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Abundance and Run Timing of Adult Salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 1996

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Abstract. — From June 19 to July 27, 1996 a resistance board weir was operated on the Gisasa River, a tributary to the Koyukuk River in west central Alaska. This was the third year of weir operation at this site. A total of 157,589 summer chum salmon *Oncorhynchus keta* and 1,952 chinook salmon *O. tshawytscha* were enumerated. The most abundant resident species were longnose sucker *Catostomus catostomus* (N=132) and Arctic grayling *Thymallus arcticus* (N=71). A total of 843 chum salmon and 407 chinook salmon were sampled for sex, length, and age from scale collections. Females comprised 51% of the chum salmon sampled. Average mid-eye to fork length (MEF) of chum salmon was 548 mm (N=428, SD=27) for females and 583 mm (N=415, SD=31) for males. Four age groups were identified for chum salmon, with 50% of the sample age 0.4 and 43% age 0.3. Females comprised 20% of the chinook salmon sampled. Average length was 829 mm MEF (N=80, SD=77) for females and 650 mm (N=327, SD=97) for males. Five age groups were identified for chinook salmon, with 60% of the sample age 1.3, 18% age 1.2, and 14% age 1.4.

Introduction

Accurate salmon escapement data are critical to evaluating harvest management strategies, particularly in mixed stock fisheries. Chum salmon *Oncorhynchus keta* and chinook salmon *O. tshawytscha* stocks from the Gisasa River, in the Koyukuk National Wildlife Refuge (Refuge), have been identified as important contributors to subsistence and commercial fisheries in the middle Yukon River drainage (USFWS 1993). Alaska National Interest Lands Conservation Act mandates that salmon populations within the Refuge be conserved in their natural diversity, international treaty obligations be fulfilled, and subsistence opportunities for local residents be maintained.

Aerial survey counts in the Yukon River drainage have been highly variable (Schultz et al. 1993), and are only an index of relative strength of a salmon run (Barton 1984). 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).

A resistance board weir (Booth 1993; Tobin 1994; Melegari and Wiswar 1995) was installed and operated by the U.S. Fish and Wildlife Service on the lower Gisasa River from June 19 to July 27, 1996. This was the third year of weir operation at this site. During the first year (1994) installation was delayed and only partial counts were obtained (Melegari and Wiswar 1995). Objectives of this study are to: (1) determine daily escapement and run timing of 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. Additionally, the weir provides timely and accurate escapement data that augments in-season management decisions made by Alaska Department of Fish and Game (ADF&G).

Study Area

The Gisasa River is a tributary of the Koyukuk River in west central interior Alaska (Figure 1). Climate of the region is continental subarctic with extreme seasonal variations of temperature. The town of Galena, approximately 64 km southeast of the mouth of the Gisasa River, has a mean annual temperature of 3.8° C. Extremes range from 32° C to -59° C. Rivers in the area generally begin to freeze during October and breakup occurs sometime in May (USFWS 1993).

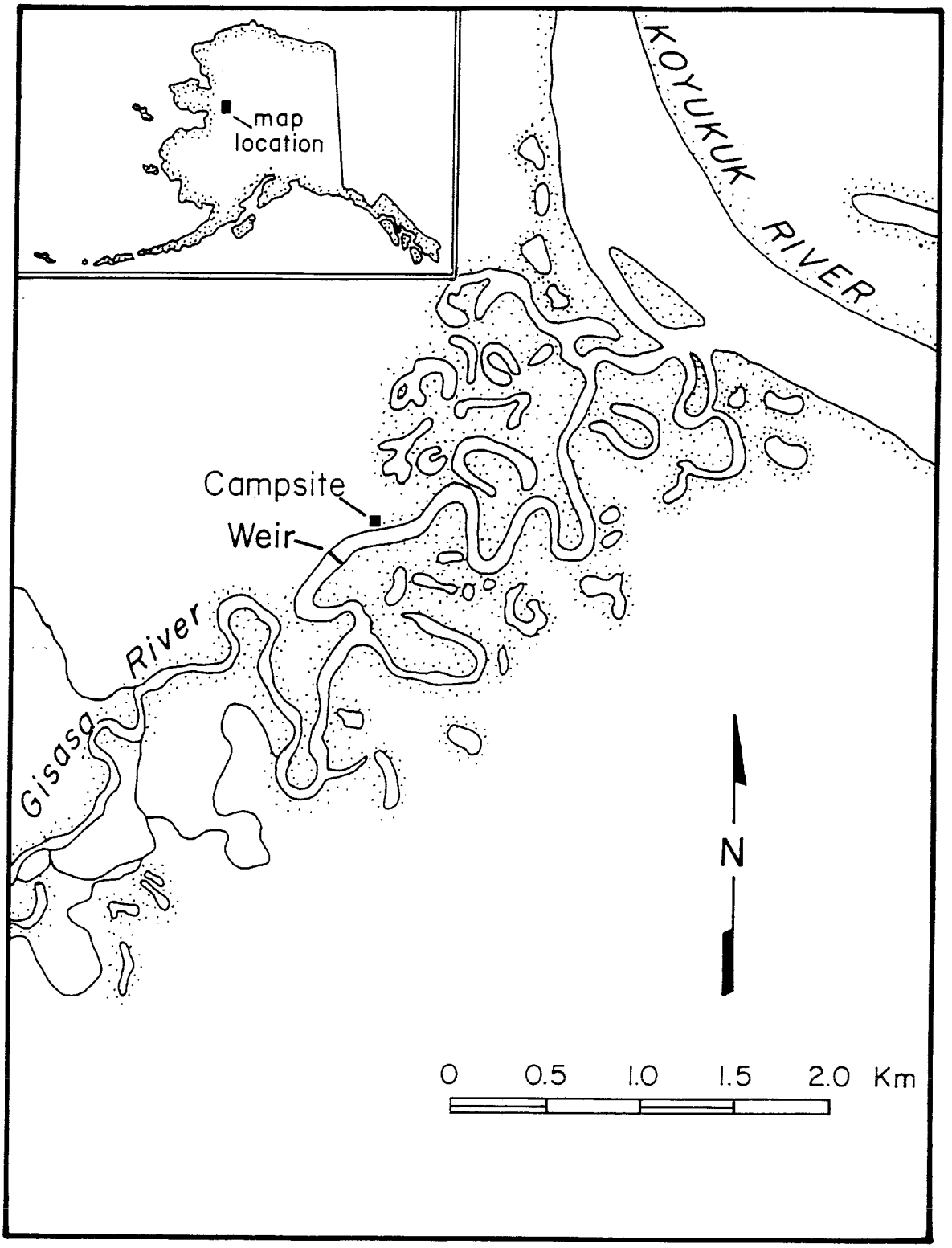
The Gisasa River flows northeast 112 km from its origin in the Nulato Hills to the Koyukuk River (65° 16'N latitude, 157° 40'W longitude, USGS. 1:63,360 series, Kateel River B-4 quadrangle). The lower third of the Gisasa River flows through the Refuge. Peak flows of area streams generally occur during snow melt and breakup, or during summer high precipitation events (USFWS 1993).

The weir site is approximately 4 km upriver from the mouth of the Gisasa River. This section of the river is straight and flow is generally laminar. 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, except *Coregonus* and *Prosopium* spp, which were grouped together as whitefish. 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. Chum and chinook salmon were sampled for scales, sexed using external characteristics and measured to the nearest 5 mm mid-eye to fork length (MEF). Scales were collected from the preferred area, two rows above the lateral line and on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin, according to ADF&G sampling protocol. One scale was taken from chum salmon and three scales were taken from chinook salmon. Scales were sent to ADF&G Commercial Fisheries Management and Development Division for processing, where acetate impressions of the scales were made and aged. All ages are reported using the European method (Jearld 1983).



Map of Gisasa River weir site, Koyukuk National Wildlife Refuge, Alaska.

Sampling occurred weekly, and sample periods ranged from one to four days for chum salmon. 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. The reported sample dates indicate the last day of sampling for that period. A students t-test ($P < 0.05$; Zar 1984) was used to compare mean lengths of males and females.

Only partial counts were completed during June 28 and 29 due to high water. The total count for chum salmon during these days was estimated by interpolating from full day counts before and after the high water (June 27 and 30). The partial counts for chinook salmon during June 28 and 29 were higher than the full day counts before and after the high water. Therefore, total counts for chinook for June 28 and 29 could not be interpolated from full day counts before and after the high water. Instead, total counts for chinook on these days was estimated by expanding the partial counts that were obtained.

Weir Operation

Construction and installation of the weir is described by Melegari and Wiswar (1995). 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. A depth gauge was installed on the side of the trap, which was located near the thalweg, and water depth was recorded daily.

Results

Biological Data

Chum salmon (N=157,589) were the most abundant species counted through the weir, followed by chinook salmon (N=1,952). A few pink salmon *O. gorbuscha* (N=43) were also counted. Five resident species were enumerated. The most abundant were longnose sucker *Catostomus catostomus* (N=132) and Arctic grayling *Thymallus arcticus* (N=71). Other resident species included northern pike *Esox lucius* (N=28), whitefish *Coregonus* and *Prosopium* spp. (N=25), and burbot *Lota lota* (N=3).

During June 19, the first full day of operation, 160 chum salmon were counted through the weir. The weir was operational for approximately 6 hours on June 18 and only 7 chum salmon were passed. The daily count increased to a high of 10,640 on July 7 then decreased to 336 by July 27, the last day of operation (Figure 2; Appendix 1). Females comprised 51% of the total chum salmon sampled (N = 843). The percent of females in weekly samples ranged from 33% during the first sample period to 76% during the last sample period (Figure 3). Lengths of all sampled chum salmon ranged from 445 mm to 695 mm. Average length of females (548 mm, SD=27) was significantly less ($P<.001$) than males (583 mm, SD=31).

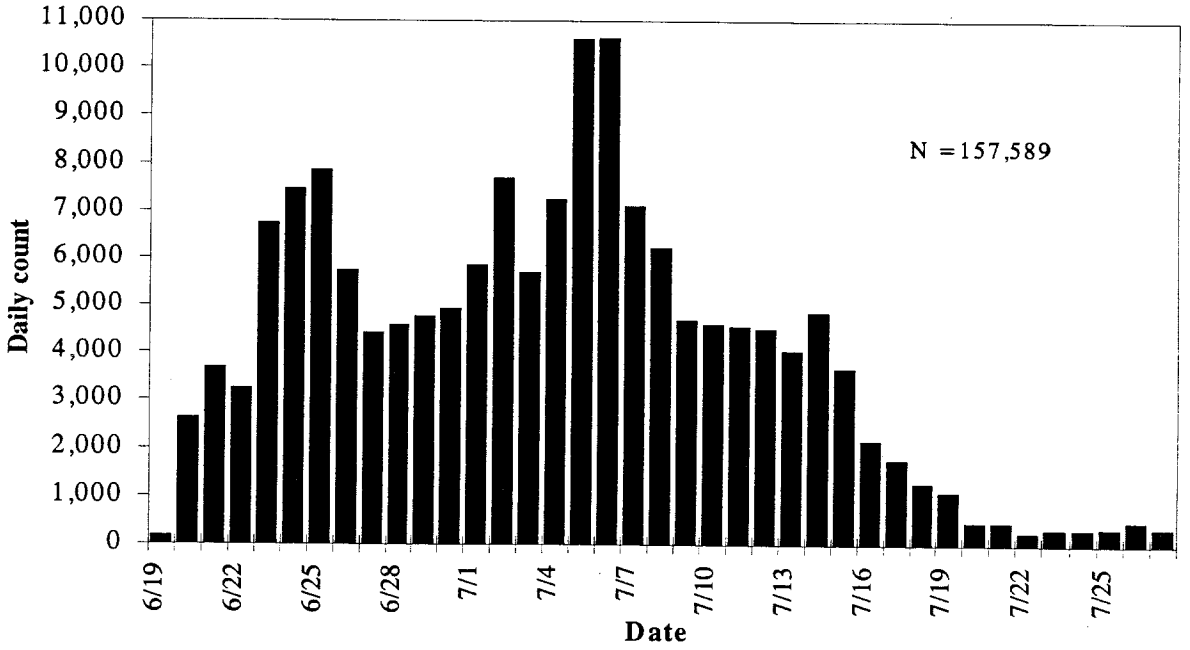


FIGURE 2.— Daily counts of chum salmon passing through Gisasa River weir, 1996. Counts for 6/28 and 6/29 are interpolated due to high water, which interrupted counting.

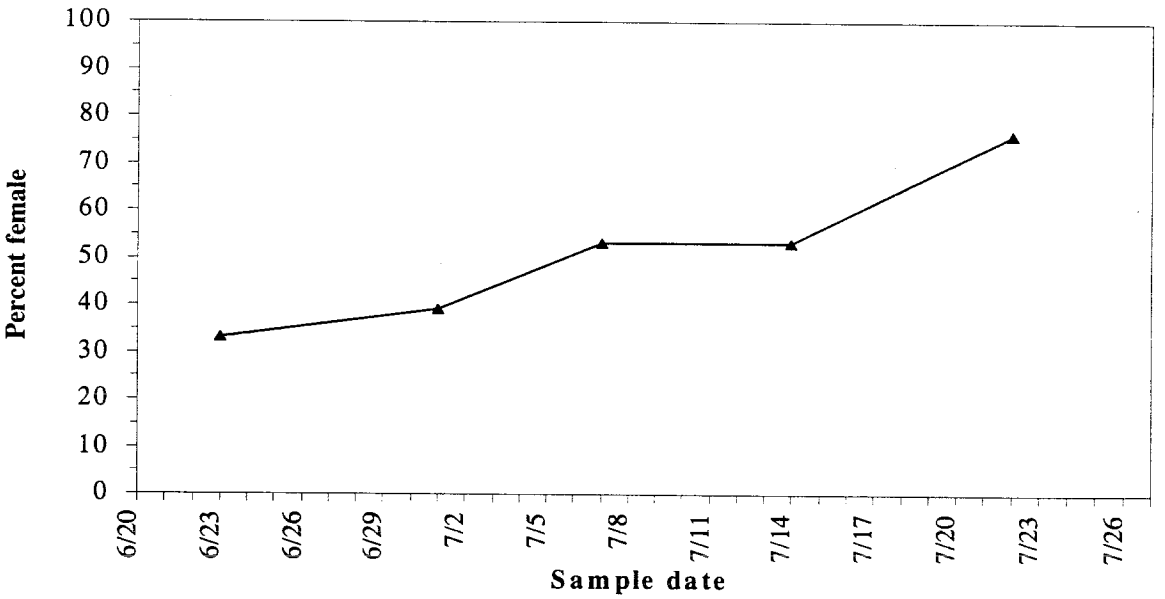


FIGURE 3.— Sex composition (percent female) of chum salmon samples from the Gisasa River weir, 1996. Sample sizes ranged from 160 to 176.

Ages were determined for 765 (91%) of the 843 chum scale samples collected, and four age groups were identified (Table 1). Age 0.4 and 0.3 fish accounted for 50% and 43% of the sample, respectively. For males age 0.4 was most common (56% of the male sample), followed by age 0.3 (35% of the male sample). Age 0.3 was most common among females (51% of the female sample) followed by age 0.4 (43% of the female sample). Additionally, samples taken during the earlier portion of the run contained a higher percentage of age 0.4 fish than samples taken later (Appendix 2). Average length of females in age groups 0.3 and 0.4 was significantly less ($P < .001$ for both age classes) than for males in corresponding age classes.

TABLE 1.— Age, length, and sex composition of chum salmon sampled at Gisasa River weir, 1996.

	Males					Females				
			Mid-eye to fork length (mm)					Mid-eye to fork length (mm)		
Age	N	%	Range	Mean	SD	N	%	Range	Mean	SD
0.3	136	17.8	515 - 645	565	24.8	192	25.1	445 - 610	535	24.5
0.4	219	28.6	515 - 695	592	28.5	161	21.0	510 - 630	559	23.1
0.5	32	4.2	565 - 685	606	25.6	24	3.1	520 - 610	573	23.2
0.6	1	0.1	650 - 650	650	-	0	0	-	-	-
Total	388	50.7	515 - 695	583	30.6	377	49.2	445 - 630	548	27.1

The first chinook salmon was counted on June 20. The daily count peaked on July 7 (N=234) and a second lower peak occurred July 13 (N=215) (Figure 4). Thirteen chinook were counted during July 27, the last day of operation. A total of 407 chinook salmon were sampled and females accounted for only 20% of the sample. The percent female during each sample period ranged from 12% to 34% (Figure 5). Lengths of chinook salmon ranged from 380 - 1010 mm. Average length of females (829 mm, SD=77) was significantly larger ($P < .001$) than for males (650 mm, SD=97).

Ages were determined for 339 (83%) of the 407 chinook scale samples collected, and five age groups were identified (Table 2). Age 1.3 was most common comprising 60% of the total sample. Age groups 1.2 and 1.4 accounted for 18% and 14% of the total sample, respectively. The majority (68%) of male samples were age 1.3, followed by age 1.4 (32%) and 1.2 (22%). Female samples were more evenly distributed between age groups 1.4 (39%), 1.5 (33%), and 1.3 (27%). Fish in age groups 1.1 and 1.2 were exclusively male while those in age group 1.5 were predominantly female. Average lengths of females in age groups 1.3 and 1.4 were significantly larger ($P < .001$ for both age groups) than males in corresponding age groups.

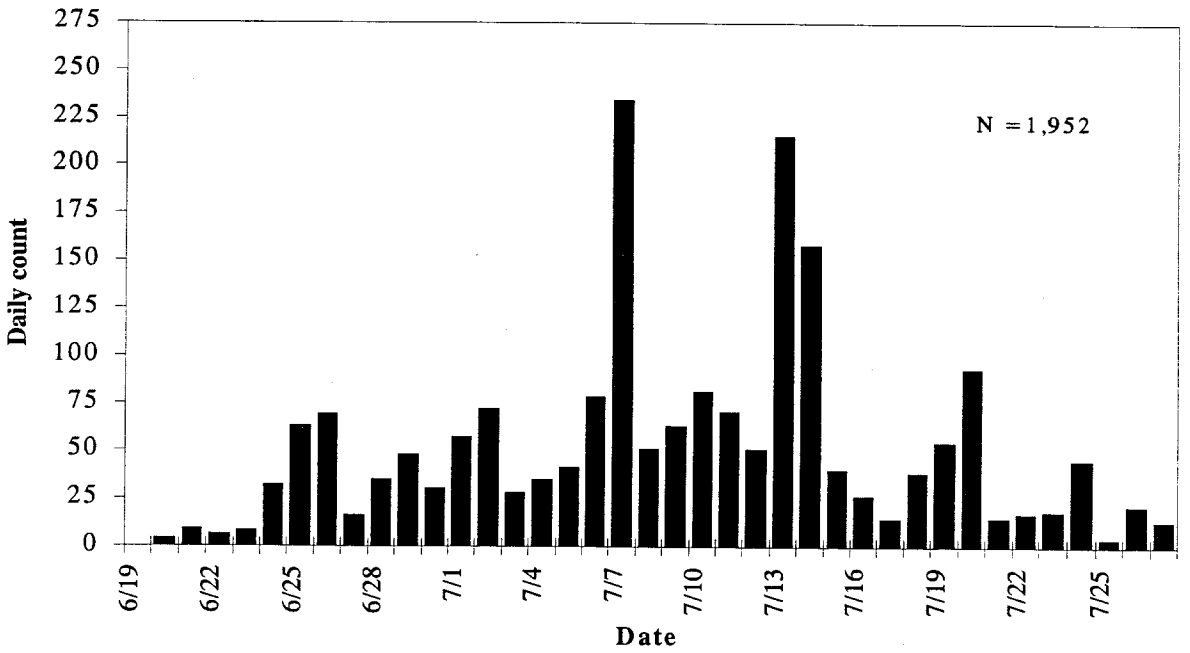


FIGURE 4.— Daily counts of chinook salmon passing through Gisasa River weir, 1996. Counts on 6/28 and 6/29 were expanded from partial counts, due to high water.

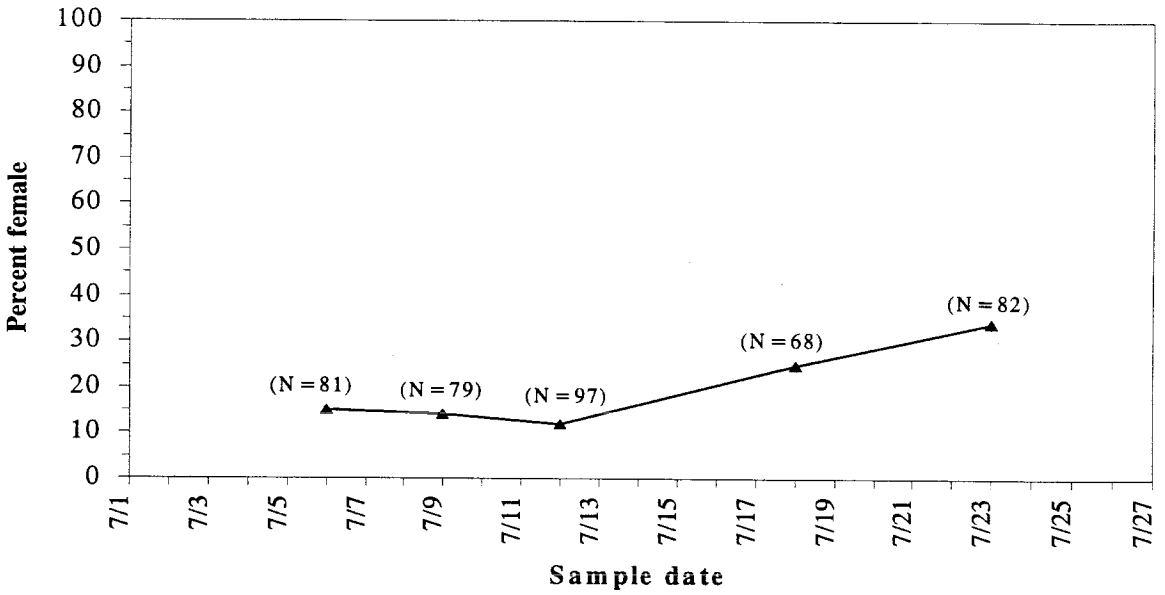


FIGURE 5.— Sex composition (percent female) of chinook salmon samples from the Gisasa River weir, 1996.

TABLE 2.— Age, length, and sex composition of chinook salmon sampled at Gisasa River weir, 1996.

	Males					Females				
			Mid-eye to fork length (mm)					Mid-eye to fork length (mm)		
Age	N	%	Range	Mean	SD	N	%	Range	Mean	SD
1.1	4	1.2	380 - 440	405	21.8	0	0.0	- -	-	-
1.2	61	18.0	414 - 592	508	44.1	0	0.0	- -	-	-
1.3	185	54.6	520 - 890	688	52.8	18	5.3	520 - 880	776	68.5
1.4	21	6.2	660 - 860	739	59.2	26	7.7	745 - 955	840	56.4
1.5	2	0.6	890 - 900	895	5.0	22	6.5	780 - 1010	886	51.4
Total	273	80.5	380 - 900	650	97.1	66	19.5	520 - 1010	829	76.7

Weir Operation

Operation of the weir began on June 19 and continued through July 27, 1996. Spawning activity immediately upstream of the weir resulted in areas where gravel accumulated on the weir panels. High water and heavy debris flows submerged several panels and interrupted counting for approximately 33 hours during June 28 and 29. The weir sustained only minor damage. Recorded water temperatures ranged from 8° C to 17° C and averaged 13° C (Appendix 4). The low of 8° occurred immediately after a high water event caused by several days of rain. The temperature quickly returned to near average as the water receded. Water depth at the trap averaged 48 cm and ranged from 36 to ≈130 cm. The high reading occurred during a highwater event, after several days of rain. During this event the water level exceeded the gauge and water depth was measured from the water level on the trap. With the exception of this high water event gauge readings ranged from 36 to 54 cm.

Discussion

Biological Data

Run timing of chum salmon during 1996 was slightly earlier than 1994 or 1995 (Figure 6). Peak migration for 1996 occurred on July 6, while peaks for 1994 and 1995 occurred on July 15 and July 11, respectively. However, during 1994 counts were incomplete due to delayed weir installation (Melegari and Wiswar 1995). Mean migration day, the day when 50% of the total count passed the weir, was July 4 during 1996 and July 9 during 1995.

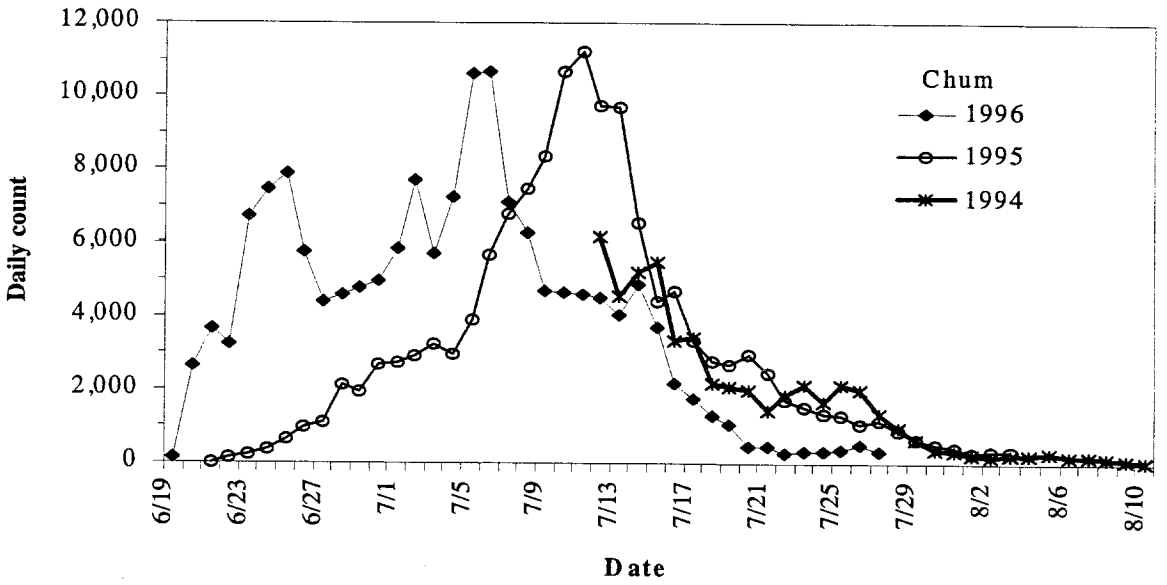


FIGURE 6.— Daily counts of chum salmon at the Gisasa River weir from 1994 to 1996. Counts for 6/28/96 and 6/29/96 are interpolated due to high water, which interrupted counting.

The 1996 weir count of chum salmon (N=157,589) was higher than 1994 or 1995 weir counts, and considerably higher than any recent aerial surveys (Table 3). ADF&G did not conduct an aerial survey during 1996. However, during 1995 the total weir count was 21.2 times greater than the corresponding aerial survey count. During 1994 the total weir count was 7.5 times greater than the corresponding aerial survey count. However, as stated, the weir count for 1994 was incomplete.

The average length of female chum salmon was significantly less than males. McBride et al. (1983) reported average lengths, from carcass samples of chum salmon on the Gisasa River, of 605 mm (N=9) for males and 540 mm (N=22) for females. Length differences between sexes of summer chum salmon have been noted on other tributaries in the Yukon River drainage (Table 4).

Run timing of chinook salmon during 1996 appeared similar to 1994 and 1995 (Figure 7); however, the total count was lower than either year. The 1996 weir count for chinook salmon was 1,952 while counts from 1994 and 1995 were 2,888 and 4,023, respectively (Table 3). The daily chinook count exceeded 100 on only three days during 1996. During 1995 the daily count exceeded 100 on 12 days and 200 on 7 days. Two peaks occurred in daily counts during 1996, one on July 7 (N=234) and one July 13 (N=215). During 1995 the peak occurred on July 13. Mean migration day was July 9 during 1996 and July 12 during 1995. As mentioned above, no aerial survey was conducted on the Gisasa River during 1996. However, during 1995 the total weir count was 9.5 times greater than the aerial survey count.

TABLE 3.— Aerial survey and weir counts from the Gisasa River, 1976-1996. (Schultz et al. 1993; Bergstrom et al. 1996).

	Chum		Chinook	
Year	Weir	Aerial	Weir	Aerial
1976		21,342		332
1977		[a] 2,204		255
1978		[a] 9,280		[a] 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		[a] 884
1991		7,003		1,690
1992		9,300		910
1993		1,581		1,573
1994	[b] 51,116	6,827	[b] 2,888	2,775
1995	136,886	6,458	4,023	410
1996	157,589	—	1,952	—

[a] Inaccurate counts due to incomplete surveys or poor survey timing or conditions

[b] Weir counts for 1994 were incomplete

TABLE 4.— Average lengths, by sex, of summer chum salmon from selected Yukon River tributaries.

		Average length (mm)		
Location	Year	Male	Female	Source
Andreafsky River	1982	581	534	McBride et al. 1983
Andreafsky River	1994	557	516	Tobin and Harper 1995
Anvik River	1982	592	545	McBride et al. 1983
Chena River	1982	579	555	McBride et al. 1983
Clear Creek	1995	582	549	[a] TCC data files
Gisasa River	1995	573	542	Melegari 1996

[a] Tanana Chiefs Conference Inc. preliminary data from 1995 counting tower operation.

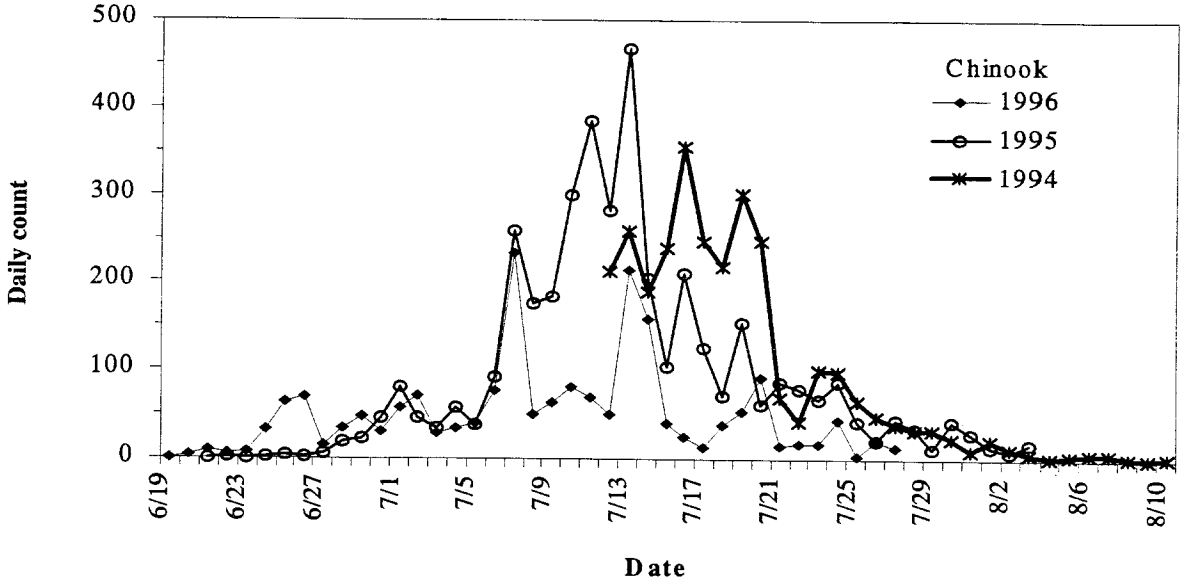


FIGURE 7.— Daily counts of chinook salmon at the Gisasa River weir from 1994 to 1996. Counts on 6/28/96 and 6/29/96 were expanded from partial counts, due to high water.

Average length of female chinook salmon was significantly larger than males. McBride et al. (1983) reported average lengths of chinook salmon from Gisasa River escapement samples of 657 mm (N=21) for males and 830 mm (N=11) for females. Length differences between sexes of chinook salmon have been noted on other tributaries in the Yukon River (Table 5). Average lengths of chinook salmon sampled from the Gisasa River during 1996 were smaller than from 1995 (Table 5, Figure 8). Additionally, there was a scarcity of larger females present in the 1996 samples (Figure 8).

TABLE 5.— Average lengths, by sex, of chinook salmon from selected Yukon River tributaries.

Location	Year	Average length (mm)		Source
		Male	Female	
Andreafsky River	1982	643	741	McBride et al. 1983
Andreafsky River	1994	707	823	Tobin and Harper 1995
Anvik River	1982	631	829	McBride et al. 1983
Chena River	1990	693	862	Evenson 1990
Gisasa River	1995	717	852	Melegari 1996
Gisasa River	1996	650	829	

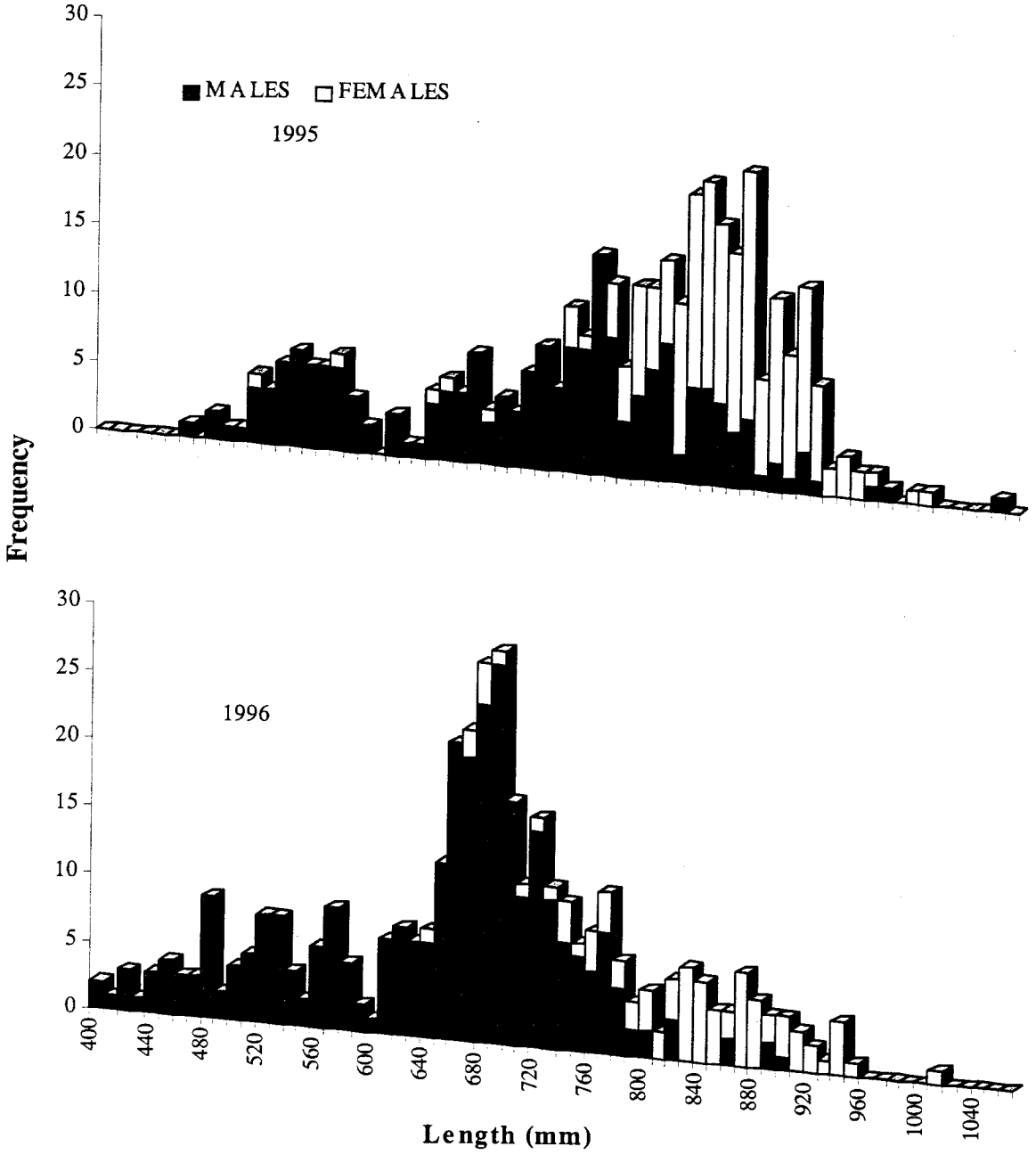


FIGURE 8.— Comparison of length frequencies of chinook salmon samples collected at Gisasa River weir during 1995 and 1996.

Weir Operation

The use of resistance board weirs in Alaska is relatively new (Tobin 1994). Resistance board weirs are less likely to be damaged or washed-out by high flows and debris than conventional rigid weir designs. When compared with sonar enumeration, resistance board weirs provide more accurate identification of species, eliminate the need for test fisheries, do not require expensive electronics equipment, and require less time interpreting data after field work is completed.

Aerial surveys are less costly than sonar or weirs. However, the data provided are highly variable and are of limited use. Weir counts at the Gisasa River have been as much as 21 times greater than aerial survey counts. Daum et al. (1992) reported expansion factors for aerial surveys to sonar counts of fall chum salmon that ranged from 2.70 to 6.17 on the Chandalar River from 1988 to 1990. Aerial survey conditions for all three years were rated fair to good. Additionally, population estimates from mark and recovery studies of chinook salmon from 1986 to 1990 on the Chena River were 1.7 to 4.9 times greater than the corresponding aerial surveys (Schultz et al. 1993). Much of the variability of aerial surveys is due to uncontrollable factors such as weather, variable run timing, and changing river conditions. Comparatively, the effects of these factors on the performance of a resistance board weir are minimal.

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. However, smaller pink salmon and resident species may have passed through the weir undetected. High water levels can temporarily submerge weir panels (Booth 1993; Tobin 1994), resulting in the need to estimate escapement over the submerged panels. High water during July 28 and July 29 submerged the panels, interrupting counting for approximately 33 hours. Minor damage (a few broken pickets) resulted from an increased debris load during the high water. Most of these breaks occurred at the downstream end of the panels and had a negligible effect on weir performance. No indications of weakened structural integrity or washout of gravel under the substrate rail were evident. However, a minimal amount of erosion did occur along the stream banks at the ends of the weir. When the water receded minor repairs to the rigid weir sections along the banks and cleaning of the weir was all that was necessary to return to fully operational condition.

Acknowledgments

Special thanks is extended to everyone who assisted with this project. Valuable logistics support, including air support, storage space, boat fuel and more, was provided by the staff of Koyukuk / Nowitna National Wildlife Refuge. Randy Brown, Kristina Evans, William Morris, Sandy Murley, and William Pilot, assisted with installation and/or operation of the weir. ADF&G Division of Commercial Fisheries Management and Development processed the scale samples. Betsy Sturm provided the map figure.

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APPENDIX 1.— Daily, cumulative, and total counts of fish passing the Gisasa River weir, 1996.

Date	Chum salmon		Chinook salmon		Pink salmon		Sockeye salmon		Longnose sucker		Northern pike		Arctic grayling		Whitefish spp.		Burbot	
	Daily	Cum.	Daily	Cum.	Daily	Cum	Daily	Cum.	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum.	Daily	Cum.
6/19	160	160	0	0	0	0	0	0	7	7	1	1	1	1	0	0	0	0
6/20	2620	2,780	4	4	0	0	0	0	0	7	0	1	4	5	0	0	0	0
6/21	3679	6,459	9	13	0	0	0	0	7	14	0	1	7	12	5	5	0	0
6/22	3234	9,693	6	19	0	0	0	0	3	17	0	1	3	15	0	5	0	0
6/23	6736	16,429	8	27	0	0	0	0	12	29	0	1	4	19	1	6	0	0
6/24	7461	23,890	32	59	0	0	0	0	4	33	1	2	8	27	0	6	0	0
6/25	7855	31,745	63	122	0	0	0	0	7	40	2	4	3	30	0	6	0	0
6/26	5744	37,489	69	191	0	0	0	0	6	46	0	4	0	30	0	6	0	0
6/27	4422	41,911	16	207	0	0	0	0	9	55	1	5	2	32	3	9	0	0
6/28	4594	46,505	35	242	0	0	0	0	0	55	0	5	0	32	0	9	0	0
6/29	4767	51,272	48	290	0	0	0	0	4	59	0	5	1	33	0	9	0	0
6/30	4939	56,211	30	320	0	0	0	0	6	65	0	5	2	35	0	9	0	0
7/1	5849	62,060	57	377	0	0	0	0	5	70	0	5	0	35	4	13	2	2
7/2	7692	69,752	72	449	0	0	0	0	6	76	1	6	9	44	1	14	1	3
7/3	5703	75,455	28	477	0	0	0	0	14	90	0	6	3	47	1	15	0	3
7/4	7250	82,705	35	512	0	0	0	0	1	91	0	6	4	51	1	16	0	3
7/5	10615	93,320	41	553	2	2	0	0	9	100	1	7	5	56	1	17	0	3
7/6	10640	103,960	78	631	0	2	0	0	5	105	0	7	0	56	0	17	0	3
7/7	7103	111,063	234	865	1	3	0	0	7	112	3	10	2	58	1	18	0	3
7/8	6241	117,304	51	916	2	5	0	0	5	117	1	11	0	58	1	19	0	3
7/9	4698	122,002	63	979	0	5	0	0	2	119	2	13	0	58	0	19	0	3
7/10	4612	126,614	81	1,060	1	6	0	0	2	121	2	15	1	59	0	19	0	3
7/11	4571	131,185	70	1,130	0	6	0	0	4	125	2	17	2	61	0	19	0	3
7/12	4511	135,696	51	1,181	4	10	0	0	1	126	1	18	0	61	1	20	0	3
7/13	4045	139,741	215	1,396	2	12	0	0	1	127	2	20	3	64	0	20	0	3
7/14	4868	144,609	158	1,554	4	16	0	0	0	127	2	22	1	65	1	21	0	3
7/15	3691	148,300	40	1,594	2	18	0	0	0	127	3	25	1	66	1	22	0	3
7/16	2160	150,460	26	1,620	2	20	0	0	0	127	1	26	3	69	0	22	0	3
7/17	1750	152,210	14	1,634	4	24	0	0	1	128	0	26	0	69	1	23	0	3
7/18	1282	153,492	38	1,672	2	26	0	0	3	131	0	26	0	69	1	24	0	3
7/19	1081	154,573	54	1,726	6	32	0	0	0	131	0	26	0	69	0	24	0	3
7/20	456	155,029	93	1,819	3	35	0	0	1	132	0	26	0	69	0	24	0	3
7/21	465	155,494	15	1,834	0	35	0	0	0	132	1	27	0	69	0	24	0	3
7/22	265	155,759	17	1,851	0	35	0	0	0	132	1	28	0	69	0	24	0	3
7/23	334	156,093	18	1,869	1	36	0	0	0	132	0	28	1	70	0	24	0	3
7/24	320	156,413	45	1,914	0	36	0	0	0	132	0	28	0	70	0	24	0	3
7/25	348	156,761	4	1,918	2	38	0	0	0	132	0	28	1	71	1	25	0	3
7/26	492	157,253	21	1,939	2	40	0	0	0	132	0	28	0	71	0	25	0	3
7/27	336	157,589	13	1,952	3	43	1	1	0	132	0	28	0	71	0	25	0	3
Total	157,589		1,952		43		1		132		28		71		25		3	

APPENDIX 2.— Age and sex composition of weekly samples of chum salmon from Gisasa River weir, 1996 (table from Alaska Department of Fish and Game, Commercial Fisheries Management and Development division).

		Brood Year and Age Group				
		1992	1991	1990	1989	
		0.3	0.4	0.5	0.6	Total
Stratum Dates:	6/22 - 6/23			Stratum 1		
Sampling Dates:	6/22 - 6/23					
Female	Sample Size	11	25	14	0	50
	Percent of Sample	7.1	16.0	9.0	0.0	32.1
Male	Sample Size	21	66	18	1	106
	Percent of Sample	13.5	42.3	11.5	0.6	67.9
Total	Sample Size	32	91	32	1	156
	Percent of Sample	20.5	58.3	20.5	0.6	100.0
	Standard Error	3.2	4.0	3.2	0.6	
Stratum Dates:	6/29 - 7/01			Stratum 2		
Sampling Dates:	6/29 - 7/01					
Female	Sample Size	19	37	5	0	61
	Percent of Sample	11.9	23.3	3.1	0.0	38.4
Male	Sample Size	32	57	9	0	98
	Percent of Sample	20.1	35.8	5.7	0.0	61.6
Total	Sample Size	51	94	14	0	159
	Percent of Sample	32.1	59.1	8.8	0.0	100.0
	Standard Error	3.7	3.9	2.3	0.0	
Stratum Dates:	7/06 - 7/07			Stratum 3		
Sampling Dates:	7/06 - 7/07					
Female	Sample Size	41	27	3	0	71
	Percent of Sample	28.7	18.9	2.1	0.0	49.7
Male	Sample Size	30	38	4	0	72
	Percent of Sample	21.0	26.6	2.8	0.0	50.3
Total	Sample Size	71	65	7	0	143
	Percent of Sample	49.7	45.5	4.9	0.0	100.0
	Standard Error	4.2	4.2	1.8	0.0	

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APPENDIX 2.— (Continued).

		Brood Year and Age Group 1992	1991	1990	1989	
		0.3	0.4	0.5	0.6	Total
Stratum Dates:	7/13 - 7/14			Stratum 4		
Sampling Dates:	7/13 - 7/14					
Female	Sample Size	42	34	0	0	76
	Percent of Sample	28.0	22.7	0.0	0.0	50.7
Male	Sample Size	31	42	1	0	74
	Percent of Sample	20.7	28.0	0.7	0.0	49.3
Total	Sample Size	73	76	1	0	150
	Percent of Sample	48.7	50.7	0.7	0.0	100.0
	Standard Error	4.1	4.1	0.7	0.0	
Stratum Dates:	7/24 - 8/01			Stratum 5		
Sampling Dates:	7/24, 8/01					
Female	Sample Size	79	38	2	0	119
	Percent of Sample	50.3	24.2	1.3	0.0	75.8
Male	Sample Size	22	16	0	0	38
	Percent of Sample	14.0	10.2	0.0	0.0	24.2
Total	Sample Size	101	54	2	0	157
	Percent of Sample	64.3	34.4	1.3	0.0	100.0
	Standard Error	3.8	3.8	0.9	0.0	
Stratum Dates:	6/22 - 7/22			Total All Strata		
Sampling Dates:						
Female	Sample Size	192	161	24	0	377
	Percent of Sample	25.1	21.0	3.1	0.0	49.3
Male	Sample Size	136	219	32	1	388
	Percent of Sample	17.8	28.6	4.2	0.1	50.7
Total	Sample Size	328	380	56	1	765
	Percent of Sample	42.9	49.7	7.3	0.1	100.0
	Standard Error	1.8	1.8	0.9	0.1	

APPENDIX 3.— Age and sex composition of samples of chinook salmon from Gisasa River weir, 1996 (table from Alaska Department of Fish and Game, Commercial Fisheries Management and Development division).

		Brood Year and Age Group					
		1993	1992	1991	1990	1989	
		1.1	1.2	1.3	1.4	1.5	Total
Stratum Dates:	7/03 - 7/06				Stratum 1		
Sampling Dates:	7/03 - 7/06						
Female	Sample Size	0	0	1	4	1	6
	Percent of Sample	0.0	0.0	1.5	6.1	1.5	9.1
Male	Sample Size	0	10	45	5	0	60
	Percent of Sample	0.0	15.2	68.2	7.6	0.0	90.9
Total	Sample Size	0	10	46	9	1	66
	Percent of Sample	0.0	15.2	69.7	13.6	1.5	100.0
	Standard Error	0.0	4.4	5.7	4.3	1.5	
Stratum Dates:	7/07 - 7/09				Stratum 2		
Sampling Dates:	7/07 - 7/09						
Female	Sample Size	0	0	3	4	2	9
	Percent of Sample	0.0	0.0	4.4	5.9	2.9	13.2
Male	Sample Size	1	19	36	3	0	59
	Percent of Sample	1.5	27.9	52.9	4.4	0.0	86.8
Total	Sample Size	1	19	39	7	2	68
	Percent of Sample	1.5	27.9	57.4	10.3	2.9	100.0
	Standard Error	1.5	5.5	6.0	3.7	2.1	
Stratum Dates:	7/10 - 7/12				Stratum 3		
Sampling Dates:	7/10 - 7/12						
Female	Sample Size	0	0	3	4	4	11
	Percent of Sample	0.0	0.0	3.6	4.8	4.8	13.3
Male	Sample Size	0	21	44	6	1	72
	Percent of Sample	0.0	25.3	53.0	7.2	1.2	86.7
Total	Sample Size	0	21	47	10	5	83
	Percent of Sample	0.0	25.3	56.6	12.0	6.0	100.0
	Standard Error	0.0	4.8	5.5	3.6	2.6	

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APPENDIX 3.— (Continued).

		Brood Year and Age Group					
		1993	1992	1991	1990	1989	
		1.1	1.2	1.3	1.4	1.5	Total
Stratum Dates:	7/15 - 7/18				Stratum 4		
Sampling Dates:	7/15 - 7/18						
Female	Sample Size	0	0	3	6	5	14
	Percent of Sample	0.0	0.0	5.7	11.3	9.4	26.4
Male	Sample Size	1	7	28	3	0	39
	Percent of Sample	1.9	13.2	52.8	5.7	0.0	73.6
Total	Sample Size	1	7	31	9	5	53
	Percent of Sample	1.9	13.2	58.5	17.0	9.4	100.0
	Standard Error	1.9	4.7	6.8	5.2	4.1	
Stratum Dates:	7/19 - 7/23				Stratum 5		
Sampling Dates:	7/19 - 7/23						
Female	Sample Size	0	0	8	8	10	26
	Percent of Sample	0.0	0.0	11.6	11.6	14.5	37.7
Male	Sample Size	2	4	32	4	1	43
	Percent of Sample	2.9	5.8	46.4	5.8	1.4	62.3
Total	Sample Size	2	4	40	12	11	69
	Percent of Sample	2.9	5.8	58.0	17.4	15.9	100.0
	Standard Error	2.0	2.8	6.0	4.6	4.4	
Stratum Dates:	7/03 - 7/23				Total All Strata		
Sampling Dates:							
Female	Sample Size	0	0	18	26	22	66
	Percent of Sample	0.0	0.0	5.3	7.7	6.5	19.5
Male	Sample Size	4	61	185	21	2	273
	Percent of Sample	1.2	18.0	54.6	6.2	0.6	80.5
Total	Sample Size	4	61	203	47	24	339
	Percent of Sample	1.2	18.0	59.9	13.9	7.1	100.0
	Standard Error	0.6	2.1	2.7	1.9	1.4	

APPENDIX 4.— Water temperature (°C) and water depth (cm) at Gisasa River weir, 1996. During 6/28 water level exceeded the gauge, and was measured from the height of the water on the trap.