U.S. Fish & Wildlife Service

Chinook and Summer Chum Salmon Abundance, Run Timing, and Age, Sex, and Length Composition in the East Fork of the Andreafsky River, Yukon Delta National Wildlife Refuge, Alaska, 2023

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Cover Photo: View of the East Fork Andreafsky River at sunset, 2023. Photo courtesy of G. Maschmann, USFWS.

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Abstract

A resistance board weir was operated on the East Fork Andreafsky River from July 9 through July 27, 2023, to estimate escapement and run timing of Chinook Salmon *Oncorhynchus tshawytscha* and summer Chum Salmon *O. keta*. Other fish species passing the weir were counted incidentally. Fish were identified to species and counted from video recordings generated by an underwater video camera and recorder. High water prevented the installation of the weir and counting did not start until July 9, approximately halfway through the season. Additionally, high water throughout the season prevented the weir from being "fish tight". Passage estimates for 2023 are therefore biased low, with large 95% confidence intervals. Chinook and summer Chum salmon were sampled to estimate age, sex, and length composition of the escapement. The Chinook Salmon count was 194 fish. The summer Chum Salmon count was 2,308 fish. Fish passage at the tails of the run were within the historically known migration period, but before and after weir operation, were estimated using a Bayesian statistical procedure. The total estimated escapement of Chinook Salmon was 223 fish (95% Bayesian highest posterior density interval, HPDI, 198–806 fish). The total estimated escapement of summer Chum Salmon was 2,671 fish (95% Bayesian highest posterior density interval, HPDI, 2,416–3,290 fish). Water temperatures were low enough to allow for sampling during the entire season, but low escapement numbers of target species compared to others made it difficult to collect some samples. Only 26 Chinook Salmon were sampled with 25 useable scale samples collected, primarily from the latter half of the run, well below the 220 minimum target sample size. Therefore, the samples were insufficient to characterize the age, sex, and length composition of the overall escapement and are not reported. A total of 249 summer Chum Salmon were sampled with 226 usable scale samples collected, primarily from the latter half of the run. Although the minimum sample size (220) was met, due to the late installation of the weir and high-water events, these samples are considered insufficient to characterize the age, sex, and length composition of the overall escapement. Of the 249 sampled summer Chum Salmon, 33.7% were female and 66.3% were male (n=165). Of the 226 usable summer Chum Salmon scales that were collected, 79.7% were age-0.3 (n=180), 19.5% were age-0.4 (n=44), and 0.9% were age-0.5 (n=2). Incidental counts of other species included 71 Pink Salmon *O. gorbuscha*, 12 Sockeye Salmon *O. nerka*, 335 Whitefish (Coregoninae), and 1 Northern Pike *Esox lucius*.

Introduction

The Andreafsky River is a major salmon producing tributary of the lower Yukon River and supports some of the largest runs of Chinook Salmon *Oncorhynchus tshawytscha* and summer Chum Salmon *O. keta* in the Yukon River drainage. Located within the Yukon Delta National Wildlife Refuge, the Andreafsky River is designated a wild and scenic river. The Andreafsky River is also the lowest major tributary in the Yukon River drainage, entering the Yukon River main stem about 160 river kilometers (rkm) from the Bering Sea. The Yukon River extends over 3,190 rkm from ice fields in British Columbia, Canada near the Gulf of Alaska, through the Yukon Territory and across interior Alaska, to its delta on the Bering Sea coast. The escapement monitoring project on the East Fork of the Andreafsky River is a key location in a drainage-wide network of salmon monitoring and assessment projects, representing lower river stocks and providing information on salmon abundance, run timing, and stock composition. Escapement estimates from the East Fork Andreafsky River weir are combined with aerial survey estimates from both the East and West forks of the Andreafsky River and are used by fisheries managers as in-season and post-season indices of lower river escapement.

Subsistence fisheries in the U.S. portion of the Yukon River drainage are jointly managed by the State of Alaska, through the Department of Fish and Game (ADF&G), and the Federal Subsistence Management program, through the U.S. Fish and Wildlife Service (USFWS). Commercial, sport, and personal use fisheries are managed by ADF&G. Within the National Wildlife Refuges, federal managers work with partners and communities to conserve fish and wildlife populations and their habitats. Biologists conduct monitoring and research efforts on species of biological and cultural significance, and where adequate, provide the science to support subsistence opportunities in the Yukon-Kuskokwim region[a]. Both state and federal managers are responsible for ensuring priority of subsistence fishing use, protecting stock diversity, ensuring equitable distribution of harvest opportunity across the drainage, and meeting Canadian border passage objectives as specified by the Yukon River Salmon Agreement[b]. In addition, ADF&G establishes escapement goals for various salmon populations in Yukon River tributaries, including East Fork Andreafsky River Chinook and summer Chum salmon (Volk et al. 2009; Fleischman and Evenson 2010). At the East Fork Andreafsky River weir, Chinook Salmon have a sustainable escapement goal (SEG) of 2,100–4,900 fish and summer Chum Salmon have an SEG of >40,000 fish (JTC 2021).

Salmon returning to the Andreafsky River contribute substantially to subsistence and commercial harvests in the lower Yukon River. Residents of 20 communities located on the Yukon Delta and Yukon River below the Andreafsky River confluence harvest salmon from mixed stocks entering the Yukon River. Most residents harvest fish for subsistence use, but many also participate in small-scale commercial fisheries. In the mixed cash-subsistence economy typical of the region, income from commercial fishing enables families to purchase the necessary gear and supplies to sustain their subsistence fishing activities. Chinook Salmon are the primary target for subsistence fisheries in the lower river, but summer and fall Chum Salmon and Coho Salmon (*O. kisutch*) are also harvested. Commercial fisheries in the lower river typically harvest summer Chum Salmon during the early season and shift to fall Chum and Coho salmon after mid-July.

Most subsistence and commercial fishing in the lower Yukon River occur in the main stem, harvesting from mixed stocks of salmon returning to spawning areas throughout the drainage.

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[a] https://www.fws.gov/refuge/Yukon-Delta/what-we-do, accessed March 19, 2024.
[b] https://www.yukonriverpanel.com/publications/yukon-river-salmon-agreement, accessed February 5, 2024.

Although individual stocks cannot be specifically targeted or avoided, in-season genetic information and daily updates from escapement counting projects are monitored closely to ensure that certain stocks are not disproportionately harvested. Genetic mixed-stock analysis (MSA) compares genotypes of harvested fish with a baseline of genotypes from known spawning populations. Genetic baselines have been developed for both Chinook and Chum salmon[c] in the Yukon River (Flannery et al. 2007). For each species, lower river spawning populations, occurring downstream from the main stem Yukon River just above the delta to the Gisasa River in the lower Koyukuk River drainage, are genetically similar and grouped together as the lower Yukon River stock. All populations within the lower Yukon River Chum Salmon stock are genetically identifiable as summer Chum Salmon. MSA sampling, however, occurs at the Pilot Station sonar project and does not include lower river populations such as those in the Andreafsky River, which spawn below the sonar site. Therefore, direct monitoring projects are needed to estimate the complete contribution of lower river populations to the mixed-stock runs. Furthermore, because MSA does not capture fine-scale distinctions among populations within the lower Yukon River Chinook and summer Chum salmon stocks, escapement monitoring projects such as the East Fork Andreafsky River weir help protect geographically distinct populations.

The Andreafsky River has been an important indicator for lower Yukon River salmon runs for many years. Aerial surveys were conducted on both the East and West forks in most years since 1954[d]. ADF&G experimented with sonar on the East Fork in the early 1980s (Buklis 1982) and operated a fish counting tower there from 1986 to 1988. The East Fork Andreafsky River weir in its current configuration has been operated annually by USFWS since 1994, except in 2020 when operation was suspended due to the COVID-19 pandemic, and 2022 when both the Andreafsky Fire swept through the area, and high water prevented installation of the weir. Escapement information from the East Fork Andreafsky River is useful for in-season management, lagging run timing through the lower river fisheries by only a few days.

Similar to previous years, daily migration counts of all fish species, and sex, length, and scale samples from Chinook and summer Chum salmon were collected at the East Fork Andreafsky River weir in 2023. Water depth, temperature, and weather conditions were also monitored. The underwater video system was incorporated into the primary fish passage chute in 2014 and continues to be used for counting fish passage through the weir. The 2023 season continued to use the newer style of weir panels manufactured before the 2019 season.

The following objectives were established for the 2023 season:

1. Estimate daily and seasonal escapement and run timing of adult Chinook and summer Chum salmon.
2. Estimate the age, sex, and length composition of the adult Chinook and summer Chum salmon escapements, with 95% confidence intervals for age-sex proportions no larger than ± 0.1.
3. Identify and count other fish species passing through the weir daily and collect water level and temperature data twice daily.

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[c] http://www.adfg.alaska.gov/index.cfm?adfg=fishinggeneconservationlab.yukonchinook_baseline, accessed February 5, 2024.
[d] https://www.adfg.alaska.gov/CF_R3/external/sites/aykdbms_website/Default.aspx, accessed February 5, 2024.

Study Area

The project site is on the East Fork of the Andreafsky River, about 40 rkm upriver from the village of St. Mary's (Figure 1). St. Mary's is on the main-stem Andreafsky River, near its confluence with the Yukon River. The upland area surrounding the weir site, including the weir materials storage area and campsite, are on Nerklikmute Native Corporation land which is leased to the U.S. Fish and Wildlife Service for the project. The weir site within the channel of the East Fork Andreafsky River is managed by the State of Alaska Department of Natural Resources, which issues a Land Use Permit[e] to USFWS for the weir.

The Andreafsky River is in the lower reaches of the Yukon River drainage, flowing into the main-stem Yukon River about 160 rkm upriver from the Bering Sea. Its headwaters in the Nulato Hills give rise to two roughly parallel tributaries (East and West forks) which flow in a southwesterly direction for over 200 rkm before converging about 7 rkm upstream of the confluence with the Yukon River. The total watershed area is approximately 5,450 km^2. The Andreafsky River supports runs of Chinook, summer Chum, Pink *O. gorbuscha*, Sockeye *O. nerka*, and Coho salmon, and is one of the largest salmon-producing tributaries in the lower Yukon River. Almost all salmon fishing on these stocks occurs below the confluence of the East and West forks and in the Yukon River. Other anadromous fish present in the Andreafsky River include Humpback *Coregonus clupeaformis*, Broad *C. nasus*, and Round *Prosopium cylindraceum* whitefish; Sheefish *Stenodus leucichthys*; Least *C. Sardinella* and Bering *C. Laurettae* cisco; and Dolly Varden *Salvelinus malma*. Resident freshwater species include Arctic Grayling *Thymallus arcticus*, Northern Pike *Esox lucius*, Burbot *Lota lota*, and Longnose Sucker *Catostomus catostomus*.

The East Fork Andreafsky River flows from its source for approximately 50 rkm through alpine tundra, and then for approximately 130 rkm through a forested river valley bordered by hills mostly less than 400 m in elevation, with willow, spruce, alder, and birch dominating the riparian zone and much of the hillsides. The streambed in this section is characterized by glides and riffles with gravel and rubble substrate. The river widens in its lowermost portion, flowing through wetlands, interspersed with forest and tundra, and bordered by hills that are typically less than 230 m in elevation. In this low gradient section of the river, water levels can be affected by fluctuations on the Yukon River. The regional climate is subarctic. Temperature records from St. Mary's for the 10-year period of 2011–2020 show an average summer temperature (Jun–Aug) of 11.3°C and an average winter temperature (Dec–Feb) of -10.9°C[f].

Methods

Weir Design and Operation

The weir structure is a modified resistance board design (Tobin 1994; Tobin and Harper 1995) with 3.5 cm-diameter pickets with a 4.8 cm gap between each picket. This spacing allows smaller Pink Salmon and resident fish to pass through the weir undetected, reducing counts of those non-target species, and allows for better water flow through the weir. The weir site coordinates were N 62° 07', W 162° 48.4', and the channel width was 105 m at that point. The

[e] http://dnr.alaska.gov/mlw/forms/#land+land-use-authorization, accessed February 5, 2024.
[f] Climate Data Online, National Oceanic and Atmospheric Administration, National Centers for Environmental Information, https://www.ncdc.noaa.gov/cdo-web/datasets#LCD, accessed September 8, 2021.

main fish passage chute was located at the deepest part of the channel, approximately 20 m from the left bank, and directed fish into the sampling trap and video chute. The video chute contained a camera box with a glass view window and a CAM-AM070 Color Analog Video Camera (Applied MicroVideo). Video recording of all fish within the video chute was activated by motion capture software (Security Spy ver. 3.0.4) on a computer system housed in the main cabin and connected by a cable to the camera at the weir. Recorded video files were replayed later for species identification and enumeration.

The weir and video system are normally operated 24 hours per day, seven days per week, except when periods of high water or other problems prevent operation. The weir was inspected each day and was cleared of debris at least once every 8 hours. Minor repairs were made to the weir as needed to ensure that it remained structurally sound and provided a fish-tight barrier. The video system was set to record a motion capture video file every hour. Crew members replayed files recorded during their respective shifts to identify species and count all fish that passed through the video chute. Counts were tallied with a computer keypad directly into a Visual Basic for Applications program in Excel, which automatically compiled a text file of fish counts for each hour and generated a 24-hour daily summary in Excel. Each morning, the previous day's data were reported by cell phone to the Northern Alaska Fish and Wildlife Conservation Office and included in a daily escapement monitoring summary report distributed to managers, biologists, and stakeholders.

Quality Control Review of Species Identification and Passage Counts

Due to the shortened season and the low numbers of fish passing through the weir this season, the typical procedures for quality control review of species identification and passage counts were changed and simplified. Low numbers of fish passing through the weir gave technicians more downtime between video hours. Technicians on duty would review the previous technicians' counts by randomly reviewing previous video files and looking for discrepancies in species identification and counts, reviewing video files of fish species that are easily misidentified, such as Sockeye Salmon, and reviewing video files of anomalous counts. For example, if a technician counted a larger number of fish than would normally be expected, these video files would be reviewed. Additionally, any discrepancies or anomalies would be discussed between the technicians. If agreement could not be made as to the identity of the fish, a third or even fourth technician would be asked to weigh-in for a final determination. Fish that could not be identified due to high turbidity were recorded as unknown.

Visual fish counts at weirs, whether by direct observation or through video recordings, are generally assumed to be a complete census of the species passage during the operating period, and error is assumed to be negligible. Therefore, formal variance statistics are not generally reported, and we do not report them in this project.

Computation of Passage for Non-Operational Days and Tails of the Run

Typically, the weir is seasonally installed within dates that are expected to observe greater than 95% of fish passage for the two target species, Chinook and summer Chum salmon. However, fish are known to pass in small numbers before and after the operational period of the weir (Brown et al. 2020). To estimate fish passage during the tails of the run, i.e., days within the typical migration period for each target species but before and after the weir operational period, a statistical arrival model was used (Sethi and Bradley 2016). This procedure was also used to estimate fish passage on days when fish were able to escape through the weir uncounted due to high water or other problems. However, if the weir remained functional and fish were counted through the passage chute for at least 6 hours in a given day, the actual count, expanded for a 24-hour period, was reported, and the estimate was not used. The model could potentially include low probability events of fish passage on days far outside the typical migration period, so it was constrained to a realistic range of dates. The range used was June 15 through August 10, based on historical Chinook and summer Chum salmon passage data from weir operations during 1994 through 2017.

When modeling arrival of fish at the weir, three possible distributions were considered: Normal, skew-Normal, and Student-*t*, with two degrees of freedom. Variability around this smooth arrival curve was modeled by Negative Binomial random variables, such that the magnitude of variability scaled positively with estimated daily passage counts. Three correlation structures were included for process variation in the Negative Binomial probability model: none (white noise), lag-1 autoregressive, and lag-1 moving average. All combinations of run shape and process variation structure were fit to the data, resulting in a candidate set of nine potential models. Model fits were made in a Bayesian framework, allowing predicted estimates for each missing passage date and the associated variability to be easily obtained. Prior distributions were specified (Table 1 in Sethi and Bradley 2016) and models were run in OpenBUGS (Spiegelhalter et al. 2007) using the R package R2OpenBUGS (Sturtz et al. 2019). Two chains were run with a burn-in period of 1,000 iterations and a thin rate of 10, resulting in 300 posterior draws stored. For each model, convergence was ensured by confirming that the Gelman-Brooks-Rubin statistic for the estimated total population abundance was less than 1.2.

Deviance information criteria (DIC) and 95% highest posterior density interval (HPDI), which is roughly a Bayesian equivalent of a 95% confidence interval, were used to select the best model from the candidate set of nine models, with an emphasis on maintaining a conservative estimate due to the shortened season and low fish passage numbers. Predicted passage from the initial and concluding tails of the run was summed separately and reported as derived parameters. For days within the weir operation period, only the observed counts expanded for 24 hours were reported for days during which the weir was fully operational for at least 6 hours. If counting was conducted for less than 6 hours, model estimated passage was reported. The total escapement estimate was the sum of fish counted during the weir operation period, arrival model estimates for the tails of the run, and missed passage estimates on any days with less than 6 hours of counting. A 95% (HPDI) was formed by adding 2.5 and 97.5 percentiles of the posterior distribution to the total counted fish.

Biological Sampling and Data Analysis

Sex and length data and scale samples were collected from Chinook and summer Chum salmon in a trap connected to the main passage chute. Both ends of the trap were closed to retain fish during sampling but were open at all other times. Water temperature was monitored to ensure that trapped fish were not in danger of heat stress, with a goal to avoid trapping if the daily average water temperatures were above 17°C for three consecutive days or 20°C at any given moment (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 3 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 Chinook Salmon were June 16–July 8, July 9–14, and July 15–31. The tertile dates designated for summer Chum Salmon were June 16–July 3, July 4–10, and July 11–31. To ensure consistent sampling effort towards meeting the target sample size for each tertile, weekly and daily targets were set. Salmon were sampled opportunistically during a day or week until the daily target was 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 mounted on gum cards matched with length and sex data from each fish and 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, and sex was visually determined or, in the case of Chinook Salmon, based on length. Based on historical sampling in the East Fork Andreafsky River, mid-eye to fork lengths (MEFL) of 650 mm form a reliable barrier between the smaller 2-ocean fish and the larger 3-ocean fish. Returning female Chinook Salmon in the 2-ocean age class, known as jills, are rare, so all Chinook Salmon <650 mm were considered males (Brady 1983; Karpovich and DuBois 2007; Larson 2020). For Chinook Salmon ≥650 mm MEFL and all Chum Salmon, external characteristics such as kype development or the presence of an ovipositor were used for determining sex.

Other Species Counts and Environmental Data

Other salmon and non-salmon species were also recorded and counted using the video system. Daily passage counts of these other fish species were documented and reported inseason, but no corrections were made for missed passage before, after, or during the weir operation period. Because counts for non-target species may not have encompassed the entire migration period of each species, they would not be considered reliable indicators of the species' run timing, migration behavior, escapement, or stock status. However, they do provide information about presence, absence, and co-migration with the target species.

Water depth was manually measured twice daily at approximately 0800 hours and 2000 hours using a staff gauge installed next to the camp. The staff gauge was not calibrated to a fixed benchmark and thus, it only provided a relative measure of water depth during the season. Water temperature and air temperature were measured twice daily at approximately 0800 hours and 2000 hours. Later in the season, high and low air temperature were also recorded. In addition, other weather information was monitored and reported in the daily in-season summary.

Results

Weir Operation

The average mid-points of the Chinook Salmon and summer Chum Salmon runs at the East Fork Andreafsky River weir are approximately July 10 and July 7, respectively, using historical run timings from 1995–2019 and 2021. Installation of the weir in 2023 was completed in the afternoon of July 8, approximately three weeks later than typical. Weir operations began at 0000 hours on July 9 and continued through 2359 hours on July 27 (Table 1). Based on normal run timing operations, 2023 missed the first half of both the Chinook and summer Chum salmon runs. High water throughout most of the season caused water to overflow the boat ramp resulting in the weir not being "fish tight" for a large portion of the season. However, daily observations of the weir did not indicate that any fish were passing over the weir unaccounted for.

Raw Counts and Escapement Estimates

During 2023 weir operations, 194 Chinook Salmon, 2,308 summer Chum Salmon, 71 Pink Salmon, 12 Sockeye Salmon, 1 Northern Pike, and 335 Whitefish species were counted (Table 1). Counts were biased low and considered minimums due to the late start of operations, high water preventing the weir from being "fish tight", and smaller species, such as Pink Salmon and Whitefish, being able to pass through the weir pickets. Additionally, the timing of weir operations did not allow for the complete enumeration of the Sockeye Salmon run.

Fish are known to pass the weir site before and after weir operations. Fish passage during these "tails" was estimated using a Bayesian statistical procedure. The total estimated escapement of Chinook Salmon was 223 fish (95% Bayesian highest posterior density interval, HPDI, 198–806 fish). The total estimated escapement of summer Chum Salmon was 2,671 fish (95% Bayesian highest posterior density interval, HPDI, 2,416–3,290 fish).

Chinook and Summer Chum Salmon Escapement and Age-Sex-Length Composition

There were no issues with high water temperatures exceeding thresholds for safe fish handling during the 2023 season. Only 26 Chinook Salmon were sampled for age, sex, and length in 2023, falling short of the target of 220–240 fish. Sample sizes were not only below target ranges but were not distributed in proportion to the roughly equal passage numbers in each tertile. Of the 26 samples, 1 fish could not be aged. Escapement age-sex proportions could not be estimated prior to the mid-point of the run because of the small sample size. Therefore, the overall sample age-sex proportions did not adequately represent East Fork Andreafsky River Chinook Salmon escapement in 2023 and are not reported.

A total of 249 summer Chum Salmon were sampled for age, sex, and length. One fish was not measured for length and 23 scales could not be aged due to aging errors, leaving 226 samples for aging. This was within the sampling target range of 220 to 240 fish but may only represent summer Chum Salmon passing through the second half of the run. The unweighted sex composition of the summer Chum Salmon sampled was 66.3% male and 33.7% female (165 males, 84 females). The estimated unweighted age composition was 79.7% age-0.3 (122 males, 58 females), 19.5% age-0.4 (33 males, 11 females), and 0.9% age-0.5 (1 male, 1 female). The unweighted average length of the 248 summer Chum Salmon that were measured was 538 mm, with males averaging 549 mm and females averaging 516 mm. The unweighted average length of age-0.3 fish was 535 mm (545 mm for males, 513 for females), age-0.4 fish was 552 mm (565 mm for males, 511 mm for females), and age-0.5 fish was 545 mm 545 mm for males, 545 mm for females).

Environmental Data

Water depth at the East Fork Andreafsky River weir fluctuated between 1.41 and 0.48 m during 2023 (Table 2). Daily average water temperatures at the weir ranged from 10.0 to 17.5ºC, which was significantly cooler than in 2019, when the temperature ranged from 14.0 to 21.8ºC. The seasonal maximum temperature of 17.5°C occurred on one half day during weir operation on

July 1. These temperatures did not exceed guideline thresholds for safe fish handling in Alaska (Shink 2020). Air temperatures ranged from a low of 7ºC to a high of 23ºC.

Discussion

The typical mid-points of the Chinook and summer Chum salmon runs at the weir are July 10 and July 7, respectively. Unfortunately, high water during the 2023 season hindered weir operations. The first full day of fish counts was July 9, so it is possible that approximately the first half of the runs were missed. However, if Chinook Salmon in 2023 exhibited the same run timing as Chinook Salmon in 2021, >90% of the run would have been captured by the dates the weir was in operation in 2023. With the drainage-wide Chinook Salmon forecast for the year predicting a poor return below the goal and preliminary passage estimates past the Pilot Station sonar being the second lowest on record (Jallen 2023), the low Chinook Salmon passage estimate of 223 (95% CI=2,416–3,290) fish past the weir was not altogether unsurprising. Due to the low sample size of Chinook Salmon, not much can be concluded concerning the age, sex, and length composition of the East Fork Andreafsky River Chinook Salmon run except that the below-average length seen at the weir was also seen at the Pilot Station sonar project (Jallen 2023). The abysmal return of summer Chum Salmon, however, was a little unexpected. Although the summer Chum Salmon pre-season forecast of 280,000–900,000 fish was below-average, the preliminary passage estimates past the Pilot Station sonar of 845,988 fish was near the upper end of the forecast range. Most summer Chum Salmon returned to the Andreafsky River in 2023 as age-0.3 (79.7%) and age-0.4 (19.5%) fish, similar to historical trends (Conitz 2018, 2019; Larson 2019; Conitz and French 2020). These fish were from the 2018 and 2019 brood years.

Prolonged, high-water temperatures in 2019 are thought to have directly affected spawning events and offspring survival (Conitz 2019; von Biela et al. 2020), which may have contributed to the low numbers of fish returning to the Andreafsky River in 2023. Large numbers of unspawned summer Chum Salmon carcasses were observed floating down the lower reaches of the Andreafsky River in July of 2019 (Conitz and French 2020), and heat-related mortalities widespread throughout Western Alaska and other parts of the state (Conitz and French 2020; Westley 2020; von Biela et al. 2020). If warming water conditions are a primary driver of the low returns, it is reasonable to expect future years, at least in the near term, may have exceptionally poor returns as well.

In 2021, newly implemented water temperature monitoring equipment allowed for a closer examination of temperature trends throughout the season, and guidance from Shink (2020) was used to modify the operational plan for the weir to alleviate heat stress on fish as much as possible. However, this guidance was not needed in 2023 due to an average water temperature of 13–14°C from June 22 through July 27. Water temperatures only met or exceeded 17°C during the late afternoon 3 times during the 2023 season and never exceeded 18°C. At no point were weir operations altered due to high water temperatures in 2023, which would have happened if the average water temperature exceeded 17°C for 3 consecutive days (Shink 2020).

Collecting biological samples according to a stratified sampling design, and roughly in proportion to run timing, which was the method used in previous years, was not accomplished for either Chinook Salmon or summer Chum Salmon in 2023. The primary reason for distributing biological samples through the run is to ensure they are not biased by variation in age and sex composition as the run progresses (Conitz and French 2020). For example, males often lead the migration in Chum Salmon (Salo 1991), so disproportionate sampling early in the season could result in overestimating the proportion of males in the run. In 2023, the total sample size goal was met for summer Chum Salmon; however, they were not evenly distributed throughout the run and may only represent the second half of the summer Chum Salmon run. The sample of Chinook Salmon was too small to provide valid inferences about the population. Estimates provided in this report should not be used for historical averages in future reports.

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Table 1. — Daily and cumulative escapement estimates of Chinook, summer Chum, and Pink salmon, and daily estimates of other species, at the East Fork Andreafsky River weir, Alaska, 2023.

Date	Chinook Daily	Chinook Cum	Chum Daily	Chum Cum	Pink Daily	Pink Cum	Sockeye Daily	Whitefish Daily	Pike Daily
9-Jul	7	7	163	163	1	1	1	4	0
10-Jul	4	11	218	381	0	1	0	13	0
11-Jul	0	11	50	431	0	1	0	9	0
12-Jul	3	14	27	458	2	3	0	6	0
13-Jul	3	17	82	540	0	3	0	4	0
14-Jul	3	20	32	572	0	3	1	4	0
15-Jul	4	24	132	704	0	3	0	6	0
16-Jul	25	49	346	1050	4	7	2	14	0
17-Jul	37	86	412	1462	6	13	1	31	0
18-Jul	55	141	472	1934	4	17	1	38	0
19-Jul	21	162	180	2114	6	23	1	85	0
20-Jul	3	165	21	2135	6	29	0	17	0
21-Jul	4	169	25	2160	6	35	1	7	0
22-Jul	13	182	57	2217	3	38	1	4	0
23-Jul	5	187	15	2232	4	42	0	22	0
24-Jul	2	189	37	2269	12	54	1	32	0
25-Jul	2	191	11	2280	5	59	1	30	1
26-Jul	1	193	3	2283	3	62	0	9	0
27-Jul	2	194	25	2308	9	71	1	21	0
Total Count	194		2,308		71		12	335	1

Note: Twenty unidentified fish passed through the weir during the 2023 season.

Table 2. — Daily relative water level (m), turbidity, water temperature (°C), and air temperature (°C) at the East Fork Andreafsky River weir, Alaska, 2023.

Date	Water Depth AM	Water Depth PM	Water Temp AM	Water Temp PM	Visual Turbidity AM	Air Temp AM	Air Temp PM
22-Jun	1.41	1.41	14.0	14.0	Moderate	14	16
23-Jun	1.37	1.37	13.5	14.0	Moderate	14	21
24-Jun	1.35	1.33	14.0	14.5	Moderate	16	19
25-Jun	1.30	1.34	13.0	14.0	Moderate	15	12
26-Jun	1.26	1.25	13.0	14.0	Moderate	11	16
27-Jun	1.21	1.17	13.0	15.0	Moderate	12	17
28-Jun	1.16	1.13	15.0	14.0	Clear	12	17
29-Jun	1.10	1.10	13.0	15.0	Clear	8	18
30-Jun	1.12	0.99	13.5	17.0	Clear	11	19
1-Jul	0.94	0.90	15.0	17.5	Clear	12	23
2-Jul	0.86	0.81	16.0	16.0	Clear	13	15
3-Jul	0.76	0.74	14.0	15.0	Clear	12	15
4-Jul	0.68	0.63	14.0	15.0	Moderate	9	13
5-Jul	0.6	0.59	14.0	14.0	Moderate	10	14
6-Jul	0.55	0.56	13.5	14.0	Clear	12	15
7-Jul	0.53	0.52	13.5	14.0	Clear	10	13
8-Jul	0.48	0.53	12.0	12.0	Clear	9	10
9-Jul	0.65	0.89	12.0	11.0	Moderate	11	12
10-Jul	1.07	1.06	11.0	11.0	High	9	11
11-Jul	1.00	0.93	11.0	12.0	High	10	15
12-Jul	0.86	0.80	11.0	12.0	High	8	13
13-Jul	0.76	0.75	11.0	11.0	Moderate	10	4
14-Jul	0.77	0.77	11.0	11.0	Moderate	13	8
15-Jul	0.74	0.70	10.0	11.0	Clear	9	12
16-Jul	0.67	0.65	10.0	12.0	Moderate	7	17
17-Jul					Moderate		
18-Jul	0.60	0.58	15.0	18.0	Clear	9	
19-Jul	0.55	0.52	15.0	16.0	Clear	13	20
20-Jul	0.53	0.55	14.0	15.0	Clear	12	15
21-Jul	0.59	0.63	13.0	14.0	Clear	12	17
22-Jul	0.68	0.68	13.0	15.0	Clear	14	20
23-Jul	0.73	0.78	14.0	14.0	Clear	21	13
24-Jul	0.68	0.64	13.0	14.0	High	13	17
25-Jul	0.6	0.59	13.0	13.0	Moderate	14	15
26-Jul	0.57	0.56	13.0	13.0	Clear	15	16
27-Jul	0.55	0.56	13.0	13.0	Clear		15
Average	0.80	0.80	13.1	13.9		11.8	15.1

Note: Blank cells indicate missing data.

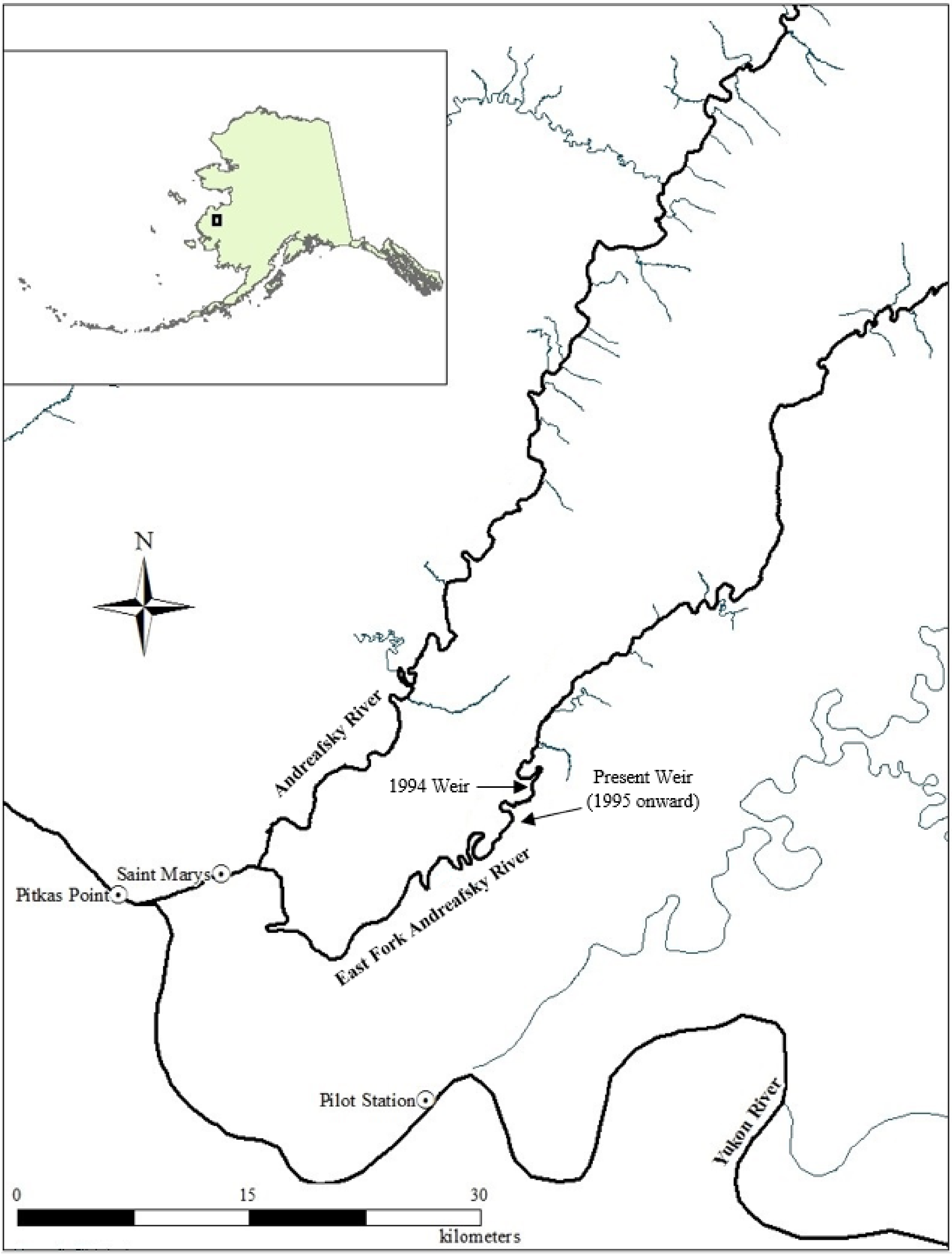

Figure 1. – Present weir location on the East Fork Andreafsky River, Alaska, 1995–2023. Note: The 1994 site was 2.4 rkm upstream of the current weir location (Tobin and Harper 1996).