Tanana Chiefs Conference, Fisheries Program

Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2009

FIS 08-201

Tanana Chiefs Conference, Fisheries Program
Fairbanks, Alaska

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Aaron W. Dupuis

Abstract

In 2009, a resistance board weir was used to collect information on abundance, run timing, and biology of returning salmon and other resident fish species migrating up Henshaw Creek, a tributary to the Koyukuk River, Alaska. An estimated 1,637 Chinook salmon *Oncorhynchus tshawytscha* and 156,933 Chum salmon *O. keta* passed through the weir, which operated from July 5 through August 7, 2009, counted. The four other fish species that were counted include: longnose sucker *Catostomus catostomus* (N = 3,837), arctic grayling *Thymallus arcticus* (N = 107), whitefish (Coregoninae; N = 15), and northern pike *Esox lucius* (N = 10). The estimated weekly sex composition for Chinook salmon ranged from 45% to 56% female fish. There were three primary age classes identified, 1.2, 1.3, and 1.4, which composed 34%, 28%, and 37% of the run, respectively. The estimated weekly sex composition for summer chum salmon ranged from 41% to 62% female fish. There were two primary age classes identified, 0.3 and 0.4, which composed 78% and 19% of the run, respectively.

Introduction

Henshaw Creek, a tributary to the Koyukuk River, is located within the Kanuti National Wildlife Refuge in the Interior of Alaska. It provides spawning and rearing habitat for Chinook salmon *Oncorhynchus tshawytscha* and chum salmon *O. keta*, as well as several other resident species. Chinook salmon and chum salmon from Henshaw Creek contribute to the mixed-stock fisheries in the Yukon and Koyukuk rivers (USFWS 1993). However, since 1997, Yukon River Chinook salmon and summer chum salmon runs have demonstrated an overall decline in productivity (Bergstrom et al. 2001; JTC 2009). These declines have led to harvest restrictions, fishery closures, and spawning escapements below management goals (Kruse 1998; Salomone and Bergstrom 2004; JTC 2009). 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). Additionally, low returns of Chinook salmon in 2008 and 2009 resulted in a commercial fishery failure pursuant to the Magnuson-Stevens Fishery Act. Because of the state of the Yukon River Chinook salmon and the complexity of mixed stock fisheries for both Chinook salmon and chum salmon, responsible management of this resource is paramount. The managers need high quality data describing Chinook salmon and chum salmon escapements and ASL if proper management strategies are to be developed.

Prior to 1999, three stock status and escapement projects were conducted in the Koyukuk River drainage to enumerate salmon stocks; the Gisasa River weir (O'Brian and Berkbigler 2006), South Fork Koyukuk River weir (Wiswar 1998), and the Clear Creek

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counting tower (C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication). Henshaw Creek has historically contributed significant numbers of Chinook salmon and summer chum salmon (Barton 1984; Berkbigler and Elkin 2006; Appendix 1) to the Koyukuk River, and has been monitored with a weir since 2000. The U. S. Fish and Wildlife Service (USFWS), Fairbanks Fish and Wildlife Field Office (FFWFO) and, more recently, biologists with the Tanana Chiefs Conference 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 current (Gisasa River) salmon escapement projects operated within the Koyukuk River drainage (e.g., Melegari and Wiswar 1995; Melegari 1996, 1997). Since 2000, escapement estimates in Henshaw Creek have ranged from 244 to 1,637 Chinook salmon and from 22,556 to 237,481 chum salmon. 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. The objectives of the 2010 Henshaw Creek weir study were to determine (1) daily escapement and run timing of adult salmon, (2) age, sex, and length (ASL) compositions of adult salmon, and (3) the upstream movement and presence of resident fishes.

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 Alatana Hills and flows in a southeasterly direction for approximately 144 km before entering the Koyukuk River. 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 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 weir site is approximately 1.5 km upstream from the mouth of Henshaw Creek. 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 Hensaw Creek weir has been installed at the same site since the project was initiated in 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

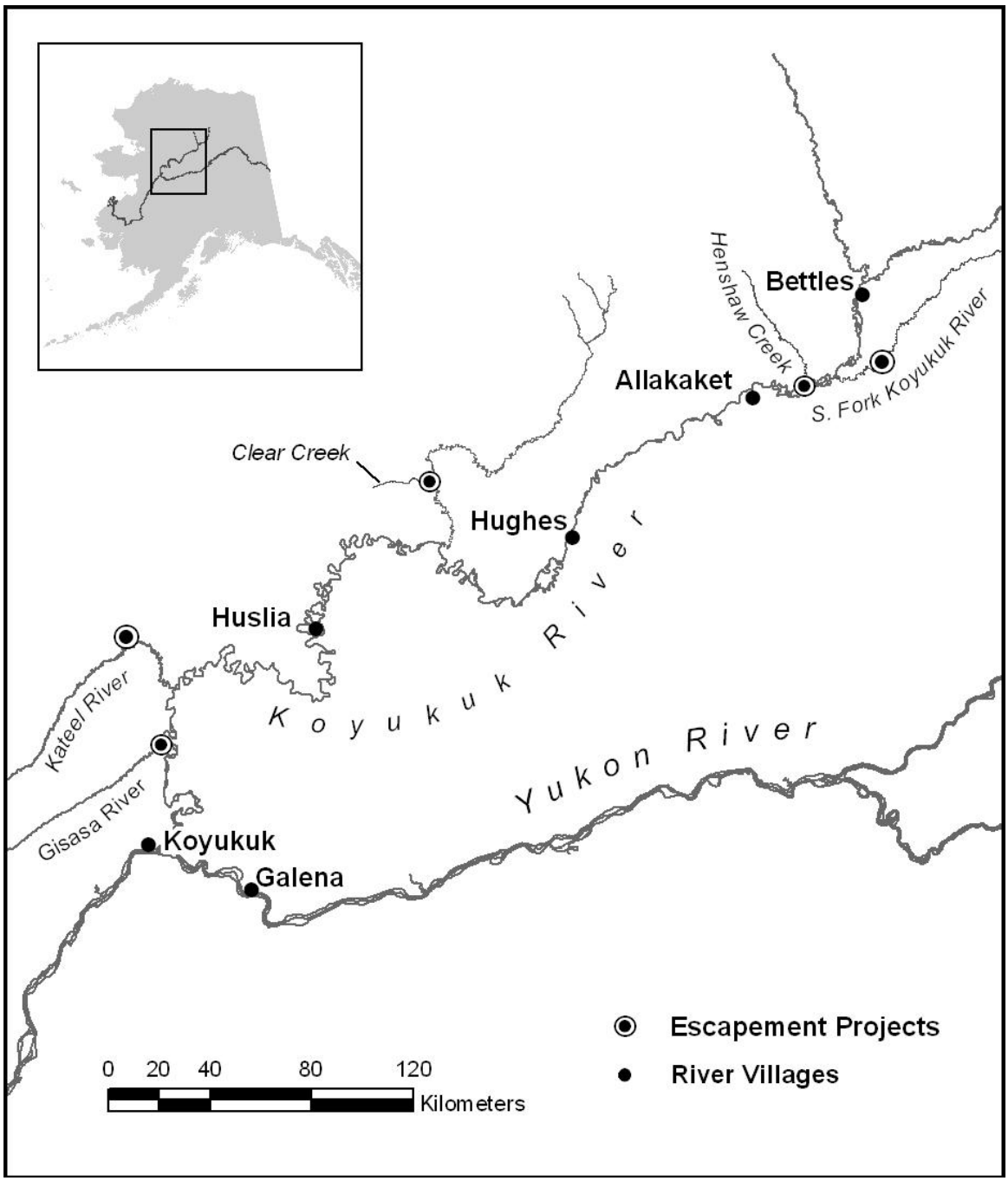

Figure 1. — Location of the Henshaw Creek weir and other active and historical tributary escapement project sites in the Koyukuk River drainage, Alaska.

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 start date of the project was based on previous years' run timing data. The end date of the project was determined inseason 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 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, seven days a week.

A stratified random sampling scheme was used to collect age, sex, and length ratio information 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 chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL), and sex was visually determined by secondary sex characteristics. Scales were used for ageing; with age class information reported using the European technique (Foerster 1968). Three scales were collected from Chinook salmon and one scale from chum salmon. 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 Service Field Office.

Data Analysis

Days with counts greater than 6 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

In 2009, the Henshaw Creek weir was fully operational on July 5, with 48 Chinook salmon and 1,349 chum salmon counted that day (Table 1). Counting continued throughout the season without interruption. The counting was discontinued at 1159 hours on August 7. The picket spacing (3.2 cm space between pickets) within the trap and weir panels was narrow enough to prevent adult Chinook salmon and chum salmon from passing through the weir. However, some individuals of the smaller fish species, such as Arctic grayling

Table 1. — Daily and cumulative (Cum) estimates of Chinook salmon and summer chum salmon passage, and daily counts of other species, at the Henshaw Creek weir, Alaska, 2009. Shaded values indicate first and third quarter points, and the midpoint of Chinook salmon and summer chum salmon passage estimates.

	Chinook salmon		Chum salmon		Longnose sucker	Northern pike	Arctic grayling	Whitefish spp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jul-5	48	48	1,349	1,349	0	0	20	0
Jul-6	44	92	2,402	3,751	2	0	3	0
Jul-7	24	116	3,062	6,813	43	0	4	0
Jul-8	11	127	2,209	9,022	461	0	9	0
Jul-9	17	144	2,547	11,569	21	1	1	0
Jul-10	24	168	3,157	14,726	15	1	0	0
Jul-11	49	217	3,032	17,758	46	0	4	0
Jul-12	64	281	2,666	20,424	1574	0	1	0
Jul-13	80	361	3,792	24,216	526	0	7	0
Jul-14	132	493	3,345	27,561	190	0	2	1
Jul-15	71	564	3,554	31,115	34	2	1	1
Jul-16	82	646	4,587	35,702	8	0	3	0
Jul-17	182	828	6,455	42,157	10	2	5	1
Jul-18	128	956	9,763	51,920	101	0	10	0
Jul-19	190	1,146	13,102	65,022	146	1	9	3
Jul-20	72	1,218	12,953	77,975	94	3	5	1
Jul-21	67	1,285	11,464	89,439	73	0	8	0
Jul-22	78	1,363	9,495	98,934	108	0	2	0
Jul-23	42	1,405	9,035	107,969	52	0	3	1
Jul-24	53	1,458	8,186	116,155	45	0	2	1
Jul-25	49	1,507	6,857	123,012	40	0	1	0
Jul-26	24	1,531	5,493	128,505	13	0	1	0
Jul-27	11	1,542	3,678	132,183	13	0	2	0
Jul-28	20	1,562	4,179	136,362	16	0	0	5
Jul-29	20	1,582	4,585	140,947	27	0	0	1
Jul-30	13	1,595	3,752	144,699	70	0	1	0
Jul-31	12	1,607	2,691	147,390	61	0	0	0
Aug-1	6	1,613	1,910	149,300	16	0	1	0
Aug-2	6	1,619	1,596	150,896	2	0	0	0
Aug-3	6	1,625	1,612	152,508	3	0	0	0
Aug-4	6	1,631	1,625	154,133	3	0	0	0
Aug-5	5	1,636	1,485	155,618	6	0	1	0
Aug-6	1	1,637	1,043	156,661	18	0	0	0
Aug-7	0	1,637	272	156,933	0	0	1	0
Total		1,637		156,933	3,837	10	107	15

Thymallus arcticus and whitefish spp. (Coregoninae), likely passed through the weir undetected.

Biological Data

The seasonal estimates of fish passage at the weir were 1,637 Chinook salmon and 156,933 summer chum salmon (Table 1). Longnose sucker *Catostomus catostomus* (N = 3,837), Arctic grayling (N = 107), whitefish spp. (N = 15), and northern pike *Esox lucius* (N = 10) were also counted at the weir.

Chinook salmon

The first Chinook salmon was counted on July 5, when 48 were passed through the weir. The last Chinook salmon were counted on August 6 (N = 1) which represented < 0.1% of the run. The first quarter point passage date was July 14, the middle passage date was July 17, and the third quarter point passage date was July 21 (Table 1). The seasonal estimate of 1,637 Chinook salmon was higher than the 2000 to 2008 average (822) and was the highest weir estimate to date (Figure 2, Appendix 1).

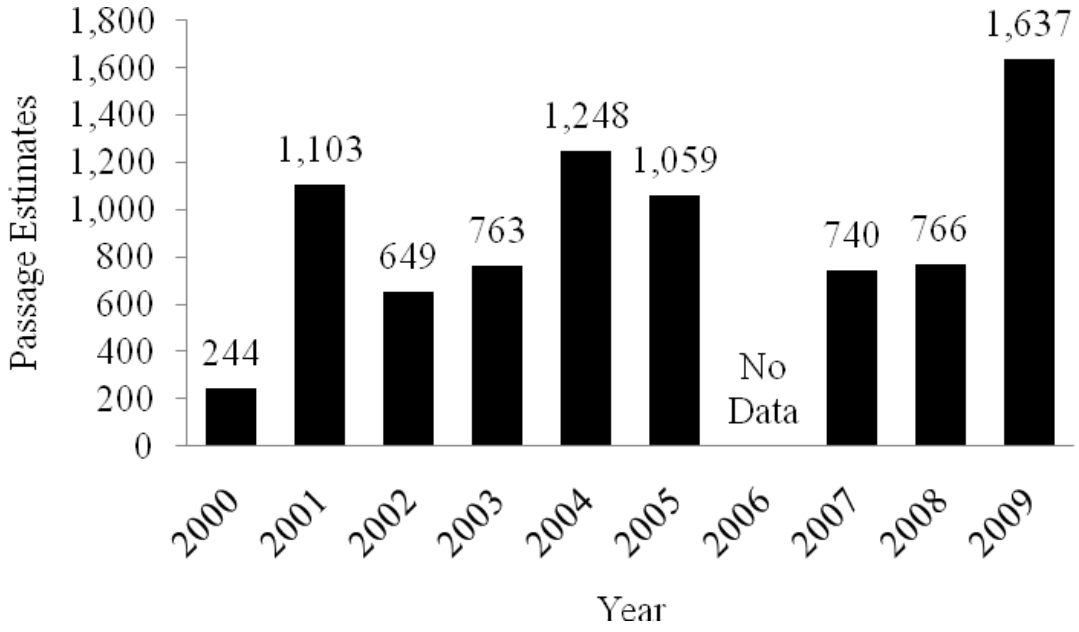

Figure 2. — Chinook salmon escapement estimates at the Henshaw Creek weir 2000 to 2009. Data from the 2006 season is incomplete due to persistent flooding events.

Samples were collected from 565 Chinook salmon during the season, with age unable to be determined for 217 (38%) of those samples. There were three primary age classes; 1.2, 1.3, and 1.4 from brood years 2005, 2004, and 2003, respectively (Table 2). Age class 1.4 was predominant overall, accounting for 37% of the season total, with stratum estimates ranging from 32% to 48%. The second most abundant age class was 1.2, accounting for 34% of the season total, with stratum estimates ranging from 26% to 37%. Age class 1.3 accounted for 28% of the season total with stratum estimates ranging from 17% to 33%. The age distributions differed between males and females. Males were predominantly age 1.2 (45%) followed by age 1.3 (39%), while females were dominated

by age class 1.4 (56%) followed by age 1.2 (24%). The estimated sex ratio for the entire run was 48% female, and estimates for each stratum ranged from 45% to 56% female fish. Female Chinook salmon ranged from 440 to 970 mm MEL and males ranged from 445 to 940 mm MEL (Table 3).

Table 2. — Age and sex ratio estimates, by stratum, of Chinook salmon at Henshaw Creek weir, Alaska, 2009. 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			
					2005	2004		2003
Strata dates	Run size (n)	Sample size (N)	% Female	Unknown age	1.2	1.3	2.2	1.4
7/6 – 7/12	281	164	47 (3.9)	60	26% (4.3)	33% (4.6)	2% (1.4)	38% (4.8)
7/13 - 7/19	865	191	45 (3.6)	81	35% (4.6)	26% (4.2)	2% (1.3)	37% (4.6)
7/20 - 7/26	385	139	56 (4.2)	47	37% (5.1)	30% (4.8)	1% (1.1)	32% (4.9)
7/27 - 8/4	106	71	54 (6.0)	29	36% (7.5)	17% (5.8)	0% (0.0)	48% (7.8)
Total	1637	565	48(2.3)	217	34% (2.8)	28% (2.7)	1% (0.8)	37% (2.9)
Female	790	278		91	24% (3.5)	18% (3.0)	2% (1.0)	56% (4.0)
Male	847	287		126	45% (4.4)	39% (4.4)	1% (1.1)	15% (3.1)

*Other age classes present included 2.3 (N = 1; 0.16% of run)

Table 3. — Length at age of female and male Chinook salmon sampled at Henshaw Creek weir, Alaska, 2009.

	Female					Male				
		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	44	574	7.9	583	440–660	70	580	5.0	583	445–665
1.3	34	713	10.2	720	580–825	63	693	7.1	690	550–815
1.4	106	838	4.9	840	690–970	22	815	18.0	825	630–940
2.2	3	585	35.0	576	530–650	2	593	32.5	593	560–625
2.3	-	-	-	-	-	1	-	-	-	700
Total	187					158				

Chum salmon

The first chum salmon was counted on July 5. During the final day of counting (August 7), 272 summer chum salmon (0.2% of the seasonal estimate) were estimated to have passed through the weir. The first quarter point passage date was July 17, the middle point passage was July 21, and the third quarter point passage date was July 25. The 2009 estimate of 156,933 summer chum salmon was higher than the 2000 to 2008 average (72,902; Figure 3). The 2009 estimate was the second largest estimate to date.

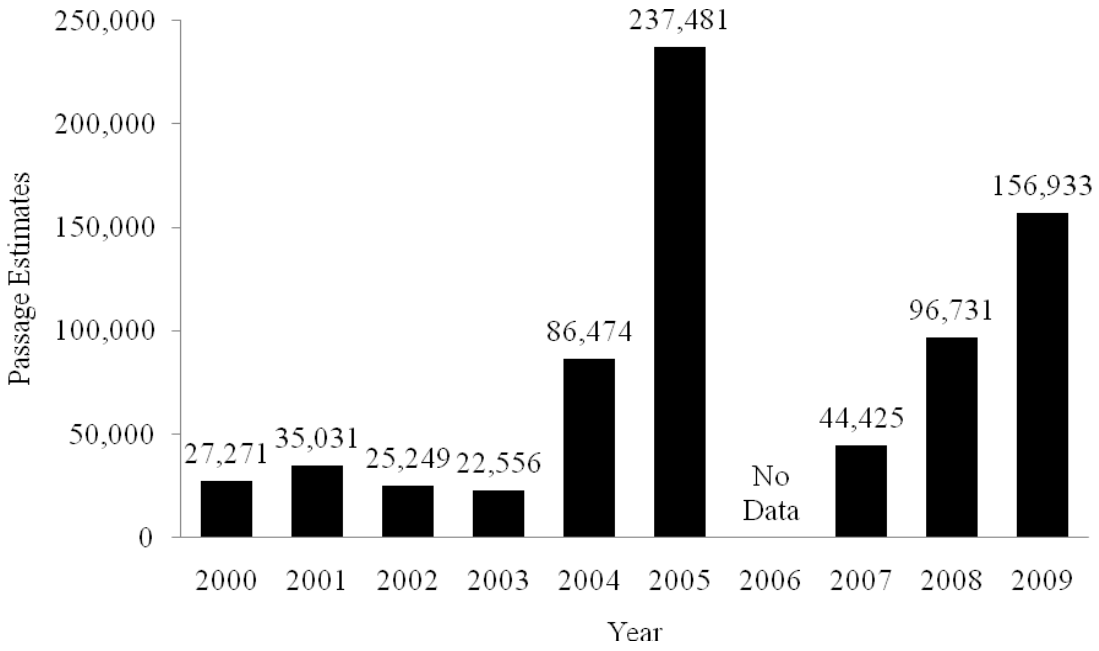

Figure 3. — Chum salmon escapement estimates at the Henshaw Creek weir 2000 to 2009. Data from the 2006 season is incomplete due to persistent flooding events.

Age, sex, and length samples were collected from 800 summer chum salmon, with age unable to be determined for 317 (39%) of those samples. There were two primary age classes; 0.3 and 0.4, from brood years 2004 and 2003, respectively (Table 4). Age class 0.3 was predominant, accounting for 78% of the season total, with stratum estimates ranging from 71% to 82%. Age class 0.4 accounted for 19% of the season total, with stratum estimates ranging from 14% to 28%. Also included was the age class 0.2, which accounted for 3% of the season total. Age distributions were similar for both sexes. The estimated sex ratio for the entire run was 53% female, and estimates for each stratum ranged from 41% to 62% female fish. Female summer chum salmon ranged from 430 to 635 mm MEL and males ranged from 440 to 680 mm MEL (Table 5). For length-at-age measurements, mean lengths of male fish were larger than females.

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. In-season management and post season evaluations of management actions are greatly enhanced by the data from this and other stock assessment projects. Additionally, this project has produced 9 years of data, enabling analyses of trends in population status, size, length, age, and gender composition of the run, developing future run projections, and setting and evaluating harvest and escapement goals and allocations. Furthermore, these time series data will become increasingly valuable as stressors such as climate change, disease, selective harvest, and overall demand on the resources of the dynamic Yukon River system continue to increase.

Table 4. — Age and sex ratio estimates, by stratum, of summer chum salmon at Henshaw Creek weir, Alaska, 2009. Standard errors are in parentheses. Season totals are calculated from weighted strata totals. Unknown age data indicate numbers of fish that could not be aged from the scales sampled and were not included in age calculations.

					Brood year and age		
					2006	2005	2004
Strata dates	Run size (N)	Sample size (n)	% Female	Unknown age	0.2	0.3	0.4
7/6 – 7/12	20,424	200	49 (3.5)	103	1% (0.0)	71%(8.8)	28% (8.8)
7/13 - 7/19	44,598	130	41 (4.3)	51	4% (2.3)	75% (5.1)	22% (5.0)
7/20 - 7/26	63,483	190	60 (3.6)	63	1% (1.7)	82% (4.1)	17% (3.5)
7/27 – 8/7	28,428	280	62 (2.9)	100	8% (1.6)	78% (3.2)	14% (2.6)
Total	156,933	800	53 (2.0)	317	3% (0.8)	78% (2.1)	19% (2.0)
Female	83,742	437		157	4% (1.0)	81% (2.6)	14% (2.4)
Male	73,191	363		160	2% (2.2)	74% (3.5)	24% (3.4)

Table 5. — Length at age of female and male summer chum salmon sampled at Henshaw Creek weir, Alaska, 2009.

	Female					Male				
		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	16	523	7.5	530	460–565	4	543	12.7	553	505–560
0.3	221	543	2.2	545	430–630	152	565	2.9	565	440–680
0.4	43	559	5.1	560	510–635	47	582	5.7	580	500–675
Total	280					203				

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Appendix 1. — Historical Chinook salmon and summer chum salmon escapement in Henshaw Creek, 1969 to 2009 (Aerial index data from Barton 1984; Alaska Department of Fish and Game unpublished data).

	Aerial Surveys			Counting Tower		Weir	
Year	Chinook Salmon	Chum Salmon	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	86,474
2006						0*	4*
2007						740	44,425
2008						766	96,731
2009						1,637	156,933

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