous years (2003-2019), but larger numbers were not observed until August 13, which is about 5 days later than the odd-year long term average

A minimum estimate of 199 adult chum salmon returned to the Kitwanga River in 2021. Based on previous years run timing (2003-2019) 90.1% of the run should have passed the KSEF. Extrapolating from this, an estimated 219 chum were expected to go through the KSEF in 2021. The 2021 escapement estimate was 67% below the average escapement of 664 fish recorded from 2003-2019 and is lower still than the average seen from 2010 to 2015 and 2017, 2018 (n=393). Male to female sex ratio was 64% and 34% respectively which falls within what has been observed in previous years. The 2021 chum sampling provided the second consecutive year with the smallest average size observed since 2008. The 2021 chum run timing was similar to what has been observed in previous years.

An estimated total of 1,740 adult coho were counted at the KSEF, KsF and spawning grounds in 2021, which is close to half the long-term average of 3,410 from 2003 to 2020. Overall, sex ratios in 2021 were in line with previous years. The 2021 length results showed that male coho sampled in 2021 were a bit smaller when compared to results observed since 2016.

The operation of field fisheries programs in general in 2021 was very challenging given COVID implications and the subsequent high waters observed in September. That said, GFA was successful in maintaining crew safety throughout the year and still collect important salmon information to maintain our long-term datasets on Kitwanga salmon.

Acknowledgements

Gitanyow Fisheries Authority would like to thank the Gitanyow Hereditary Chiefs Office for their continued leadership and support for the GFA program. In 2021 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 2021 GFA technicians included: Les McLean, Earl McLean, Melissa Shirey (Biologist), Phillip Johnson, Brenton Williams, Morgan Douse, Johnny Martin, and Katrina Morgan. A special thanks to Dean Miller for his invaluable work and for his overall technical expertise. GFA project leads in 2021 included: Mark Cleveland and Jordan Beblow.

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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).

Over fishing in mixed stock fisheries in the ocean is thought to be one of the leading causes 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).

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 20%. With an average exploitation of 16% over the last four years.

The KSEF not only provides fishery management benefits for the Kitwanga sockeye salmon recovery plan, but it is also used as a middle Skeena salmon index to gauge the annual escapements of Kitwanga chinook, pink, chum and coho salmon. The information collected at the KSEF is relied upon in-season and post-season by DFO and First Nation fisheries managers that use the index to help manage Skeena salmon fisheries.

In 2021, the KSEF was operated with funds provided by the Pacific Salmon Commission, Fisheries and Ocean's Canada and from the Gitanyow Huwilp Sustainability Fund. This report summarizes the sampling results and findings for the KSEF program in 2021.

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.

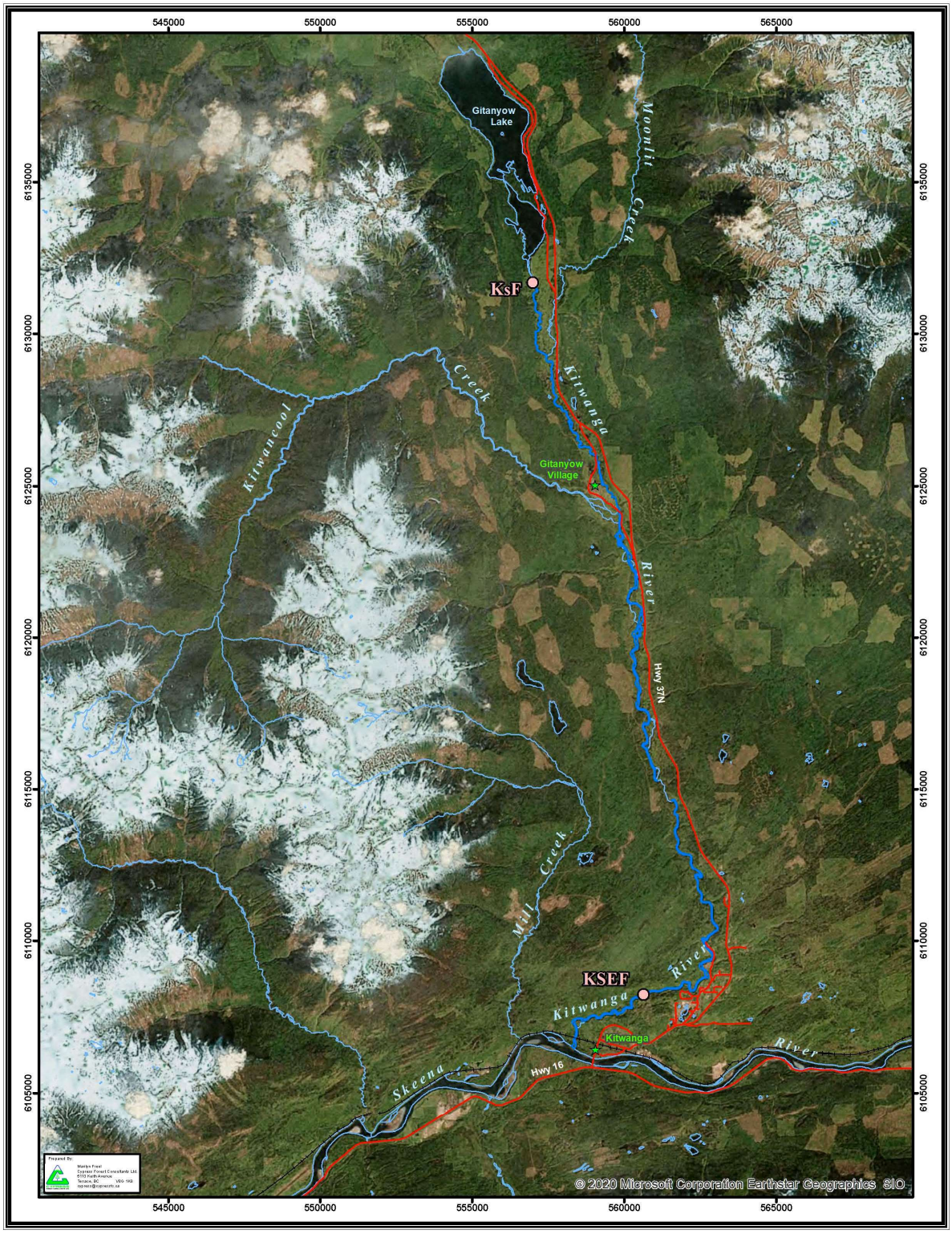

Figure 1: Skeena River and the lower Kitwanga Watershed including the KSEF, KsF and Gitanyow Lake.

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) and through camera counting boxes. From late fall through to the following summer, fence panels and counting boxes are removed allowing other 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.

The KSEF design is based on a rotating panel system attached to a series of nine aluminum transoms and an associated walkway. The transoms and walkway are mounted to 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" which is designed to block even adult pink salmon, the smallest of the five salmon species counted at the site. 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 utilizes a custom engineered mechanical system, powered by a compressed air that opens each panel to clean off debris in the same manner as the manual system (Figure 2). Air is supplied to the 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 at a desired preprogrammed schedule.

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).

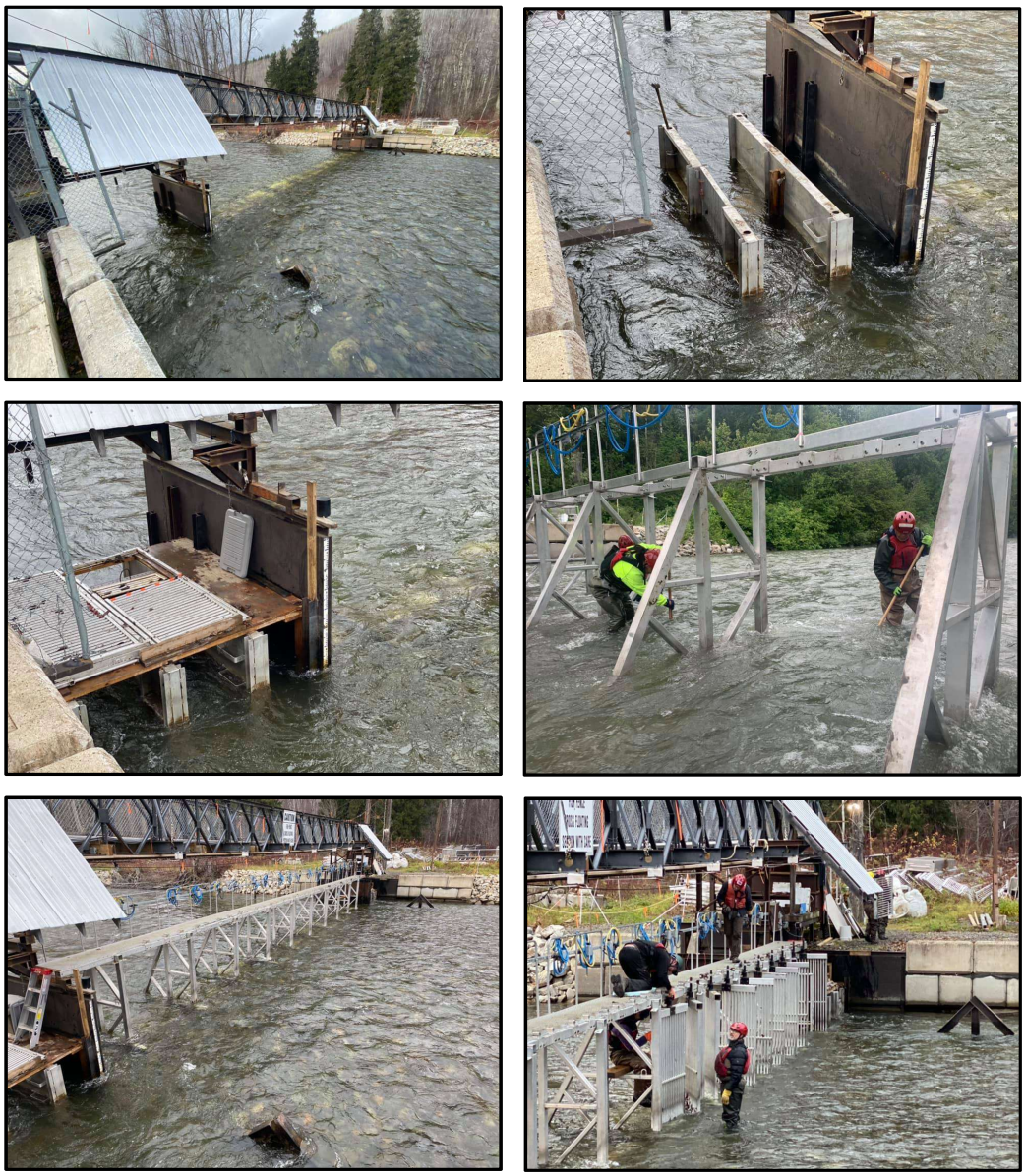

Figure 3: Photo series of installation of the KSEF structure.

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 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 2021, 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, predator wounds, etc.), 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. In 2021, the sockeye scales were sent to the BC Provincial Aging Lab 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 at least two fisheries technicians operate the KSEF on a daily basis. The hours of fence operation are usually during daylight hours only[2]. The KSEF is closed nightly preventing upstream migration between dusk and dawn.

A permanently erected stage gauge is used 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 2021. Water Service Canada installed a hydrometric station, approximately 45 m downstream from the KSEF in

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

the early spring of 2021. Water levels, discharge and water temperature can be accessed through this station.

Starting in 2018, GFA has been successfully operating digital video camera recorders (DVR) to identify and count fish movement past the KSEF in addition to the two traditional counting boxes. This technology has proven to be very effective and fish seem to prefer using the camera chutes over and above the trap boxes. In fact, the system works so well that when GFA staff wish to collect biological samples from passing salmon, camera boxes must often to closed to force salmon through the sampling areas. In 2021, GFA operated a camera chute on river left (Figure 5).

Figure 5: Photo top left shows counting chute on river left and top right, sockeye going through, bottom left Chinook going through and bottom right, chum going through.

In 2020, GFA purchased, completely renovated and permanently set-up a mobile trailer for GFA office space and staff lodging to replace an old, out dated office building. The new office trailer was retrofitted and completed in time for the installation of the KSEF in early July of 2020 (Figure 6).

Figure 6: View of new GFA office at KSEF.

4. RESULTS

The operation of the KSEF in 2021 marked the 19th consecutive year that the facility was used to enumerate salmon on the Kitwanga River. The KSEF was operational from July 15th to September 20th, 2021. Normal operations at the KSEF would see the project continue to the end of October, when most of the returning salmon would have passed the site. Water levels at the KSEF were higher than the long term averages recorded between 2004 to 2019 (excluding 2018 low flow year) for the majority of the program through to the removal of the fence starting on September 21 (Figure 7). During the evening of September 20 and the early morning of September 21, after heavy rainfall and flooding on the Kitwanga River, all the panels had to be left opened to relieve pressure on the fence and potentially prevent permanent damage to the facility (Figure 8). The river discharge increased over 40 m^3/s over a 13-hour period. During this period large logs and other debris were carried down the river and were lodged on the fence. GFA crews spent a considerable amount of time, when safety permitted, dislodging debris and cleaning the site, which was made more challenging by the persistent high flow through the week that followed. The hydrograph from

Water Survey Canada for the period leading up to the September 20/21 event is shown in Figure 9.

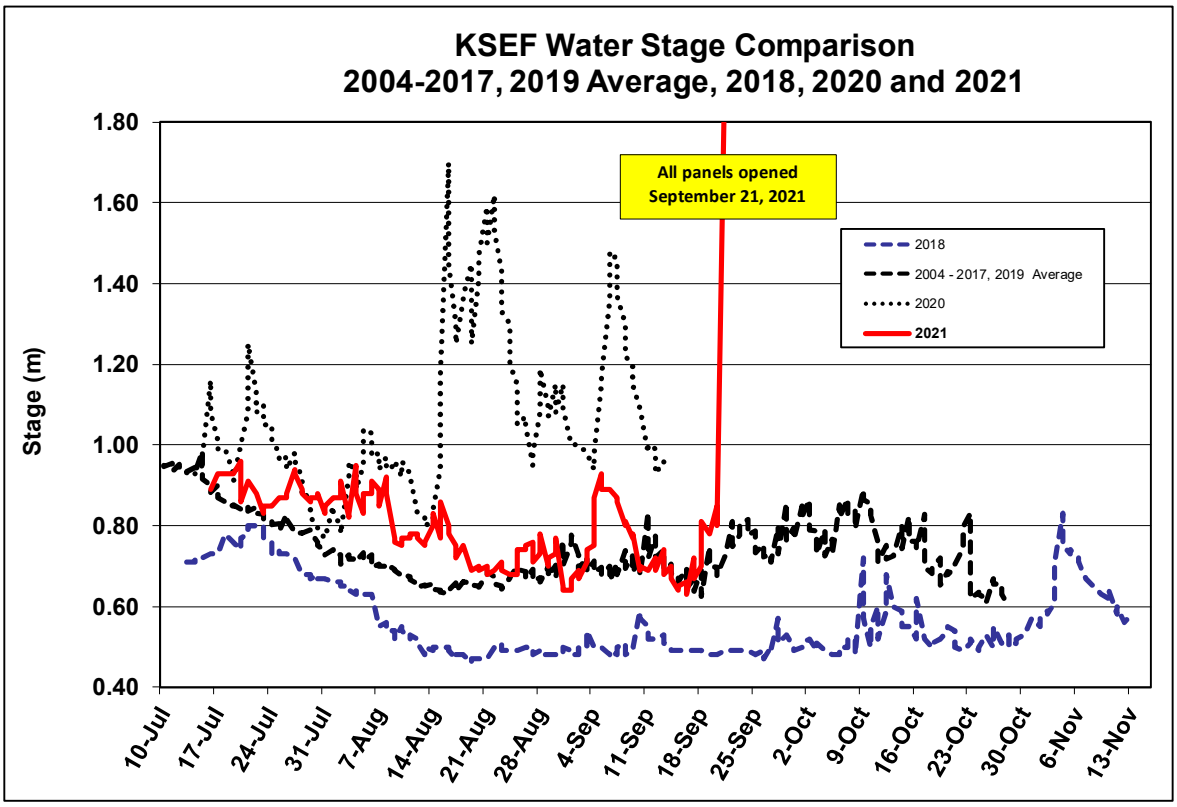

Figure 7: Average stage recordings at the KSEF (2004-2017, 2019 average, 2018, 2020) vs. 2021 results.

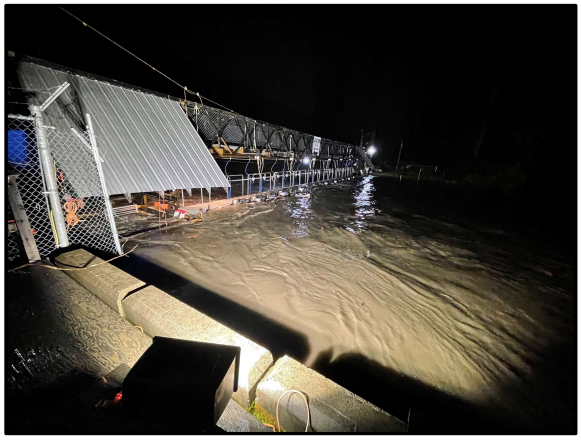

Figure 8: Photo during the night on top left shows water up to counting boxes and near to top of panels. Photo on the top right shows water and debris built up to top of panels and water spilling over right bank. Bottom photo shows view towards right bank of water overtop of sampling area on left bank.

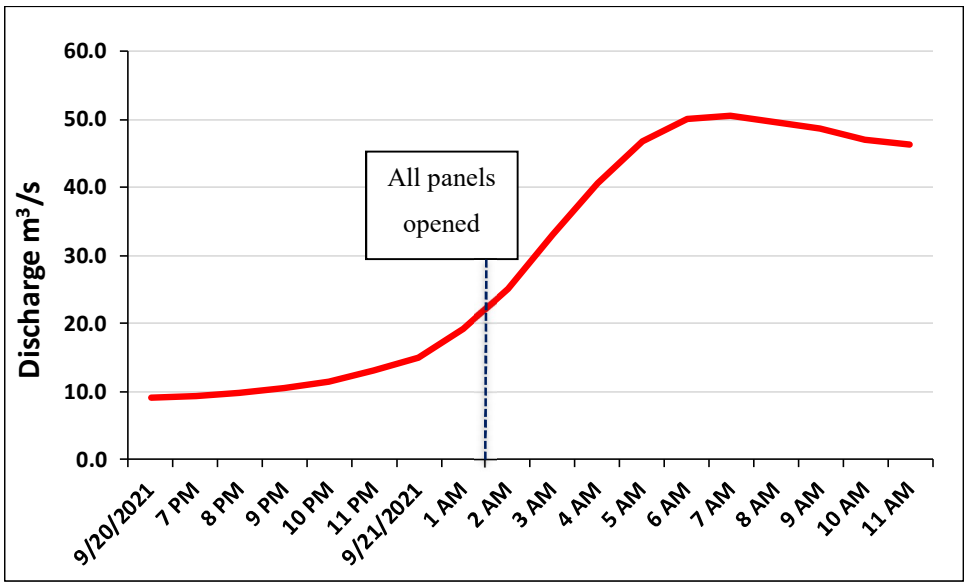

Figure 9: Hydrograph of Kitwanga River discharge from evening of September 20 to morning of September 21 (Water Service Canada).

As a result of the high water event, there was significant damage to the fence, including major scour along both banks and damage to some of the panels and sampling boxes. GFA in conjunction with DFO, is planning to conduct repairs in February of 2022.

A remote telemetry underwater digital video camera recorder (DVR) system has been in operation at the KsF since the start of the KSEF operations for 2021 (Figure 10). Many salmon spawn between the KSEF and KsF but all sockeye spawn above the KsF in Gitanyow Lake, so the installation and operation of the KsF as a back-up is very important to the Kitwanga sockeye rebuilding program. The system performed remarkably well and counted sockeye, coho, and trout through the facility uninterrupted using mostly solar power through to its close on November 8th. On September 20th, when panels had to be opened at the KSEF, we had a cumulative count at the KsF of 125 (61% of KSEF count) and GFA was confident that all sockeye were enumerated at both fences. The autonomous counting system at the KsF ensured that GFA was able to get an uninterrupted and complete sockeye count as well as a coho count (in combination with stream walks) in 2021.

Figure 10: View of camera box at KsF on October 31, 2021,

Water temperatures in the Kitwanga River were slightly higher for parts of the period that the KSEF was operational and fluctuated between 10-13°C prior to the fence being removed (Figure 11). Overall water temperatures were considered adequate for salmon survival during the operations of the KSEF in 2021.

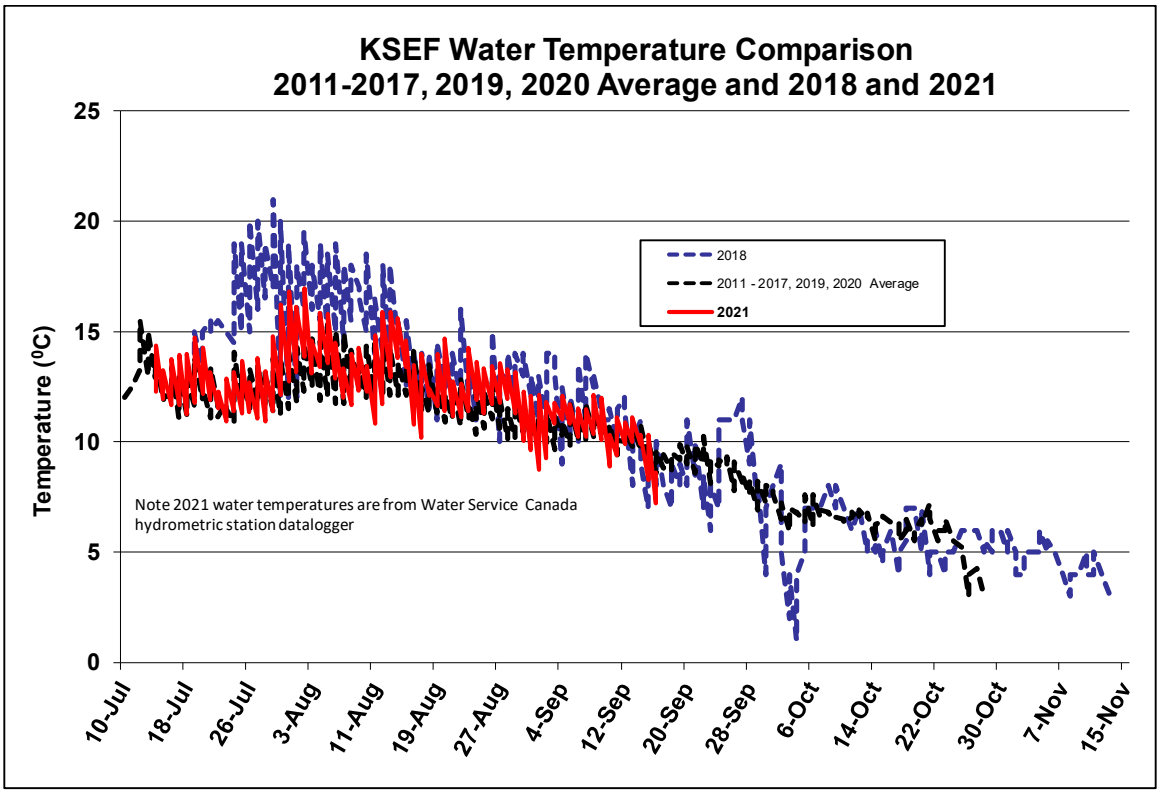

Figure 11: Average water temperature at the KSEF (2011-2017, 2019, 2020 average and 2018) vs. 2021 results.

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

4.1 Sockeye

A complete Kitwanga sockeye count was accurately estimated in 2021 through the operations of the KSEF and KsF between July 15 and October 29, 2021. A total of 290 sockeye were counted through the two facilities, 204 through the KSEF and 86 through the KsF (Figure 12).

This escapement is well below the long-term (2003-2020) average of 3,694.

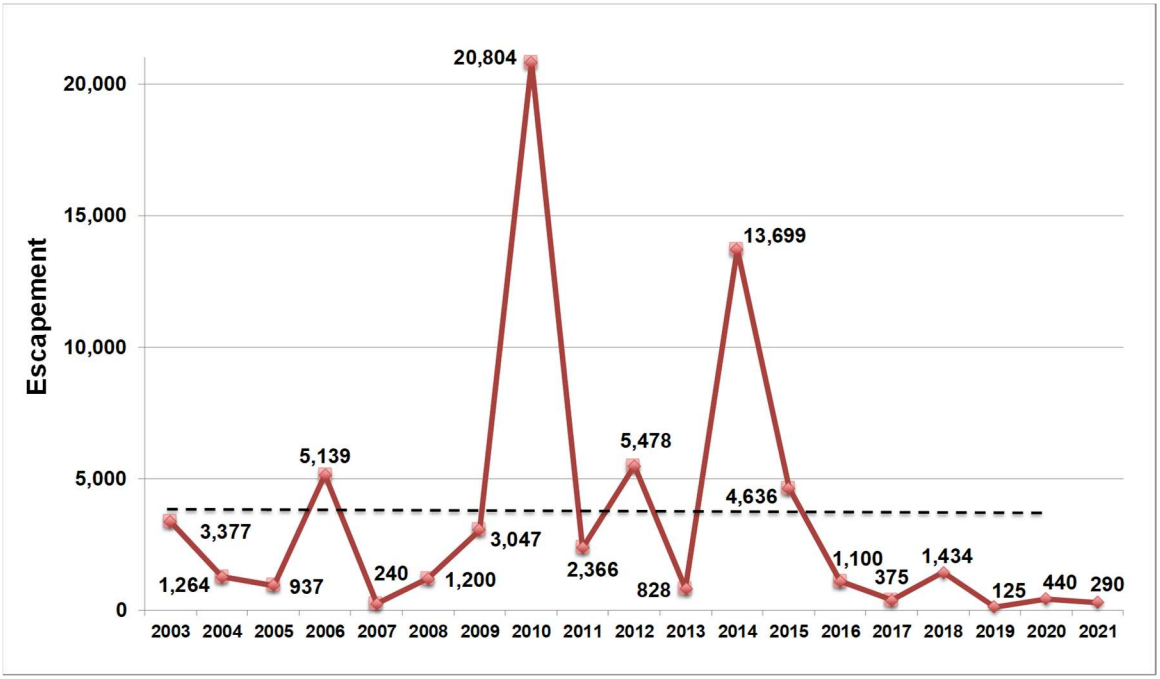

Figure 12: Annual Sockeye escapement into the Kitwanga River through the KSEF from 2003 to 2021 - Dashed line is average from 2003 to 2020.

Once the KSEF was installed and rendered fish tight on July 15th, the first sockeye to pass the site occurred on July 31st. Because the KSEF was closed down early in 2021, it is not possible to compare 2021 sockeye run timing with previous years' KSEF observations, but we have timing data from the KsF and will be able to use this as a baseline for coming years. However, we note that usually 50% of the run has passed the KSEF by August 30, and 75% by September 11 of any given year (Figure 13). Figure 13 also shows the run timing through the KsF. Taking into account the time it takes sockeye to migrate to the KsF, which is just downstream from their spawning grounds in Gitanyow Lake; an average of 14 days based on radio telemetry and PIT tag studies conducted in 2017, 2018 and in 2021. In looking at the run timing with this information, the 2021 timing appears to be in line with previous years.

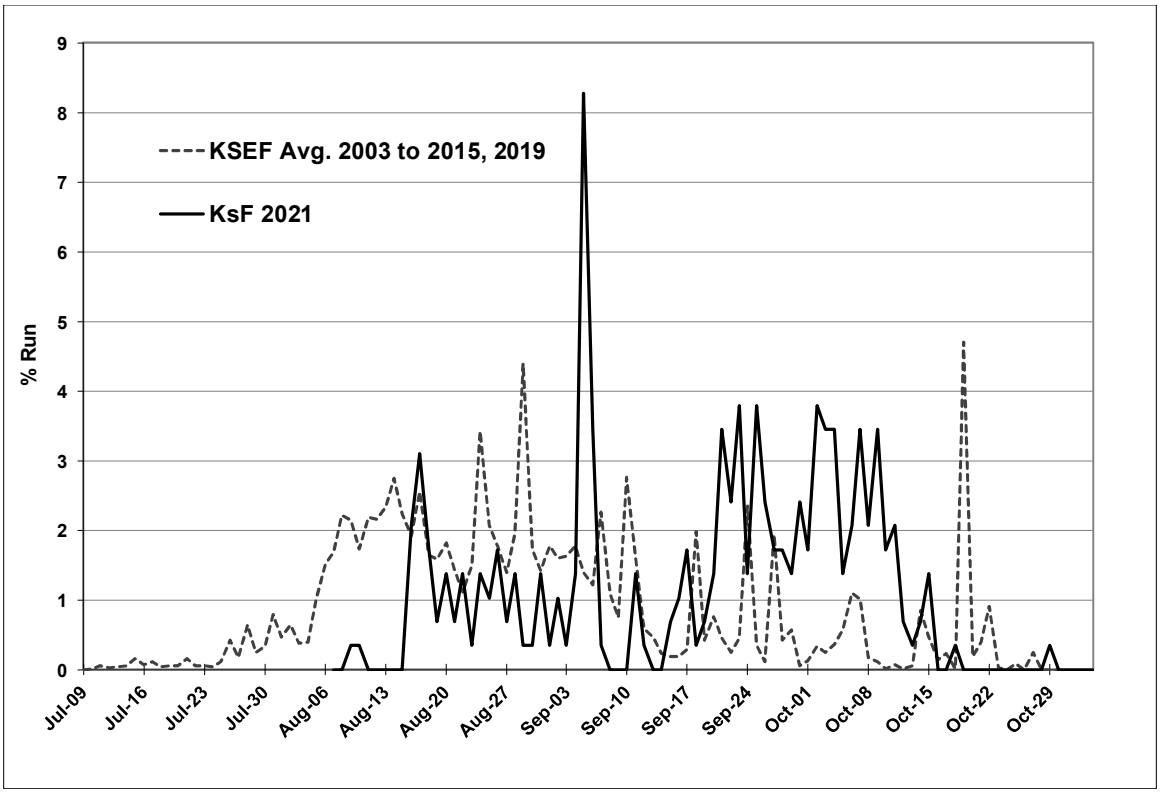

Figure 13: Kitwanga River sockeye salmon average run timing (daily run percent) for 2003-2015 and 2019 at the KSEF and 2021 run timing through the KsF.

Preliminary fishery exploitation rates for 2021 reported by DFO in 2021 were estimated at 48%, 43% in the Alaskan Marine, 0% Canadian Marine including in-river demonstration fisheries, 5% In-river FSC and 0% in-river recreational (pers. comm., Carr-Harris, 2021). Without exploitation (estimated 268 sockeye removed), the estimated total return for 2021 would have been approximately 558 sockeye (Figure 14). The exploitation rate is over double what has occurred over the last four years and the highest since 2016 (30%).

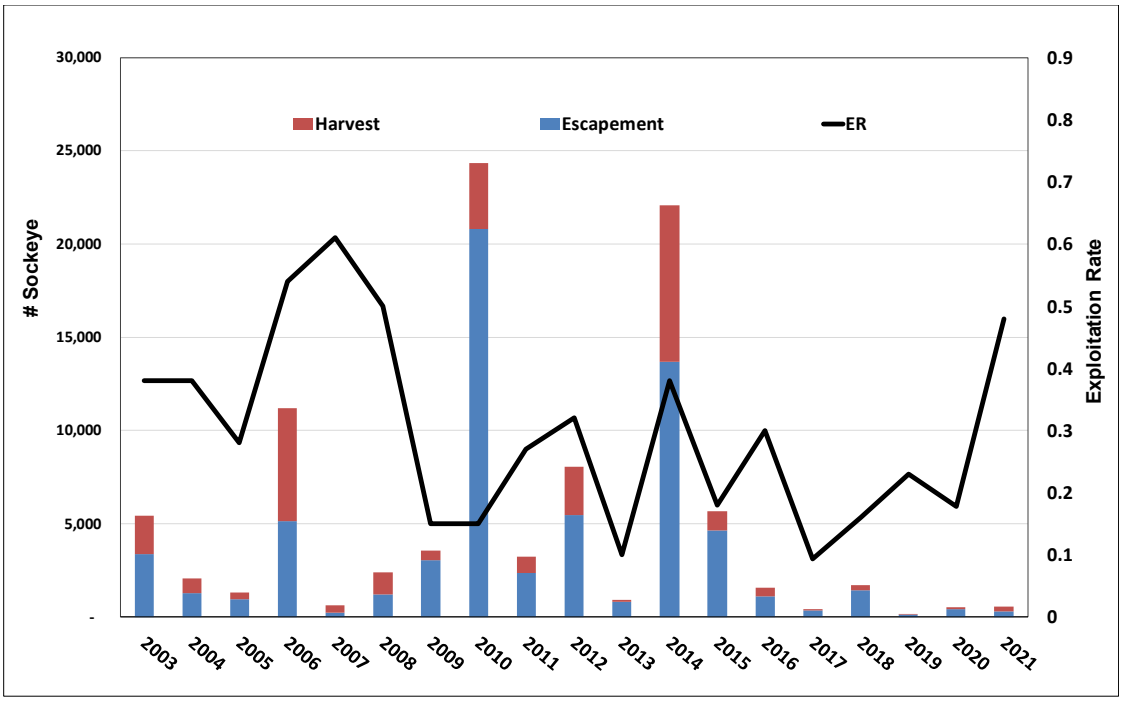

Figure 14: Kitwanga River sockeye salmon escapement and exploitation 2003-2021.

Fork length measurements, age and sex data were collected from 34 sockeye (~12% of the run) in 2021. Females and males each comprised 50% (n=17 respectively), which is within the normal sex ratio distribution observed previously. When male and female average length was compared to previous years, the 2021 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).

Fork length histogram (5cm intervals) showed a uni-modal distribution, dominated by fish in the 51cm to 55cm size class (38% - Figure 15), which is comparable to previous years.

Table 1: Sockeye salmon fork length (cm) statistics at the KSEF in 2021.

	Female	Male	Combined
Mean	53	57	55
Min	47	50	47
Max	58	63	63
Count	17	17	34

Table 2: Average length (cm) for sockeye female, male and combined Sexes from 2003 to 2021.

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
2020	53	53	53
2021	53	57	55

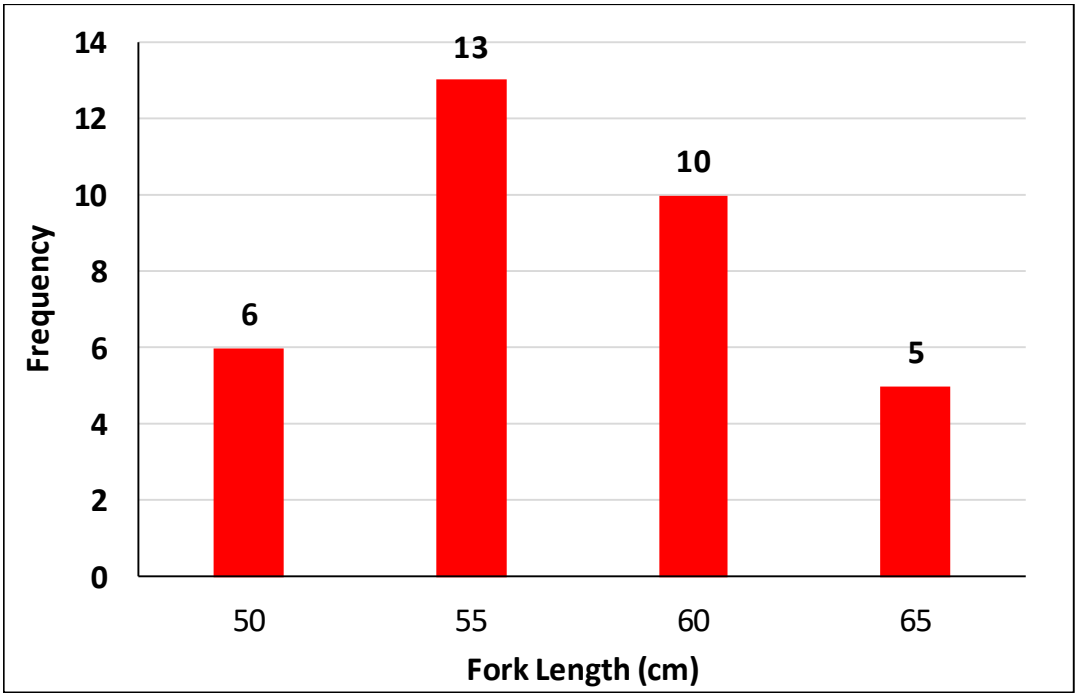

Figure 15: Fork length distribution for sockeye salmon in 2021 (n=34); X axis labels are 5 cm length class upper boundaries.

In 2021, scale samples were collected from 34 adult sockeye complete with sex and length data and submitted to the BC Provincial Aging Lab for age determination. Age results for the 2021 sockeye samples were not available for inclusion in this report but will be presented in the 2022 KSEF Annual Report. On average (2003-2020), 4-year-olds have comprised 81% of the run, with 5-year olds at 18% 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 2016. 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 2016.

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
2003	2006			2007			2008	-	68 (100%)
2004	2007	41	40	2008	54.9 (61%)	59.6 (39%)	2009	58 (43%)	61 (57%)
2005	2008	-	39 (100%)	2009	54 (54%)	57 (46%)	2010	-	63 (100%)
2006	2009	42 (100%)	NA	2010	53.8 (48%	56.5 (52%)	2011	59.3 (45%)	61 (55%)
2007	2010	-	NA	2011	54.8 (55%)	59.1 (45%)	2012	60 (42%)	61 (58%)
2008	2011	50 (67%)	44 (33%	2012	55 (48%)	57.4 (52%)	2013	58.2 (14%)	61.5 (86%)
2009	2012	-	-	2013	53 (45%)	56.4 (55%)	2014	59 (58%)	61 (42%)
2010	2013	-	-	2014	52 (49%)	56 (51%)	2015	56 (41%)	58 (59%)
2011	2014	40 (100%)	NA	2015	53 (60%)	55 (40%)	2016	-	61 (100%)
2012	2015	-	-	2016	55 (50%)	57 (50%)	2017	58 (45%)	59 (55%)
2013	2016	-	41 (100%)	2017	54 (57%)	57 (43%)	2018	-	-
2014	2017	-	-	2018	53.7 (56%)	56.4 (44%)	2019	-	62 (100%)
2015	2018	-	-	2019	53 (80%)	53 (20%)	2020	-	-
2016	2019	-	-	2020	53 (27%)	53 (77%)			

4.2 Chinook Salmon

A total of 544 Chinook were counted at the KSEF in 2021 prior to the fence being opened due to high water on September 21. This is less than half of the long-term escapement average of 1,294 from 2003 to 2019 (Figure 16). Compared to

the long-term (2003-2019) average run timing, 100% of the 2021 run is estimated to have passed through the KSEF by the time it was opened on September 21 (Figure 17). Overall, Chinook arrived later to the fence in 2021, but the peak of run timing was earlier when compared with the 2003-2019 average run timing, with 78% of the run passing through the KSEF by August 14. Which compares to 63% (average between 2003-2019) seen previously to this date (Figure 17).

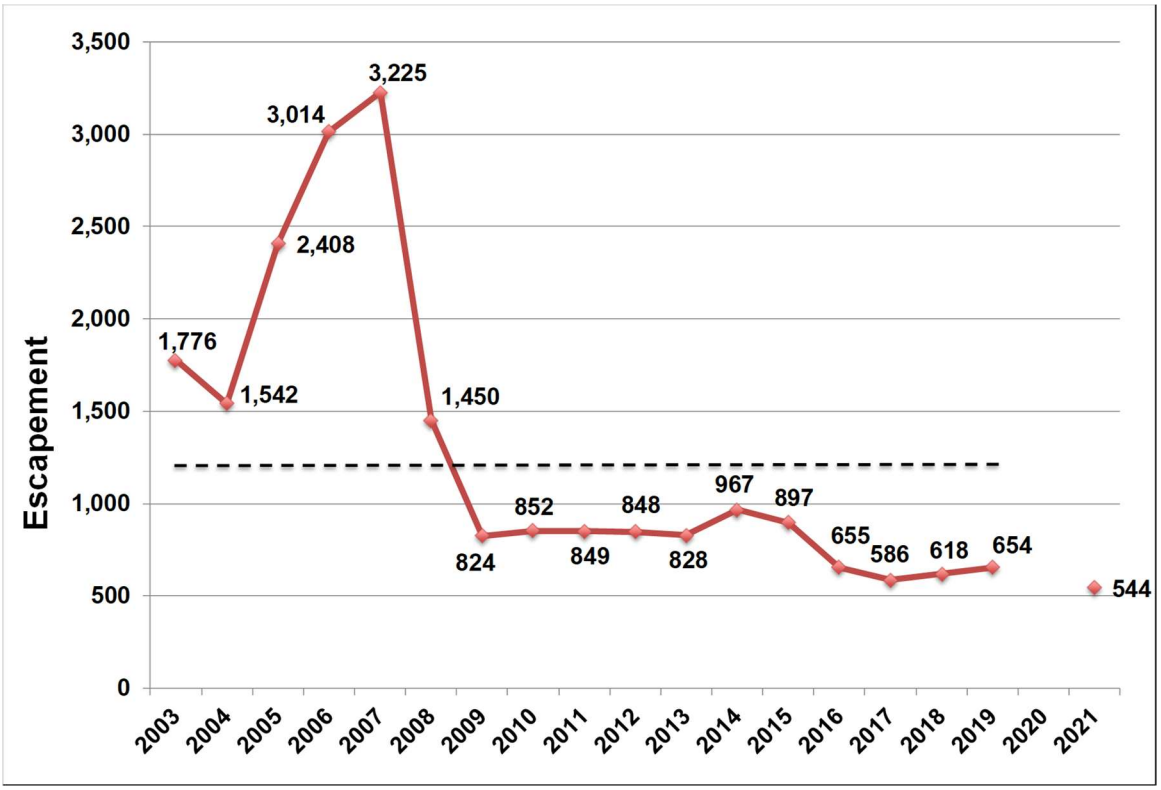

Figure 16: Annual Chinook escapement into the Kitwanga River through the KSEF from 2003 to 2021 - Dashed line is average from 2003 to 2020. *Note we did not get an overall escapement for 2020, with a minimum of 119 counted through the fence.*

Length, age, and sex data was collected from 40 Chinook salmon in 2021[3]. Female and male sex ratios were 60:40, falling within the parameters of what has been seen previously and within a healthy sex ratio breakdown for salmon populations. Average fork length of the total sample was 78 cm and males and females were 73 and 84 cm respectively (Table 4). The 2021 length results

[3] Sex determination was not taken for two of the samples.

showed that male Chinook sampled in 2021 were a bit smaller when compared to results observed since 2008 (Table 5).

Fork length histogram (5cm intervals) showed a bi-modal distribution, dominated by fish in the 71cm to 75cm and 81cm to 85cm size classes (24% and 32% respectively- Figure 18), which is comparable to previous years.

Age results for the 2021 Chinook samples were not available for inclusion in this report but will be presented in the 2022 KSEF Annual Report. Age results for 2020 that were not available in 2020 are presented below (Table 6). Of the readable scales from 2020 (4 out of 9 samples sent), two were 3-year olds originating from the 2017 broodyear followed by one 4-year old originating from the 2016 broodyear and one 6-year old originating from the 2014 broodyear.

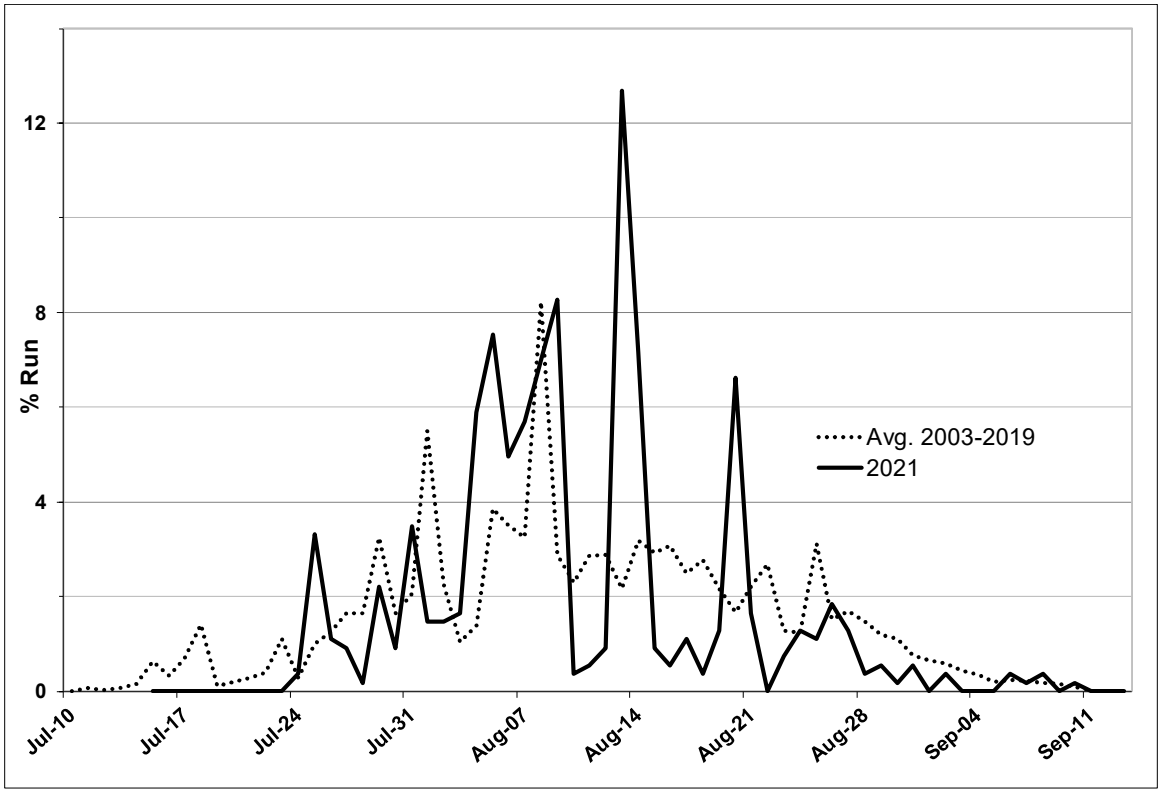

Figure 17: Kitwanga River Chinook salmon average run timing (daily run percent) for 2003-2019 compared with 2021 at the KSEF.

Table 4: Chinook salmon fork length (cm) statistics at the KSEF in 2021.

	Male	Female	Combined
Mean	73	84	78
Min	62	58	62
Max	90	100	100
Count	15	23	38

Table 5: Average length (cm) for Chinook female, male and combined sexes from 2008 to 2021.

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
2020	76.7	82.0	79.3
2021	73.2	84.1	78.0

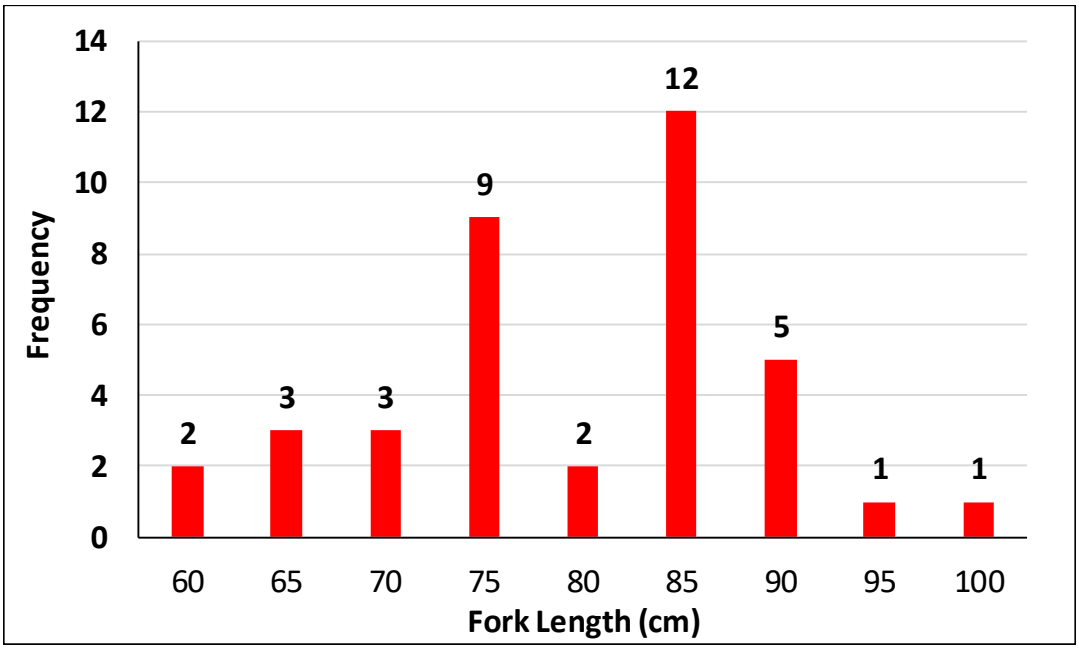

Figure 18; Fork length distribution for Chinook salmon in 2021 (n=38); X axis labels are 5 cm length class upper boundaries.

On average (2008-2019), 5-year-olds have comprised 53% of the run, with 4-year olds at 35%, 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 6; Age distribution for Chinook salmon sampled in 2020 at the KSEF.

European	Gilbert-Rich	Brood Yr.	Frequency	Percent
14	62	**2014**	1	25%
12	42	**2016**	1	25 %
11	32	**2017**	2	50%
		Total	4	100%

Table 7 shows the average fork length (cm) for age and sex for brood years 2005 to 2016. 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, 5.4, 2.7 and 4.9 respectively.

Table 7: Average fork length (cm) for age class, and sex for Chinook salmon - brood years 2005 to 2017.

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	84	-
2014	2017	-	42.4	2018	78.3	74.8	2019	85.6	90.1	2020	89	-
2015	2018	-	67.0	2019	-	76	2020	-	-	2021		
2016	2019	-	-	2020	55	55	2021					
2017	2020	-	41.5	2021								

4.3 Pink Salmon

A total of 179,967 odd-year pink were counted at the KSEF in 2021. This is in the range of the odd-year average of 204,181 from 2003 to 2019 (Figure 19). Compared to the long-term (2003-2019) average run timing, 100% of the 2021 run is estimated to have passed through the KSEF by the time it had to be opened due to high water on September 21 (Figure 18). In 2021, the first pink salmon

were counted at the KSEF on July 27, which is in line with previous years, but larger numbers were not observed until August 13, which is about 5 days later than the odd-year long term average (Figure 20).

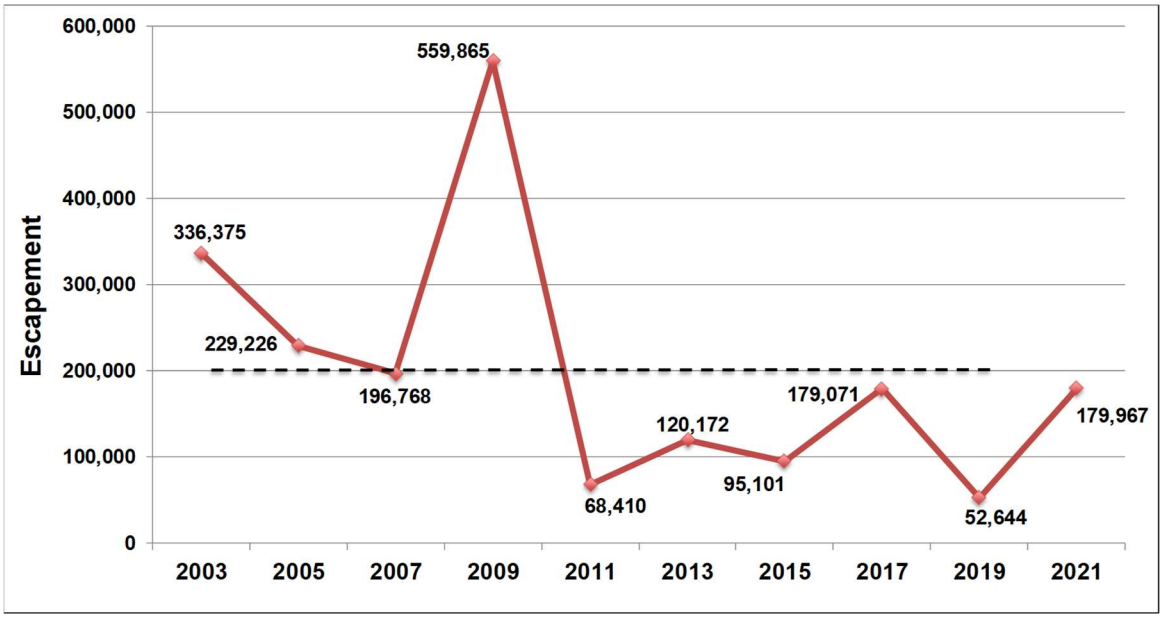

Figure 19: Annual escapement for odd-year pink runs at the KSEF from 2003 to 2021 - Dashed line is average odd year from 2003 to 2019.

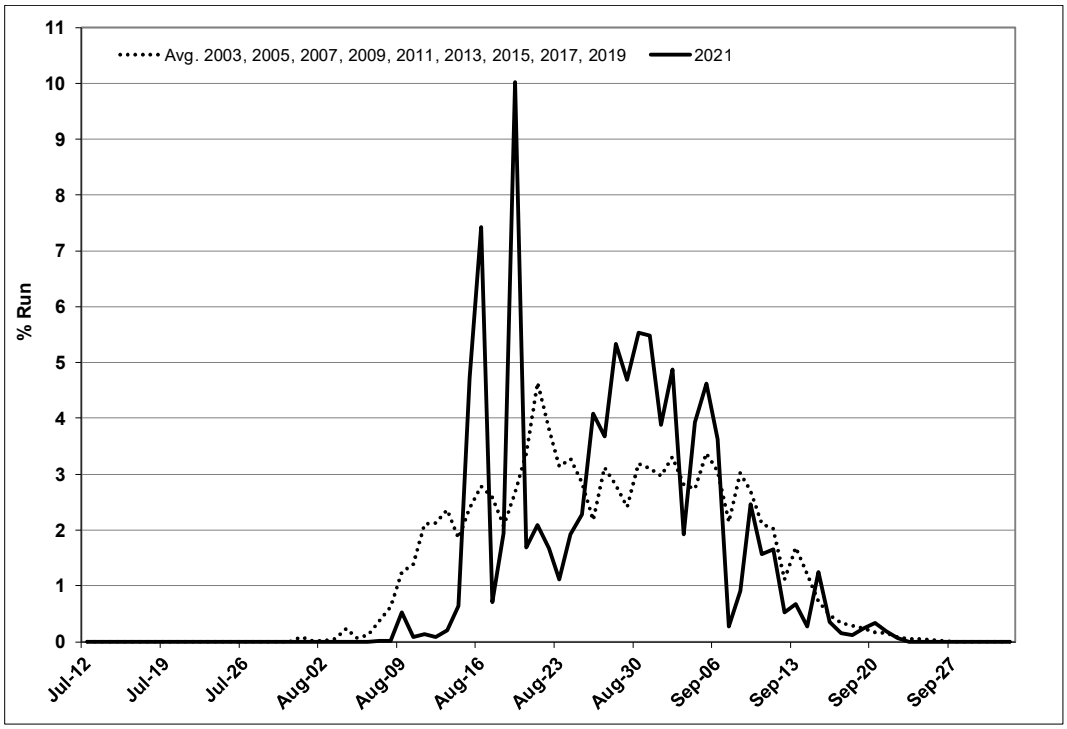

Figure 20: Average odd-year run timing for pink salmon (daily run %) from 2003 to 2021.

4.4 Chum Salmon

A minimum estimate of 199 chum were counted at the KSEF in 2021 prior to the fence being opened on September 21. Based on previous years run timing (2003-2019), 90.1% of the run should have passed the KSEF. Extrapolating from this, an estimated 219 chum were expected to go through the KSEF in 2021. This is below the long-term average of 664 from 2003 to 2019 (Figure 21).

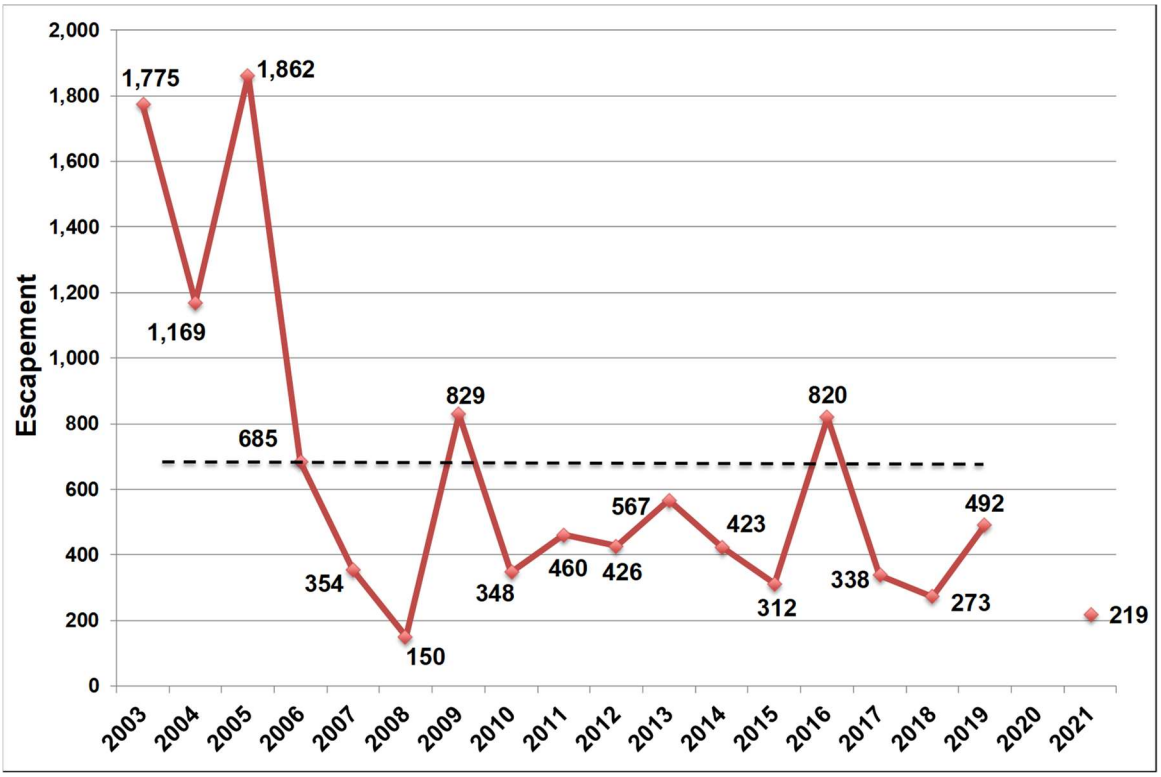

Figure 21: Annual escapement for chum salmon at the KSEF from 2003 to 2021 - Dashed line is average from 2003 to 2019. *Note we did not get an overall escapement for 2020, with a minimum of 35 counted through the fence.*

In 2021, the first chum salmon was counted at the KSEF on August 6th, which is comparable with previous years (Figure 22).

Fork length, sex and age data was collected from 15 chum salmon in 2021[4]. Male to female sex ratio was 2:1 and on average, males were smaller in size (67

[4] Sex determination was not taken for one of the samples.

and 72cm respectively; Table 8). The 2021 length samples were the second consecutive year with the smallest average size observed since 2008 (Table 9).

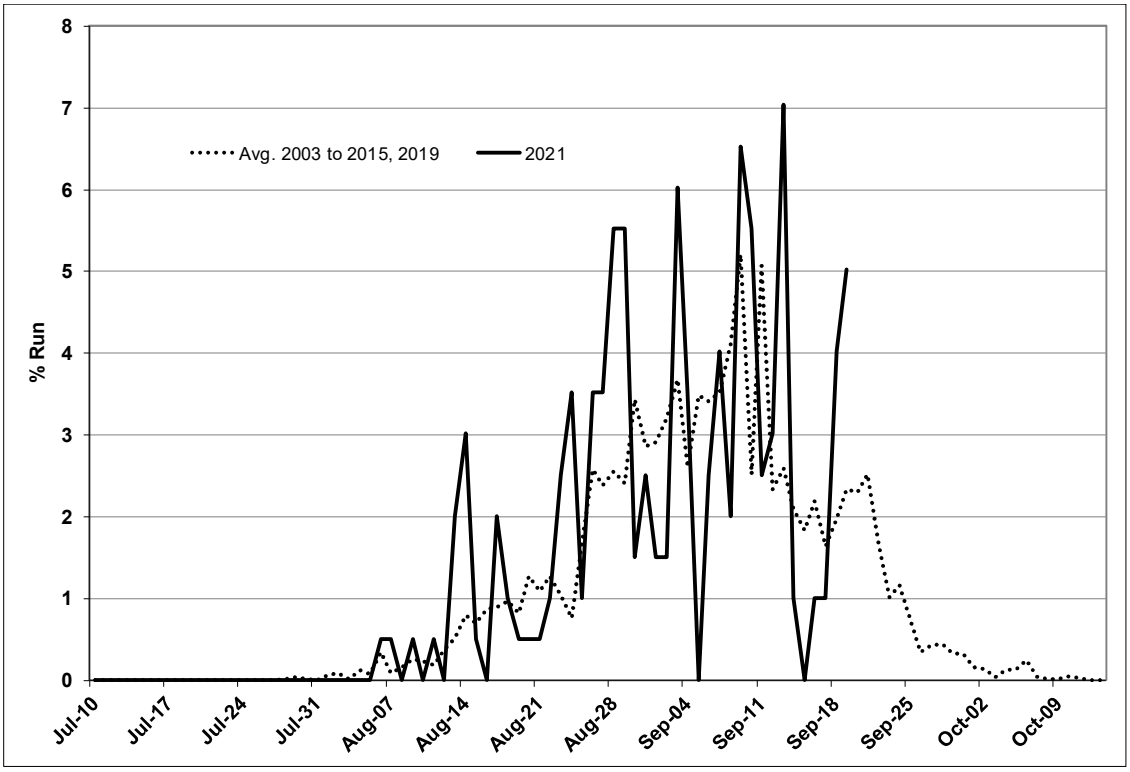

Figure 22: Kitwanga River chum salmon average run timing (daily run %) for 2003-2015, 2019[5] versus 2021 at the KSEF.

Table 8: Chum salmon fork length (cm) statistics at the KSEF in 2021.

	Male	Female	Combined
Mean	66.6	72.3	68.2
Min	56	64	56
Max	76	80	80
Count	9	5	14

Table 9: Average length (cm) for chum female, male and combined sexes from 2008 to 2021.

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

[5] 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
2013	76.8	74.3	75.4
2014	72.1	72.0	72.1
2015	75.9	75.3	75.5
2016	80.3	74.4	77.3
2017	77.9	77.0	77.5
2018	68.9	72.8	70.8
2019	76.2	75.9	76.1
2020	69.5	68.2	68.5
2021	66.6	72.3	68.2

Age results for 2020 that were not available in 2020, are presented below (Table 10). Of the eight readable scales collected from 2020, 50% were 4-year olds originating from the 2016 broodyear followed by 5-year olds (25%) originating from the 2015 broodyear and 3-year olds (25%) originating from the 2017 broodyear.

Table 10: Age distribution for chum salmon sampled in 2020 at the KSEF.

European	Gilbert-Rich	Brood Yr.	Frequency	Percent
04	51	**2015**	2	25%
03	41	**2016**	4	50%
02	31	**2017**	2	25%
		Total	8	100%

Age results for the 2021 are presented below in Table 11. Of the readable scales from the 2021 aging sample (15 sampled), 53.3% were 3-year olds originating from the 2018 broodyear followed by 4-year olds (46.7%) originating from the 2017 broodyear.

Table 11: Age distribution for chum salmon sampled in 2021 at the KSEF.

European	Gilbert-Rich	Brood Yr.	Frequency	Percent
03	41	**2017**	7	46.7%
02	31	**2018**	8	53.3%
		Total	15	100%

On average (2008-2021), 4-year-olds have comprised 69% of the run, with 5-year olds at 16%, and 3-year olds at 15%. A notable exception occurred in 2012 when age 5 fish dominated the run (73%).

Table 12 shows the average fork length (cm) for age and sex for brood years 2006 to 2018. There was only one year of data with age 6 chum (2013).

Table 12: Average fork length (cm) for age class, and sex for chum salmon - brood years 2006 to 2018.

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	79.0	-	2020		
2015	2018	66.0	65.9	2019	75.6	76.4	2020	70.0	74.0	2021		
2016	2019	-	71.0	2020	72.3	65.0	2021					
2017	2020	61.0	-	2021	76.8	70.7						
2018	2021	65.5	63.7									

4.5 Coho Salmon

An estimate of 1,740 coho were counted at the KSEF, KsF and through multiple stream walks on known spawning areas in 2021. This is close to half the long-term average of 3,410 from 2003 to 2020 (Figure 23). As Figure 23 demonstrates, Kitwanga coho returns have been variable for the study period.

In 2021, the first coho salmon was counted at the KSEF on August 12th. Compared to the long-term (2003-2015 and 2019) average run timing, 37% of the 2021 run is estimated to have passed through the KSEF by the time it was opened on September 21 (Figure 24).

Length, age, and sex data was collected from 39 coho salmon in 2021 prior to the fence being opened due to high water on September 21[6]. Male and female coho sex ratios from the samples were 40% and 60% respectively falling within the parameters of what has been seen previously on the Kitwanga River. Average fork length for males and females were 58cm and 61cm respectively (Table 13).

[6] Sex determination was not taken for four of the samples.

The 2021 length results showed that male coho sampled in 2021 were a bit smaller when compared to results observed since 2016 (Table 14).

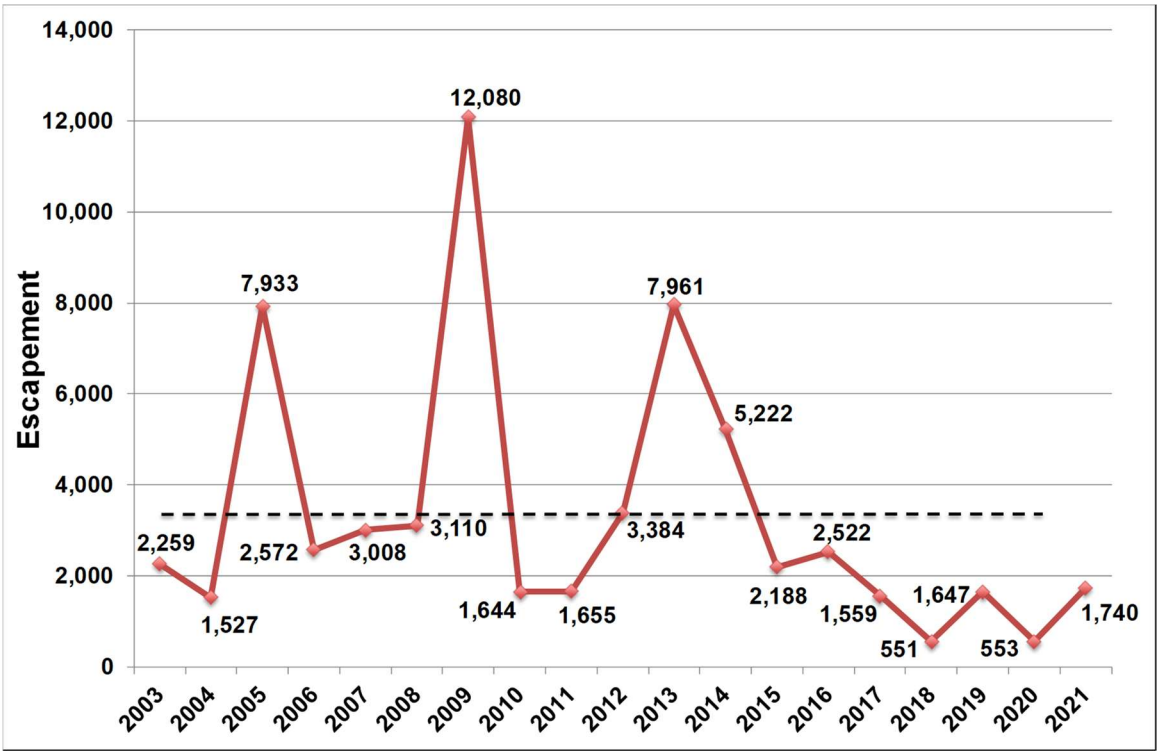

Figure 23: Annual escapement for coho salmon from 2003 to 2021 at the KSEF - Dashed line is average from 2003 to 2020.

Fork length histogram (5cm intervals) showed a uni-modal distribution, dominated by fish in the 61cm to 65cm size class (40% - Figure 25), which is comparable to previous years.

Age results for the 2021 coho samples were not available for inclusion in this report but will be presented in the 2022 KSEF Annual Report.

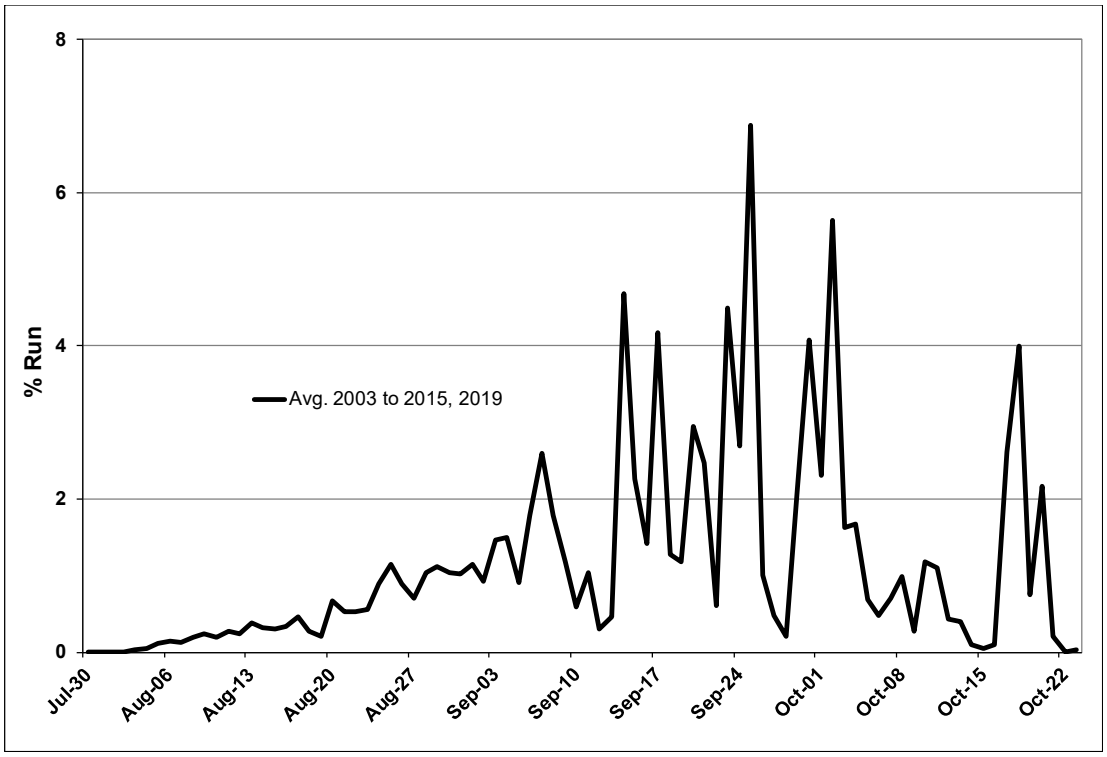

Figure 24: Kitwanga River coho salmon average run timing (daily run %) for 2003-2015, 2019[7] at the KSEF.

Table 13: Coho salmon fork length (cm) statistics at the KSEF in 2021.

	Male	Female	Combined
Mean	57.5	61.1	59.7
Min	50	54	50
Max	67	67	67
Count	14	21	35

Table 14: Average length (cm) for coho female, male and combined sexes from 2010 to 2021.

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

[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.

Year	Male	Female	Combined
2019	61.8	60.1	60.9
2020	57.8	55.2	56.4
2021	57.5	61.1	59.7

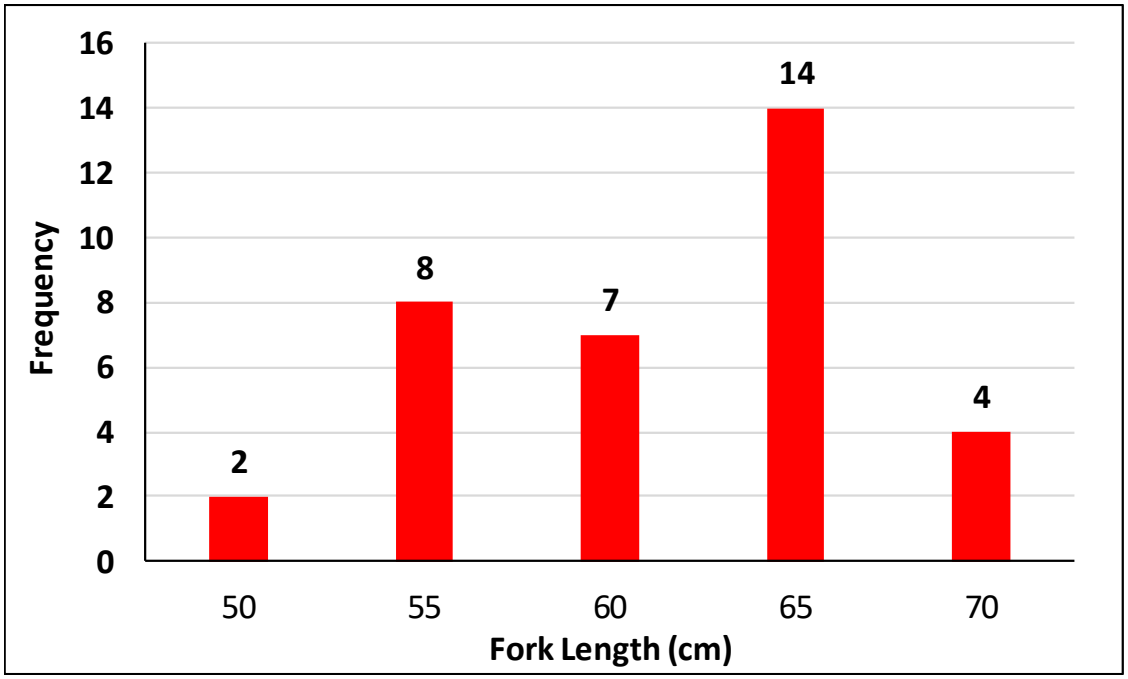

Figure 25: Fork length distribution for coho salmon in 2021 (n=35); X axis labels are 5 cm length class upper boundaries.

On average (2010-2019), 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 2016. Over this time period the lengths have remained relatively consistent with fork length standard deviations for ages 3 and 4 of 3.4, 3.3 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 2016.

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	62.0	58.3	2020		
2016	2019	61.8	64.8	2020					

In the spring of 2020, GFA applied 7,434 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 2020 CWT smolts were expected to return as adults in the fall of 2021. A total of 279 CWT fish out of 739 examined fish were counted through the KSEF and KsF in 2021. Extrapolating to the total run, an estimated 661 tagged fish passed through the fence in 2021 (8.9% 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 2021 was 290, which was well below the long-term (2003-2020) average of 3,694. Overall, the exploitation rate on Kitwanga sockeye had remained relatively low in recent years (average of 16%) but was

much higher in 2021 at 48%, primarily through catches from the Alaskan Marine Fisheries (43%).

Overall, the 2021 escapement is part of a more recent low trend in 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, continue to reduce body condition factor and later run timing (Carr-Harris and Cox-Rogers 2020) and is likely impacting salmon success.

Fork length measurements, age and sex data were collected from 34 sockeye (~12% of the run) in 2021. Females and males were equal (n=17 respectively), which is within the normal sex ratio distribution observed previously. Compared to previous years, the 2021 length results fell within the historical range over the last 19 years.

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 concluding in the spring of 2021, GFA updated our Kitwanga sockeye salmon recovery plan (Cleveland et al 2021), originally completed in 2006

(Cleveland et al 2006), with additional directed studies to come from the revised strategy.

A total of 544 Chinook were counted at the KSEF in 2021. This is less than half of the long-term escapement average of 1,294 from 2003 to 2019. Compared to the long-term (2003-2019) average run timing, 100% of the 2021 run is estimated to have passed through the KSEF by the time it was opened on September 21. Overall, Chinook arrived later to the fence in 2021, but the peak of run timing was earlier when compared with the 2003-2019 average run timing, with 78% of the run passing through the KSEF by August 14. Which compares to 63% (average between 2003-2019) seen previously to this date. Chinook salmon in 2021 (n=544) 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)[8], the average escapement has dropped to 628, which is cause for concern.

Overall, sex ratios in 2021 were in line with previous years and a healthy population. The 2021 length results showed that female Chinook sampled in 2021 were very similar when compared to results observed since 2008 and male Chinook sampled in 2021 were the smallest on record (average) when compared to results observed since 2008.

A total of 179,967 adult pink salmon migrated past the KSEF in 2021 which is in the range of the odd-year average of 204,181 from 2003 to 2019. In the Kitwanga watershed odd year runs normally dominate over even year runs. The 2021 pink return originated from the 2019 brood year, which had an escapement of 52,644 fish, indicating the 2021 return was well above replacement value for the stock. The run timing in 2021 was in line with previous years (2003-2019), but larger

[8] Note we did not get an overall escapement for 2020, with a minimum of 119 counted through the fence.

numbers were not observed until August 13, which is about 5 days later than the odd-year long term average

A minimum estimate of 199 adult chum salmon returned to the Kitwanga River in 2021. Based on previous years run timing (2003-2019) 90.1% of the run should have passed the KSEF. Extrapolating from this, an estimated 219 chum were expected to go through the KSEF in 2021. The 2021 escapement estimate was 67% below the average escapement of 664 fish recorded from 2003-2019 and is lower than the relatively low average seen from 2010 to 2015 and 2017, 2018 (n=393). Male to female sex ratio was 64% and 34% respectively which falls within what has been observed in previous years. On average, males were smaller in size than females (67 and 72cm respectively) with 2021 chum sampling providing the second consecutive year with the smallest average size observed since 2008. The 2021 chum run timing was similar to what has been observed in previous years.

An estimated total of 1,740 adult coho were counted at the KSEF, KsF and spawning grounds in 2021, which is close to half the long-term average of 3,410 from 2003 to 2020. Overall, sex ratios in 2021 were in line with previous years. The 2021 length results showed that male coho sampled in 2021 were a bit smaller when compared to results observed since 2016.

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