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Abundance and Run Timing of Adult Salmon in Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2004

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Abstract

During 2004, a resistance board weir was used to record escapement information for Chinook *Oncorhynchus tshawytscha* and chum salmon *O. keta* in the Gisasa River, a tributary of the Koyukuk River, Alaska. An estimated total of 1,774 Chinook salmon migrated through the weir. Five age groups were identified from 540 Chinook salmon sampled, with age 1.2 (39%) dominating. The sex ratio was 31% female and 69% male. The mean length for 181 females was 835 mm, range 560-985 mm, and the mean length for 359 males was 648 mm, range 340-920 mm. An estimated total of 37,851 chum salmon migrated through the weir. Three age groups were identified from 724 chum salmon sampled, with age 0.3 (75%) dominating. The sex ratio was 44% female and 56% male. The mean length for 357 females was 553 mm, range 470-630 mm, and the mean length for 367 males was 588 mm, range 480-680 mm. The most abundant non-salmon species was longnose sucker *Catostomus catostomus* (N=29), followed by Arctic grayling *Thymallus arcticus* (N=23), whitefish (Coregoninae; N=21), and northern pike *Esox lucius* (N=11). Chinook and chum salmon escapement counts from this portion of the Koyukuk River drainage assist fisheries managers in making in-season decisions during the Yukon River commercial and subsistence fishing seasons, provide post-season evaluation of various management practices, and assist in developing future run projections.

Introduction

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). Chinook, chum, and coho salmon *O. kisutsh* use 1,931 km of the Yukon River and 675 km of the Koyukuk River for migration routes to spawning grounds (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 (Vania et al. 2002). Genetic studies reported by Wilmot et al. (1992) showed that these two runs were genetically distinct and differed in life history and phenotypic characteristics, i.e. run timing, spawning locations, and morphology. Chinook and summer chum salmon run timing in the Yukon River starts in late May and continues through mid-July (Wiswar 2000). Fall chum salmon run timing starts in late June and continues through early September (Vania et al. 2002). Chinook salmon spawn throughout the Yukon River drainage, whereas summer chum salmon spawn mainly in the lower and middle reaches (Minard 1996). Fall chum salmon spawn mainly in the upper portions of the Yukon River drainage.

Recent declines in Yukon River salmon runs, particularly summer and fall chum salmon have led to harvest restrictions, complete fishery closures, and spawning escapements below management goals on many tributaries (Kruse 1998; Vania et al. 2002). The collection of accurate

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escapement estimates from these tributaries is required to determine exploitation rates and stock-recruit relationships (Labelle 1994), and to maintain genetic diversity and sustainable harvest (Vania et al. 2002). Management of the Yukon River fishery is complex due to the inability to determine specific stock abundance and run timing, overlapping of multi-species salmon runs, the increasing efficiency of the fishing fleet, allocation issues, and the immense size of the Yukon River drainage. In an attempt to understand this mixed-stock salmon fishery, several studies are being conducted along the main stem and tributaries of the Yukon River to provide managers with information required to assess in-season Chinook and chum salmon escapements (Vania and Golembeski 2000).

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. Additional USFWS goals are to conserve fish and wildlife populations, maintain habitats in their natural diversity, and provide the opportunity for continued subsistence use by local residents (USFWS 1993). In the Koyukuk River drainage (a middle Yukon River tributary), Chinook and summer chum salmon (hereafter referred to as chum salmon) utilize tributaries that run through National Wildlife Refuge boundaries. The Koyukuk River originates in the Brooks Range, and the river flows southwesterly, passing through the Kanuti (Kanuti Refuge) and Koyukuk/Nowitna (Koyukuk Refuge) National Wildlife Refuges before entering the Yukon River, 818 km upriver from the mouth. The Kanuti Refuge is located on the upper Koyukuk River near the villages of Allakaket, Alatna, and Bettles. The Koyukuk Refuge is located on the lower Koyukuk River near the villages of Koyukuk, Galena, Huslia, and Hughes.

Historically, escapement information on salmon stocks from the Koyukuk River has been collected by aerial surveys. The Alaska Department of Fish and Game, Division of Commercial Fisheries (ADF&G-DCF) 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, such as counting towers, floating weirs, and hydroacoustics. To collect baseline information on salmon stocks in the Koyukuk River drainage, the U.S. Fish and Wildlife Service-Fairbanks Fish and Wildlife Field Office (USFWS-FFWFO) and Bureau of Land Management (BLM) have designed and operated stock status and escapement projects in five different Koyukuk River tributaries. Floating weirs have been operated by USFWS-FFWFO on the Gisasa River since 1994 (VanHatten 2004), on Henshaw Creek since 2000 (VanHatten 2005), the South Fork of the Koyukuk River from 1996 to 1997 (Wiswar 1997, 1998) and on the Kateel River in 2002 (VanHatten 2005). The weir study on the South Fork of the Koyukuk River was discontinued in 1997 due to persistent high water conditions. A counting tower was operated by the Tanana Chiefs Conference (TCC) and BLM on Clear Creek, a tributary of the Hogatza River, from 1995 to 2000 (VanHatten 1999). A standard picket weir was installed on Clear Creek in 2001 and is currently in operation (C. Kretsinger, Bureau of Land Management, Fairbanks, personal communication).

Historical data on Chinook and summer chum salmon in the Gisasa River include aerial survey counts collected from 1960 to 1998 (Barton 1984; Schultz et al. 1993; Vania et al. 2002; Appendix 1). Chinook salmon estimates from aerial surveys ranged from 45 fish in 1978 to 2,775 fish in 1994. Summer chum salmon aerial survey estimates ranged from 0 fish in 1961 to

56,904 fish in 1975. Escapement estimates from a resistance board weir were collected from 1994 to 2004 (Melegari and Wiswar 1995; Melegari 1996, 1997; Wiswar 1998, 1999, 2000, 2001; VanHatten 2002, 2004, 2005). Annual weir counts for Chinook salmon ranged from 1,774 fish in 2004 to 4,023 fish in 1995 (Appendix 1). Chum salmon weir escapements ranged from 10,155 fish in 1999 to 158,752 fish in 1996. This report describes the 2004 Gisasa River escapement project conducted by USFWS-FFWFO. The objectives of the 2004 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.

Study Area

The Gisasa River is located 90 km upriver from the mouth of the Koyukuk River in the western interior of Alaska (Figure 1). The headwaters originate in the Nulato Hills and the river flows 112 km northeast, passing through the Koyukuk Refuge, before draining into the Koyukuk River (65^{o} 15.206' N latitude, 157^{o} 42.529' W longitude, USGS 1:63,360 series, Kateel River B-4 quadrangle). Climate conditions of the Koyukuk River drainage are characteristically continental with seasonal temperature variations and very low precipitation. The air temperature ranges from 18^{o} C during summer months to -57^{o} C during winter months (USFWS 1993). The hydrology of this area is very dynamic throughout the year with high water levels during spring and low water levels in summer.

The Gisasa River channel configuration is typically meandering with alternating cut banks and gravel bars. The substrate varies from gravel and cobble in high velocity areas to mud and silt in lower velocity areas. The lower river sections are characteristically more uniform in appearance with gradual sloping mud banks and emergent shoreline vegetation (USFWS 1993). The weir site is located 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 intermediate diameter).

Methods

Weir Operation

A resistance board weir was used to collect biological information from adult salmon as they migrated into the Gisasa River to spawn. The project start date was based on previous years' run timing data. The end date was determined in-season; when the daily count of each species dropped to less than 1% of the seasonal passage to date and continued at this low level for three or more consecutive days. The construction and installation of resistance board weirs was described by Tobin (1994). Each picket of the weir was made of schedule-40, polyvinyl chloride electrical conduit with 2.5 cm inside diameter and individual pickets spaced 3.2 cm apart, gap between pickets (Wiswar 2001). During daily visual inspection, the weir was cleaned of debris, fish carcasses, and gravel dislodged by spawning fish. A live trap installed near mid-channel allowed salmon and other fish species to be recorded as they passed through the weir.

Biological Data

Run timing and abundance of adult Chinook and chum salmon were estimated by recording and plotting the number of each species of fish passing through the weir each day. Because non-salmon species were not handled, it was difficult to identify different whitefish species; therefore all whitefish species were grouped under the subfamily Coregoninae. Fish that could not be

identified as they passed through the weir were grouped in a separate category, labeled "unidentified".

The counting schedule was designed to count migrating fish species 24 hours a day, 7 days a week for the duration of the project. The daily counting schedule began at 0000 hours and ended at 2400 hours. The 24-hour counting period was divided into eight 3-hour periods, with crew members being assigned two specific periods. During time periods when biological sampling was conducted, an additional crew member would assist.

A stratified random sampling scheme was used to collect age, length, and sex ratio information from both adult salmon species. Sampling started at the beginning of each week and generally was conducted over a 3-4 day period, targeting 160 salmon /species /week. Scales were used for ageing salmon with age class information being reported using the European technique (Foerster 1968). Three scales were collected from Chinook salmon and one scale from 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 from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Scales from both adult salmon species were sent to ADF&G-DCF for processing. Some scales could not be aged do to loss or deterioration. These were placed in a category called unknown age and data from these fish were not included in sample sizes or any age, sex or length calculations. Lengths of Chinook and chum salmon were measured to the nearest 5 mm from mid-eye to fork of the caudal fin (MEL). Sex ratio data were collected during age and length sampling. The sex of each fish was visually determined by secondary sex characteristics. Daily escapement counts and sex ratios were reported to USFWS-FFWFO in Fairbanks.

Data Analysis

When daily counts were missed due to high water they were estimated by linear interpolation between the daily counts before and after the high water event. Incomplete 24h counts due to high water were adjusted for a 24h period. Historic run weir estimate totals were revised to account for missed daily counts and incomplete daily counts. Revised totals are presented in report text, Figure 3, and Appendices.

Calculations for age and sex information were treated as a stratified random sample (Cochran 1977) with statistical weeks as the strata. Each statistical week was defined as beginning on Wednesday and ending on Tuesday. Within a week, the proportion of the samples composed of a given sex or age, $\hat{p}_{ij}$, were calculated as

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j},$$

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 $\hat{p}_{ij}$ was calculated as

$$\hat{v}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_j - 1}.$$

Sex and age compositions for the total run of Chinook and chum salmon of a given sex/age, $\hat{p}_i$ were calculated as

$$\hat{p}_i = \sum_{j-1} \hat{W}_j \hat{p}_{ij,}$$

where the stratum weight $\hat{W}_j$ was calculated as

$$\hat{W}_j = \frac{N_j}{N},$$

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, $\hat{v}(\hat{p}_i)$ of sex and age compositions for the run was calculated as

$$\hat{v}(\hat{p}_i) = \sum_{j-1} \hat{W}_j^2 \hat{v}(\hat{p}_{ij}).$$

Results and Discussion

Weir Operation

In 2004, the Gisasa River weir operated from June 24 to August 1 (Table 1; Figure 2). When the weir was in operation the picket spacing within the trap and weir panels was narrow enough to prevent adult Chinook and chum salmon from passing through the weir. However, smaller fish species, such as Arctic grayling *Thymallus arcticus* and whitefish, likely passed through the weir undetected.

Biological Data

A total of 1,774 Chinook salmon, 37,851 chum salmon, and 106 resident fish were counted as they passed through the weir (Table 1). The most abundant non-salmon species was longnose sucker *Catostomus catostomus* (N=29) followed by Arctic grayling (N=23), whitefish (Coregoninae; N=21), and northern pike *Esox lucius* (N=11). Twenty-two fish could not be identified as they passed through the weir.

The first Chinook salmon was counted on June 26 and the last Chinook salmon was counted on August 1 (Table 1; Figure 2). The first quartile migrated through the weir by July 9, the median migration date was July 13, and the third quartile passed the weir on July 16. There were 586 Chinook salmon sampled for age composition with 46 (8%) of the samples classified as unknown (Table 2). Age composition of sampled Chinook salmon included five age groups: age 1.1 (1%), age 1.2 (39%), age 1.3 (31%), age 1.4 (29%), and age 1.5 (0.4%). In general, Chinook salmon populations are made up of six different age classes, with six year-old fish dominating (Groot and Margolis 1998). The 2004 seasonal Chinook salmon sex ratio was comprised of 31% females, representing a stratified seasonal estimate of 548 female fish (Table 2). A high proportion of females on the spawning ground is indicative of the general health and productivity of a salmon population (Groot and Margolis 1998). In 2004, the Chinook salmon age

distribution by sex was unevenly divided among the five age groups with age 1.4 dominating the females (76%) and ages 1.2 (57%) and 1.3 (38%) dominating the males (Table 2). In 2004, the average female Chinook salmon length was 835 mm with a range from 560 to 985 mm (Table 3). The average male Chinook salmon length was 648 mm with a range from 340 to 920 mm.

The first chum salmon was counted on June 24 and the last chum salmon was counted on August 1 (Table 1; Figure 2). The first quartile migrated through the weir by July 3, the median migration date was July 10, and the third quartile passed the weir on July 16. There were 724 chum salmon sampled for age composition with 84 (10%) classified as unknown (Table 4). Age composition of sampled chum salmon consisted of three age groups: age 0.2 (8%), age 0.3 (75%) and age 0.4 (17%). In general, chum salmon are comprised of age 0.2, age 0.3, and age 0.4 fish with age 0.3 fish dominating (Groot and Margolis 1998). In 2004, female chum salmon comprised 44% of the run, representing a stratified seasonal estimate of 16,778 female fish (Table 4). The age distribution by sex was unevenly divided among the three age groups with age 0.3 chum salmon dominating females (78%) and males (72%; Table 4). The average female chum salmon length was 553 mm with a range from 470 to 630 mm (Table 3). The average male chum salmon length was 588 mm with a range from 480 to 680 mm.

The 2004 Chinook salmon escapement estimate (1,774 fish) was 67% of the 1995-2003 average of 2,656 fish (Figure 3; Appendix 1 and 2). The 2004 chum salmon escapement (37,851 fish) was 76% of the 1995-2003 average of 49,730 fish (Figure 3; Appendix 1 and 3). The Gisasa River Chinook salmon escapement counts fluctuated between 1995 and 2004 (Figure 3). From 1995 to the present the Chinook salmon escapement counts ranged from 1,774 in 2004 to 4,023 in 1995. The chum salmon counts have also undergone considerable fluctuation, ranging from 10,155 in 1999 to 158,752 in 1996. In general, the run size of Chinook salmon returning to the Gisasa River has followed a slightly decreasing trend since 2001 while chum salmon run sizes for the Gisasa River have been steadily increasing since 1999.

Conclusion

Due to the complexity of the Yukon River mixed-stock salmon fishery and the difficulty in managing specific stocks, it is essential to continue collecting information from individual salmon populations, including stocks in the Koyukuk River drainage. It is recommended that the three current enumeration projects in the drainage at Henshaw Creek, Clear Creek, and Gisasa River provide a valuable index of salmon escapement, and as such, should be continued. In addition, these projects allow population status, trends and changes to be monitored and analyzed over a long time-series.

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Table 1. Daily and cumulative (Chinook and chum salmon only) counts of fish migrating through Gisasa River weir, Alaska, 2004 (Cum = Cumulative). * indicates first, middle and third quartile of run.

	Chinook salmon		Chum salmon		Longnose sucker	Arctic grayling	Whitefish spp.	Northern pike	Unidentified
	Daily	Cum	Daily	Cum	Daily	Daily	Daily	Daily	Daily
24-Jun	0	0	36	36	0	0	0	0	0
25-Jun	0	0	459	495	1	0	0	0	0
26-Jun	14	14	1,005	1,500	2	0	0	0	0
27-Jun	14	28	1,527	3,027	2	1	3	2	0
28-Jun	6	34	1,499	4,526	1	1	3	0	0
29-Jun	9	43	1,732	6,258	2	1	5	1	0
30-Jun	14	57	1,007	7,265	3	0	3	0	0
1-Jul	14	71	853	8,118	2	0	1	1	0
2-Jul	18	89	900	9,018	4	0	0	1	0
3-Jul	35	124	858	*9,876	1	0	0	0	1
4-Jul	10	134	709	10,585	1	0	1	0	0
5-Jul	36	170	1,201	11,786	0	0	2	0	2
6-Jul	38	208	1,855	13,641	0	0	0	1	1
7-Jul	39	247	1,093	14,734	1	0	0	0	1
8-Jul	34	281	1,836	16,570	0	3	0	0	0
9-Jul	283	*564	1,939	18,509	0	0	0	0	0
10-Jul	127	691	1,655	*20,164	0	2	0	0	0
11-Jul	147	838	1,596	21,760	0	2	0	0	0
12-Jul	17	855	1,568	23,328	0	1	0	0	0
13-Jul	142	*997	1,824	25,152	1	0	2	0	0
14-Jul	55	1,052	1,632	26,784	1	2	0	0	0
15-Jul	265	1,317	1,289	28,073	1	0	1	0	0
16-Jul	40	*1,357	1,503	*29,576	1	0	0	0	1
17-Jul	170	1,527	1,240	30,816	2	3	0	0	0
18-Jul	47	1,574	917	31,733	1	1	0	1	1
19-Jul	11	1,585	951	32,684	0	1	0	0	1
20-Jul	19	1,604	685	33,369	0	1	0	1	3
21-Jul	18	1,622	846	34,215	0	1	0	1	2
22-Jul	20	1,642	572	34,787	0	1	0	1	1
23-Jul	28	1,670	478	35,265	0	1	0	0	1
24-Jul	20	1,690	600	35,865	0	0	0	0	1
25-Jul	15	1,705	577	36,442	0	0	0	0	1
26-Jul	13	1,718	357	36,799	0	0	0	0	1
27-Jul	12	1,730	333	37,132	0	0	0	0	1
28-Jul	8	1,738	207	37,339	0	0	0	0	0
29-Jul	15	1,753	186	37,525	0	0	0	1	1
30-Jul	13	1,766	131	37,656	1	0	0	0	1
31-Jul	7	1,773	132	37,788	1	0	0	0	1
1-Aug	1	1,774	63	37,851	0	1	0	0	0
Total	1,774		37,851		29	23	21	11	22

Table 2. Age and sex ratios estimates by stratum of Chinook salmon sampled at Gisasa River weir, Alaska, 2004. Standard errors are in parentheses. Season totals are calculated from weighted strata totals. Unknown age data indicate numbers of fish that could not be aged from the scales sampled. These were not included in sex ratio, age distribution calculations, or sample size.

					Brood year and age				
					1997	1998	1999	2000	2001
Strata	Run size (N)	Sample size (n)	Unknown age	Percent female	1.5	1.4	1.3	1.2	1.1
Jun 24 - Jul 4	134	85	10	52 (5.1)	1% (1.2)	32% (5.1)	28% (4.9)	39% (5.3)	0% (0.0)
Jul 5 - Jul 11	704	143	12	29 (3.6)	0% (0.0)	18% (3.3)	34% (4.0)	48% (4.2)	0% (0.0)
Jul 12 - Jul 18	736	155	12	32 (3.6)	0% (0.0)	25% (3.5)	35% (3.8)	40% (3.9)	1% (0.6)
Jul 19 - Jul 25	131	106	7	42 (4.6)	0% (0.0)	39% (4.8)	26% (4.3)	32% (4.6)	3% (1.6)
Jul 26 - Aug 1	69	51	5	45 (6.6)	2% (2.0)	41% (7.0)	25% (6.2)	31% (6.6)	0% (0.0)
Total	1,774	540	46	31 (2.1)	0.4% (0.3)	29% (1.9)	31% (2.0)	39% (2.1)	1% (0.4)
Female	548	181	21		1% (0.8)	76% (3.2)	17% (2.8)	6% (1.7)	0% (0.0)
Male	1,226	359	25		0% (0.0)	4% (1.1)	38% (2.6)	57% (2.6)	1% (0.6)

Table 3. Length at age of female and male Chinook and chum salmon sampled at Gisasa River weir, Alaska, 2004.

	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						4	398	408	21.5	340-435
1.2	10	613	610	10.5	560-670	203	607	615	3.1	465-710
1.3	31	734	740	13.4	620-875	136	698	703	4.8	590-860
1.4	138	872	880	4.7	580-985	16	796	838	28.1	520-920
1.5	2	935	935	15.0	920-950					
Total	181	835	860	7.0	560-985	359	648	635	4.2	340-920
					Chum salmon					
0.2	33	535	535	4.0	490-585	13	565	570	8.5	500-615
0.3	280	552	550	1.6	470-630	266	582	580	2.0	480-665
0.4	44	572	568	4.3	520-630	88	611	620	3.6	500-680
Total	357	553	550	1.5	470-630	367	588	590	1.8	480-680

Table 4. Age and sex ratios estimates by stratum of chum salmon sampled at Gisasa River weir, Alaska, 2004. Standard errors are in parentheses. Season totals are calculated from weighted strata totals. Unknown age data indicate numbers of fish that could not be aged from the scales sampled. These were not included in sex ratio, age distribution calculations, or sample size.

					Brood year and age		
					1999	2000	2001
Strata	Run size (N)	Sample size (n)	Unknown age	Percent female	0.4	0.3	0.2
Jun 24 - Jul 4	10,585	146	14	12 (4.1)	29% (3.8)	64% (4.0)	6% (2.0)
Jul 5 - Jul 11	11,175	144	16	11 (4.0)	17% (3.1)	76% (3.6)	7% (2.1)
Jul 12 - Jul 18	9,973	139	21	12 (4.2)	14% (2.9)	83% (3.2)	4% (1.6)
Jul 19 - Jul 25	4,709	152	15	7 (4.0)	13% (2.8)	77% (3.4)	10% (2.4)
Jul 26 - Aug 1	1,409	143	18	2 (4.1)	12% (2.7)	77% (3.5)	11% (2.6)
Total	37,851	724	84	44 (2.1)	17% (1.4)	75% (1.6)	8% (1.0)
Female	16,778	357	38		12% (1.7)	78% (2.2)	9% (1.5)
Male	21,073	367	46		22% (2.1)	72% (2.3)	6% (1.2)

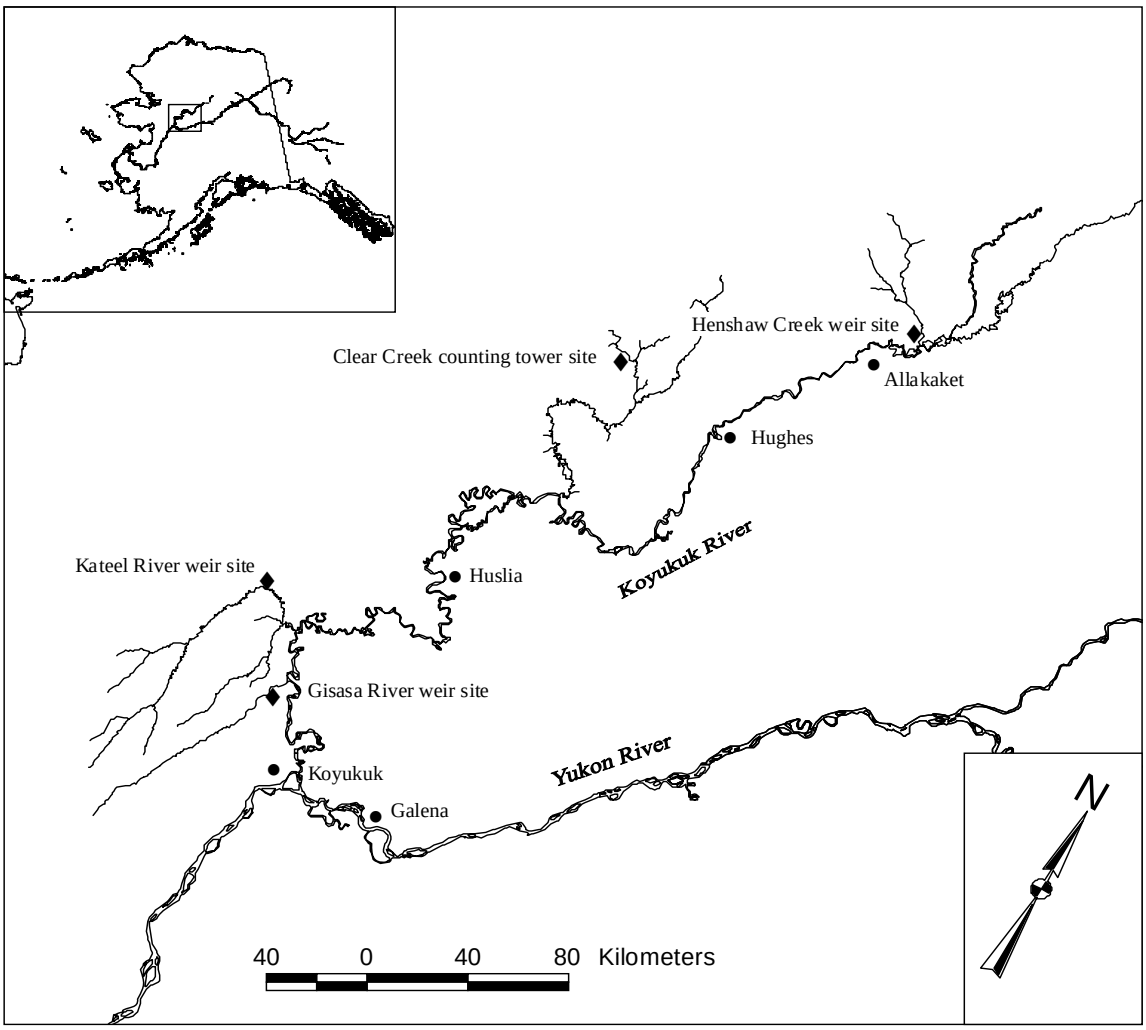

Figure 1. The Koyukuk River and tributary escapement study sites (♦), Alaska, 2004.

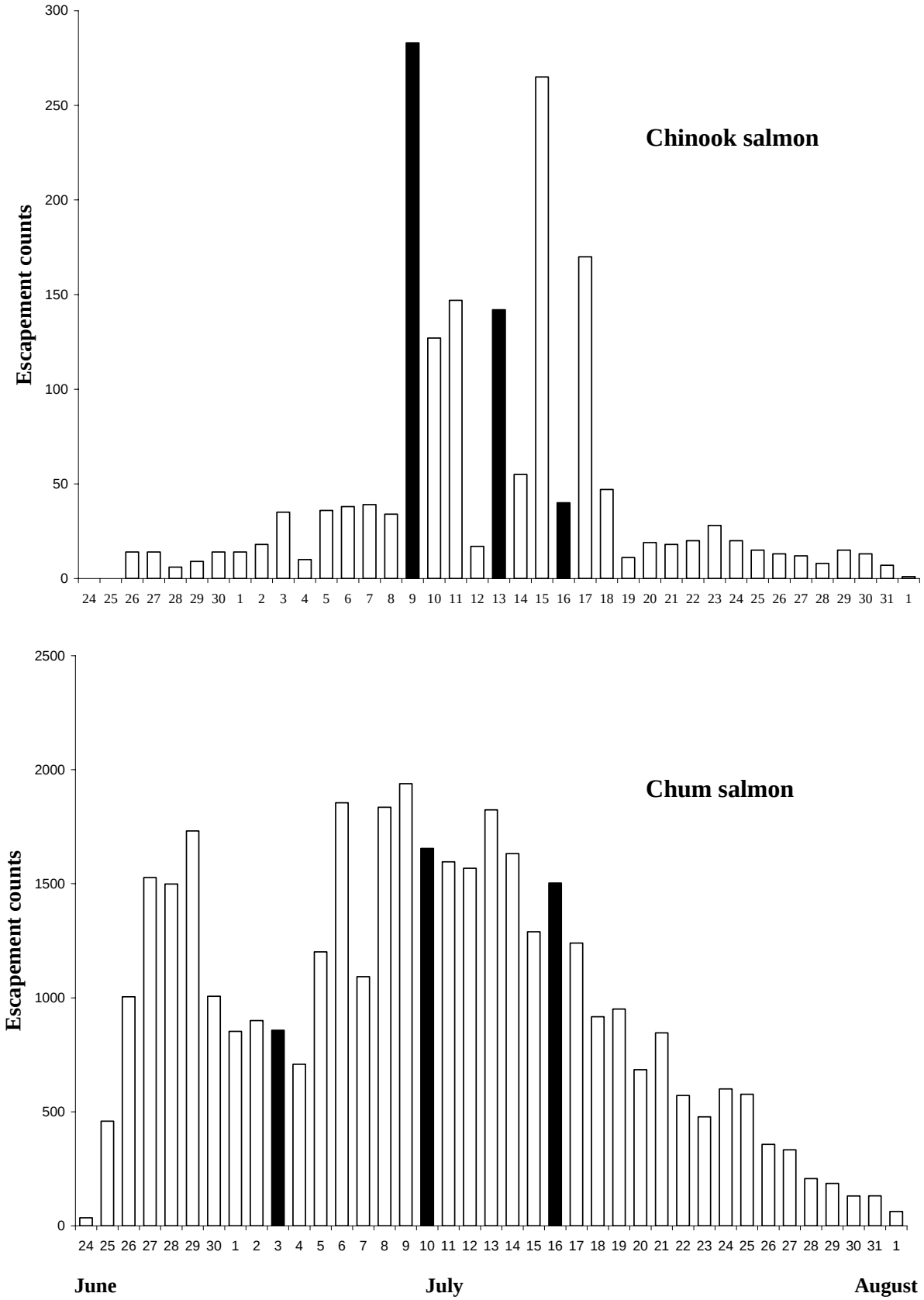

Figure 2. Daily escapement counts of Chinook salmon and chum salmon recorded at Gisasa River Weir, Alaska, 2004. Shaded areas represent first, middle, and third quartile of run.

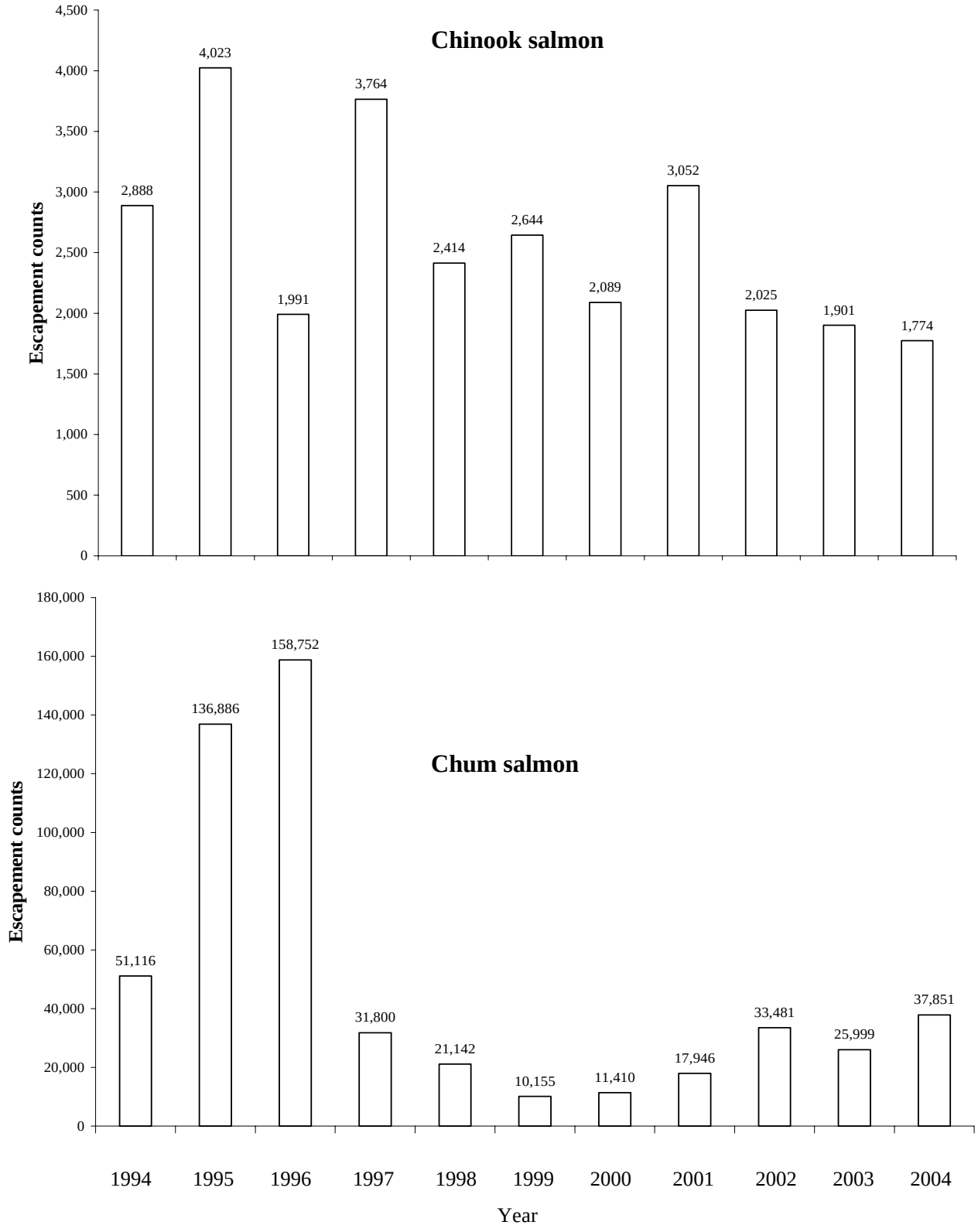

Figure 3. Chinook and chum salmon escapement counts recorded at Gisasa River weir, Alaska, 1994-2004.

Appendix 1. Historical Chinook and chum salmon escapements for Gisasa River, Alaska, 1960-2004. All data except weir estimates are from Barton (1984) and ADF&G, unpublished data. Aerial index estimates are surveys that are rated as poor, fair, or good. Ratings are based on a combination of various environmental conditions such as wind, weather, water, visibility, bottom, time, distance surveyed, and spawning time. Years with no data are left out. Weir estimate totals in bold indicate revisions from previously published data.

	Aerial index estimates			Weir estimates	
Year	Chinook salmon	Chum salmon	Rating	Chinook salmon	Chum salmon
1960	300	400	Good		
1961	266	0	Good		
1974	161	22,022	Good		
1975	385	56,904	Good		
1976	332	21,342	Good		
1977	255	2,204	Good		
1978	45	9,280	Good		
1979	484	10,962	Good		
1980	951	10,388	Good		
1982	421	334	Good		
1983	572	2,356	Good		
1985	735	13,232	Good		
1986	1,346	12,114	Good		
1987	731	2,123	Good		
1988	797	9,284	Good		
1990	884	450	Good		
1991	1,690	7,003	Good		
1992	910	9,300	Good		
1993	1,573	1,581	Good		
1994	2,775	6,827	Good	2,888	51,116
1995	410	6,458	Good	4,023	136,886
1996				**1,991**	**158,752**
1997	144	686	Good	3,764	31,800
1998	889		Poor	**2,414**	**21,142**
1999				**2,644**	**10,155**
2000				2,089	11,410
2001				3,052	**17,946**
2002				**2,025**	**33,481**
2003				**1,901**	**25,999**
2004				1,774	37,851

Appendix 2. Gisasa River weir historical Chinook salmon daily counts and season totals, 1994-2004. Totals in bold indicate revisions from previously published data.

Date	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
14-Jun				0							
15-Jun				0							
16-Jun				0							
17-Jun				0							
18-Jun				0							
19-Jun			0	0							
20-Jun			4	0							
21-Jun		0	9	0	0						
22-Jun		1	6	0	0				0		
23-Jun		0	8	0	0	0			0		
24-Jun		2	32	0	0	0			0		0
25-Jun		4	63	0	0	0			0		0
26-Jun		1	69	0	0	0			1		14
27-Jun		5	16	1	2	0			0		14
28-Jun		19	**46	3	0	1	0		3	2	6
29-Jun		23	*76	9	1	0	0		0	8	9
30-Jun		46	30	2	2	0	0		4	8	14
1-Jul		82	57	33	5	0	0		5	25	14
2-Jul		46	72	11	*13	0	0		5	32	18
3-Jul		35	28	6	**18	0	0		9	**25	35
4-Jul		57	35	78	**22	0	0		0	**18	10
5-Jul		39	41	120	**26	1	0		15	*11	36
6-Jul		92	78	64	*30	2	13		41	23	38
7-Jul		258	234	70	37	1	8	18	134	36	39
8-Jul		175	51	138	71	5	70	41	103	73	34
9-Jul		184	63	310	71	45	40	43	135	186	283
10-Jul		300	81	320	107	60	21	26	134	222	127
11-Jul		385	70	144	116	80	28	100	100	109	147
12-Jul	212	281	51	424	142	19	40	63	259	88	17
13-Jul	259	468	215	137	163	83	82	63	359	120	142
14-Jul	189	205	158	38	225	49	103	117	66	26	55
15-Jul	239	104	40	112	102	50	345	306	78	79	265
16-Jul	355	211	26	146	155	89	223	196	37	41	40
17-Jul	248	126	14	632	115	37	59	299	48	94	170
18-Jul	219	72	38	92	147	154	177	238	23	217	47
19-Jul	302	155	54	257	74	30	66	258	37	102	11
20-Jul	248	62	93	88	62	397	41	388	63	94	19
21-Jul	70	87	15	91	50	363	66	254	22	50	18
22-Jul	42	79	17	142	75	27	188	74	27	57	20
23-Jul	100	68	18	98	54	26	53	44	16	11	28
24-Jul	99	87	45	38	90	70	89	25	18	53	20
25-Jul	65	42	4	120	**84	307	42	36	15	8	15
26-Jul	48	21	21	25	**78	276	13	37	73	22	13
27-Jul	39	45	13	15	**73	103	23	14	91	8	12
28-Jul	33	35			**67	106	18	27	**61	9	8
29-Jul	32	11			*61	68	79	149	**32	16	15
30-Jul	24	42			33	40	52	20	*2	6	13
31-Jul	9	29			17	**33	27	88	9	3	7
1-Aug	21	14			14	**27	27	18		13	1
2-Aug	12	8			12	**20	34	23		0	
3-Aug	5	17				*13	24	9		6	
4-Aug	2					13	16	28			
5-Aug	3					15	10	29			
6-Aug	5					23	3	12			
7-Aug	6					11	9	4			
8-Aug	1							5			
9-Aug	0										
10-Aug	1										
Total	***2,888	4,023	**1,991**	3,764	**2,414**	**2,644**	2,089	3,052	**2,025**	**1,901**	1,774

*Adjusted count, partial day
**Adjusted count, missing day
***Incomplete season

Appendix 3. Gisasa River weir historical Chum salmon daily counts and season totals, 1994-2004. Totals in bold indicate revisions from previously published data.

Date	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
14-Jun				0							
15-Jun				0							
16-Jun				8							
17-Jun				0							
18-Jun				1							
19-Jun			160	8							
20-Jun			2,620	11							
21-Jun		3	3,679	10	8						
22-Jun		131	3,234	30	20				19		
23-Jun		254	6,736	28	69	0			3		
24-Jun		382	7,461	60	114	0			68		36
25-Jun		653	7,855	535	279	0			150		459
26-Jun		955	5,744	247	147	0			128		1,005
27-Jun		1,123	4,422	696	202	0			228		1,527
28-Jun		2,117	**4,982	1,074	253	0	27		356	248	1,499
29-Jun		1,950	*5,542	696	291	0	146		570	230	1,732
30-Jun		2,678	4,939	373	297	1	35		1,331	561	1,007
1-Jul		2,747	5,849	769	359	0	6		1,116	890	853
2-Jul		2,911	7,692	681	*390	0	11		803	655	900
3-Jul		3,253	5,703	852	**838	1	33		833	**680	858
4-Jul		2,967	7,250	1,431	**1,286	113	140		430	**706	709
5-Jul		3,908	10,615	1,895	**1,734	115	462		1,059	*731	1,201
6-Jul		5,663	10,640	1,678	*2,182	50	410		1,765	609	1,855
7-Jul		6,765	7,103	1,466	1,075	257	386	229	2,293	1,181	1,093
8-Jul		7,439	6,241	1,162	1,017	376	493	705	2,122	957	1,836
9-Jul		8,347	4,698	925	1,041	517	366	758	1,879	1,222	1,939
10-Jul		10,664	4,612	1,096	911	467	352	1,176	2,446	1,004	1,655
11-Jul		11,207	4,571	1,052	740	423	414	1,305	1,493	1,455	1,596
12-Jul	6,178	9,710	4,511	1,394	658	281	500	1,522	1,731	1,303	1,568
13-Jul	4,528	9,699	4,045	1,081	623	299	559	1,781	1,898	1,361	1,824
14-Jul	5,195	6,519	4,868	1,113	735	497	500	2,032	1,608	909	1,632
15-Jul	5,449	4,396	3,691	1,140	534	423	678	1,741	1,017	1,287	1,289
16-Jul	3,347	4,690	2,160	1,339	687	426	778	998	1,225	529	1,503
17-Jul	3,450	3,344	1,750	1,248	644	277	579	727	1,186	1,321	1,240
18-Jul	2,193	2,761	1,282	693	487	372	931	575	1,086	1,924	917
19-Jul	2,089	2,706	1,081	795	385	372	512	708	774	1,439	951
20-Jul	2,007	2,944	456	721	253	388	390	616	728	823	685
21-Jul	1,416	2,461	465	724	310	300	298	549	669	626	846
22-Jul	1,864	1,709	265	1,233	262	202	370	492	544	432	572
23-Jul	2,138	1,524	334	1,081	267	267	291	432	377	264	478
24-Jul	1,676	1,343	320	564	292	354	173	266	272	411	600
25-Jul	2,120	1,280	348	918	**294	644	154	250	268	209	577
26-Jul	1,994	1,073	492	367	**296	433	100	142	315	168	357
27-Jul	1,325	1,158	336	605	**297	252	141	114	226	212	333
28-Jul	994	896			**299	239	112	149	**178	310	207
29-Jul	671	656			*301	315	215	146	**130	316	186
30-Jul	360	500			91	165	206	87	*82	264	131
31-Jul	321	439			69	**184	171	76	75	120	132
1-Aug	247	299			58	**203	90	67		204	63
2-Aug	205	330			47	**221	116	63		207	
3-Aug	225	332				*240	88	56		231	
4-Aug	238					135	72	50			
5-Aug	259					168	44	43			
6-Aug	194					109	25	41			
7-Aug	169					69	36	44			
8-Aug	130							6			
9-Aug	81										
10-Aug	53										
Total	***51,116	136,886	**158,752**	31,800	**21,142**	**10,155**	11,410	**17,946**	**33,481**	**25,999**	37,851

*Adjusted count, partial day

**Adjusted count, missing day

***Incomplete season