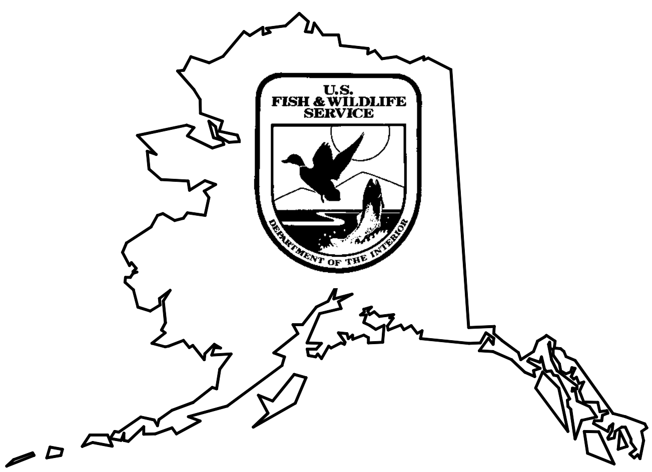
Alaska Fisheries Data Series Number 2002-5

Abundance and Run Timing of Adult Salmon in Three Tributaries of the Koyukuk River, Alaska, 2001

Gareth K. VanHatten



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United States Department of the Interior
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Region 7
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Abstract.—During 2001 three-salmon escapement studies were conducted on three tributaries within the Koyukuk River drainage, Alaska. These studies were operated to collect baseline information for management purposes. Resistance board weirs were method of choice for collecting biological data from chinook *Oncorhynchus tshawytscha* and summer chum salmon *O. keta* stocks spawning in the Gisasa River, Kateel River, and Henshaw Creek. Additionally, passage information on longnose sucker *Catostomus catostomus*, northern pike *Esox lucius*, Arctic grayling *Thymallus arcticus*, and whitefish *Coregonus* spp. were recorded.

From July 7 to August 8, 2001 a resistance board weir was operated on the Gisasa River. This was the eighth consecutive year of operating a resistence board weir at this site. A total of 3,052 chinook and 17,936 summer chum salmon passed through the weir. The most abundant resident species passing through the weir were longnose suckers (N=36). The chinook salmon escapement was slightly above the 1994-2000 average of 2,748 fish. The median passage date for chinook salmon was July 19. Female chinook salmon comprised 42% of the run, with age classes 1.3 and 1.4 dominating (78%) both sexes. The 2001 summer chum salmon escapement was substantially lower than the 1994-2000 average of 59,008 fish. The median passage date for summer chum salmon was July 14. Female summer chum salmon comprised 49% of the run with age class 0.4 dominating (80%) both sexes.

From July 4 to 18 a resistance board weir was constructed but not installed on the Kateel River. Due to unforeseen problems, i.e. logistical problems and reduction in crew size, the weir was not installed during the 2001 field season and therefore biological data were not collected. Even though the weir was not installed, it was constructed and prepared for installation in 2002.

From June 25 to August 12, 2001 a resistence board weir was operated on Henshaw Creek. This was the second year of operating a weir at this site. A total of 1,091 chinook and 34,777 summer chum salmon passed through the weir. The most abundant resident species passing through the weir were longnose suckers (N=2,378). The 2001 chinook salmon escapement was 5.7 times greater than the 2000 escapement. The median date of passage for chinook salmon was July 19. Female chinook salmon comprised 40% of the run with age classes 1.3 and 1.4 dominating (87%) both sexes. The 2001 summer chum salmon escapement was 1.4 times greater than the 2000 escapement. The median date of passage for chum salmon was July 20. Female summer chum salmon comprised 61% of the run with age class 0.4 dominating (63%) both sexes.

Introduction

General—In accordance with the Alaska National Interest Lands Conservation Act of 1980, the U.S. Fish and Wildlife Service (USFWS) is obligated to conserve the natural diversity of fish and wildlife resources on National Wildlife Refuge lands. A high priority of USFWS is the protection of salmon stocks within the Yukon River drainage. Due to recent declines of these salmon runs, particularly summer and fall chum salmon, there have been harvest restrictions, complete fishery closures, and spawning escapement below management goals on many tributaries in the Yukon River drainage (Bergstrom et al. 1995; Kruse 1998). The need to collect accurate escapement estimates from these tributaries is required to determine exploitation rates, and spawner recruit relationships (Labelle 1994). In addition, monitoring salmon escapements into spawning areas is required to determine if genetic diversity and sustainable harvests of those salmon stocks are being provided for. Unfortunately, due to the mixed stock nature of the Yukon River fishery, management practices are complex (Tobin and Harper 1998). In an attempt to understand this mixed salmon fishery, several studies are being conducted along the lower main stem of the Yukon River that provide managers with information required to assess the in-season run of chinook and summer chum salmon (Vania and Golembeski 2000).

The Yukon River drainage, encompassing 854,700 km^2, is among the largest producers of wild chinook *Oncorhynchus tshawytscha* and chum salmon *O. keta* stocks in North America (Daum and Osborne 1999). In addition to chinook and chum salmon, coho salmon *O. kisutsh*, use 1,931 km of the Yukon River and 678 km of the Koyukuk River (Buklis and Barton 1984, Bergstrom et al. 1995). The Yukon River is the only North American drainage that has two distinct runs of chum salmon, which are referred to as summer and fall runs (Bergstrom et al. 1995). Genetic studies reported by Wilmot et al. (1992) show that these two runs are distinct and differ in life history and phenotypic characteristics, i.e. run timing, spawning locations, and morphology. The run of chinook and summer chum salmon in the Yukon River starts in early June and continues through mid-July (Wiswar 2000). Chinook salmon spawn throughout the Yukon River drainage, whereas summer chum salmon spawning mainly in the lower and middle reaches (Minard 1996).

In the Koyukuk River drainage, chinook and summer chum salmon utilize tributaries that run through National Wildlife Refuge boundaries, including the Koyukuk and Kanuti National Wildlife Refuges. Historically, escapement information on salmon stocks has been collected by aerial surveys. The Alaska Department of Fish and Game (ADF&G) Division of Commercial Fisheries, has conducted these surveys on several index tributaries within the Koyukuk River drainage intermittently since 1960 (Barton 1984). Unfortunately, aerial surveys are highly variable and only represent an index of instantaneous escapement. To record total escapements, aerial survey methods have been replaced with more accurate population assessment methods like counting towers, floating weirs, and sonar. To collect baseline information on salmon stocks in the Koyukuk River drainage, stock status and escapement projects has been conducted on four different Koyukuk River tributaries. Three projects use floating weirs and one project is a counting tower to enumerate passing fish. A floating weir has been operated on the Gisasa River since 1994 (Wiswar 2001), on Henshaw Creek since 2000 (VanHatten and Wiswar, in preparation), and on the South Fork Koyukuk River in 1996 and 1997 (Wiswar 1998a). A counting tower has been operated on Clear Creek, Hogatza River, since 1995 (Kretsinger, Bureau of Land Management, Fairbanks, personal communication).

This report describes the 2001 USFWS, Fairbanks Fishery Resources Office, escapement projects in the Koyukuk River drainage. The three projects use floating weirs and are located on the Gisasa River, Kateel River, and Henshaw Creek (Figure 1).

Gisasa River.—Monitoring salmon escapements to the Gisasa River plays an important role in understanding part of the Yukon River salmon fishery by aiding fishery managers in assessing their management actions and fulfills Congressional mandates. Historical data on chinook and summer chum salmon in the Gisasa River were limited to aerial surveys conducted between 1974 and 1998 (Barton 1984; unpublished data, ADF&G; Appendix 1). Chinook salmon estimates, from aerial surveys when conditions were rated fair to good, averaged 400 fish from 1974-1984 (range=161-951) and 1,074 fish from 1985-1998 (range=410-2,775). Summer chum salmon aerial survey estimates were highest from 1974 to 1976, averaging 33,423 fish (range=21,342-56,904). From 1979 to 1995 summer chum salmon estimates averaged 6,207 fish ranging from 1,581-13,232 (Schultz et al. 1993; Barton 1984; Bergstrom et al. 1996; unpublished data, ADF&G; Appendix 1). Between 1994 and 2000 the Gisasa River weir study recorded escapements that ranged from 1,952 to 4,023 chinook salmon and 9,452 to 157,589 summer chum salmon (Melegari and Wiswar 1995; Melegari 1996, 1997; Wiswar 1998b, 1999, 2000; Appendix 1; Figure 2).

Kateel River.—Recently there has been a desire by fishery mangers to conduct additional salmon escapement projects on other tributaries of the Koyukuk River. The Kateel River was selected to fulfill this desire (Figure 1). Due to the proximity of this tributary to the Gisasa River, the information collected on the Kateel River would be used to assess the relationship in spawning escapement numbers between the two tributaries. A weir was intended to be constructed and installed by the USFWS in 2001 on the Kateel River but the weir was not installed.

Henshaw Creek.—Henshaw Creek produces a large escapement of chinook and summer chum salmon within the upper Koyukuk River drainage (Figure 1). In 1996 and 1997 a weir on the South Fork Koyukuk River, a tributary of the upper Koyukuk River, was operated to collect escapement counts from chinook and summer chum salmon. Due to persistent high water conditions throughout both field seasons caused incomplete counts to be recorded, the study was cancelled. In an effort to continue collecting salmon data from the upper Koyukuk River other escapement projects were initiated in 1999. A counting tower was operated in 1999 on Henshaw Creek; however, due to high water conditions during a three week time period, the study only estimated 12 chinook and 1,510 summer chum salmon (VanHatten 1999). In 2000, a resistence board weir was installed and operated during the full season which estimated 193 chinook and 24,406 summer chum salmon (VanHatten and Wiswar, in preparation). Historically, aerial survey estimates of chinook salmon ranged from six to 561 fish and for summer chum salmon ranged from 12 to 24,780 fish (Barton 1984, Appendix 2).

The objectives of each Koyukuk River tributary study were to: (1) determine daily escapement and run timing of adult salmon; (2) determine sex and size composition of adult salmon; and (3) determine the presence and movement of resident fish.

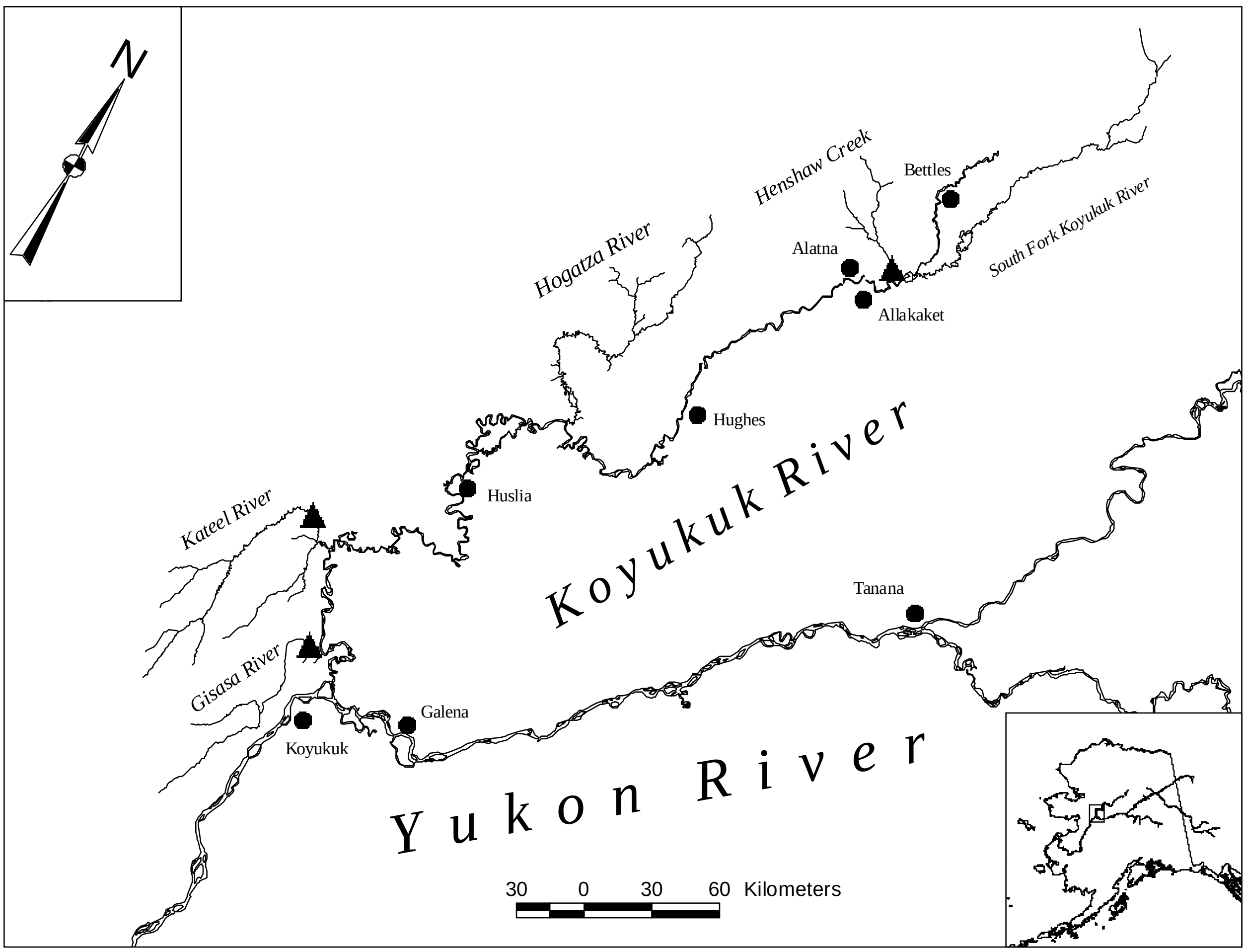


Figure 1.—Tributaries of the Koyukuk River that have resistence board weir studies, Gisasa River, Kateel River, and Henshaw Creek and counting tower study, Hogatza River, Alaska, 2001. ▲ Indicate weir sites.

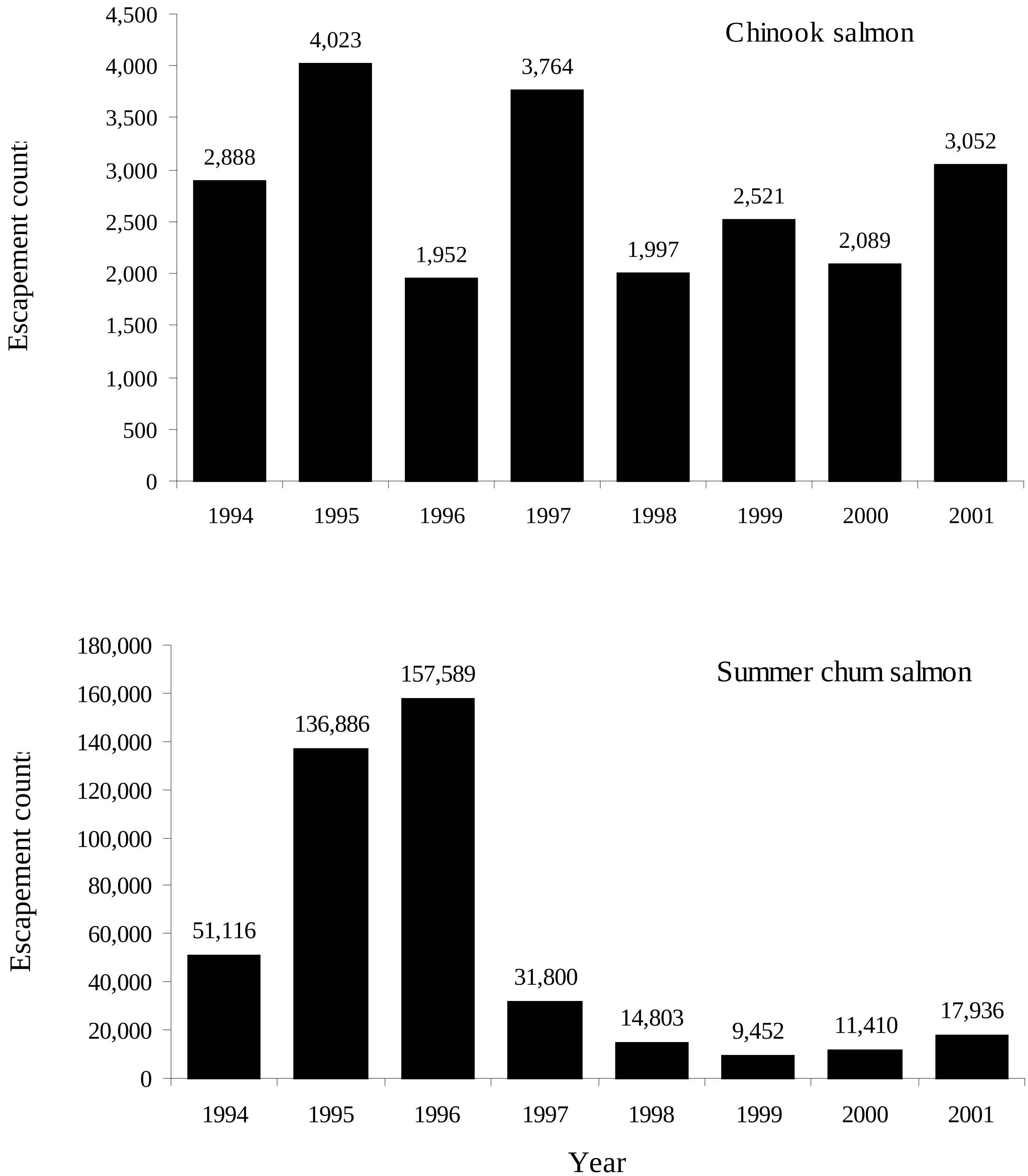


Figure 2.—Historical chinook and summer chum weir escapement counts (1994-2001) from Gisasa River, Alaska, 2001.

Study Area

General.—Climate conditions of the Koyukuk River drainage are characteristically continental with seasonal temperature variations and very low precipitation. The air temperature ranges from 18° to 21° C in summer to -57° C in winter (USFWS 1993a). The hydrology of this area is very dynamic throughout the year with high water levels during spring and low water levels in summer. The lower stream channel sections are characteristically more uniform in appearance with gradual sloping mud banks and emergent shoreline vegetation (USFWS 1993a). The substrate composition along the Koyukuk River varies from gravel and cobble in high water velocity sections to mud and silt in eddies and sloughs.

Gisasa River.—The Gisasa River is located 90 km upriver from the mouth of the Koyukuk River in west central interior Alaska (Figure 1). The headwaters originate in the Nulato Hills and the river flows 112 km northeast, passing into the Koyukuk National Wildlife Refuge (Koyukuk Refuge), before draining into the Koyukuk River (65° 16' N latitude, 157° 40' W longitude, USGS 1:63,360 series, Kateel River B-4 quadrangle). The residents of the interior villages below the Koyukuk River confluence depend on the Koyukuk Refuge's fishery resources for subsistence use.

The location of the weir site is approximately 4 km upriver from the mouth of the Gisasa River. This site was selected for its optimal width (76 m), depth (0.5 m), and substrate composition (medium size gravel 25-50 mm).

Kateel River.—The Kateel River is located 157 km upriver from the mouth of the Koyukuk River in west central interior Alaska (Figure 1). The headwaters of the Kateel River originate in the Nulato Hills and the river flows northeasterly for 200 km passing, into the Koyukuk National Wildlife Refuge (Koyukuk Refuge), before draining into the Koyukuk River (65° 32' N latitude, 157° 45' W latitude, USGS 1:63,360 series, Kateel River B-4 quadrangle).

The location of the weir site is approximately 47 km upriver from the mouth of the Kateel River. This site was selected for its optimal width (31 m), depth (0.6 m), and substrate composition (small cobble 50-150 mm).

Henshaw Creek.—Henshaw Creek is located 721 km upriver from the mouth of the Koyukuk River in north central Alaska (Figure 1). The headwaters originate in the Alatna Hills and the river flows southeasterly for 144 km, passing into the Kanuti National Wildlife Refuge (Kanuti Refuge), before entering the Koyukuk River (66° 33' N latitude, 152° 13' W longitude, USGS 1:63,360 series, Bettles C-5 quadrangle). The Kanuti Refuge lies near the Arctic Circle with the Brooks Range to the north and the Ray Mountains to the south (USFWS 1993b). Although there are no villages located within the Refuge, local villagers living downstream of the Kanuti Refuge depend on salmon species for subsistence use.

The location of the weir site is approximately 1.5 km upriver from the mouth of Henshaw Creek. This site was selected for its optimal width (29 m), depth (0.6 m), and substrate composition (small cobble 50-150 mm).

Methods

Weir Operation.—In 2001, resistence board weirs were operated on the Gisasa River and Henshaw Creek, with an additional weir built but not installed on the Kateel River. The primary goal of the weirs were to collect biological information from adult salmon with a secondary goal of recording resident fish species movement in each system. Construction and installation of each weir were patterned after Tobin (1994). Visual inspection of the weir was conducted on a daily basis for holes and structural integrity. During visual inspection, the weir was cleaned of debris. A live trap, installed near mid-channel, allowed migrating salmon and resident species to be counted and sampled, if needed.

Biological Data.—Run timing and abundance of salmon species and daily movements of resident fish species were recorded as they migrated through the weir each day. The daily counting schedule began and ended at midnight. *Coregonus* spp. and *Prosopium cylindraccum* were grouped as whitefish species.

Data Analysis.—Sex, age, and length information were collected as a stratified random sample (Cochran 1977) and stratified by week. Each statistical week was defined as beginning on Monday and ending on Sunday. Sampling began at the beginning of each week and, generally, was conducted over a 3-4 day period, with a target of 160 fish/species. Scales were used for ageing salmon and ages were reported using the European technique (Foerster 1968). Three scales were collected from chinook and one scale from summer chum salmon. Scales were sampled from the area located on the left side of the fish and two rows above the lateral line on a diagonal line from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both salmon species were sent to ADF&G for processing. Daily sex ratios were determined by visual inspection with emphasis on kype, belly, coloration, eyes, size, and shape. Salmon were sexed using two methods: 1) sex was recorded when sampling for age and length data, and 2) salmon were periodically sexed throughout the day by crew members physically handling the fish as they migrated into the trap. Lengths of chinook and chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL).

Seasonal sex ratios and age class distribution, with standard error, were calculated by weighted weekly totals. Within a week, the proportion of the samples composed of a given sex or age, p_{ij}, were calculated as

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

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

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

Sex and age compositions for the total run of chinook and summer chum salmon of a given sex/age, p_i, were calculated as

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

where the stratum weight (W_j) was calculated as

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

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. A variance of sex and age compositions for the run were calculated as

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

Results

Gisasa River

Weir operation.—Operation of the weir began on July 7 and continued through August 8, 2001. Even though there were multiple rain events during the study period, the weir maintained its structural integrity during these high flows. There were no hydrological and climatological data collected during the 2001 field season.

Biological data.—Summer chum salmon were the most abundant salmon species counted through the weir (N=17,936) followed by chinook salmon (N=3,052; Table 1). Of the four resident species migrating through the weir, longnose sucker *Catostomus catostomus* (N = 36) was the most abundant, followed by Arctic grayling *Thymallus arcticus* (N=7), northern pike *Esox lucius* (N=3), and whitefish species (N=1; Table 1).

Chinook salmon.—Chinook salmon were first counted on July 7 with a daily count of 18, and counting stopped on August 8 with a daily count of 5 (Figure 3; Table 1). Between July 14 and 21, 67% of the enumerated run migrated through the weir with daily passage rates near or exceeding 300 fish on three days. The chinook salmon daily passage rates had two entry peaks with the first occurring on July 20 with 388 fish and the second occurring on July 29 with 149 fish. The median passage date occurred on July 19, one day earlier than the 2000 run. The 2001 run had a similar entry pattern as the 2000 run with the first quartile passing on July 15.

The seasonal sex ratio consisted of 42% females with low weekly sex ratios of 28% during week one and increasing to 80% by week six of the study (Table 2). Of the 693 chinook salmon sampled for age composition, 60 (9%) were classified as unknown. Age composition of chinook salmon sampled made up four age groups: age 1.5 (3%), age 1.4 (53%), age 1.3 (25%), and age 1.2 (18%; Table 3). The average female chinook salmon length was 847 mm with a range from 565 mm to 980 mm MEL (Table 4). The average male chinook salmon length was 676 mm with a range from 335 mm to 980 mm MEL.

Chum salmon.—Summer chum salmon were first counted on July 7 with a daily count of 229, and counting stopped on August 8 with a daily count of 8 (Figure 3; Table 1). Between July 10 and 15, 53% of the enumerated run migrated through the weir with daily passage rates near or exceeding 1,100 fish on six days. The daily summer chum salmon passage indicated a uni-modal run with peak daily count of 2,032 fish occurring on July 14. The median passage date also occurred July 14, two days earlier than the 2000 run. Based on the enumerated fish, the 2001 run arrived two days later than 2000 with the first quartile passing on July 12 versus July 10 in 2000.

The seasonal sex ratio consisted of 49% females with weekly sex ratios ranging from 44% to 57% through out the run (Table 2). Of the 728 summer chum salmon sampled for age composition, 147 (20%) were classified as unknown. Age composition of summer chum salmon sampled made up three age groups: age 0.5 (4%), age 0.4 (80%), and age 0.3 (11%; Table 3). The average female summer chum salmon length was 550 mm with a range from 470 mm to 630 mm MEL (Table 4). The average male summer chum salmon length was 577 mm with a range of 420 mm to 690 mm MEL.

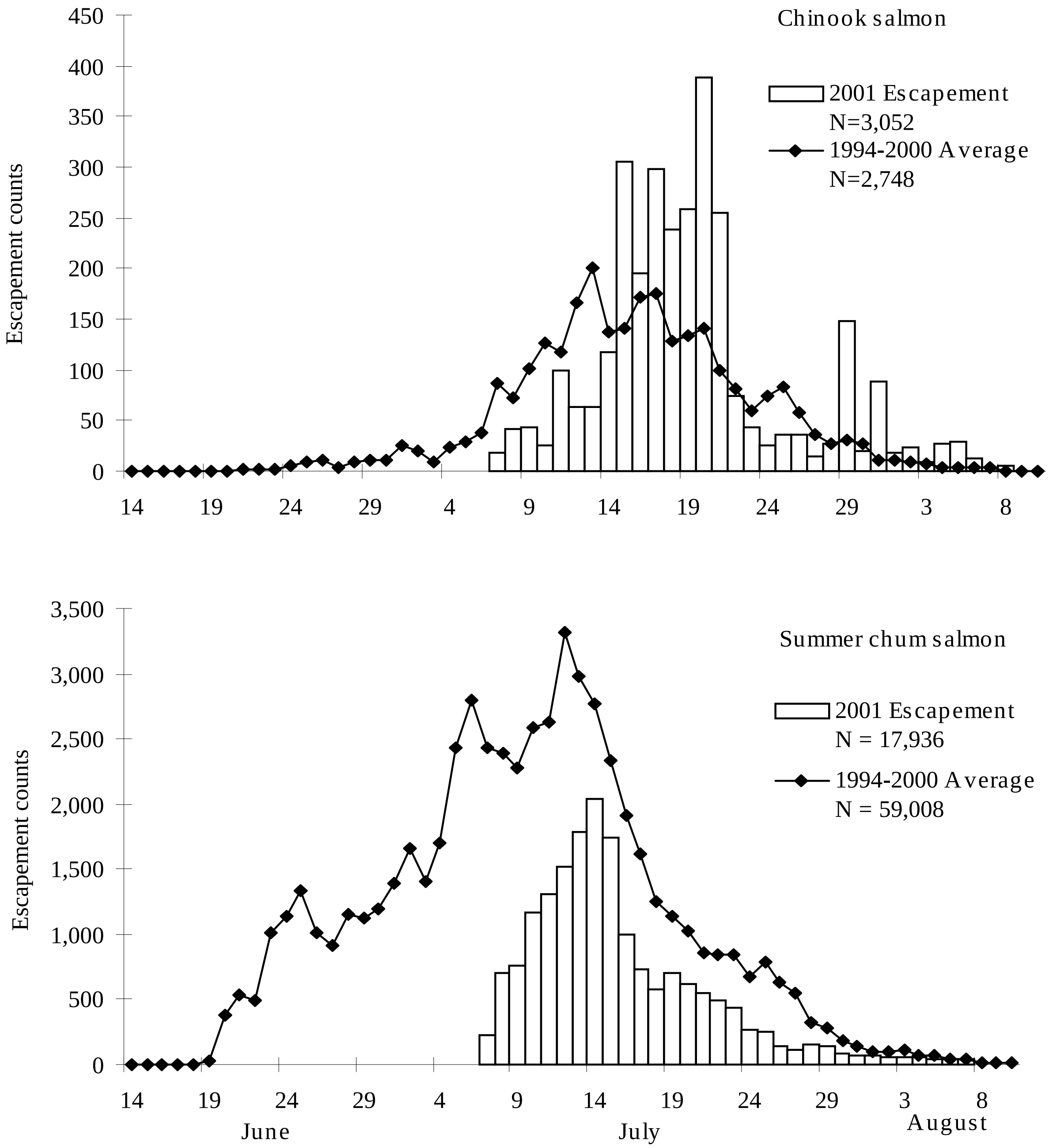


Figure 3.—Daily escapement counts of chinook and summer chum salmon at Gisasa River, Alaska, 2001, with average daily counts from 1994-2000.

Table 1.—Daily and cumulative (chinook and summer chum salmon only) counts of fish passing through the Gisasa River weir, Alaska, 2001. (cum = cumulative).

	Chinook salmon		Summer chum salmon		Longnose sucker	Arctic grayling	Northern pike	Whitefish spp.
Date	Daily	cum	Daily	cum	Daily	Daily	Daily	Daily
7-Jul	18	18	229	229	0	0	0	0
8-Jul	41	59	705	934	0	0	1	0
9-Jul	43	102	758	1,692	1	0	0	0
10-Jul	26	128	1,166	2,868	0	1	0	0
11-Jul	100	228	1,305	4,173	2	0	0	0
12-Jul	63	291	1,522	5,695	0	0	0	0
13-Jul	63	354	1,781	7,476	1	0	0	0
14-Jul	117	471	2,032	9,508	3	0	0	0
15-Jul	306	777	1,741	11,249	6	0	0	0
16-Jul	196	973	998	12,247	0	1	0	0
17-Jul	299	1,272	727	12,974	4	0	0	0
18-Jul	238	1,510	575	13,549	2	0	0	0
19-Jul	258	1,768	708	14,257	5	0	0	0
20-Jul	388	2,156	616	14,873	2	0	0	0
21-Jul	254	2,410	549	15,422	2	1	0	1
22-Jul	74	2,484	492	15,914	1	0	0	0
23-Jul	44	2,528	432	16,346	2	0	0	0
24-Jul	25	2,553	266	16,612	0	0	0	0
25-Jul	36	2,589	250	16,862	0	0	0	0
26-Jul	37	2,626	142	17,004	1	0	0	0
27-Jul	14	2,640	114	17,118	1	0	1	0
28-Jul	27	2,667	149	17,267	1	0	0	0
29-Jul	149	2,816	146	17,413	0	0	0	0
30-Jul	20	2,836	87	17,500	0	2	0	0
31-Jul	88	2,924	76	17,576	1	1	1	0
1-Aug	18	2,942	67	17,643	0	0	0	0
2-Aug	23	2,965	63	17,706	0	0	0	0
3-Aug	9	2,974	56	17,762	0	0	0	0
4-Aug	28	3,002	50	17,812	0	0	0	0
5-Aug	29	3,031	43	17,855	1	1	0	0
6-Aug	12	3,043	41	17,896	0	0	0	0
7-Aug	4	3,047	44	17,940	0	0	0	0
8-Aug	5	3,052	6	17,946	0	0	0	0
Total		3,052		17,936	36	7	3	1

Table 2.—Sex ratios of chinook and summer chum salmon sampled at the Gisasa River weir, Alaska, 2001. SEs are in parentheses. Season total is calculated from weighted abundance of weekly totals.

Time period	Run size	N	Percent female	Estimated number of females
Chinook salmon				
Jul 1-8	59	0		
Jul 9-15	718	169	28 (1.7)	201
Jul 16-22	1,707	218	44 (1.2)	751
Jul 23-29	332	175	46 (2.7)	153
Jul 30-Aug 5	215	199	74 (3.0)	159
Aug 6-12	21	20	80 (8.9)	17
Season total	3,052	781	42 (0.9)	1,282
Summer chum salmon				
Jul 1-8	934	0	0	0
Jul 9-15	10,305	437	50 (2.4)	5,158
Jul 16-22	4,665	238	57 (3.2)	2,659
Jul 23-29	1,499	243	44 (3.2)	660
Jul 30-Aug 5	442	231	49 (3.3)	217
Aug 6-12	91	84	56 (5.4)	51
Season total	17,936	1,233	49 (1.6)	8,789

Table 3.—Percent weekly age estimates of chinook and summer chum salmon sampled at the Gisasa River weir, Alaska, 2001. SEs are in parentheses. Season total is calculated from weighted abundance of weekly totals.

Chinook salmon

			Brood year and age			
			1994	1995	1996	1997
Time period	Run size	N	1.5	1.4	1.3	1.2
Jul 1-8	59					
Jul 9-15	718	152	1 (0.7)	47 (4.1)	32 (3.8)	20 (3.2)
Jul 16-22	1,707	150	3 (1.5)	53 (4.1)	25 (3.6)	18 (3.1)
Jul 23-29	332	148	4 (1.6)	53 (4.1)	23 (3.5)	20 (3.3)
Jul 30-Aug 5	215	165	4 (1.5)	76 (3.3)	10 (2.4)	10 (2.3)
Aug 6-12	21	18	0	83 (9.0)	6 (5.6)	11 (7.6)
Season total	3,052	633	3 (0.9)	53 (2.5)	25 (2.2)	18 (2.0)

Summer chum salmon

			Brood year and age		
			1995	1996	1997
Time period	Run size	N	0.5	0.4	0.3
Jul 1-8	934	0			
Jul 9-15	10,305	129	2 (1.3)	95 (2.0)	3 (1.5)
Jul 16-22	4,665	123	8 (2.5)	70 (4.2)	22 (3.7)
Jul 23-29	1,499	131	4 (1.7)	66 (4.2)	30 (4.0)
Jul 30-Aug 5	442	137	7 (2.1)	69 (4.0)	24 (3.7)
Aug 6-12	91	61	8 (3.5)	61 (6.3)	31 (6.0)
Season total	17,936	581	4 (1.0)	80 (1.6)	11 (1.4)

Table 4.—Length at age of female and male chinook and summer chum salmon sampled at the Gisasa River weir, Alaska, 2001.

	Female					Male				
		Mid-eye to fork length (mm)					Mid-eye to fork length (mm)			
Age	N	Mean	Median	SE	Range	N	Mean	Median	SE	Range
Chinook salmon										
1.1	0					1	335.0			
1.2	0					104	528.6	530.0	4.3	420-650
1.3	30	827.3	840.0	16.1	565-940	109	698.0	680.0	7.2	520-920
1.4	269	848.6	850.0	2.5	670-980	103	800.8	805.0	7.6	470-980
1.5	14	862.9	875.0	11.9	770-920	4	792.5	770.0	41.1	720-910
Total	313	847.2	850.0	2.7	565-980	321	676.2	680.0	7.3	335-980
Summer chum salmon										
0.2	1	490.0				0				
0.3	62	524.7	522.5	2.9	480-585	61	553.2	550.0	3.2	505-660
0.4	217	557.9	560.0	1.9	470-630	209	583.3	580.0	2.5	420-690
0.5	13	555.8	555.0	5.8	525-605	19	594.5	590.0	6.6	560-650
Total	293	550.5	550.0	1.7	470-630	289	577.7	575.0	2.1	420-690

Kateel River

Since the weir was not installed during the 2001 field season, biological information was not collected from either salmon species or resident species.

Henshaw Creek

Weir Operation.—Operation of the weir began on June 25 and continued through August 12, 2001. Even though there were multiple rain events during the study period, the weir maintained its structural integrity during these high flows.

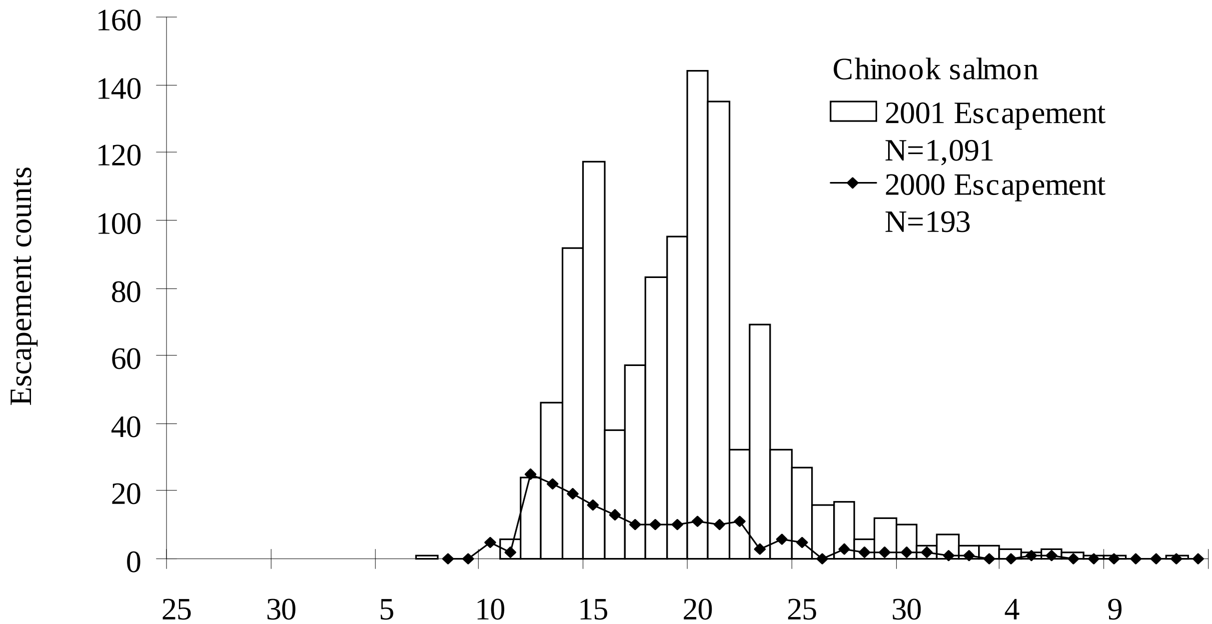
Biological Data.—Summer chum salmon were the most abundant salmon species counted through the weir (N=34,777) followed by chinook salmon (N=1,091; Table 6). Of the four resident species migrating through the weir, longnose sucker (N=2,378) was the most abundant, followed by Arctic grayling (N=239), northern pike (N=8), and whitefish species (N=2; Table 6).

Chinook salmon.—The first chinook salmon passed the weir on July 7 after 12 days of operation, and the last chinook counted was on August 12 which was estimated to be the end of the run (Figure 4; Table 6). Between July 14 and July 23, 79% of the total run migrated through the weir with daily passage rates near or exceeding 110 fish on three different days. The chinook salmon daily passage rates indicated a bimodal run with peak daily counts of 117 and 144 occurring on July 15 and 20, respectively (Figure 4). The median passage date occurred on July 19, three days later than 2000 (July 16). The run arrived two days later than 200 with the first quartile passing on July 15 versus July 13 in 2000.

The seasonal sex ratio consisted of 40% females with the weekly sex ratios starting low at 21% and increasing to 55% by the latter part of July (Table 7). Of the 430 chinook salmon sampled for age composition, 53 (12%) were classified as unknown. Age composition of chinook salmon sampled made up four age groups: age 1.5 (1%), age 1.4 (45%), age 1.3 (42%), and age 1.2 (12%; Table 8). The average female chinook salmon length was 826 mm with a range from 605 mm to 925 mm MEL (Table 9). The average male chinook salmon length was 700 mm with a range from 450 mm to 885 mm MEL.

Chum salmon.—The first chum salmon passed the weir on July 9, and counting stopped on August 12 with a daily count of 77 (Figure 4; Table 6). Between July 12 and July 26, 93% of the total run migrated through the weir with daily passage rates near or exceeding 1,000 fish on 15 days. The summer chum salmon passage rates indicated a bimodal run with peak counts of 1,972 and 3,259 fish occurring on July 13 and 20, respectively (Figure 4; Table 6). The median passage date occurred on July 20, two days earlier than 2000 (July 22). The run arrived one day earlier than 2000 run with the first quartile passing on July 17 versus July 18 in 2000.

The seasonal sex ratio consisted of 61% females with weekly sex ratios ranging from 59% to 68% (Table 7). Of the 789 chum salmon sampled for age composition, 162 (21%) were classified as unknown. Age composition of chum salmon made up four age groups; age 0.5 (2%), age 0.4 (63%), age 0.3 (34%), and age 0.2 (0%; Table 8). The average female chum salmon length was 549 mm with a range from 430 mm to 665 mm MEL (Table 9). The average male chum salmon length was 580 mm with a range from 480 mm to 725 mm MEL (Table 9).



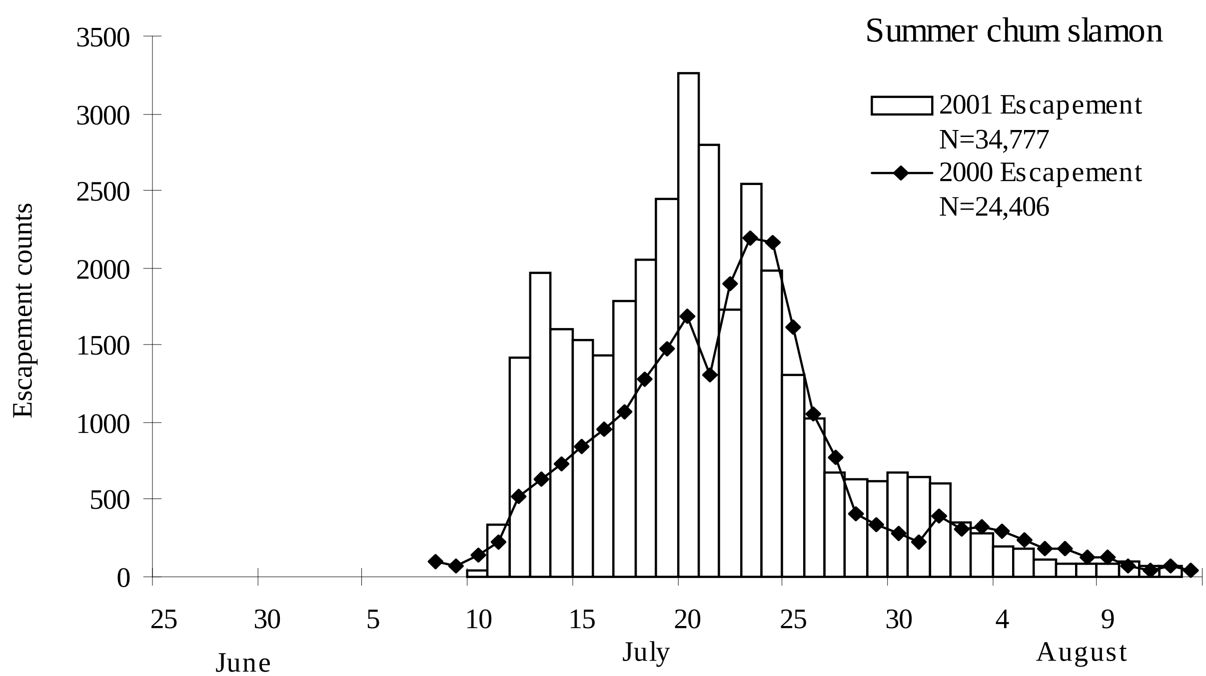


Figure 4.—Daily escapement counts of chinook and chum salmon at Henshaw Creek, Alaska, 2001, with estimates from 2000.

Table 6.—Daily and cumulative (chinook and summer chum salmon only) counts of fish passing through Henshaw Creek weir, Alaska, 2001.

	Chinook salmon		Chum salmon		Longnose sucker	Arctic grayling	Northern pike	Whitefish spp.
Date	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
25-Jun	0	0	0	0	0	0	0	0
26-Jun	0	0	0	0	0	0	0	0
27-Jun	0	0	0	0	0	0	0	0
28-Jun	0	0	0	0	1	3	0	0
29-Jun	0	0	0	0	18	3	0	0
30-Jun	0	0	0	0	52	1	0	0
1-Jul	0	0	0	0	18	3	2	0
2-Jul	0	0	0	0	19	45	0	0
3-Jul	0	0	0	0	9	27	1	1
4-Jul	0	0	0	0	47	27	0	0
5-Jul	0	0	0	0	5	6	0	1
6-Jul	0	0	0	0	3	2	0	0
7-Jul	1	1	0	0	0	10	0	0
8-Jul	0	1	0	0	3	6	2	0
9-Jul	0	1	1	1	36	6	1	0
10-Jul	0	1	41	42	166	4	0	0
11-Jul	6	7	335	377	78	0	1	0
12-Jul	24	31	1,420	1,797	15	1	0	0
13-Jul	46	77	1,972	3,769	50	0	0	0
14-Jul	92	169	1,602	5,371	39	4	0	0
15-Jul	117	286	1,530	6,901	445	1	0	0
16-Jul	38	324	1,438	8,339	515	3	1	0
17-Jul	57	381	1,791	10,130	110	0	0	0
18-Jul	83	464	2,048	12,178	34	1	0	0
19-Jul	95	559	2,452	14,630	61	0	0	0
20-Jul	144	703	3,259	17,889	20	3	0	0
21-Jul	135	838	2,793	20,682	0	2	0	0
22-Jul	32	870	1,725	22,407	7	15	0	0
23-Jul	69	939	2,541	24,948	170	0	0	0
24-Jul	32	971	1,988	26,936	235	0	0	0
25-Jul	27	998	1,312	28,248	0	51	0	0
26-Jul	16	1,014	1,022	29,270	9	0	0	0
27-Jul	17	1,031	681	29,951	1	0	0	0
28-Jul	6	1,037	634	30,585	10	1	0	0
29-Jul	12	1,049	614	31,199	0	0	0	0
30-Jul	10	1,059	681	31,880	0	0	0	0
31-Jul	4	1,063	652	32,532	1	0	0	0
1-Aug	7	1,070	598	33,130	52	3	0	0
2-Aug	4	1,074	353	33,483	31	0	0	0
3-Aug	4	1,078	288	33,771	5	1	0	0

Table 6.—Continued.

Date	Chinook salmon		Chum salmon		Longnose sucker	Arctic grayling	Northern pike	Whitefish spp.
	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily
4-Aug	3	1,081	203	33,974	0	0	0	0
5-Aug	2	1,083	188	34,162	24	1	0	0
6-Aug	3	1,086	117	34,279	83	1	0	0
7-Aug	2	1,088	84	34,363	0	2	0	0
8-Aug	1	1,089	80	34,443	0	1	0	0
9-Aug	1	1,090	90	34,533	0	1	0	0
10-Aug	0	1,090	94	34,627	0	4	0	0
11-Aug	0	1,090	73	34,700	0	0	0	0
12-Aug	1	1,091	77	34,777	6	0	0	0
Season total		1,091		34,777	2,378	239	8	2

Table 7.—Sex ratios of chinook and summer chum salmon sampled at Henshaw Creek, Alaska, 2001. SEs are in parentheses.

Time period	Total number of salmon counted	N	Percent female	Estimated number of females
Chinook salmon				
Jun 25-Jul 1	0	0		
Jul 2-8	1	1	0	0
Jul 9-15	285	192	21 (2.9)	60
Jul 16-22	584	584	43 (2.1)	251
Jul 23-29	179	157	55 (4.0)	98
Jul 30-Aug 5	34	33	55 (8.8)	19
Aug 6-13	8	8	50 (18.9)	4
Season total	1,091	975	40 (1.5)	436
Summer chum salmon				
Jun 25-Jul 1	0	0		
Jul 2-8	0	0		
Jul 9-15	6,901	137	63 (4.1)	4,348
Jul 16-22	15,506	160	59 (3.9)	9,149
Jul 23-29	8,792	535	59 (2.1)	5,187
Jul 30-Aug 5	2,963	427	67 (2.3)	1,985
Aug 6-12	615	298	68 (2.7)	418
Season total	34,777	1,557	61 (2.0)	21,214

Table 8.—Percent weekly age estimates of chinook and summer chum salmon sampled at Henshaw Creek, Alaska, 2001. SEs are in parentheses.

Chinook salmon

			Brood year and age			
			1994	1995	1996	1997
Time period	Total number of salmon counted	N	1.5	1.4	1.3	1.2
Jun 25-Jul 1	0	0				
Jul 2-8	1	1	0	0	100	0
Jul 9-15	285	155	1 (0.6)	30 (3.7)	63 (3.9)	6 (2.0)
Jul 16-22	584	102	1 (1.0)	47 (5.0)	38 (4.8)	14 (3.4)
Jul 23-29	179	87	1 (1.1)	59 (5.3)	24 (4.6)	16 (4.0)
Jul 30-Aug 5	34	25	4 (4.0)	56 (10.0)	24 (8.7)	16 (7.5)
Aug 6-12	8	7	0	57 (20.2)	14 (14.3)	29 (18.4)
Season total	1,091	377	1 (0.6)	45 (3.0)	42 (2.9)	12 (2.0)

Summer chum salmon

			Brood year and age			
			1995	1996	1997	1998
Time period	Total number of salmon counted	N	0.5	0.4	0.3	0.2
Jun 25-Jul 1	0	0				
Jul 2-8	0	0				
Jul 9-15	6,901	108	2 (1.3)	94 (2.4)	5 (2.0)	0
Jul 16-22	15,506	123	2 (1.1)	80 (3.6)	18 (3.5)	0
Jul 23-29	8,792	138	2 (1.2)	54 (4.3)	44 (4.2)	0
Jul 30-Aug 5	2,963	131	4 (1.7)	46 (4.4)	50 (4.4)	0
Aug 6-12	615	127	2 (1.4)	50 (4.5)	46 (4.4)	1 (0.8)
Season total	34,777	627	2 (0.7)	63 (2.0)	34 (2.0)	0 (0.0)

Table 9.—Length at age of female and male chinook and summer chum salmon sampled at Henshaw Creek, Alaska, 2001.

	Female					Male				
		Mid-eye to fork length (mm)					Mid-eye to fork length (mm)			
Age	N	Mean	Median	SE	Range	N	Mean	Median	SE	Range
Chinook salmon										
1.2	0					44	533.9	525.0	8.9	450-740
1.3	24	786.5	802.5	17.3	605-905	142	697.4	697.5	5.6	490-860
1.4	108	834.4	830.0	4.8	620-835	55	777.6	780.0	7.2	640-885
1.5	4	842.5	842.5	37.8	770-915	0				
Total	136	826.1	827.5	5.2	605-925	241	685.9	700.0	6.5	450-885
Summer chum salmon										
0.2	1	480.0				0				
0.3	149	532.6	530.0	2.4	430-640	64	559.5	555.0	4.5	480-650
0.4	254	558.6	557.5	2.1	450-665	144	594.2	590.0	3.6	520-725
0.5	8	546.9	545.0	11.4	500-595	7	577.1	575.0	8.4	550-620
Total	412	548.8	545.0	1.7	430-665	215	583.3	580.0	2.9	480-725

Discussion

Gisasa River and Henshaw Creek

Weir Operation.—In 2001, the weirs on the Gisasa River and Henshaw Creek performed well and were effective in both passing fish and in collecting biological information. The picket spacing within each weir panel was adequate, preventing adult chinook and summer chum salmon from passing between the pickets. However, smaller resident species, i.e. Arctic grayling, northern pike, and whitefish, may have passed undetected through the weir.

High water levels can temporarily submerge weir panels (Tobin 1994), causing some fish to escape over the weir. At Henshaw Creek during the 2000 field season, high water affected counting for eight days. For these missing days escapement counts had to be estimated. To overcome high water problems and provide more reliable escapement counts over the entire season, the weir site was moved 0.5 km upstream in 2001. Even though there were multiple rain events during the 2001 field season, the counting schedule was not interrupted by high water.

Biological Data.—The post season analysis for chinook and summer chum salmon in the Gisasa River and Henshaw Creek was assessed as above the 2000 escapement counts. The 2001 chinook salmon escapement was 1.5 times greater in the Gisasa River (Figure 5) and 5.6 times greater in the Henshaw Creek than the 2000 escapements (Figure 4). The estimates of 2001 mainstem Yukon River chinook salmon passage at Pilot Station was 2.0 times greater than 2000 counts (JTC 2001). The 2001 summer chum salmon escapement was 1.6 times greater in the Gisasa River (Figure 5) and 1.4 times greater in Henshaw Creek than the 2000 escapement (Figure 4). The estimates of 2001 mainstem Yukon River summer chum salmon passage at Pilot Station was slightly less than 2000 counts (JTC 2001).

Salmon stock abundance in the Gisasa River has fluctuated considerably in the past few years. Since 1995, the chinook salmon escapement counts ranged from a high of 4,023 in 1995 to a low of 1,952 in 1996 (Figure 2). The summer chum salmon escapements also showed fluctuation during this time period, reaching a high of 157,589 in 1996 to a low of 9,452 in 1999 (Figure 2). Presently the cause of these fluctuations is unknown but a combination of oceanic and freshwater conditions could be at fault (Beacham and Starr 1982, Kruse 1998). Unfortunately, a weir on Henshaw Creek has only collected total chinook and summer chum salmon abundance since 2000, therefore historical comparisons cannot be made until a longer time series database has been formed.

The late weir installation in the Gisasa River in 2001 may have caused the beginning portions of the salmon run to be missed. The weir was operational on July 7, which was a later date than previous years. From 1995 to 2000, excluding 1994 due to partial counts, 13% of chinook salmon and 47% of summer chum salmon passed the weir by this date. The weir was installed late due to river and ice conditions on the Yukon and Koyukuk Rivers. In 2001, fishery managers reported these conditions prevailing longer than previous years and were present into June. Because of these conditions, the 2001 chinook and summer chum salmon runs were reported entering the Yukon River later than in 2000 (ADF&G, Ligneau, personal communication). The late entry of both salmon species into the Yukon River, could have also caused late entry into the Gisasa River. In this case, the late installation of the weir may not have substantially underestimated the two runs, especially for summer chum salmon.

Sex ratios of salmon escapements are indicative of the general health of the run. A large salmon escapement does not mean the run is healthy unless the stocks have a good representation of females. Generally, during the salmon spawning period, there are higher proportion of males during the early stages of the run while the females dominate during the later stages (Beacham and Starr 1982). The Gisasa River and Henshaw Creek chinook salmon escapement followed this trend. In the Gisasa River there were 28% females during the beginning stages of the run and 80% females during the later stages. In Henshaw Creek the chinook salmon escapement showed 21% females during the beginning stages and 55% females during the later stages. The summer chum salmon female sex ratio for both the Gisasa River and Henshaw Creek did not follow this trend. The Gisasa River female sex ratio remained fairly consistent throughout the run, ranging from 44% to 57% and the Henshaw Creek female sex ratio remained above 59% throughout the run.

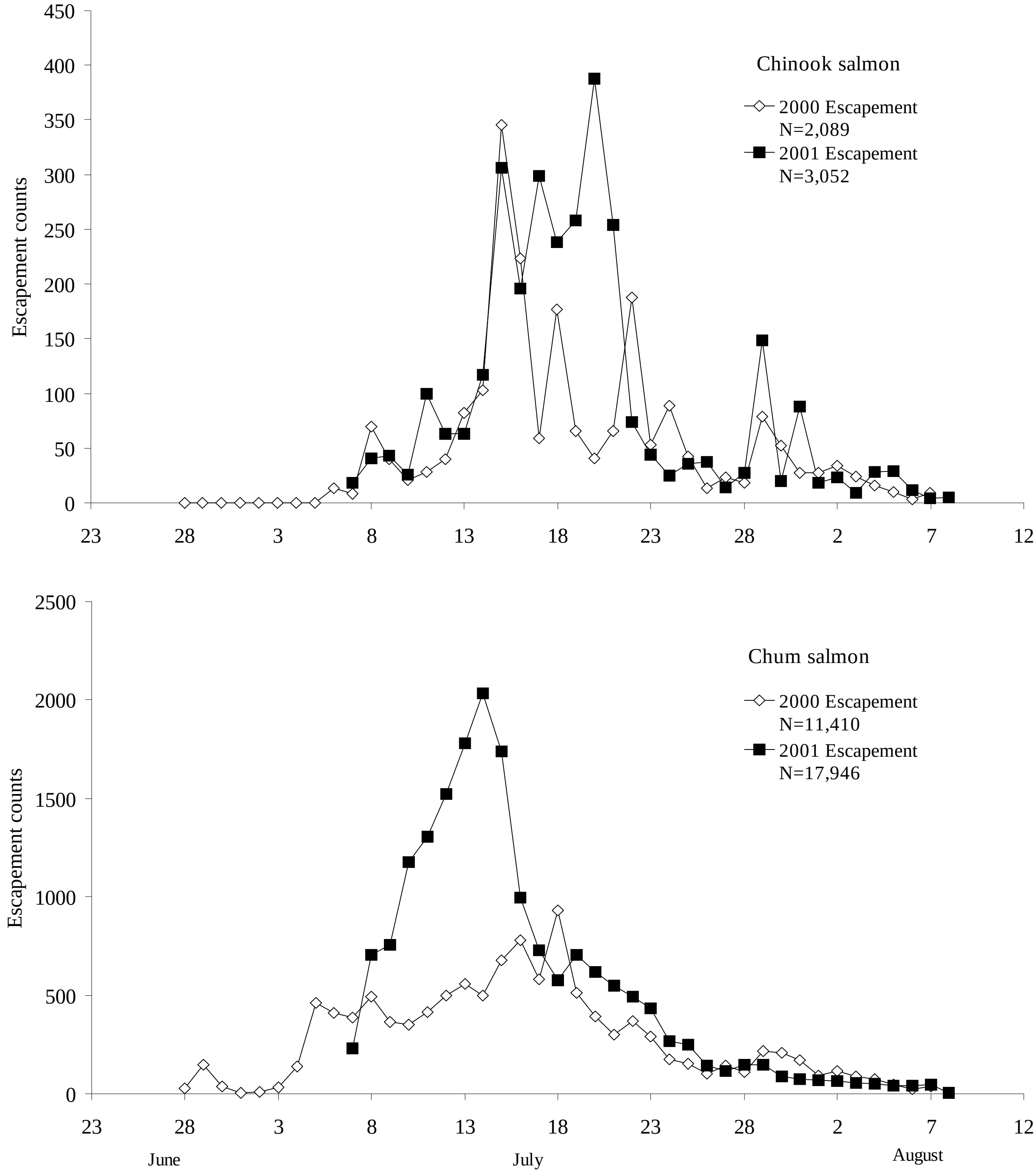


Figure 5.—Daily and seasonal escapement counts for chinook salmon sampled at Gisasa River, 2000 and 2001.

Kateel River

Transportation and staffing problems in 2001 prohibited the installation of the weir on the Kateel River. One of the problems involved the timing of the barge for shipping the materials and supplies to the mouth of the Kateel River. The barge was behind schedule in making trips to the villages on the Yukon River due to late breakup. During 2001 spring breakup, ice jams were present which caused the flooding of several villages along the Yukon River. These high water levels and floating debris caused the departure of the barge to be delayed two weeks until June 30.

The second problem involved the use of the Bureau of Land Management-Alaska Fire Service helicopter. A helicopter was intended to be used during the week of June 25-29 to ferry materials and supplies from the mouth of the Kateel River to the study site. Due to the late arrival of the materials and supplies by the barge, the use of the helicopter was delayed up to the week of July 2-7. On July 5 the helicopter made several trips from the mouth to the study site. Unfortunately, the helicopter was redirected to a small fire south of Galena on July 6, which caused the use of the helicopter to be delayed an additional three days. All large materials and supplies were ferried to the study site by July 9. Even though all the material and supplies were at the site by July 11, there were crew problems with that would have delayed the installation another week, until July 18.

The Kateel River is located between the Gisasa River (67 km down river) and Henshaw Creek (315 km up river) which allows the use of the data from these systems to get an indication of run status. Using historical results from these studies, it was estimated that a major proportion of both salmon runs would have already migrated through the Kateel River weir location by July 18. Based on the 1995 to 2000 Gisasa River weir data, the proportion of chinook migrating through the weir by this date ranged from 27% to 86% with an average of 68% and the summer chum salmon ranged from 52% to 97% with an average of 89% (Wiswar 2001). Also, data from the Henshaw Creek weir project in 2000 recorded 43% chinook and 35% summer chum salmon migrating through the weir by July 18. With the additional time needed to install and make the weir operational, at least 50% of both salmon runs would have passed the study site before the weir was functional. It was decided to delay the project until 2002.

Conclusion

The operation of weirs on tributaries within the Koyukuk River drainage is an important management tool for ADF&G-Division of Commercial Fisheries and USFWS managers in analyzing and understanding the dynamic characteristics of chinook and summer chum salmon.

In response to the poor chinook and summer chum salmon escapements during the last 5 years benchmarks should be developed to alert fishery managers when in-season projections indicate undesirable escapement magnitudes in the Koyukuk River (Tobin and Harper 1998).

Although the Kateel River weir study did not operate in 2001, due to logistical problems, the same logistical problems should not be encountered in 2002. It is recommended that the crew arrive on site by June 17, 2002 to ensure any unforeseen difficulties with weir installation can be addressed.

Transportation of material, supplies, and personnel to the Kateel River study site was a hindrance to the construction and installation of the weir in 2001. Therefore, it is recommended that the study site be moved 20 km downstream. The 2001 crew leader has picked out a site that is closer to the mouth and is in an area that would decrease logistical problems, i.e. transportation from Galena to mouth of Kateel River and from mouth of Kateel River to weir site.

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Appendix 1.—Historical chinook and summer chum salmon escapements for Gisasa River, Alaska, 1974-2001. All data except weir estimates are from Barton (1984) and ADF&G, unpublished data. a = Incomplete surveys due to poor survey conditions.

	Aerial index estimates		Weir	
Year	Chinook salmon	Chum salmon	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	2,888	51,116
1995	410	6,458	4,023	136,886
1996			1,952	157,589
1997[a]	144	686	3,764	31,800
1998	889		1,997	14,803
1999			2,521	9,452
2000			2,089	11,410
2001			3,052	17,936

APPENDIX 2.—Historical chinook and summer chum salmon escapements for Henshaw Creek, Alaska, 1960-2001. All data except weir and counting tower estimates are from Barton (1984) and ADF&G, unpublished data. Aerial index estimates are surveys that are rated as poor, fair, good, or any combination. Ratings are based on a combination of various environmental conditions, wind, weather, water, visibility, bottom, time, distance surveyed, and spawn stage.

	Aerial index estimates			Counting tower		Weir	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon	Chinook salmon	Chum salmon
1960			Poor				
1969	6	300	Not rated				
1975	118	1,219	Not rated				
1976	94	624	Fair				
1982	48	12	Fair				
1983	551	3,289	Good				
1984	253	532	Poor				
1985	393	3,724	Good				
1986	561	2,475	Fair				
1987	20	35	Not rated				
1988	180	1,106	Good-poor				
1989							
1990	369	1,237	Good-fair				
1991	455	2,148	Good				
1992							
1993							
1994	526	2,165	Fair				
1995							
1996	138	24,780	Fair				
1997							
1998	97	151	Fair				
1999				12	1,510		
2000						193	24,406
2001						1,091	34,777