U.S. Fish & Wildlife Service

Abundance and Run Timing of Adult Salmon in Henshaw Creek, Kanuti National Wildlife Refuge, Alaska, 2005

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Brandy Berkbigler and Kimberly Elkin

Abstract

A resistance board weir was operated on Henshaw Creek between June 21 and August 8, 2005 to collect information on abundance, run timing, and biology of returning salmon. This was the sixth year of operating a weir at this location. A total estimate of 1,059 Chinook *Oncorhynchus tshawytscha* and 237,481 chum salmon *O. keta* passed through the weir. The sex ratio for Chinook salmon was comprised of 44% female fish. Three age groups, 1.4, 1.3, and 1.2, were identified from 127 Chinook salmon sampled with age 1.3 (53%) dominating. Female Chinook salmon ranged from 490 to 970 mm mid-eye-to fork length (MEL) and males ranged from 430 to 950 mm MEL. For length-at-age, mean lengths of female fish were larger than males. For chum salmon the run was comprised of 44% female fish. Two age groups, 0.3 and 0.4, were identified from 693 chum salmon sampled and the run was dominated by age group 0.3 (98%). Female chum salmon ranged in length from 450 to 680 mm MEL and males ranged from 450 to 690 mm MEL. Five other fish species were counted. Longnose sucker *Catostomus catostomus* (N = 1,719) were the most abundant and the other species were Arctic grayling *Thymallus arcticus* (N = 124), sockeye salmon *O. nerka* (N = 18), northern pike *Esox lucius* (N = 12), and whitefish (Coregoninae) (N = 10).

Introduction

Henshaw Creek provides spawning and rearing habitat for Chinook *Oncorhynchus tshawytscha* and chum *O. keta* salmon. Henshaw Creek is located within the Kanuti National Wildlife Refuge (Refuge) and is a major tributary flowing into the Koyukuk River drainage. The Refuge is located near the villages of Allakaket, Alatna, and Bettles in north-central Interior Alaska. Chinook and summer chum salmon from Henshaw Creek contribute to the mixed stock subsistence and commercial fisheries occurring in the Yukon River drainage (USFWS 1993).

Within federal conservation units, continued subsistence use of fish and wildlife resources by rural residents and the conservation of those resources are mandated in the Alaska National Interests Lands Conservation Act (1980). Yukon River salmon stocks, especially chum salmon, began to decline in the late 1990s (Kruse 1998) and this led to harvest restrictions, complete fishery closures, and spawning escapements below management goals (Salomone and Bergstrom 2004). Management of individual stocks does not occur and accurate escapement data are limited throughout the Yukon River drainage. Escapement estimates prior to 1999 were primarily from aerial surveys (Barton 1984) which are highly variable and are only an index of relative run strength. The inseason management of the salmon fisheries is conducted on information provided from the preseason outlook based on parent stock returns, test fisheries, Pilot Station sonar, run strength from lower river escapement projects, and subsistence and commercial harvest reports (Vania and Golembeski 2000).

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Salmon escapement projects using fish weirs and counting towers provide accurate information for evaluation of management practices. 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'Brien 2006), South Fork Koyukuk River weir (Wiswar 1998), and the Clear Creek counting tower (C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication). After 1997, the South Fork Koyukuk River weir study was abandoned due to persistent high water events that prevented operation of the project. A counting tower was operated on Henshaw Creek in 1999 (VanHatten 1999; Appendix 1). In 2000, the weir formerly used on the South Fork Koyukuk River was moved to Henshaw Creek, where high water events would be less likely to compromise the performance of the weir while still maintaining an escapement project in the upper Koyukuk River drainage. Additionally, Henshaw Creek is classified as an index stream for Chinook and summer chum salmon (ADF&G 2000) where there is historic information on salmon escapement. Aerial survey estimates for escapements in Henshaw Creek between 1960 and 1999 ranged from six to 593 Chinook salmon and 12 to 15,397 chum salmon (Barton 1984; Appendix 1). The Henshaw Creek escapement project was continued in 2005 and the objectives of the weir 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 of resident fish.

Study Area

Henshaw Creek is a small clear water tributary of the Koyukuk River in north-central Alaska (66° 33'N, 152° 14' W) (Orth 1967; Figure 1). The headwaters originate in the Alatna Hills and the river flows southeasterly for 144 km before entering the Koyukuk River. The climate of this area is cold and continental, which is characterized by extreme seasonal temperature variations and very low precipitation. There is an extreme range in air temperature with recorded temperatures from 18° to 21°C in summer months to recorded lows of -57°C in winter months (USFWS 1993). Stream flows are highest during the spring months in response to snow melt with sporadic high discharge periods throughout the summer in response to local rain showers.

Channel configuration is typically meandering with alternating cut banks and gravel bars. The substrate is primarily gravel (8 - 64 mm) and small cobble (64 - 128 mm) in the higher velocity currents and sand and silt in the pools. The weir site is approximately 1.5 km upstream from the mouth of Henshaw Creek. The width of the channel at the weir site is about 30 m with an average depth of 0.6 m during most of the summer.

Methods

Weir Operation

A resistance board weir was used to collect escapement counts and biological information from adult salmon as they migrated into Henshaw Creek to spawn. 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 continued at this low level for three or more consecutive days. The construction and installation of resistance board weirs was described by Tobin (1994). Each picket of the weir was made of schedule-40, polyvinyl chloride electrical conduit with 2.5 cm inside diameter and individual pickets spaced 3.2 cm apart. During daily visual inspection, the weir was cleaned of debris, fish carcasses, and gravel dislodged by spawning fish. A live trap installed near mid-channel allowed salmon and resident fish species to be recorded as they passed through the weir.

Biological Data

Run timing and abundance of adult Chinook and chum salmon were estimated by recording and plotting the number of each species of fish passing through the weir each day. Because non-salmon species were not handled, it was difficult to identify different 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, 7 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 3-4 day period, targeting 160 salmon /species /week. Scales were used for ageing salmon with age class information being 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 ADF&G for processing. Lengths of Chinook and chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL). Sex ratio data were collected during age and length sampling. Sex of each fish was visually determined by secondary sex characteristics. Daily escapement counts and sex ratios were reported to USFWS-FFWFO in Fairbanks.

Data Analysis

When daily counts were missed due to high water, the missing daily counts were estimated by linear interpolation between the daily count before and after the high water event. Incomplete 24-h counts due to high water were adjusted for a 24-h period.

Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with statistical weeks as the strata. Each statistical week was 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 and chum salmon of a given sex/age, $\hat{p}_i$ were calculated as

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

where the stratum weight $\hat{W}_j$ 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

The weir was operated from June 21 through August 8, 2005. There were eight days of missed daily counts during the season. This was due to high flow on July 13-16 and July 18-21. It is likely that due to the spacing between each weir picket, small individuals of some non-salmon species passed undetected through the weir.

Biological Data

A total of 1,059 Chinook salmon were estimated to have passed through the weir (Table 1). This was the third largest escapement of the six years of weir operation (Appendix 1 and 2). The first Chinook salmon arrived on July 1 and the last Chinook salmon was counted on August 5 (Table 1). The median migration date was July 14 (Table 1). There were 127 Chinook salmon sampled for ASL composition (Table 2) and an additional eight fish were of unknown age and omitted from further analysis. The Chinook salmon run in Henshaw Creek was comprised of three age groups with age 1.3 the dominant group (53%). This age group is from a relatively weak parent escapement year (2000) (Appendix 1). Age groups 1.2 and 1.4 were about equally represented (~ 22-25%). The Chinook salmon sex composition consisted of 44% females and this was slightly higher that what was observed in past years which have ranged from 20 to 40% female fish (FFWFO 2005; VanHatten and Voight 2005; O'Brien and Berkbigler 2005). Female Chinook salmon ranged from 490 to 970 mm mid-eye-to fork length (MEL) and males ranged from 430 to 950 mm MEL (Table 3). Length-at-age measurements of female fish were larger than males.

The estimated escapement for chum salmon was 237,481 fish. The escapement in 2005 greatly exceeded the previous high escapement (N = 86,474) that was observed in 2004 (Appendix 1 and 2). The first chum salmon arrived on June 30 and fish were still moving through the weir on the last day we operated the weir, August 8, when 685 chum salmon were counted (Table 1). The median migration date was July 21 (Table 1). Age was estimated from 693 chum salmon sampled for ASL composition (Table 4) and an additional 61 were of unknown age and omitted from further analysis. This year's run was comprised of two age groups, 0.3 and 0.4, and was strongly dominated by age 0.3 (98%). There have been other years described with a dominant age group. In 2002, age 0.4 comprised 80% of the run and in 2003 age group 0.3 comprised 86% (VanHatten and Voight 2005). The chum salmon run was comprised of 44% female fish (Table 4) and this ratio is lower than what has been recorded in past years (50-61%) (FFWFO 2005; VanHatten and Voight 2005; O'Brien and Berkbigler 2005). Female chum salmon ranged in length from 450 to 680 mm MEL and males ranged from 450 to 690 mm MEL (Table 5).

Eighteen sockeye salmon *O. nerka* were counted passing the weir. The most abundant non-salmon species was longnose sucker *Catostomus catostomus* (N = 1,719), followed by Arctic grayling *Thymallus arcticus* (N = 124), northern pike *Esox lucius* (N = 12) and whitefish sp. (N = 10).

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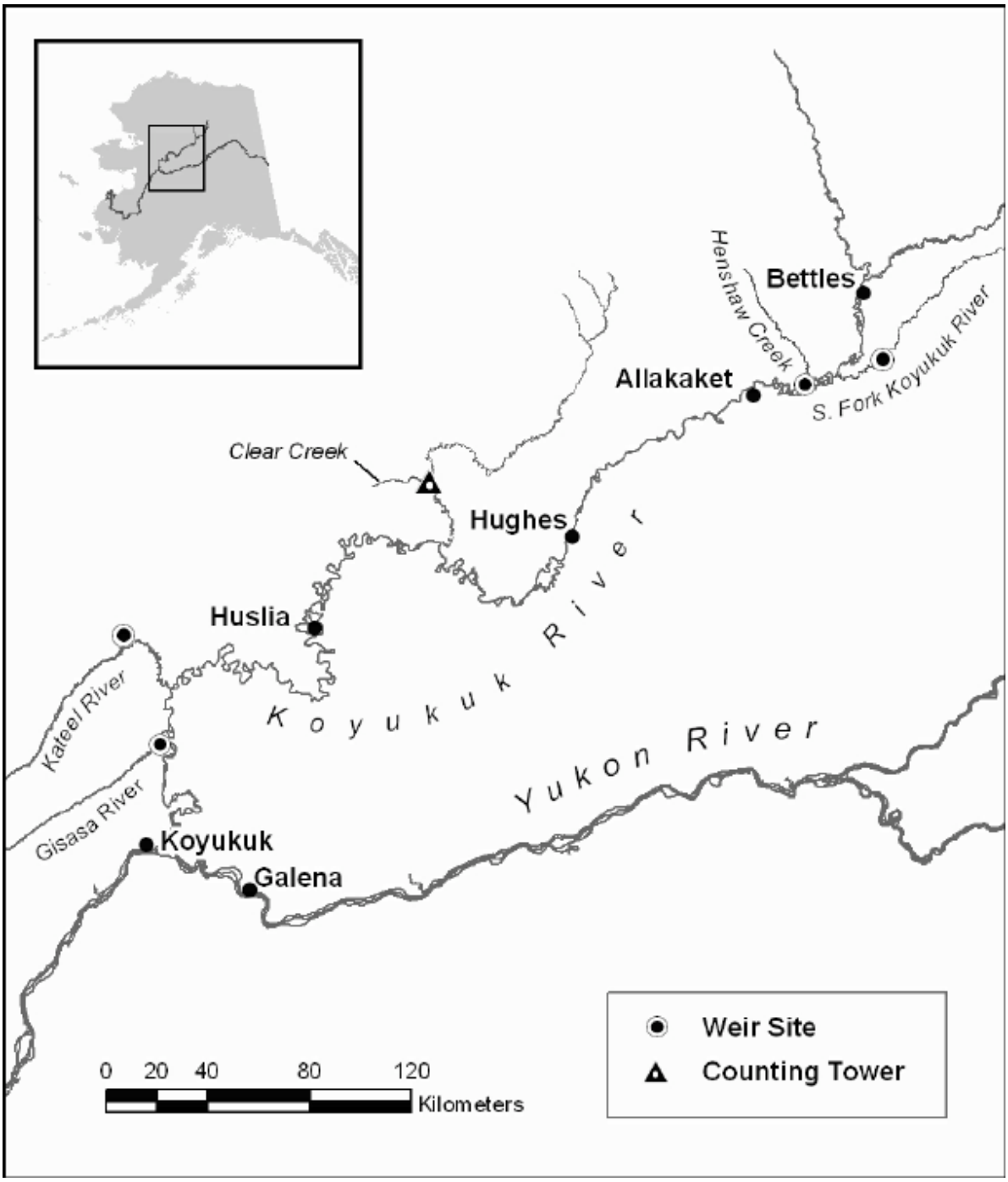


Figure 1. Location of the Henshaw Creek weir and other active and historical tributary escapement project sites in the Koyukuk River drainage, Alaska.

Table 1. Daily estimates and cumulative estimates of fish passing the Henshaw Creek weir, Alaska, 2005. Cum = cumulative. * = Counts for Chinook and chum salmon only were interpolated or adjusted to 24 hrs on these dates due to high water. ☼ = first, mid, and third quartiles for Chinook and chum salmon escapement run timing.

	Chinook salmon		Chum salmon		Sockeye salmon	Longnose sucker	Arctic grayling	Northern pike	Whitefish spp
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily	Daily
Jun 21	0	0	0	0	0	23	0	0	0
Jun 22	0	0	0	0	0	37	0	0	0
Jun 23	0	0	0	0	0	5	0	0	0
Jun 24	0	0	0	0	0	35	0	1	0
Jun 25	0	0	0	0	0	39	1	1	0
Jun 26	0	0	0	0	0	42	1	0	0
Jun 27	0	0	0	0	0	85	0	0	0
Jun 28	0	0	0	0	0	91	0	0	0
Jun 29	0	0	0	0	0	118	0	0	0
Jun 30	0	0	1	1	0	102	0	0	0
Jul 01	1	1	7	8	0	8	1	0	0
Jul 02	2	3	8	16	0	35	1	0	0
Jul 03	1	4	22	38	0	39	0	0	0
Jul 04	4	8	115	153	0	23	3	0	0
Jul 05	3	11	350	503	0	10	3	0	0
Jul 06	7	18	1,097	160	0	3	0	0	0
Jul 07	44	62	3,236	4,836	0	15	3	1	0
Jul 08	73	135	5,689	10,525	0	283	7	1	0
Jul 09	28	163	6,015	16,540	0	34	0	1	0
Jul 10	38	201	5,997	22,537	0	87	2	0	0
Jul 11	53	254	5,698	28,235	0	42	4	0	0
Jul 12	105	☼ 359	7,745	35,980	0	541	51	0	0
Jul 13*	96	455	8,379	44,359					
Jul 14*	88	☼ 543	9,013	53,372					
Jul 15*	79	622	9,646	☼ 63,018					
Jul 16*	71	693	10,280	73,298					
Jul 17	62	755	10,914	84,212	0	0	0	0	0
Jul 18*	56	☼ 811	10,985	95,197	0	16	26	0	0
Jul 19*	49	860	11,056	106,253					
Jul 20*	43	903	11,128	117,381					
Jul 21*	36	939	11,199	☼128,580					
Jul 22	30	969	11,270	139,850	0	0	0	0	0
Jul 23	14	983	13,541	153,391	0	0	0	0	0
Jul 24	18	1,001	12,145	165,536	0	0	2	0	0
Jul 25	10	1,011	13,661	☼179,197	0	0	2	1	0
Jul 26	8	1,019	11,079	190,276	0	0	3	2	2
Jul 27	7	1,026	8,739	199,015	1	0	2	1	2
Jul 28	6	1,032	8,085	207,100	1	0	2	0	0
Jul 29	5	1,037	6,464	213,564	2	1	1	0	1
Jul 30	4	1,041	4,897	218,461	2	0	1	1	0
Jul 31	5	1,046	3,012	221,473	0	0	3	1	3
Aug 1	3	1,049	3,152	224,625	2	0	0	1	0
Aug 2	3	1,052	3,117	227,742	3	2	2	0	0
Aug 3	3	1,055	2,668	230,410	1	0	2	0	0
Aug 4	2	1,057	2,329	232,739	2	0	0	0	0
Aug 5	2	1,059	1,799	234,538	2	2	0	0	1
Aug 6	0	1,059	1,349	235,887	0	1	1	0	0
Aug 7	0	1,059	909	236,796	0	0	0	0	1
Aug 8	0	1,059	685	237,481	2	0	0	0	0
Total	1,059		237,481		18	1,719	124	12	10

Table 2. Percent weekly and seasonal sex ratio and age distribution of Chinook salmon sampled at Henshaw Creek weir, 2005. Standard errors are in parentheses.

					% Brood year and age		
		Run	Sample	%	1999	2000	2001
Time period	Sex	size (N)	size (n)	Female	1.4	1.3	1.2
June 20-26		0	0				
June 27-July 3		4	0				
July 4-10		197	74	42 (5.8)	22 (4.8)	50 (5.9)	28 (5.3)
July 11-17		554	36	47 (8.4)	31 (7.8)	61 (8.2)	8 (4.7)
July 18-24		246	5	40 (24.5)	20 (20.0)	40 (24.5)	40 (24.5)
July 25-31		45	5	40 (24.5)	0	40 (24.5)	60 (24.5)
August 1-8		13	7	14 (14.3)	19 (18.4)	29 (18.4)	43 (20.2)
Run total		1,059	127	44 (7.4)	25 (6.3)	53 (7.3)	22 (6.4)
	Female	462	53		43 (12.9)	42 (7.2)	15 (10.7)
	Male	593	74		11 (4.4)	61 (10.0)	28 (9.4)

Table 3. Length-at-age of female and male Chinook salmon sampled at Henshaw Creek weir, 2005. Standard errors are in parentheses.

	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	8	571 (14.1)	578	490-615	24	533 (12.3)	745	430-655
1.3	25	722 (15.2)	750	540-810	40	721 (11.5)	738	430-655
1.4	20	826 (13.9)	820	720-970	10	770 (29.6)	730	680-950
Total	53				74			

Table 4. Percent weekly and seasonal sex ratio and age distribution of summer chum salmon sampled at Henshaw Creek weir, 2005. Standard errors are in parentheses.

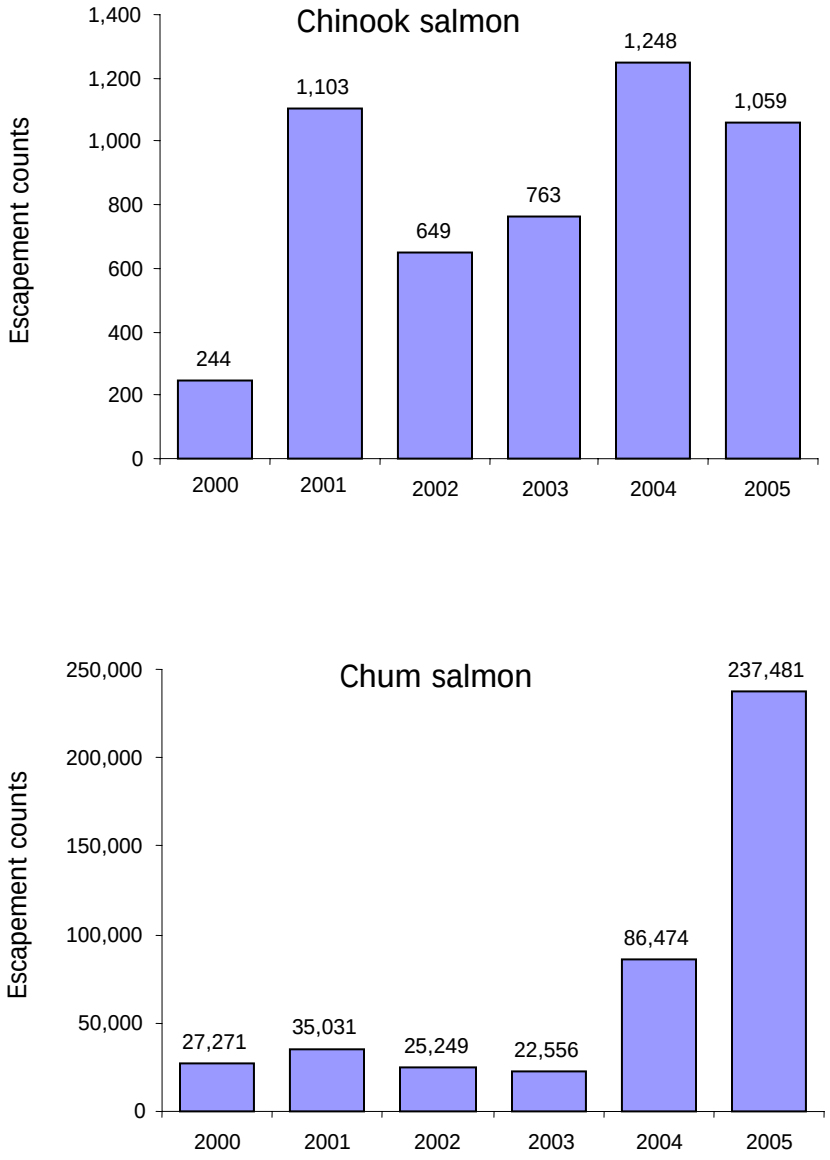
					% Brood year and age	
					2001	2000
Time period	Sex	Run size (N)	Sample size (n)	% Female	0.3	0.4
June 20-26		0	0			
June 27-July 3		38	0			
July 4-10		22,499	149	34 (3.9)	91 (2.4)	9 (2.24)
July 11-17		61,675	151	39 (4.0)	99 (0.9)	1 (0.9)
July 18-24		81,324	66	45 (6.2)	99 (1.5)	1 (1.5)
July 25-31		55,937	178	48 (3.8)	100	0
August 1-8		16,008	149	50 (4.1)	99 (0.9)	1 (0.9)
Run total		237,481	693	44 (2.6)	98 (0.6)	2 (0.6)
	Female	103,590	299		99 (0.6)	1 (0.6)
	Male	133,853	394		98 (1.0)	2 (1.0)

Table 5. Length-at-age of female and male summer chum salmon sampled at Henshaw Creek weir, 2005. Standard errors are in parentheses.

	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
0.3	293	543 (1.7)	540	450-680	381	572 (1.8)	570	450-690
0.4	6	722 (12.4)	588	520-605	13	600 (8.3)	605	540-640
Total	299				394			

Appendix 1. Chinook and chum salmon escapements for Henshaw Creek, Alaska, 1960-2005 (source: Barton 1984; VanHatten 1999; FFWFO 2005; VanHatten and Voight 2005; Alaska Department of Fish and Game, unpublished data; this study). Aerial surveys are rated as poor, fair, good or any combination when multiple stream reaches were surveyed. Rating is based on a combination of various environmental conditions: wind, weather, water, visibility, substrate, time, distance surveyed, and spawn stage. Counting tower operated for only 12 non-continuous days.

	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	237,481



Appendix 2. Chinook and summer chum salmon escapement counts recorded at the Henshaw Creek weir, Alaska, 2000-2005.