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

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United States Department of the Interior
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Abstract. — From June 14 to July 27, 1997 a resistance board weir was operated on the Gisasa River, a tributary to the Koyukuk River in west central Alaska. This was the fourth year of weir operation at this site. A total of 31,800 summer chum salmon *Oncorhynchus keta* and 3,764 chinook salmon *O. tshawytscha* passed through the weir. The most abundant resident species were longnose sucker *Catostomus catostomus* (N=78) and Arctic grayling *Thymallus arcticus* (N=32). Chum salmon escapement was only 22% of the average of 1995-1996. Also, there was no peak period in the escapement that has been observed in previous years. Females comprised 51% of the chum salmon sampled. Four age groups were identified with age 0.4 comprising 70% of the 220 chum sampled. Chinook escapement was comparable to 1994-1996. Females comprised 23% of the chinook salmon sampled. There were two peaks in the run; the first occurred between July 9-12 and the other July 17-19. Seven age groups were identified for chinook salmon; predominant ages were 1.2 and 1.3 for males and 1.4 for females.

Introduction

Summer and fall chum *Oncorhynchus keta* and chinook salmon *O. tshawytscha* spawning in the Gisasa River 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 (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.

Koyukuk National Wildlife Refuge (Refuge) is located near the villages of Nulato, Koyukuk, Galena, Huslia, 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 Gisasa River in 1994 (Melegari and Wiswar 1995), the first year of a multi-year escapement study, that has continued through 1997. The objectives of the study are to: (1) determine daily escapement and run timing of adult salmon into the Gisasa River; (2) determine sex and size composition of chinook and chum salmon in the Gisasa River; (3) evaluate the effectiveness of aerial surveys as a method for salmon escapement estimation in the Gisasa River; (4) determine presence and movement of resident fish in the Gisasa River.

At the Gisasa River weir, chum salmon summer run escapement numbers have ranged from about 51,000 to 158,00 fish. Chinook salmon escapement has ranged from 2,000 to 4,000 fish (Melegari and Wiswar 1995; Melegari 1996, 1997). Other historical data on the fishery resources in the Gisasa River are limited to aerial surveys conducted between 1969 and 1997 (Barton 1984; unpublished data, Alaska Department of Fish and Game; Appendix 1). Aerial survey counts of chum salmon from the Gisasa River were highest from 1974 to 1976 averaging 33,423 (range = 21,342 - 56,904). Counts, for years when survey conditions were rated fair to good, from 1985 to 1993 averaged 7,805 (range = 1,581 - 13,232) Aerial survey counts of chinook salmon in the Gisasa River have been higher during recent years. Counts, for years when survey conditions were rated fair to good, averaged 445 (range = 161 - 951) from 1974 - 1984 and 1218 (range = 410 - 2775) from 1985 - 1995 (Schultz et al. 1993; Bergstrom et al. 1996).

Study Area

The Gisasa River is a tributary of the Koyukuk River in west central interior Alaska (Figure 1). The Gisasa River flows northeast 112 km from its origin in the Nulato Hills to the Koyukuk River (65° 16'N latitude, 157° 40'W longitude, USGS. 1:63,360 series, Kateel River B-4 quadrangle). The lower third of the Gisasa River flows through the Refuge. Climate of the region is continental subarctic which is characterized by extreme seasonal variations of temperature and relatively low precipitation. The village of Galena, approximately 64 km southeast of the mouth of the Gisasa River, has a mean annual temperature of 3.8° C. Summer and winter temperature extremes range from 32° C to -59° C, respectively. Stream flow is characterized by peak flows during late May and early June in response to snowmelt. Rainstorms may produce secondary peaks in summer. Rivers in the area generally begin to freeze during October (USFWS 1993).

The weir site is approximately 4 km upriver from the mouth of the Gisasa River. This section of the river is relatively straight. The river channel slopes gradually from the stream banks and average maximum depth is approximately 0.5 m. Substrate at the weir site consists primarily of medium sized gravel.

Methods

Biological Data

All fish passing through the weir were counted and identified to species. Daily counts began at 0001 hours and ended at midnight. Fish were released from the trap and counted at varying time intervals, corresponding to the intensity of migration. River flow was lower in 1997 than observed 1994-1996 and it was felt that the low water impeded fish movement through the trap. To prevent fish from backing up in front of the weir, two panels were temporarily removed in the area of the thalweg to aid access upstream. Fish were counted as they swam over the base rail. 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 a 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. Due to the low number of chinook salmon passing through the weir sampling occurred nearly daily to ensure that the desired sample size was obtained. Lengths from chum and chinook salmon were measured to the nearest 0.5 cm from the mid-eye to 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. Chum salmon were collected opportunistically off the weir as they floated back down stream after spawning. One scale and a section of vertebrae anterior to the caudal peduncle were collected to compare age structures. Scales from both chinook and chum salmon were sent to ADF&G Commercial Fisheries Management and Development Division for processing, where acetate impressions of the scales were made and aged. Vertebrae were aged by USFWS personnel. All ages are reported using the European method (Jearld 1983). A students t-test ($P < 0.05$; Zar 1984) was used to compare mean length at age of males and females.

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

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

where n_{ij} is the number of fish of sex/age 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/age composition for the total run of summer chum and chinook salmon of a given sex/age, 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 run. Variance of age composition for the summer or fall run will be calculated as

$$v(p_i) = \sum_{j=1} W_j^2 v(p_{ij}).$$

Weir Operation

Construction and installation of the weir is described by Tobin (1994). During operation the weir was visually inspected daily for holes and structural integrity. Fish carcasses and debris were cleaned from the weir as they accumulated, often several times a day. Cleaning usually involved walking on the weir panels until they were partially submerged and allowing the current to flush the debris off. Occasionally larger debris would have to be physically pushed off the weir. Water temperature (°C) was recorded daily at approximately 1200 hours from a thermometer suspended approximately midway between the water surface and the riverbed.

Results

Weir Operation

Operation of the weir began on June 14 and continued through July 27, 1997. Spawning activity immediately upstream of the weir resulted

in areas where gravel accumulated on the weir panels. River discharge throughout the period of operation was lower than that experienced during previous years. Modification to sampling by removing panels for passing fish was successful.

Water Temperature

Water temperatures ranged from 11° to 19°C and averaged 15.4°C. The high temperature was recorded on July 4 and 5; the low temperature was on June 16 and 17.

Biological Data

Chum salmon (N=31,800) were the most abundant species counted through the weir followed by chinook salmon (N=3,764; Appendix 2). Four resident species were counted. The most abundant were longnose sucker *Catostomus catostomus* (N=78) followed by Arctic grayling *Thymallus arcticus* (N=32), northern pike *Esox lucius* (N=6), and Dolly Varden *Salvelinus malma* (N=1).

Chum salmon.—Chum salmon were first counted on June 16 (Appendix 2). Their numbers remained low (<60 fish/d) until June 25 when the escapement increased to over 500 fish. Escapement counts for the remainder of the time were generally between 700 and 1400 fish/d. The run exhibited no strong peak in the migration. During the two week period between July 4 and July 17 when counts were highest there was not much difference in the daily fish counts (Figure 2; Appendix 2). The sex ratio for the run was 51% female with weekly ratios ranging from 34% at the beginning of the run to 60% during the last week escapement was monitored (Table 1). Male chums ranged from 440 to 700 mm MEL (Tables 2 and 3). Females ranged from 430 to 640 mm MEL. There was 73% agreement when comparing vertebrae to scales for age estimates. Only vertebrae ages are reported here. Four age groups were determined from vertebrae (Table 3). The run was consisted predominately of age 0.4 fish which comprised 73% of the male and 65% of the female fish sampled. Average length of females in age groups 0.3 and 0.4 was significantly less ($P < 0.001$ for both age classes) than for males in corresponding age classes.

Chinook salmon.—The first chinook salmon observed at the weir was on June 27 (Appendix 2). About 70% of the chinook passed through the weir during the 11 d of July 9-19 (Figure 2; Appendix 2). The sex ratio for the run was 23% female with weekly ratios ranging from 14% early in the run to 50% during the last week escapement was monitored (Table 4). Male chinook ranged from 430 to 910 mm MEL (Tables 5 and 6). Females ranged from 585 to 990 mm MEL. The chinook run was comprised of seven age groups (Table 6). Male chinook in age groups 1.2 and 1.3 comprised 58% of the run and females in age group 1.4 comprised 27% (Table 7).

Discussion

Weir Operation

The weir performed well and was effective in allowing accurate counts of migrating salmon. Picket spacing of the trap and the weir panels was adequate to prevent adult chum and chinook salmon from passing between the pickets. Smaller sized resident species may have passed through the weir undetected.

Water Temperature

In 1997, water temperatures in the Gisasa River averaged 2.4°C higher than those recorded in 1996 (Melegari 1997). Comparing water temperatures at time chum salmon spawn from a review by Hale (1981) to the Gisasa River in 1997 show the average temperature in the Gisasa River in 1997 was over 4°C warmer than in most of the rivers in Hale's review.

Biological Data

In 1993, aerial surveys reported low summer chum escapement in the Yukon drainage (ADFG

1997). This year (1997) was the first year to assess the effects of the 1993 brood year. Post season analysis of commercial harvest and escapement data throughout the Yukon drainage indicated a low return of summer chum (JTC 1977). However, escapement to individual tributaries was variable; in some streams escapement was low and in others it was near average. The 1997 weir count of chum salmon (N=31,800) was about 23% of the average of the 1995 and 1996 weir counts (Melegari 1996,1997). Based solely on the 1997 escapement, the Gisasa River summer chum salmon may experience a low recruitment again in 2001.

The lack of peak period of migration observed in previous years (Melegari and Wiswar 1995; Melegari 1996, 1997) is probably attributed to the overall low daily counts (Figure 2). Even with a less characteristic migration plot, the median migration day in 1997 (July 10), the day when 50% of the total count passed the weir, was similar to the dates in 1995 (July 9) and 1996 (July 4).

Post season assessment indicated that chinook salmon abundance in the Yukon River was above average. Escapement numbers for chinook (N=3,764) in the Gisasa River were relatively high when compared to 1994-1996 ($\bar{x}$ = 2,954, range = 1,952-4,023) (Melegari and Wiswar 1995; Melegari 1996, 1997). The escapement trend was similar to previous years with a peak migration occurring about the second week of July. The median migration date of July 13, 1997 was similar to 1995 (July 12) and 1996 (July 9)(Melegari 1996, 1997).

Six year old fish generally comprise the majority of returning fish in the Yukon River (Brady 1983). For the Gisasa River this held true for six year old (1991 brood year) female chinook in 1997; however, older males were comprised primarily of age group 1.3 which were from the 1992 brood year (Table 7).

ADFG attempted an aerial survey on July 23, 1997. Wind that day disturbed the water surface which prevented a clear view of fish in the water column. Low fish counts recorded during the aerial survey reflected the day's weather conditions (Appendix 2).

Acknowledgments

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TABLE 1.—Sex ratio of chum salmon sampled at the Gisasa River weir, Alaska, 1997.

Time period	Total number of chum passing through the weir	N	Percent female (SE)	Estimated number of females
June 23-29	3,404	307	34 (2.7)	1,157
June 30- July 6	7,679	350	47 (2.7)	3,609
July 7-13	8,176	350	52 (2.7)	4,251
July 14- 20	7,049	350	57 (2.7)	4,018
July 21-27	5,492	400	60 (2.5)	3,295
Run total	31,800	1,757	51 (1.2)	16,330

TABLE 2.—Lengths of chum salmon sampled at the Gisasa 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
June 23-29	202	595.6	2.0	520-660	105	569.6	2.0	520-625
June 30- July 6	184	588.4	2.2	440-670	166	567.8	1.7	490-630
July 7-13	167	582.5	2.3	520-670	183	555.3	1.8	465-620
July 14- 20	152	566.3	2.5	490-645	198	539.6	2.1	520-620
July 21-27	140	555.0	2.8	460-660	210	533.8	2.0	430-630

TABLE 3.—Length at age of male and female chum salmon sampled at the Gisasa River weir, Alaska, 1997. Ages from vertebrae.

		Males				Females		
		Mid-eye to fork length (mm)				Mid-eye to fork length (mm)		
Age	N	Mean	SE	Range	N	Mean	SE	Range
0.3	20	554.8	8.0	495-630	25	543.4	5.0	490-585
0.4	83	601.6	3.9	530-700	70	568.5	2.6	525-640
0.5	10	605.0	11.1	520-640	11	574.1	9.8	525-620
0.6	0				1	640		

TABLE 4.—Sex ratio of chinook salmon sampled at the Gisasa River weir, Alaska, 1997.

Time period	Total number of chinook passing through the weir	N	Percent female (SE)	Estimated number of females
June 29- July 6	327	113	17 (3.5)	55
July 7-13	1,543	190	14 (2.5)	216
July 14- 20	1,365	132	25 (3.8)	341
July 21-27	529	121	50 (4.6)	264
Run total	3,764	556	23 (1.9)	876

TABLE 5.—Lengths of chinook salmon sampled at the Gisasa 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
June 29- July 6	94	639.7	10.8	460-910	19	810.5	24.2	585-980
July 7-13	163	614.3	7.3	430-855	27	840.7	12.1	690-990
July 14- 20	99	638.0	11.3	430-910	33	833.5	7.1	750-915
July 21-27	60	647.0	16.4	460-910	61	846.7	5.7	755-960

TABLE 6.—Length at age of male and female chinook salmon sampled at the Gisasa 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
1.1	2	462.5	32.5	430-495	0			
1.2	182	551.0	3.3	430-665	2	667.5	82.5	585-750
1.3	122	672.7	5.1	540-855	10	760.0	26.5	640-870
1.4	60	799.2	9.0	625-910	116	845.1	4.4	740-980
1.5	0				1	990		
2.2	1	590			0			
2.3	1	610			0			

TABLE 7.—Percent weekly age estimates of chinook salmon passing through the Gisasa River weir, 1997. SE in parentheses.

Time period	Period total	N	Brood year and age													
			1990		1991				1992				1993		1994	
			1.5		1.4		2.3		1.3		2.2		1.2		1.1	
			Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Jun 29-Jul 6	327	97	0	0	14.4 (3.6)	11.3 (3.2)	1.0 (1.0)	0	33.0 (4.8)	5.2 (2.7)	0	0	34.0 (4.8)	1.0 (1.0)	0	0
Jul 7-13	1,543	167	0	0.6 (0.6)	7.2 (2.0)	12.6 (2.6)	0	0	32.9 (3.6)	1.8 (1.0)	0.6 (0.6)	0	43.7 (3.8)	0	0.6 (0.6)	0
Jul 14-20	1,365	122	0	0	13.9 (3.1)	25.4 (4.0)	0	0	22.1 (3.8)	0	0	0	36.9 (4.4)	0.8 (0.8)	0.8 (0.8)	0
Jul 21-27	529	111	0	0	15.3 (3.4)	47.7 (4.8)	0	0	7.2 (2.5)	1.8 (1.3)	0	0	27.9 (4.3)	0	0	0
Total	3,764	497	0	0.2 (0.2)	11.7 (1.6)	27.0 (2.1)	0.1 (0.1)	0	22.1 (1.9)	1.8 (0.7)	0.2 (0.2)	0	36.2 (2.3)	0.2 (0.1)	0.4 (0.3)	0

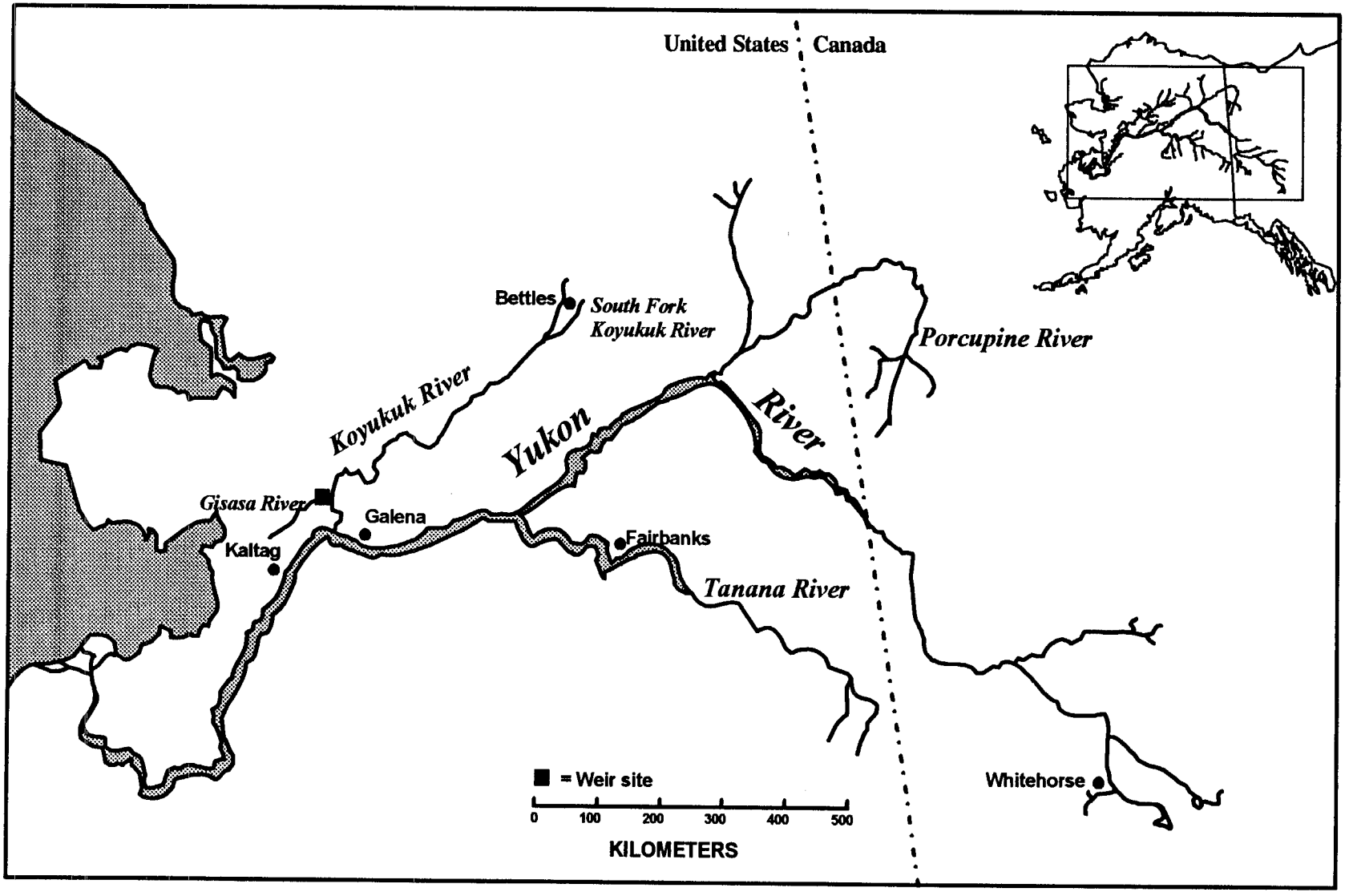

FIGURE 1.— Location of Gisasa River weir.

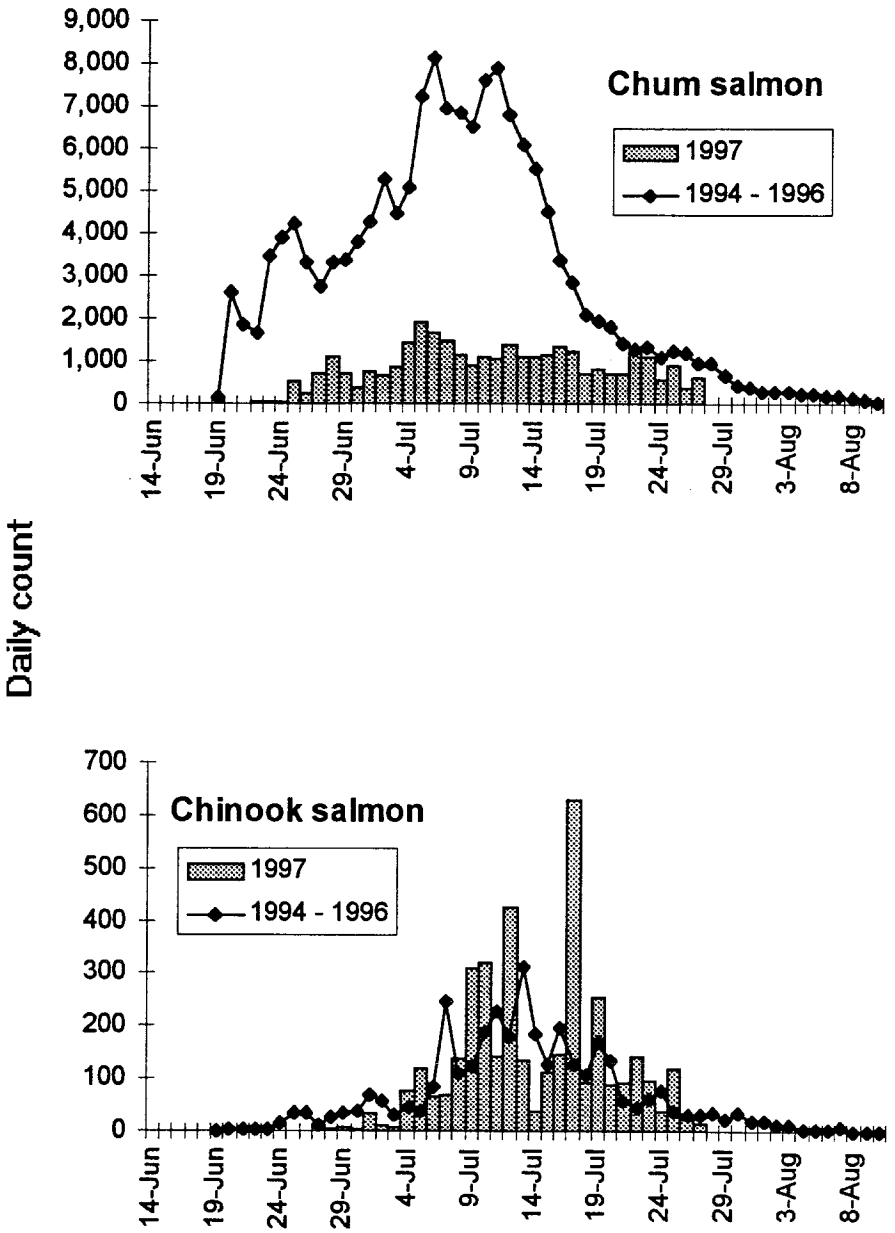

FIGURE 2.—Daily counts of chum and chinook and chum salmon at the Gisasa River weir, 1997 with the average daily counts from 1994 through 1996.

APPENDIX 1.— Salmon escapement counts from aerial counts in the Gisasa River, 1974-1997 (source: Barton 1984; Alaska Department of Fish and Game, unpublished data).

	Escapement counts	
Year	Chum salmon	Chinook salmon
1974	22,022	161
1975	56,904	385
1976	21,342	332
1977[a]	2,204	255
1978[a]	9,280	45
1979	10,962	484
1980	10,388	951
1981	—	—
1982[a]	334	421
1983[a]	2,356	572
1984	—	—
1985	13,232	735
1986	12,114	1,346
1987	2,123	731
1988	9,284	797
1989	—	—
1990[a]	450	884
1991	7,003	1,690
1992	9,300	910
1993	1,581	1,573
1994	6,827	2,775
1995	6,458	410
1996	—	—
1997[a]	686	144

[a] Incomplete surveys due to poor survey conditions.

APPENDIX 2.—Daily and cumulative (salmon spp. only) counts of fish passing through the Gisasa River weir, 1997. (Cum = cumulative).

Date	Chum salmon		Chinook salmon		Longnose sucker	Arctic grayling	Northern pike	Dolly Varden
	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jun 14	0	0	0	0	6	3	0	0
Jun 15	0	0	0	0	5	1	0	0
Jun 16	8	8	0	0	3	0	0	0
Jun 17	0	8	0	0	1	0	0	0
Jun 18	1	9	0	0	1	10	0	0
Jun 19	8	17	0	0	0	4	0	0
Jun 20	11	28	0	0	0	6	0	1
Jun 21	10	38	0	0	0	0	0	0
Jun 22	30	68	0	0	6	1	0	0
Jun 23	28	96	0	0	2	0	0	0
Jun 24	60	156	0	0	7	0	0	0
Jun 25	535	691	0	0	5	1	0	0
Jun 26	247	938	0	0	2	0	0	0
Jun 27	696	1,634	1	1	1	0	0	0
Jun 28	1,074	2,708	3	4	8	1	0	0
Jun 29	696	3,404	9	13	1	0	0	0
Jun 30	373	3,777	2	15	2	1	1	0
Jul 1	769	4,546	33	48	8	0	0	0
Jul 2	681	5,227	11	59	7	0	0	0
Jul 3	852	6,079	6	65	1	0	0	0
Jul 4	1,431	7,510	78	143	1	0	0	0
Jul 5	1,895	9,405	120	263	0	0	0	0
Jul 6	1,678	11,083	64	327	2	0	1	0
Jul 7	1,466	12,549	70	397	3	0	0	0
Jul 8	1,162	13,711	138	535	1	0	0	0
Jul 9	925	14,636	310	845	3	0	1	0
Jul 10	1,096	15,732	320	1,165	1	0	0	0
Jul 11	1,052	16,784	144	1,309	0	0	0	0
Jul 12	1,394	18,178	424	1,733	0	2	0	0
Jul 13	1,081	19,259	137	1,870	0	0	0	0
Jul 14	1,113	20,372	38	1,908	0	0	0	0
Jul 15	1,140	21,512	112	2,020	0	0	0	0
Jul 16	1,339	22,851	146	2,166	0	0	0	0
Jul 17	1,248	24,099	632	2,798	0	0	0	0
Jul 18	693	24,792	92	2,890	1	0	0	0
Jul 19	795	25,587	257	3,147	0	0	0	0
Jul 20	721	26,308	88	3,235	0	0	0	0
Jul 21	724	27,032	91	3,326	0	0	0	0
Jul 22	1,233	28,265	142	3,468	0	0	2	0
Jul 23	1,081	29,346	98	3,566	0	0	0	0

APPENDIX 2.—Continued.

Date	Chum salmon		Chinook salmon		Longnose sucker	Arctic grayling	Northern pike	Dolly Varden
	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
Jul 24	564	29,910	38	3,604	0	0	1	0
Jul 25	918	30,828	120	3,724	0	0	0	0
Jul 26	367	31,195	25	3,749	0	2	0	0
Jul 27	605	31,800	15	3,764	0	0	0	0
Total	31,800		3,764		78	32	6	1