Inseason Harvest and Effort Estimates for the 2022 Kuskokwim River Subsistence Salmon Fisheries During Block Openings

by

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ABSTRACT

Management of subsistence fisheries for salmon (*Oncorhynchus* sp.) in the Kuskokwim River has historically been conducted with minimal inseason harvest information. Due to this lack of information, managers have faced challenges making well-supported and defensible inseason decisions regarding fishing opportunities that simultaneously achieve conservation and subsistence harvest objectives, particularly during years of weak Chinook Salmon (*O. tshawytsch*a) runs. In response to conservation concerns for the 2022 Kuskokwim River Chinook and Chum (*O. keta*) salmon runs, the Kuskokwim River Inter-Tribal Fish Commission, in collaboration with the United States Fish and Wildlife Service–Yukon Delta National Wildlife Refuge, the Orutsararmiut Native Council, and independent contractors collected and processed data to produce inseason subsistence salmon harvest estimates from the mainstem Kuskokwim River within the boundaries of the Yukon Delta National Wildlife Refuge, between and including the villages of Tuntutuliak and Akiak. Input data included drift and set gillnet counts from aerial surveys, and subsistence harvester interviews at the Bethel boat harbor, Bethel area fish camps, and community-based harvest monitors from the Lower Kuskokwim River villages of Eek, Napakiak, Napaskiak, Kwethluk, Akiachak, Akiak, and Tuluksak. Using methods developed and refined during 2016–2018, the best estimate of total subsistence salmon harvest in the study area was 58,980 (95% confidence limits [CL]: 54,680–63,790) during 11 fishing opportunities with data collection between June 1 and July 9, 2022. Most salmon harvested were Chinook Salmon (29,950; 95% CL: 27,410–32,630), followed by Sockeye Salmon (*O. nerka;* 25,400; 22,770–28,540), and Chum Salmon (3,630; 3, 100–4,170). These estimates do not include harvests that (a) occurred in tributaries of the lower Kuskokwim River, (b) occurred downriver of Tuntutuliak or upriver of Akiak, (c) arose from non-gillnet capture methods, or occurred during fishing opportunities on July 4, 10, and 16. While the sampling and analytical methods remained standardized and generally consistent with previous years, harvest and effort estimation for the 2022 season, similar to 2021, was facilitated by a customized software package (termed 'KuskoHarvEst') for program R that provides an intuitive, menu-driven workflow. This allowed the co-authors to independently execute the estimation model and confer on results. This software will be useful for future seasons in which inseason harvest and effort estimates are desired for the lower Kuskokwim River subsistence salmon fishery and during which similar sampling occurs.

INTRODUCTION

Inseason management of Kuskokwim River salmon fisheries is undertaken in the face of a severe lack of information, due in a large part to the size and remoteness of the system and limited funds to monitor inseason harvests. Fully-informed management would require continuous and accurate information on run timing, harvest, and escapement for each return year (Staton and Catalano 2019). With knowledge on these three components, it would be possible to know how much of the run is yet to come, how much escapement potential remains, and how many more fish may be harvested. Inseason management of Kuskokwim River salmon has historically been conducted with little of this information and has instead relied largely on a

single and highly uncertain index (the Bethel Test Fishery[1] [BTF]) of run abundance, run timing, and species composition to inform decision-making. Western science has developed methods to obtain more detailed information on run timing (Staton et al. 2017) and relative run size (e.g., a recent new mainstem sonar project[2], and a Bayesian approach to update run size forecasts with inseason data on a daily basis; Staton and Catalano 2019), and delivering this information to managers and stakeholders in a timely manner for decision-making. Local and Indigenous Knowledge provided by Kuskokwim River harvesters and Tribal inseason managers during Federal-Tribal and public management meetings provides additional information on run forecasts, timing, and size. Based on observations of non-salmon species migrations, weather patterns, year-round climate, run timing information, and other natural indicators, this Local and Indigenous Knowledge can provide an input to Western scientific tools used to predict salmon run characteristics.

However, even with perfect holistic information on these run characteristics, the number of fish harvested riverwide inseason is unknown, despite its critical importance for structuring inseason fishing opportunities and ensuring adequate salmon escapement. Timely inseason subsistence harvest estimates have only been available relatively recently in the Kuskokwim River (2016–2022) to inform inseason management and remain a critical information source necessary to successfully manage weak salmon runs. This document follows previous procedures (Staton and Coggins 2016, 2017; Staton 2018; Decossas 2019a, 2020; Russell et al. 2021) to present inseason salmon harvest estimates from short-duration Kuskokwim River subsistence fishing opportunities during the 2022 season.

In response to multi-year conservation concerns for the Kuskokwim River Chinook Salmon (*Oncorhynchus tshawytscha*) season (Larson 2022), and the expectation of a weak Chum Salmon (*O. keta*) return in 2022, the Refuge Manager of the Yukon Delta National Wildlife Refuge (YDNWR), through action by the Federal Subsistence Board[i], assumed primary management authority of the Kuskokwim River Chinook Salmon subsistence fishery within the boundaries of the YDNWR on June 1, 2022 (Figure 1)[3]. This area is also commonly referred to as federal waters of the Kuskokwim River or the lower Kuskokwim River.

The Refuge Manager, in consultation with the Kuskokwim River Inter-Tribal Fish Commission (KRITFC) Tribal In-Season Managers as YDNWR's collaborative management partners, decided that the use of restricted fishing time, area closures, and type-of-gear restrictions would provide an adequate means to manage the fishery. The restricted fishing time, or "block openings," provided limited harvest opportunity with closed periods between openings allowing Chinook and Chum salmon to pass through areas of high fishing effort, thereby protecting significant amounts of returning salmon for spawner escapement and for harvesters residing above YDNWR boundaries. Block openings also provided specific windows to gather data for inseason harvest estimation and gave decisionmakers time in between openings to identify the nature of subsequent fishing opportunities. Additionally, both the Refuge Manager and KRITFC managers agreed that several block opening fishing opportunities should be announced prior to

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[1] http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareakuskokwim.btf
[2] https://www.adfg.alaska.gov/CF_R3/external/sites/aykdbms_website/ProjectInformation.aspx
[3] https://static1.squarespace.com/static/5afdc3d5e74940913f78773d/t/62730ea0df9db54e46c40d8f/1651707553054/3-KS-01-22_5.1.2022.pdf

the beginning of the Chinook Salmon season for people to plan for fishing, which provides greater certainty for subsistence harvesters and reduces complexity of inseason management. The Refuge Manager and KRITFC also agreed that 6-inch set gillnet opportunities should be provided to Federally-qualified subsistence users in order to provide a "taste of salmon" from June 1 to June 11.

On May 2, 2022, the Refuge Manager published the first emergency special action (ESA) of the season. Effective June 1. ESA 3-KS-01-22 announced: (1) closures of salmon spawning tributaries within YDNWR boundaries; (2) set gillnet openings of 18 hours each on June 1, 4, and 8; and (3) 12-hour drift and set gillnet openings on June 12 and 16. This approach of announcing a limited number of fisheries openings was intended to provide subsistence harvest opportunity without risking Chinook and Chum salmon escapement until additional data become available. The Refuge Manager subsequently announced additional openings shown below. Because of conservation concerns for salmon populations, these subsistence opportunities were limited to Federally qualified subsistence users, which include all residents of the Kuskokwim River drainage per regulations written in Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA).

The Refuge Manager expected relatively few Chinook and Chum salmon would be harvested during these early opportunities because of past low numbers of salmon in the river during the front-end closure, plus the net length and operational restrictions for gillnets during this time. Additionally, subsistence fishing with dip nets, beach seines, fish wheels, and rod and reel remained open with retention of any salmon caught allowed by Federally qualified subsistence users. Harvests from these non-gillnet methods are not included in the estimates provided in this report. In addition, estimates were not made for harvests that occurred in non-spawning tributaries, downstream of YDNWR boundaries, or upstream of area D1 (Figure 1). These harvest areas were excluded because aerial surveys do not monitor these areas, interview data coverage was variable, and harvests were generally thought to be small relative to mainstem harvests with gillnet gear.

There were 11 subsistence fishery opportunities between June 1 and July 16, 2022, in the YDNWR boundaries:

1. 6/1/22 6:00 am – 10:00 pm; 16 hours; ESA 3-KS-01-22; Set Gillnet Only
2. 6/4/22 6:00 am – 10:00 pm; 16 hours; ESA 3-KS-01-22; Set Gillnet Only
3. 6/8/22 6:00 am – 10:00 pm; 16 hours; ESA 3-KS-01-22; Set Gillnet Only
4. 6/12/22 06:00 am – 06:00 pm; 12 hours; ESA 3-KS-01-22; Drift or Set Gillnet
5. 6/16/21 06:00 am – 06:00 pm; 12 hours; ESA 3-KS-01-22; Drift or Set Gillnet
6. 6/22/22 06:00 am – 06:00 pm; 12 hours; ESA 3-KS-02-22; Drift or Set Gillnet
7. 6/29/22 06:00 am – 6/30/22 6:00 pm; 36 hours; ESA 3-KS-03-22; Set Gillnet Only
8. 7/3/22 06:00 am – 7/4/22 06:00 pm; 36 hours; ESA 3-KS-03-22; Set Gillnet Only
9. 7/9/22 06:00 am – 06:00 pm; 12 hours; ESA 3-KS-05-22; Drift Gillnet Only
10. 7/10/22, 06:00 am – 10:00 pm; 16 hours, ESA 3-KS-05-22; Set Gillnet Only
11. 7/16/22 06:00 am – 010:00 pm; 16 hours; ESA 3-KS-05-22; Set Gillnet Only

Federal restrictions for the harvest of Chinook salmon were rescinded on July 21, 2022, per the Refuge Manager's ESA "3-KS-01 thru 3-KS-05-22 (rescinding)."

Harvest estimates were not made for the July 4, 10, and 16 set gillnet-only opportunities because little effort was anticipated /or insufficient data were collected.

METHODS

The inseason harvest estimation framework that was developed and applied to the 2016–2022 Kuskokwim River salmon seasons required two primary types of information: (1) an estimate of the total number of fishing trips each day (termed "effort"); and (2) completed trip interview information from subsistence harvesters to document fishing trip gear and catch characteristics including: total trip time, fishing location, active fishing time, and catch by species (Staton and Coggins 2016, 2017; Staton 2018). For a complete description of analytical and sampling methods, see Staton (2018).

Aerial Net Counts

For each harvest opportunity or block opening (duration of 12 to 36 hours depending on date and legal gear), USFWS conducted one to two flights between the communities of Tuntutuliak and just above Akiak, depending on factors such as expected effort, weather, and budget considerations (Tables 1 and 2; Figure 1). Flights were scheduled to capture net counts between low and high tides when the tides were moving the strongest (which are the most popular times to fish), and flights were spaced throughout the openings. Individual flights lasted from 1.0 to 2.5 hours (one longer flight of 3:45 related to an enforcement stop), with 2.0 to 3.0 hours between flights when multiple flights occurred on a given day (Tables 1 and 2). The analytical method for converting aerial counts to estimates of total effort includes estimates of trips that were likely to have been counted on multiple flights, and trips that were unlikely to have been counted on any flight, is described in Staton (2018).

One notable change in 2022 involved how downriver and upriver flight counts of set gillnets were treated. In prior years, the number of set gillnets used for analysis below Bethel was the maximum of the downriver and upriver aerial counts, similar to what is done for drift gillnets. Based on recommendations from YDNWR staff, set gillnet counts from below Bethel in 2022 were treated as sums of the downstream and upstream flights because many set gillnet locations are only visible on either the downriver or upriver passes.

Completed Trip Interviews

Information from harvester trips was obtained from three sources: (1) the Bethel boat harbor, (2) Bethel area fish camps, and (3) seven lower Kuskokwim River villages other than Bethel. Interview data from sources (1) and (2) were collected by the Orutsararmiut Native Council (ONC) using the same methods that have been used since 2015. Data from lower Kuskokwim

River villages other than Bethel were collected by KRITFC community harvest monitors with the same methods beginning in 2017 as part of a community-based harvest monitoring (CBHM) project designed to provide interview data from areas of the YDNWR other than the Bethel area. In 2022, ten KRITFC community harvest monitors were located in the villages of Eek, Napakiak, Napaskiak, Kwethluk, Akiachak, Akiak, and Tuluksak. Data from all sources were generally compiled in a timely manner (by12 to 24 hours following an opening) to be included in harvest estimates. However, interview data for a small number of cases were received too late for inclusion in the inseason harvest reports. These interview data are included in this final report and had little effect on harvest estimates, but note that catch and effort estimates on an individual data in this report may differ slightly from inseason harvest estimates.

Analytical Methods

The analytical methods in 2022 were similar to those used in 2016–2021 and are described in Staton (2018). Some notable changes in 2021 and 2022 involved introducing consistency in the decision rules that deem an interview unsuitable to be used in the estimation. These changes included: (1) exclusion of net-in-water times that were more than three standard deviations from the average for a given opening and gear type; (2) capping net-in-water times to not exceed reported trip duration; and (3) excluding catch-per-unit-effort data from interviews that changed the estimate of average total salmon catch per trip by more than 5%. Note that some interviews were available from fishing efforts in reporting strata O (i.e., downriver of the YDNWR boundary or in non-spawning tributaries) and in strata D1, D2, and D3 above Akiak (Figure 1) but were not included in these harvest estimates due to a lack of aerial survey coverage for these areas.

Harvest estimates were made through a custom software package for program R entitled 'KuskoHarvEst[4]' (Staton 2021). 'KuskoHarvEst' aims to: (1) facilitate installation of software needed to perform estimation and generate reports, (2) remove software editing needed to for each harvest opportunity, and (3) enforce consistency and remove subjectivity in data quality checking and censoring. The package accomplishes these tasks by being self-contained, easily downloadable, and providing an intuitive menu-driven workflow for all data processing and estimation steps. Routines in the R package are automated for conducting calculations developed in the 2016–2018 seasons (Staton and Coggins 2016, 2016; Staton 2018). Note that the software as currently configured does not accommodate interviews from harvesters that fished across multiple days (i.e., for a fishing trip that started on one day and ended on the subsequent day). For the June 29-30 and July 3-4 openings in 2022, the reported harvest was apportioned between adjacent days according to hours of the fishing trip reported for those adjacent days.

Following the conclusion of the 2021 season, software development continued based on feedback from the 2021 experience with the first version, largely to improve the ability to detect and handle data formatting issues (B. Staton, Quantitative Ecological Services, pers. com.). Minor edits to the harvest estimation program continued in 2022 as issues were resolved. Each co-author reviewed the updated software prior to the 2022 season and had the opportunity to independently use the software inseason to produce the estimates for each harvest opportunity.

[4] https://github.com/bstaton1/KuskoHarvEst

Results were consistent among co-authors, with the biggest issue being data formatting errors that were often, but not always, identified by the interface computer code.

RESULTS

6/1/2022 Opening (Set Gillnet Only)

An estimated total of 33 set gillnet trips occurred in the study area during the 16-hour opening on June 1 (Table 3; Figure 2). The estimated total salmon harvest was 30 (95% CL: 0–90), with all harvested salmon being Chinook Salmon (Tables 4 and 6; Figure 4). Harvest estimates were produced from 27 trip interviews, of which 14 (52%) came from KRITFC community harvest monitors, 10 (27%) from the Bethel boat harbor, and 3 (11%) from Bethel area fish camps (Figure 5). For the June 1 opening, trip duration averaged 10.1 hours, and soak time averaged 10.0 hours among all interviews (data not shown).

6/4/2022 Opening (Set Gillnet Only)

An estimated total of 80 set net trips occurred between Tuntutuliak and Akiak during the 16-hour opening on June 4 (Table 3; Figure 2). The estimated total salmon harvest was 90 (95% CL: 50–140). All of the salmon harvest was Chinook Salmon (Tables 4 and 6; Figure 4). Harvest estimates were produced from 33 trip interviews, of which 21 (64%) came from KRITFC community harvest monitors, 9 (27%) from the Bethel boat harbor, and 3 (9%) from Bethel area fish camps (Figure 5). For the June 4 opening, trip duration averaged 9.3 hours, and soak time averaged 9.0 hours among all interviews (data not shown).

6/8/2022 Opening (Set Gillnet Only)

An estimated total of 84 set net trips occurred between Tuntutuliak and Akiak during the 16-hour opening on June 8 (Table 3; Figure 2). The estimated total salmon harvest was 140 (95% CL: 80–210). Most (86%) of the harvest was Chinook Salmon (120; 95% CL: 70–190), followed by Sockeye Salmon at 14% of the harvest (20; 95% CL: 0–50), with no Chum Salmon harvested (Tables 4 and 6; Figure 4). Harvest estimates were produced from 35 trip interviews, of which 22 (63%) came from KRITFC community harvest monitors, 8 (23%) from the Bethel boat harbor, and 5 (14%) from Bethel area fish camps (Figure 5). For the June 8 opening, trip duration averaged 9.6 hours and soak time averaged 9.3 hours among all interviews (data not shown).

6/12/2022 Opening (Drift and Set Gillnet)

An estimated total of 455 drift boat trips and 22 set net trips occurred in the study area during the 12-hour opening on June 12 (Table 3; Figures 2 and 3). The estimated total salmon harvest was 5,800 (95% CL: 4,390–7,620). The majority of the harvest (91%) was Chinook Salmon (5,300;

95% CL: 3,960–6,950), followed by smaller amounts of Sockeye Salmon at 8% of the harvest (440; 95% CL: 300–630) and Chum Salmon at 1% of the harvest (60; 95% CL: 20–120) (Tables 4–6; Figure 4). Harvest estimates were produced from 223 trip interviews, of which 120 (54%) came from the Bethel boat harbor, 87 (39%) from KRITFC community harvest monitors, and 18 (7%) from Bethel area fish camps (Figure 5). Fifteen interviews were from set net harvesters with the remaining 208 interviews from drift net users.

Based on the distribution of relevant drift net interview quantities from the June 12 opening (Figure 6), trip duration varied widely among harvesters (average 4.6 hours), and soak time was skewed towards less than 6 hours (average 4.6 hours). Over half of the harvesters caught less than 10 salmon per trip (average of 8.2 salmon/trip among all interviews). As in recent years, the average harvesters interviewed by KRITFC community harvest monitors and at Bethel area fish camps had higher catch rates and spent more time actively fishing than most people interviewed at the Bethel boat harbor.

6/16/2022 Opening (Drift and Set Gillnet)

An estimated total of 473 drift boat trips and 36 set net trips occurred within the study area during the 12-hour opening on June 16 (Table 3; Figures 2 and 3). The estimated total salmon harvest was 9,790 (95% CL: 7,880–12,070). As in the June 12 opening, most (79%) of the harvest was Chinook Salmon (7,700; 95% CL: 6,370–9,160), followed by Sockeye Salmon at 20% of the harvest (1,920; 95% CL: 1,260–2,970), and Chum Salmon at 2% of the harvest (160; 95% CL: 90–270) (Tables 4–6; Figure 4).

Harvest estimates were produced from 248 completed trip interviews, of which 139 (56%) came from the Bethel boat harbor, 84 (34%) came from KRITFC community harvest monitors, and 25 (10%) came from Bethel area fish camps (Figure 5). Eight of these interviews were from set net fishers and the remaining 240 were from drift boat harvesters.

Based on the distribution of relevant drift net interview quantities from this opening (Figure 7), trip duration (average 7.0 hours) and soak durations (average 5.0 hours) were only slightly longer than the June 12 opening. Total salmon per trip (average 15.0) and Chinook Salmon per trip (average 12.0) increased from the June 12 opening (Figure 7). Sockeye Salmon catch rates more than tripled while Chum Salmon catch rates marginally increased over June 12.

6/22/2022 Opening (Drift and Set Gillnet)

An estimated total of 572 drift boat trips and 20 set net trips occurred in the study area during the 12-hour opening on June 22 (Table 3; Figures 2 and 3). The estimated total salmon harvest was 28,750 (95% CL: 25,780–31,990). The majority of the harvest was Chinook Salmon (14,030; 95% CL: 12,950–15,650), which was a substantial increase in total number of Chinook Salmon harvested but a substantial decline in the proportion of the catch (49%) compared to previous openings. Sockeye Salmon comprised 48% of the salmon harvest (13,760; 95% CL: 11,720–

16,170), followed by Chum Salmon at 3% of the harvest (950; 95% CL: 750–1,180) (Tables 4–6; Figure 4).

Harvest estimates were produced from 183 trip interviews, of which 117 (64%) came from the Bethel boat harbor, 52 (28%) from KRITFC community harvest monitors, and 14 (8%) from Bethel area fish camps (Figure 5). Six interviews were from set net harvesters with the remaining 177 interviews from drift net users.

Based on the distribution of relevant drift harvester interview quantities from this opening (Figure 8), trip duration varied widely among harvesters, but declined from the previous opening and averaged 5.5 hours, and soak time averaged 3.7 hours. Catches of all salmon increased to an average of 35 salmon per trip. Harvesters interviewed by KRITFC community harvest monitors and at Bethel area fish camps again spent more time actively fishing and had substantially higher soak times and catch rates than most people interviewed at the Bethel boat harbor.

6/29/2022 Opening (Set Gillnet Only)

The existing 'KuskoHarvEst' analysis software was developed for short-term openings of less than 24 hours. For the 36-hour set gillnet opening from 6:00 am on June 29 to 6:00 pm on June 30, it was necessary to split effort and harvest at midnight between June 29 and 30 for those harvesters fishing past midnight. The following summary is only for estimated catch and effort on June 29.

An estimated total of 74 set net trips occurred within the study area on June 29 (Table 3; Figure 2). The estimated total salmon harvest was 3,460 (95% CL: 2,610–4,500). Most of the harvest in this opening (76%) was Sockeye Salmon (2,620; 95% CL: 1,850–3,510), followed by 17% Chinook Salmon (580; 95% CL: 390–820), and 4% Chum Salmon (270; 95% CL: 170–390) (Tables 4 and 6; Figure 4).

Harvest estimates for June 29 were produced from 75 completed trip interviews, of which 36 (48%) came from KRITFC community harvest monitors, 28 (37%) came from the Bethel boat harbor, and 11 (15%) came from Bethel area fish camps (Figure 5). Note that 34% of these harvesters fished past midnight and their proportional harvest and effort data for June 30 are summarized under the following opening. Based on the distribution of relevant interview quantities for June 29 (Figure 9), trip times averaged 7.6 hours and net soak times averaged 7.2 hours.

6/30/2022 Opening (Set Gillnet Only)

Again, note that the existing analysis was developed for short-term openings of less than 24 hours, so the co-authors split effort and harvest at midnight between June 29 and 30 for those harvesters fishing past midnight. The following summary is for estimated catch and effort on June 30.

An estimated total of 72 set net trips occurred in the study area on June 30 (Table 3; Figure 2). Estimated total salmon harvest on June 30 was 2,420 (95% CL: 1,800–3,230). Most harvest in this opening (52%) was Sockeye Salmon (1,270; 95% CL: 770–1,900), followed by 40% Chinook Salmon (970; 95% CL: 770–820), and 4% Chum Salmon (270; 95% CL: 170–390) (Tables 4 and 6; Figure 4).

Harvest estimates for June 30 came from 56 trip interviews, of which 32 (57 %) came from KRITFC community harvest monitors, 13 (23%) from the Bethel boat harbor, and 11 (20%) from Bethel area fish camps (Figure 5). Based on the distribution of relevant interview quantities for June 30 (Figure 10), trip times averaged 10.5 hours and net soak times averaged 10.0 hours.

7/3/2022 Opening (Set Gillnet Only)

For the 36-hour set gillnet opening from 6:00 am on July 3 to 6:00 pm on July 4, it was necessary to split effort and harvest at midnight between July 3 and 4 for those harvesters fishing past midnight. The following summary is only for estimated catch and effort on July 3.

An estimated total of 69 set net trips occurred within the study area on July 3 (Table 3; Figure 2). The estimated total salmon harvest was 2,120 (95% CL: 1,540–2,830). Most (55%) harvest in this opening was Sockeye Salmon (1,160; 95% CL: 630–1,840), followed by 31% Chinook Salmon (660; 95% CL: 470–620), and 14% Chum Salmon (300; 180–440) (Tables 4 and 6; Figure 4).

Harvest estimates were produced from 35 completed trip interviews, of which 31 (89%) came from KRITFC community harvest monitors, 4 (11%) from Bethel area fish camps, and none from the Bethel boat harbor (Figure 5). Based on the distribution of relevant interview quantities from July 3 (Figure 11), trip duration averaged 8.1 hours, and soak duration average 7.5 hours.

7/4/22 Opening (Set Gillnet Only)

While 13 set nets were observed during aerial surveys on July 4 (Table 1), data ware obtained from only nine interviews, which was insufficient to develop harvest estimates.

7/9/22 Opening (Drift Gillnet Only)

An estimated total of 147 boat trips occurred in the study area during the 12-hour drift gillnet opening on July 9 (Table 3; Figure 3). The estimated total salmon harvest was 6,380 (95% CL: 5,330–7,640). The majority (66%) of the harvest was Sockeye Salmon (4,210; 95% CL: 3,300–5,380), followed by 27% Chum Salmon (1,700; 95% CL: 1,300–2,160), and 7% Chinook Salmon (470; 95% CL: 340–620) (Table 6; Figure 4).

Harvest estimates were produced from 79 trip interviews, of which 64 (81%) came from the Bethel boat harbor, 12 (15%) from KRITFC community harvest monitors, and 3 (4%) from Bethel area fish camps (Figure 5).

Based on the distribution of relevant drift harvester interview quantities from this opening (Figure 12), trip duration (average 4.4 hours) and soak time (average 2.5 hours) were reduced from recent openings.

7/10/22 Opening (Set Gillnet Only)

Due to an anticipation of substantially reduced harvest effort during the July 10 set net only opening, no data were collected.

7/16/22 Opening (Set Gillnet Only)

Due to an anticipation of substantially reduced harvest effort during the July 16 set net only opening, no data were collected.

Total Harvest across All Openings

Insufficient or no data were available to make harvest estimates for the July 4, 10, and 16 openings. In addition, 43 interviews of harvesters fishing stratum O (primarily non-spawning tributaries and below Eek Island) and 67 interviews of harvesters fishing strata D, and D3 above Akiak generally had inconsistent or no aerial survey coverage to obtain net counts. Therefore, interview data were not expanded to total estimates. Thus, total harvest estimates reported here should be considered as minimum estimates and interpreted with caution considering these aspects.

Across all openings, an estimated total of 58,980 (95% CL: 54,680–63,790) salmon was harvested (Table 6; Figure 13). This estimate does not include harvests that (a) occurred in tributaries of the lower Kuskokwim River; (b) were from non-gillnet capture methods; or (c) occurred during fishing opportunities on July 9, July 10, and July 17. This was 12% less than the average annual harvest of all salmon from 2016–2021 (Table 8). The 2022 Chinook Salmon harvest of 29,950 fish (95% CL: 27,410–32,630) comprised 51% of the total 2022 salmon harvest. The Chinook Salmon harvest in 2022 was the second largest harvest since this inseason monitoring program began in 2016 and 26% larger than the 2016–2021 average harvest (Table 8).

Sockeye Salmon was the second largest contributor (43% of total) to the 2022 inseason harvest estimate with a total of 25,400 fish (95% CL: 22,770–28,540). The 2022 harvest of Sockeye Salmon was the largest inseason amount since 2016 and 31% larger than the average Sockeye Salmon harvest during 2016–2021 (Table 8).

The total inseason estimate of 3,630 (95% CL: 3,100–4,170) Chum Salmon harvested in 2022 comprised 6% of the estimate for all salmon (Table 8). This was the lowest inseason estimate of Chum Salmon harvest since 2016 in terms of both the number of fish and the proportion of the total harvest. The 2022 Chum Salmon harvest was 85% less than the average harvest during 2016–2021.

In 2022, harvesters in geographic stratum C (Napaskiak to Akiachak; Table 6; Figures 1 and 14) caught the most total salmon, accounting for 43% of all salmon harvest, followed by stratum A (Eek Island to Johnson River; 24%), stratum B (Johnson River to Napaskiak; 24%), and stratum D1 (Akiachak to Akiak; 9%) (Table 4). Drift net effort in 2022 peaked on the June 22 opening, whereas maximum set net effort occurred on June 4 (Table 3).

Synthesis of Key Information on 6/12 Opening

June 12 is a key opening date, following June 1 to June 11 restrictions to allow early returning Chinook Salmon to migrate upstream. But it remains important to continue synthesizing information on a June 12 opening that have been gathered from 2016 to 2022, during which 12-hour openings were implemented. There are several notable findings from June 12 fishing opportunities during 2016–2022. The number of drift and set net trips from Tuntutuliak to Akiak were similar in magnitude, but peaked at 584 trips in 2017, steadily declined to 409 trips in 2021, and in 2022 increased to 477 trips, a level only 3% less than the 2016–2022 average (Table 7).

In terms of total harvest, this first combined 12-hour drift and set gillnet opening in 2022 resulted in an estimated total salmon harvest that was 3% higher than the June 12 average from 2016–2021 (Table 7). The estimated number of Chinook Salmon harvested in this opening (5,300) was the second highest for this date since 2016 and 19% higher than the 2016–2021 average. The estimate of 60 Chum Salmon harvested in this opening was the lowest for this date since 2016 and 94% less than the longer-term average. In contrast, the June 12 Sockeye Salmon harvest was 31% higher than the 2016–2021 average. The species ratio (Chum+Sockeye:Chinook) in 2022 (<0.1) was the second lowest since 2016.

DISCUSSION

Overall Summary

For the 2022 season, an inseason estimated total of 58,980 (95% CL: 54,680–63,790) salmon were harvested (Table 8). This estimate was 12% below the average during 2016–2021, the years for which the current inseason harvest estimation program has been implemented. The largest catch component (51%) in 2022 was the Chinook Salmon harvest of 29,950 fish (95% CL 27,410–32,630), representing the second largest inseason harvest estimate for Chinook Salmon since 2016. Sockeye Salmon was the second largest contributor (43%) to the 2022 inseason harvest estimate with a total of 25,400 fish (95% CL: 22,770–28,540). The 2022 harvest of Sockeye Salmon was the largest inseason amount since 2016, and 31% larger than the average Sockeye Salmon harvest during 2016–2021 (Table 8). Chum Salmon comprised only 6% of the

total 2022 inseason harvest estimate, and the harvest of 3,630 (95% CL: 3,100–4,170) Chum Salmon was the lowest catch since 2016.

As noted previously, these 2022 estimates do not include harvests from the July 4, 10, and 16 openings; from non-salmon spawning tributaries; from areas outside the YDNWR boundaries; or from areas upriver from Akiak. Thus, these should be considered minimum subsistence harvest estimates that will be revised through the Alaska Department of Fish and Game household surveys (e.g., McDevitt et al. 2021).

For set gillnets fished over midnight between days (e.g., June 29–30 and July 3–4), it was necessary to divide the catch across days for accommodation by the harvest estimation code. This resulted in insufficient data to estimate harvests for July 4. This also likely resulted in an overestimation of the number of nets fished across multi-day openings, although the total catch estimate should still be fairly accurate. Revision of the estimation code is a future consideration.

It should also be noted that data presented in this report may differ slightly from harvest summaries provided following individual openings. Substantial effort is made to receive the interview and flight data within 12 hours after an opening, and process that data into a harvest estimate that can be distributed in 1-2 days after an opening. However, in several instances, for a variety of reasons, interview data were not received until an initial harvest summary was distributed. These late data have been included in this report and did not have a substantial effect on harvest estimates, but did improve the precision of the estimates.

One other aspect that complicated the 2022 sampling design was the continuing occurrence of the COVID-19 pandemic. For example, a COVID-19 outbreak in Kwethluk resulted in instructions for residents to isolate, impeding KRITFC face-to-face interviews in that village. Fortunately, the current interview format is adaptable to phone interviews provided that the community monitor and the person being interviewed are both within cell phone coverage.

Reliability of Assumptions

All reported analyses assumed the interview information to be random samples from the population of harvesters during the openings (Bernard et al. 1998). This assumption is not unique to this analysis, or creel surveys in general, but is made in every statistical analysis where samples are used to make inferences on a population. We must highlight that sampling for the completed trip interviews was not implemented in a truly random sense, but was opportunistic. The potential for non-randomness could raise questions about the harvest estimates in terms of accuracy and precision. If data were systematically biased (e.g., some people interviewed fished longer and had higher catch rates than non-sampled harvesters), then the resulting estimates would also be biased. While surveys had both high and low catches, we believe these estimates thoroughly represent the available harvest results and efforts. In addition, the software was recently revised to exclude interview data that exceeding three standard deviations from the mean (B. Staton, Quantitative Ecological Services, pers. com).

We believe the samples, although gathered opportunistically, provide a good representation of the lower Kuskokwim River subsistence fishery during block openings. Fishing opportunities in the 2022 season were relatively short in duration, ranging from 12 to 36 hours, meaning that surveyor coverage at interview locations could sample a representation of harvesters returning to these locations, leading us to believe temporal representation was high (i.e., the samples should identify variability due to the time of day that different trips occurred). However, due to the size of the study area and the number of communities involved, spatial representation is more difficult to guarantee. The lower Kuskokwim River can be generally separated into three major sections based on river morphology, harvester behavior, and harvester density: (1) upriver from Bethel, (2) around Bethel, and (3) downriver from Bethel. A majority of the surveys collected were from around Bethel, primarily through the Bethel boat harbor surveys conducted by ONC. While most of the population of subsistence harvesters is based in and around Bethel, catch rates outside of Bethel can differ substantially from Bethel area harvests. For example, the villages of Napaskiak and Napakiak are relatively short boat rides (about 6 and 10 river miles, respectively) from Bethel but exhibit different effort and harvest characteristics from Bethel.

Overall, interviews by ONC at the Bethel boat harbor and Bethel area fish camps provided a respectable representation of the subsistence fishery in the Bethel area. Concurrently, KRITFC provided coverage through community-based harvest monitors based below Bethel in the villages of Eek, Napakiak, and Napaskiak, and above Bethel in the villages of Kwethluk, Akiachak, Akiak, and Tuluksak. Given this broad geographic coverage within the study area, we believe data collected through the monitoring program are representative of the lower river subsistence fishery.

Other Harvest Not Monitored or Accounted For

Harvest estimates in this document for salmon within the study area are believed to be accurate for river areas represented by interviews and aerial net counts, but are undoubtedly biased low as an estimate for all of 2022. For example, gillnet harvests occurred in areas designated as non-spawning tributaries that were still part of the Kuskokwim River drainage. Harvest in these areas is poorly documented (Decossas 2019b). The 2022 interviews collected some information from subsistence users who fished in the non-salmon spawning tributaries (i.e., Johnson River, Tuntutuliak River, and Pailleq Slough). This aspect is further amplified because data from non-salmon spawning tributaries are oftrn collected only when the mainstem fishery is open for fishing, whereas non-salmon spawning tributaries are open throughout the salmon season with fewer gear restrictions (e.g., gillnets with ≥ 6” mesh are allowed). No data collected from non-salmon spawning tributaries were included in these 2022 harvest estimates. Harvest estimates were not generated for these locations, similar to previous years, because subsistence harvest interviews are generally collected only for announced fishing openings, and aerial surveys do not typically cover these areas. Similarly, this was the first year to have a community harvest monitor based in Tuluksak. Interview data from the 2022 season indicated that most people from Tuluksak fished upriver from the village, but aerial surveys to count nets end near Tuluksak. This aspect will be explored in the future provided a community harvest monitor continues to be based in Tuluksak. While harvests in these locations are not believed to be detrimental to

meeting escapement needs, the magnitude of salmon harvest in these locations remains unknown.

Additionally, federally-qualified users were also able to harvest Chinook Salmon before June 1 with up to 6" mesh size gillnets. During this time period, harvest and effort was not monitored, although the number of Chinook Salmon in the Kuskokwim River is believed to have been minimal.

Finally, the co-authors would like to note that inseason harvest monitoring did not extend far into the 2022 Coho Salmon run, which came back as one of the lowest, if not the lowest, Coho Salmon returns on record. Reasons for forgoing inseason harvest monitoring during the Coho Salmon return (generally the end of July through September) included: (1) lack of KRITFC, ONC, and YDNWR funding and personnel capacity to continue harvest survey projects after mid-July; (2) relinquishment of Federal management on July 21 and the corresponding end of Federal-Tribal in-season management decision making; and (3) a subsequent ADF&G closure to nearly all fishing with nearly all means and methods in order to conserve Coho Salmon. The KRITFC, YDNWR, and ONC are exploring ways to extend inseason harvest monitoring through the Coho Salmon return in future years, anticipating a continued decline in Coho Salmon abundance following trends of other species in the Kuskokwim River and other Western Alaska rivers.

Sensitivity of Harvest Estimates

Sensitivity of the estimates to assumption violations was investigated by producing effort and harvest estimates using data from smaller subsets of all of the available interviews (e.g., removing Bethel boat harbor interviews). Results of these analyses showed that the estimates were generally robust to leaving out information (i.e., making the information used presumably less representative), and the results ranged from small changes (<5%) in point estimates to larger changes (25–0%). Typically, harvest estimates increased when Bethel boat harbor data were removed and decreased when the CBM interviews were removed. In most cases, the point estimate of the analysis with left-out data fell within the 95% CL of the original estimate and the qualitative conclusion did not change.

One aspect that needs clarification is that all reported values are rounded to the nearest 10. As a result, some table values if summed across date, location, or species might not add up to the displayed total. This is due to rounding values and is an aspect considered for future resolution.

Technical Review of Harvest Estimates

During 2022, the harvest estimation model was run independently by the co-authors and the resulting estimates were compared. Output differences were usually tied to data entry or formatting errors. After resolving data issues, harvest estimates were sent to an open email list that included USFWS-KRITFC inseason managers and researchers, the Kuskokwim River Salmon Management Working Group, and interested stakeholders.

Scalability of the Model

The current methods for estimating inseason salmon harvests are effective when applied to most fishery conditions that have occurred since 2016 (i.e., relatively few opportunities, each short in duration). However, if the frequency and duration of fishing opportunities were to increase, a more carefully designed random sampling program may be needed to produce reliable harvest estimates. This is because longer openings make it more difficult to justify the assumption of random sampling at existing locations with interview coverage. Currently, interviewers are focused toward the end or just after the end of an opening. But as the duration of an opening increases, decisions need to be made about the most appropriate time and place to conduct interviews to ensure interviews are a representative sample of the fishery. Interviews by phone have aided the interview process, but it is still uncertain how interviews might be randomized over a longer duration opening.

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Table 1. Raw set gillnet counts from each flight and geographic stratum. Openings on June 2 and 5, and July 10 and 16 were set gillnet only opportunities.
No flights were conducted for the July 10 and 16 openings.

		Flight Times[1]		Geographic Stratum[2]				
Opening	Date	Start	Stop	A	B	C	D	Total
1	6/1/2022	15:00	16:30	1	5	22	5	33
2	6/4/2022	13:55	15:33	4	15	51	10	80
3	6/8/2022	14:00	15:34	1	8	56	19	84
4	6/12/2022	10:15	12:00	1	0	13	1	15
4	6/12/2022	15:00	16:32	0	3	13	3	19
5	6/16/2022	10:00	12:00	0	4	24	7	35
5	6/16/2022	14:00	16:00	0	1	17	6	24
6	6/22/2022	10:25	11:45	0	0	15	2	17
6	6/22/2022	15:00	16:30	0	2	9	2	13
7	6/29/2022	8:32	10:16	0	5	55	14	74
7	6/30/2022	13:18	14:400	0	6	53	13	72
8	7/3/2022	15:45	19:30	2	3	52	16	69
8	7/4/2022	13:30	15:30	0	0	7	6	13
9	7/9/2022	10:02	11:36	0	0	0	0	0
9	7/9/2022	14:06	16:36	0	0	0	0	0
10	7/10/2022	ND	ND	ND	ND	ND	ND	ND
11	7/16/2022	ND	ND	ND	ND	ND	ND	ND

[1]ND = No data
[2]Geographic strata: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak

Table 2. Raw drift gillnet counts from each flight and geographic stratum. Openings on June 1, 4, 8, and 29, and July 3–4, 10, and 16 were for set gillnets only.
No flights were conducted for the July 10 and 16 openings.

		Flight Times[1]		Geographic Stratum[2]				
Opener	Date	**Start**	**Stop**	**A**	**B**	**C**	**D**	Total
1	6/1/2022	15:00	16:30	0	0	0	0	0
2	6/4/2022	13:55	15:33	0	0	0	0	0
3	6/8/2022	14:00	15:34	0	0	0	0	0
4	6/12/2022	10:15	12:00	84	77	156	27	344
4	6/12/2022	15:00	16:32	68	40	157	24	289
5	6/16/2022	10:00	12:00	92	76	165	41	374
5	6/16/2022	14:00	16:00	103	87	158	41	389
6	6/22/2022	10:25	11:45	104	87	180	37	408
6	6/22/2022	15:00	16:30	49	84	94	22	249
7	6/29/2022	8:32	10:16	0	0	0	0	0
7	6/30/2022	13:18	14:40	0	0	0	0	0
8	7/3/2022	15: 45	19:30	0	0	0	0	0
8	7/4/2022	13:30	15:30	0	0	0	0	0
9	7/9/2022	10:02	11:36	8	9	60	3	80
9	7/9/2022	14:06	16:36	10	18	57	5	90
10	7/10/2022	ND	ND	ND	ND	ND	ND	ND
11	7/16/2022	ND	ND	ND	ND	ND	ND	ND

[1]ND = No data
[2]Geographic strata: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak

Table 3. Estimated drift and set gillnet trips by date and geographic stratum. These quantities were derived from the raw counts presented in Tables 1 and 2.

				Geographic Stratum[1]				
Gear	Opening	Date	Duration[2]	A	B	C	D1	Total
Drift Net	1	6/1/2022	16	NA	NA	NA	NA	NA
	2	6/4/2022	16	NA	NA	NA	NA	NA
	3	6/8/2022	16	NA	NA	NA	NA	NA
	4	6/12/2022	12	109	83	226	37	455
	5	6/16/2022	12	121	101	200	51	473
	6	6/22/2022	12	129	157	234	52	572
	7	6/29/2022	18	NA	NA	NA	NA	NA
	7	6/30/2022	18	NA	NA	NA	NA	NA
	8	7/3/2022	18	NA	NA	NA	NA	NA
	8	7/4/2022	18	NA	NA	NA	NA	NA
	9	7/9/2022	12	16	23	101	7	147
	10	7/10/2022	16	NA	NA	NA	NA	NA
	11	7/10/2022	16	NA	NA	NA	NA	NA
Set Net	1	6/1/2022	16	1	5	22	5	33
	2	6/4/2022	16	4	15	512	10	80
	3	6/8/2022	16	1	8	56	19	84
	4	6/12/2022	12	1	2	16	3	22
	5	6/16/2022	12	0	3	25	8	36
	6	6/22/2022	12	0	2	15	3	20
	7	6/29/2022	18	0	5	55	14	74
	7	6/30/2022	18	0	6	53	13	72
	8	7/3/2022	18	2	3	52	12	69
	8	7/4/2022	18	ND	ND	ND	ND	ND
	9	7/9/2022	12	NA	NA	NA	NA	NA
	10	7/10/2022	16	ND	ND	ND	ND	ND
	11	7/16/2022	16	ND	ND	ND	ND	ND

[1]Geographic strata: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak
[2]Duration is the number of hours in the opening.
[3]ND = No data or insufficient data, NA = not applicable

Table 4. Salmon harvests from set gillnets by subsistence opening, species, and geographic stratum in 2022. Numbers within parentheses are 95% confidence limits.

		Geographic Stratum[1]				
Opening	Species	A	B	C	D	Total
6/1/2022	Chinook	0	10	20	10	30
		(0-0)	(0-10)	(060)	(0-10)	(0-90)
	Chum	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
	Sockeye	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
	Total	0	10	20	10	30
		(0-0)	(0-10)	(0-60)	(0-10)	(0-90)
6/4/2022	Chinook	0	20	60	10	90
		(0-10)	(10-30)	(30-90)	(0-20)	(50-140)
	Chum	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-10)	(0-0)
	Sockeye	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
	Total	0	20	60	0	90
		(0-10)	(10-30)	(30-90)	(10-20)	(50-140)
6/8/2022	Chinook	0	10	80	30	120
		(0-0)	(10-20)	(50-120)	(20-40)	(70-190)
	Chum	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
	Sockeye	0	0	10	10	20
		(0-0)	(0-0)	(0-30)	(0-10)	(0-50)
	Total	0	10	100	30	140
		(0-0)	(10-20)	(60-140)	(20-50)	(80-210)
6/12/2022	Chinook	0	10	40	10	60
		(0-0)	(0-10)	(20-70)	(0-10)	(20-100)
	Chum	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
	Sockeye	0	0	0	0	0
		(0-0)	(0-0)	(0-10)	(0-0)	(0-10)
	Total	0	10	40	10	60
		(0-0)	(0-10)	(20-80)	(0-20)	(30-110)
6/16/2022	Chinook	0	10	120	40	170
		(0-0)	(0-30)	(40-230)	(10-70)	(60-330)
	Chum	0	0	0	0	0
		(0-0)	(0-0)	(0-10)	(0-0)	(0-10)
	Sockeye	0	0	0	0	0
		(0-0)	(0-0)	(0-10)	(0-0)	(0-20)
	Total	0	10	130	40	180
		(0-0)	(0-30)	(40-240)	(10-80)	(60-350)

-continued-

Table 4-(Page 2 of 2).

Opening	Species	Geographic Stratum[1] A	B	C	D	Total
6/22/2022	Chinook	0	20	180	40	230
		(0-0)	(10-40)	(90-260)	(20-50)	(120-350)
	Chum	0	0	0	0	0
		(0-0)	(0-0)	(0-0)	(0-0)	(0-0)
	Sockeye	0	20	180	40	240
		(0-0)	(10-40)	(100-270)	(20-60)	(130-370)
	Total	0	50	360	70	480
		(0-0)	(30-70)	(220-510)	(40-100)	(330-680)
6/29/2022	Chinook	0	40	430	110	580
		(0-0)	(30-60)	(290-610)	(70-160)	(390-820)
	Chum	0	20	200	50	270
		(0-0)	(10-30)	(120-290)	(30-70)	(170-390)
	Sockeye	0	180	1,940	490	2,620
		(0-0)	(120-240)	(1,380-2,610)	(350-660)	(1,850-3,510)
	Total	0	230	2,570	650	3,460
		(0-0)	(180-300)	(1,940-3,340)	(490-850)	(2,610-4,500)
6/30/2022	Chinook	0	80	720	180	970
		(0-0)	(60-100)	(570-890)	(140-220)	(770-1,200)
	Chum	0	20	130	30	180
		(0-0)	(10-20)	(70-210)	(20-50)	(100-280)
	Sockeye	0	110	930	230	1,270
		(0-0)	(60-160)	(570-1,400)	(140-340)	(770-1,900)
	Total	0	200	1,780	440	2,420
		(0-0)	(150-270)	(1,330-2,380)	(320-580)	(1,800-3,230)
7/3/2022	Chinook	20	30	500	110	660
		(10-20)	(20-40)	(360-640)	(80-150)	(470-840)
	Chum	10	20	230	50	300
		(0-10)	(10-20)	(130-330)	(30-80)	(180-440)
	Sockeye	30	50	870	200	1,160
		(20-50)	(30-80)	(480-1,390)	(110-320)	(630-1,840)
	Total	60	90	1,590	370	2,120
		(40-80)	(70-120)	(1,160-2,130)	(270-490)	(2,830)
All Openings	Chinook	30	230	2,140	520	2,920
		(20-40)	(190-260)	(1,830-2,470)	(450-610)	(2,490-3,360)
	Chum	10	50	560	140	750
		(0-10)	(30-60)	(420-710)	(100-170)	(560-950)
	Sockeye	30	360	3,950	970	5,320
		(20-50)	(290-440)	(3,150-4,940)	(770-1,210)	(4,240-6,640)
	Total	70	630	6,650	1,630	8,990
		(50-90)	(550-730)	(5,780-7,760)	(1,410-1,900)	(7,800-10,480)

[1]Geographic strata: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak

Insufficient data were available to estimate set gillnet harvests on July 4, 10, and 16.

Table 5. Salmon harvests from drift gillnets by subsistence opening, species, and geographic stratum in 2022. Numbers within parentheses are 95% confidence limits.

		Geographic Stratum[1]				
Opening	Species	A	B	C	D	Total
6/12/2022	Chinook	1,770	810	2,280	380	5,240
		(760-3,190)	(620-1,010)	(1,500-3,230)	(260-540)	(3,920-6,880)
	Chum	10	30	20	0	60
		(0-30)	(0-80)	(10-30)	(0-0)	(20-120)
	Sockeye	90	90	230	40	440
		(20-200)	(50-120)	(120-380)	(20-60)	(300-630)
	Total	1,870	930	2,520	420	5,740
		(800-3,390)	(710-1,170)	(1,670-3,580)	(290-590)	(4,330-7,570)
6/16/2022	Chinook	2,790	1,650	2,450	630	7,520
		(1,630-4,170)	(1,380-1,950)	(1,950-3,080)	(510-790)	(6,230-8,990)
	Chum	70	70	20	10	160
		(10-150)	(30-120)	(10-40)	(0-10)	(80-270)
	Sockeye	960	460	400	100	1,920
		(360-2,030)	(350-580)	(300-500)	(80-130)	(1,260-2,970)
	Total	3,820	2,180	2,870	740	9,600
		(2,100-6,180)	(1,860-2,570)	(2,340-3,540)	(610-900)	(7,720-11,850)
6/22/2022	Chinook	3,540	4,320	4,850	1,080	13,800
		(3,000-4,130)	(3,610-5,180)	(3,700-6,110)	(820-1,430)	(12,360-15,420)
	Chum	270	320	290	60	950
		(180-380)	(210-450)	(150-460)	(30-100)	(750-1,180)
	Sockeye	3,670	4,400	4,460	990	13,520
		(2,750-4,910)	(3,270-5,870)	(3,130-5,990)	(710-1,330)	(11,480-15,940)
	Total	7,480	9,040	9,610	2,140	28,270
		(6,300-8,950)	(7,560-10,870)	(7,490-11,960)	(1,680-2,670)	(25,370-31,480)
7/9/2023	Chinook	100	130	230	20	470
		(60-140)	(80-190)	(140-360)	(10-20)	(340-620)
	Chum	370	500	780	50	1,700
		(170-610)	(230-790)	(550-1,040)	(40-70)	(1,300-2,160)
	Sockeye	460	620	2,920	200	4,210
		(270-650)	(380-860)	(2,090-4,040)	(150-280)	(3,300-5,380)
	Total	930	1,250	3,930	270	6,380
		(610-1,310)	(840-1,740)	(3,060-5,100)	(210-350)	(5,330-7,640)
All Openings	Chinook	8,200	6,920	9,810	2,110	27,030
		(6,520-10,110)	(6,130-7,810)	(8,310-11,520)	(1,790-2,490)	(24,570-29,740)
	Chum	720	920	1,110	130	2,880
		(490-990)	(620-1,240)	(830-1,400)	(90-170)	(2,400-3,380)
	Sockeye	5,180	5,570	8,010	1,330	20,080
		(3,900-6,750)	(4,400-7,070)	(6,370-9,820)	(1,030-1,690)	(17,600-22,800)
	Total	14,100	13,400	18,930	3,570	50,000
		(11,570-16,950)	(11,750-15,420)	(16,260-21,750)	(3,060-4,150)	(45,800-54,200)

[1]Geographic strata: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak

Table 6. Salmon harvests from both drift and set gillnets by subsistence opening, species, and geographic stratum in 2022. Numbers within parentheses are 95% confidence limits.

		Geographic Stratum[1]				
Opening	Species	A	B	C	D	Total
6/1/2022	Chinook	0 (0-0)	10 (0-10)	20 (0-60)	10 (0-10)	30 (0-90)
	Chum	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	0 (0-0)	10 (0-10)	20 (0-16)	0 (0-0)	30 (0-90)
6/4/2022	Chinook	0 (0-10)	20 (10-30)	60 (30-90)	10 (10-20)	90 (50-40)
	Chum	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	0 (0-10)	20 (10-30)	60 (30-90)	10 (10-20)	90 (50-140)
6/8/2022	Chinook	0 (0-0)	10 (10-20)	80 (50-120)	30 (20-40)	120 (70-190)
	Chum	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Sockeye	0 (0-0)	0 (0-0)	10 (0-30)	10 (0-10)	20 (0-50)
	Total	0 (0-0)	10 (10-20)	100 (60-140)	30 (20-50)	140 (80-210)
6/12/2022	Chinook	1,780 (760-3,190)	820 (630-1,020)	2,320 (1,540-3,270)	390 (270-550)	5,300 (3,960-6,950)
	Chum	10 (0-30)	30 (0-80)	20 (10-30)	0 (0-0)	60 (20-120)
	Sockeye	90 (20-200)	90 (50-120)	230 (120-380)	40 (20-60)	440 (300-630)
	Total	1,870 (800-3,390)	930 (710-1,170)	2,570 (1,720-3,610)	430 (300-600)	5,800 (4,390-7,620)
6/16/2022	Chinook	2,790 (1,630-4,170)	1,670 (1,400-1,960)	2,570 (2,060-3,180)	670 (540-820)	7,700 (6,370-9,160)
	Chum	70 (10-150)	70 (30-120)	20 (10-40)	10 (0-10)	160 (90-270)
	Sockeye	960 (360-2,030)	460 (350-580)	400 (300-500)	100 (80-130)	1, 920 (1,260-2,970)
	Total	3,820 (2,100-6,180)	2,200 (1,870-2,590)	2,990 (2,460-3,650)	780 640-940)	9,790 (7,880-12,070)

-continued-

Table 6–(Page 2 of 3).

Opening	Species	Geographic Stratum[1] A	B	C	D	Total
6/22/2022	Chinook	3,540 (3,000-4,130)	4,350 (3,640-5,200)	5,030 (3,870-6,320)	1,120 (850-1,450)	14,030 (12,590-15,650)
	Chum	270 (180-380)	320 (210-450)	290 (150-460)	60 (30-100)	950 (750-1,180)
	Sockeye	3,670 (2,750-4,910)	4,420 (3,300-5,890)	4,650 (3,330-6,150)	1,030 (740-1,370)	13,760 11,720-16,170)
	Total	7,480 (6,300-8,950)	9,090 (7,600-10,920)	9,970 (7,830-12,320)	2,210 (1,740-2,750)	28,750 (25,780-31,990)
6/29/2022	Chinook	0 (0-0)	40 (30-60)	430 (290-610)	110 (70-160)	580 (390-820)
	Chum	0 (0-0)	20 (10-30)	200 (120-290)	50 (30-70)	270 (170-390)
	Sockeye	0 (0-0)	180 (120-240)	1,940 (1,380-2,610	490 (350-660)	2,620 (1,850-3,510)
	Total	0 (0-0)	230 (180-300)	2,570 (1,940-3,340)	650 (490-850)	3,460 (2,610-4,500)
6/30/2022	Chinook	0 (0-0)	80 (60-100)	720 (570-890)	180 (140-220)	970 (770-1,200)
	Chum	0 (0-0)	20 (10-20)	130 (70-210)	30 (20-50)	180 (100-280)
	Sockeye	0 (0-0)	110 (60-160)	930 (570-1,400)	230 (140-340)	1,270 (770-1,900)
	Total	0 (0-0)	200 (150-270)	1,780 (1,330-2,380)	440 (320-580)	2,420 (1,800-3,230)
7/3/2022	Chinook	20 (10-20)	30 (20-40)	500 (360-640)	110 (80-150)	660 (470-840)
	Chum	10 (0-10)	10 (10-20)	230 (130-330)	50 (30-80)	300 (180-440)
	Sockeye	30 (20-50)	50 (30-80)	870 (480-1,390)	200 (110-320)	1,160 (630-1,840)
	Total	60 (40-80)	90 (70-120)	1,590 (1,160-2,130)	370 (270-490)	2,120 (1,540-2,830)
7/9/2022	Chinook	100 (60-140)	130 (80-190)	230 (140-360)	20 (10-20)	470 (340-620)
	Chum	370 (170-610)	500 (230-790)	780 (550-1,040)	50 (40-70)	1,700 (1,300-2,160)
	Sockeye	460 (270-650)	620 (380-860)	2,920 (2,090-4,040)	200 (150-280)	4,210 (3,300-5,380)
	Total	930 (610-1,310)	1,250 (840-1,740)	3,930 (3,060-5,100)	270 (210-350)	6,380 (5,330-7,640)

-continued-

Table 6–(Page 3 of 3).

Opening	Species	Geographic Stratum[1] A	B	C	D	Total
Total	Chinook	8,230 (6,550-10,140)	7,140 (6,340-8,030)	11,950 (10,400-13,700)	2,630 (2,290-3,000)	29,950 (27,410-32,630)
	Chum	730 (500-1,000)	960 (670-1,280)	1,670 (1,370-2,010)	260 (210-320)	3,630 (3,100-4,170)
	Sockeye	5,210 (3,950-6,780)	5,930 (4,760-7,440)	11,960 (10,130-14,090)	2,300 (1,970-2,720)	25,400 (22,770-28,540)
	Total	14,170 (11,640-17,020)	14,030 (12,360-16,060)	25,590 (22,910-28,480)	5,190 (4,630-5,850)	58,980 (54,680-63,760)

[1]Geographic strata: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak

Table 7. Key harvest characteristics of 12-hour openings on June 12 in all years where inseason harvest was rigorously monitored. These numbers correspond only to the mainstem Kuskokwim River between and including the villages of Tuntutuliak and Akiak.

	2016	2017	2018	2019	2020	2021	2022	2016-2021 Average
Drift and set effort	560	584	497	489	426	409	477	458
Total salmon harvest	5,290	5,620	7,250	8,650	3,820	3,680	5,800	5,528
Total salmon/net	9.4	9.6	14.5	17.7	9.0	9.0	12.1	12.1
Chinook harvest	4,460	2,400	5,230	8,040	3,240	3,260	5,300	4,277
Chinook/boat	8.0	4.1	10.5	16.4	7.6	8.0	11.1	9.5
Chum harvest	610	2430	1770	310	460	70	60	942
Sockeye harvest	220	800	250	290	100	350	440	335
Chum/Sockeye total	830	3,230	2.020	600	590	420	500	1,252
Chum-Sockeye/net	1.5	5.5	4.1	1.2	1.4	1.0	1.0	2.7
Species ratio	0.2	1.3	0.4	0.1	0.2	0.1	0.1	0.4

Table 8. Minimum annual harvest estimates by salmon species from the Kuskokwim River inseason harvest estimation program, 2016–2022.

	2016	2017	2018	2019	2020	2021	2022	2016-2021 Average
Chinook Salmon	28,019	8,630	20,870	40,120	23,210	21,630	29,950	23,747
Chum Salmon	27,398	54,420	43,570	7,170	5,590	4,220	3,630	23,728
Sockeye Salmon	25,026	24,080	23,320	13,400	6,710	23,600	25,400	19,356
Total Salmon	80,443	87,130	87,750	60,710	35,500	49,440	58,980	66,829

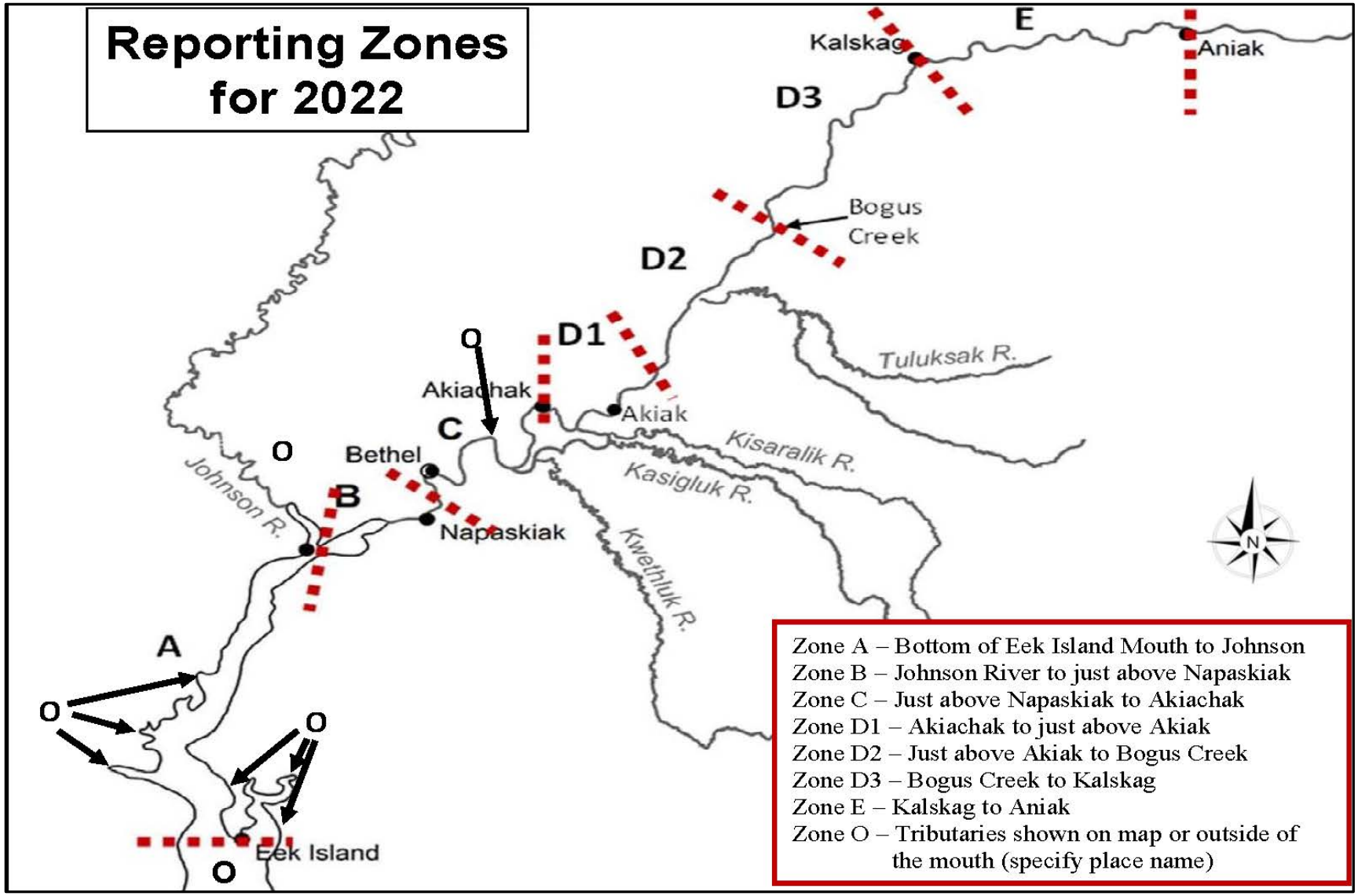

Figure 1. Map of the Yukon Delta National Wildlife Refuge waters that compose the survey area with geographic strata noted (A – E). Dashed lines indicate strata boundaries.

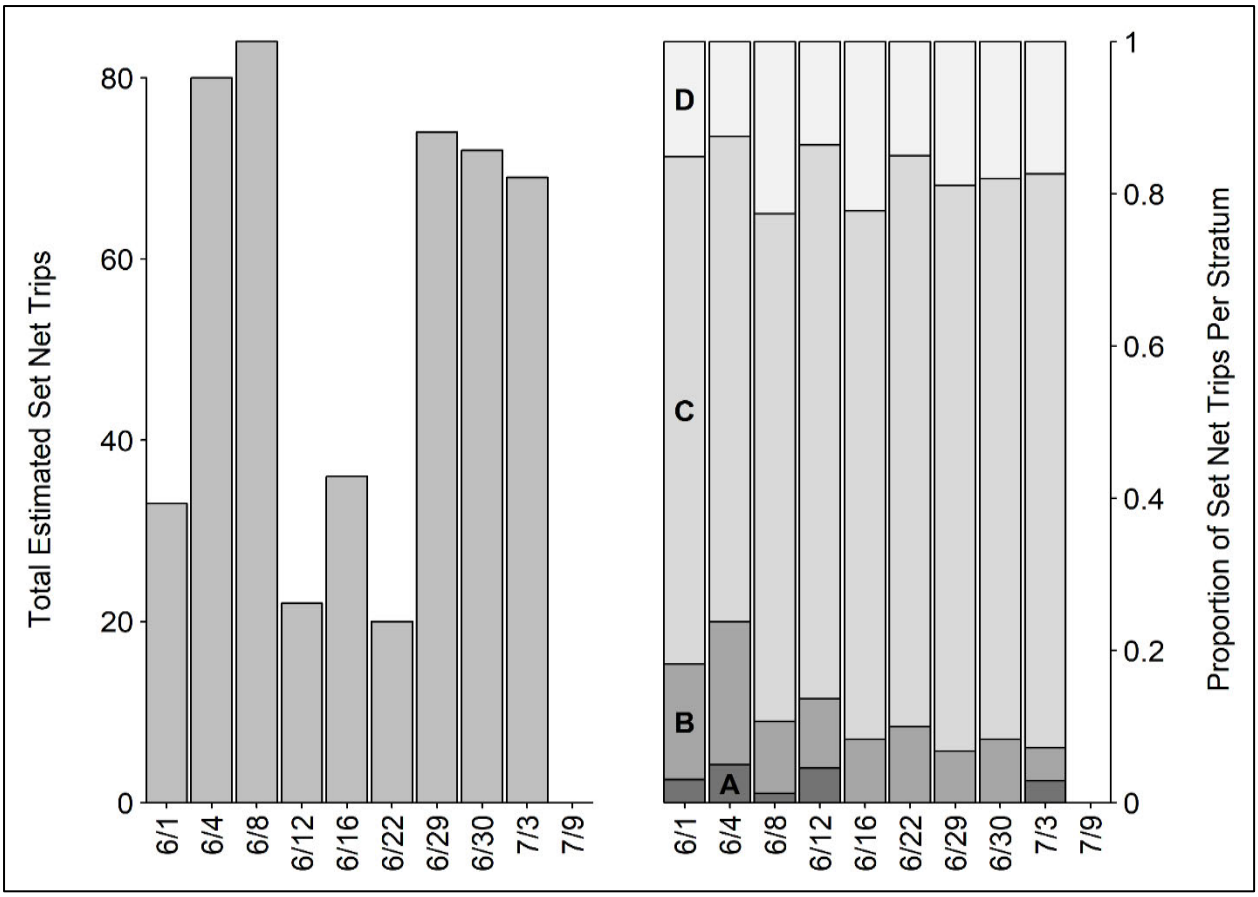

Figure 2. The (left) total estimated set net trips by opening and (right) proportion of all estimated set net trips that occurred in each geographic stratum by opening.
Note: Set net effort is not shown for July 4, 10, and 16 due to insufficient data.
Geographic strata are: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, and D = Akiachak to Akiak

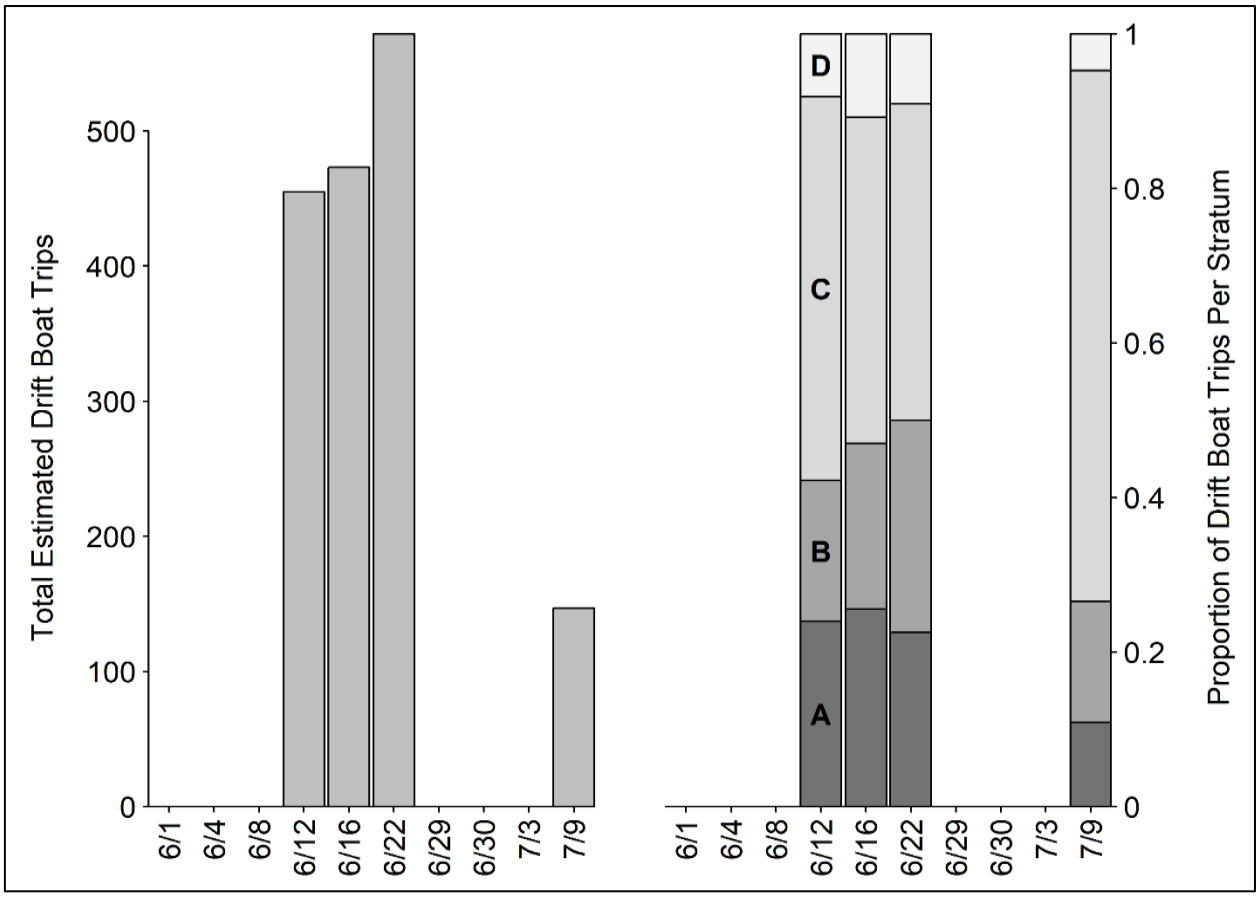

Figure 3. Total (*left*) estimated drift boat trips by opening and *(right)* proportion of all estimated trips that occurred in each geographic stratum by opening.
Note: Openings before June 12 and on June 29-30 and July 3-4, 10, and 16 were for set gillnets only. Geographic strata are: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, and D = Akiachak to Akiak

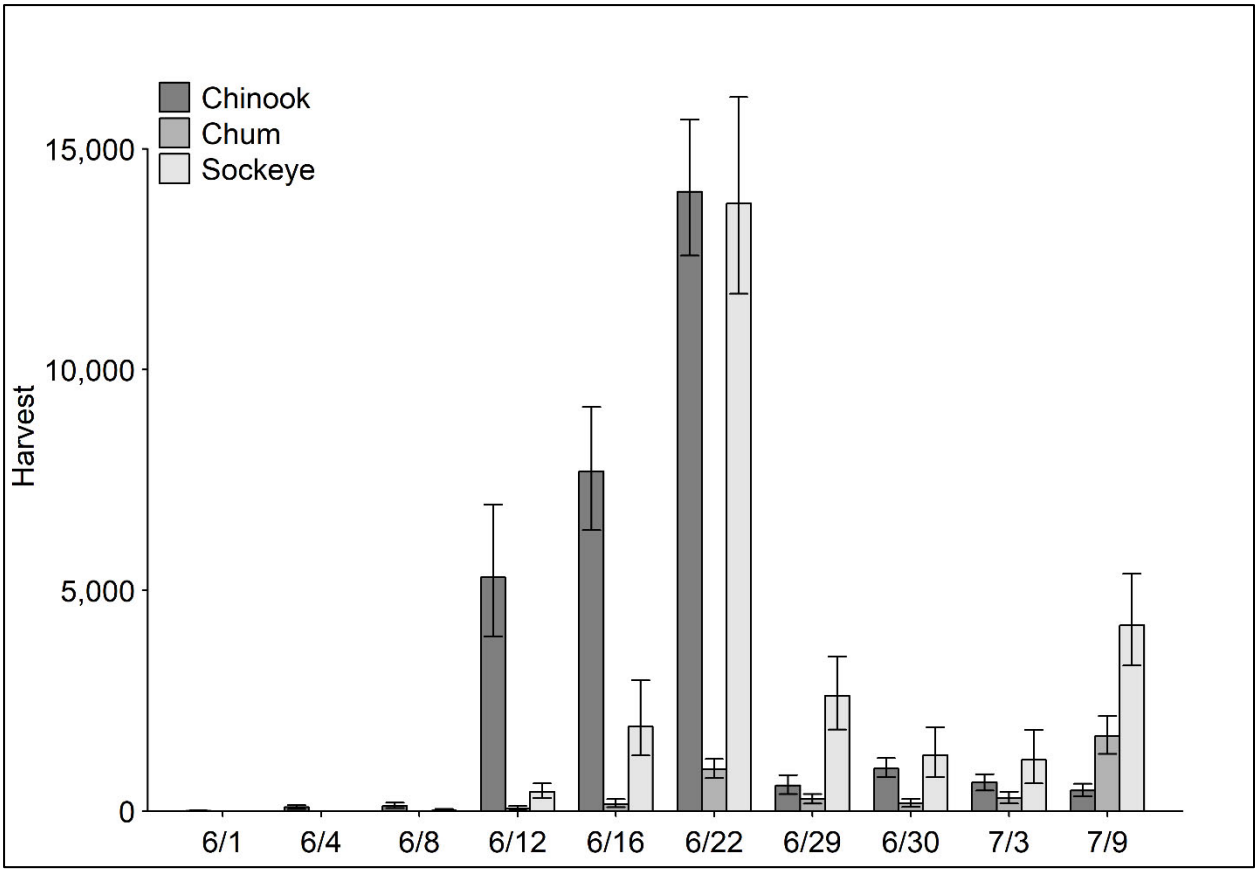

Figure 4. Estimated salmon harvest by species in the openings for which data were collected; estimates include both drift net and set net harvests.

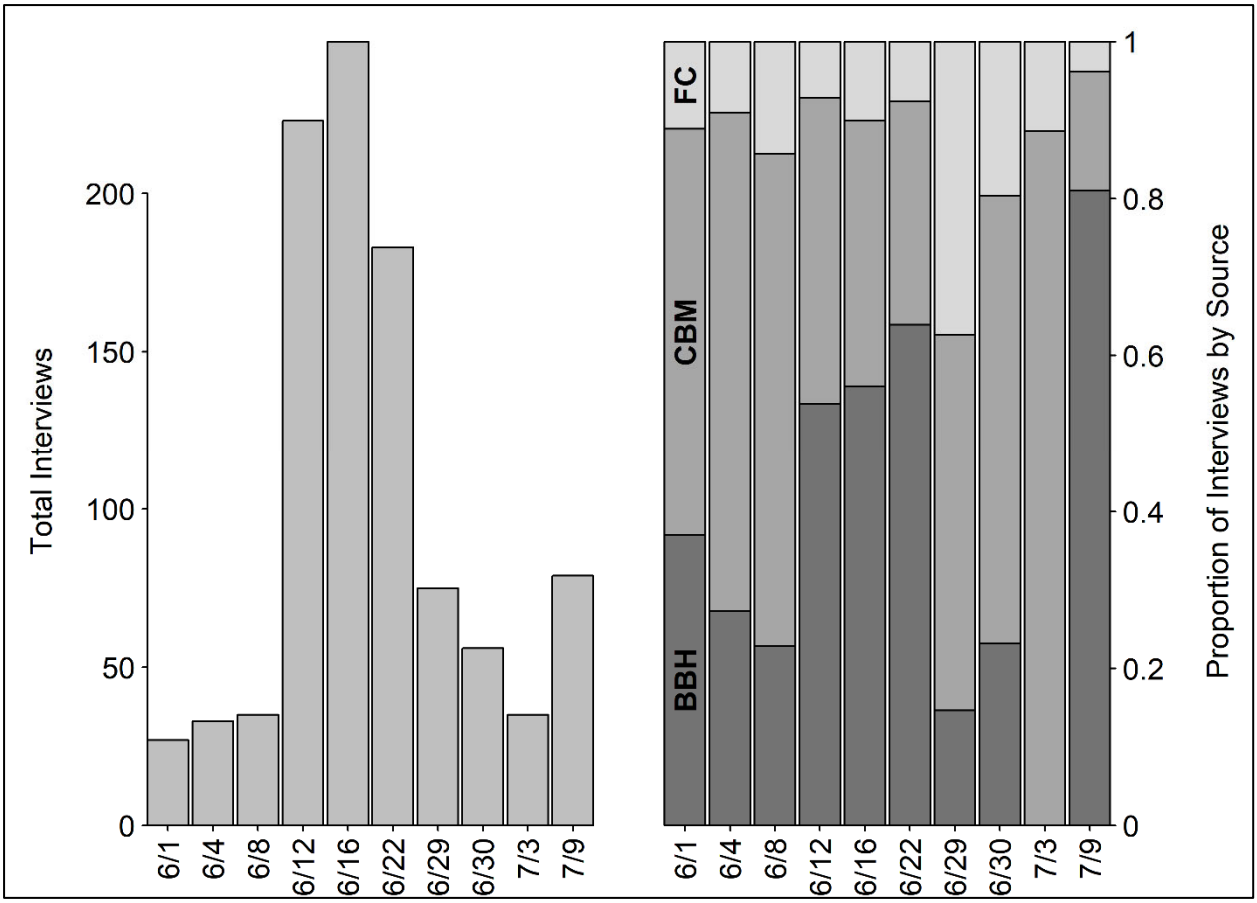

Figure 5. Total number (*left*) of interviews used to inform the harvest estimates from each opening and (*right*) proportion of all interviews that came from each source by opening.

Data sources were: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

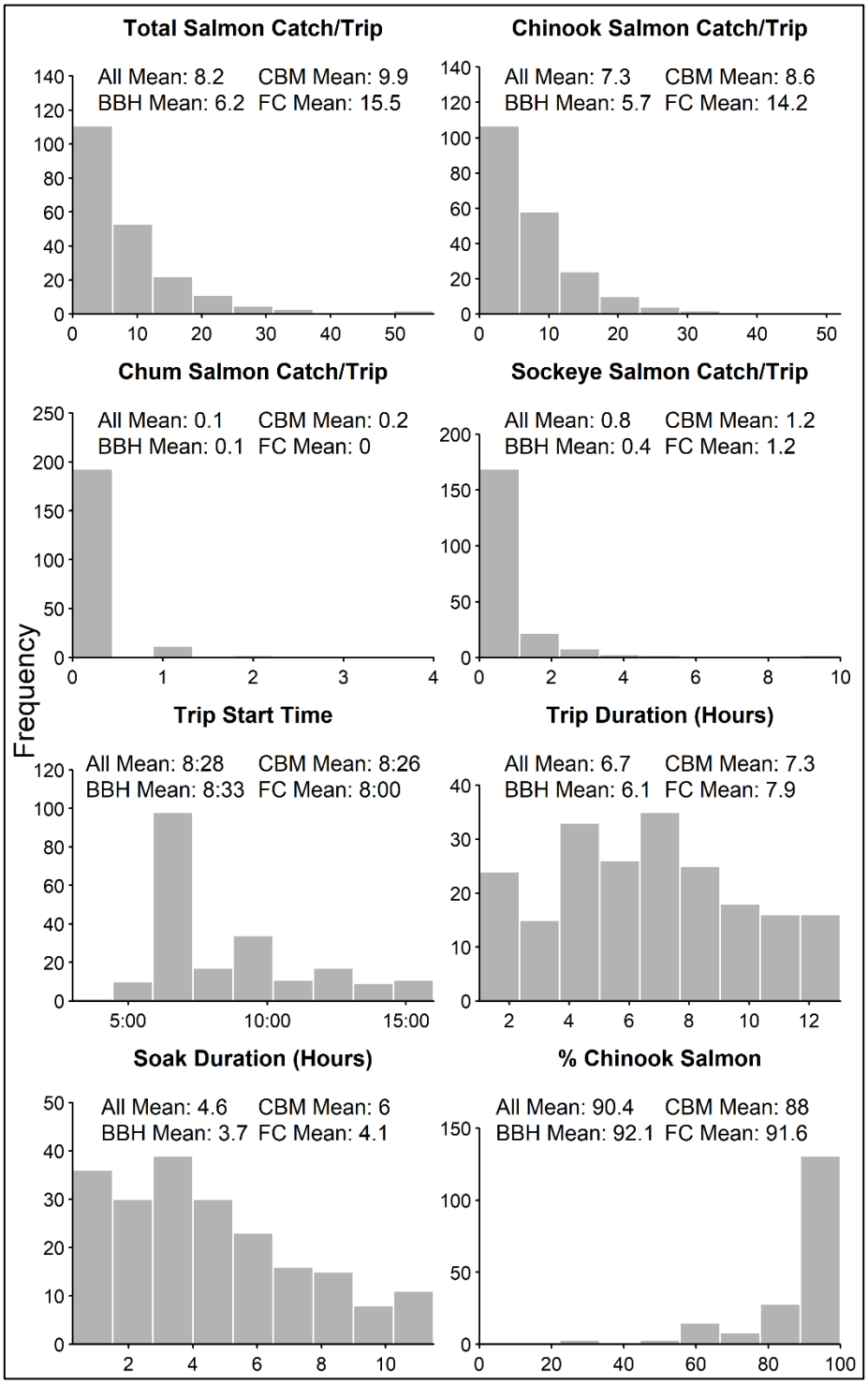

Figure 6. Distribution of relevant quantities from completed drift boat trip interviews during the 6/12/2022 opening, with means for all available interviews and by data source. BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

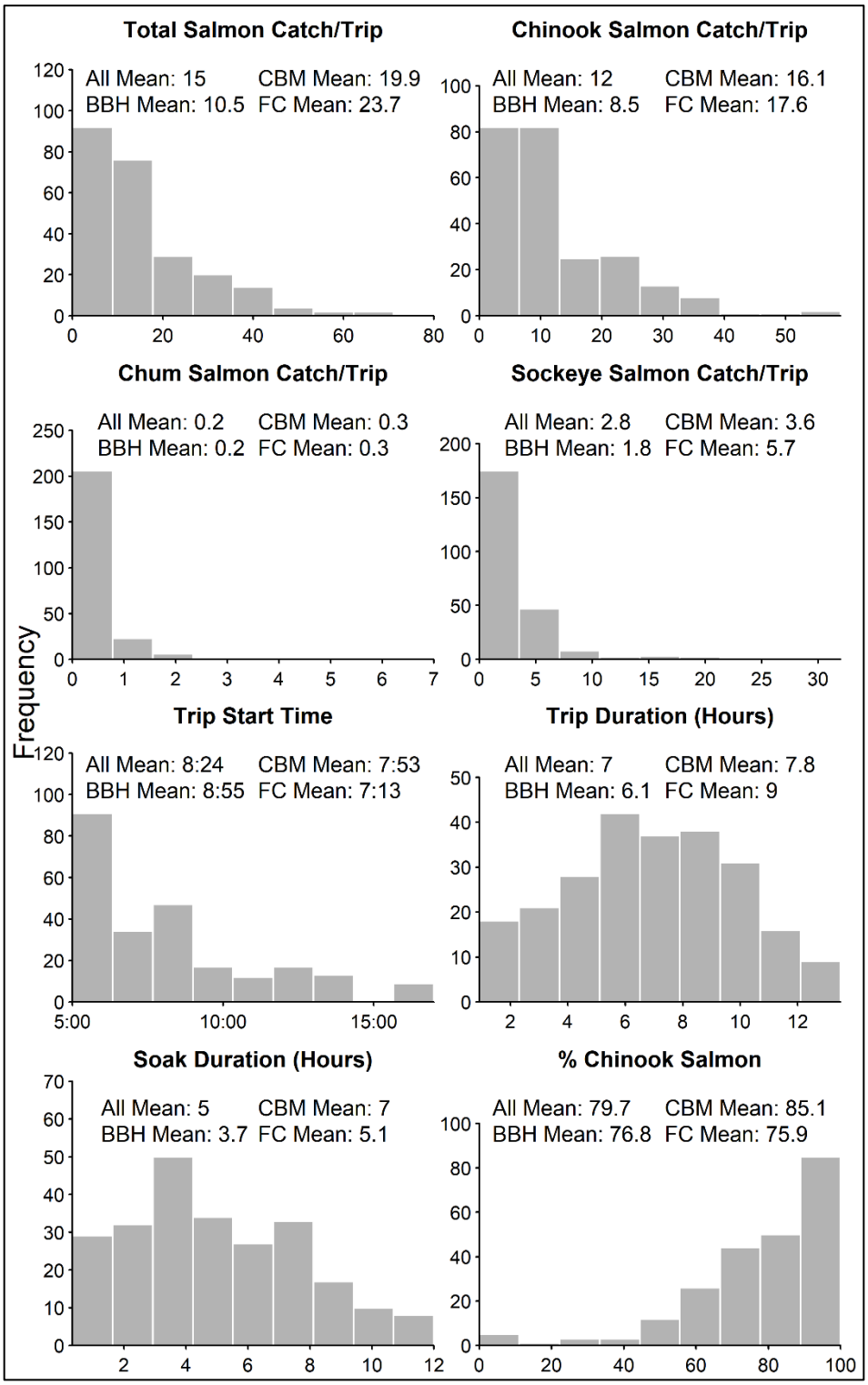

Figure 7. Distribution of relevant quantities from completed drift boat trip interviews during the 6/16/2022 opening, with means for all available interviews and by data source. BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC

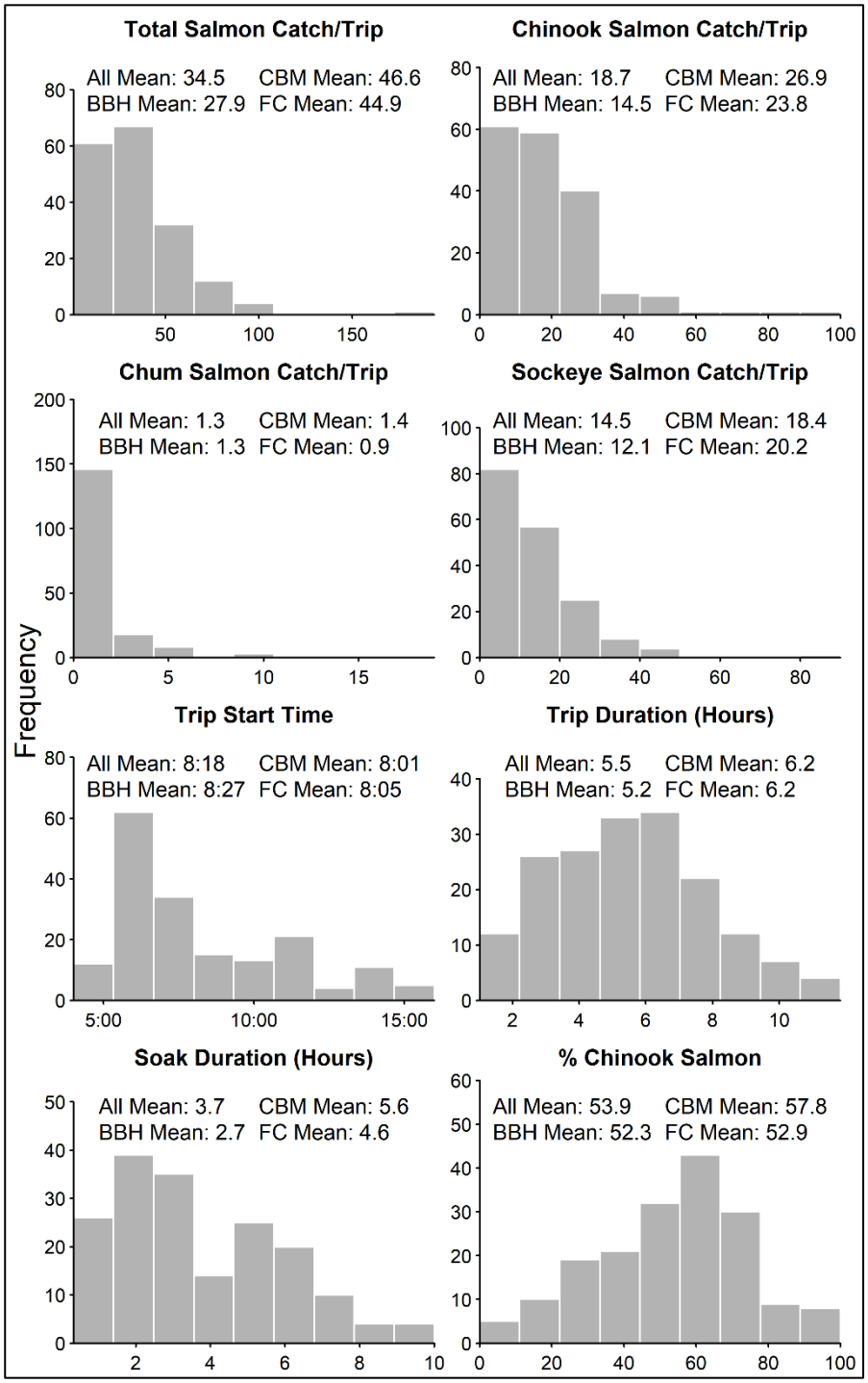

Figure 8. Distribution of relevant quantities from completed drift boat trip interviews during the 6/22/2022 opening, with means for all available interviews and by data source. BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

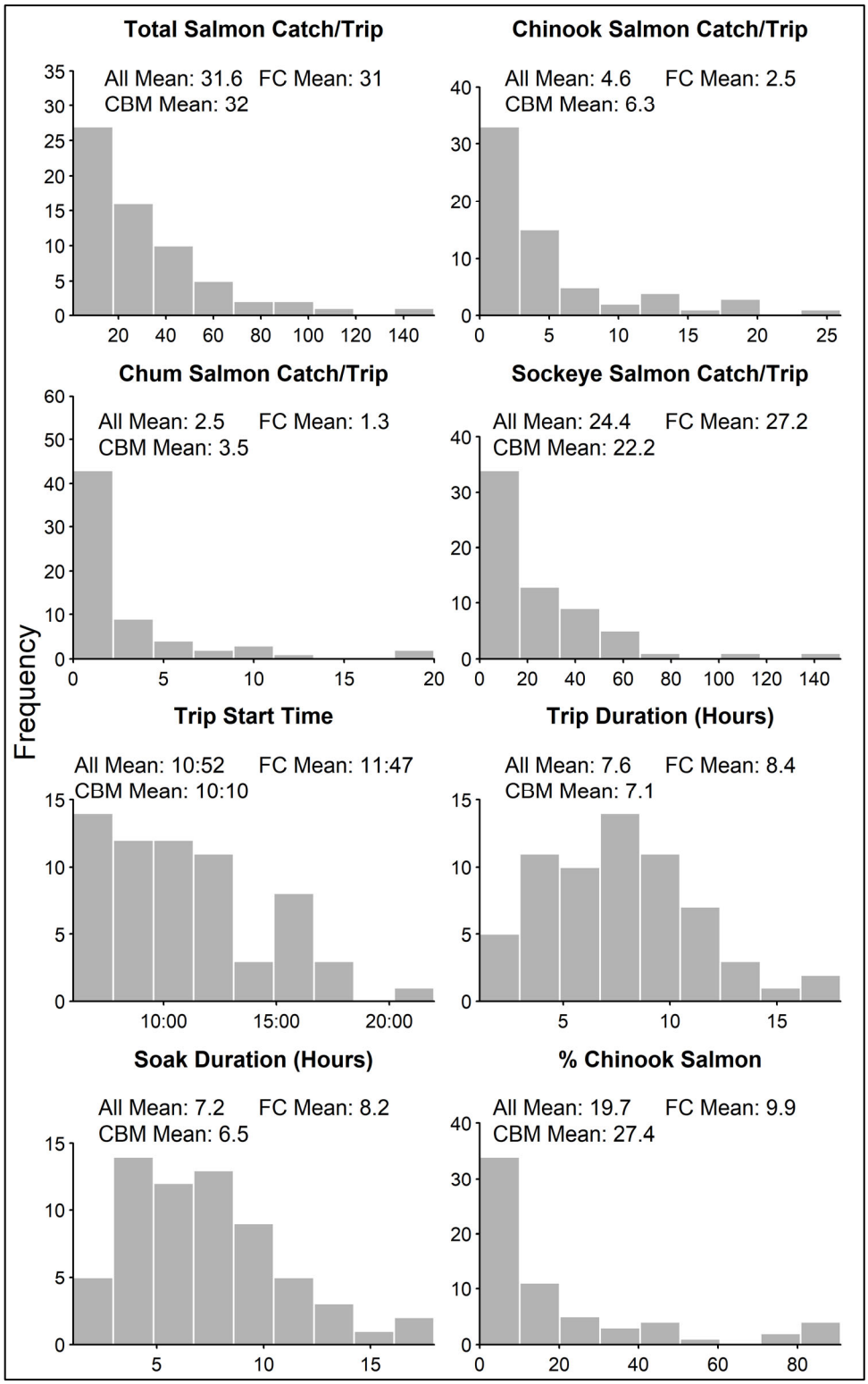

Figure 9. Distribution of relevant quantities from completed set net trip interviews for the 6/29/2022 opening, with means for all available interviews and by data source. BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

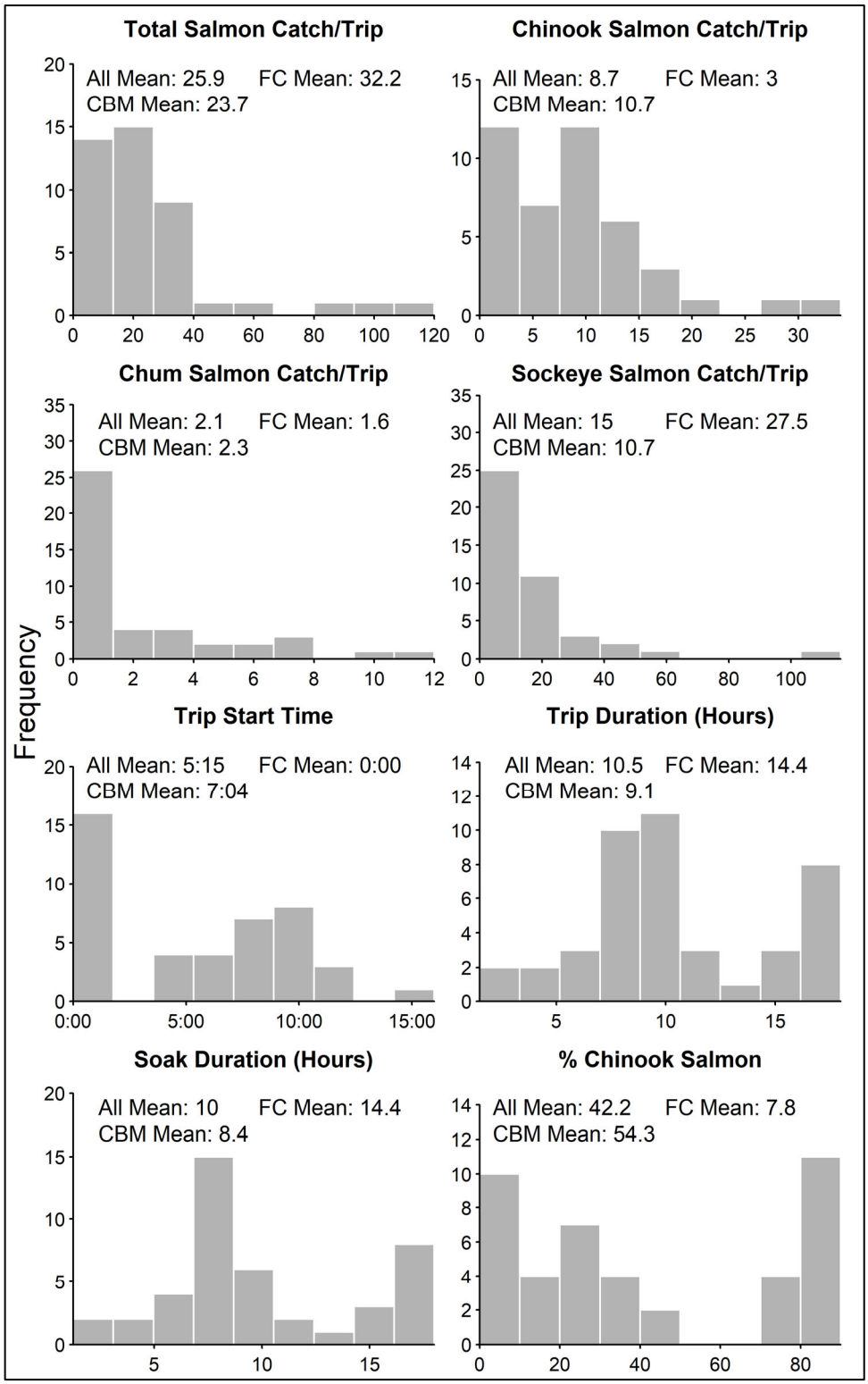

Figure 10. Distribution of relevant quantities from completed set net trip interviews for the 6/30/2022 opening, with means for all available interviews and by data source. BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

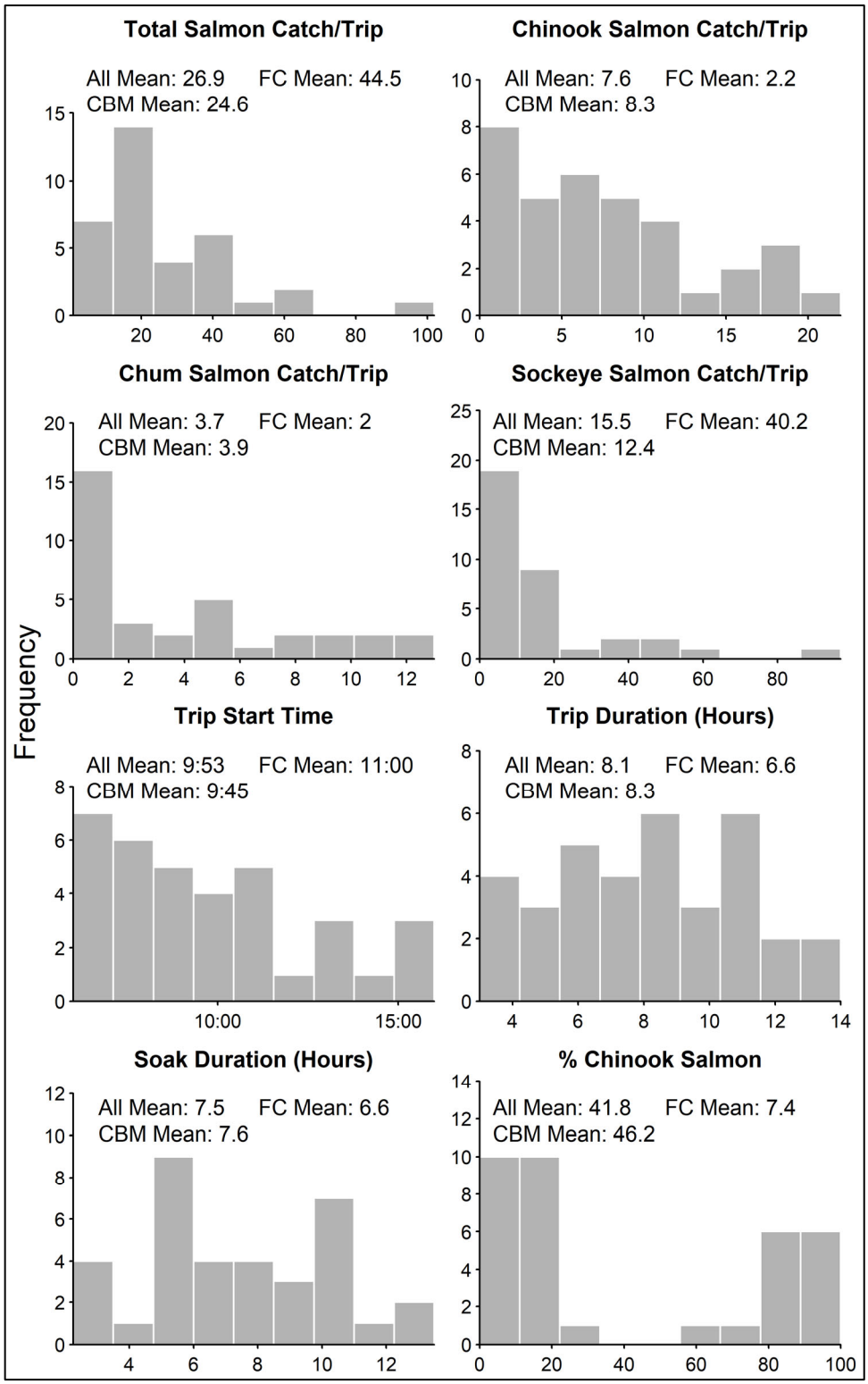

Figure 11. Distribution of relevant quantities from completed set net trip interviews for the 7/3/2022 opening, with means for all available interviews and by data source. BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

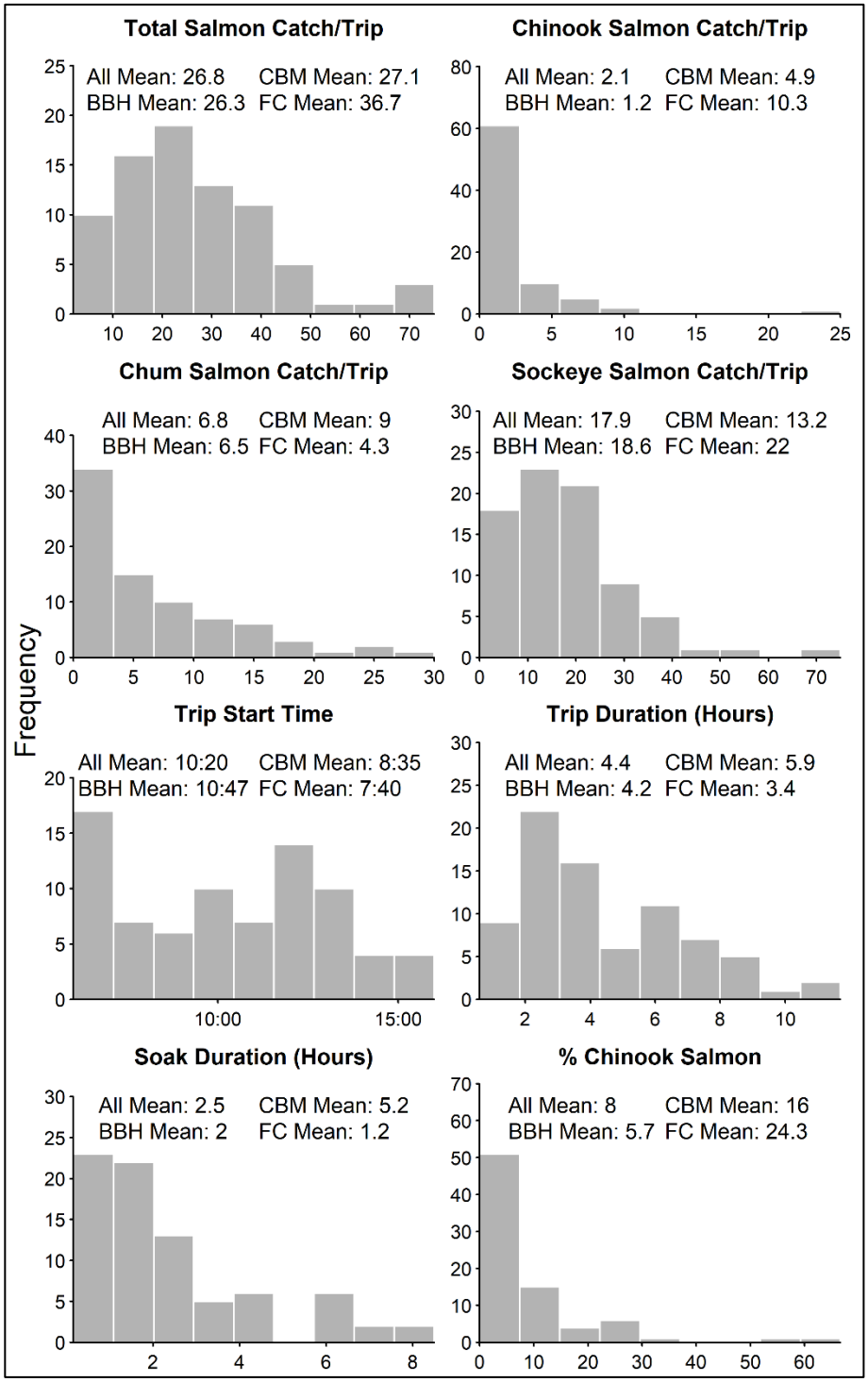

Figure 12. Distribution of relevant quantities from completed drift boat trip interviews during the 7/9/22 opening, with means for all available interviews and by data source.
BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based harvest monitoring (KRITFC)

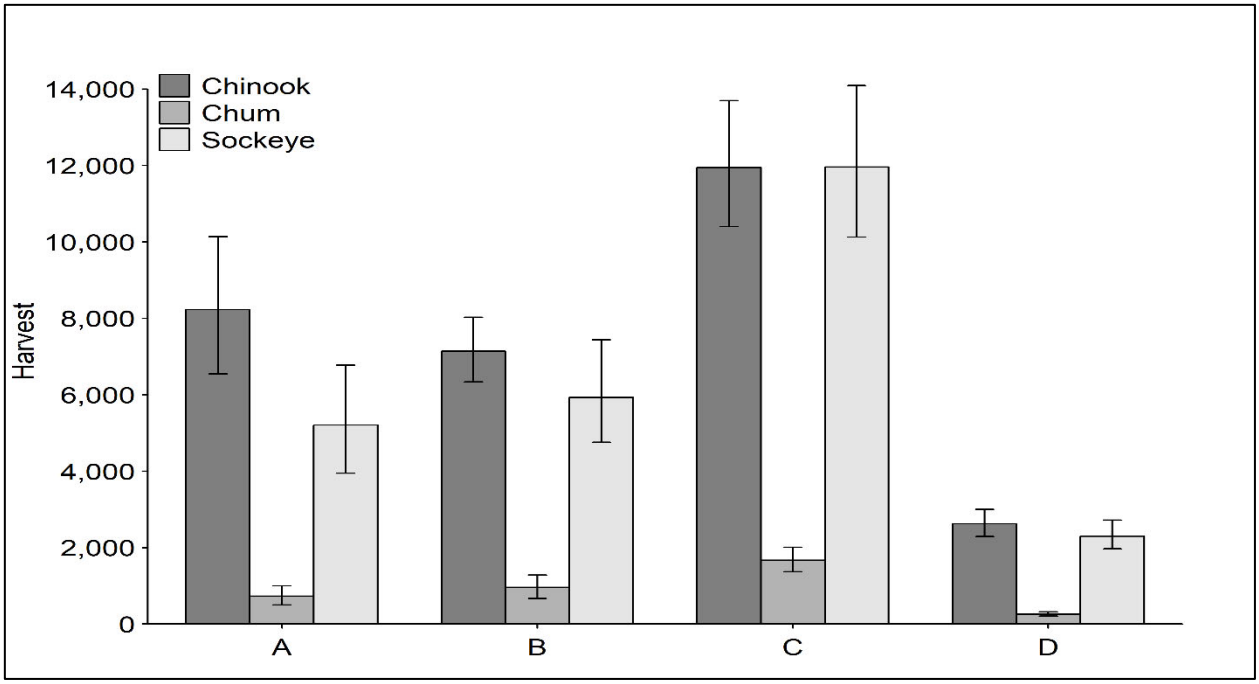

Figure 13. Total salmon harvest by species and strata across all openings for which harvest estimates were produced including both drift nets and set nets.

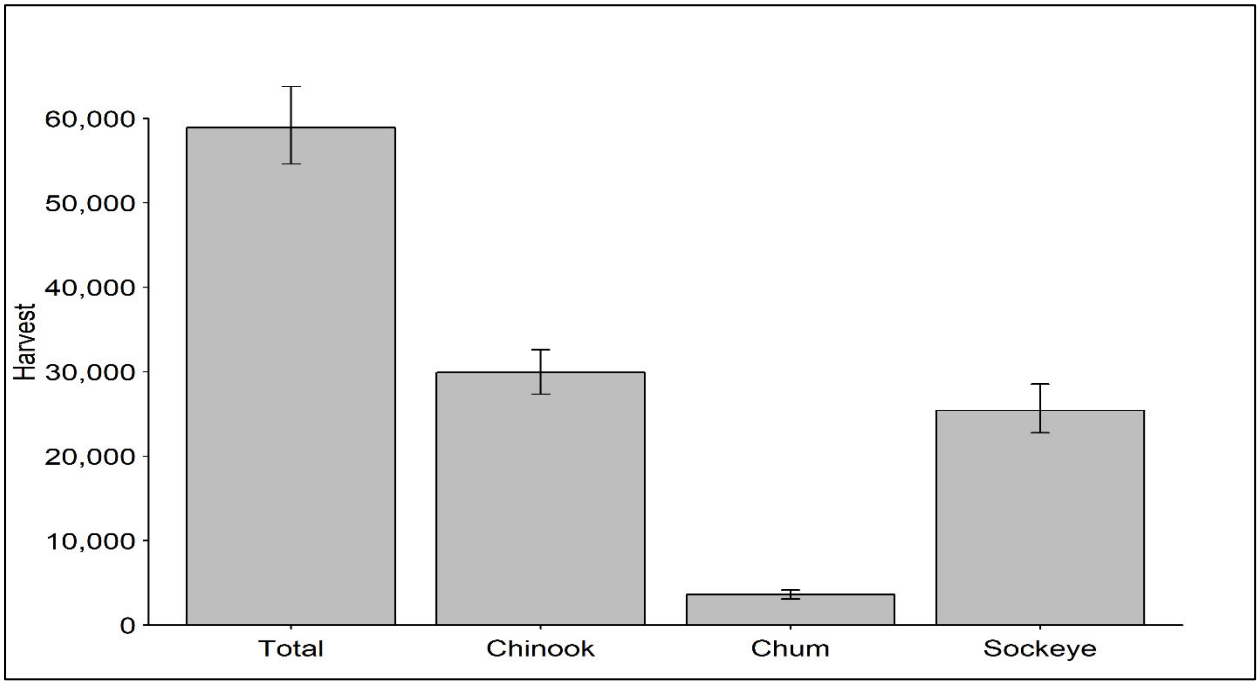

Figure 14. Total salmon harvest by species across all openers for which harvest estimates were produced including both drift nets and set nets.
Geographic strata are: A = below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, and D = Akiachak to Akiak.