Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2010

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Tanana Chiefs Conference, Fisheries Program
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Abstract

In 2010, 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 857 Chinook salmon *Oncorhynchus tshawytscha* and 105,398 Chum salmon *O. keta* passed through the weir, which operated from June 23 through August 8, 2010. The four other fish species were counted were: longnose sucker *Catostomus catostomus* (N = 1,825), arctic grayling *Thymallus arcticus* (N = 35), whitefish (Coregoninae; N = 7), and northern pike *Esox lucius* (N = 3). The estimated weekly sex composition for Chinook salmon ranged from 46% to 67% female fish. There were three primary age classes identified, 1.2, 1.3, and 1.4, which composed 20%, 58%, and 20% of the run, respectively. The estimated weekly sex composition for summer chum salmon ranged from 41% to 63% female fish. There were two primary age classes identified, 0.3 and 0.4, which composed 65% and 26% 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

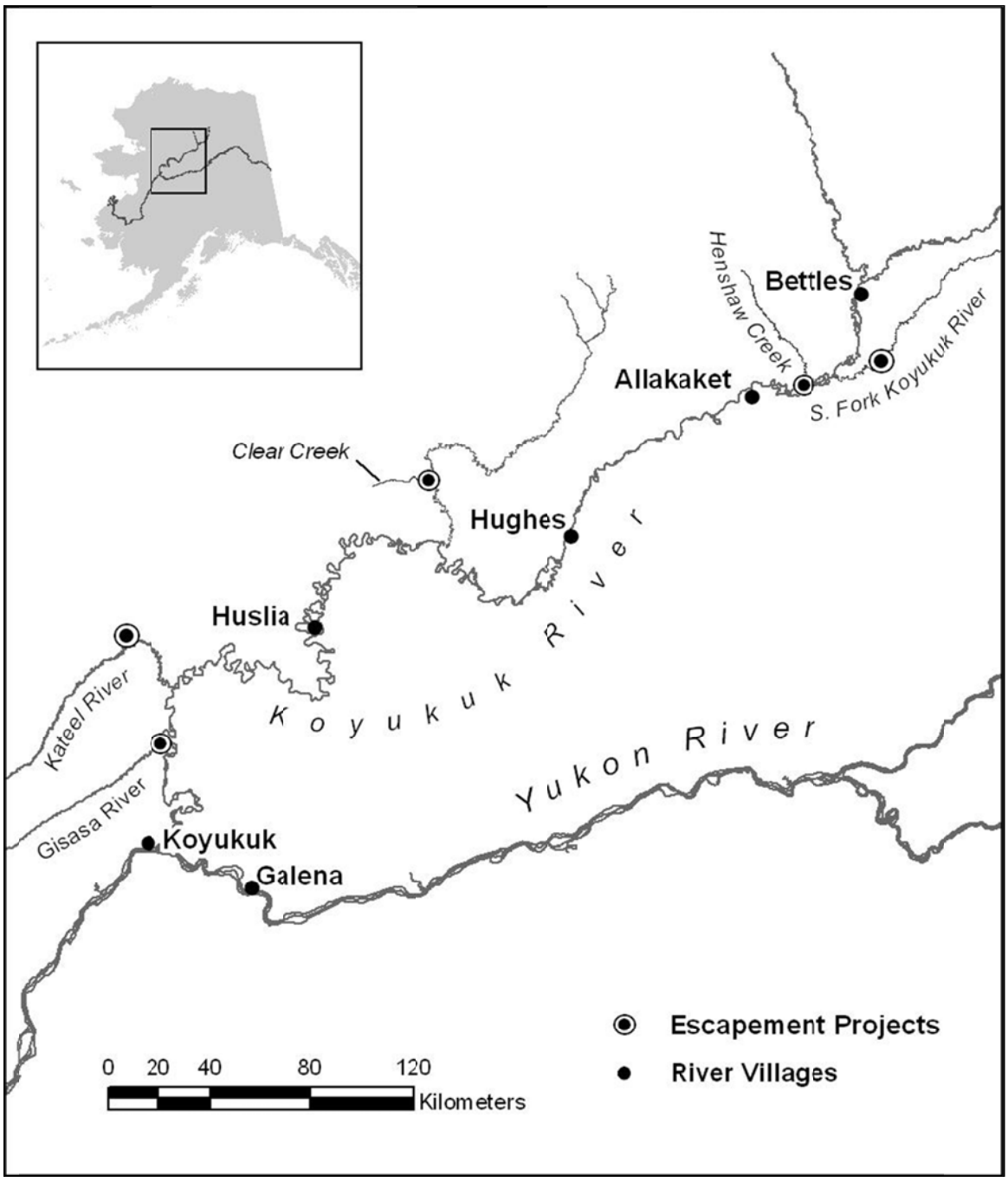
Henshaw Creek is a small, clear water tributary of the Koyukuk River in north-central Alaska (Figure 1). The creek originates in the Alatana Hills and flows in a southeasterly direction for approximately 144 km before entering the Koyukuk River. The weir site is approximately 1.5 km upstream from the 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 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 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



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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 2010, the Henshaw Creek weir was fully operational on June 23, with no fish counted that day (Table 1). Counting continued throughout the season with interruptions in counting occurring from July 7 to July 9 and on July 22 due to high water conditions. The counting was discontinued at 1159 hours on August 8. The picket spacing (3.2cm 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, 2010. Shaded values indicate first and third quarter points, and the midpoint of Chinook salmon and summer chum salmon passage estimates. * indicates dates that were missed due to high water events; counts from those dates were derived from linear interpolation.

	Chinook salmon		Chum salmon		Longnose sucker	Northern pike	Arctic grayling	Whitefish spp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jun-23	0	0	0	0	354	0	0	0
Jun-24	0	0	0	0	342	0	0	0
Jun-25	0	0	0	0	10	1	1	0
Jun-26	0	0	0	0	38	0	0	0
Jun-27	0	0	0	0	0	0	0	0
Jun-28	0	0	0	0	5	0	2	0
Jun-29	0	0	0	0	109	0	0	0
Jun-30	0	0	0	0	75	0	1	0
Jul-1	0	0	0	0	97	0	0	0
Jul-2	0	0	0	0	215	0	1	0
Jul-3	0	0	0	0	99	0	0	0
Jul-4	0	0	0	0	83	0	0	0
Jul-5	0	0	4	4	157	0	0	1
Jul-6	0	0	28	32	166	0	0	0
Jul-7*	3	3	510	542	*	*	*	*
Jul-8*	6	9	992	1,534	*	*	*	*
Jul-9*	8	17	1,474	3,008	*	*	*	*
Jul-10	11	28	1,956	4,964	2	0	2	1
Jul-11	34	62	5,240	10,204	17	1	1	0
Jul-12	40	102	6,850	17,054	5	0	7	0
Jul-13	43	145	7,577	24,631	1	0	4	0
Jul-14	45	190	9,055	33,686	0	0	0	0
Jul-15	47	237	9,067	42,753	1	0	0	0
Jul-16	30	267	5,755	48,508	1	0	1	0
Jul-17	36	303	5,203	53,711	1	0	2	0
Jul-18	49	352	5,450	59,161	0	0	1	0
Jul-19	68	420	8,361	67,522	0	0	0	0
Jul-20	130	550	7,633	75,155	0	0	0	0
Jul-21	92	642	3,053	78,208	8	0	0	0
Jul-22*	47	689	1,752	79,960	*	*	*	*
Jul-23	1	690	450	80,410	0	0	0	0
Jul-24	27	717	2,843	83,253	0	0	0	0
Jul-25	16	733	3,528	86,781	0	0	1	0
Jul-26	27	760	3,261	90,042	0	0	0	0
Jul-27	17	777	2,330	92,372	0	0	0	0
Jul-28	18	795	2,014	94,386	0	0	1	0
Jul-29	11	806	1,474	95,860	0	0	0	0
Jul-30	10	816	1,618	97,478	1	1	0	1
Jul-31	19	835	1,535	99,013	1	0	0	0
Aug-1	10	845	1,465	100,478	5	0	1	1
Aug-2	6	851	1,388	101,866	4	0	1	1
Aug-3	2	853	947	102,813	6	0	3	0

Aug-4	4	857	778	103,591	7	0	0	1
Aug-5	0	857	527	104,118	7	0	4	1
Aug-6	0	857	559	104,677	8	0	1	0
Aug-7	0	857	411	105,088	0	0	0	0
Aug-8	0	857	310	105,398	0	0	0	0
Total	857		105,398		1,825	3	35	7

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

Biological Data

The seasonal estimates of fish passage at the weir were 857 Chinook salmon and 105,398 summer chum salmon (Table 1). Longnose sucker *Catostomus catostomus* (N = 1,825), Arctic grayling (N = 35), whitefish spp. (N = 7), and northern pike *Esox lucius* (N = 3) were also counted at the weir.

Chinook salmon

The first Chinook salmon was counted on July 10 (fish counts from July 7-9 were interpolated). The last Chinook salmon were counted on August 4 (N = 4) which represented 0.4% of the run. The first quarter point passage date was July 15, the middle passage date was July 20, and the third quarter point passage date was July 21 (Table 1). The seasonal estimate of 857 Chinook salmon was 6% lower than the 2000 to 2009 average (912) and was the fifth highest weir estimate to date (Figure 2, Appendix 1).

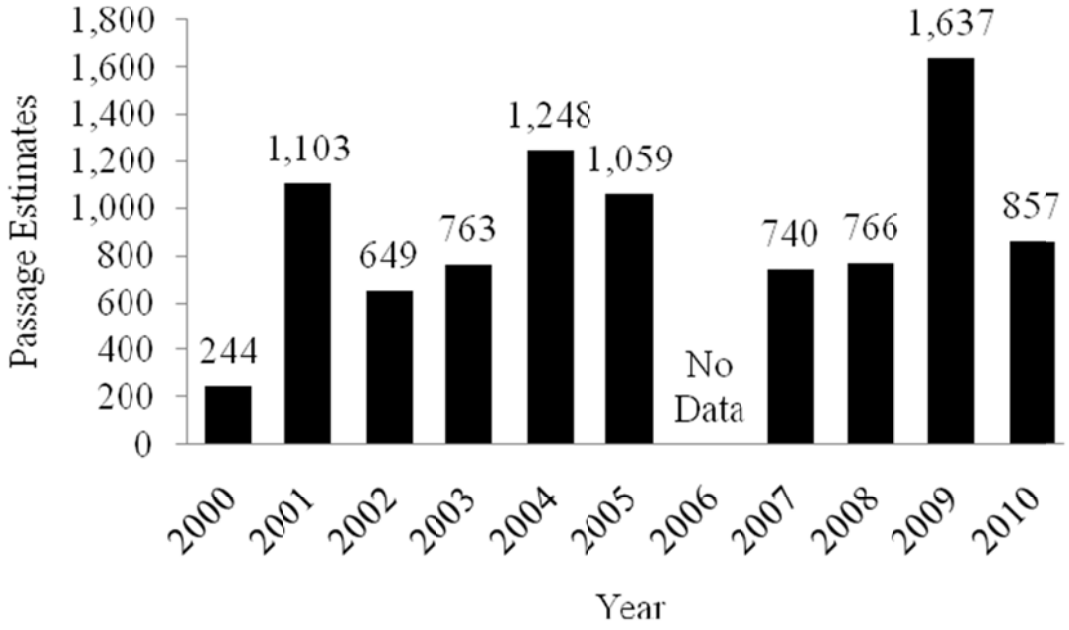

Figure 2. — Chinook salmon escapement estimates at the Henshaw Creek weir 2000 to 2010. Data from the 2006 season is incomplete due to persistent flooding events.

Samples were collected from 299 Chinook salmon during the season, with age unable to be determined for 90 (30%) of those samples. There were three primary age classes; 1.2, 1.3, and 1.4 from brood years 2006, 2005, and 2004, respectively (Table 2). Age class 1.3 was predominant overall, accounting for 58% of the season total, with stratum estimates ranging from 50% to 60%. The next most abundant age classes were 1.2 and 1.4 (each accounting for 20% of the season total). Stratum estimates for age 1.2 ranged from 11% to 26% and stratum estimates for age 1.4 ranged from 14% to 33%. Males were predominantly age 1.3 (58%) followed by age 1.2 (33%), while females were dominated by age class 1.3 (56%) followed by age 1.4 (33%). The estimated sex ratio for the entire run was 50% female, and estimates for each stratum ranged from 47% to 67% female fish. Female Chinook salmon ranged from 470 to 1000 mm MEL and males ranged from 390 to 910 mm MEL (Table 3).

Table 2. — Age and sex ratio estimates, by stratum, of Chinook salmon at Henshaw Creek weir, Alaska, 2010. 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			
					2006	2005	2004	2003
Strata dates	Run size (n)	Sample size (N)	% Female	Unknown age	1.2	1.3	1.4	1.5
7/5 – 7/11	62	15	67 (12.6)	6	11% (11.1)	56% (17.6)	33% (16.7)	0% (0.0)
7/12 - 7/18	290	107	48 (4.9)	34	18% (4.5)	59% (5.8)	19% (4.6)	1% (1.4)
7/19 - 7/25	381	114	46 (4.7)	27	26% (4.8)	60% (5.3)	14% (3.7)	0% (0.0)
7/26 – 8/4	124	63	59 (6.3)	23	13% (5.3)	50% (8)	33% (7.5)	0% (0.0)
Total	857	299	50 (2.9)	90	20% (2.8)	58% (3.5)	20% (2.8)	0.5% (0.5)
Female	430	151		49	8% (2.5)	56% (5)	33% (4.8)	0.1% (1.0)
Male	427	148		41	33% (4.5)	58% (4.8)	7% (2.5)	0% (0.0)

*Other age classes present included 1.1 (N = 1; 0.4% of run), 2.2 (N = 1; 0.4% of run), 2.3 (N = 1; 0.4% of run), 2.4 (N = 1; 0.4% of run)

Table 3. — Length at age of female and male Chinook salmon sampled at Henshaw Creek weir, Alaska, 2010.

	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
1.1	0	-	-	-	-	1	-	-	-	390
1.2	8	522	13.6	530	470–575	34	532	7.1	540	420–600
1.3	57	767	5.7	760	630–850	63	722	6.7	730	565–850
1.4	34	826	7.5	820	750–945	7	765	52.0	790	510–910
1.5	1	-	-	-	1000	0	-	-	-	-
2.2	0	-	-	-	-	1	-	-	-	440
2.3	0	-	-	-	-	1	-	-	-	730
2.4	1	-	-	-	950	0	-	-	-	-
Total	101					255				

Chum salmon

The first chum salmon was counted on July 5. During the final day of counting (August 8), 310 summer chum salmon (0.3% of the seasonal estimate) were estimated to have passed through the weir. The first quarter point passage date was July 14, the middle point passage was July 17, and the third quarter point passage date was July 22. The 2010 estimate of 105,398 summer chum salmon was 30% higher than the 2000 to 2009 average (81,350; Figure 3). The 2010 estimate was the third largest estimate to date.

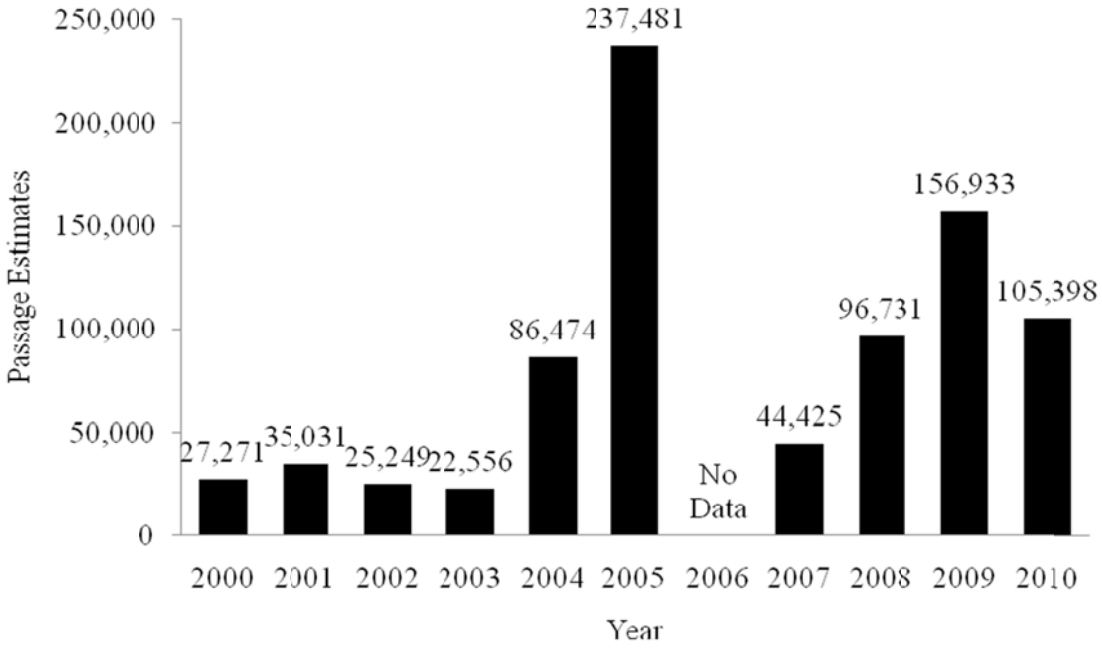

Figure 3. — Chum salmon escapement estimates at the Henshaw Creek weir 2000 to 2010. Data from the 2006 season is incomplete due to persistent flooding events.

Age, sex, and length samples were collected from 676 summer chum salmon, with age unable to be determined for 114 (17%) of those samples. There were two primary age classes; 0.3 and 0.4, from brood years 2006 and 2005, respectively (Table 4). Age class 0.3 was predominant, accounting for 65% of the season total, with stratum estimates ranging from 61% to 72%. Age class 0.4 accounted for 26% of the season total, with stratum estimates ranging from 15% to 34%. Also included were age classes 0.2 and 0.5, accounting for 9% and <0.1% of the season total, respectively. Age distributions were similar for both sexes. The estimated sex ratio for the entire run was 48% female, and estimates for each stratum ranged from 36% to 63% female fish. Female summer chum salmon ranged from 440 to 610 mm MEL and males ranged from 475 to 695 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 8 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, 2010. 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			
					2007	2006	2005	2004
Strata dates	Run size (N)	Sample size (n)	% Female	Unknown age	0.2	0.3	0.4	0.5
7/5 – 7/11	10,204	76	36 (5.5)	17	5% (2.9)	63% (6.3)	32% (6.1)	0% (0.0)
7/12 - 7/18	48,957	160	41 (3.9)	22	5% (1.9)	61% (4.2)	34% (4.0)	0% (0.0)
7/19 - 7/25	27,620	160	55 (3.9)	35	14% (3.2)	70% (4.1)	16% (3.3)	0% (0.0)
7/26 – 8/8	18,617	280	63 (2.9)	40	13% (2.1)	72% (2.9)	15% (2.3)	0.4% (0.0)
Total	105,398	676	48 (2.2)	114	9% (1.3)	65% (2.4)	26% (2.2)	<0.1% (0.1)
Female	50,341	355		59	12% (2.9)	68% (3.2)	20% (2.8)	0% (0.0)
Male	55,057	321		55	6% (1.9)	63% (3.4)	31% (3.3)	0.1% (0.1)

Table 5. — Length at age of female and male summer chum salmon sampled at Henshaw Creek weir, Alaska, 2010.

	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	38	508	4.5	505	440–570	20	532	7.1	540	475–595
0.3	204	533	2.0	530	460–610	176	555	2.1	555	480–620
0.4	50	559	3.6	555	500–610	70	597	4.7	600	495–695
0.5	0	-	-	-	-	1	-	-	-	495
Total	296					266				

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Appendix 1. — Historic Chinook salmon and summer chum salmon escapement in Henshaw Creek 1960 to 2010 (aerial index data from Barton 1984 and ADF&G 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
2010						857	105,398

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