Tanana Chiefs Conference, Fisheries Program

Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2012

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Cover Photo: Henshaw Creek Weir 2012, courtesy of Jonathan Henzie

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Abstract

A resistance board weir was operated by the Tanana Chiefs Conference fisheries program to collect information on abundance and run timing of Chinook salmon *Oncorhynchus tshawytscha* and chum salmon *O. keta* migrating up Henshaw Creek, a tributary to the Koyukuk River, Alaska. The Henshaw Creek weir has been operated annually for the last 13 years. In 2012 the weir was operated from June 24 through August 4. A total of 922 Chinook and 292,082 summer chum salmon passed through the weir; representing an estimated <1% and 13% respectively, of the total Yukon run size counted by the Pilot Station Sonar for these two species in 2012. Other fish species that passed through the weir included longnose sucker *Catostomus catostomus* (N = 3,443), whitefish spp. (*Coregoninae*; N = 109), Arctic grayling *Thymallus arcticus* (N = 58), and northern pike *Esox Lucius* (N = 27). The estimated weekly sex composition for Chinook salmon ranged from 24% to 63% female fish, and averaged 40% for the season. Four age classes of Chinook salmon were identified from 289 aged scale samples; age class 1.2, 1.3, 1.4, and 1.5, with the predominant age class being 1.3 (49%). Mean length-at-age of female Chinook salmon was larger than males in age classes 1.3 and 1.4. The estimated weekly sex composition for summer chum salmon ranged from 31% to 67% female fish, and averaged 53% for the season. Four age classes of chum salmon were identified from 478 aged scale samples; age class 0.2, 0.3, 0.4, and 0.5, with the predominate age class being 0.3 (84%). Mean length-at-age of male chum salmon was larger than females in age classes 0.3, 0.4, and 0.5. The Henshaw Creek weir has provided a valuable long term data set dating back to the year 2000. The continuation of this project, and other escapement projects, is vital to successful management of Chinook and chum salmon, as 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 the contributions smaller tributaries make 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 chum salmon *O. keta*, as well as several other resident species. Chinook and summer chum salmon from Henshaw Creek contribute to the mixed-stock fisheries in the Yukon and Koyukuk rivers (USFWS 1993). Since 1997, Chinook and summer chum salmon runs of the Yukon River Basin have demonstrated an

overall decline in productivity (Bergstrom et al. 2001; JTC 2013). These declines have led to harvest restrictions, fishery closures, and spawning escapements below management goals (Kruse 1998; JTC 2013). In 2000, the Alaska Board of Fisheries classified Yukon River Chinook salmon as a stock of yield concern in response to poor returns and low harvests (Hayes et al. 2006). Low returns of Chinook salmon in 2008 and 2009 resulted in a commercial fishery failure pursuant to the Magnuson-Stevens Fishery Act. Low returns of Chinook salmon continued through the 2012 run. 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. In addition to commercial fishery closures, management actions during the past several seasons have included intensified gear restrictions on subsistence fishers, coupled with reductions in and closures of subsistence salmon fishing periods (JTC 2013). 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. Responsible management of these resources is paramount considering the current state of the Yukon River Chinook salmon and the complexity of mixed stock fisheries for both Chinook and summer chum salmon. In order to develop proper management strategies, managers need high quality data describing Chinook 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 to better understand the contributions smaller tributaries make to the overall salmon runs in the Yukon River.

Henshaw Creek has historically produced substantial numbers 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 1,637 Chinook salmon and from 22,556 to 292,082 summer chum salmon (Dupuis, 2012). Both Chinook 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 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 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 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 and summer chum salmon escapements were enumerated using a resistance board weir. The weir was installed June 23rd and was fully operational with enumeration beginning June 24 at 00:00 and ending August 4 at 12:00, with no interruptions occurring to suspend operation. The picket spacing (3.2cm space between pickets) within the trap and weir panels was narrow enough to prevent adult Chinook and summer chum salmon from passing through the weir undetected. However, some individuals of the smaller fish species, such as Arctic grayling *Thymallus arcticus* and whitefish spp. (*Coregoninae*), likely passed through the weir undetected.

Biological Data:

Total fish passage through the weir was 922 Chinook salmon and 292,082 summer chum salmon (Table 1). The next most abundant species was longnose sucker *Catostomus catostomus* (N = 3,443), followed by whitefish spp. (*Coregoninae;* N = 109), Arctic grayling *Thymallus arcticus* (N = 58), and northern pike *Esox Lucius* (N = 27, Table 1).

Chinook salmon

Total Chinook passage through the weir was 2.6% higher than the 2000-2011 average of 899 (no data was collected in 2006, and is therefore not included in the average; Figure 2). The first Chinook salmon passed through the weir on July 5 (N = 1).The final Chinook salmon passed through the weir on August 3 (N = 2). The mid-point of fish passage occurred on July 20, with the first and third quarter passage dates occurring on July 15 and July 24, respectively (Table 1, Figure 3).

Due to low fish passage during the first weeks of weir operations, sampling objectives for age, sex, and length were not attained. Therefore, these weeks were combined to make the first statistical strata June 24 through July 14 (Table 2). Samples were collected from 318 Chinook salmon, with age unable to be determined for 29 (9%) of those samples, primarily due to scale regeneration. Overall, four age classes were identified; age class 1.2, 1.3, 1.4, and 1.5, from brood years 2008, 2007, 2006, and 2005 respectively. Age class 1.3 was predominant, accounting for 49% of the season total, with stratum estimates ranging from 32% to 71%. The next most abundant age class was 1.4, accounting for 34% of the season total, with stratum estimates ranging from 22% to 63%. Age class 1.2 accounted for 16% of the season total, with stratum estimates ranging from 5% to 26%. Age class 1.5 accounted for less than 1% of the season total, with a sample size of one.

The age distribution varied between male and female Chinook salmon. Males were predominantly age 1.3 (61%), followed by age 1.2 (27%), and age 1.4 (12%), whereas, females were predominantly age 1.4 (67%), followed by age 1.3 (32%), and age 1.5 (<1%). The estimated sex ratio for the entire Chinook run was 40% female, with stratum estimates ranging from 24% to 63%. The proportion of females in the run steadily increased over time, starting at 24% during statistical week 1, and ending at 63% for the final statistical week (Table 2).

Female Chinook salmon length ranged from 554 to 975 mm MEFL, and male Chinook salmon lengths ranged from 491 to 930 mm MEFL (Table 3). Mean length-at-age of female Chinook salmon was larger than males in age classes 1.3 and 1.4, with female means of 747 mm (age 1.3) and 830 mm (age 1.4) compared to male means of 696 mm (age 1.3) and 785 mm (age 1.4).

Chum salmon

Total chum salmon passage was 254.4% higher than the 2000-2011 average of 114,823 (no data was collected in 2006, and is therefore not included in the average). A total of 292,082 chum salmon passed through the weir, and is the highest return on record (Table 1; Figure 4). The first chum salmon passed through the weir July 6 (N = 3). During the final day of weir operation, August 4, 1,939 chum salmon passed through the weir accounting for less than 1% of the season total. The mid-point of summer chum salmon passage was July 20, with the first and third quarter passage dates occurring on July 15 and July 26 respectively (Table 1, Figure 5).

Due to low fish passage during the first weeks of weir operations, sampling objectives for age, sex, and length were not attained. Therefore, these weeks were combined to make the first statistical strata June 24 through July 14 (Table 4). Samples were collected from 600 chum salmon, with age unable to be determined from 122 (20%) of those samples, primarily due to scale regeneration. Overall, four age classes of chum salmon were identified; age 0.2, 0.3, 0.4, and 0.5 from brood years 2009, 2008, 2007, and 2006 respectively (Table 4). Age class 0.3 was predominant, accounting for 84% of the season total, with stratum estimates ranging from 69% to 92%. The next most abundant age class was 0.4, accounting for 13% of the season total, with stratum estimates ranging from 8% to 26%. Age class 0.5 accounted for 2% of the season total, and age class 0.2 accounted for less than 1% of the season total. The estimated sex ratio for the entire run was 53% female, with stratum estimates ranging from 31% to 67% (Table 4).

Female chum salmon length ranged from 426 mm to 632 mm MEFL, and male chum salmon lengths ranged from 492 mm to 665 mm MEFL (Table 5). Mean length-at-age of male chum salmon was larger than females in age classes 0.3, 0.4, and 0.5, with male means of 560 mm (age 0.3), 577 mm (age 0.4), and 592 (age 0.5) compared to female means of 539 mm (age 0.3), 548 mm (age 0.4), and 572 mm (age 0.5). Male mean length-at-age for age class 0.2 was 503 mm compared to the female mean of 511 mm. However, the male sample size for age class 0.2 was small, N = 1 (Table 5).

Final 2012 Henshaw Creek weir summer chum escapement totals represented an estimated 13% of the entire Yukon summer chum run counted by the Pilot Station Sonar (JTC 2013). 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 is used by USFWS and ADF&G-DCF managers to help direct in-season management decisions and post season evaluations. Additionally, the time series data from Henshaw Creek will be used in evaluating 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. Additionally, this project has collected and produced 12 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 time series data are increasing in importance due to the continual increase of stresses placed on these salmon resources.

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Table 1. — Daily and cumulative (Cum) counts of Chinook and summer chum salmon passage, and daily counts of other fish species, at the Henshaw Creek weir, Alaska, 2012. Asterisks (*) denote first, mid, and third quarter points of Chinook and summer chum salmon passage.

	Chinook Salmon		Summer chum		Longnose Sucker	Arctic Grayling	Northern Pike	Whitefish sp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jun-30					0	1	0	0
Jul-1					0	2	1	0
Jul-2					351	0	0	0
Jul-3					295	0	0	0
Jul-4					1	0	0	0
Jul-5	1	1	0	0	5	0	1	0
Jul-6	1	2	3	3	57	1	0	0
Jul-7	3	5	25	28	313	0	0	0
Jul-8	2	7	149	177	54	0	0	0
Jul-9	5	12	2,671	2,848	5	5	0	0
Jul-10	28	40	5,984	8,832	14	3	2	3
Jul-11	43	83	8,865	17,697	5	2	4	7
Jul-12	40	123	10,241	27,938	6	6	4	1
Jul-13	56	179	14,319	42,257	22	7	2	48
Jul-14	36	215	14,927	57,184	1	4	0	1
Jul-15	52	*267	17,038	*74,222	3	1	1	4
Jul-16	62	329	16,207	90,429	123	2	1	7
Jul-17	28	357	13,441	103,870	11	1	0	0
Jul-18	23	380	12,964	116,834	2	1	0	0
Jul-19	39	419	14,432	131,266	0	1	0	0
Jul-20	99	*518	19,950	*151,216	0	3	0	0
Jul-21	62	580	16,296	167,512	79	9	1	7
Jul-22	58	638	14,228	181,740	226	0	2	0
Jul-23	46	684	12,890	194,630	233	1	1	3
Jul-24	58	*742	10,424	205,054	192	0	1	5
Jul-25	39	781	10,407	215,461	84	1	0	1
Jul-26	21	802	8,751	*224,212	201	0	0	0
Jul-27	39	841	12,127	236,339	402	1	1	7
Jul-28	17	858	11,320	247,659	147	2	0	0
Jul-29	25	883	9,623	257,282	203	2	0	0
Jul-30	15	898	7,928	265,210	116	1	0	1
Jul-31	10	908	6,768	271,978	90	0	1	0
Aug-1	8	916	7,038	279,016	114	1	1	7
Aug-2	4	920	6,514	285,530	48	0	0	3
Aug-3	2	922	4,613	290,143	8	0	2	1
Aug-4	0	922	1,939	292,082	32	0	1	3
Total		922		292,082	3,443	58	27	109

Table 2. — Age and sex ratio estimates, by stratum, of Chinook salmon at Henshaw Creek weir, Alaska 2012. 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	2008	2007	2006	2005
	Run size	Sample size		Age				
Strata Dates	(n)	(N)	% Female		1.2	1.3	1.4	1.5
Jun 24 - Jul 14	215	45	24	4	7% (4.1)	71% (7.2)	22% (6.5)	0% (0.0)
Jul 15 - 21	365	142	35	13	26% (3.9)	45% (4.4)	29% (4.0)	0% (0.0)
Jul 22 - 28	278	112	53	12	12% (3.3)	43% (5.0)	44% (5.0)	1% (1.0)
Jul 29 – Aug 4	64	19	63	0	5% (5.3)	32% (11.0)	63% (11.4)	0% (0.0)
Total	922	318	40	29	16% (2.1)	49% (2.9)	34% (2.8)	<1% (0.3)
Female	368	132		11	0% (0.0)	32% (4.4)	67% (4.4)	<1% (0.8)
Male	554	186		18	27% (3.3)	61% (3.8)	12% (2.7)	0% (0.0)

Table 3. — Length at age of male and female Chinook salmon sampled at Henshaw Creek weir, Alaska, 2012.

	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	50	559	41.7	555.5	491 - 690	0	-	-	-	-
1.3	98	696	49.4	692	556 - 809	38	747	74.3	765	554 - 863
1.4	20	785	67.9	777.5	643 - 930	82	830	47.0	831	717 - 975
1.5	0	-	-	-	-	1	915	-	915	915
Total	168					121				

Table 4. — Age and sex ratio estimates, by stratum, of chum salmon at Henshaw Creek weir, Alaska 2012. 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	2009	2008	2007	2006
	Run size	Sample size		Age				
Strata Dates	(n)	(N)	% Female		0.2	0.3	0.4	0.5
Jun 24 - Jul 14	57,184	80	31	6	1% (1.4)	69% (5.4)	26% (5.1)	4% (2.3)
Jul 15 - 21	110,328	200	52	43	1% (0.9)	84% (2.9)	12% (2.6)	3% (1.3)
Jul 22 - 28	80,147	120	67	19	0% (0.0)	91% (2.8)	9% (2.8)	0% (0.0)
Jul 29 – Aug 4	44,423	200	61	54	<1% (0.7)	92% (2.3)	8% (2.2)	0% (0.0)
Total	292,082	600	53	122	<1% (0.4)	84% (1.8)	13% (1.6)	2% (0.7)
Female	155,770	331		72	1% (1.4)	86% (2.3)	11% (2.1)	2% (0.9)
Male	136,312	269		50	<1% (0.9)	82% (2.7)	15% (2.6)	2% (0.9)

Table 5. — Length at age of female and male chum salmon sampled at Henshaw Creek weir, Alaska, 2012.

	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	1	503	-	503.0	503	3	511	8.5	510	503 - 520
0.3	184	560	26.8	557.0	492 - 665	225	539	28.1	542.0	426 -612
0.4	31	577	24.8	575.0	537 - 613	27	548	36.3	555.0	457 - 632
0.5	3	592	22.0	591.0	571 - 615	4	572	19.8	566	557 - 600
Total	219					259				

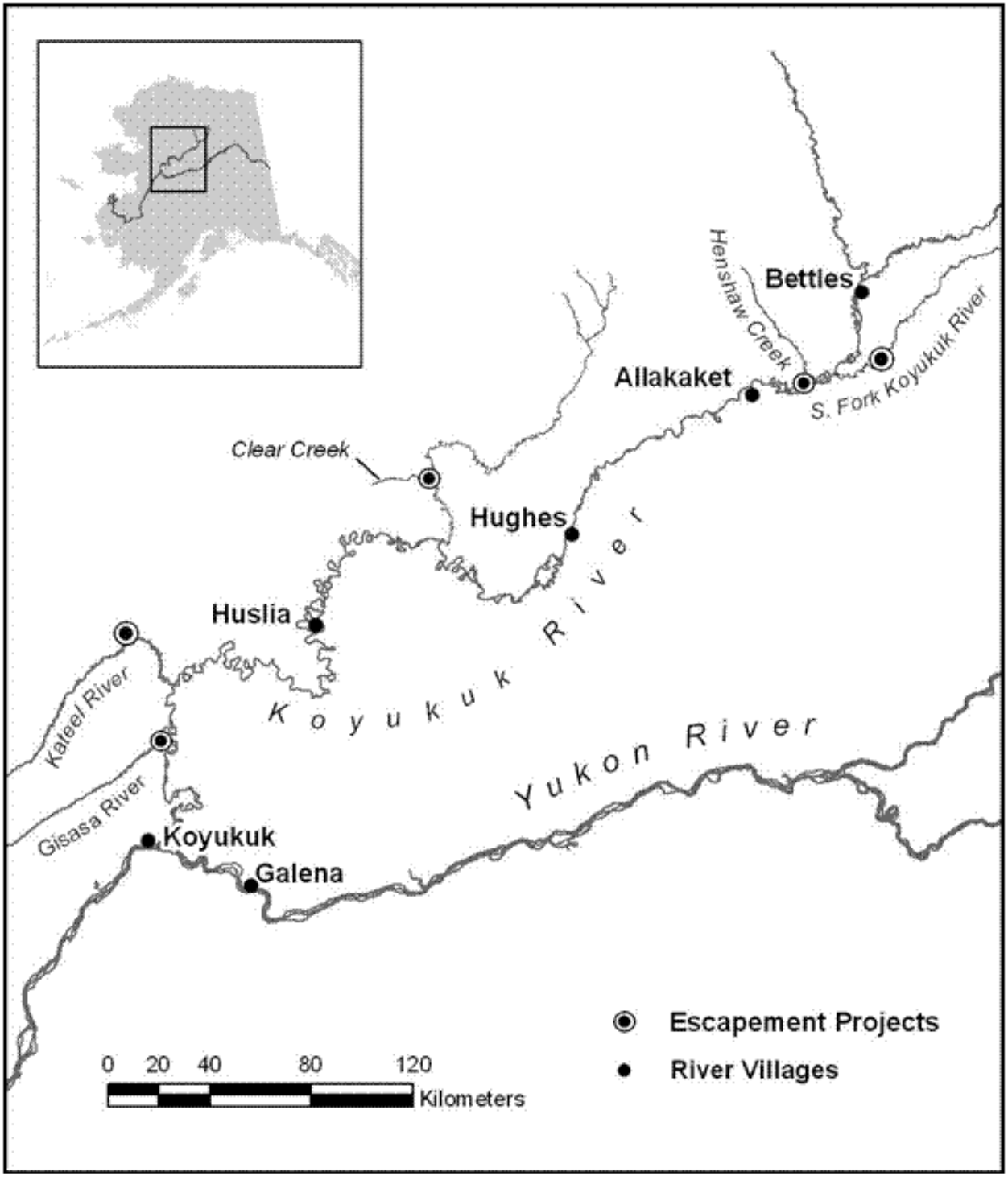

Figure 1. — Location of the Henshaw Creek weir and other active and historical tributary escapement project sites in the Koyukuk River drainage, Alaska.

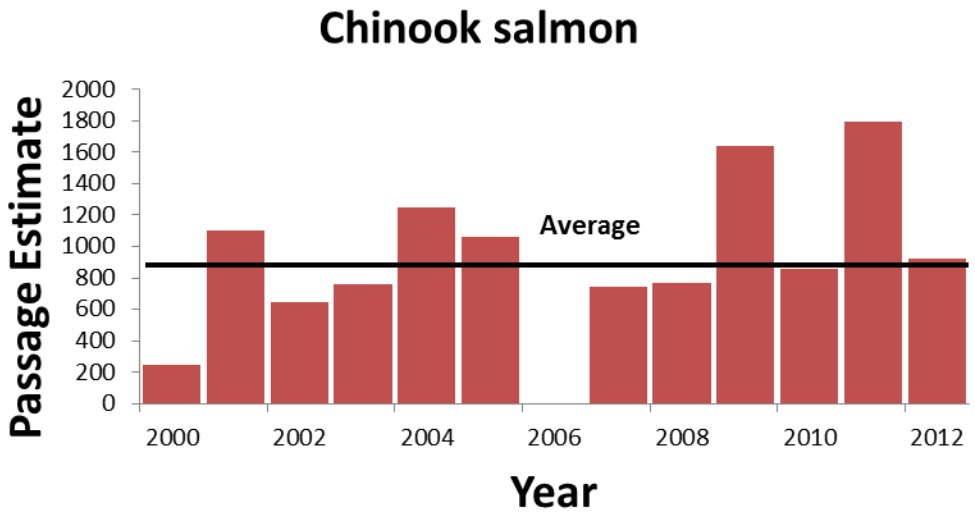

Figure 2. — Chinook salmon escapement estimates from Henshaw Creek weir 2000 through 2012. The weir was not operational in 2006 due to high water events. Therefore, no data was collected in 2006. The horizontal line represents the average escapement estimate (N = 899) from 2000 through 2012, omitting 2006.

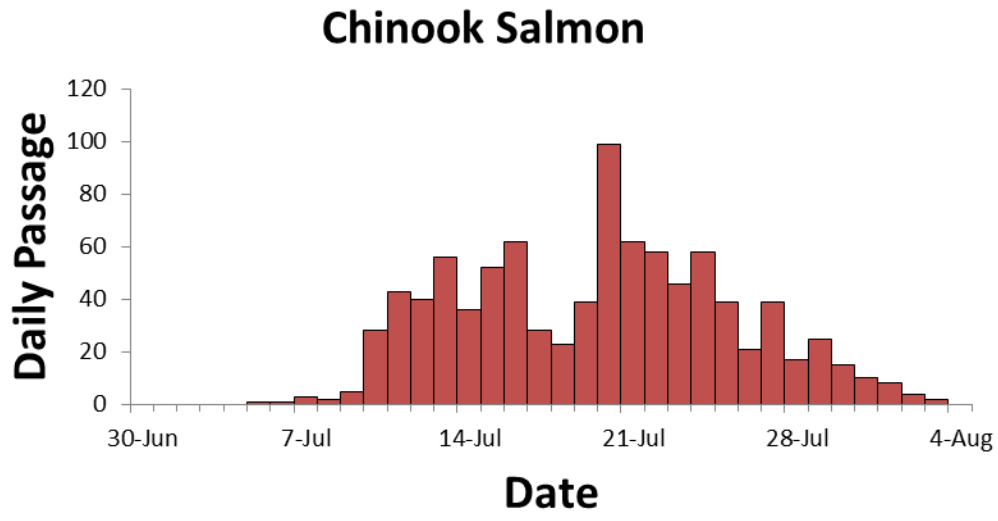

Figure 3. — Chinook salmon daily passage through Henshaw Creek weir 2012.

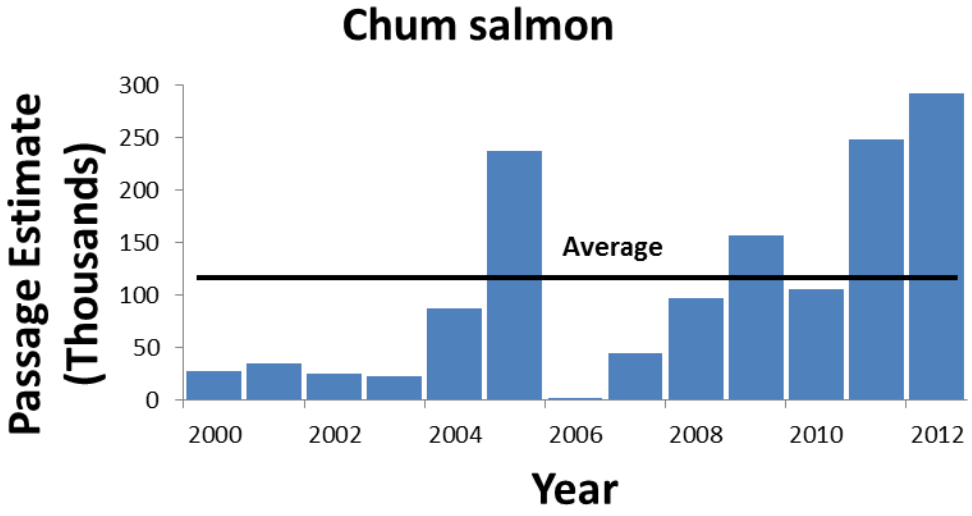

Figure 4. — Chinook salmon escapement estimates from Henshaw Creek weir 2000 through 2012. The weir was not operational in 2006 due to high water events. Therefore, no data was collected in 2006. The horizontal line represents the average escapement estimate (N = 114,823) from 2000 through 2012, omitting 2006.

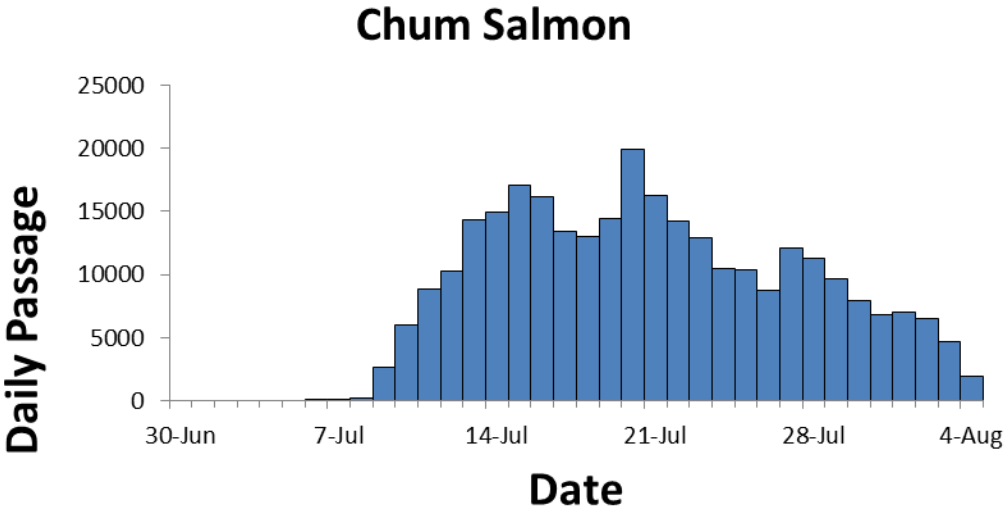

Figure 5. — Chum salmon daily passage through Henshaw Creek Weir 2012.

Appendix 1. — Historical Chinook salmon and summer chum salmon escapement estimates in the Henshaw Creek, 1960 – 2012 (Aerial index data from Baron 1984; Alaska Department of Fish and Game unpublished data).

Year	Aerial index estimates		Survey rating	Tower estimates		Weir estimates	
	Chinook salmon	Chum salmon		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

*Escapement estimates in 2006 were not completed due to persistent flooding events.