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Abundance and Run Timing of Adult Salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska, 2023

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Cover Photo: Gisasa River Weir, 2023. Photo courtesy of USFWS.

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Jeremy Carlson

Abstract

A resistance board weir was operated by the U.S. Fish and Wildlife Service, Northern Alaska Fish and Wildlife Field Office to collect information on abundance, run timing, and biology of returning adult Chinook Salmon *Oncorhynchus tshawytscha* and summer Chum Salmon *O. keta* in the Gisasa River. The weir has been operated at this location since 1994 except for 2018, 2020, and 2021. This is the sixth-year video technology has been incorporated into the project since 2015. In 2023, the weir was operated from the end of the day on July 4 through August 2 during which an estimated 477 Chinook Salmon and 16,921 summer Chum Salmon passed through the weir. Other species enumerated through the weir, in order of abundance, were Northern Pike *Esox lucius* (N = 69), Sockeye Salmon *O. nerka* (N = 23), Longnose Sucker *Catostomus catostomus* (N = 6), Humpback Whitefish *Coregonus pidschian* (N = 4), Dolly Varden *Salvelinus malma* (N = 2), Arctic Grayling *Thymallus arcticus* (N = 1), Broad Whitefish *Coregonus nasus* (N = 1), and Pink Salmon *O. gorbuscha* (N = 1). A total of 33 Chinook Salmon and 288 summer Chum Salmon were sampled for age, sex, and length (ASL) data. The sample size goal was not met for Chinook Salmon and ASL analyses could not be performed for this species. The summer Chum Salmon ASL samples were divided into four strata (July 4 through 9, July 10 through 18, July 19 through 26, and July 27 through August 2). The estimated percent female based on weighted strata totals was 58. There were two primary age classes identified for summer Chum Salmon: 0.3 and 0.4. Length-at-age of male summer Chum Salmon was larger than females.

Introduction

The Gisasa River, located within the Koyukuk National Wildlife Refuge in northcentral interior Alaska, is a tributary of the Koyukuk River and provides spawning and rearing habitat for Chinook Salmon *Oncorhynchus tshawytscha* and summer Chum Salmon *O. keta*. These salmon species in the Gisasa River contribute to mixed stock subsistence and commercial fisheries in the Yukon River (USFWS 1993). The U.S. Fish and Wildlife Service (USFWS), through Section 302 of the Alaska National Interest Lands Conservation Act, has a responsibility to ensure that salmon populations within federal conservation units are conserved in their natural diversity, international treaty agreements are met, and subsistence opportunities are maintained.

Yukon River salmon returns declined in the late 1990s (Kruse 1998). These declines led to harvest restrictions, complete fishery closures, and spawning escapements below management goals (Vania et al. 2002). Since the late 1990s, summer Chum Salmon returns have shown considerable variability with no pattern of declining numbers, although 2021 was the lowest summer Chum Salmon return on record (JTC 2022). However, Chinook Salmon returns rebounded and continued to improve from 2001 to 2006, and then declined again from 2007 to 2016. The 2017 passage was the highest since 2003, while the 2021 passage was the lowest Chinook Salmon return since 2003 (JTC 2022). In the Yukon River drainage, management of individual stocks does not occur, and accurate escapement

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data are limited. In-season management of the salmon fisheries is conducted using preseason projections based on parent stock returns, salmon counts from sonar projects at Pilot Station and Eagle, data from test fisheries and escapement assessment projects, and harvest data from subsistence and commercial fisheries.

Historically, escapement information on individual salmon stocks from the Koyukuk River has been collected by aerial surveys. The Alaska Department of Fish and Game (ADF&G) has conducted these surveys on several index tributaries within the Koyukuk River drainage intermittently since 1960 (Barton 1984). Aerial survey results, however, are highly variable and provide only a point in time index of relative run strength. Counts produced using weirs or counting towers provide a better estimation of escapement, and weirs provide a platform for collecting other biological data. Weirs or counting towers have been operated on five different Koyukuk River tributaries since 1994, but only the weir on the Gisasa River was operational in 2023 (Figure 1).

The USFWS, Northern Alaska Fish and Wildlife Field Office (NAFWFO), has operated a resistance board weir on the Gisasa River since 1994 (Melegari and Wiswar 1995) (Appendix 1). Chinook Salmon escapement estimates from weir counts on the Gisasa River through 2023 range from 477 to 4,023 fish per year. Summer Chum Salmon escapement estimates for the same period range from 3,300 to 261,305 fish per year. The Gisasa River weir study objectives for 2023 were to: (1) determine daily fish passage, estimate seasonal escapement, and describe run timing of adult Chinook and summer Chum Salmon; (2) determine age, sex, and length composition of adult Chinook and summer Chum Salmon; (3) document observations of resident fish; and (4) work with Tanana Chiefs Conference (TCC), as the tribal organization for the region, to transition operation of the project from USFWS staff to TCC.

Study Area

The Gisasa River headwaters originate in the Nulato Hills, and the river flows northeast as it passes through the Koyukuk National Wildlife Refuge. Approximately 112 km from its source, the Gisasa River enters the Koyukuk River at roughly 65° 15.149' N, 157° 42.925' W (USGS 1:63,360 series, Kateel River B-4 quadrangle), 90 km upriver from the confluence of the Koyukuk and Yukon rivers (Figure 1). Climate in the region is continental subarctic with dramatic seasonal temperature variations and low precipitation. Mean annual air temperature at the village of Galena, 64 km southeast of the Gisasa River is 3.8 °C with extremes ranging from 32 °C during summer to -57 °C during winter (USFWS 1993). The hydrology of this area is dynamic throughout the year, with lower flows generally occurring in late summer. Peak flows usually occur during spring break up or occasionally during summer high precipitation events. Rivers in the area generally begin to freeze during October and break up during May.

The weir site is located approximately 4 km upriver from the mouth of the Gisasa River. This section of the river is straight with generally laminar flow. The river channel cross section slopes gradually from both stream banks to the thalweg and is approximately 45 m wide. The water depth at the trap near the thalweg ranged from 96 to 132 cm (Appendix 2). Predominant substrate at the weir site consists of medium-sized gravel 35 to 70 mm in diameter.

Methods

Weir Operation

A resistance board weir was used to enumerate and collect biological data from adult salmon as they migrated up the Gisasa River to spawn. The Gisasa River weir has been installed at the same site since the project was initiated in 1994, following the construction and installation methods described by Tobin (1994). More detailed information on deployment of the Gisasa River weir can be found in Melegari and Wiswar (1995). A live trap was installed approximately mid-channel, near the thalweg, allowing fish to be recorded as they passed through the weir and, when necessary, the trap was closed to collect fish for sampling. The weir was visually inspected for integrity and cleaned of debris daily. Cleaning consisted of raking debris from the upstream surface of the weir or walking across each panel to submerge it enough to allow the current to wash debris downstream. The picket spacing within the trap and weir panels (3.5 cm between pickets) was narrow enough to prevent adult Chinook and summer Chum Salmon from passing through the weir. However, some individuals of smaller fish species, such as Arctic Grayling *Thymallus arcticus* and Whitefish *Coregonus* spp., were likely able to pass through the weir undetected.

A video camera system was installed on the upstream side of the weir trap box to capture video footage of migrating salmon and other species. The video camera box funneled fish into a narrow passage chute that allowed for the continual movement of fish through the weir, and motion capture video recording was used to count and identify all species passing through the weir. A new, narrower passage chute first deployed in 2015 helped improve species identification and made enumeration easier by limiting overlapping fish in the view window.

Once video counting began, motion capture features were enabled, and all counting was conducted from individual motion capture files. Motion capture files were saved to a hard drive and reviewed to produce hourly counts of fish identified to species. Total hourly counts were entered into an electronic data sheet daily. The video box was equipped with LED lights so that fish could be observed and counted 24 hours per day. Escapement counts and sex ratios from the previous day were reported daily to the NAFWFO by satellite telephone or inReach device. Adjustments to video settings and equipment were made as necessary to optimize image quality and performance of the system. During the first week of weir operation, motion capture performance was closely monitored and compared to visual counts to verify that settings were adjusted properly and all fish passing the camera were detected. After the initial verification period, only motion capture video files were used for the remainder of the season. Accuracy was monitored throughout the season with short visual observation periods.

The target start date for weir operation was June 18. The end date of the project was determined inseason, when the daily count of both Chinook and summer Chum Salmon dropped to less than 1% of the seasonal passage to date for three consecutive days, or when logistical constraints required stopping before this point was reached.

Hydrological Data

Water depth (cm) was recorded twice daily at the weir trap at approximately 1000 hours and 2200 hours. Water temperature (°C) was taken twice daily with a handheld thermometer upstream of the weir in a section of river where water was well mixed.

Biological Data

Sex and length data and scale samples (to determine age) were collected from Chinook and summer Chum Salmon in a trap connected to the passage chute. Both ends of the trap were closed to retain fish during sampling but were open at all other times. To avoid temperature stress, sampling and fish handling were suspended if water temperatures remained above 17 °C for three consecutive days or any time temperatures reached or exceeded 20 °C (Shink 2020). The sample size goal for each species was 220–240 fish for the season. This goal was based on a statistical calculation indicating that a minimum of 180 samples are required to obtain eight simultaneous 95% confidence intervals for age-sex classes such that each interval is no more that ± 0.1 unit wide (Bromaghin 1993). The sample size was increased by 25% above this minimum as an allowance for unreadable scales and other sampling errors. To accurately characterize the composition of the entire run, the total number of samples must be distributed throughout the run roughly in proportion to escapement, while not exceeding the target number of samples. As a pre-season guideline for sampling, the season was divided into three periods, or tertiles, based on historical fish passage counts, and the target sample size within each tertile was 73–80 fish. The tertile dates designated for both Chinook and summer Chum Salmon were July 4–9, July 10–18, and July 19–31. To ensure consistent sampling effort towards meeting the target sample size for each tertile, daily and weekly targets were set. Salmon were sampled opportunistically during a day or week until these targets were met.

For age determination, three scales from each Chinook Salmon and one scale from each summer Chum Salmon were collected from the preferred sampling area (INPFC 1963). Scales were collected from the left side of the fish, 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 the Stock Biology group at ADF&G Division of Commercial Fisheries in Anchorage for age analysis (Eaton 2015). Fish length was measured from mid-eye to fork of tail (MEFL), and sex was visually determined from external characteristics such as kype development or the presence of an ovipositor. Previous studies have shown that nearly all age-1.1 and -1.2 Chinook Salmon, including those less than 650 mm (MEFL) are males (Brady 1983; Bales 2007; Karpovich and DuBois 2007). Therefore, all age-1.1 and -1.2 Chinook Salmon and those fish less than 650 mm (MEFL) were assumed to be males.

Data Analysis

The biological sampling guideline based on previous years' run timing is for crew guidance only and does not ensure that sample distribution over time will correspond to actual run timing. Therefore, age, sex, and length data were post-stratified during analysis by distributing them into two or more periods which had approximately equal fish passage numbers. Weighted estimates from each period were then combined to form seasonal estimates of age and sex composition.

Means and standard errors were calculated and reported for fish lengths within each age and sex class. Lengths within each age-sex class were assumed not to vary substantially over the seasonal progression of the run, so length calculations were made on pooled, unweighted samples within each age-sex class.

Age and sex composition was calculated as population proportions based on the number of sampled fish in each age and sex class. In each sampling period i, a number of fish n_i were sampled, and of these, a number n_{ij} were determined to be of class j (by age, sex, or age and sex combined). The proportion p_{ij} of fish of class j in sampling period i was estimated as:

$$\widehat{p_{ij}} = \frac{n_{ij}}{n_i} \; . \qquad (1)$$

Sample proportions were weighted by the proportion N_i/N of the total population N available for sampling within period i (i.e., proportion of the total seasonal escapement counted during period i). Weighted sample proportions were summed across K periods to provide a pooled seasonal estimate of the proportion of class j, as:

$$\hat{p}_j = \sum_{i=1}^{K} \frac{N_i}{N} \hat{p}_{ij}. \quad (2)$$

The variance of each seasonal age, sex, or age-sex class proportion was estimated as:

$$\widehat{Var}(\hat{p}_j) = \sum_{i=1}^{K} \left(1 - \frac{n_i}{N_i}\right)\left(\frac{N_i}{N}\right)^2 \frac{\hat{p}_{ij}(1 - \hat{p}_{ij})}{n_i - 1}. \quad (3)$$

Using the above equation for variance and assuming asymptotic normality, 95% confidence intervals (CI) were constructed as:

$$\hat{p}_j \pm 1.96\sqrt{\widehat{Var}(\hat{p}_j)}. \quad (4)$$

Results and Discussion

Weir Operation

The target start date of June 18 was not met due to a late spring breakup and associated high water. However, the weir was fully operational and fish tight at 1500 hours on July 4, with 6 Chinook Salmon and 207 summer Chum Salmon passing through on that day. Counting became increasingly difficult starting on July 9 due to rising water and decreased visibility and continued to be difficult until July 16. Counts should be considered underestimates from July 9 through July 16 due to high turbidity and low visibility. In addition, no data were collected on July 11 and 12 due to high water and unsafe conditions. The video camera system worked well for most of the season, except during this high-water event, when turbidity was extremely high and made video capture impossible. Weir operations were stopped for the season at 0000 hours on August 3.

Hydrological Data

The average river stage height during weir operations was 109 cm and ranged between 96 cm and 132 cm. Water temperature during the season averaged 12 °C and ranged from 7 °C to 17 °C (Figure 2, Appendix 2).

Biological Data

An estimated 477 Chinook Salmon and 16,921 summer Chum Salmon (Table 1) passed through the weir during the period of operation. The next most abundant species was Northern Pike *Esox lucius* ($N = 69$), followed by Sockeye Salmon *O. nerka* ($N = 23$), Longnose Sucker *Catostomus catostomus* ($N = 6$), Humpback Whitefish *Coregonus pidschian* ($N = 4$), Dolly Varden *Salvelinus malma* ($N = 2$), Arctic Grayling *Thymallus arcticus* ($N = 1$), Broad Whitefish *Coregonus nasus* ($N = 1$), and Pink Salmon *O. gorbuscha* ($N = 1$).

Chinook Salmon — The estimated Chinook Salmon escapement (*N* = 477) was well below the 1995–2022 historical average annual escapement of 1,994 (Figure 3, Appendix 1). Six Chinook Salmon passed through the weir on July 4 which was the date the weir was installed. Ten Chinook Salmon passed through the weir on the last day of counting (August 2), representing 2.1% of total escapement. We assume the estimated Chinook Salmon escapement to be an underestimate because high, turbid water prevented accurate escapement estimates for Chinook Salmon between July 9 and July 16 with no data collected on July 11 and 12. The mid-point of Chinook Salmon passage occurred on July 20, with the first and third quarter passage dates occurring on July 15 and July 26, respectively (Table 1, Figure 4). We assume the actual quartile passage dates would be earlier than reported here, as counting started late this season due to high water.

Sex and length data, and scale samples were collected from 33 Chinook Salmon. Due to the low total run size, there was difficulty obtaining samples, and the sample size goal was not achieved. Because of the insufficient number of samples, ASL analyses could not be performed for Chinook Salmon.

Summer Chum Salmon — The estimated summer Chum Salmon escapement (*N* = 16,921) was well below the 1995–2022 historical average annual escapement of 64,185 (Figure 5, Appendix 1). A total of 207 summer Chum Salmon passed through the weir on July 4, which was the date the weir was installed. A total of 258 summer Chum Salmon passed through the weir on the last day of counting (August 2), representing 1.5% of total escapement (August 2). We assume the estimated summer Chum Salmon escapement to be an underestimate because high, turbid water prevented accurate escapement estimates for summer Chum Salmon between July 9 and July 16 with no data collected on July 11 and 12. In addition, a small number of summer Chum Salmon likely passed the site after the weir was removed for the season. The mid-point of summer Chum Salmon passage occurred on July 21, with the first and third quarter passage dates occurring on July 16 and July 26, respectively (Table 1, Figure 6). We assume the actual quartile passage dates would be earlier than reported here, as counting started late this season due to high water.

Sex and length data, and scale samples were collected from 288 summer Chum Salmon. Age was unable to be determined for 13.9% of the samples (*n* = 40), due to the scale being missing, inverted, illegible, regenerated, or absorbed (Table 2). Four age classes of summer Chum Salmon were identified, 0.2, 0.3, 0.4, and 0.5, from brood years 2020, 2019, 2018, and 2017. Age classes 0.3 and 0.4 comprised 67% and 32% of the escapement respectively. Age classes 0.2 and 0.5 were represented by three and four females in each age class, respectively. (Table 3).

The estimated sex composition for summer Chum Salmon based on weighted strata totals was 58% female, which was slightly higher than the 1995–2022 average of 52% female (Table 2, Appendices 3 and 4). Female summer Chum Salmon lengths ranged from 425 to 585 mm MEFL (Table 3). Male summer Chum Salmon lengths ranged from 475 to 640 mm MEFL (Table 3). Mean length-at-age of male summer Chum Salmon was larger than that of females for both predominant age classes, 0.3 and 0.4 (Table 3).

The Gisasa River weir has produced 27 years of salmon escapement data (1994–2023, excluding 2018, 2020, and 2021). In addition to helping state and federal fisheries managers direct in-season management decisions, these data are instrumental to developing future run projections and evaluating escapement goals and harvest allocations throughout the Yukon River drainage. Long-term data sets such as these allow for the analysis of trends in salmon population status, size, length, age, and sex composition, which continues to be of great importance as stressors affecting Yukon

River salmon, including climate change, disease, selective harvest, and overall demand, change over time.

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Table 1. — Daily and cumulative (cum) estimates of Chinook Salmon and summer Chum Salmon passage, and daily estimates of other species, at the Gisasa River weir, Alaska, 2023.

Date	Chinook Salmon daily	Chinook Salmon cum	Chum Salmon daily	Chum Salmon cum	Sockeye Salmon daily	Northern Pike daily	Arctic Grayling daily	Whitefish daily	Longnose Sucker daily	Dolly Varden daily	Pink Salmon daily
Jul-04	6	6	207	207	0	1	0	0	0	0	0
Jul-05	13	19	233	440	0	0	0	0	0	0	0
Jul-06	10	29	316	756	0	0	0	0	0	0	0
Jul-07	30	59	929	1,685	0	3	1	0	0	0	0
Jul-08	18	77	775	2,460	0	2	0	0	0	0	0
Jul-09	13	90	497	2,957	0	7	0	1	0	0	0
Jul-10	17	107	440	3,397	0	0	0	0	0	0	0
Jul-11	ND	107	ND	3,397	ND	ND	ND	ND	ND	ND	ND
Jul-12	ND	107	ND	3,397	ND	ND	ND	ND	ND	ND	ND
Jul-13	3	110	108	3,505	0	0	0	0	0	0	0
Jul-14	8	118	350	3,855	0	3	0	0	0	0	0
Jul-15	14	132*	273	4,128	0	0	0	0	0	0	0
Jul-16	12	144	397	4,525*	0	1	0	0	0	0	0
Jul-17	20	164	738	5,263	0	3	0	0	0	1	0
Jul-18	33	197	1,008	6,271	0	3	0	0	0	0	0
Jul-19	31	228	1,029	7,300	1	3	0	1	0	0	0
Jul-20	23	251*	809	8,109	0	3	0	0	1	0	1
Jul-21	32	283	581	8,690*	0	9	0	0	0	1	0
Jul-22	22	305	546	9,236	2	4	0	0	0	0	0
Jul-23	18	323	781	10,017	2	2	0	1	1	0	0
Jul-24	16	339	1,081	11,098	1	1	0	0	0	0	0
Jul-25	12	351	923	12,021	2	1	0	1	3	0	0
Jul-26	24	375*	1,016	13,037*	0	5	0	0	0	0	0
Jul-27	22	397	899	13,936	1	4	0	0	1	0	0
Jul-28	19	416	704	14,640	2	2	0	0	0	0	0
Jul-29	18	434	601	15,241	2	1	0	0	0	0	0
Jul-30	9	443	444	15,685	2	1	0	1	0	0	0
Jul-31	14	457	597	16,282	4	4	0	0	0	0	0
Aug-1	10	467	381	16,663	3	4	0	0	0	0	0
Aug-2	10	477	258	16,921	1	2	0	0	0	0	0
Total	477	477	16,921	16,921	23	69	1	5	6	2	1

Note: Asterisks (*) indicate first quarter, mid, and third quarter points of Chinook Salmon and summer Chum Salmon passage estimates. In 2023, counts are considered underestimates due to high water and low visibility. No data were collected on July 11 and 12 due to extremely high water and unsafe conditions.

Table 2. — Age and sex ratio estimates of summer Chum Salmon at the Gisasa River weir, Alaska, 2023.

Strata dates	Run size (N)	Sample size (n)	% Female	Unknown age	Brood year 2020 (age 0.2)	Brood year 2019 (age 0.3)	Brood year 2018 (age 0.4)	Brood year 2017 (age 0.5)
July 4–9	2,957	94	37%	6	1.1% (1.2)	77.9% (4.5)	18.6% (4.2)	2.3% (1.6)
July 10–18	3,314	88	59%	10	1.2% (1.2)	68.2% (5.1)	28.2% (4.9)	2.4% (1.7)
July 19–26	6,766	69	64%	5	0% (0.0)	64.6% (6.0)	35.4% (6.0)	0% (0.0)
July 27–Aug 2	3,884	37	65%	19	2.9% (0.8)	60.0% (8.4)	37.1% (8.3)	0% (0.0)
Total	16,921	288	58%*	40	1.1% (0.7)	66.6% (3.3)	31.5% (3.3)	0% (0.0)
Female	9,893*	155	-	27	1.8% (1.2)	66.1% (4.5)	30.5% (4.4)	0% (0.0)
Male	7,028*	133	-	13	0% (0.0)	67.0% (5.0)	33.0% (5.0)	0% (0.0)

Note: Standard errors are in parentheses. *Season totals calculated from weighted strata totals. Unknown age indicates numbers of fish that could not be aged from the scales sampled and were not included in age calculations.

Table 3. — Length-at-age of male and female summer Chum Salmon sampled at Gisasa River weir, Alaska, 2023.

Age	Male N	Male mean	Male SE	Male median	Male range	Female N	Female mean	Female SE	Female median	Female range
0.2	-	-	-	-	-	3	512	8.3	520	495–520
0.3	90	559	3.1	560	475–640	98	531	2.1	530	495–580
0.4	35	564	4.5	565	510–610	41	543	3.2	550	500–585
0.5	-	-	-	-	-	4	534	6.3	533	520–550
Total	125	561	2.53	560	475–640	146	518	1.8	535	425–585

Note: Length was measured mid-eye to fork, MEFL (mm).

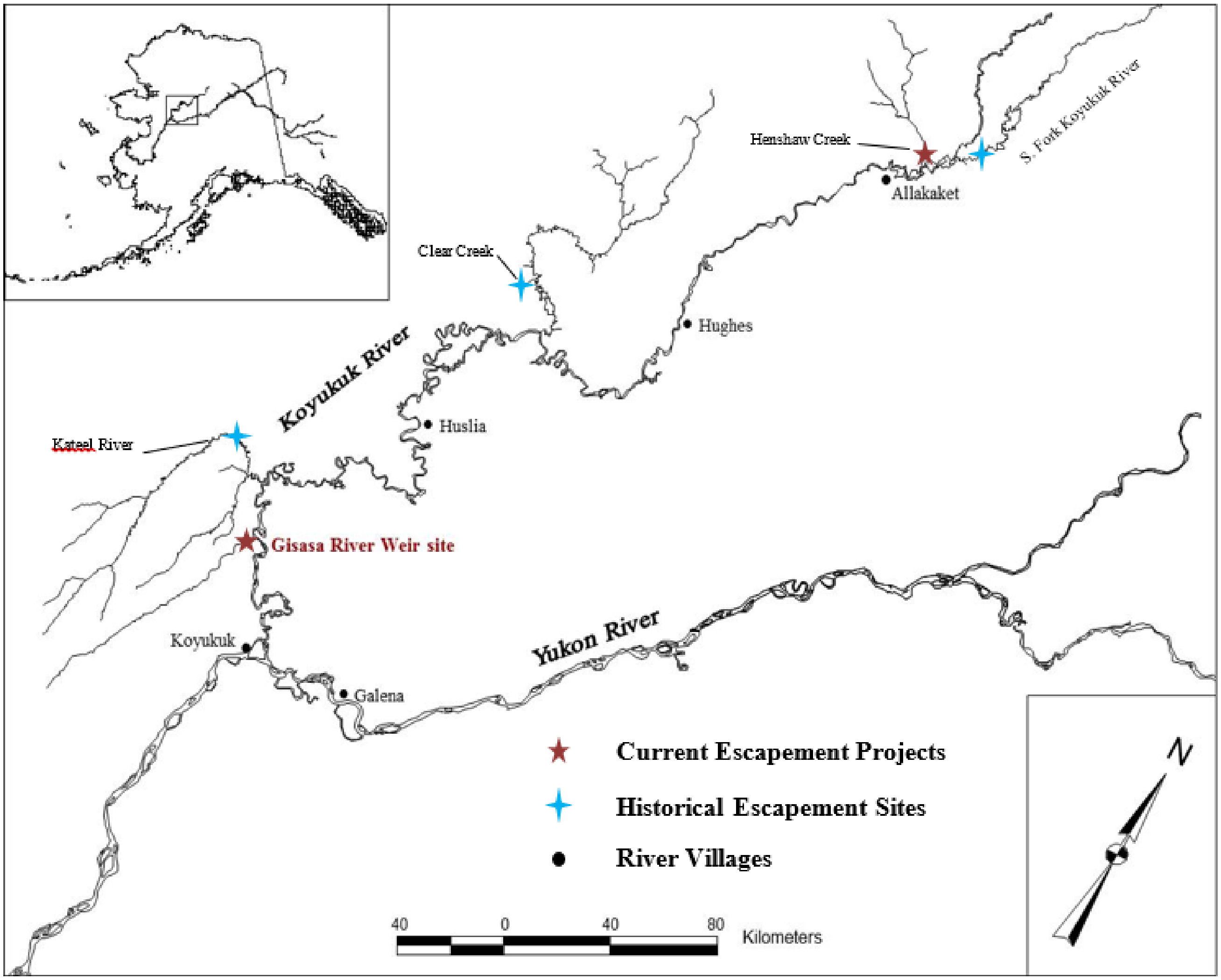


Figure 1. — Location of the Gisasa River weir and other active and historical tributary escapement project sites in the Koyukuk River drainage, Alaska.

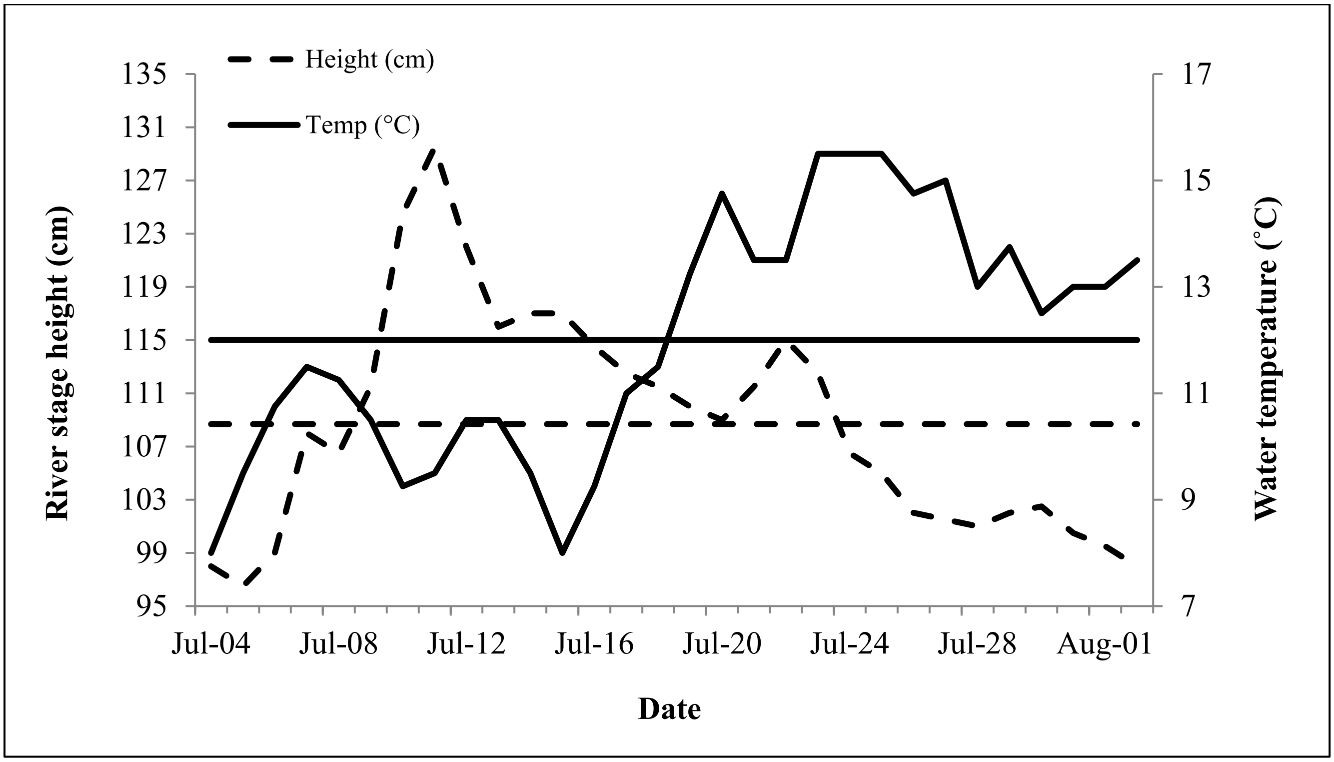


Figure 2. — Average daily river stage height and water temperature at the Gisasa River weir, Alaska, 2023.

Note: Horizontal lines represent the 2023 average river stage height (dashed) and water temperature (solid). The average was calculated from the morning and evening water temperature and river stage height values.

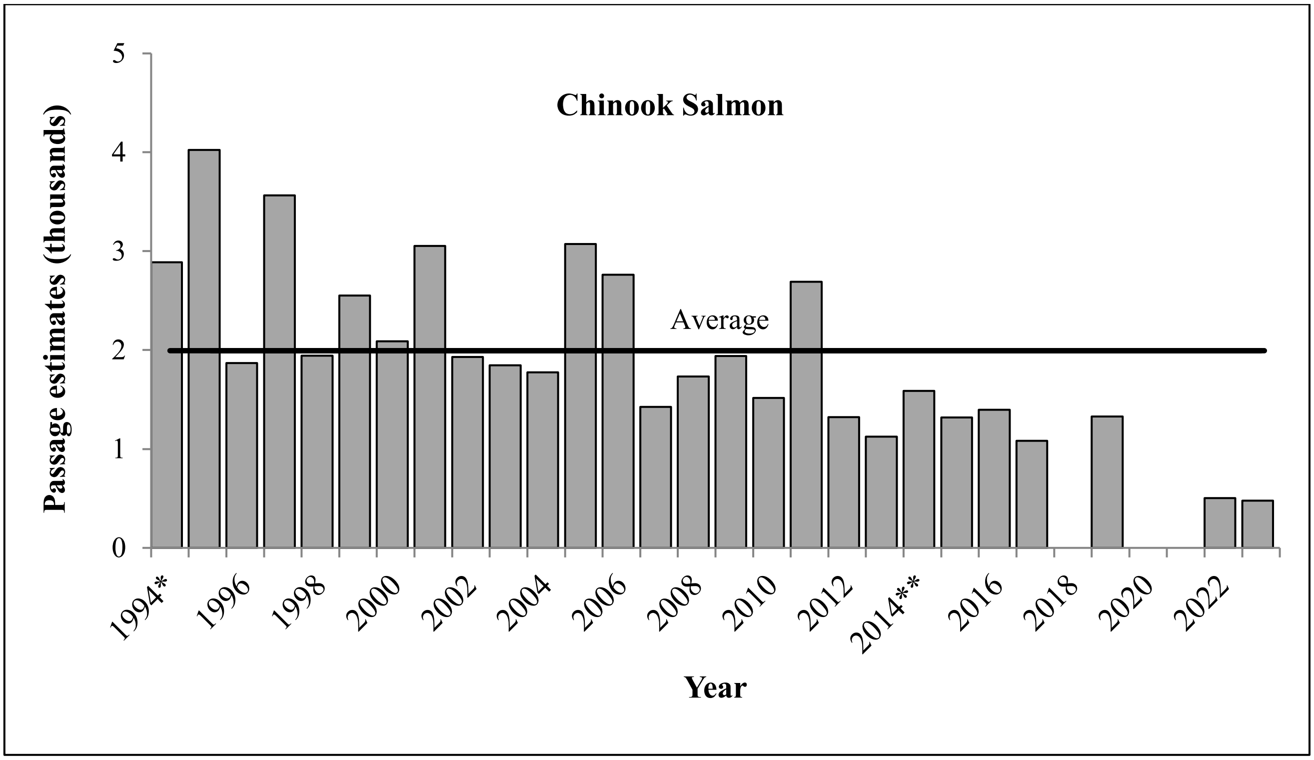


Figure 3. — Chinook Salmon escapement estimates at the Gisasa River weir, Alaska, 1994–2023.

Note: *Data from the first year of operation (1994) represent only a partial count; counting did not begin until July 10, after the run was underway. These data are not included in the average. **Data from 2014 represent a partial count due to high water events and are not included in the average. The horizontal line represents the 1995–2022 average. The weir was not operated in 2018, 2020, and 2021. In 2023, counts are considered underestimates due to high water and low visibility. No data were collected on July 11 and 12 due to extremely high water and unsafe conditions.

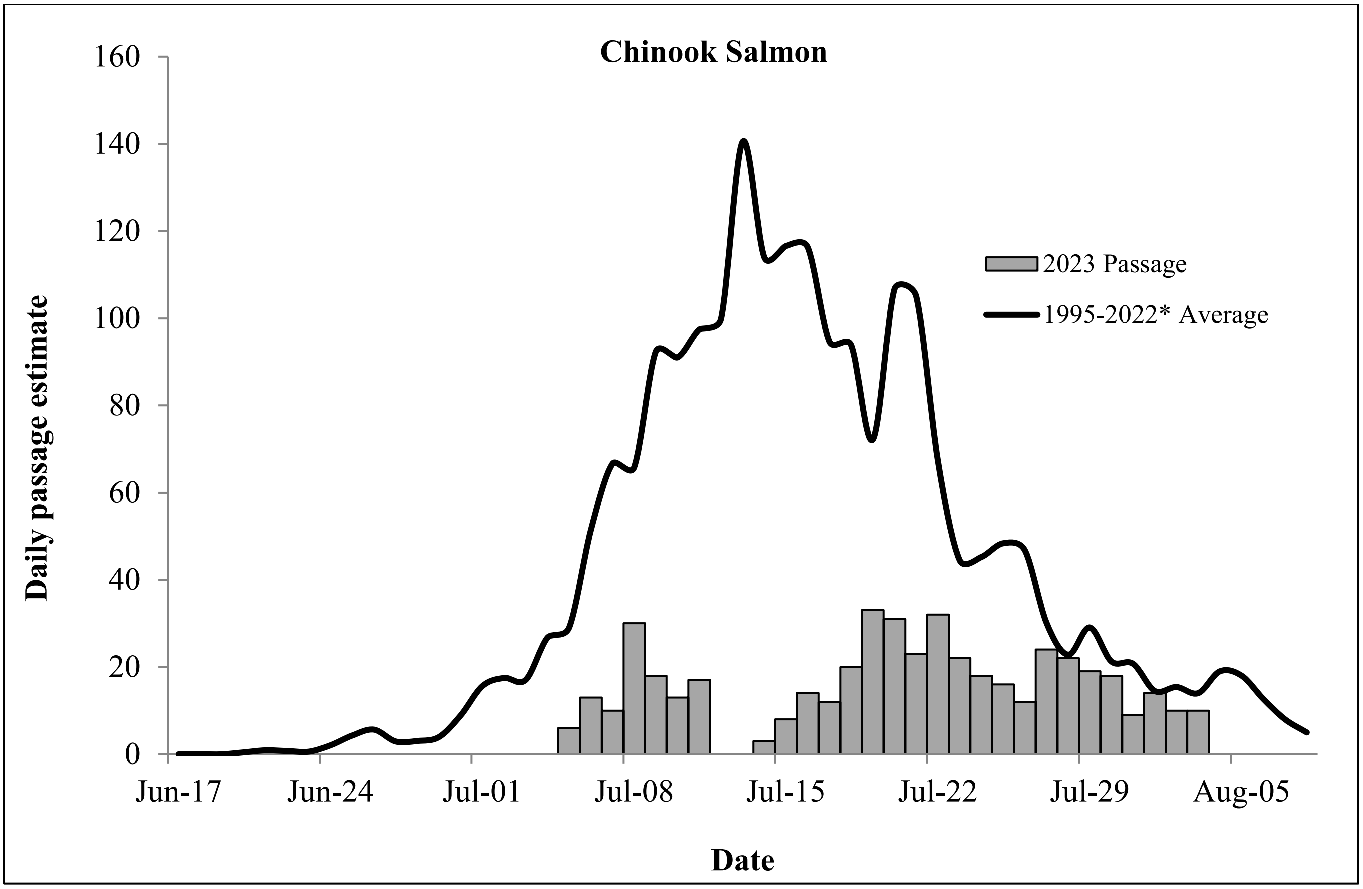


Figure 4. — Daily 2023 and average daily (1995–2022) Chinook Salmon passage estimates through the Gisasa River weir, Alaska.

Note: The weir did not operate in 2018, 2020, and 2021*. In 2023, counts are considered underestimates due to high water and low visibility. No data were collected on July 11 and 12 due to extremely high water and unsafe conditions.

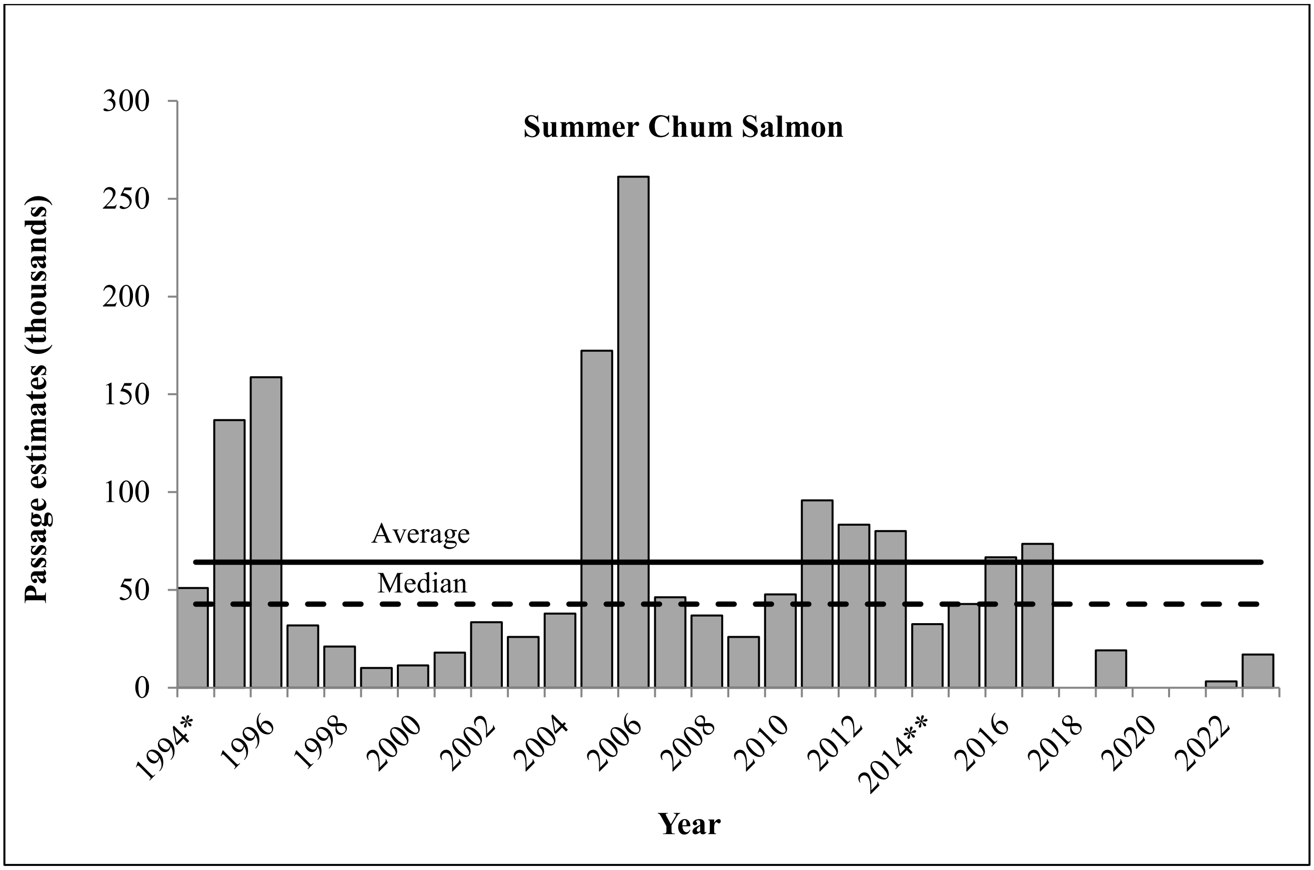


Figure 5. — Summer Chum Salmon escapement estimates at the Gisasa River weir, Alaska, 1994–2023.

Note: *Data from the first year of operation (1994) represent only a partial count; counting did not begin until July 10, after the run was underway. These data are not included in averages. **Data from 2014 represent a partial count due to high water events and are not included in the average. The horizontal lines represent the 1995–2019 average (solid) and median (dashed). The weir was not operated in 2018, 2020, and 2021. In 2023, counts are considered underestimates due to high water and low visibility. No data were collected on July 11 and 12 due to extremely high water and unsafe conditions.

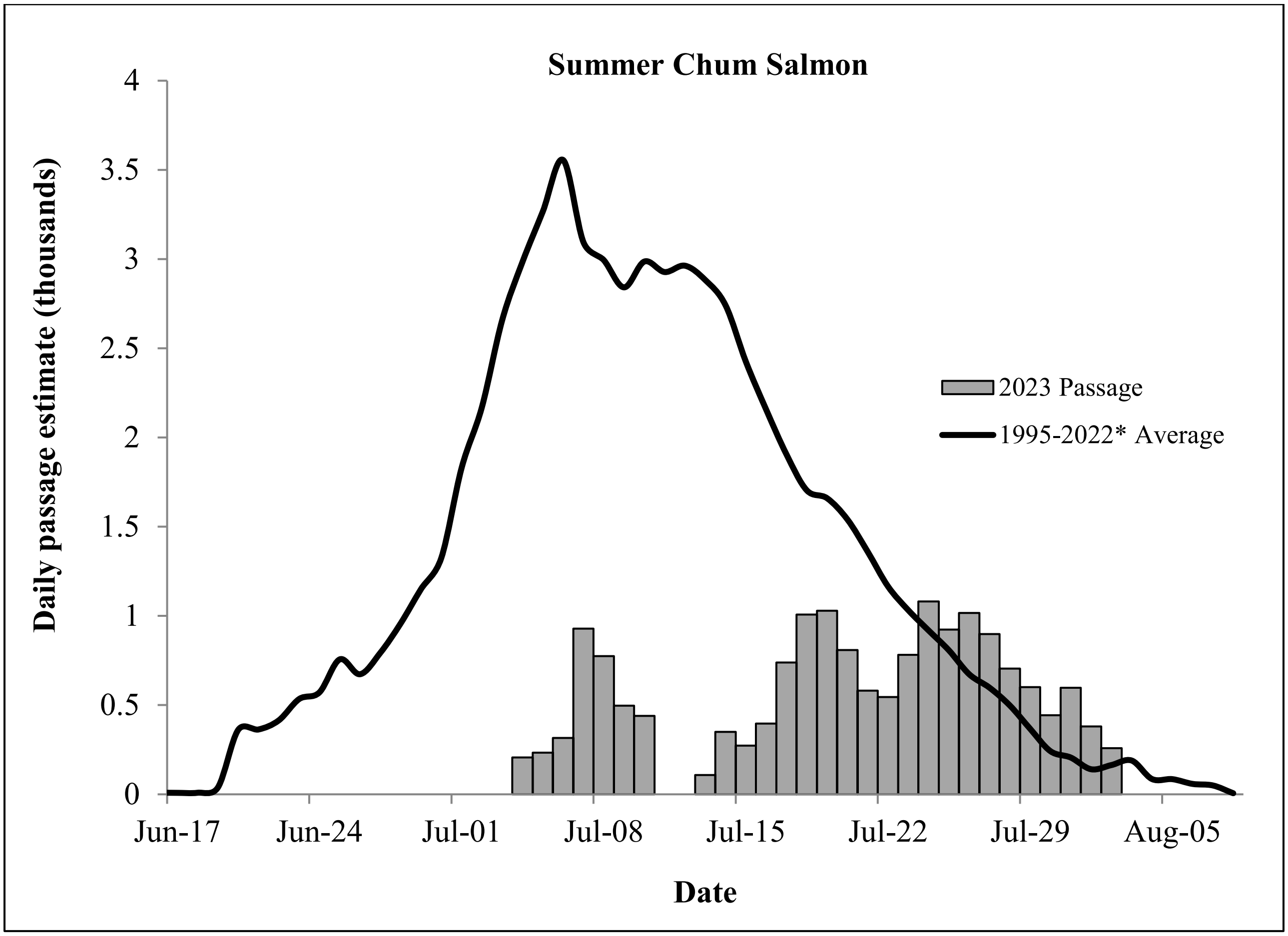


Figure 6. — Daily 2023 and average daily (1995–2022) Summer Chum Salmon passage estimates through the Gisasa River weir, Alaska.

Note: The weir did not operate in 2018, 2020, and 2021*. In 2023, counts are considered underestimates due to high water and low visibility. No data were collected on July 11 and 12 due to extremely high water and unsafe conditions.

Appendix 1. — Historical Chinook Salmon and Chum Salmon escapement estimates in the Gisasa River, Alaska, 1960–2023.

Year	Aerial index estimates - Chinook Salmon	Aerial index estimates - summer Chum Salmon	Aerial survey rating	Weir estimates - Chinook Salmon	Weir estimates - summer 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	33	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	1,298		Good	3,052	17,946
2002	506		Good	2,025	33,481
2003				1,901	25,999
2004	731		Good	1,774	37,851
2005	958		Good	3,111	172,259
2006	843	1,000	Fair	3,031	261,306
2007	593		Fair	1,427	46,257
2008	487	20,470	Fair	1,738	36,938
2009	515	1,060	Good	1,955	25,904
2010	564	1,096	Fair	1,516	47,669
2011	906	13,228	Good	2,692	95,796
2012				1,323	83,423
2013	201	9,300	Surveyed too late	1,126	80,055
2014				1,589	32,523
2015	558	5,601	Good	1,319	42,747
2016				1,395	66,670
2017	452	8,058	Fair	1,083	73,584

-continued-

Appendix 2. — Page 2 of 2.

Year	Aerial index estimates - Chinook Salmon	Aerial index estimates - summer Chum Salmon	Aerial survey rating	Weir estimates - Chinook Salmon		Weir estimates - summer Chum Salmon	
2018				ND	a	ND	a
2019				1,328		19,099	
2020				ND	b	ND	b
2021				ND	b	ND	b
2022				503		3,300	
2023				477		16,921	

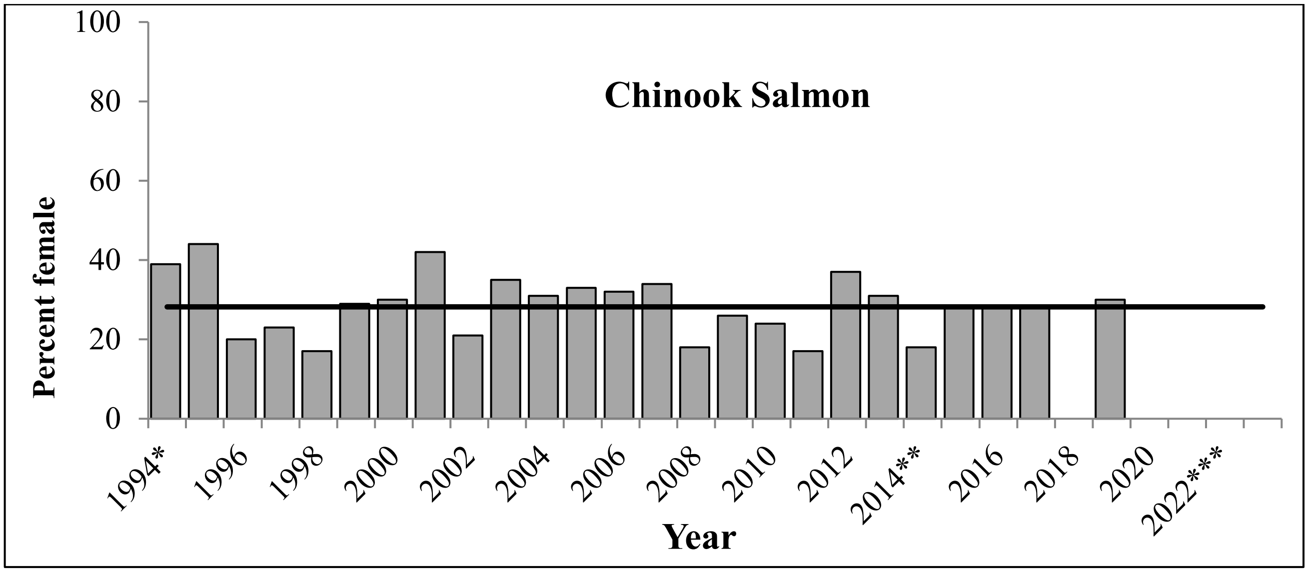
Note: Aerial index data are from Barton (1984) and the Alaska Department of Fish and Game Joint Technical Committee (JTC) (2022). In 2023, counts are considered underestimates due to high water and low visibility. No data were collected on July 11 and 12 due to extremely high water and unsafe conditions.
[a] No escapement estimates due to persistent flooding.
[b] No escapement estimates due to COVID-19 pandemic.

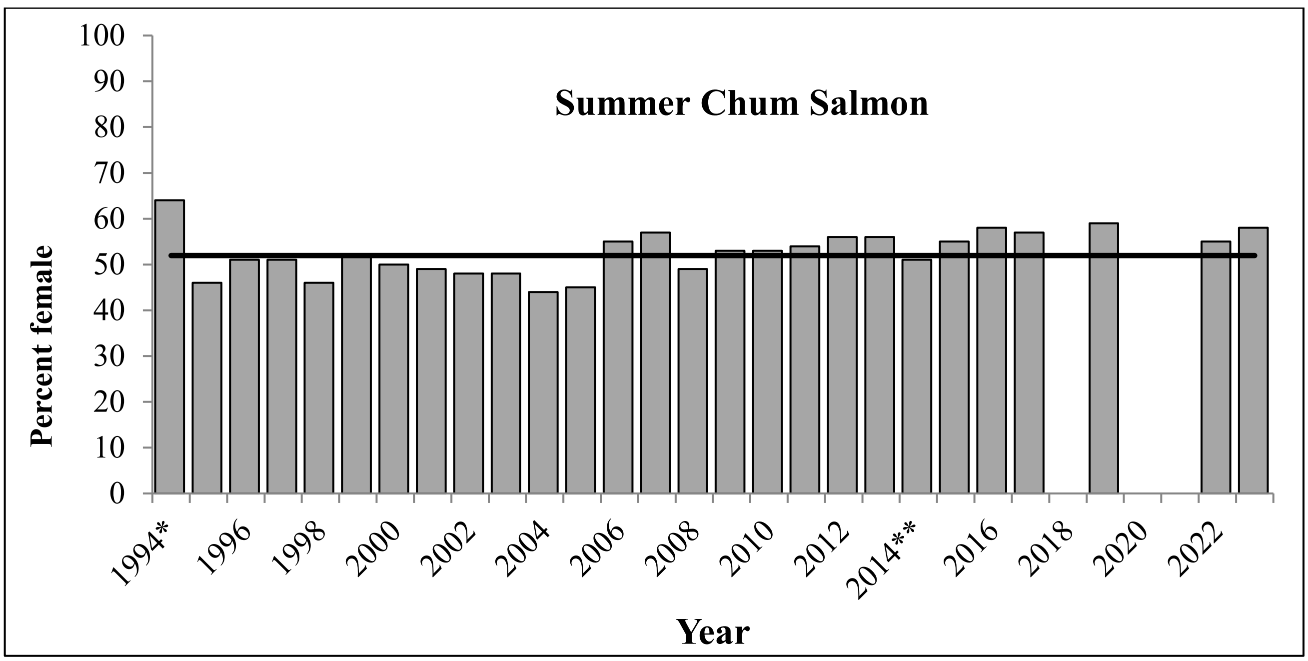
Appendix 2. — Water depth, water temperature, and air temperature data collected at the Gisasa River weir, Alaska, 2023.

Date	AM water depth (cm)	PM water depth (cm)	AM water temp (°C)	PM water temp (°C)	Low air temp (°C)	High air temp (°C)
4-Jul	-	98	-	8.0	-	19.5
5-Jul	96	97	8.0	11.0	9.2	13.4
6-Jul	98	100	10.5	11.0	11.2	15.8
7-Jul	108	108	11.0	12.0	10.9	17.3
8-Jul	107	106	11.0	11.5	10.1	15.7
9-Jul	111	112	10.0	11.0	9.7	12.6
10-Jul	119	130	9.0	9.5	9.8	14.8
11-Jul	132	127	9.0	10.0	10.1	15.5
12-Jul	124	120	10.0	11.0	13.3	19.7
13-Jul	118	114	10.0	11.0	9.1	16.2
14-Jul	115	119	10.0	9.0	8.6	11.7
15-Jul	117	117	7.0	9.0	7.3	14.6
16-Jul	115	114	8.5	10.0	6.2	18.7
17-Jul	111	114	10.0	12.0	7.4	23.2
18-Jul	112	111	11.0	12.0	9.3	24.9
19-Jul	110	110	12.0	14.5	11.6	19.4
20-Jul	109	109	14.5	15.0	13.3	22.0
21-Jul	111	112	13.0	14.0	14.4	18.1
22-Jul	115	115	12.0	15.0	12.4	24.1
23-Jul	115	110	15.0	16.0	10.8	28.6
24-Jul	107	106	14.0	17.0	14.0	28.3
25-Jul	106	104	14.5	16.5	11.8	24.9
26-Jul	103	101	14.0	15.5	11.0	25.9
27-Jul	102	101	15.0	15.0	14.2	19.8
28-Jul	101	101	13.0	13.0	9.9	18.2
29-Jul	102	102	13.0	14.5	10.9	18.7
30-Jul	103	102	12.0	13.0	6.3	18.2
31-Jul	100	101	13.0	13.0	8.7	19.2
1-Aug	100	99	12.0	14.0	11.6	21.0
2-Aug	98	98	12.0	15.0	11.6	22.5
Average	109	109	11.5	12.8	10.5	19.4

Note: Water depth is the water level at the trap.

Appendix 3. — Historical percentages of female Chinook Salmon and summer Chum Salmon for the Gisasa River weir, Alaska, 1994–2023.





Note: *Data from the first year of operation (1994) represent only a partial count; counting did not begin until July 10, after the run was underway and these data are not included in the average. **Data from 2014 represent a partial count due to high water events and are not included in the average. For Chinook salmon, the horizontal line represents the 1995–2019 average. For summer Chum Salmon the horizontal line represents the 1995–2022 average. The weir was not operated in 2018, 2020, and 2021. ***The ASL sample size goal was not met for Chinook Salmon in 2022 and 2023, and therefore data were not analyzed or included in the historical average.

Appendix 4. — Historical percentages of female Chinook Salmon and summer Chum Salmon sampled at the Gisasa River weir, Alaska.

Year	Chinook % female	Summer Chum % female
*1994	39	64
1995	44	46
1996	20	51
1997	23	51
1998	17	46
1999	29	52
2000	30	50
2001	42	49
2002	21	48
2003	35	48
2004	31	44
2005	33	45
2006	32	55
2007	34	57
2008	18	49
2009	26	53
2010	24	53
2011	17	54
2012	37	56
2013	31	56
**2014	18	51
2015	28	55
2016	28	58
2017	28	57
2018		
2019	30	59
2020		
2021		
***2022		53
***2023		58
Average	28	52

Note: *Indicates incomplete data from the first year of operation (1994); data collection did not begin until July 10. **Indicates incomplete data from 2014 when high water events impeded weir operation for most of the season. The weir was not operated in 2018, 2020, and 2021. ***The ASL sample size goal was not met for Chinook Salmon in 2022 and 2023, and therefore data were not analyzed.