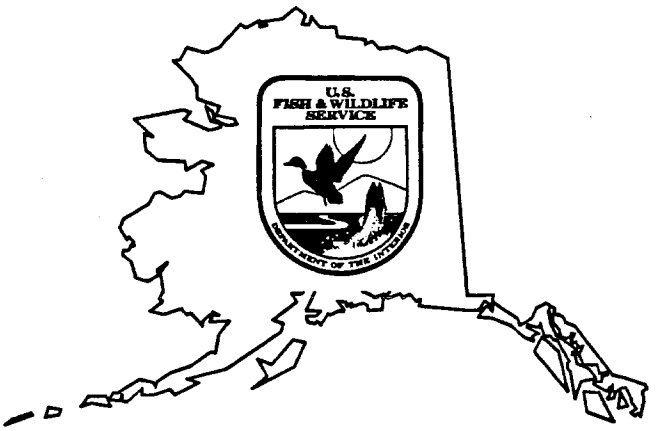
Alaska Fisheries Data Series Number 2001-1

Abundance and Run Timing of Adult Salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2000

David W. Wiswar



United States Department of the Interior
Fish and Wildlife Service
Region 7
Fishery Resources

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Abstract. — From June 28 to August 7, 2000 a resistance board weir was operated on the Gisasa River, a tributary to the Koyukuk River in west-central Alaska. This was the seventh year of operating the weir at this site. A total of 2,089 chinook salmon *Oncorhynchus tshawytscha* and 11,410 summer chum salmon *O. keta* passed through the weir. The most abundant resident species was the longnose sucker *Catostomus catostomus* (N=43). Chinook salmon escapement was low but fell within the range of weir counts from 1994 to1999. Between July 14 and 22, 61% of the chinook salmon passed through the weir. Females made up 30% of the chinook salmon. The chinook salmon sex ratio has ranged from 17 to 42% female since the project began in 1994. Age groups 1.3 and 1.4 accounted for 52 and 38% of the run, respectively. Chum salmon escapement was only 16% of the average weir counts from previous years. The sex ratio of the chum salmon sampled was about even. Age 0.4 chum salmon made up 62% of the run.

Chinook *Oncorhynchus tshawytscha* and summer chum salmon *O. keta* spawning in the Gisasa River contribute to the subsistence and commercial fisheries occurring in the Yukon drainage. The chinook and summer chum salmon runs enter the Yukon River in early June and continue through mid-July. Chinook salmon spawn throughout the Yukon drainage, whereas summer chum spawning distribution is in the lower and middle reaches (Minard 1996). Recent declines of Yukon River salmon stocks, particularly summer chum salmon (Schultz et al. 1993; Kruse 1998), have led to harvest restrictions, complete fishery closures, and spawning escapements below management goals. The year 2000 escapement was the third consecutive year of poor returns for chinook salmon and the fourth year for summer chum salmon. For chum salmon, the declining returns in 1998-2000 followed three years of high escapement parent stocks from 1994 through 1996. In the mixed-stock fishery of the Yukon River, overfishing of some salmon

stocks may have contributed to their 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 run strength.

The Koyukuk National Wildlife Refuge (Refuge) is located near the villages of Nulato, Koyukuk, Galena, Huslia, and Hughes. The residents of these villages depend on the Refuge's fishery resources for subsistence. Continued subsistence use by rural residents of fish and wildlife resources within National Wildlife Refuges and the conservation of those resources are 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 in the Gisasa River in 1994, the first year of a multi-year escapement study, which has continued through 2000. 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; and (4) determine presence and movement of resident fish in the Gisasa River. No aerial survey was conducted in 2000; therefore, objective (3) is not addressed in this report.

Salmon escapement at the Gisasa River weir between 1994 and 1999 has ranged from about 2,000 to 4,000 chinook and 9,900 to 158,000 chum salmon (Melegari and Wiswar 1995; Melegari 1996, 1997; Wiswar 199o, 1999, 2000). Other historical data on salmon abundance in the Gisasa River are limited to aerial surveys conducted between 1969 and 1998 (Barton 1984; unpublished data, Alaska Department of Fish and Game [ADF&G]; Appendix 1).

Study Area

The Gisasa River is a tributary of the Koyukuk River in west-central Alaska (Figure 1). The 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° 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 usually 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 between the stream banks and average maximum depth is approximately 0.5 m. Substrate at the weir site consists primarily of medium-sized gravel.

Methods

Weir Operation

Construction and installation of the weir is described by Tobin (1994). 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. 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 had 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.

Biological Data

All fish passing through the weir were counted and identified to species except whitefish *Coregonus* and *Prosopium* spp. which were grouped under the subfamily Coregoninea. 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.

Length and sex ratio were determined from a weekly target sample of 160 chinook and chum salmon. Samples were generally taken over a four day period beginning on Monday of each week and consisted of the first 40 fish passing through the weir. Lengths from chinook and chum salmon were measured to the nearest 5 mm from the mid-eye to fork of the caudal fin (MEL). Three scales were collected from chinook salmon and one scale from chum 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. 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. All ages are reported using the European method (Foerster 1968).

Data were treated as a stratified random sample (Cochran 1977); statistical weeks were defined as strata. Within a week, the proportion of the sample composed 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 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 of sex/age composition for the run will be calculated as

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

Results

Weir Operation

Operation of the weir began on June 28 and continued through August 7, 2000. Spawning activity immediately upstream of the weir resulted in areas where gravel accumulated on the weir panels.

Water Temperature

Water temperatures ranged from 8° to 14°C and averaged 11.1°C. The high temperature was recorded between July 8 and 13; the low temperature was on July 28, 29, and August 6.

Biological Data

Chum salmon (N=11,410) were the most abundant salmon species counted through the weir, followed by chinook salmon (N=2,089) (Appendix 2). Sockeye *O. nerka* (N=4) and pink salmon *O. gorbuscha* (N=4) were also counted at the weir. Four resident species were counted and the most abundant was longnose sucker *Catostomus catostomus* (N=43).

Chinook salmon.—The first chinook salmon was observed at the weir on July 6 (Appendix 2). About 61% of the chinook passed through the weir between July 14 and 24 (Figure 2). During this time, there were five days when daily counts exceeded 100 fish/d. The median migration day, the day when 50% of the total count had passed the weir, was July 18. The sex ratio for the run was 30% female with weekly ratios (discounting the last sample period as it was only one day) ranging from 15% early in the run to 55% during the latter part (Table 1). Male chinook salmon ranged from 405 to 910 mm MEL (Table 2 and Appendix 3). Females ranged from 595 to 960 mm MEL. The chinook salmon run was composed of four age groups (Table 3). Age groups 1.3 and 1.4 made up 91% of the run.

Chum salmon.—Chum salmon were first counted on June 28 (Appendix 2). There was no strong peak period of abundance as observed in most previous years (Figure 2). Escapement counts between July 12 and 19 ranged between 500 and 1,000 fish/d and accounted for 44% of the run. The median migration day was July 16. The sex ratio for the run was even with weekly ratios ranging from 41% early in the run to 60% during the last full week escapement was monitored (Table 4). Male chums ranged from 490 to 680 mm MEL (Table 5 and Appendix 4). Females ranged in length from 430 to 655 mm MEL. Five-year-old chum salmon made up 62% of the run (Table 6).

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.

Biological Data

Chinook salmon escapement in 2000 for the Gisasa River was among the lowest

recorded and follows the overall trend of poor returns during the past three years for the Yukon River drainage. Ocean conditions that are suspected to have contributed to the run failures of chinook and chum salmon in 1997-1999 (Kruse 1998) were expected to prevail and affect the run in 2000.

The chinook salmon sex ratio in the Gisasa River has ranged from 17 to 42% female. These ratios are similar to those observed at the weir on the Andreafsky River (Tobin and Harper 1999). Although the reason for the low female sex ratio is unclear, selective harvest for larger fish due to mesh size has been thought to be a factor. However, this year the commercial harvest in the lower Yukon River was greatly reduced through harvest restrictions, which may preclude it as a contributor to these skewed ratios. Low female sex ratios should be taken into account when assessing escapement in spawning tributaries and future preseason forecasts for run strength.

Six-year-old fish generally make up the majority of returning chinook salmon in the Yukon River (Brady 1983). In 2000, six-year-old fish (1994 brood year) in the Gisasa River accounted for 38% of the run and five-year-old chinook predominated (52%). This age composition was similar to that reported at the Andreafsky weir (Harper and Zabkar, in preparation). Escapement in the Anvik River was more consistent with the general trend in age composition with 53% six-year-old chinook (ADF&G, unpublished data). Six-year-old chinook salmon were from the 1994 brood year. Escapement in the spawning tributaries from that year were described as being above average in magnitude (ADF&G 2000).

The summer chum salmon run in 2000 for the Yukon River drainage was poor for the fourth consecutive year; this, notwithstanding the above-average escapements from 1994 through 1996, which would return 4- and 5-year-old fish. The reasons for the poor returns are the same as those offered for chinook salmon (Kruse 1998), in addition to low snowfall during the winter of 1995-96. The summer chum salmon run in 2004, which will reflect this year's escapement of 4-year-old fish, will probably be very low.

Acknowledgments

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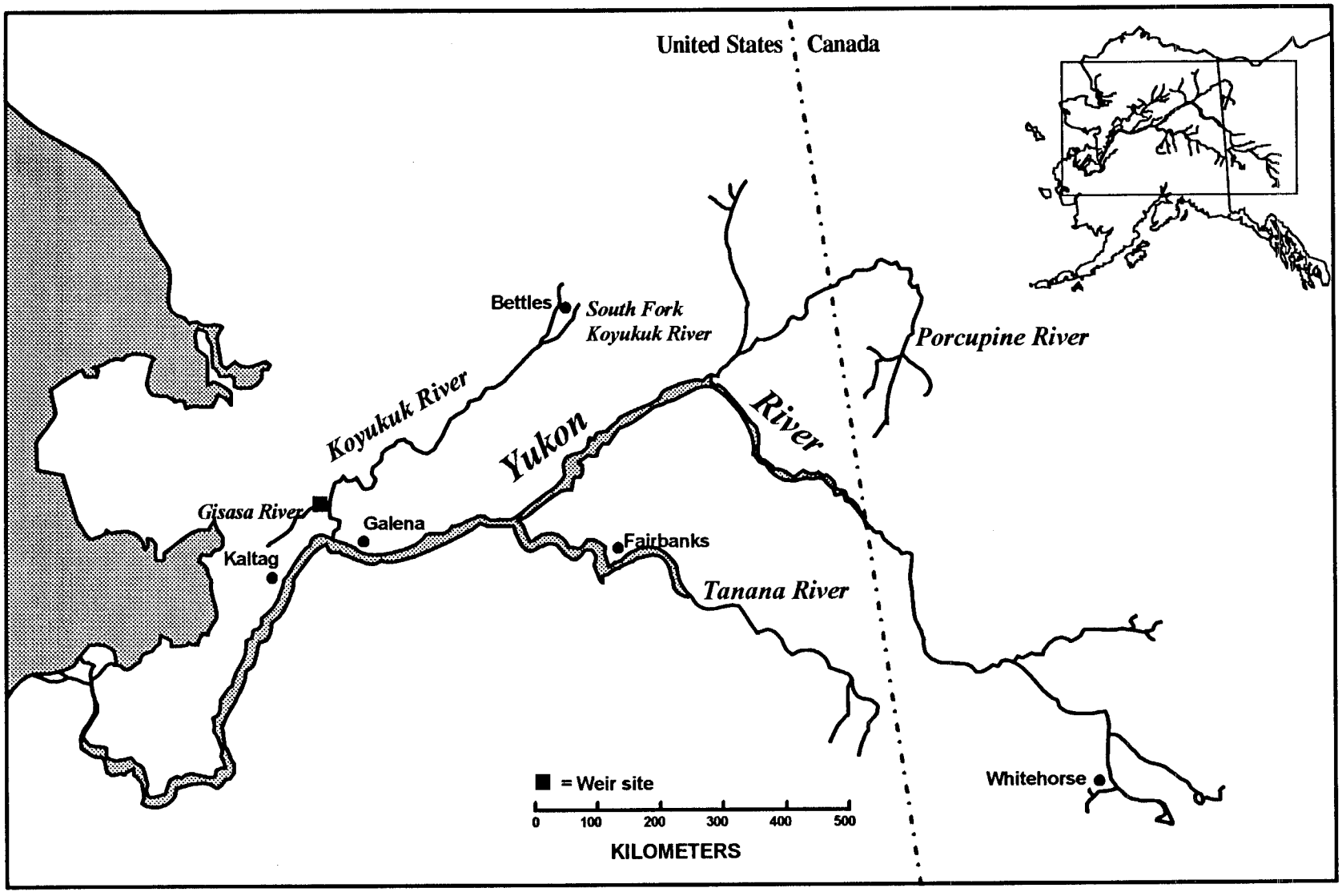
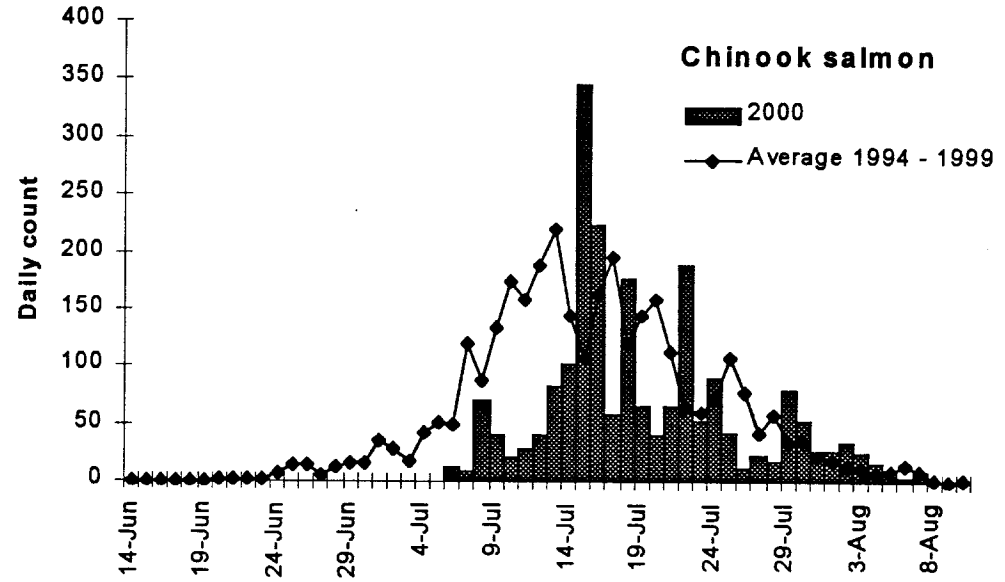


FIGURE 1.— Location of Gisasa River weir.



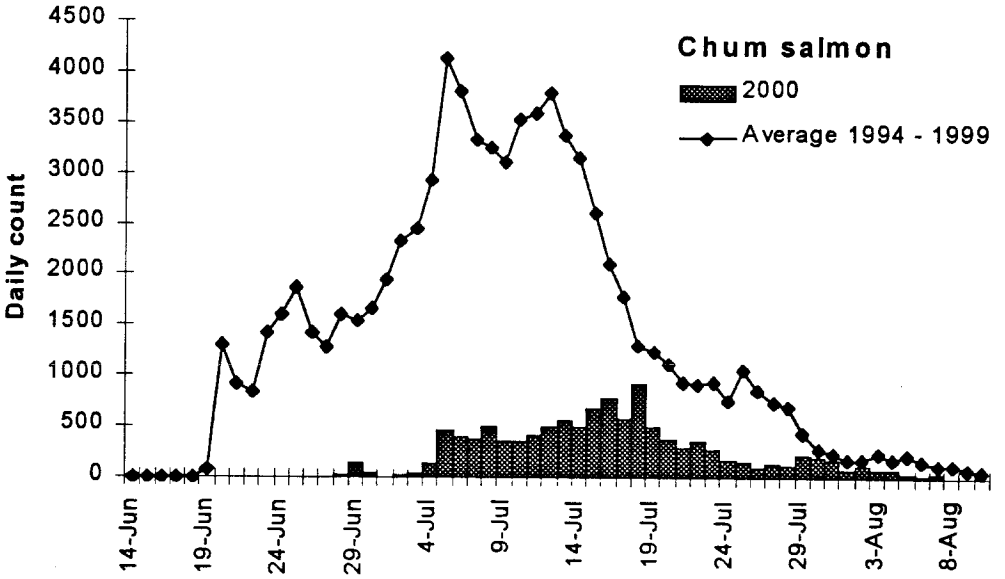


FIGURE 2.—Daily counts of chinook and chum salmon at the Gisasa River weir, 2000, with average daily counts from 1994 through 1999.

TABLE 1.—Sex ratio of chinook salmon sampled at the Gisasa River weir, Alaska, 2000. SEs are in parentheses.

Time period	Total number of chinook passing through the weir	N	Percent female	Estimated number of females
June 28- July 2	0	0	0	0
July 3-9	131	89	16 (3.2)	21
July 10-16	842	168	15 (1.2)	125
July 17-23	650	342	42 (1.9)	274
July 24-30	316	201	43 (2.8)	137
July 31-August 6	141	138	55 (4.2)	78
August 7	9	8	0	0
Run total	2,089	946	30 (1.0)	634

TABLE 2.—Lengths of chinook salmon sampled at the Gisasa River weir, Alaska, 2000.

	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 28- July 2	0				0			
July 6-9	75	727.5	6.4	640-880	14	810.0	16.5	670-895
July 10-16	142	697.3	7.1	430-910	25	811.2	13.3	625-945
July 17-23	106	700.6	8.7	430-880	71	822.9	7.3	595-945
July 24-30	96	683.9	9.7	405-880	64	816.5	6.3	675-925
July 31-August 6	58	699.2	14.6	415-910	70	814.4	6.8	700-960
August 7	8	581.9	46.1	410-815	0			

TABLE 3.—Percent weekly age estimates of chinook salmon passing through the Gisasa River weir, 2000. SEs are in parentheses.

			Brood year and age			
			1993	1994	1995	1996
Time period	Run	N	1.5	1.4	1.3	1.2
June 28- July 2	0	0	0	0	0	0
July 3-9	131	55	0	49 (6.8)	51 (6.8)	0
July 10-16	842	155	2 (1.1)	32 (3.8)	59 (4.0)	7 (2.0)
July 17-23	650	152	3 (1.5)	42 (4.0)	46 (4.1)	9 (2.3)
July 24-30	316	149	2 (1.4)	40 (4.0)	50 (4.1)	8 (2.2)
July 31-August 6	141	115	3 (1.5)	44 (4.6)	50 (4.7)	4 (1.9)
August 7	9	8	0	13 (12.5)	25 (16.4)	63 (18.3)
Total	2,089	634	2 (1.2)	38 (4.3)	52 (4.4)	7 (2.4)

TABLE 4.—Sex ratio of chum salmon sampled at the Gisasa River weir, Alaska, 2000.

Time period	Total number of chum passing through the weir	N	Percent female (SE)	Estimated number of females
June 28- July 2	225	124	41 (3.3)	93
July 3-9	2,290	160	41 (1.0)	930
July 10-16	3,781	527	51 (0.8)	1,930
July 17-23	3,371	549	52 (0.9)	1,738
July 24-30	1,101	419	57 (1.5)	625
July 31-August 6	606	357	60 (2.0)	365
August 7	36	30	70 (7.8)	25
Run total	11,410	2,166	50 (0.5)	5,706

TABLE 5.—Lengths of chum salmon sampled at the Gisasa River weir, Alaska, 2000.

	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 28- July 2	73	610.0	3.3	560-680	51	579.1	3.6	520-655
July 3-9	95	601.5	2.8	550-665	65	576.4	2.6	545-625
July 10-16	87	592.6	3.1	530-665	73	564.2	3.3	500-640
July 17-23	81	569.4	3.2	510-675	79	544.4	2.3	510-610
July 24-30	72	573.1	3.5	510-680	86	544.8	2.1	505-605
July 31-August 6	68	564.6	3.3	490-635	92	540.0	2.7	430-630
August 7	9	572.2	15.8	515-665	21	530.5	5.0	490-580

TABLE 6.— Percent weekly age estimates of chum salmon passing through the Gisasa River weir, 2000. SEs are in parentheses.

			Brood year and age		
			1994	1995	1996
Time period	Run	N	0.5	0.4	0.3
June 28- July 2	225	112	7 (2.4)	89 (2.9)	4 (1.8)
July 3-9	2,290	143	3 (1.4)	85 (3.0)	12 (2.7)
July 10-16	3,781	139	2 (1.2)	73 (3.8)	25 (3.7)
July 17-23	3,371	175	1 (0.8)	43 (3.8)	55 (3.8)
July 24-30	1,101	103	7 (2.5)	40 (4.9)	53 (4.9)
July 31-August 6	606	135	2 (1.0)	42 (4.3)	56 (4.3)
August 7	36	26	4 (3.8)	27 (8.9)	69 (9.2)
Total	11,410	833	3 (1.4)	62 (3.8)	36 (3.7)

APPENDIX 1.— Salmon escapement counts from aerial counts in the Gisasa River, 1974-2000 (source: Barton 1984; Alaska Department of Fish and Game, unpublished data).

	Escapement counts	
Year	Chinook salmon	Chum salmon
1974	161	22,022
1975	385	56,904
1976	332	21,342
1977[a]	255	2,204
1978[a]	45	9,280
1979	484	10,962
1980	951	10,388
1981	—	—
1982[a]	421	334
1983[a]	572	2,356
1984	—	—
1985	735	13,232
1986	1,346	12,114
1987	731	2,123
1988	797	9,284
1989	—	—
1990[a]	884	450
1991	1,690	7,003
1992	910	9,300
1993	1,573	1,581
1994	2,775	6,827
1995	410	6,458
1996	—	—
1997[a]	144	686
1998	889	—
1999	—	—
2000	—	—

[a] Incomplete surveys due to poor survey conditions.

APPENDIX 2.— Daily and cumulative (chinook and chum salmon only) counts of fish passing through the Gisasa River weir, 2000. (Cum = cumulative).

	Chinook salmon		Summer chum salmon		Longnose sucker	Whitefish spp.	Arctic grayling	Northern pike	Sockeye salmon	Pink salmon
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily	Daily	Daily
28-Jun	0	0	27	27	0	0	1	0	0	0
29-Jun	0	0	146	173	0	0	0	0	0	0
30-Jun	0	0	35	208	0	0	0	0	0	0
1-Jul	0	0	6	214	1	0	0	1	0	0
2-Jul	0	0	11	225	0	0	0	0	0	0
3-Jul	0	0	33	258	0	0	0	0	0	0
4-Jul	0	0	140	398	1	1	0	0	0	0
5-Jul	0	0	462	860	0	0	0	1	0	0
6-Jul	13	13	410	1,270	6	0	0	0	0	0
7-Jul	8	21	386	1,656	11	0	0	0	0	0
8-Jul	70	91	493	2,149	4	0	0	0	0	0
9-Jul	40	131	366	2,515	2	0	0	0	0	0
10-Jul	21	152	352	2,867	3	0	0	0	0	0
11-Jul	28	180	414	3,281	10	0	0	0	0	0
12-Jul	40	220	500	3,781	2	0	0	1	0	0
13-Jul	82	302	559	4,340	0	0	0	0	0	0
14-Jul	103	405	500	4,840	1	0	0	0	0	0
15-Jul	345	750	678	5,518	0	1	0	0	0	0
16-Jul	223	973	778	6,296	1	0	0	0	0	0
17-Jul	59	1,032	579	6,875	0	0	0	0	0	0
18-Jul	177	1,209	931	7,806	0	0	0	0	0	0
19-Jul	66	1,275	512	8,318	1	0	0	0	0	0
20-Jul	41	1,316	390	8,708	0	0	0	0	0	0
21-Jul	66	1,382	298	9,006	0	0	0	0	0	0
22-Jul	188	1,570	370	9,376	0	0	0	0	0	0
23-Jul	53	1,623	291	9,667	0	0	0	0	0	0
24-Jul	89	1,712	173	9,840	0	0	0	0	0	1
25-Jul	42	1,754	154	9,994	0	0	0	0	0	1
26-Jul	13	1,767	100	10,094	0	0	1	1	0	0
27-Jul	23	1,790	141	10,235	0	0	0	0	0	1
28-Jul	18	1,808	112	10,347	0	0	0	0	0	0
29-Jul	79	1,887	215	10,562	0	0	0	0	0	0
30-Jul	52	1,939	206	10,768	0	0	0	1	1	0
31-Jul	27	1,966	171	10,939	0	0	0	0	0	1

APPENDIX 2.— Continued.

Date	Chinook salmon Daily	Chinook salmon Cum	Summer chum salmon Daily	Summer chum salmon Cum	Longnose sucker Daily	Whitefish spp. Daily	Arctic grayling Daily	Northern pike Daily	Sockeye salmon Daily	Pink salmon Daily
1-Aug	27	1,993	90	11,029	0	0	0	0	2	0
2-Aug	34	2,027	116	11,145	0	0	0	0	0	0
3-Aug	24	2,051	88	11,233	0	0	0	0	1	0
4-Aug	16	2,067	72	11,305	0	0	0	0	0	0
5-Aug	10	2,077	44	11,349	0	0	0	0	0	0
6-Aug	3	2,080	25	11,374	0	0	0	0	0	0
7-Aug	9	2,089	36	11,410	0	0	0	0	0	0
Total		2,089		11,410	43	2	2	5	4	4

APPENDIX 3.—Length at age of male and female chinook salmon sampled at the Gisasa River weir, Alaska, 2000.

	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	44	502.5	8.6	405-630	1	595		
1.3	286	699.1	3.3	550-880	52	779.3	5.6	675-870
1.4	105	773.2	6.5	460-910	158	825.4	3.9	670-935
1.5	1	790			13	906.5	11.3	840-960

APPENDIX 4.—Length at age of male and female chum salmon sampled at the Gisasa River weir, Alaska, 2000. Age estimates from scales.

	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	129	563.1	2.3	490-665	171	540.0	1.8	430-615
0.4	270	595.9	1.8	530-680	234	564.6	1.8	490-650
0.5	17	607.4	7.7	550-665	10	570.5	10.3	540-655