Alaska Fisheries Data Series Number 98-1

Abundance and Run Timing of Adult Salmon in the South Fork Koyukuk River, Kanuti National Wildlife Refuge, Alaska, 1997

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Abstract.—A resistance board weir was installed on the South Fork Koyukuk River about 32 km above the confluence of the mainstem Koyukuk River and 2 km above Fish Creek. This was the second year of a multi-year salmon escapement study. The weir was in operation from July 6 through September 11, 1997; however, high flows prevented counting between August 16 - 23 and August 28 - September 11. Chum and chinook salmon were sampled weekly (target N = 160 fish/week) for length and sex information. Additionally, scales were collected from chinook to estimate age.

Summer chum escapement between July 6-August 15 was 11,237 fish. The run peaked August 3 - 9. The sex ratio for the run was 47 % female. Male chums ranged from 505 to 740 MEL. Females ranged from 460 to 655 mm MEL. When counting was resumed on August 24, chum salmon passing through the weir were assumed to be the fall component of the run. A total of 2,685 chums were counted between August 24 and 27. The sex ratio was 43 % female.

A total of 1,643 chinook salmon were counted between July 6 and August 27. Most of the run (82%) had passed through the weir by July 20. The sex ratio for the run was 51 % female. There were four age groups represented; age group 1.4 years dominates both males (51%) and female (82%).

Introduction

Summer and fall chum *Oncorhynchus keta* and chinook salmon *O. tshawytscha* spawning in the South Fork Koyukuk River (South Fork) contribute to the subsistence and commercial fisheries occurring on the Yukon drainage. The summer chum salmon run enters the Yukon River in early June and continues through mid-July with a spawning distribution in the lower and middle reaches of the Yukon drainage. The fall chum salmon run is characterized by entering the river after mid-July with a spawning distribution in tributaries of the upper Yukon River (Minard 1996). Chinook salmon run timing is similar to that of summer run chum salmon. Recent declines of Yukon River salmon stocks, particularly summer chum salmon (Schultz et al. 1993), have led to harvest restrictions, complete fishery closures, and spawning escapements below management goals. In the mixed stock fishery of the Yukon River, overfishing of some salmon stocks may have

contributed to the decline. Management of individual stocks does not occur and accurate escapement data are limited throughout the Yukon drainage. Escapement estimates are primarily from aerial surveys (Barton 1984; Appendix 1), which are highly variable and are only an index of relative strength of the runs.

Kanuti National Wildlife Refuge is located near the villages of Alatna, Allakaket, Bettles, Evansville, and Hughes. The resident of these villages depend on the refuge's fishery resources for subsistence. Continued subsistence use by local residents of fish and wildlife habitats and resources in National Wildlife Refuges, and the conservation of those resources is mandated in the Alaska National Interests Lands Conservation Act (1980). Accurate monitoring of salmon escapement and specific stock assessment projects are important components in refining fisheries management and also fulfill Congressional mandates. To that end, a resistance board fish weir (Tobin 1994) was installed on the South Fork in 1996 (Wiswar 1997), the first year of a multi-year escapement study, and continued in 1997. The objectives of the study are to:

1. Determine escapement of salmon into the South Fork above the confluence of Fish Creek
2. Determine size, sex ratio, and age composition of chum and chinook salmon in the South Fork, and
3. Determine presence of larger size resident fish species in the South Fork.

In 1996 at the South Fork weir, the chum salmon summer run escapement was 37,450 fish and the fall run was 21,651 fish. Chinook salmon totaled 1,232 fish that year (Wiswar 1997). Other historical data on the fishery resources in the South Fork are limited to aerial surveys, primarily of the summer chum and chinook run, conducted between 1969 and 1997 (Barton 1984; unpublished data, Alaska Department of Fish and Game; Appendix 1) and sonar enumeration of the fall chum run in 1990 (Troyer 1993).

Study area

The South Fork Koyukuk River originates in the Philip Smith Mountains and flows approximately 225 km southwesterly to the mainstem Koyukuk River. Major tributaries are the Jim River and Fish Creek. The weir site is 32 km above the confluence of the mainstem Koyukuk River and 2 km above Fish Creek (Figure 1). River flow throughout this reach consists of long runs and short riffle areas during early summer low water. Substrate is small gravel and sand.

Climate of the region is continental subarctic with extreme seasonal variations in temperature. Normal daily maximum temperatures are between 60 and 70° F May through August and about 47° F in September. Normal daily minimum temperatures are coldest in January and February at -20° to -18° F, respectively. Peak flows occur during breakup and high precipitation events during summer. Highest rainfall occurs in August. Snowfall has occurred during all months except June and July; heaviest snowfall is November through January (NOAA 1994).

Methods

All fish passing through the weir were identified to species and counted with the exception of *Coregonus* and *Prosopium* spp. which were grouped together as whitefish. The trap was generally opened at 0800 and closed at midnight. Fish were released from the trap at varying time intervals corresponding to the intensity of the migration. Each picket of the weir was schedule 40 polyvinyl chloride (PVC) electrical conduit with a 2.5 cm inside diameter. The space between individual pickets was 3.2 cm.

Length and sex ratio were determined from weekly target sample of 160 chum and chinook salmon. Samples were generally taken over a 4 d period beginning on Monday of each week and consisted of the first 40 fish passing through the weir. Lengths from chum and chinook salmon were measured to the nearest 0.5 cm from the mid-eye to

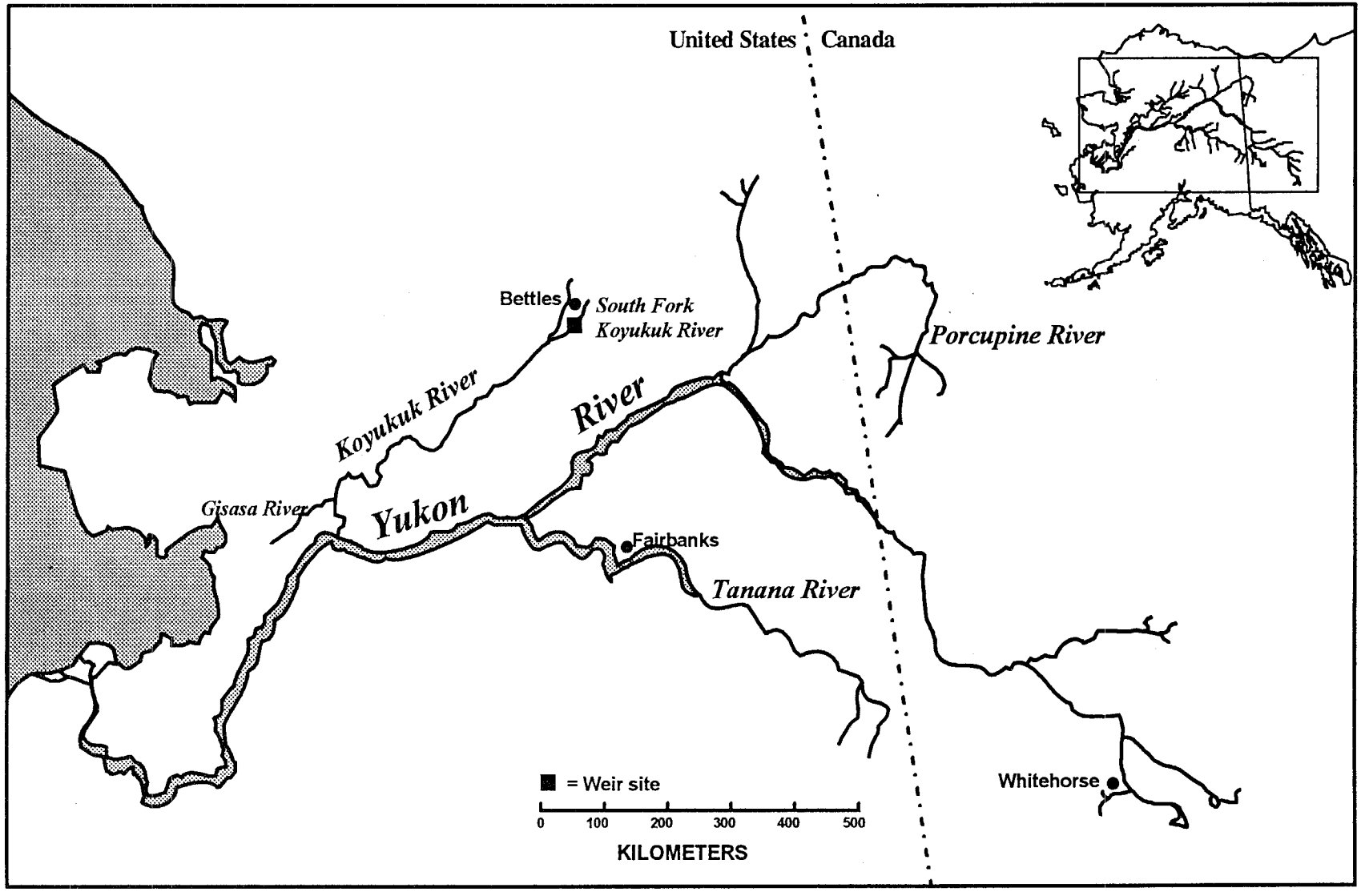

FIGURE 1.—Location of South Fork Koyukuk River weir.

fork of the caudal fin (MEL). Three scales were collected from chinook salmon from the preferred 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. Collection of chinook scales did not begin until July 19. Scales ages were determined by Alaska Department of Fish and Game (ADFG), Commercial Fisheries Management and Development Division. Ages are reported using the European method (Jearld 1983).

Data were treated as a stratified random sample (Cochran 1977); statistical weeks defined the strata. Within a week, the proportion of the sample comprised of a given sex, p_{ij}, was calculated as

$$p_{ij} = \frac{n_{ij}}{n_j}$$

where n_{ij} is the number of fish of sex i sampled in week j, and n_j is the total number of fish sampled in week j. The variance of p_{ij} was calculated as

$$v(p_{ij}) = \frac{p_{ij}\,(1-p_{ij})}{n_j-1}$$

Sex composition for the total run of chum and chinook salmon of a given sex, p_i, was calculated as

$$p_i = \sum_{j=1} W_j\, p_{ij}$$

where the stratum weight

$$W_j = \frac{N_j}{N}$$

and N_j equals the total number of fish of a given species passed through the weir during week j and N is the total number of fish of a given species passed through the weir during the summer or fall run.

It was anticipated that there could be difficulty in determining the end of the summer run of chum salmon and those fish comprising the beginning of the fall run in August. When counting was resumed on August 24, chum salmon passing through the weir were assumed to be the fall component of the run.

Results

Weir Operation

High flows prevented placement of the weir in the river earlier than the beginning of July. The weir was in place from July 6 through September 11; however, high flows prevented counting between August 16 - 23 and August 28 - September 11.

Biological Data

Chum salmon were the most abundant fish species counted at the weir (Appendix 2). Summer chum escapement between July 6-August 15 was 11, 237 fish. The fall chum run totaled 2,685 fish counted between August 24 - 27. Chinook salmon counted at the weir between July 6 and August 27 totaled 1,643 fish. Four resident fish species were counted. Whitefish *Coregonus* and *Prosopium* spp. were the most abundant species (N= 272) followed by Arctic grayling *Thymallus arcticus* (N= 22), northern pike *Esox lucius* (N= 6), and longnose sucker *Catastomus catastomus* (N= 2).

Summer run chum salmon.— The summer chum salmon run peaked between August 3-9 accounting for 55% of the total escapement (Figure 2; Appendix 2). The sex ratio for the run was 47 % female (Table 1). The weekly sex ratio ranged from 30 to 54% female with the female proportion higher towards the end of the run. Male chums ranged from 505 to 740 MEL (Table 2). Females ranged from 460 to 655 mm MEL.

Fall run chum salmon.— The fall run was enumerated for only the 4 d period of August 24-27 (Figure 2; Appendix 2). The sex ratio was 43 %

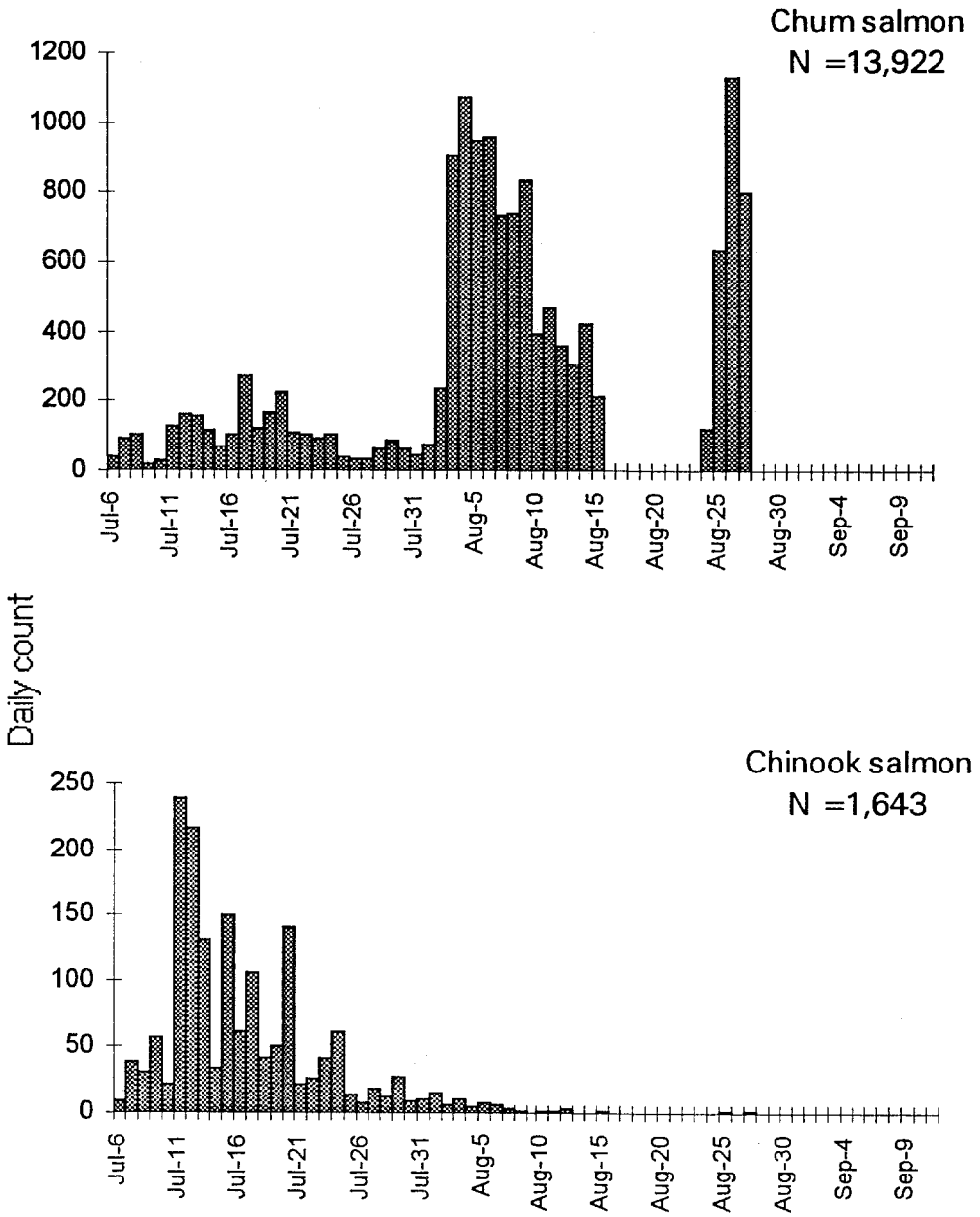

FIGURE 2.—Daily counts of chum and chinook salmon at the South Fork Koyukuk River weir, 1997. High flow events prevented counting between August 16 and 23 and after August 27 when the trap and weir panels were submerged.

TABLE 1.—Sex ratio of summer and fall run chum salmon sampled at the South Fork Koyukuk River weir, Alaska, 1997.

Time period	Total number of chum salmon passing through the weir	N	Percent female (SE)	Estimated number of females
		Summer run		
Jul 6-12	565	217	40 (3.3)	224
Jul 13-19	1,004	198	32 (3.3)	319
Jul 20-26	709	166	30 (3.6)	214
Jul 27- Aug 2	616	151	43 (4.0)	265
Aug 3-9	6,187	179	54 (3.7)	3,318
Aug 10-16	2,156	169	44 (3.8)	957
Aug 17-23[a]				
Run total	11,237	1,080	47	5,297
		Fall run		
Aug 24-27	2,685	135	43 (4.3)	1,155

[a] No data collected due to high water.

female. Males ranged from 520 to 665 mm MEL (Table 2). Female chums ranged from 520 to 640 mm MEL.

Chinook salmon.—Chinook salmon were counted daily from July 6 through August 8; thereafter, their migration was sporadic (Figure 2; Appendix 2). The last chinook counted was on August 27. Most of the run (81%) had passed through the weir by July 20. The weekly sex ratio from July through mid-August ranged from 14 to 65 % female (Table 3). Males ranged in length from 460 to 1,005 mm MEL and females measured 455 to 965 mm MEL (Tables 4). Four age groups were determined from scales (Table 5). The chinook run consisted of predominately age 1.4 fish which comprised 51% of the male and 92% of the female fish.

TABLE 2.—Lengths of chum salmon sampled at the South Fork Koyukuk River weir, Alaska, 1997.

	Males				Females			
		Mid-eye to fork length (mm)				Mid-eye to fork length (mm)		
Time period	N	Mean	SE	Range	N	Mean	SE	Range
				Summer run				
Jul 6-12	115	592.7	2.7	505-675	76	566.3	3.2	510-640
Jul 13-19	135	607.8	3.1	510-740	63	565.6	2.7	515-615
Jul 20-26	116	297.9	2.8	520-660	50	563.3	4.5	495-655
Jul 27- Aug 2	105	606.3	3.3	515-680	73	568.9	3.4	505-640
Aug 3-9	83	606.1	3.2	545-685	96	581.3	3.3	460-650
Aug 10-16	94	601.7	3.3	530-685	75	583.0	2.9	520-640
Aug 17-23[a]								
				Fall run				
Aug 24-27	77	605.7	3.6	520-665	68	586.8	3.2	520-640

[a] No data collected due to high water.

TABLE 3.—Sex ratio of chinook salmon sampled at the South Fork Koyukuk River weir, Alaska, 1997.

Time period	Total number of chinook passing through the weir	N	Percent female (SE)	Estimated number of females
Jul 6-12	615	156	42 (4.0)	260
Jul 13-19	574	174	50 (3.8)	287
Jul 20-26	313	110	65 (4.6)	202
Jul 27-Aug 2	99	68	64 (5.9)	64
Aug 3-9	33	33	48 (8.8)	16
Aug 10-16	7	7	14 (14.2)	1
Aug 17-23[a]				
Aug 24-30	2	2	0	0
Run total	1,643	550	51	830

[a] No data collected due to high water.

Discussion

The migration of chum and chinook salmon in the South Fork began several days prior to the completion of installing the weir. Prior to weir installation, low numbers (<15 fish/d) were observed migrating past the weir site as early as July 1; although, the daily number of migrating fish was likely greater than the observed. There were several days when only partial counts for the day were obtained (Appendix 2). Partial count days coincided with high flow events when panels were partially or temporarily submerged.

The number of summer chum counted passing through the weir in 1997 (N=11,237) was 30% of the escapement in 1996 (N=37,450)(Wiswar 1997). Depressed summer chum run numbers were a trend observed in the Gisasa River in the lower Koyukuk drainage (unpublished data, U.S. Fish and Wildlife Service) and in many other rivers monitored in the Yukon River drainage (United States/Canada Yukon River Joint Technical Committee 1997). Chinook salmon escapement in 1997 was considered an average run year for the Yukon drainage (United States/Canada Yukon River Joint Technical Committee 1997). In the South Fork, the chinook salmon run in 1997 (N=1,643) was greater than 1996 (N=1,232) (Wiswar 1997).

Peak migration of summer chum salmon in the South Fork in 1997 occurred about a week later

TABLE 4.—Weekly mean lengths of chinook salmon sampled at the South Fork Koyukuk River weir, Alaska, 1997.

	Males				Females			
		Mid-eye to fork length (mm)				Mid-eye to fork length (mm)		
Time period	N	Mean	SE	Range	N	Mean	SE	Range
Jul 6-12	92	764.1	12.0	520-980	69	751.8	16.4	455-940
Jul 13-19	87	751.2	13.1	485-985	88	818.1	11.2	500-955
Jul 20-26	39	813.2	19.0	460-960	71	835.6	9.0	555-945
Jul 27-Aug 2	24	714.8	31.8	500-950	44	858.9	7.0	715-955
Aug 3-9	17	637.4	25.0	520-780	15	877.7	12.9	800-965
Aug 10-16	5	770.0	81.4	510-1,005				

TABLE 5.—Length at age of male and female chinook salmon sampled at the South Fork Koyukuk River weir, Alaska, 1997.

	Males				Females			
		Mid-eye to fork length (mm)				Mid-eye to fork length (mm)		
Age	N	Mean	SE	Range	N	Mean	SE	Range
1.2	19	569.2	12.6	460-685	1	600		
1.3	20	732.5	18.9	605-910	7	750.7	42.0	555-855
1.4	40	864.9	9.6	745-1,005	118	852.3	4.2	710-965
1.5	0				2	830.0	30.0	800-860

than that observed in 1996 (Wiswar 1997). When peak run timing of chum in the South Fork is compared to the Gisasa River (Melegari and Wiswar 1994; Melegari 1996, 1997; unpublished data, U.S. Fish and Wildlife Service), the South Fork has been 3 to 4 weeks later. Run timing of chinook salmon in the South Fork and Gisasa rivers (Melegari 1997) was similar; both runs peaked between the first and second weeks of July. The escapement of summer chum salmon was declining in mid-August when counting ceased due to high river flows that submerged the weir panels and trap. By this time the chinook migration had essentially ended. An aerial survey conducted by ADFG on July 29 estimated 640 chum and 1,001 chinook salmon. Cumulative weir counts on July 29 for chum and chinook salmon were 3.6 and 1.6 times greater than the aerial surveys estimates.

The fall chum migration on the South Fork is the only fall run monitored in the Koyukuk drainage. Because only four days of escapement were monitored at the weir in August characterization of the run is not possible. Last year (1996), over 21, 000 chum were counted passing through the weir (Wiswar 1997). In 1990, a Bendix riverine sonar was used to count the fall chum escapement passing a site about 3 km below the present weir location. Over 19,000 chums were electronically counted moving upstream between August 2 and September 25 (Troyer 1993).

The sex ratio of chum salmon generally changes over the course of the run with males predominating early in spawning rivers (Salo 1991). This tendency in summer chums was observed in the Koyukuk drainage where in the South Fork in 1997 and 1996 (Wiswar 1997) and Gisasa River in 1994-97 (Melegari and Wiswar 1995; Melegari 1996, 1997; unpublished data, U.S. Fish and Wildlife Service) the percent female composition increased as the run progressed.

Numbers of resident fish species counted at the weir were relatively low. Spacing of the weir pickets would allow smaller size fish to move upstream without being counted at the trap; therefore, resident fish counts are conservative. There were several days in mid-July and again during the third week of August when over 15 whitefish/d passed upstream through the trap. More information would be needed from these fish to determine if this was a migration pattern.

Acknowledgments

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APPENDIX 1.—Aerial salmon escapement counts in the South Fork Koyukuk River including Jim River, excluding Fish Creek (source: Barton 1984; Alaska Department of Fish and Game, unpublished data).

	Escapement counts		
Year	Summer chum	Fall chum	Chinook
1969	29		33
1971	6,950	652	230
1974	57		14
1975	15,209		181
1976	4,817		189
1977	1,412		83
1978	3,421		154
1980	33		49
1981			
1982	2		20
1983	726		312
1984	315		108
1985	942		535
1986	2,445		794
1987	436		236
1988	462	242	157
1989	728	280	419
1990	233		288
1991	308		630
1992	349		591
1993	124		421
1994	324		528
1995	439		358
1996	4,920		268
1997	640		1,001

APPENDIX 2.—Daily and cumulative (salmon spp. only) counts of fish passing through the South Fork Koyukuk River weir, 1997. (Cum = cumulative; * = partial daily count).

	Chum salmon		Chinook salmon		Northern pike	Whitefish spp.	Arctic grayling	Longnose sucker
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jul 6*	39	39	9	9	1	0	0	0
Jul 7	91	130	39	48	1	2	0	0
Jul 8	103	233	31	79	1	2	0	0
Jul 9	17	250	57	136	0	0	0	0
Jul 10	28	278	22	158	0	0	0	0
Jul 11	125	403	240	398	0	0	1	0
Jul 12	162	565	217	615	0	2	0	0
Jul 13	155	720	131	746	0	23	6	0
Jul 14	113	833	33	779	0	0	0	0
Jul 15*	72	905	150	929	0	0	0	0
Jul 16*	104	1,009	62	991	0	33	0	0
Jul 17	271	1,280	106	1,097	0	22	7	0
Jul 18	124	1,404	42	1,139	0	3	0	1
Jul 19	165	1,569	50	1,189	0	3	0	0
Jul 20	223	1,792	141	1,330	0	5	0	0
Jul 21*	111	1,903	22	1,352	0	7	0	0
Jul 22*	105	2,008	26	1,378	0	3	0	0
Jul 23*	93	2,101	41	1,419	0	3	0	0
Jul 24	104	2,205	61	1,480	0	18	0	0
Jul 25	40	2,245	14	1,494	0	1	0	0
Jul 26	33	2,278	8	1,502	0	1	0	0
Jul 27	37	2,315	19	1,521	0	1	0	0
Jul 28	66	2,381	13	1,534	0	1	0	0
Jul 29	86	2,467	27	1,561	0	1	0	0
Jul 30	66	2,533	9	1,570	0	2	0	0
Jul 31	49	2,582	10	1,580	0	0	0	0
Aug 1*	73	2,655	15	1,595	0	2	0	0
Aug 2	239	2,894	6	1,601	0	4	1	0
Aug 3	908	3,802	11	1,612	0	0	0	0
Aug 4	1,071	4,873	4	1,616	0	2	0	0
Aug 5	948	5,821	7	1,623	0	9	0	0
Aug 6	955	6,776	6	1,629	1	8	0	0
Aug 7*	730	7,506	3	1,632	0	6	0	1
Aug 8	741	8,247	2	1,634	0	14	0	0
Aug 9	834	9,081	0	1,634	0	0	0	0
Aug 10	395	9,476	1	1,635	0	1	0	0

APPENDIX 2.—Continued.

Date	Chum salmon		Chinook salmon		Northern pike	Whitefish spp.	Arctic grayling	Longnose sucker
	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Aug 11	470	9,946	2	1,637	1	0	0	0
Aug 12	356	10,302	3	1,640	0	0	0	0
Aug 13	303	10,605	0	1,640	1	2	0	0
Aug 14	421	11,026	0	1,640	0	28	0	0
Aug 15*	211	11,237	1	1,641	0	8	0	0
Aug 16	High flow event; no daily counts at weir until August 24. Weir panels and trap submerged.							
Aug 17								
Aug 18								
Aug 19								
Aug 20								
Aug 21								
Aug 22								
Aug 23								
Aug 24*	120	11,357	0	1,641	0	0	0	0
Aug 25	634	11,991	1	1,642	0	21	0	0
Aug 26	1,130	13,121	0	1,642	0	15	6	0
Aug 27	801	13,922	1	1,643	0	19	1	0
Aug 28	High flow event continued passed September 11, study was terminated on that date;							
Aug 29	no additional daily counts at weir. Weir panels and trap submerged.							
Aug 30								
Aug 31								
Sep 1								
Sep 2								
Sep 3								
Sep 4								
Sep 5								
Sep 6								
Sep 7								
Sep 8								
Sep 9								
Sep 10								
Sep 11								
Total	13,922		1,643		6	272	22	2