Tanana Chiefs Conference

Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2015

FIS 14-209

Tanana Chiefs Conference, Fisheries Program
Fairbanks, Alaska
June 2016

Tanana Chiefs Conference

The Tanana Chiefs Conference's Fisheries Program strives to continually build educational capacity and expertise in fisheries science and management throughout the TCC region, including the Yukon and Kuskokwim River drainages. Our goals are to utilize western science and traditional knowledge to enable sustainable fisheries, and to advocate for cultural and traditional fishing and hunting rights. We endeavor to accomplish these goals by partnering with other Tribal organizations, NGO's, and State and Federal agencies to better manage, protect, and preserve our fisheries resources.

http://www.tananachiefs.org/sustainability/fish-wildlife/

Cover Photo: Black bear feeding on a Henshaw Creek Summer Chum Salmon, courtesy of Brian McKenna, 2015.

Authors:

Brian McKenna
Tanana Chiefs Conference
Wildlife & Parks Department
201 First Avenue, Suite 300
Fairbanks, Alaska 99701
Phone: 907-452-8251 ext. 3318
Brian.mckenna@tananachiefs.org

Nicole Farnham
Tanana Chiefs Conference
Wildlife & Parks Department
201 First Avenue, Suite 300
Fairbanks, Alaska 99701
Phone: 907-452-8251 ext. 3002
Nicole.farnham@tananachiefs.org

Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2015

Brian McKenna & Nicole Farnham

Abstract

The Tanana Chiefs Conference Fisheries program operated a resistance board weir to collect information on abundance and run timing of Chinook Salmon *Oncorhynchus tshawytscha* and Summer Chum Salmon *O. keta* migrating up Henshaw Creek, a tributary to the Koyukuk River, Alaska in the Summer of 2015. The weir was operational between June 24 and August 5, and represented the 16th year of operation since the projects inception. The estimated Chinook Salmon escapement was the highest escapement recorded in the history of project (N = 2,391), and more than doubled the 2000-2013 average estimated escapement of Chinook Salmon (N = 966). The estimated sex composition for Chinook Salmon was 40% female. Three age classes of Chinook Salmon constituted the majority of the run; age class 1.2, 1.3, and 1.4. The predominant age class for Chinook Salmon was age class 1.3 (41%), followed by age class 1.4 (34%) and age class 1.2 (25%). The estimated Summer Chum Salmon escapement was 238,529, and nearly doubled the 2000-2013 average estimated escapement of 127,914 Summer Chum Salmon. The estimated sex composition for Summer Chum Salmon was 64% female. Age classes 0.3 and 0.4 constituted the majority of the Summer Chum Salmon run. The predominant age class for Summer Chum Salmon was age class 0.4 (59%), followed by age class 0.3 (37%). Four other fish species passed through the weir including Longnose Sucker *Catostomus catostomus*, Arctic Grayling *Thymallus arcticus*, whitefish spp. (Coregoninae), and Northern Pike *Esox lucius*. The continued operation of this weir has provided a valuable long term data set dating back to the year 2000. The continuation of this, and other, escapement projects is vital to the successful management of Chinook Salmon and Summer Chum Salmon stocks. The data they provide aid managers in developing stock specific spawner-recruit relationships and evaluating how tributary systems respond to management actions. Furthermore, quality escapement data from tributaries like Henshaw Creek can help managers understand population specific contributions to the overall salmon runs throughout the Yukon River.

Introduction

Henshaw Creek, a tributary to the Koyukuk River, is located within the Kanuti National Wildlife Refuge (KNWR) in the Interior of Alaska. Henshaw Creek provides spawning and rearing habitat for Chinook Salmon *Oncorhynchus tshawytscha* and Summer Chum Salmon *O. keta*, as well as several other resident fish species. Chinook Salmon and Summer Chum Salmon from Henshaw Creek contribute to the mixed-stock fisheries in the Yukon and Koyukuk rivers (USFWS 1993).

Chinook Salmon and Summer Chum Salmon runs of the Yukon River Basin have demonstrated an overall decline in productivity (Bergstrom et al. 2001; JTC 2014). These declines have led to harvest restrictions, fishery closures, and spawning escapements below management goals (Kruse 1998; JTC 2015). In 2000, the Alaska Board of Fisheries classified Yukon River Chinook Salmon as a stock of yield concern in response to low returns (Hayes et al. 2006). Low returns of Chinook Salmon have persisted since 2007, resulting in subsistence fishery restrictions and closures, as well as multiple commercial fishery failures pursuant to the Magnuson-Stevens Fishery Act. During these low return years, in-season management efforts to protect Chinook Salmon were enacted by fishery managers in an attempt to meet biological escapement goals and to comply with international treaty obligations. These management actions included intensified gear restrictions on subsistence fishers, coupled with fishery closures of subsistence salmon fishing periods (JTC 2016). These management actions resulted in increased hardships for Native Alaskans who rely heavily upon salmon as a subsistence food resource as well as a means to continue to practice their ancestral, cultural and traditional way of life. Because of the current state of the Yukon River Chinook Salmon, and the complexity of mixed stock fisheries for both Chinook Salmon and Summer Chum Salmon, responsible management of these resources is paramount. In order to develop proper management strategies, managers need high quality data describing Chinook Salmon and Summer Chum Salmon escapements and age, sex, and length data (ASL). Without accurate escapement estimates from multiple Yukon River tributaries, managers are unable to determine stock specific spawner-recruit relationships (Labelle 1994), and will lack data to evaluate how these systems respond to management actions. Furthermore, quality escapement data from tributaries throughout the Yukon drainage can help fisheries managers to better understand population specific contributions to the overall salmon runs in the Yukon River.

Henshaw Creek has been determined to be an important producer of Chinook Salmon and Summer Chum Salmon, and has been monitored with a weir since 2000 (Barton 1984; Dupuis, 2012). The U.S. Fish and Wildlife Service (USFWS), Fairbank Fish and Wildlife Field Office (FFWFO) and, more recently, biologists with the Tanana Chiefs Conference (TCC) have collected salmon escapement and ASL data from the weir since it was installed (e.g., VanHatten 2002; O'Brien and Berkbigler 2005). The Henshaw Creek weir project is one of two salmon escapement projects currently operated within the Koyukuk River drainage (Carlson, 2012). Since 2000, escapement estimates in Henshaw Creek have ranged from 244 to 2,391 Chinook Salmon and from 22,556 to 292,082 Summer Chum Salmon (Appendix 1). Both Chinook Salmon and Summer Chum Salmon from Henshaw Creek contribute to the subsistence harvests of villages within the Kanuti National Wildlife Refuge as well as to the harvests of subsistence and commercial fisheries occurring in the Yukon River. Information collected at Henshaw Creek weir is important to fisheries managers who have the difficult task of managing the complex mixed stock, subsistence and commercial salmon fisheries in the Yukon River. Pre-season estimates, in-season management actions and post season evaluations of management actions are enhanced by the data from this project. Objectives of the Henshaw Creek weir were to (1) determine daily escapement and run timing of adult salmon, (2) determine age, sex, and length compositions of adult salmon, (3) document upstream movement and presence of resident fishes, and (4) serve as an outreach platform for KNWR staff and Partners Program fisheries biologist to conduct an onsite science camp.

Study Area

Henshaw Creek is a small, clear water tributary of the Koyukuk River in north-central Alaska (Figure 1). The creek originates in the Alatna Hills and flows southeasterly for approximately 144 km before entering the Koyukuk River. The weir site is approximately 1.5 km upstream from the mouth of Henshaw Creek. The climate of this area is cold and continental, and is characterized by extreme seasonal temperature variations and low precipitation. Summer air temperatures range from 18˚C to 21˚C, with winter lows nearing -57˚C (USFWS 1993). Stream discharge is the highest during the spring in response to snow melt with occasional peak discharge periods in the Summer as a result of heavy rain showers.

Channel configuration is typically meandering with alternating cut banks and gravel bars. The substrate is composed primarily of medium to large gravel (8–64 mm) and small cobble (64–128 mm) in the areas of higher water velocity. Sand and silt substrate is common in the pools. The channel width at the weir site is approximately 30 m with an average depth of 0.6 m for most of the Summer.

Methods

Weir Construction and Deployment

A resistance board weir was used to enumerate and collect biological data from adult salmon as they migrated up Henshaw Creek to spawn. The Henshaw Creek weir has been installed at the same site since 2000, following the construction and installation methods described by Tobin (1994). Each picket of the weir was made of schedule-40 polyvinyl chloride (PVC) electrical conduit with 2.5 cm inside diameter with individual pickets spaced 3.2 cm apart. The weir was visually inspected for integrity and cleaned of debris daily. A live trap was installed approximately mid-channel, near the thalweg, allowing fish to be recorded as they passed through the weir and, when necessary, the trap could be closed to hold fish for sampling. Water depth (cm) and temperature (°C) were recorded daily at the trap.

Biological Data

The project start date was based on previous years' run timing data. The end date of the project was determined in-season when the daily count of each species dropped to less than 1% of the seasonal passage to date and remained at this level for at least three consecutive days. Run timing and abundance of adult Chinook Salmon and Summer Chum Salmon were estimated by recording the number of each species of fish passing through the weir each day. Because non-salmon fish species were not handled, it was difficult to differentiate between whitefish species. Therefore, all whitefish were grouped under the subfamily *Coregoninae*.

The daily counting schedule was dependent upon the level of fish passage through the weir. During the beginning and end of the run, when hourly counts were low, counting was conducted between 0800 and 2400 hours, with the trap closed from 2400 to 0800 hours to prevent upstream passage during unmonitored times. As the run increased in strength, the counting schedule increased to 24 hours a day.

A stratified random sampling scheme (Cochran 1977), with weeks as the strata, was used to collect age, sex, and length data from both adult salmon species. Sampling started at the beginning of each week and generally was conducted over a three to four day period, targeting 160 salmon/species/week. Lengths of Chinook Salmon and Summer Chum Salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEFL), and sex was visually determined by external morphological characteristics. Scales were used for ageing; with age class information reported using the European method (Foerster 1968). Three scales were collected from each Chinook Salmon sampled, and one scale from each Summer Chum Salmon sampled. Scales were sampled from the area located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both adult salmon species were sent to the Alaska Department of Fish and Game Division of Commercial Fisheries. Age 1.2 Chinook salmon were assumed to be males regardless of their field determination (Brady 1983; Bales 2007; Karpovich and Dubois 2007). Daily escapement counts and sex ratios were reported to the U.S. Fish and Wildlife Service Fairbanks Fish and Wildlife Field Office.

Data Analysis

Days with counts greater than 6 hours (h) but less than 24 h were adjusted for a 24 h period using:

$$E_d = (24/T_d) \bullet C_d,$$

Where E_d = estimated daily count for day d, T_d = number of hours sampled during day d, and C_d = number of fish counted during the time sampled in day d. Counts from days with less than 6 h of the day counted were disregarded and those days were treated as completely missed days. Completely missed days were estimated by linear interpolation from the daily counts before and after the missing period.

Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with statistical weeks as the strata. A statistical week was generally defined as beginning on Monday and ending on Sunday. Within a week, the proportion of the samples composed of a given sex or age, $\hat{p}_{ij}$, were calculated as:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j},$$

where n_{ij} is the number of fish by sex i or age i sampled in week j, and n_j is the total number of fish sampled in week j. The variance of $\hat{p}_{ij}$ was calculated as:

$$\hat{v}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_j - 1}.$$

Sex and age compositions for the total run of Chinook Salmon and Summer Chum Salmon of a given sex or age, $\hat{p}_i$ were calculated as:

$$\hat{p}_i = \sum_{j-1} \hat{W}_j \hat{p}_{ij,}$$

where $\hat{W}_j$ = the stratum weight and was calculated as:

$$\hat{W}_j = \frac{N_j}{N},$$

and N_j equals the total number of fish of a given species passing through the weir during week *j*, and *N* is the total number of fish of a given species passing through the weir during the run. Variance, $\hat{v}(\hat{p}_i)$ of sex and age compositions for the run was calculated as

$$\hat{v}(\hat{p}_i) = \sum_{j-1} \hat{W}_j^2 \hat{v}(\hat{p}_{ij}).$$

Results and Discussion

Weir Operation

Chinook Salmon and Summer Chum Salmon escapements were enumerated in 2015 using a resistance board weir. The start date of the weir operations was based on historical run timing data and the current years run timing forecast. The weir was fully operational on June 24, with enumeration beginning at 0900 hours. There were no interruptions in counting throughout the season. Enumeration ended at 2400 hours on August 5. The picket spacing (3.2 cm space between pickets) within the trap and weir panels was narrow enough to prevent adult Chinook Salmon and Summer Chum Salmon from passing through the weir undetected. However, some smaller fish species, such as Arctic Grayling *Thymallus arcticus* and whitefish spp. (Coregoninae), were able to pass through the weir undetected. The average river stage height during weir operations was 67 cm. Morning and evening river stage readings ranged from 63 to 70 cm between June 26 and August 5. The average water temperature was 11.5°C between June 24 and August 5, with individual readings ranging from 8.4°C to 14.1°C (Figure 2, Appendix 1). Additional water quality parameters were recorded during the project including conductivity, dissolved oxygen, and pH (Appendix 2).

Chinook salmon

The estimated Chinook Salmon escapement was the highest escapement recorded in the history of project (N = 2,391), and more than double the 2000–2013 average estimated escapement of 966 Chinook salmon (Figure 3, Appendix 3). The first Chinook Salmon passed through the weir on June 29. On the final day of counting, August 5, 10 Chinook Salmon passed through the weir. The mid-point of Chinook Salmon passage occurred on July 18, with the first and third quarter passage dates occurring on July 12 and July 21 respectively (Table 1, Figure 4).

Scale samples were collected from 511 Chinook Salmon for ageing analysis. Age was unable to be determined for 10% of the samples (n = 52), primarily due to scale regeneration (Table 2). Six age classes of Chinook Salmon were identified; age classes 1.2, 2.1, 1.3, 2.3, 1.4, and 2.4, from

brood years 2011 through 2008. Three age classes of Chinook Salmon constituted the majority of the run; age class 1.2, 1.3, and 1.4. The predominant age class for Chinook salmon was age class 1.3 (41%), followed by age class 1.4 (34%) and age class 1.2 (25%, Table 2).

The estimated sex composition for Chinook Salmon was 40% female, with individual strata ranging between 38% and 49% female (Table 2). The overall female composition of 40% was slightly higher than the 2000–2013 average of 36% female (Figure 5, Appendix 4). Female Chinook Salmon length-at-age ranged from 561 mm to 888 mm MEFL. Male Chinook salmon length-at-age ranged from 443 mm to 898 mm MEFL (Table 3). Mean length-at-age of female Chinook salmon was larger than males in the predominant age classes of 1.3 and 1.4.

Chum salmon

The estimated Summer Chum Salmon escapement was 238,529, almost twice the 2000−2013 average estimated escapement of 127,914 Summer Chum Salmon (Figure 6). The first Summer Chum Salmon passed through the weir June 25. On August 5, the final day of counting, 1,245 Summer Chum Salmon passed through the weir. The mid-point of the Summer Chum Salmon passage occurred on July 20, with the first and third quarter passage dates occurring on July 15 and July 24 respectively. The mid-point of Summer Chum Salmon passage was July 19, with the first and third quarter passage dates occurring on July 15 and July 23 respectively (Table 1, Figure 7).

Samples were collected from 929 Summer Chum Salmon. Age was unable to be determined for 13% of these samples, primarily due to scale regeneration. Four age classes of Summer Chum Salmon were identified; age classes 0.2, 0.3, 0.4, and 0.5 from brood years 2012, 2011, 2010, and 2009 respectively (Table 4). Age classes 0.3 and 0.4 constituted the majority of the Summer Chum Salmon run The predominant age class for Summer Chum Salmon was age class 0.4 (59%), followed by age class 0.3 (37%, Table 4).

The estimated sex composition for Summer Chum Salmon was 64% female, with individual strata ranging between 36% and 73% female (Table 4). The overall female composition was above the 2000–2013 average of 53% female (Figure 8, Appendix 4). Female Summer Chum Salmon length-at-age ranged from 450 mm to 642 mm MEFL. Male Summer Chum Salmon length-at-age ranged from 448 mm to 680 mm MEFL. Mean length-at-age of male Summer Chum Salmon was larger than females in age classes 0.2, 0.3, and 0.4 (Table 5).

Summer Chum Salmon escapement at the Henshaw Creek weir represented 17% of the entire Yukon River Summer Chum Salmon run estimate past the Pilot Station Sonar (JTC 2016). The information collected at the Henshaw Creek weir is vital to the difficult task of managing the complex mixed-stock subsistence and commercial salmon fisheries in the Yukon River. The data collected at the Henshaw Creek weir are used by state and federal fisheries managers to help direct in-season management decisions and in post-season analyses. Additionally, the time series data from Henshaw Creek is used to evaluate long term trends in salmon escapements and stock compositions. These analyses, and the data that support them, will become increasingly important when determining the impacts of fishing regulation changes (e.g. net mesh size restrictions) in the Yukon River and the effects of climate change on salmon stocks.

Biological Data:

The most abundant non-salmon species was the longnose sucker *Catostomus catostomus.* The passage estimate for longnose sucker was N = 4,930. Passage estimates for other non-salmon species were as follows: whitefish spp. N = 109, arctic grayling N = 58, and northern pike *Esox lucius* N = 27 (Table 1).

Additionally, this project has collected and produced 16 years of data allowing managers to analyze trends in population status, size, length, age, and gender composition, as well as helping to develop future run projections, and creating and evaluating harvest and escapement goals and allocations throughout the Yukon River. Finally, these long term data sets are increasing in importance due to the continual increase of stresses placed on these salmon resources.

Acknowledgements

Funding support for this project was provided through the U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, under project number FIS-14-209. Appreciation is extended to the Henshaw Creek field crew for data collection; to the U.S. Fish and Wildlife Service-Fairbanks Fish and Wildlife Field Office for logistical support, data analysis, and reviews and editing; to the Office of Subsistence Management for final review and edits; to the Kanuti National Wildlife Refuge for logistical and technical support; and to the Alaska Department of Fish and Game for providing in-kind ageing analyses.

References

Bales, J. 2007. Salmon age and sex composition and mean lengths for the Yukon River Area, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07-04, Anchorage.

Barton, L. H. 1984. A catalog of Yukon River salmon spawning escapement surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries. Fairbanks, Alaska.

Bergstrom, D. J., and ten co-authors. 2001. Annual management report Yukon area, 1999. Alaska Department of Fish and Game. Regional Information Report Number 3A01-01. Anchorage, Alaska.

Brady, J. A. 1983. Lower Yukon River salmon test and commercial fisheries, 1981. Alaska Department of Fish and Game, Technical Data Report 89:91 p.

Carlson, J. G. 2012. Abundance and Run Timing of Adult Salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2011. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Number 2012-6, Fairbanks, Alaska

Cochran, W. G. 1977. Sampling techniques, 3rd edition. John Wiley and sons, New York.

Dupuis, A. W. 2012. Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2008-2011. Tanana Chiefs Conference, Fisheries Program Report Number FIS 08-201, Fairbanks, Alaska. http://alaska.fws.gov/asm/pdf/fisheries/reports/08-201final.pdf

Foerster, R.E. 1968. The Sockeye salmon, *Oncorhynchus nerka*. Fisheries Research Board of Canada, Bulletin 161, Ottawa, Canada.

Hayes, S.J., D.F. Evenson, and G.J. Sandone. 2006. Yukon River Chinook salmon stock status and action plan: a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 06-38, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2014. Yukon River salmon 2013 season summary and 2014 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A14-01, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2015. Yukon River salmon 2014 season summary and 2015 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A15-01, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2016. Yukon River salmon 2015 season summary and 2016 season outlook. Alaska Department of Fish and

Game, Division of Commercial Fisheries, Regional Information Report 3A16-01, Anchorage.

Karpovich, S., and L. DuBois. 2007. Salmon age and sex composition and mean lengths for the Yukon River Area, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-05, Anchorage.

Kruse, G. E. 1998. Salmon run failures in 1997-1998: A link to anomalous ocean conditions? Alaska Fisheries Resource Bulletin 5(1):55-63.

Labelle, M. 1994. A likelihood method for estimating pacific salmon escapement based on fence counts and mark-recapture data. Canadian Journal of Fisheries Aquatic Science, 51:552-556.

O'Brien, J. P., B. L. Berkbigler. 2005. Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2004 . U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Number 2005-15 Fairbanks, Alaska.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai, Alaska.

USFWS (U.S. Fish and Wildlife Service). 1993. Fishery Management Plan-Koyukuk National Wildlife Refuge. Fairbanks Fishery Resource Office, Fairbanks, Alaska.

VanHatten, G. K. 2002. Abundance and run timing of adult salmon in three tributaries of the Koyukuk River, 2001. U.S. Fish and Wildlife Service-Fairbanks Fishery Resources Office, Alaska Fisheries Data Series Number 2002-5.

Table 1. — Daily and cumulative estimates of Chinook Salmon and Summer Chum Salmon passage, and daily counts of other fish species, at Henshaw Creek weir, Alaska, 2015. Asterisks (*) denote the first quarter, midpoint, and third quarter of passage estimates.

	Chinook Salmon		Summer Chum		Longnose Sucker	Arctic Grayling	Northern Pike	Whitefish sp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jun-24	0	0	0	0	5	0	0	0
Jun-25	0	0	10	10	14	0	0	0
Jun-26	0	0	1	11	18	0	1	0
Jun-27	0	0	4	15	15	3	0	0
Jun-28	0	0	43	58	32	1	0	0
Jun-29	1	1	159	217	70	0	1	1
Jun-30	0	1	323	540	84	3	0	0
Jul-1	2	3	1,340	1,880	370	9	1	2
Jul-2	11	14	1,900	3,780	424	8	2	8
Jul-3	2	16	765	4,545	90	8	0	2
Jul-4	10	26	2,266	6,811	538	6	0	1
Jul-5	22	48	2,878	9,689	547	8	1	2
Jul-6	20	68	3,717	13,406	574	6	0	5
Jul-7	22	90	3,733	17,139	189	6	0	2
Jul-8	28	118	2,094	19,233	76	3	1	3
Jul-9	81	199	6,781	26,014	8	1	0	0
Jul-10	87	286	8,769	34,783	223	8	2	6
Jul-11	177	463	5,804	40,587	667	4	0	13
Jul-12	173	*636	4,647	45,234	243	7	1	5
Jul-13	64	700	4,764	49,998	51	0	0	3
Jul-14	219	919	4,464	54,462	9	3	1	4
Jul-15	54	973	6,517	*60,979	5	4	0	1
Jul-16	44	1,017	4,371	65,350	2	4	0	2
Jul-17	159	1,176	10,977	76,327	3	1	0	6
Jul-18	107	*1,283	12,514	88,841	8	2	0	1
Jul-19	193	1,476	19,895	108,736	4	1	0	0
Jul-20	267	1,743	22,305	*131,041	3	9	0	2
Jul-21	230	*1,973	18,150	149,191	6	7	0	4
Jul-22	75	2,048	14,892	164,083	13	1	0	1
Jul-23	39	2,087	12,355	176,438	31	3	0	4
Jul-24	54	2,141	10,907	*187,345	106	12	0	2
Jul-25	43	2,184	8,837	196,182	130	8	1	7
Jul-26	38	2,222	7,441	203,623	82	4	1	7
Jul-27	28	2,250	7,306	210,929	67	3	0	2
Jul-28	33	2,283	5,727	216,656	47	2	0	2
Jul-29	20	2,303	5,219	221,875	60	7	0	2
Jul-30	21	2,324	4,203	226,078	40	10	2	1
Jul-31	13	2,337	2,905	228,983	5	6	0	0
Aug-1	6	2,343	2,586	231,569	8	1	0	2
Aug-2	10	2,353	2,386	233,955	10	3	0	0
Aug-3	12	2,365	1,872	235,827	9	0	0	0
Aug-4	16	2,381	1,457	237,284	24	5	0	1
Aug-5	10	2,391	1,245	238,529	20	4	0	1
Total		2,391		238,529	4,930	181	15	105

Table 2. — Age and sex ratio estimates of Chinook Salmon at the Henshaw Creek weir, Alaska, 2015. Standard errors are in parentheses. Season totals are calculated from weighted strata totals. Unknown age indicates numbers of fish that could not be aged from the scales sampled and were not included in age calculations.

					Brood Year and age		
				Unknown	2011	2010	2009
Strata Dates	Run size (N)	Sample size (n)	% Female	Age	1.2	1.3	1.4
Jun 24–Jul 9	199	98	41	19	20% (4.6)	44% (5.6)	34% (5.4)
Jul 10–16	818	164	38	14	14% (2.9)	45% (4.1)	40% (4)
Jul 17–24	1,124	167	39	10	31%(3.7)	39% (3.9)	29% (3.6)
Jul 25–Aug 5	250	82	49	9	36% (5.6)	32% (5.5)	33% (5.5)
Total	2,391	511	40	52	25% (2.1)	41% (2.4)	34% (2.3)
Female	955	208		18	0.3% (0.3)	36% (3.7)	64% (3.7)
Male	1,436	303		34	42% (3.1)	45% (3.1)	13% (2.2)

*Other age classes present included: 2.1 (N=1, 0.2% of run), 2.3 (N= 2: 0.3% of run), and 2.4 (N= 1; 0.2% of run)

Table 3. — Length at age of male and female Chinook Salmon sampled at the Henshaw Creek weir, Alaska, 2015.

	Male					Female				
	Mid-eye to fork length (mm)					Mid-eye to fork length (mm)				
Age	N	Mean	SE	Median	Range	N	Mean	SE	Median	Range
1.2	111	564.0	53.9	563.5	443–745	1	561	-	561	561
2.1	1	385.0	-	385.0	385	0	-	-	-	-
1.3	122	725.4	50.7	727.0	617–854	65	770.5	46.1	765.0	757–874
2.3	2	671.5	65.8	671.5	625–718	0	-	-	-	-
1.4	33	780.5	57.9	782.0	677–898	123	826.2	46.3	824.0	870–888
2.4	0	-	-	-	-	1	775	-	775	775
Total	269					190				

Table 4. — Age and sex ratio estimates of Summer Chum Salmon at the Henshaw Creek weir, Alaska, 2015. Standard errors are in parentheses. Season totals are calculated from weighted strata totals. Unknown age indicates numbers of fish that could not be aged from the scales sampled and were not included in age calculations.

					Brood Year and age			
					2012	2011	2010	2009
Strata Dates	Run size (N)	Sample size (n)	% Female	Unknown Age	0.2	0.3	0.4	0.5
June 25–July 3	3,780	168	36	42	0% (0)	6% (2.2)	90% (2.6)	3% (1.6)
July 4–10	22,234	161	52	19	0% (0)	19% (3.3)	80% (3.4)	1% (0.7)
July 11–17	39,336	160	54	18	1% (1)	23% (3.5)	75% (3.7)	1% (1)
July 18–24	111,088	160	69	20	0% (0)	41% (4.2)	59% (4.2)	0% (0)
July 25–30	49,640	160	68	17	10% (2.5)	46% (4.2)	43% (4.2)	1% (0.7)
Aug 1–5	12,451	120	73	7	9% (2.7)	58% (4.7)	33% (4.4)	1% (0.9)
Total	238,529	929	64	123	3% (0.6)	37% (2.2)	59% (2.2)	1% (0.2)
Female	153,660	538		67	2% (0)	40% (2.8)	57% (2.8)	0.4% (0.3)
Male	84,869	391		56	4% (0)	32% (3.7)	63% (3.7)	1% (0.5)

Table 5. — Length at age of female and male Summer Chum Salmon sampled at the Henshaw Creek weir, Alaska, 2015.

	Male					Female				
	Mid-eye to fork length (mm)					Mid-eye to fork length (mm)				
Age	N	Mean	SE	Median	Range	N	Mean	SE	Median	Range
0.2	13	508	24.0	506.0	448–538	13	483	22.5	480	450–517
0.3	77	559	31.4	560.0	483–664	179	534	29.3	535.0	474–625
0.4	239	582	48.5	582.0	493–680	276	556	25.3	556.0	490–620
0.5	6	608	24.8	606.5	582–646	3	611	44.3	630	560–642
Total	335					471				

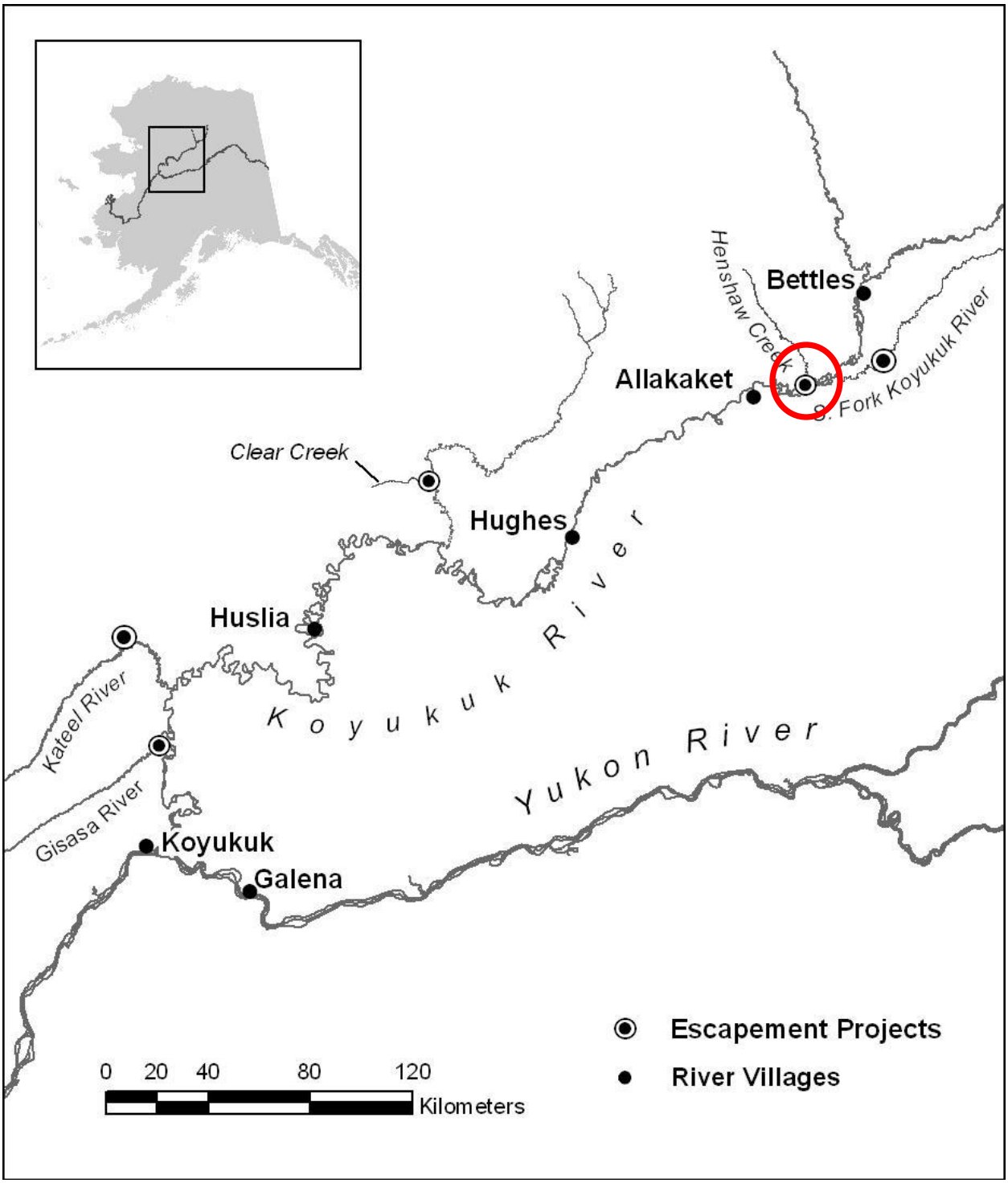

Figure 1. — Location of the Henshaw Creek weir and other active and historical tributary escapement project sites in the Koyukuk River drainage, Alaska.

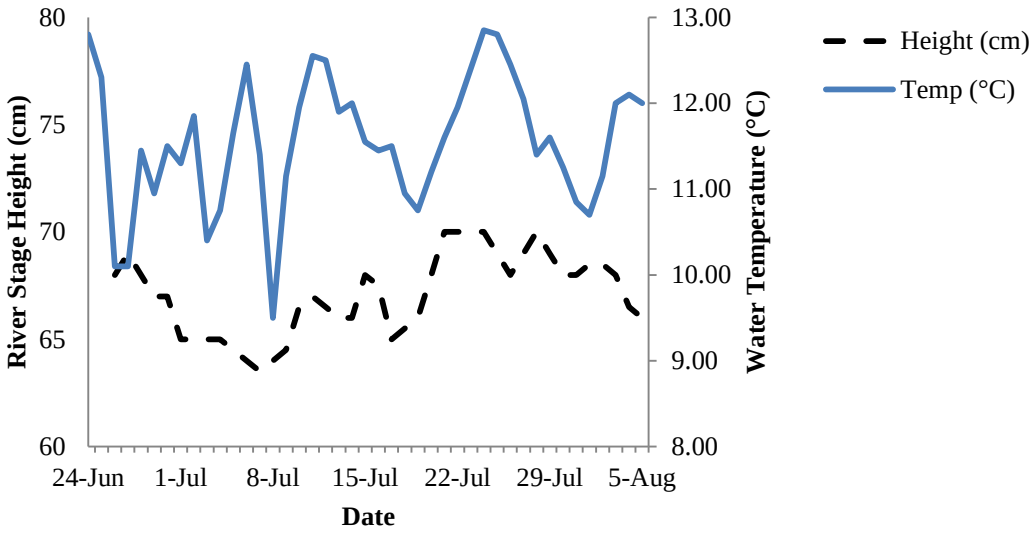

Figure 2. — Average daily river stage height and water temperature at the Henshaw Creek weir, Alaska, 2015. Average daily water temperature and river stage height were calculated using the average of the morning and evening recorded values.

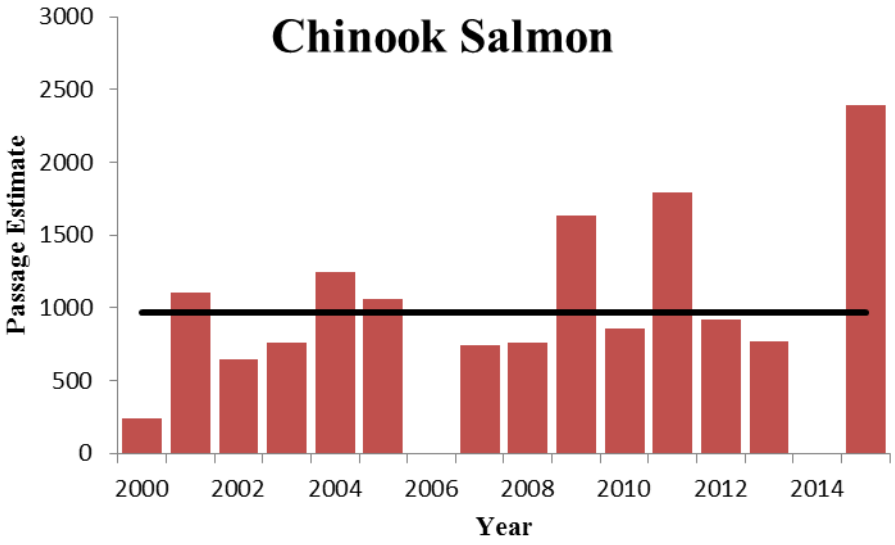

Figure 3. — Annual estimates of Chinook Salmon escapement at Henshaw Creek weir, Alaska, 2000–2015. No data was collected in 2006 and 2014 due to high water events. The horizontal line represents the 2000–2013 average escapement estimate (N = 966), omitting 2006.

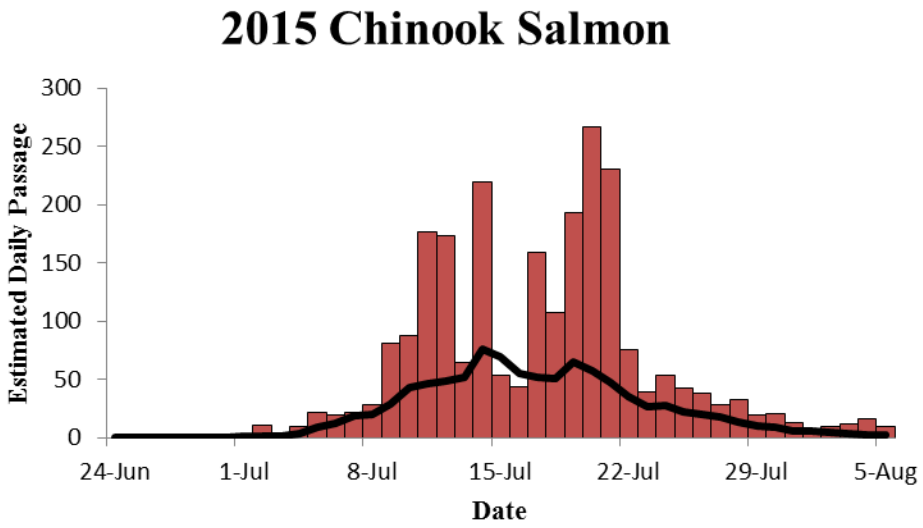

Figure 4. — Daily estimates of Chinook Salmon escapement at the Henshaw Creek weir, Alaska, 2015. Solid black line denotes the 2000–2013 (omitting 2006) average daily Chinook Salmon escapements.

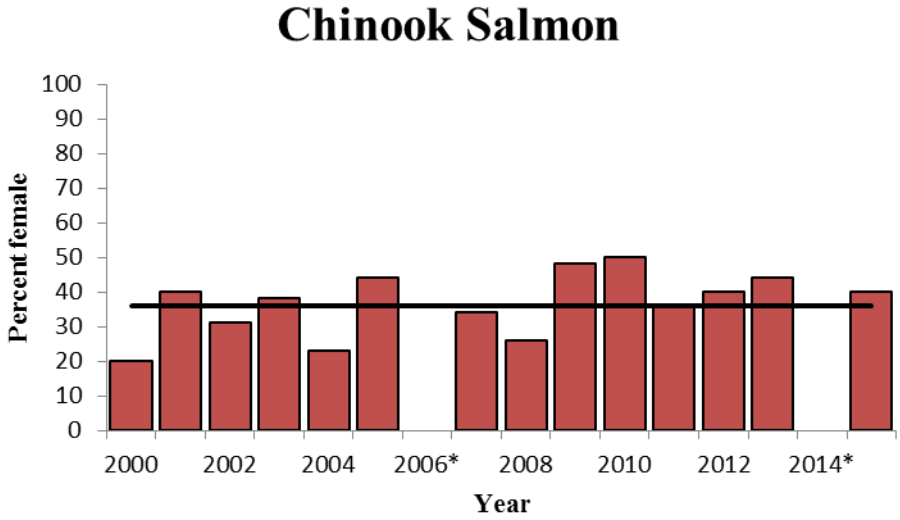

Figure 5. — Historical percent female Chinook Salmon at the Henshaw Creek weir 2000–2015. No data was collected in 2006* and 2014* due to high water events. The horizontal line represents the 2000–2013 average.

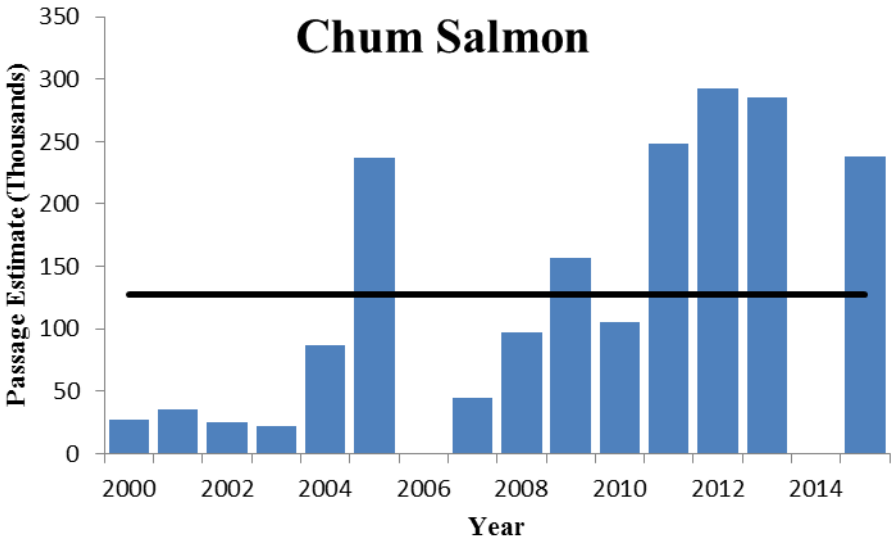

Figure 6. — Annual estimates of Summer Chum Salmon escapement at Henshaw Creek weir, Alaska, 2000–2015. No data was collected in 2006 and 2014 due to high water events. The horizontal line represents the 2000–2013 average escapement estimate (N = 127,914), omitting 2006.

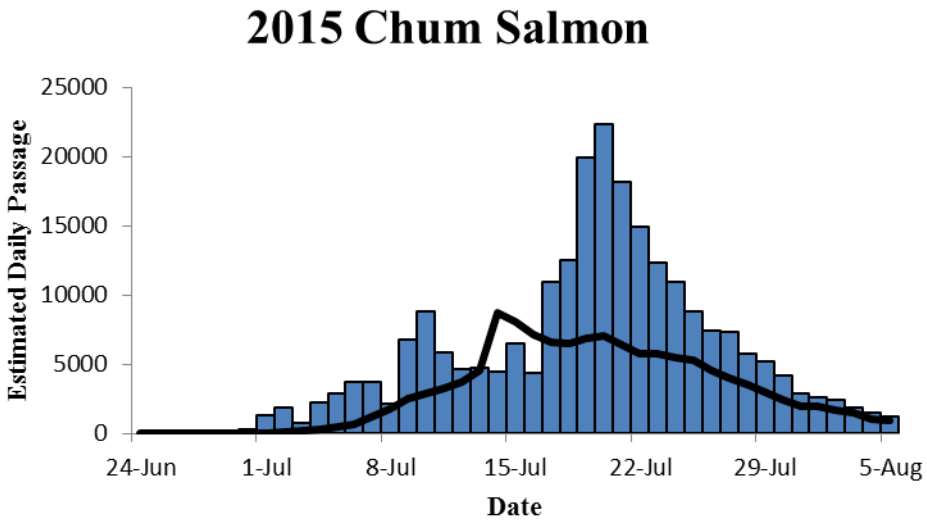

Figure 7. — Daily estimates of Summer Chum Salmon escapement at the Henshaw Creek weir, Alaska, 2015. Solid black line denotes the 2000–2013 (omitting 2006) average daily Summer Chum Salmon escapements.

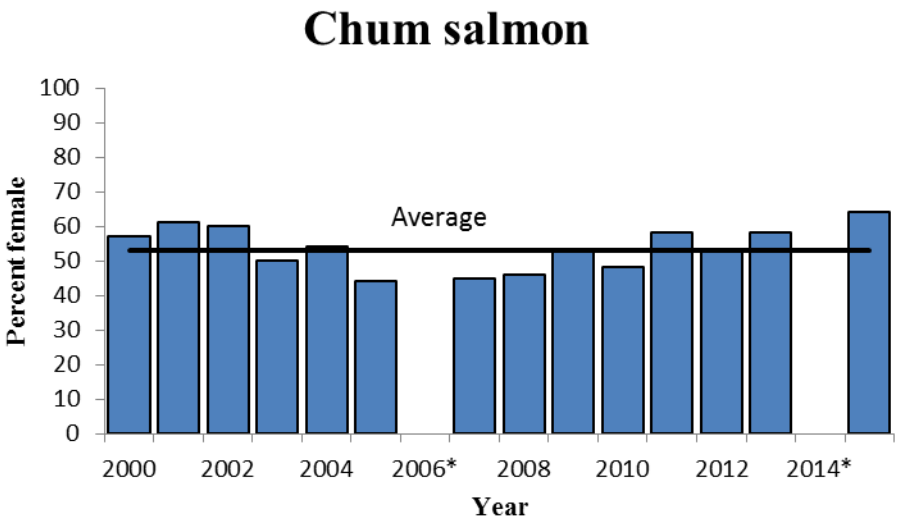

Figure 8. — Historical percent female Summer Chum Salmon at the Henshaw Creek weir 2000–2015. No data was collected in 2006* and 2014* due to high water events. The horizontal line represents the 2000–2013 average.

Appendix 1. — Water depth, water temperature, and air temperature data collected at the Henshaw Creek weir, 2015. Water depth is the water level at the trap.

	Water Depth (cm)		Water Temperature (°C)		Air Temperature (°C)	
Date	AM	PM	AM	PM	AM	PM
24-Jun	-	-	11.8	13.8	20.5	24.6
25-Jun	-	-	11.3	13.3	18.7	19.9
26-Jun	68	68	10.4	9.8	9.4	15.0
27-Jun	69	69	8.4	11.8	12.1	18.6
28-Jun	68	68	10.3	12.6	14.0	19.6
29-Jun	67	67	10.1	11.8	12.8	17.9
30-Jun	67	67	-	11.5	12.8	19.6
1-Jul	65	65	9.7	12.9	15.9	21.1
2-Jul	65	65	10.7	13.0	15.8	14.8
3-Jul	65	65	10.1	10.7	10.1	15.8
4-Jul	65	65	8.9	12.6	12.6	24.1
5-Jul	65	64	10.6	12.7	17.8	23.8
6-Jul	64	64	10.9	14.0	21.9	27.3
7-Jul	64	63	11.7	11.1	16.3	15.4
8-Jul	64	64	9.0	10.0	13.4	12.1
9-Jul	64	65	9.5	12.8	13.2	19.7
10-Jul	66	67	10.5	13.4	15.1	19.8
11-Jul	67	67	11.2	13.9	17.0	18.7
12-Jul	67	66	11.0	14.0	14.1	22.6
13-Jul	66	66	11.0	12.8	19.1	21.6
14-Jul	66	66	10.6	13.4	15.0	22.4
15-Jul	66	70	11.2	11.9	13.2	15.5
16-Jul	70	65	10.2	12.7	13.8	21.5
17-Jul	65	65	10.9	12.1	13.1	16.2
18-Jul	65	66	10.4	11.5	13.1	15.8
19-Jul	66	66	10.3	11.2	12.1	15.0
20-Jul	66	70	10.2	12.2	12.9	17.6
21-Jul	70	70	10.7	12.5	16.2	21.4
22-Jul	70	70	10.5	13.4	16.2	21.3
23-Jul	70	70	10.9	13.9	18.1	22.4
24-Jul	70	70	11.6	14.1	16.3	23.1
25-Jul	70	68	11.8	13.8	15.2	18.1
26-Jul	68	68	11.3	13.6	13.6	19.6
27-Jul	68	70	11.6	12.5	15.0	17.4
28-Jul	70	70	10.4	12.4	10.7	18.1
29-Jul	70	68	10.6	12.6	11.8	16.6
30-Jul	68	68	10.4	12.1	9.7	19.7
31-Jul	68	68	9.8	11.9	13.1	17.6
1-Aug	68	69	10.4	11.0	12.1	14.3
2-Aug	69	68	10.3	12.0	13.4	18.0
3-Aug	68	68	10.8	13.2	14.6	20.6
4-Aug	67	66	10.8	13.4	14.6	22.2
5-Aug	66	66	10.9	13.1	13.8	19.4
Average	67	67	10.6	12.5	14.4	19.2

Appendix 2 — Water quality parameters collected during the 2015 project at the Henshaw Creek weir, Alaska.

	Conductivity (µS/cm)		Dissolved Oxygen (mg/L)		pH	
Date	AM	PM	AM	PM	AM	PM
24-Jun	76.0	80.2	10.21	10.55	7.43	7.41
25-Jun	75.3	79.2	10.21	10.48	7.44	7.42
26-Jun	73.4	72.5	10.18	10.58	7.42	7.41
27-Jun	69.8	76.1	10.91	11.01	7.46	7.44
28-Jun	73.3	78.1	10.53	10.92	7.53	7.45
29-Jun	73.3	76.5	10.48	10.81	7.43	7.47
30-Jun	-	76.1	-	11.01	-	7.52
1-Jul	72.8	79.2	10.75	10.86	7.45	7.42
2-Jul	74.9	79.6	10.42	10.92	7.39	7.38
3-Jul	73.9	74.8	10.45	10.98	7.48	7.40
4-Jul	71.5	78.9	10.98	10.96	7.49	7.50
5-Jul	75.2	79.3	10.45	10.67	7.52	7.46
6-Jul	75.8	82.3	10.22	10.32	7.42	7.52
7-Jul	77.7	75.9	9.29	9.71	7.45	7.40
8-Jul	73.9	73.2	10.00	10.34	7.44	7.57
9-Jul	72.7	80.1	10.55	10.43	7.46	7.56
10-Jul	76.0	82.9	10.05	10.12	7.49	7.55
11-Jul	78.5	84.1	9.61	9.75	7.52	7.41
12-Jul	77.8	84.3	9.39	9.36	7.47	7.50
13-Jul	77.9	81.8	9.25	9.41	7.44	7.49
14-Jul	77.0	83.2	9.09	9.34	7.36	7.48
15-Jul	78.4	78.4	8.79	9.20	7.47	7.42
16-Jul	75.9	81.7	9.33	9.40	7.45	7.46
17-Jul	78.0	80.9	8.90	9.14	7.38	7.34
18-Jul	77.4	79.8	9.16	9.16	7.44	7.48
19-Jul	77.6	79.8	8.98	9.65	7.40	7.52
20-Jul	77.5	81.4	9.04	9.12	7.40	7.47
21-Jul	78.6	83.2	8.73	8.83	7.48	7.42
22-Jul	78.7	85.5	8.55	8.64	7.49	7.45
23-Jul	80.0	87.0	8.23	8.25	7.43	7.42
24-Jul	81.8	87.6	7.85	8.05	7.32	7.34
25-Jul	82.6	87.2	7.71	8.07	7.34	7.30
26-Jul	81.5	86.6	8.02	8.33	7.36	7.32
27-Jul	82.4	84.2	8.23	8.79	7.37	7.33
28-Jul	78.3	83.1	8.44	9.14	7.45	7.41
29-Jul	79.0	84.2	8.79	9.20	7.38	7.35
30-Jul	79.6	83.3	8.70	9.73	7.37	7.44
31-Jul	78.2	83.0	9.24	9.83	7.42	7.50
1-Aug	79.8	80.7	8.74	10.00	7.36	7.41
2-Aug	79.5	83.0	8.75	10.03	7.33	7.48
3-Aug	80.7	85.8	8.79	10.09	7.36	7.42
4-Aug	80.8	86.4	8.68	9.92	7.36	7.47
5-Aug	81.3	85.8	8.35	10.25	7.36	7.48
Average	77.2	81.3	9.36	9.80	7.42	7.44

Appendix 3. — Historical estimates of Chinook Salmon and Summer Chum Salmon escapement at the Henshaw Creek weir, Alaska, 1960–2015 (Aerial index data from Baron 1984; Alaska Department of Fish and Game unpublished data).

Year	Aerial index estimates			Tower estimates		Weir estimates	
	Chinook Salmon	Chum Salmon	Survey rating	Chinook Salmon	Chum Salmon	Chinook Salmon	Chum Salmon
1960	Present		Poor				
1969	6	300	Not Rated				
1975	118	1,219	Not Rated				
1976	94	624	Fair				
1982	48	12	Fair				
1983	553	3,288	Good-Fair				
1984	253	532	Poor				
1985	393	3,724	Good				
1986	561	2,475	Fair				
1987	20	35	Not Rated				
1988	180	1,106	Good-Poor				
1990	369	1,237	Good-Fair				
1991	455	2,148	Good				
1992	Present	Present	Poor				
1993	330	1,173	Good				
1994	526	2,165	Fair				
1995	271	15,397	Good				
1996	69	12,890	Fair				
1997	593	1,800	Fair				
1998	97	151	Fair				
1999	119	2,703	Poor	0	1,510		
2000						244	27,271
2001						1,103	35,031
2002						649	25,249
2003						763	22,556
2004						1,248	86,474
2005						1,059	237,481
2006						0*	4*
2007						740	44,425
2008						766	96,731
2009						1,637	156,933
2010						857	105,398
2011						1,796	248,247
2012						922	292,082
2013						772	285,008
2014						0*	0*
2015						2,391	238,529

*No escapement estimates in 2006 and 2014 due to persistent flooding.

Appendix 4. — Historical percent female Chinook Salmon and Summer Chum Salmon sampled at the Henshaw Creek weir. No data was collected in 2006* and 2014* due to high water events.

Year	Chinook % Female	Chum % Female
2000	20	57
2001	40	61
2002	31	60
2003	38	50
2004	23	54
2005	44	44
2006*		
2007	34	45
2008	26	46
2009	48	53
2010	50	48
2011	36	58
2012	40	53
2013	44	58
2014*		
2015	40	64
Average	36	53