In-season Harvest and Effort Estimates for the 2019 Kuskokwim River Subsistence Salmon Fisheries During Block Openers

GARY DECOSSAS, U.S. Fish and Wildlife Service, Yukon Delta National Wildlife Refuge, P.O. Box 346, Bethel, AK 99559

ABSTRACT

Management of the Kuskokwim River Chinook Salmon (*Oncorhynchus tshawytscha*) subsistence fishery has historically been conducted with minimal in-season harvest information. Because of this lack of information, it is challenging to make well-supported and defensible decisions regarding fishing opportunities to simultaneously achieve conservation and subsistence harvest objectives, particularly during years of weak runs. In response to an anticipated weak 2019 Kuskokwim River Chinook Salmon run, the United States Fish and Wildlife Service in collaboration with the Kuskokwim River Inter-Tribal Fish Commission and the Orutsararmiut Native Council, collected data to produce in-season subsistence salmon harvest estimates from that portion of the main stem Kuskokwim River within the boundaries of the Yukon Delta National Wildlife Refuge between and including the villages of Tuntutuliak and Akiak. Using methods developed and refined during 2016 – 2018, I estimated the total subsistence salmon harvest in this area was 60,710 (95% CL: 50,070 – 72,840) during six fishing opportunities between June 11 and June 22, 2019. Most salmon harvested were Chinook Salmon (40,120; 95% CL: 32,410 – 48,930), followed by Sockeye Salmon (*O. nerka*; 13,400; 10,640 – 16,760), and Chum Salmon (*O. keta*; 7,170; 4,960 – 10,100). Methodologies refined during this study should be useful to structure future efforts to estimate subsistence salmon harvest on the Kuskokwim River as well as other fisheries with similar characteristics.

INTRODUCTION

In-season 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). In order to manage in a fully-informed way, a manager would require continuous and accurate information on run timing, harvest, and escapement. With knowledge on these three components, it would then 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. In-season management of Kuskokwim River salmon has historically been conducted with very little of this information, and has instead relied largely on a single index (the Bethel Test Fishery; hereafter BTF) of run abundance, run timing, and species composition to inform decision-making. Work has been done to develop and evaluate methods of obtaining more detailed information regarding run timing (Staton et al. 2017) and run size (e.g., a relatively new main stem sonar project and a Bayesian approach to update run size forecasts with in-season data on a daily basis; Staton and Catalano 2019) and delivering this information to managers and stakeholders in a timely manner for decision-making. However, even with perfect information on these run characteristics, the manager is still left wondering about how many fish have been harvested to date, which is important for structuring future fishing opportunities. Timely in-season subsistence harvest estimates have only recently been available in the Kuskokwim River (2015 – 2018) for in-season management consideration, and are arguably the most critical information source necessary to successfully manage weak salmon runs. This document presents in-season salmon harvest estimates from short-duration Kuskokwim River subsistence fishing opportunities during the 2019 season using a recently developed harvest estimation technique (Staton and Coggins 2016, 2017; Staton 2018).

In response to an anticipated weak 2019 Kuskokwim River Chinook Salmon (*Oncorhynchus tshawytscha*) run (pre-season forecast midpoint of 132,000 fish), the United States Fish and Wildlife Service (USFWS), through action by the Federal Subsistence Board (Federal Special Action 3-KS-03-19), assumed primary management authority of the Kuskokwim River Chinook subsistence fishery within the boundaries of the Yukon Delta National Wildlife Refuge (YDNWR) on June 1, 2019.

The Federally designated in-season manager, along with YDNWR staff and in collaboration with the Kuskokwim River Inter-Tribal Fish Commission (KRITFC), designed and implemented a management strategy based on explicit objectives informed by the best available scientific information. The Alaska Department of Fish and Game (ADF&G) was invited to provide input throughout the process, but declined. In pre-season management meetings, the Federal in-season manager accepted the KRITFC's recommended escapement objective of 110,000 Chinook Salmon. However, based on the USFWS's scientific analysis, the Federal in-season manager believed an escapement objective of 95,000 Chinook Salmon could meet the USFWS's conservation and subsistence objectives. Based on these positions and agreements, the Federal in-season manager's harvest range was anything between 22,000 (harvest target) and 32,000 (harvest limit) Chinook Salmon considering the anticipated run size of approximately 132,000 fish. These harvest figures were subject to further revision should in-season assessment information suggest a larger or smaller harvest would be warranted.

It was decided that the use of fishing time, area, and gear restrictions would provide an adequate means to manage the fishery. These "block openings" would allow for limited harvest opportunity, with periods between openings allowing for harvest estimation and decision-making to identify the nature of subsequent fishing opportunities. Additionally, both the Federal in-season manager and the KRITFC agreed that several "block opening" fishing opportunities should be announced prior to the beginning of the Chinook Salmon season in order to allow people to plan for fish, which provides greater certainty to subsistence fishermen and reduces the complexity of in-season management. The Federal in-season manager was comfortable using the semi-schedule approach to the fishery based on analyses of previous in-season harvest monitoring (ongoing since 2016), which suggested that any 12-hour harvest opportunity provided during the June 12 – June 30 time frame would result in a harvest of Chinook Salmon between 3,000 – 7,000 fish. Given that the agreed harvest target on the season was 22,000 Chinook, the Federal in-season manager felt that anywhere from three to five opportunities could be provided without compromising the achievement of the harvest target. Based on this agreement, the Federal in-season manager announced three 12-hour opportunities on June 12, 15, and 19 pre-season (3-KS-06-19).

The Federal in-season manager and the KRITFC also agreed that 6" set gillnet opportunities should be provided to Federally qualified subsistence users in order to provide a "taste of salmon" during the early portion of the season. Through consultation with the KRITFC and independent village visits by YDNWR staff, all subsistence users expressed their dislike for 4" mesh size gillnets in the river when Chinook Salmon are present, as this mesh size is perceived as a "salmon" killer because large salmon may entangle and then drop out of the net. In order to alleviate these concerns, the Federal in-season manager (for the first time ever), provided two 12-hour 6" set gillnet opportunities on June 1 and June 8. These opportunities coincided with ADF&G's 4" set gillnet opportunities for species other than Chinook Salmon, but otherwise, followed the same net length and operation restrictions as the 4" set gillnet opportunities (net length: 60 feet or less; bank orientation; and cannot be operated more than 100 feet from the ordinary high water mark). The Federal in-season manager assumed that few Chinook Salmon would be harvested during these opportunities (<1,000 Chinook Salmon) because of the number of the relatively low number of Chinook Salmon in the river plus the net length and operational restrictions for the gillnets during this time. Additionally, subsistence fishing for Chinook Salmon with dip nets, beach seines, fish wheels, and rod and reel remained open to Federally qualified subsistence users during the duration of Federal restrictions. These methods were not previously available during Federal restrictions for Chinook Salmon prior to this year

There were six subsistence fishery openers during June 2019 within the YDNWR boundaries:

- 6/1/2019 (12 hours; 10:00am – 10:00pm; FSA 3-KS-04-19; SET NETS ONLY)
- 6/8/2019 (12 hours; 10:00am – 10:00pm; FSA 3-KS-05-19; SET NETS ONLY)
- 6/12/2019 (12 hours; 06:00am – 06:00pm; FSA 3-KS-06-19)
- 6/15/2019 (12 hours; 06:00am – 06:00pm; FSA 3-KS-06-19)
- 6/19/2019 (12 hours; 06:00am – 06:00pm; FSA 3-KS-06-19)
- 6/22/2019 (12 hours; 06:00am – 06:00pm; FSA 3-KS-08-19)

Shortly after the sixth opener, the ADF&G Area Manager opened the Sockeye and Chum salmon subsistence fisheries indefinitely with similar restrictions that were in-place during the Federal subsistence opportunities (i.e. <= 6" mesh size, 25 fathoms net length above Johnson River, 50 fathoms net length below Johnson River). Federal restrictions for the harvest of Chinook Salmon were rescinded on July 1, 2019 per Federal Subsistence Board action (Federal Special Action 3-KS-03-19) and recognition that the bulk of the Chinook Salmon run had moved upriver and conservation needs for escapement were likely to be met.

METHODS

The in-season harvest estimation framework that was developed and applied to the 2016–2018 Kuskokwim River salmon seasons required two primary types of information: (1) an estimate of the total number of fishing trips each day and (2) completed trip interview information from fishers documenting their gear, fishing location, fishing time, and catch (Staton and Coggins 2016, 2017; Staton 2018). Only a brief description of methodological design is provided, see Staton 2018 for a more complete description.

Aerial Net Counts

For each opener, two to three aerial survey flights were flown to count the number of drift boats and set nets fishing within the YDNWR boundaries between the communities of Tuntutuliak and Akiak (**Figure 1**). Flights were scheduled to capture boat counts between low and high tide when the tides were moving the strongest, which are the most popular times to fish, and such that the flights were spaced relatively equally throughout the opener. This often resulted in 2-3 hours between the end of one flight and the start of the next flight (**Table 1 and Table 2**). On two occasions, inclement weather prevented USFWS from flying scheduled effort surveys: 6/19/2019 and 6/22/2019. Both of these canceled flights were the first of three scheduled flights for 12 hour openers, though the latter two flights each day were flown with no issues.

Completed Trip Interviews

Information from fisher trips was obtained from three sources: (1) the Bethel boat harbor, (2) Bethel area fish camps, and (3) several main stem villages other than Bethel. Interview data from sources (1) and (2) were collected by personnel from Orutsararmiut Native Council (ONC) and were the predominate sources used by Staton and Coggins (2016). Data from source (3) were collected by Bering Sea Fishermen's Association (BSFA) staff beginning in 2017 as part of a community-based monitoring project that was designed to, among other things, provide interview data from areas of the YDNWR other than solely the Bethel area. In 2019, BSFA village monitors were located in the villages of Tuntutuliak, Napaskiak, Kwethluk, and Akiak. Data from all sources were compiled in a timely manner to be included into the harvest estimates.

Analytical Methods

The analytical methods in 2019 were identical to those used in 2016, 2017, and 2018 and are fully described in Staton and Coggins (2016) and Staton (2018) and will not be presented here.

RESULTS

First Opener (6/1/2019)

An estimated total of 92 set net trips occurred in the study area (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 120 (95% CL: 70–170). Almost all salmon harvest was made up of Chinook Salmon (100; 60–140), followed by Chum Salmon (20; 0 – 40) (**Table 4**; **Figure 4**). Total harvest during this opportunity was similar to estimated harvest during the 4” set gillnet opportunity provided by ADF&G on June 6, 2018. All Chinook Salmon harvested during this opportunity with set gillnets were above the Johnson River.

Harvest estimates were produced from 22 trip interviews, of which 4 (18%) came from the Bethel boat harbor, 4 (18%) from Bethel area fish camps, and 14 (64%) from BSFA community monitors (**Figure 5**).

Of particular interest to note, there were 9 drift nets observed fishing in the main stem Kuskokwim River during this opportunity, mainly around the community of Tuntutuliak. Additionally, several trip interviews from the area were recorded as using drift gillnets in the area. From these interviews, a total of 49 Chinook Salmon were reported to have been harvested in the mainstem Kuskokwim River with drift gillnets.

Second Opener (6/8/2019)

An estimated total of 171 set net trips occurred between Tuntutuliak and Akiak (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 780 (95% CL: 570 – 1,030). Most of the salmon harvest was made up of Chinook Salmon (740; 540 – 970), followed by Chum Salmon (30; 10 – 50), and Sockeye Salmon (10; 0 – 20) (**Table 4**; **Figure 4**).

Harvest estimates were produced from 59 trip interviews, of which 27 (46%) came from the Bethel boat harbor, 9 (15%) from Bethel area fish camps, and 23 (39%) from BSFA community monitors (**Figure 5**).

Unlike the previous opportunity on June 1, there were no drift nets observed fishing in the main stem Kuskokwim River during this opportunity. However, several trip interviews from the area were recorded as using drift gillnets. From these interviews, a total of 106 Chinook Salmon were reported to have been harvested in the mainstem Kuskokwim River with drift gillnets.

Third Opener (6/12/2019)

An estimated total of 446 drift boat trips and 43 set net trips occurred in the study area on 6/12/2019 during the 12-hour opener (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 8,650 (95% CL: 6,820 – 10,140). Almost all harvest (93%) was made up of Chinook Salmon (8,040; 6,240 – 10,140) followed by relatively equal and much smaller amounts of Chum (310; 95% CL: 230 – 400) and Sockeye salmon (290; 95% CL: 190 – 430) (**Table 4**, **Figure 4**). The number of Chinook Salmon harvested during this opportunity is the largest harvest of Chinook Salmon on June 12 since in-season harvest estimates have been produced (2016). Before this opportunity, the largest number of Chinook Salmon harvested was in 2016, with a total of 5,200 Chinook Salmon. Interestingly, this opportunity also had the lowest estimated boat count total on June 12 (446 vs. 632 in 2016). The reason for the high harvest total is likely due to the lower than normal numbers of Chum and Sockeye salmon in the river during this time or the Chinook Salmon run was larger than observed in previous years. Usually during this time period, the ratio of Chum/Sockeye to Chinook Salmon is around 1; however, the ratio this year was much closer to 0 (0.1). Chum salmon were running late for the 2019 season.

Harvest estimates were produced from 165 trip interviews, of which 85 (51%) came from the Bethel boat harbor, 16 (10%) from Bethel area fish camps, and 64 (39%) from BSFA community monitors (**Figure 5**). Five interviews were from set net fishers and the remaining 160 interviews were from drift boat fishers. Based on the distribution of relevant interview quantities from the first opener (**Figure 6**), there seemed to be two pulses of fishery entry times: one with the vast majority of fishers entering early in the morning (6 – 7 AM) and a second starting at 10 AM. Most trips lasted between 2 and 8 hours (average of 5.8 hours), and soak time was skewed towards shorter soaks of 2 to 6 hours. Most fishers caught between 7 and 15 salmon per trip, with almost all of these salmon being Chinook Salmon. As was in 2018, the average fisher interviewed by BSFA community monitors caught more total salmon, started their trips earlier, and spent more time actively fishing than the average fisher interviewed at the Bethel boat harbor (**Figure 6**). Overall, Chinook Salmon made up approximately 82% of catches across all interviewed fishers. Between 6/10/2019 and 6/12/2019, the BTF catches were comprised of 89% Chinook Salmon on average, which meshes well with ratios observed in the fishery. This is a new phenomenon compared to other year's initial opportunities as Chinook Salmon were dominating the system with the later return of Chum Salmon.

Fourth Opener (6/15/2019)

An estimated total of 500 drift boat trips and 15 set net trips occurred within the study area on 6/15/2019 (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 8,980 (7,510 – 10,530). As in the first opener, most of theharvest was Chinook Salmon (83%; 7,480; 6,190 – 8,890), followed by Sockeye Salmon (13%; 1,140; 820 – 1,550), and Chum Salmon (4%; 350; 210 – 520) (**Table 4**, **Figure 4**). Harvest estimates were produced from 210 completed trip interviews, of which 100 (48%) came from the Bethel boat harbor, 31 (14%) came from Bethel area fish camps, and 79 (38%) came from BSFA community monitors (**Figure 5**). Ten of these interviews were from set net fishers and the remaining 200 were from drift boat fishers. Based on the distribution of relevant interview quantities from the fourth opener (**Figure 7**), trip start time, trip duration, and soak hours all remained relatively similar to the June 12 opportunity.

Overall, the number of salmon per boat and Chinook Salmon per boat remained relatively similar to the previous opportunity; however, Sockeye Salmon were slightly more prevalent during this opportunity compared to last (0.6 vs. 1.6). Chum Salmon harvest still remained low and similar to the previous harvest opportunity. Overall, Chinook Salmon made up 79% of catches across all interviewed fishers. Between 6/13/2019 and 6/15/2018, the BTF catches were comprised of 91% Chinook Salmon on average. Continuing the trend from the previous opportunity, the river was dominated by Chinook Salmon, especially given the continued late return of Chum Salmon.

Fifth Opener (6/19/2019)

An estimated total of 466 drift boat trips and 25 set net trips occurred within the study area on 6/19/2019 (**Table 3**, **Figures 2 and 3**). The mean estimated total salmon harvest was 18,870 (15,860 – 22,220). Majority of harvest was Chinook Salmon (72%; 13,630; 11,350 – 16,110), followed by Sockeye Salmon (15%; 2,900; 2,180 – 3,800), and Chum Salmon (13%; 2,340; 1,550 – 3,400) (**Table 4**, **Figure 4**). The number of Chinook Salmon harvested during the opportunity is almost double the maximum number of Chinook Salmon harvested during any 12-hour period prior to 2019. This harvest was surprising to most in-season managers but was not that unexpected given the low ratios of Chum/Sockeye salmon to Chinook Salmon and the timing of this opportunity being close to the historical peak of the Chinook Salmon run.

Harvest estimates were produced from 187 completed trip interviews, of which 81 (43%) came from the Bethel boat harbor, 39 (21%) came from Bethel area fish camps, 67 (36%) came from BSFA community monitors (**Figure 5**). Eight of these interviews were from set net fishers and the remaining 179 were from drift boat fishers. Based on the distribution of relevant interview quantities from the fifth opener (**Figure 8**), trip start time, trip duration, and soak hours all remained relatively similar to the previous opportunities; however, the number of salmon per boat doubled from the previous opportunity (13 vs 26). Chinook salmon catch per boat increased from the previous opportunity by almost 8 per boat across all interview sources. Chum and Sockeye salmon per boat had noticeable increases from previous opportunities, but still well below what was seen in previous years. Overall, Chinook Salmon made up 71% of the catches across all interviewed fishers, which was about a 7% decrease from the previous opportunity. Between 6/17/2019 and 6/19/2019, the BTF catches were comprised of 86% Chinook Salmon on average. Historically, Chinook Salmon catches at the BTF during this time account for about 25% of the catches. Once again, the species composition was dominated by Chinook Salmon in comparison to other species that are normally present during this time, especially Chum Salmon.

Sixth Opener (6/22/2019)

An estimated total of 426 drift boat trips and 11 set net trips occurred within the study area on 6/22/2019 (**Table 3**, **Figure 2 and 3**). The mean estimated total salmon harvest was 23,310 (19,240–28,130). Majority of harvest (57% combined) during this opportunity was Chum (18%; 4,120; 2,960 – 5,690) and Sockeye salmon (39%; 9,060; 7,450 – 10,960), followed by Chinook Salmon (43%; 10,130; 8,030 – 12,680) (**Table 4**, **Figure 4**). Although, in magnitude, Chinook Salmon composed most of the harvest, Chum and Sockeye salmon harvest in combination exceeded the number of Chinook Salmon harvested during this opportunity.

These harvest estimates were produced from 192 completed trip interviews, of which 87 (45%) came from the Bethel boat harbor, 41 (21%) came from Bethel area fish camps, and 64 (33%) came from BSFA community monitors. Six of these interviews were from set net fishers and the remaining 186 were from drift boat fishers. Based on the distribution of relevant interview quantities from the fourth opener (**Figure 9**), trip start time stayed relatively the same as previous opportunities, but there was a noticeable decrease in trip duration and soak hours (~ 1.5 hours). Once again the number the salmon per boat increased from 26 to 38, but the number of Chinook Salmon per boat slightly decreased from the previous opportunity (18 vs. 17). However, the number of Chum and Sockeye salmon per boat more than tripled during the opportunity as compared to the previous opportunity. This noticeable increase in Chum and Sockeye salmon harvest is more than likely due to increased numbers of these salmon in the river, as well as people meeting their Chinook Salmon needs more so than previous years. For the first time in the 2019 subsistence fishery season, the average percent of Chinook Salmon catch was below 50% across all interviews (avg. 43%). Between 6/20/2019 and 6/22/2019, the BTF catches were comprised of 61% Chinook salmon on average. Unlike previous opportunities, the fishery seemed more selective of Chum and Sockeye salmon in comparison to the BTF catches. As stated earlier, this makes sense as more fishers were meeting their Chinook Salmon needs earlier in the season than in previous years, focusing more of their attention of Chum and Sockeye salmon.

Total Harvest across All Openers

Across all openers, an estimated total of 60,710 (50,070 – 72,840) salmon were harvested. Most of the harvest was Chinook salmon (66%; 40,120; 32,410 – 48,930), followed by Sockeye salmon (22%; 13,400; 10,640 – 16,760), and Chum salmon (12%; 7,170; 4,960 – 10,100) (**Table 4**; **Figure 11**). Fishers within geographic stratum A (below the Johnson River) harvested the most total salmon, accounting for 37% of all salmon harvest, closely followed by geographic stratum C (Napaskiak to Akiachak), which accounted for 31% of all salmon harvest. The number of Chinook Salmon harvested in stratum's A and C were similar to one another, which makes sense given these two areas had the most estimated boat trips (**Tables 2 and 4**; **Figure 11**). Unlike previous years, there was no discernable decline in drift boats and set gillnet effort as the season progressed. The follows a trend found in the 2018 (Staton 2018), which stated the decline in effort was less pronounced than in previous years (**Figures 2 and 3**). Continuing the same trends from 2018, the proportion of drift boats fishing in stratum A (below the Johnson River) did not decline as the season progressed, but instead stayed constant at around ~30% (**Figure 2**). It is interesting that the number of boats counted below the Johnson River this year increased by about 10% from 2018. This observation makes sense because fishers below the Johnson River can use 300 foot nets, as opposed to above the Johnson River where only 150 foot nets can be used.

Synthesis of Key Information on 6/12 Openers

Given that 6/12 is a key opener date (due to Alaska Board of Fisheries regulations implemented in 2016 that mandate that no directed Chinook Salmon harvest opportunity is provided before 6/11), I thought it important to continue the synthesizing of key information that has been gathered from 2016 to 2019, during which 12-hour openers were implemented.

First thing to note is the number of drift boat trips between Tuntutuliak and Akiak are similar in magnitude, but steadily decreased since 2016 (524, 523, 466, and 446; avg. 490; **Table 7**). Conversely, the number of total salmon harvested has increased steadily since 2016 (5,100; 5,420; 6,500; 8,650; avg. 6,418). One thing to note is that the number of Chinook Salmon harvested in 2019 was almost doubled compared to other years. The lowest species ratio for June 12 was also observed in 2019 (0.1; **Table 7**). Although this ratio is like the 2016 ratio (0.2), almost double the amount of Chinook Salmon were harvested in comparison. Similar to 2016, the harvest of Chum and Sockeye for 2019 was relatively low (810 vs 600).

DISCUSSION

Overall Summary

For the 2019 season, an estimated total of 60,710 (50,070 – 72,840) salmon were harvested. Chinook Salmon (66%; 40,120; 32,410 – 48,930) made up most of the harvest, followed by Sockeye Salmon (22%; 13,400; 10,640 – 16,760), and Chum Salmon (12%; 7,170; 4,960 – 10,100). Total salmon harvest for 2019 was around 20,000 – 30,000 fish less than in recent years; however, Chinook Salmon harvest in 2019 was the largest since the in-season harvest monitoring program began in 2016. In contrast, the harvest of Chum and Sockeye salmon were drastically less than previous years (2016 to 2018: 58,000 – 73,000 vs. 2019: 20,570).

The large differences in 2019 harvest as compared to previous years is likely due in large part to the higher than expected return of Chinook Salmon as well as a late Chum Salmon run and late Sockeye Salmon return. Additionally, Chinook Salmon run timing for 2019 appears to be 1-2 days earlier than average, which is something that has not happened since at least 2014. The combination of these factors led to lower than expected Chinook Salmon to Chum/Sockeye ratios for the month of June when fishing opportunities were provided. Although these factors were different for 2019, subsistence users' effort and the number of salmon per boat remained within expectations based on previous data collected from the in-season harvest monitoring program.

Reliability of Assumptions

All reported analyses assumed the interview information was a random sample from the population of fishers during the opener. This assumption is not unique to this analysis, or even creel surveys in general, but is made in every statistical analysis where samples are used to make inference on a population. It cannot be overemphasized that the sampling design for the completed trip interviews was not implemented in a random sense, but could be much more accurately described as opportunistic. This issue of non-randomness certainly brings to question the validity of the resulting harvest estimates in terms of accuracy and precision. If the information obtained was systematically biased (e.g., fishers in the sample fished longer and had higher catch rates than non-sampled fishers), then the resulting estimates would also be biased. I attempted to account for this in several ways. First, although the information was treated though it was random, each time harvest estimates were presented to stakeholders and decision-makers, I attempted to make them fully aware of the limitations of the analysis. Second, I produced estimates of uncertainty and emphasized that the estimates be interpreted in the full context of their uncertainty. To embrace this level of uncertainty, decisions were often made by considering both a "most likely" and a "worst case" scenario, using the point estimate and the upper bound of the estimates, respectively.

Additionally, I do believe the harvest data collected through the monitoring program is a good representation of the subsistence fishery. The lower Kuskokwim River can be generally separated into three major sections: (1) above Bethel, (2) around Bethel, and (3) below Bethel. A majority of the surveys collected were from the around Bethel section, primarily through the Bethel boat harbor surveys conducted by ONC. This is good as a majority of the population in the subsistence fishery is based around the Bethel area. However, ONC also collected surveys from the Bethel area fish camps, which complemented the information gathered at the boat harbor. Also the community-based monitoring program had a presence in the village of Napaskiak, which is just a several minute boat ride from Bethel. Overall, gathering information from these locations give a respectable indication of the subsistence fishery in and around the Bethel area. With respect to the areas above and below Bethel, coverage was also excellent. The above Bethel area had community-based monitors were stationed in the villages of Kwethluk and Akiak, which are some of the most prominent and largest communities above the Bethel area. The below Bethel area was primarily informed by the community-based monitors stationed in Tuntutuliak. Tuntutuliak is a village located about 4 hours downstream of the Bethel area and is one of the larger (if not largest) communities found in the lower river. Given this kind of coverage within the lower river, it is unlikely the samples collected through the monitoring program are not representative of the lower river subsistence fishery.

Other Harvest Not Monitored or Accounted For

It is important to note that the harvest estimates in this document for salmon within the study area are more than likely biased low compared to the "true" harvest, especially in comparison to previous year's harvest estimates. This is because unlike previous years under Federal restrictions, more opportunities were provided during time periods in which fishing has not typically been allowed and fishing with selective gear types (i.e. rod and reel, beach seine, fish wheels, and dip nets) for Chinook Salmon was allowed for Federally qualified users throughout the season. Moreover, data collected during the in-season harvest monitoring (particularly BSFA community monitors) was able to collect more information than previous years from subsistence users who fished in the non-salmon spawning tributaries (i.e. Gweek, Johnson, Tuntutuliak, Pailleq), which indicated more salmon harvest occurs in those locations than previously thought (although this information is only collected when the fishery in the mainstem is open).

For example, Federally qualified users were able harvest Chinook Salmon before June 1 with ≤ 6" mesh size gillnets. During this time period, harvest and effort was not monitored. Although it was expected that Chinook Salmon harvest during this time was minimal, the earlier run-timing of Chinook Salmon this year could have made Chinook Salmon more vulnerable to harvest as compared to previous years, especially in the lower mainstem below the Johnson River.

Additionally, ADF&G opened the Chum and Sockeye salmon subsistence fisheries on June 26, which was before Federal management of Chinook Salmon was relinquished (July 1). Since 2016, Federal restrictions and State gillnet restrictions have continued through the first week of July. Just like the time period before June 1, harvest and effort was not monitored in a rigorous manner like during announced opportunities. It is unlikely the Chinook Salmon harvest during this time period was as high as early and mid-season opportunities because in-season data presented during meetings indicated that many subsistence users had met their Chinook Salmon harvest needs. However, it is likely that subsistence users who fished during this time period would have caught Chinook Salmon in some non-miniscule quantity because of the lower than average Chum and Sockeye to King Salmon ratios observed in the BTF.

Furthermore, selective gear types such as rod and reel, beach seine, fish wheels, and dip nets could be used to harvest Chinook Salmon by Federally qualified subsistence users throughout the entire Chinook salmon run. Although many subsistence users do not traditionally use this gear when gillnets are allowed, it is reasonable to assume some subsistence users participated in the Chinook Salmon subsistence fishery using these gear types given gillnets were not allowed in between opportunities. Compared to the two previous examples, the number of Chinook Salmon harvested with these gear types is probably minimal, but still worth mentioning because these gear types have not previously been allowable in either Federal or State waters when the gillnet fishery is closed.

Finally, data collected through the Bethel boat harbor and community-based monitoring survey programs detected more trips occurring in non-salmon spawning tributaries as compared to 2018 when the non-salmon spawning classification was first added to the in-season subsistence harvest surveys. Harvest estimates from these locations were not generated as subsistence harvest surveys are only collected during announced opportunities and fishing in these locations is not prohibited when the mainstem Kuskokwim River is closed. Although harvest data from the non-salmon spawning tributaries was not included in this report, harvests from these locations were similar to harvest in the mainstem, albeit gear characteristics were different (i.e. ≥ 6” mesh size gillnets were more prevalent). It is believed that harvests in these locations are not detrimental to meeting escapement needs; however, the magnitude of Chinook Salmon harvest in these locations remains an unknown quantity.

Regardless, undocumented harvest during the in-season subsistence harvest monitoring program will be reflected in the ADF&G post-season subsistence harvest surveys that take place in the fall. For the last three years, the estimates in the post-season harvest survey are generally within a reasonable realm with the inseason harvest estimates (*unpublished analysis*).

Sensitivity of Harvest Estimates

Sensitivity of the estimates to assumption violations was investigated by producing effort and harvest estimates using data from only a smaller subset 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 (25-50%). Typically, when Bethel boat harbor data were removed, the harvest estimates increased and harvest estimates decreased when the community-based monitoring 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 in no cases did the qualitative conclusion change.

Technical Review of Harvest Estimates

As was done in previous years, YDNWR staff had the opportunity to present the information and estimates to technical advisors from ADF&G, BSFA, and ONC shortly before making them public. While this review was relatively informal and abbreviated by necessity to allow timely consideration by managers for subsequent decisions, I believe that additional review was helpful to allow for screening of gross errors in data analysis and interpretation. Though no major alterations were suggested by these reviewers, I believe that the review bolstered the credibility and reliability of the work.

Scalability of the Model

The current methods for estimating in-season salmon harvests are effective when applied to years with similar fishery conditions like what has occurred since 2016 (i.e. relatively few opportunities and each short in duration). However, if fishery conditions were to expand to more opportunities with longer durations, then a more carefully designed random sampling program will be necessary. This is because the longer the opportunities will make it more difficult to justify the assumption of random sampling, particularly in the harvest collection component. Unlike for 12-hour opportunities, it is unreasonable to keep a monitor at an access site for the majority of an opportunity that is several times longer so decisions would have to be made about the most appropriate time or place to have the monitors gathering information (while also ensuring they are collecting a representative sample of the fishery at the time).

If managers wish to have inseason harvest estimates as fishery management becomes less restrictive, a more rigorous sampling program will be required. Thankfully, there are common and well-practiced methods in existence today that can be implemented with a little work (Bernard et al. 1998). Here are a two major considerations that will be faced in such an effort:

> (1) Longer opportunities means lower fisher density at access points as compared to short duration opportunities. As fisher return becomes more dispersed decisions have to be made as to when the most appropriate time to sample returning fishers (typically accomplished through random sampling of time slots, like AM vs PM). Similarly, decisions on what day of the week to sample is also very common. Standard practice for accomplishing this task is to sample in proportion to effort (e.g. weekends versus weekdays). However, given the fishery has never been monitored in a fashion to help answer these questions, choosing dates and times to minimize bias will be a difficult task.
>
> (2) Longer opportunities also means fishing effort will be less concentrated. Given, the current aerial effort surveys are resource intensive, a subsampling program would have to be developed to accurately characterize a more open fishery when fishers are not limited to a tight time window. Thus, decisions would have to be made on how to develop a sampling schedule. Additionally, the current effort expansion model would need to be adapted to accommodate the change in survey methodology.

While these considerations present a formidable barrier, they are not impossible to complete with proper direction and time.

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Table 1. Raw drift gillnet/boat counts from each flight and geographic stratum. The first two openers were set gillnet only opportunities.

Opener	Date	Flight Times		Geographic Stratum[1]				Total
		F_1	F_2	A	B	C	D	
1	6/1/2019	15:15	17:00	6	2	1	0	9
2	6/8/2019	11:00	12:40	0	0	0	0	0
3	6/12/2019	07:08	08:35	66	23	102	32	223
3	6/12/2019	12:15	13:33	116	42	141	23	322
3	6/12/2019	16:06	17:40	54	38	111	26	229
4	6/15/2019	07:18	08:38	89	42	136	38	305
4	6/15/2019	12:45	14:18	100	59	127	21	307
4	6/15/2019	16:00	17:30	44	44	122	15	223
5	6/19/2019	12:10	13:40	100	56	127	33	316
5	6/19/2019	16:03	17:47	63	58	126	18	265
6	6/22/2019	12:05	14:05	68	49	91	30	238
6	6/22/2019	16:00	17:47	45	32	59	7	143

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

Table 2. Raw set gillnet counts from each flight and geographic stratum. The first two openers were set gillnet only opportunities.

Opener	Date	Flight Times		Geographic Stratum[1]				Total
		F_1	F_2	A	B	C	D	
1	6/1/2019	15:15	17:00	3	10	38	24	84
2	6/8/2019	11:00	12:40	9	11	81	53	154
3	6/12/2019	07:08	08:35	4	1	14	4	23
3	6/12/2019	12:15	13:33	1	3	24	7	35
3	6/12/2019	16:06	17:40	0	3	13	12	28
4	6/15/2019	07:18	08:38	0	0	7	4	11
4	6/15/2019	12:45	14:18	0	1	8	1	10
4	6/15/2019	16:00	17:30	0	2	9	4	15
5	6/19/2019	12:10	13:40	0	2	14	8	24
5	6/19/2019	16:03	17:47	1	1	6	2	10
6	6/22/2019	12:05	14:05	0	0	6	5	11
6	6/22/2019	16:00	17:47	0	0	2	0	2

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

Table 3. Estimated drift boat trip and set nets by day and geographic stratum. The derivation of these quantities from the raw counts presented in Tables 1 and 2 is presented in the text.

Gear	Opener	Date	Duration[2]	Geographic Stratum[1]				Total
				A	B	C	D	
Drift Boat	1	6/1/2019	12	NA	NA	NA	NA	NA
	2	6/8/2019	12	NA	NA	NA	NA	NA
	3	6/12/2019	12	133	59	205	49	446
	4	6/15/2019	12	136	86	234	43	500
	5	6/19/2019	12	129	92	204	40	466
	6	6/22/2019	12	128	92	169	37	426
Set Net	1	6/1/2019	12	4	12	47	29	92
	2	6/8/2019	12	10	12	90	59	171
	3	6/12/2019	12	4	3	24	12	43
	4	6/15/2019	12	0	2	9	4	15
	5	6/19/2019	12	1	2	14	8	25
	6	6/22/2019	12	0	0	6	5	11

[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 opener.

Table 4. Salmon harvest from both drift nets and set nets from all six openers by species and geographic stratum. Numbers within parentheses are 95% confidence limits.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/1/201	Chinook	0 (0-10)	10 (0-20)	50 (20-90)	30 (10-60)	100 (60-140)
	Chum	0 (0-0)	0 (0-10)	10 (0-30)	10 (0-20)	20 (0-40)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	0 (0-10)	10 (10-30)	60 (20-100)	40 (10-70)	120 (70-170)
6/8/2019	Chinook	40 (30-70)	50 (30-80)	390 (230-590)	250 (150-390)	740 (540-970)
	Chum	0 (0-0)	0 (0-0)	20 (0-40)	10 (0-20)	30 (10-50)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-10)	0 (0-10)	10 (0-20)
	Total	50 (30-70)	50 (30-80)	410 (250-620)	270 (160-410)	780 (570-1,030)
6/12/2019	Chinook	3,950 (2,310-5,880)	610 (420-830)	2,110 (1,480-2,920)	1,370 (1,200-1,570)	8,040 (6,240-10,140)
	Chum	30 (0-70)	30 (10-60)	120 (80-170)	130 (80-190)	310 (230-400)
	Sockeye	120 (40-240)	60 (30-90)	120 (70-180)	0 (0-0)	290 (190-430)
	Total	4,100 (2,470-6,050)	700 (490-950)	2,350 (1,680-3,210)	1,500 (1,330-1,690)	8,650 (6,820-10,760)
6/15/2019	Chinook	2,730 (1,930-3,650)	1,410 (920-1,970)	1,780 (1,390-2,220)	1,560 (850-2,410)	7,480 (6,190-8,890)
	Chum	150 (30-300)	80 (40-140)	80 (50-120)	40 (10-90)	350 (210-520)
	Sockeye	460 (170-820)	210 (130-310)	430 (300-580)	50 (20-80)	1,140 (820-1,550)
	Total	3,340 (2,360-4,410)	1,700 (1,170-2,290)	2,290 (1,820-2,820)	1,640 (930-2,530)	8,980 (7,510-10,530)
6/19/2019	Chinook	4,750 (3,000-6,660)	2,460 (1,910-3,060)	3,800 (2,780-5,160)	2,630 (1,830-3,270)	13,630 (11,350-16,110)
	Chum	1,480 (730-2,510)	240 (160-330)	450 (310-630)	170 (50-300)	2,340 (1,550-3,400)
	Sockeye	1,230 (560-2,090)	650 (480-850)	890 (720-1,080)	120 (50-210)	2,900 (2,180-3,800)
	Total	7,460 (4,940-10,340)	3,350 (2,680-4,090)	5,140 (3,950-6,700)	2,920 (2,120-3,530)	18,870 (15,860-22,220)

Table continues below

Table 4 Continued.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/22/2019	**Chinook**	3,380 (1,610-5,800)	1,530 (1,100-2,020)	3,380 (2,690-4,250)	1,830 (1,260-2,470)	10,130 (8,030-12,680)
	Chum	1,810 (730-3,320)	760 (530-1,040)	1,200 (940-1,500)	350 (220-500)	4,120 (2,960-5,690)
	Sockeye	2,280 (1,120-3,780)	2,150 (1,730-2,610)	4,200 (3,240-5,330)	430 (260-600)	9,060 (7,450-10,960)
	Total	7,470 (3,940-11,870)	4,440 (3,630-5,310)	8,780 (7,160-10,700)	2,610 (2,010-3,200)	23,310 (19,240-28,130)
All Openers	**Chinook**	14,850 (8,880-22,070)	6,070 (4,380-7,980)	11,510 (8,590-15,230)	7,670 (5,300-10,170)	40,120 (32,410-48,930)
	Chum	3,470 (1,490-6,200)	1,110 (740-1,580)	1,880 (1,380-2,490)	710 (360-1,120)	7,170 (4,960-10,100)
	Sockeye	4,090 (1,890-6,930)	3,070 (2,370-3,860)	5,640 (4,330-7,180)	600 (330-900)	13,400 (10,640-16,760)
	Total	22,420 (13,740-32,750)	10,250 (8,010-12,750)	19,030 (14,880-24,150)	8,980 (6,560-11,430)	60,710 (50,070-72,840)

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

Note: Total means and 95% confidence intervals within an opener were obtained via bootstrapping. Quantities totaled between openers were obtained using the sum of the bootstrapped summaries.

Table 5. Salmon harvest from drift boat trips from all six openers by species and geographic stratum. Numbers within parentheses are 95% confidence limits.

Opener	Species	Geographic Stratum[1] A	B	C	D	Total
6/1/201	Chinook	NO ESTIMATES AVAILABLE				
	Chum					
	Sockeye					
	Total					
6/8/2019	Chinook	NO ESTIMATES AVAILABLE				
	Chum					
	Sockeye					
	Total					
6/12/2019	Chinook	3,910 (2,270-5,840)	580 (400-790)	1,860 (1,290-2,610)	1,250 (1,130-1,370)	7,600 (5,820-9,700)
	Chum	30 (0-70)	30 (10-60)	110 (70-150)	120 (70-190)	290 (210-380)
	Sockeye	120 (40-240)	60 (30-90)	120 (70-180)	0 (0-0)	290 (190-430)
	Total	4,050 (2,420-6,000)	670 (460-910)	2,090 (1,480-2,880)	1,370 (1,270-1,480)	8,180 (6,390-10,300)
6/15/2019	Chinook	2,730 (1,930-3,650)	1,400 (900-1,950)	1,720 (1,330-2,150)	1,530 (830-2,380)	7,380 (6,090-8,790)
	Chum	150 (30-300)	80 (40-140)	80 (50-110)	40 (10-90)	350 (210-510)
	Sockeye	460 (170-820)	200 (120-300)	390 (270-540)	30 (10-50)	1,080 (760-1,490)
	Total	3,340 (2,360-4,410)	1,680 (1,150-2,270)	2,190 (1,720-2,720)	1,600 (880-2,480)	8,810 (7,340-10,370)
6/19/2019	Chinook	4,740 (2,990-6,660)	2,440 (1,900-3,050)	3,720 (2,710-5,080)	2,590 (1,790-3,230)	13,500 (11,230-15,970)
	Chum	1,480 (730-2,510)	240 (160-320)	450 (300-620)	170 (50-290)	2,330 (1,540-3,390)
	Sockeye	1,230 (560-2,080)	640 (470-840)	830 (660-1,010)	80 (20-160)	2,780 (2,070-3,680)
	Total	7,450 (4,930-10,330)	3,330 (2,660-4,070)	4,990 (3,820-6,550)	2,840 (2,030-3,440)	18,610 (15,620-21,950)

Table continues below

Table 5 Continued.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/22/2019	Chinook	3,380 (1,610-5,800)	1,530 (1,100-2,020)	3,290 (2,610-4,150)	1,760 (1,180-2,390)	9,960 (7,850-12,510)
	Chum	1,810 (730-3,320)	760 (530-1,040)	1,150 (890-1,450)	300 (190-450)	4,020 (2,860-5,580)
	Sockeye	2,280 (1,120-3,780)	2,150 (1,730-2,610)	4,060 (3,100-5,190)	310 (150-470)	8,800 (7,190-10,710)
	Total	7,470 (3,940-11,870)	4,440 (3,630-5,310)	8,490 (6,890-10,420)	2,370 (1,770-2,940)	22,780 (18,700-27,610)
All Openers	Chinook	14,760 (8,800-21,950)	5,950 (4,300-7,810)	10,590 (7,940-13,990)	7,130 (4,930-9,370)	38,440 (30,990-46,970)
	Chum	3,470 (1,490-6,200)	1,110 (740-1,560)	1,790 (1,310-2,330)	630 (320-1,020)	6,990 (4,820-9,860)
	Sockeye	4,090 (1,890-6,920)	3,050 (2,350-3,840)	5,400 (4,100-6,920)	420 (180-680)	12,950 (10,210-16,310)
	Total	22,310 (13,650-32,610)	10,120 (7,900-12,560)	17,760 (13,910-22,570)	8,180 (5,950-10,340)	58,380 (48,050-70,230)

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

Note: Total means and 95% confidence intervals within an opener were obtained via bootstrapping. Quantities totaled between openers were obtained using the sum of the bootstrapped summaries

Table 6. Salmon harvest from set nets from all five openers by species and geographic stratum. Numbers within parentheses are 95% confidence limits.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/1/201	Chinook	0 (0-10)	10 (0-20)	50 (20-90)	30 (10-60)	100 (60-140)
	Chum	0 (0-0)	0 (0-10)	10 (0-30)	10 (0-20)	20 (0-40)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	0 (0-10)	10 (10-30)	60 (20-100)	40 (10-70)	120 (70-170)
6/8/2019	Chinook	40 (30-70)	50 (30-80)	390 (230-590)	250 (150-390)	740 (540-970)
	Chum	0 (0-0)	0 (0-0)	20 (0-40)	10 (0-20)	30 (10-50)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-10)	0 (0-10)	10 (0-20)
	Total	50 (30-70)	50 (30-80)	410 (250-620)	270 (160-410)	780 (570-1,030)
6/12/2019	Chinook	40 (10-90)	30 (0-70)	250 (30-550)	120 (20-270)	440 (170-780)
	Chum	0 (0-10)	0 (0-0)	10 (0-30)	10 (0-20)	20 (0-50)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	40 (10-100)	30 (0-70)	260 (30-580)	13 0(20-290)	460 (180-820)
6/15/2019	Chinook	0 (0-0)	10 (10-30)	60 (30-110)	30 (10-50)	100 (60-160)
	Chum	0 (0-0)	0 (0-0)	0 (0-10)	0 (0-0)	0 (0-10)
	Sockeye	0 (0-0)	10 (0-20)	40 (0-80)	20 (0-40)	60 (20-110)
	Total	0 (0-0)	20 (10-40)	100 (40-170)	40 (20-70)	170 (100-240)
6/19/2019	Chinook	10 (0-10)	10 (0-30)	80 (0-190)	40 (0-110)	140 (40-260)
	Chum	0 (0-0)	0 (0-0)	10 (0-20)	0 (0-10)	10 (0-20)
	Sockeye	0 (0-10)	10 (0-20)	60 (20-110)	40 (10-70)	110 (60-170)
	Total	10 (0-20)	20 (0-40)	150 (30-310)	80 (20-180)	260 (110-450)

Table continues below

Table 6 Continued.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/22/2019	Chinook	0 (0-0)	0 (0-0)	90 (40-170)	80 (40-140)	170(100-260)
	Chum	0 (0-0)	0 (0-0)	50 (10-100)	50 (10-80)	100 (40-160)
	Sockeye	0 (0-0)	0 (0-0)	140 (80-220)	120 (70-190)	260 (170-370)
	Total	0 (0-0)	0 (0-0)	290 (180-420)	240 (150-350)	530 (390-700)
All Openers	Chinook	90 (40-180)	110 (40-230)	920 (350-1,700)	550 (230-1,020)	1,690 (970-2,570)
	Chum	0 (0-10)	0 (0-10)	100 (10-230)	80 (10-150)	180 (50-330)
	Sockeye	0 (0-10)	20 (0-40)	240 (100-420)	180 (80-310)	440 (250-670)
	Total	100 (40-200)	130 (50-260)	1,270 (550-2,200)	800 (380-1,370)	2,320 (1,420-3,410)

[1]Geographic strata: A = Below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak
Note: Total means and 95% confidence intervals within an opener were obtained via bootstrapping. Quantities totaled between openers were obtained using the sum of the bootstrapped summaries.

Table 7. Key harvest characteristics of 12-hour openers on 6/12 in all years where in-season harvest was rigorously monitored. These numbers correspond only to the main stem Kuskokwim River between and including the villages of Tuntutuliak and Akiak.

	2016	2017	2018	2019	Average
Drift Effort	524	523	466	446	490
Total Salmon Harvest	5,100	5,420	6,500	8,650	6,418
Total Salmon/Boat	10	10	14	19	13
Chinook Harvest	4,290	2,240	4,590	8,040	4,790
Chinook/Boat	8	4	10	18	10
Chum/Sockeye Harvest	810	3,180	1,910	600	1,625
Chum/Sockeye/Boat	2	6	4	1	3
Species Ratio	0.2	1.4	0.4	0.1	0.5

Figure 1. Map of the Yukon Delta National Wildlife Refuge waters with geographic strata noted (A – D). Solid circles indicate strata boundaries; hollow circles indicate other points of interest.

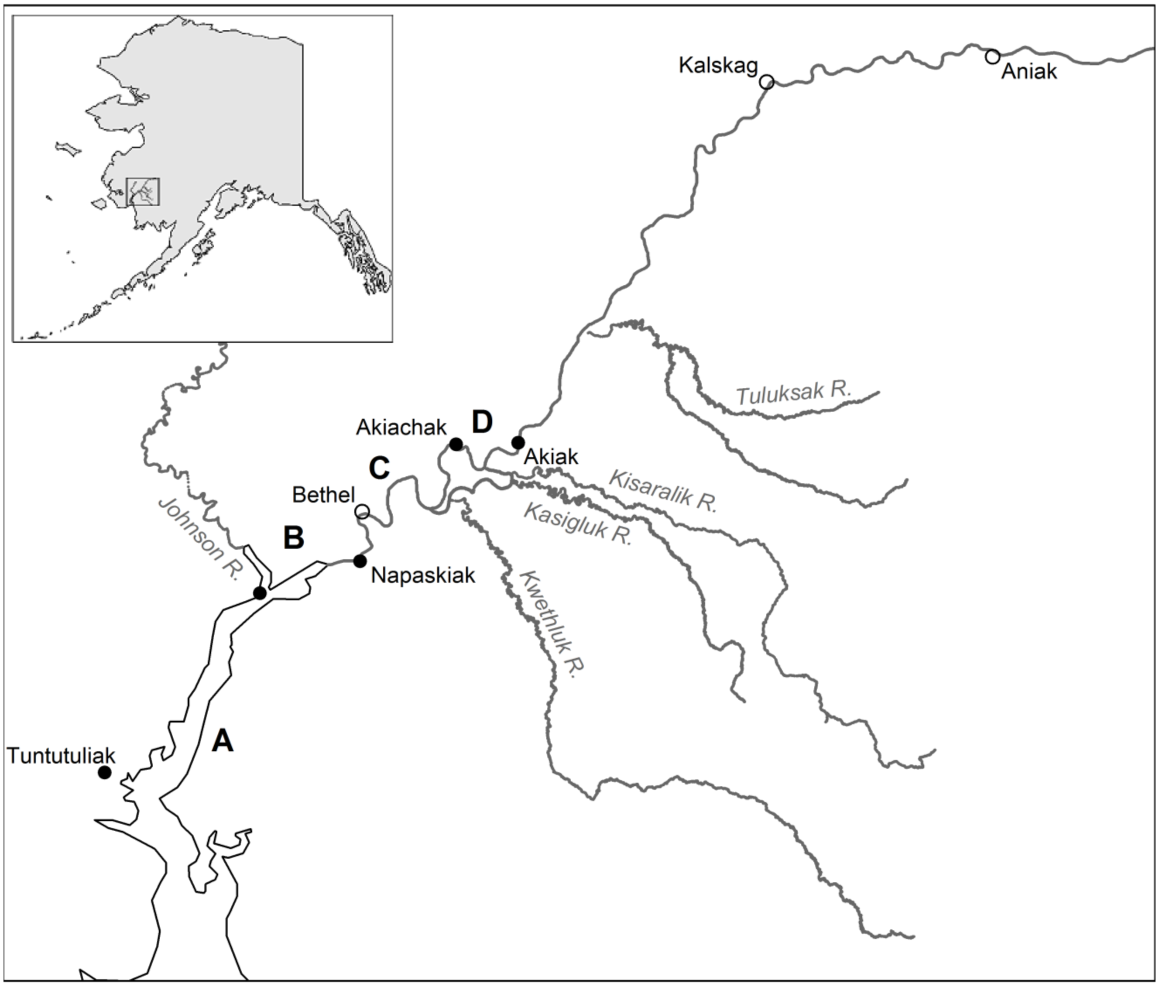
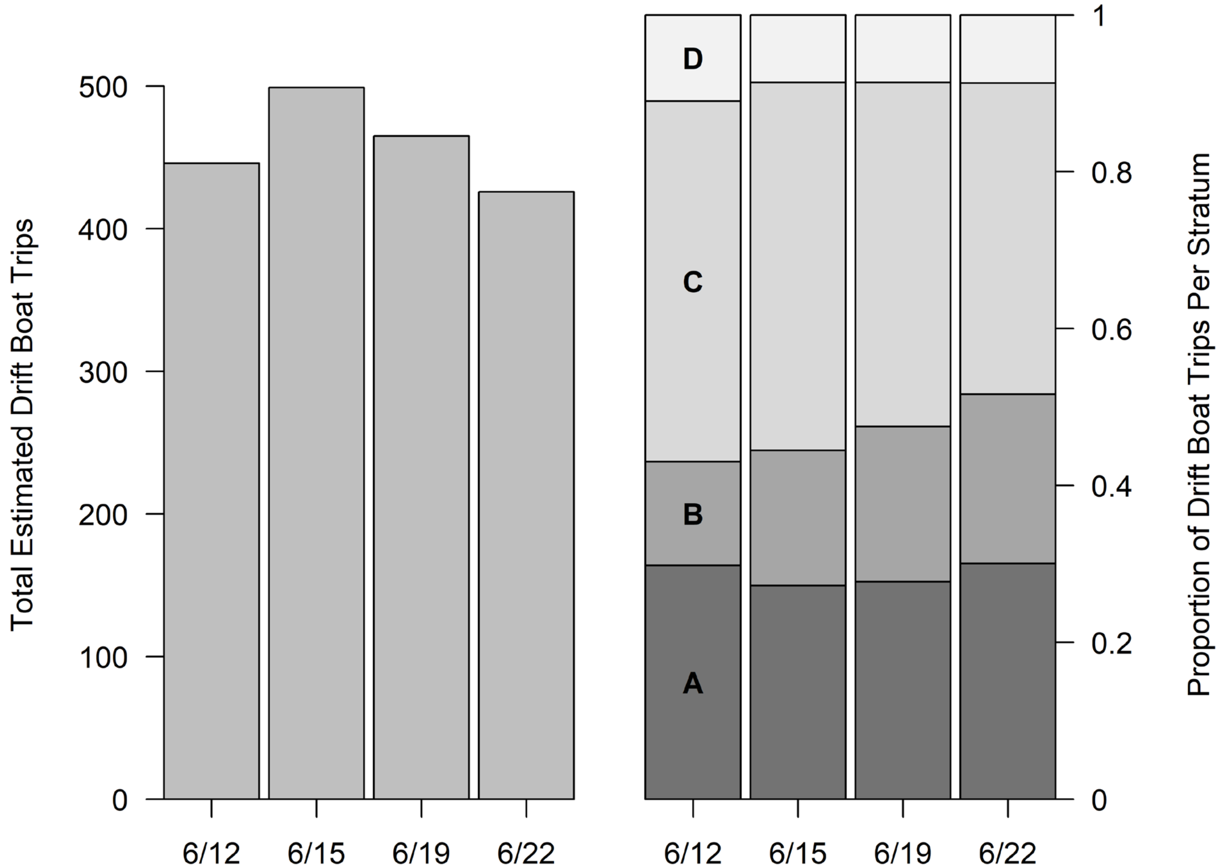
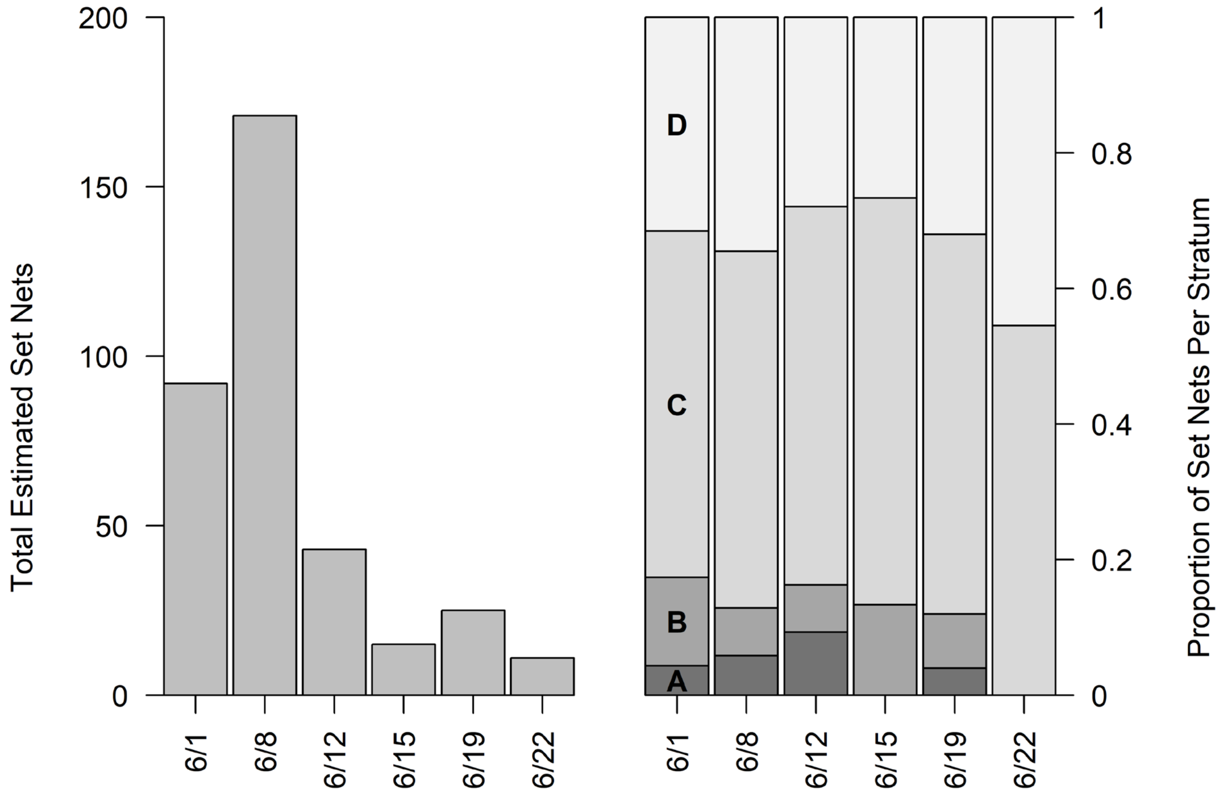


Figure 2. *Left*: Total estimated drift boat trips by opener. *Right*: the proportion of all estimated trips that occurred in each geographic stratum[1] by opener. This figure does not show the 6/1 and 6/8 opportunities as drift net estimates were not produced for those opportunities since they were set gillnet opportunities.



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

Figure 3. *Left*: Total estimated set net trips by opener. Note 6/1 and 6/8 opportunities were for set gillnets only. *Right*: The proportion of all estimated set net trips that occurred in each geographic stratum[1] by opener.



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

Figure 4. Estimated salmon harvest by species in each of the four openers. Estimates include harvest from both drift nets and set nets.

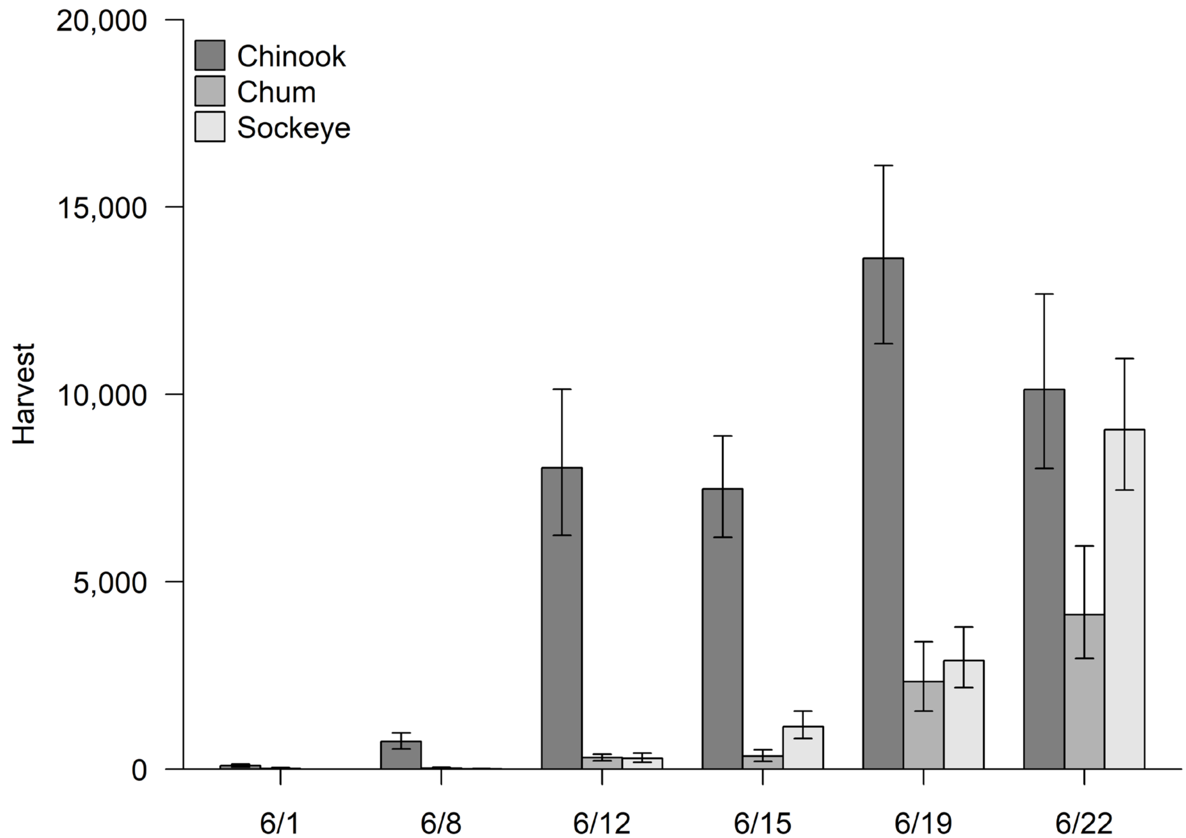
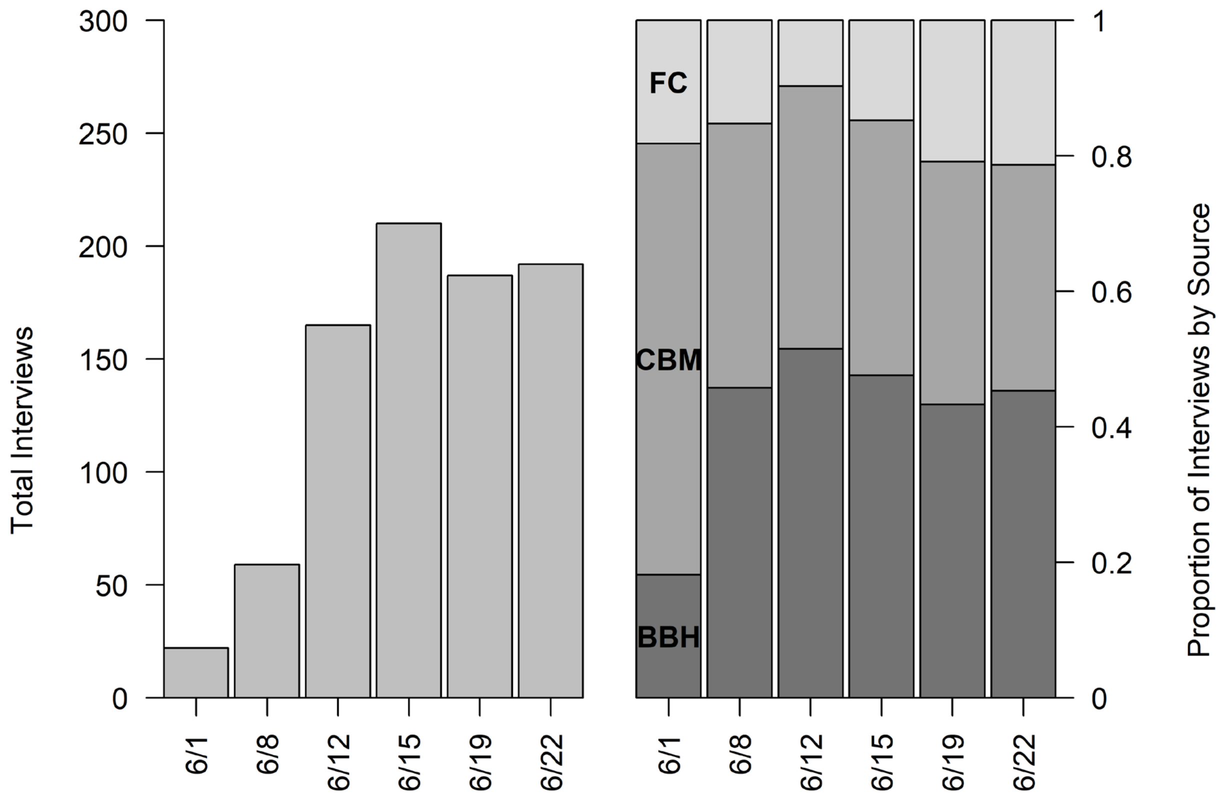
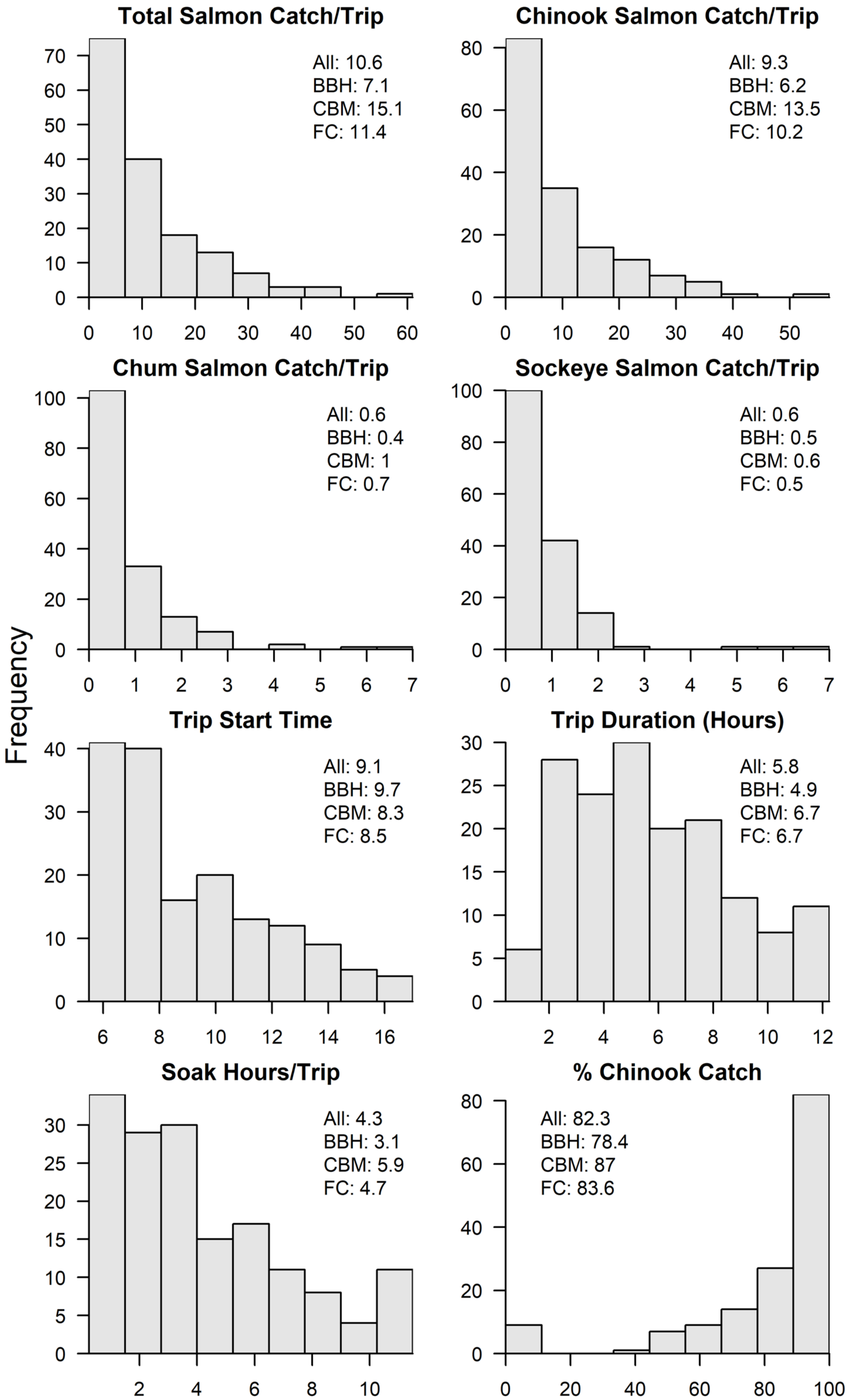


Figure 5. *Left*: Total number of interviews used to inform the harvest estimates from each opener. *Right*: The proportion of all interviews that came from each source[1] by opener.



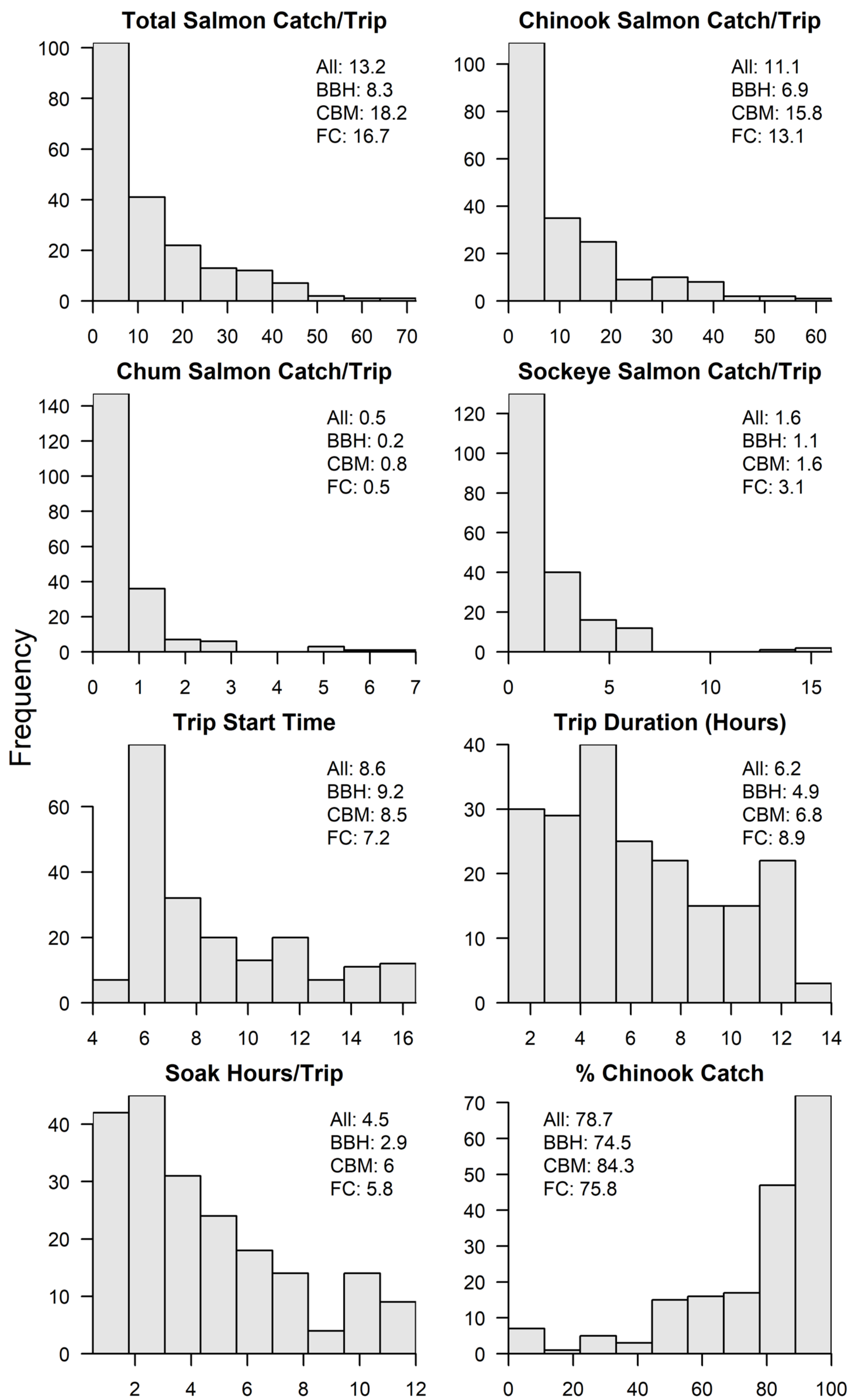
[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA)

Figure 6. Distribution of relevant quantities from completed drift boat trip interviews during the first drift gillnet opener (6/12/2019), with means for all available interviews and by data source[1].



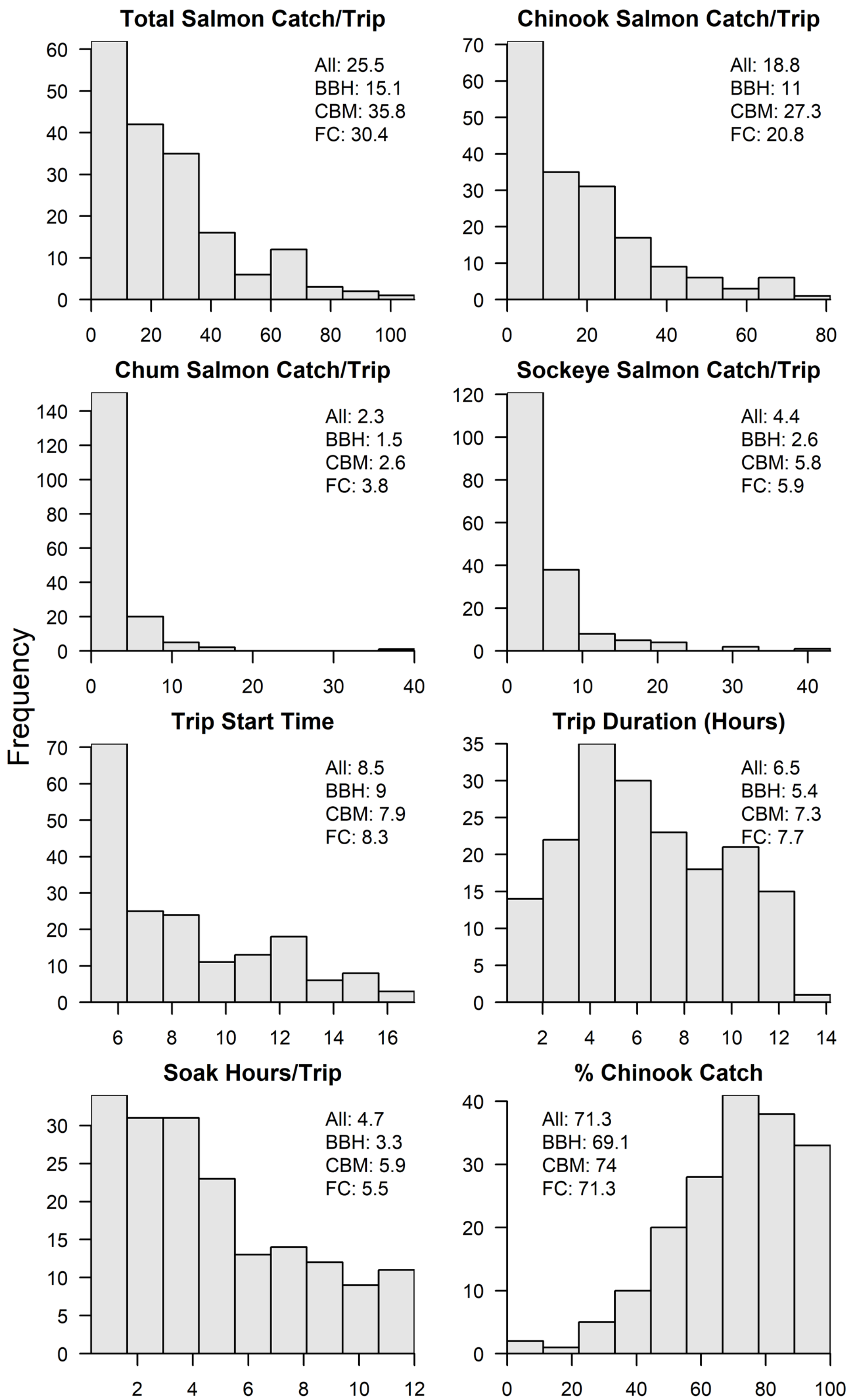
[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA).

Figure 7. Distribution of relevant quantities from completed drift boat trip interviews during the second drift gillnet opener (6/15/2019), with means for all available interviews and by data source[1].



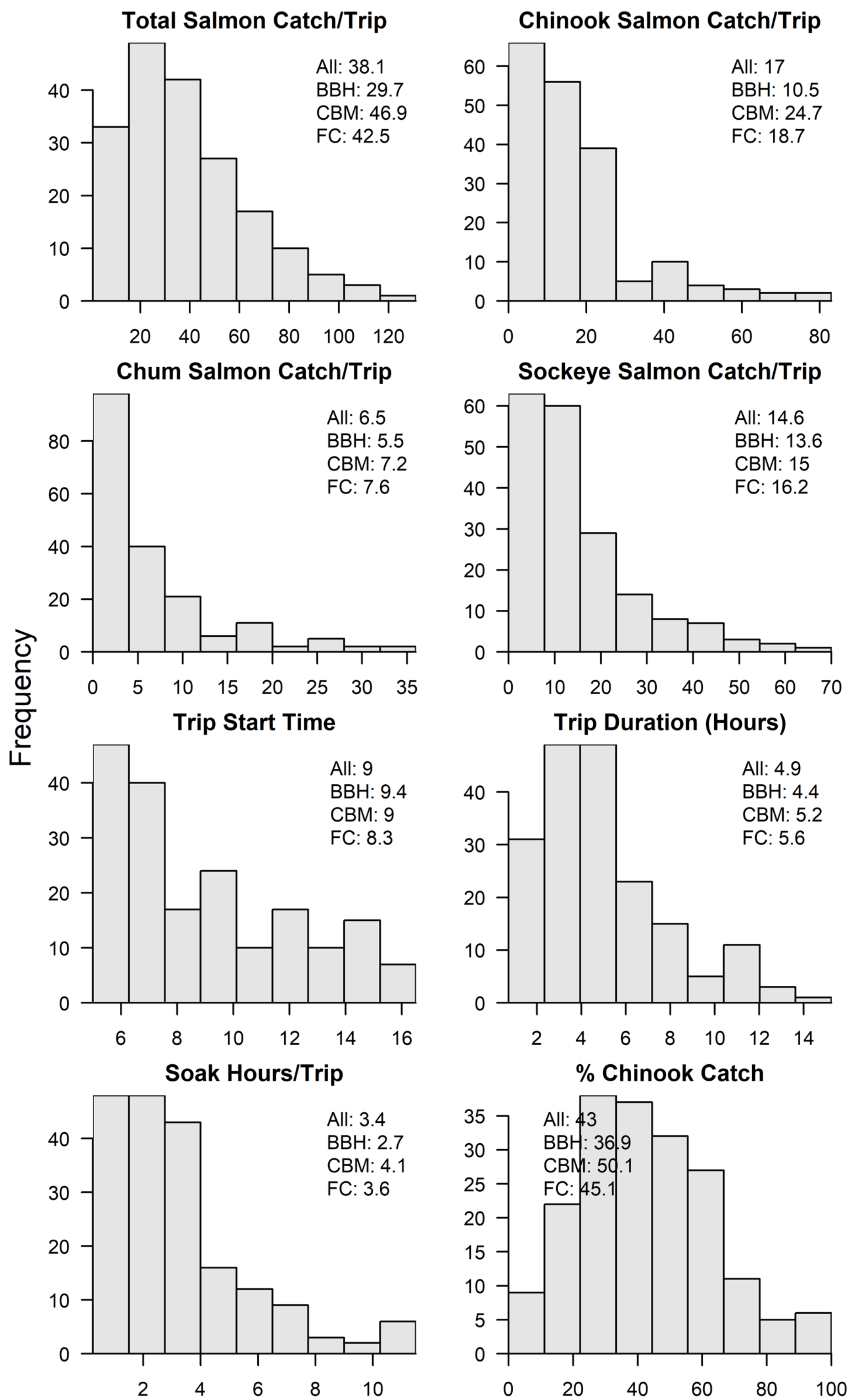
[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA).

Figure 8. Distribution of relevant quantities from completed drift boat trip interviews during the third drift gillnet opener (6/19/2019), with means for all available interviews and by data source[1].



[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA).

Figure 9. Distribution of relevant quantities from completed drift boat trip interviews during the fourth drift gillnet opener (6/22/2019), with means for all available interviews and by data source[1].



[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA).

Figure 11. Total salmon harvest by species across all six openers combined between drift nets and set nets.

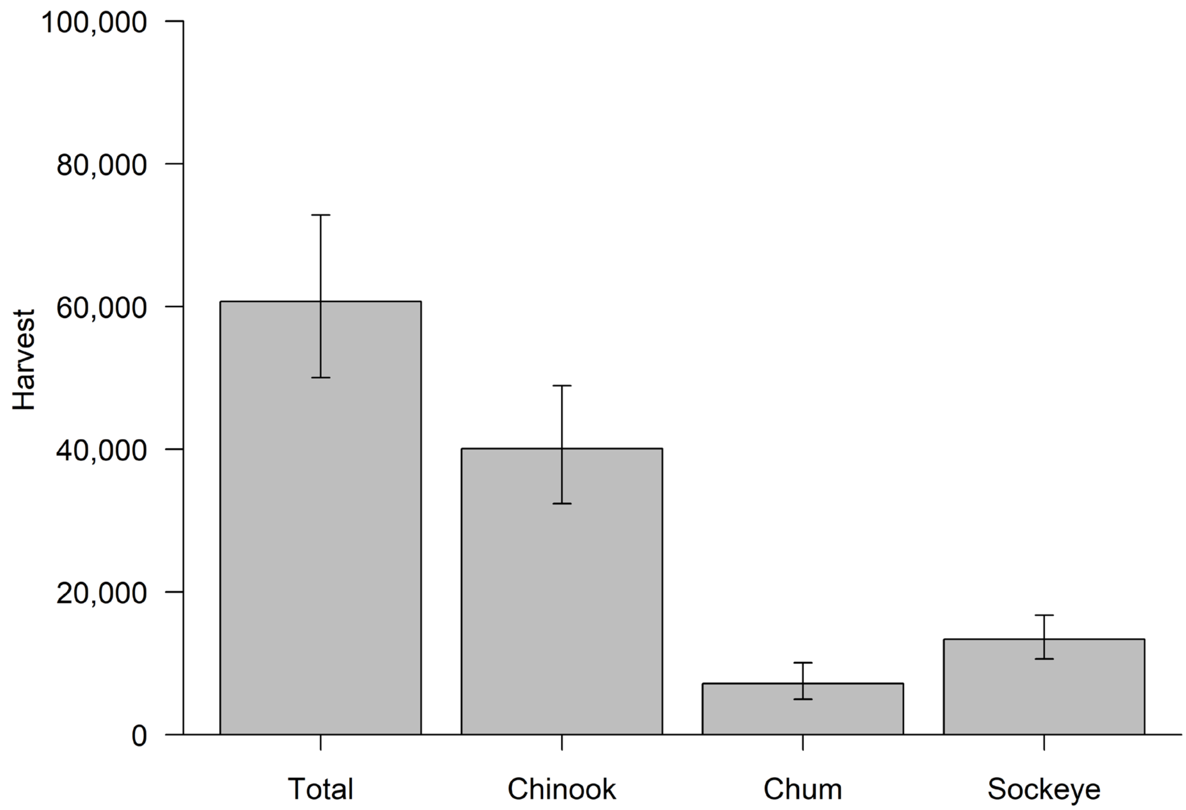
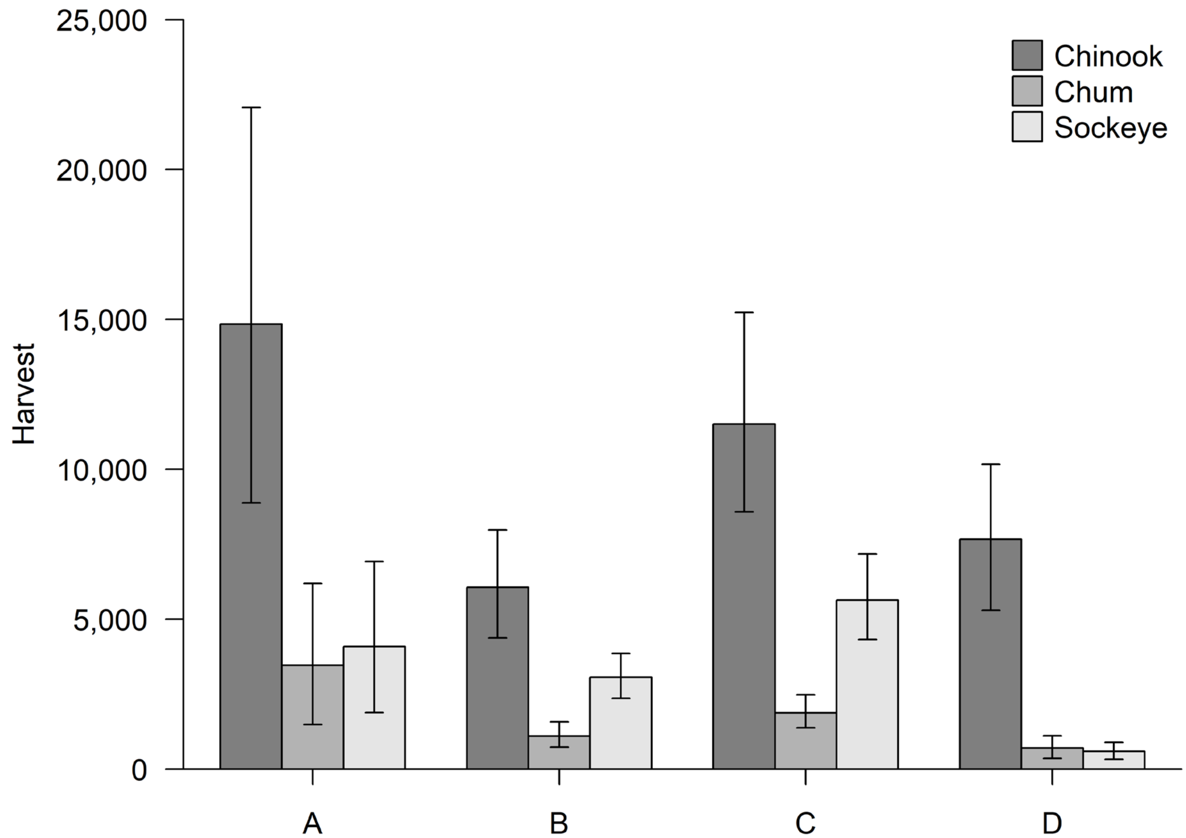


Figure 12. Total estimated salmon harvest by species and geographic stratum across all six openers combined between drift nets and set nets.



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