In-season Harvest and Effort Estimates for the 2020 Kuskokwim River Subsistence Salmon Fisheries During Block Openers

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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 in-season management decisions regarding fishing opportunities to simultaneously achieve conservation and subsistence harvest objectives, particularly during years of weak Chinook Salmon runs. In response to an uncertain 2020 Kuskokwim River Chinook Salmon run, and given recent years with low returns, the United States Fish and Wildlife Service in collaboration with the Bering Sea Fishermen's Association and the Orutsararmiut Native Council, collected data to produce in-season subsistence salmon harvest estimates from that portion of the mainstem 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, The author estimated the total subsistence salmon harvest in this area was 35,500 (95% CL: 29,310 – 42,470) during seven fishing opportunities between June 3 and June 24, 2020. Most salmon harvested were Chinook Salmon (23,210; 95% CL: 19,060 – 28,050), followed by Sockeye Salmon (*O. nerka*; 6,710; 5,170 – 8,380), and Chum Salmon (*O. keta*; 5,590; 4,120 – 7,350). Methodologies refined during this study will be useful to structure future efforts to estimate subsistence salmon harvests 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 and limited funds to monitor in-season harvests. In order to manage in an informed way, a manager would require continuous and accurate information on run timing, harvest, and escapement (Staton and Catalano 2019). 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 (Staton and Catalano 2019). 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 [BTF]) of run abundance, run timing, and species composition to inform decision-making. Methods have been developed to obtain more detailed information on run timing (Staton et al. 2017) and run size (e.g., a relatively new mainstem 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 still wonders how many fish have been harvested to date, which is important for structuring future fishing opportunities and ensuring adequate escapement. Timely in-season subsistence harvest estimates have only recently been available in the Kuskokwim River (2015 – 2019) for in-season management consideration, and are arguably the most critical information source necessary to successfully manage weak salmon runs. This document follows previous procedures to present in-season salmon

harvest estimates from short-duration Kuskokwim River subsistence fishing opportunities during the 2020 season using a recently developed harvest estimation technique (Staton and Coggins 2016, 2017; Staton 2018).

In response to an anticipated uncertain 2020 Kuskokwim River Chinook Salmon (*Oncorhynchus tshawytscha*) run (pre-season forecast midpoint of 227,000 fish; however, coming off of decade of low abundances), the United States Fish and Wildlife Service (USFWS), through action by the Federal Subsistence Board (https://www.fws.gov/uploadedFiles/2020_NR_FSB%20June%20Teleconference%20Results.pdf), 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, 2020 (**Figure 1**).

The Federal inseason manager used the BayesTool (https://bstaton.shinyapps.io/BayesTool/) to inform harvest limits for the 2020 Kuskokwim River Chinook Salmon subsistence fishery. The BayesTool requires the manager to state risk tolerance in relation to an escapement minimum that allows for a sustainable Chinook Salmon population in the future. For the 2020 season, the Federal inseason manager wanted to limit the possibility of going below the lower bound of ADF&G's drainage wide escapement goal of 65,000 Chinook Salmon to a 20% chance. Based on the results generated from the BayesTool and centered on the lower limit (65,000) and risk tolerance (20%), this implied a potential harvest of 106,000 Chinook Salmon, with an expected escapement of 121,000 Chinook Salmon. These initial harvest limits and expected escapements were based on the preseason forecast generated by the BayesTool (218,000; 95% CI: 125,000 – 380,000).

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" 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 Kuskokwim River Inter-Tribal Fish Commission (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 fishing, which provides greater certainty to subsistence fishers and reduces complexity of in-season management. The Federal in-season manager was comfortable using the semi-scheduled 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 – 14,000 fish. Given past fishery performance, the Federal in-season manager felt that anywhere from three to five opportunities could be announced in advance of the season without compromising risk tolerance for escapement. Thus, the Federal in-season manager, in consultation with the KRITFC, announced three 12-hour opportunities on June 12, 15, and 18 pre-season (3-KS-03-20).

The Federal in-season manager and the 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" 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-inch mesh 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 inseason manager provided three, 24-hour 6-inch set gillnet opportunities on June 3 – 4, June 6 – 7, and June 9 – 10. These opportunities coincided with ADF&G's 6-inch set gillnet opportunities for species other than Chinook Salmon (net length: 60 feet or less; bank orientation; and not located more than 100 feet from the ordinary high water mark). This was the first time that ADF&G allowed for 6-inch or less set nets during the front-end closure period (June 1 – June 11) following the Alaska Board of Fisheries regulation changes in the winter of 2019. The Federal in-season manager predicted that few Chinook Salmon would be harvested during these opportunities (<6,000 Chinook Salmon maximum) because of the relatively low number of

Chinook Salmon in the river during the front-end closure plus the net length and operational restrictions for 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 first became available during Federal restrictions for Chinook Salmon in 2019. Harvest from these methods are not included in the estimates provided in this report.

There were seven subsistence fishery openers during June 2020 within the YDNWR boundaries:

- 6/3 – 6/4/2020 (24 hours; 11:00am – 11:00am; FSA 3-KS-02-20; SET NETS ONLY)
- 6/6 – 6/7/2020 (24 hours; 11:00am – 11:00am; FSA 3-KS-02-20; SET NETS ONLY)
- 6/9 – 6/10/2020 (24 hours; 11:00am – 11:00am; FSA 3-KS-02-20; SET NETS ONLY)
- 6/12/2020 (12 hours; 06:00am – 06:00pm; FSA 3-KS-03-20)
- 6/15/2020 (12 hours; 06:00am – 06:00pm; FSA 3-KS-03-20)
- 6/18/2020 (12 hours; 06:00am – 06:00pm; FSA 3-KS-03-20)
- 6/24/2020 (12 hours; 06:00am – 06:00pm; FSA 3-KS-05-20)

Federal restrictions for the harvest of Chinook Salmon were rescinded on July 1, 2020 per Federal Subsistence Board action. After July 1, ADF&G continued restrictions to the subsistence fishery, which were finally lifted on July 7.

METHODS

The in-season harvest estimation framework that was developed and applied to the 2016–2020 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 more details.

Aerial Net Counts

For each opener, two 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 evenly throughout the opener. This often resulted in 2-3 hours between the end of one flight and the start of the next flight (**Tables 1 and 2**).

On six occasions, inclement weather or flying conditions prevented USFWS from completing scheduled effort surveys: 6/3/2020, 6/4/2020, 6/7/2020, 6/9/2020, 6/10/2020, and 6/24/2020. Scheduled aerial surveys on June 3, June 4, June 7, June 9, and June 10 were partial surveys as only certain sections of the river were surveyed. On June 3, the Akiachak to Akiak portion of the survey was not completed due to smoke in the area. On June 4, the upstream end of Straight Slough to Akiak portion of the survey was not completed, as well as the below Johnson River portion of the survey, due to smoke and fog. On June 7, 9, and 10, the below Johnson River portion of the survey was not completed because of fog and smoky conditions. The June 4 survey was not used to produce harvest estimates because of the large portion of missed survey areas. The June 7, 9, and 10 surveys were used to produce harvest estimates in areas where the survey was completed (i.e. above the Johnson River) because the below Johnson portion of the aerial survey typically does not have very many set gillnets during the front-end closure period (i.e. set gillnet effort below the Johnson was predicted to be 0).

Furthermore, no flights were flown on the June 24, 2020, opportunity as inclement and stormy weather prevented flights from taking off. Given the lack of aerial surveys conducted during this opportunity, harvest estimates in this document for the June 24 opportunity were based on historical effort from the 12-hour fishing opportunity on June 24, 2018 (410 drifts nets, 18 set nets, and see **Table 3** for information by strata). The historical effort from this date was chosen because it was the lowest effort of any of the other historical opportunities situated around June 24. The lowest effort opportunity was chosen because many users reported below average effort during the June 24, 2020 opportunity due to the stormy weather conditions along the Kuskokwim River during this time. Given the weather conditions, the historical effort utilized to produce a harvest estimate for the June 24, 2020 opportunity is more than likely an overestimate of actual effort, particularly in the lower reaches of the river (i.e., below the Johnson River) as strong storms produced large waves in the location, making fishing dangerous.

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 mainstem villages other than Bethel. Interview data from sources (1) and (2) were collected by personnel from Orutsararmiut Native Council (ONC) since 2015 and were the predominate sources used by Staton and Coggins (2016). Data from source (3) have been collected by the Bering Sea Fishermen's Association (BSFA) since 2017 as part of a community-based monitoring (CBM) project designed to provide interview data from areas of the YDNWR other than the Bethel area. In 2020, 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 in harvest estimates.

Analytical Methods

The analytical methods in 2020 were identical to those used in 2016 - 2019 and are fully described in Staton and Coggins (2016) and Staton (2018).

RESULTS

First Opener (6/3/2020 – 6/4/2020)

An estimated total of 82 set net trips occurred in the study area (**Table 3**; **Figures 2 and 3**). The estimated total salmon harvest was 180 (95% CL: 50–410); all salmon harvested in this opportunity were Chinook Salmon (**Table 4**; **Figure 4**). All Chinook Salmon harvested during this opportunity were with set gillnets and from above the Johnson River (Strata B and C). The effort and harvest estimates are likely underestimates given aerial surveys could not be completed in strata D (Akiachak to Akiak).

Harvest estimates were produced from 29 trip interviews, all of which came from the Bethel boat harbor surveys conducted by ONC (**Figure 5**).

Second Opener (6/6/2020 – 6/7/2020)

An estimated total of 113 set net trips occurred between Tuntutuliak and Akiak (**Table 3**; **Figures 2 and 3**). The estimated total salmon harvest was 680 (95% CL: 460 – 940). Most of the salmon harvest was Chinook Salmon (570; 370 – 830), followed by Chum Salmon (90; 50 – 140), and Sockeye Salmon (20; 0 – 40) (**Table 4**; **Figure 4**).

Harvest estimates were produced from 45 trip interviews, of which 27 (60%) came from the Bethel boat harbor, 5 (11%) from Bethel area fish camps, and 13 (29%) from BSFA community monitors (**Figure 5**).

Third Opener (6/9/2020 – 6/10/2020)

An estimated total of 107 set net trips occurred between Tuntutuliak and Akiak (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 780 (95% CL: 590 – 980). Most of the salmon harvest was Chinook Salmon (670; 520 – 840), followed by Chum Salmon (90; 40 – 140), and Sockeye Salmon (20; 0 – 50) (**Table 4**; **Figure 4**).

Harvest estimates were produced from 39 trip interviews, of which 23 (59%) came from the Bethel boat harbor and 16 (41%) from BSFA community monitors (**Figure 5**).

Fourth Opener (6/12/2020)

An estimated total of 406 drift boat trips and 20 set net trips occurred in the study area on 6/12/2020 during the 12-hour opener (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 3,820 (95% CL: 2,940 – 4,920). Almost all harvest (85%) was made up of Chinook Salmon (3,240; 2,520 – 4,140) followed by smaller amounts of Chum Salmon (490; 95% CL: 300 – 730) and Sockeye salmon (100; 95% CL: 60 – 140) (**Table 4**, **Figure 4**). In terms of total harvest, the first drift gillnet opportunity in 2020 resulted in the smallest total salmon harvest since inseason harvest monitoring began in 2016. The number of Chinook Salmon harvest in this opportunity was the second smallest behind 2017 (~2,400 Chinook Salmon harvested). Harvest of Chum and Sockeye salmon in this opportunity (590 total harvest) were similar to 2019 (600).

Harvest estimates were produced from 205 trip interviews, of which 117 (57%) came from the Bethel boat harbor, 22 (11%) from Bethel area fish camps, and 66 (32%) from BSFA community monitors (**Figure 5**). Twelve interviews were from set net fishers and the remaining 193 interviews were from drift net 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 – 9 AM) and a second smaller pulse starting at noon. Most trips lasted between 4 and 8 hours (average of 6.5 hours), and soak time was skewed towards shorter soaks of 6 hours or less (average 4.4 hours).

Most fishers caught between 4 and 11 salmon per trip, with almost all of these salmon being Chinook Salmon. As in 2018 and 2019, the average fisher interviewed by BSFA community monitors and ONC staff at Bethel area fish camps 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 85% of catches across all interviewed fishers. From June 9 to 12, the BTF catches averaged 91% Chinook Salmon, which agrees well with composition observed in the fishery. This continues the pattern that began in 2019 of high composition of Chinook Salmon and low composition of Chum and Sockeye salmon during the early portion of the season.

Fifth Opener (6/15/2020)

An estimated total of 459 drift boat trips and 35 set net trips occurred within the study area on 6/15/2020 (**Table 3**; **Figures 2 and 3**). The mean estimated total salmon harvest was 6,480 (5,410 – 7,670). As in the first opener, most of the harvest was Chinook Salmon (78%; 5,080; 4,190 – 6,090), followed by Chum Salmon (12%; 790; 600 – 1,010), and Sockeye Salmon (9%; 610; 470 – 780) (**Table 4**, **Figure 4**).

Harvest estimates were produced from 191 completed trip interviews, of which 96 (50%) came from the Bethel boat harbor, 29 (15%) came from Bethel area fish camps, and 66 (35%) came from BSFA

community monitors (**Figure 5**). Eight of these interviews were from set net fishers and the remaining 183 were from drift boat fishers. Based on the distribution of relevant interview quantities from this opportunity (**Figure 7**), a majority of fishers started their trip earlier (i.e., before 9 AM), soaked longer (average 5 hours), and generally stayed out on the river longer (average 7 hours) compared to the June 12, 2020 opportunity.

Overall, the number of salmon per boat (~10) and Chinook Salmon per boat (~8) increased from the previous opportunity (~7 and ~6, respectively). Chum and Sockeye salmon catches both increased slightly (~1%) compared to the previous opportunity. Chinook Salmon comprised 78% of catches across all interviewed fishers. Between June 12 and June 15, the BTF catches were comprised of 100% Chinook Salmon on average.

Sixth Opener (6/18/2020)

An estimated total of 554 drift boat trips and 27 set net trips occurred within the study area on 6/18/2020 (**Table 3**, **Figures 2 and 3**). In terms of historical effort, this was the largest number of drift boats estimated during this time period since the first 12 hours of the June 21, 2016 opportunity (~ 555 drift boats). Overall, it's the third largest number of drift boats estimated in a 12 hour period since the inseason harvest monitoring program began in 2016.

The mean estimated total salmon harvest was 12,260 (10,900 – 13,710). The majority of the harvest was Chinook Salmon (66%; 8,160; 7,270 – 9,120), followed by an equal mixture of Sockeye Salmon (17%; 2,060; 1,620 – 2,560), and Chum Salmon (17%; 2,040; 1,680 – 2,440) (**Table 4**, **Figure 4**). The number of Chinook Salmon harvested during this opportunity is the third largest in a 12-hour opportunity since the inseason harvest monitoring program began in 2016. Similar to 2019, high harvest during this opportunity was expected given the relatively 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 193 completed trip interviews, of which 89 (46%) came from the Bethel boat harbor, 33 (17%) came from Bethel area fish camps, 71 (37%) came from BSFA community monitors (**Figure 5**). Four of these interviews were from set net fishers and the remaining 189 were from drift boat fishers.

Based on the distribution of relevant interview quantities from the sixth opener (**Figure 8**), trip start time, trip duration, and soak hours all remained relatively similar to the previous opportunities, while the number of salmon per boat (~10 to ~ 17), Chinook Salmon per boat (~8 to ~ 12), and Chum/Sockeye Salmon per boat (~1 to ~ 3) all increased from the last opportunity.

Overall, Chinook Salmon made up 69% of the catches across all interviewed fishers, which was roughly a 8% decrease from the previous opportunity. Between June 15 and June 18, the BTF catches were comprised of 85% Chinook Salmon on average. Historically, Chinook Salmon catches at the BTF during this time account for about 26% 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.

Seventh Opener (6/24/2020)

As stated in the methods, aerial surveys were not able to be completed for this harvest opportunity. As such, the effort utilized in the calculation of harvest for this opportunity was based on the estimated effort from the June 24 harvest opportunity in 2018. The effort from this date was chosen because it was the lowest historical effort estimated in a 12-hour opportunity nearest to the date of the 2020 fishing opportunity. Based on comments from local users at the Kuskokwim River Salmon Management Working

Group directly following the opportunity, it is highly likely that actual effort was much lower than what was utilized in this report (i.e., less harvest as a result). As such, this results section will primarily focus on the distribution of relevant interview quantities rather than the amount of harvest suggested by inputting historical effort information.

Based on the historical effort information utilized for this opportunity to produce harvest estimates, the mean estimated total salmon harvest was 11,300 (8,960 – 13,840). A majority (53% combined) during this opportunity was Chum (18%; 2,090; 1,450 – 2,890) and Sockeye salmon (35%; 3,900; 3,020 – 4,810), followed by Chinook Salmon (47%; 5,310; 4,140 – 6,620) (**Table 4**, **Figure 4**). Although, Chinook Salmon composed the largest single component of the harvest, Chum and Sockeye salmon harvest in combination exceeded the number of Chinook Salmon harvested during this opportunity. Species harvest composition is very similar to the June 22 opportunity in 2019; however, the magnitude of harvest was much smaller than in 2019 (23,310 in 2019 versus ≤ 11,300 in 2020).

These harvest estimates were produced from 138 completed trip interviews, of which 70 (51%) came from the Bethel boat harbor, 20 (14%) came from Bethel area fish camps, and 48 (35%) came from BSFA community monitors. Four of these interviews were from set net fishers and the remaining 134 were from drift boat fishers. This was the smallest number of interviews collected during a drift gillnet opportunity in 2020. The number of Bethel boat harbor surveys declined from an average of 100 per drift gillnet opportunity in the previous three opportunities to 70 surveys in this opportunity. The same trend is apparent in the CBM surveys. Bethel area fish camp surveys collected were reduced to a lesser extent (average of 28 previously versus 20 on June 24). Overall, based on the reduction in the number of surveys, it was apparent that effort was much lower than the previous opportunities.

Based on the distribution of relevant interview quantities from the seventh opener (**Figure 9**), trip start time stayed relatively the same as the previous opportunities (average ~ 9 AM); however, there was a decrease of about an hour in average soak time and trip duration as compared to the previous opportunity on June 18. The number of salmon per boat increased from ~17 in the previous opportunity to ~23 in the June 24 opportunity. This increase in salmon per boat is primarily due to the increase in Chum and Sockeye salmon catch (~3 on June 18, but ~ 5 – 7 on June 24). The Chinook Salmon catch per trip remained relatively consistent in the June 18 and June 24 fishing periods. This increase was expected as both Chum Salmon and Sockeye Salmon runs were still building during this opportunity, and it is highly likely that fishers were fishing in areas conducive to catching Sockeye and Chum salmon (protected areas near the bank rather than fishing deeper in the main channel).

For the first time in the 2020 subsistence fishery season, Chinook Salmon catch composition (the composition of each salmon species out of the total salmon assemblage) was below 50% across all interviews (average 49%). Between June 21 and June 24, the BTF catches were comprised of 53% Chinook salmon on average.

Total Harvest across All Openers

Before reading the paragraph below, readers should note that unlike the previous years for the inseason harvest monitoring program, one drift gillnet harvest opportunity (June 24) did not have an aerial survey flown. Effort for the June 24, 2020 opportunity was based on effort observed in June 24, 2018. Therefore, the total harvest discussed in this section should be interpreted with caution considering this caveat.

Across all openers, an estimated total of 35,500 (29,310 – 42,470) salmon were harvested. In terms of historical total harvest, this was the smallest amount of total salmon harvested in the study area since the inseason harvest monitoring program's inception in 2016; this represents a 40% decrease in total salmon harvest from 2019. The Yukon Delta NWR Fisheries Program believes this observation is fairly accurate

because the abundance of Chinook Salmon, Chum Salmon, and river-type Sockeye Salmon were far below the overall average for the 2020 season.

Most of the harvest was Chinook salmon (65%; 23,210; 19,060 – 28,050), followed by Sockeye salmon (19%; 6,710; 5,170 – 8,380), and Chum salmon (16%; 5,590; 4,120 – 7,350) (**Table 4**; **Figure 10**).

Fishers within geographic stratum A (below the Johnson River) harvested the most total salmon, accounting for 40% of all salmon harvest, closely followed by geographic stratum C (Napaskiak to Akiachak), which accounted for 39% of all salmon harvested. The Chinook Salmon harvests 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**). In 2020, it appeared that the number of boats drifting increased as the season reached the historical peak of the Chinook Salmon run, reaching an almost record amount of effort in the third drift gillnet opportunity on June 18. This makes sense given the low abundance of salmon species in 2020 (particularly earlier in the season) and the late run-timing of all salmon species.

Synthesis of Key Information on 6/12 Openers

Given that June 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 June 12), I thought it important to continue the synthesizing of key information that has been gathered from 2016 to 2020, during which 12-hour openers were implemented.

There are several notable findings from the synthesis of key information of the June 12 fishing opportunities in 2016-2020. The number of drift boat trips between Tuntutuliak and Akiak are similar in magnitude, but have steadily decreased since 2016 (524, 523, 466, 446, 406; avg. 473; **Table 7**). The lowest total harvest was observed in the first drift net opportunity on June 12, 2020, and since the inseason harvest monitoring program's inception in 2016. It was also the lowest Chinook Salmon harvest on a June 12 opportunity since 2017 (a year that was hampered with catchability issues due to clear, warm water). Chum and Sockeye salmon harvest remained relatively consistent with 2019, but far lower when compared to harvest in 2017 and 2018. The species ratio in 2020 (0.2) was very similar to 2019 (0.1) and remained lower than average (0.5). Historically speaking, the species ratio at the Bethel Test Fishery averages around 1:1 near or soon after June 12; however, in only one year (2018) has the subsistence's fisheries been above a 1:1 ratio. This is more than likely attributable to the efficiency of the subsistence fishery.

DISCUSSION

Overall Summary

For the 2020 season, an estimated total of 35,500 (29,310 – 42,470) salmon were harvested. Chinook salmon made up a majority of the harvest (65%; 23,210; 19,060 – 28,050), followed by Sockeye salmon (19%; 6,710; 5,170 – 8,380), and Chum salmon (16%; 5,590; 4,120 – 7,350) (**Table 4**; **Figure 10**). Total salmon harvest was the smallest since the inseason program harvest monitoring program began in 2016. Chinook Salmon harvest was almost 50% less than the 2019 harvest, while Chum and Sockeye salmon harvests (12,300 fish) were 40% less than 2019 (20,570). Reduction in harvest is likely due to the weak and late salmon runs observed in 2020 as the number of opportunities provided in 2020 (7 opportunities, total of 120 hours) were more than the number of opportunities provided in 2019 (6 opportunities, total of 72 hours). Moreover, harvest was limited due to the inclement weather experienced in the region during the June 24th opportunity.

Additionally, as stated previously, total harvest estimates do include harvest estimated from the June 24, 2020 opportunity. Due to inclement weather, scheduled aerial surveys to enumerate effort were not

attempted; therefore, historical effort data (June 24, 2018) were used to produce a harvest estimate. Although the utilized historical effort estimates were the smallest effort from around a similar date, based on conversations with local users at meetings during the season, the actual effort was smaller. With that being said, readers should be aware that harvest for the June 24 opportunity and total harvest presented in this report is likely a maximum estimate of harvest in the study area (i.e., mainstem between Tuntutuliak and Akiak).

One other aspect that complicated the 2020 sampling design was the occurrence of the novel coronavirus (COVID-19) pandemic. In order to protect the safety of local residents and interviewers, protocols were implemented to either eliminate face-to-face contacts, or to apply social distancing if interviewing people in the field. Substantially more interviews in 2020 were conducted by telephone within the CBM program, which reduced the personal approach of the interviews and, in some cases, made obtaining an interview more difficult since many harvesters operating in fish camps associated with lower Kuskokwim villages do not have phone reception.

Reliability of Assumptions

All reported analyses predicted 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 inferences 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 uncertainty 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. This project methodology attempted to account for this in several ways. First, although the information was treated though it was random, each time harvest estimates were presented, stakeholders and decision-makers were made fully aware of the limitations of the analysis. Second, estimates of uncertainty were produced. 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, harvest data collected through the monitoring program is considered 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 adequate 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 CBM program had a presence in the village of Napaskiak, which is just a several minute boat ride from Bethel but exhibits different effort and harvest characteristics. Overall, gathering information from these locations gave 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 Bethel. The below Bethel area was primarily informed by the community-based monitors stationed in Tuntutuliak, a village located about 4 hours downstream of the Bethel area and is one of the larger communities in the lowest river. Given this kind of coverage within the lower river, data collected through the monitoring program are likely 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 prior to 2019, 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, the 2020 in-season harvest monitoring (particularly BSFA community monitors) collected more information than previous years from subsistence users who fished in the non-salmon spawning tributaries (i.e., Gweek, Johnson, Tuntutuliak, and Pailleq), which indicated more salmon harvest occurs in those locations than previously thought. This difference is further amplified because data from non-salmon tributaries are only collected when mainstem fishery is open, whereas non-salmon tributaries are open every day with few gear restrictions.

For example, Federally-qualified users were able to harvest Chinook Salmon before June 1 with ≤ 6" mesh size gillnets. During this time period, harvest and effort was not monitored. Chinook Salmon harvest during this time was minimal, but likely non-zero.

Additionally, 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 these gears when gillnets are allowed, it is reasonable to assume some subsistence users targeted Chinook Salmon subsistence fishery using these alternative gear types in between gillnet 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 CBM survey programs detected more trips occurring in non-salmon spawning tributaries as compared to 2018 and 2019 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). While harvests in these locations are not believed to be detrimental to meeting escapement needs, the magnitude of Chinook Salmon harvest in these locations remains unknown. Additionally, many of the non-salmon spawning tributary interviews are conducted in Tuntutuliak, which has access to at least three of the major non-salmon spawning tributaries located in the lower Kuskokwim River (Kialik, Kinak, Tagarayak, and Pailleq).

Regardless, undocumented harvest during the in-season subsistence harvest monitoring program will be reflected in the ADF&G and ONC 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 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 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 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 the frequency and duration of fishing opportunities were increased, a more carefully designed random sampling program will be necessary. This is because longer opportunities 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. There are common and well-practiced methods in existence today that can be implemented (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 versus 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, the fishery has never been monitored in a fashion to help answer these questions and careful consideration must be given to choosing dates and times to minimize bias.
>
> (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. 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.

Other Means of Enumerating Effort

Lastly, the author would just like to mention that YDNWR staff have considered mounting a camera on the aerial survey planes in order to use the imagery to count drift and set gillnets during announced fishing opportunities. This could allow multiple individuals to count nets rather than the one or two staff that normally count boats during opportunities, and also allow for effort estimates to be more certain.

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Table 1. Raw drift gillnet/boat counts from each flight and geographic stratum. The first three openers were set gillnet only opportunities. No flights were conducted for the June 24 opportunity (thus; absence of data).

Opener	Date	Flight Times		Geographic Stratum[1]				Total
		F_1	F_2	A	B	C	D	
1*	6/3/2020	15:15	16:40	0	2	0	0	2
1*	6/4/2020	09:30	09:53	NA	0	0	NA	0
2	6/6/2020	15:06	16:36	2	2	1	0	5
2*	6/7/2020	08:26	09:20	NA	0	0	0	0
3*	6/9/2020	14:46	16:00	NA	0	0	0	0
3*	6/10/2020	08:05	09:15	NA	0	0	0	0
4	6/12/2020	08:50	10:06	64	37	137	35	273
4	6/12/2020	13:57	15:10	93	58	141	32	324
5	6/15/2020	09:21	10:32	106	50	163	30	349
5	6/15/2020	14:27	15:47	108	48	156	22	334
6	6/18/2020	08:51	10:08	150	76	195	43	464
6	6/18/2020	13:05	14:30	112	86	156	16	370

[1]Geographic strata: A = Below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak. * = partial or incomplete flight

Table 2. Raw set gillnet counts from each flight and geographic stratum. The first two openers were set gillnet only opportunities. No flights were conducted for the June 24 opportunity (thus; absence of data).

Opener	Date	Flight Times		Geographic Stratum[1]				Total
		F_1	F_2	A	B	C	D	
1*	6/3/2020	15:15	16:40	0	9	53	NA	62
1*	6/4/2020	09:30	09:53	NA	2	3	NA	5
2	6/6/2020	15:06	16:36	0	18	73	14	105
2*	6/7/2020	08:26	09:20	NA	5	40	12	57
3*	6/9/2020	14:46	16:00	NA	18	65	9	92
3*	6/10/2020	08:05	09:15	NA	0	13	0	13
4	6/12/2020	08:50	10:06	1	0	9	1	11
4	6/12/2020	13:57	15:10	0	1	9	9	19
5	6/15/2020	09:21	10:32	0	1	21	1	23
5	6/15/2020	14:27	15:47	2	2	25	6	35
6	6/18/2020	08:51	10:08	2	2	21	0	25
6	6/18/2020	13:05	14:30	0	0	11	2	13

[1]Geographic strata: A = Below Johnson River, B = Johnson River to Napaskiak, C = Napaskiak to Akiachak, D = Akiachak to Akiak. * = partial or incomplete flight.

Table 3. Estimated drift boat trip and set nets by day and geographic stratum. These quantities were derived from the raw counts presented in Tables 1 and 2.

Gear	Opener	Date	Duration[2]	Geographic Stratum[1]				Total
				A	B	C	D	
Drift Boat	1	6/3-4/2020	24	NA	NA	NA	NA	NA
	2	6/6-7/2020	24	NA	NA	NA	NA	NA
	3	6/9-10/2020	24	NA	NA	NA	NA	NA
	4	6/12/2020	12	106	64	190	46	406
	5	6/15/2020	12	144	66	214	35	459
	6	6/18/2020	12	173	110	233	38	554
	7*	6/24/2020	12	91	67	197	54	410
Set Net	1	6/3-4/2020	24	NA	11	71	NA	82
	2	6/6-7/2020	24	0	15	79	19	113
	3	6/9-10/2020	24	NA	10	91	5	106
	4	6/12/2020	12	1	0	9	9	20
	5	6/15/2020	12	2	2	25	6	35
	6	6/18/2020	12	2	2	21	2	27
	7*	6/24/2020	12	0	2	12	4	18

[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.

* Flight on 6/24/2020 could not be completed due to inclement weather. Effort estimates provided in this table for 6/24/2020 are historical effort estimates from June 24, 2018, which was the lowest historical effort for a fishery occurring on or near June 24 since 2016.

Table 4. Salmon harvest from both drift nets and set nets from all seven openers by species and geographic stratum. Numbers within parentheses are 95% confidence limits. Harvest estimates for the June 24 opportunity were calculated based on historical effort collected on June 24, 2018.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/3-4/2020	Chinook	0 (0-0)	20 (0-60)	160 (30-380)	0 (0-0)	180 (50-410)
	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)	20 (0-60)	160 (30-380)	0 (0-0)	180 (50-410)
6/6-7/2020	Chinook	0 (0-0)	80 (40-130)	400 (210-640)	100 (50-150)	570 (370-830)
	Chum	0 (0-0)	10 (0-20)	60 (20-110)	10 (10-30)	90 (50-140)
	Sockeye	0 (0-0)	0 (0-10)	10 (0-30)	0 (0-10)	20 (0-40)
	Total	0 (0-0)	90 (50-140)	470 (270-720)	110 (70-170)	680 (460-940)
6/9-10/2020	Chinook	0 (0-0)	60 (50-80)	570 (420-750)	30 (20-40)	670 (520-840)
	Chum	0 (0-0)	10 (0-10)	80 (30-120)	0 (0-10)	90 (40-140)
	Sockeye	0 (0-0)	0 (0-10)	20 (0-50)	0 (0-0)	20 (0-50)
	Total	0 (0-0)	70 (50-100)	670 (480-880)	40 (30-50)	780 (590-980)
6/12/2020	Chinook	1,660 (1,000-2,530)	350 (240-470)	1,000 (800-1,240)	230 (170-290)	3,240 (2,520-4,140)
	Chum	330 (140-570)	50 (30-80)	60 (30-100)	50 (20-70)	490 (300-730)
	Sockeye	20 (0-60)	20 (10-30)	60 (30-80)	0 (0-0)	100 (60-140)
	Total	2,010 (1,200-3,090)	410 (290-550)	1,120 (890-1,380)	270 (200-360)	3,820 (2,940-4,920)

Table continues below

Table 4 Continued.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/15/2020	Chinook	2,180 (1,410-3,070)	530 (400-670)	1,960 (1,540-2,430)	410 (350-480)	5,080 (4,190-6,090)
	Chum	360 (210-530)	100 (70-140)	240 (150-380)	90 (70-110)	790 (600-1,010)
	Sockeye	210 (90-350)	60 (30-100)	280 (200-360)	60 (40-90)	610 (470-780)
	Total	2,750 (1,810-3,820)	700 (540-860)	2,480 (1,990-3,010)	560 (490-640)	6,480 (5,410-7,670)
6/18/2020	Chinook	3,810 (3,120-4,600)	1,340 (1,060-1,630)	2,590 (2,130-3,070)	430 (300-590)	8,160 (7,270-9,120)
	Chum	1,050 (780-1,350)	310 (220-410)	560 (360-820)	120 (80-160)	2,040 (1,680-2,440)
	Sockeye	1,130 (740-1,590)	330 (230-460)	560 (400-730)	50 (30-70)	2,060 (1,620-2,560)
	Total	6,000 (4,920-7,200)	1,980 (1,620-2,340)	3,700 (3,010-4,470)	590 (430-780)	12,260 (10,900-13,710)
6/24/2020*	Chinook	1,550 (680-2,590)	1,020 (790-1,270)	2,430 (1,790-3,250)	310 (190-410)	5,310 (4,140-6,620)
	Chum	730 (190-1,450)	420 (330-500)	890 (600-1,240)	50 (30-70)	2,090 (1,450-2,890)
	Sockeye	1,300 (670-1,960)	570 (410-750)	1,910 (1,380-2,550)	110 (70-170)	3,900 (3,020-4,810)
	Total	3,580 (1,690-5,710)	2,010 (1,680-2,370)	5,230 (4,010-6,700)	480 (340-630)	11,300 (8,960-13,840)
All Openers	Chinook	9,200 (6,210-12,790)	3,400 (2,580-4,310)	9,110 (6,920-11,760)	1,510 (1,080-1,960)	23,210 (19,060-28,050)
	Chum	2,470 (1,320-3,900)	900 (650-1,160)	1,890 (1,190-2,770)	320 (210-450)	5,590 (4,120-7,350)
	Sockeye	2,660 (1,500-3,960)	980 (680-1,360)	2,840 (2,010-3,800)	220 (140-340)	6,710 (5,170-8,380)
	Total	14,340 (9,620-19,820)	5,280 (4,230-6,420)	13,830 (10,680-17,540)	2,050 (1,560-2,630)	35,500 (29,310-42,470)

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

Table 5. Salmon harvest from drift boat trips from four drift gillnet openers by species and geographic stratum. Numbers within parentheses are 95% confidence limits. Harvest estimates for the June 24 opportunity were calculated based on historical effort collected on June 24, 2018.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/12/2020	Chinook	1,660 (1,000-2,530)	340 (230-470)	960 (760-1,190)	190 (130-240)	3,150 (2,430-4,040)
	Chum	330 (140-570)	50 (30-80)	60 (30-100)	40 (20-70)	480 (290-730)
	Sockeye	20 (0-60)	20 (10-30)	60 (30-80)	0 (0-0)	100 (60-140)
	Total	2,010 (1,190-3,080)	410 (290-550)	1,080 (850-1,340)	230 (160-310)	3,730 (2,850-4,820)
6/15/2020	Chinook	2,170 (1,400-3,060)	520 (400-660)	1,860 (1,430-2,330)	380 (320-450)	4,930 (4,040-5,930)
	Chum	360 (210-530)	100 (70-140)	230 (130-360)	80 (60-100)	770 (580-990)
	Sockeye	210 (90-350)	60 (30-100)	270 (200-350)	60 (40-90)	600 (460-770)
	Total	2,740 (1,800-3,810)	680 (530-850)	2,350 (1,870-2,880)	530 (460-600)	6,300 (5,240-7,480)
6/18/2020	Chinook	3,800 (3,100-4,590)	1,320 (1,050-1,620)	2,440 (2,000-2,920)	410 (280-570)	7,980 (7,080-8,940)
	Chum	1,050 (780-1,350)	310 (220-410)	530 (330-790)	110 (80-150)	2,000 (1,630-2,400)
	Sockeye	1,130 (740-1,590)	330 (230-460)	560 (400-730)	50 (30-70)	2,060 (1,620-2,560)
	Total	5,980 (4,900-7,190)	1,960 (1,600-2,320)	3,520 (2,850-4,290)	570 (410-760)	12,040 (10,680-13,480)
6/24/2020*	Chinook	1,550 (680-2,590)	1,000 (770-1,250)	2,290 (1,650-3,100)	260 (150-360)	5,100 (3,940-6,400)
	Chum	730 (190-1,450)	410 (330-500)	850 (570-1,210)	40 (10-60)	2,040 (1,400-2,840)
	Sockeye	1,300 (670-1,960)	570 (400-740)	1,850 (1,330-2,500)	90 (60-140)	3,810 (2,940-4,730)
	Total	3,580 (1,690-5,710)	1,980 (1,640-2,330)	5,000 (3,790-6,460)	400 (260-540)	10,950 (8,640-13,490)

Table continues below

Table 5 Continued.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
All Openers	Chinook	9,180 (6,180-12,770)	3,180 (2,450-4,000)	7,550 (5,840-9,540)	1,240 (880-1,620)	21,160 (17,490-25,310)
	Chum	2,470 (1,320-3,900)	870 (650-1,130)	1,670 (1,060-2,460)	270 (170-380)	5,290 (3,900-6,960)
	Sockeye	2,660 (1,500-3,960)	980 (670-1,330)	2,740 (1,960-3,660)	200 (130-300)	6,570 (5,080-8,200)
	Total	14,310 (9,580-19,790)	5,030 (4,060-6,050)	11,950 (9,360-14,970)	1,730 (1,290-2,210)	33,020 (27,410-39,270)

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

Table 6. Salmon harvest from set nets from all five openers by species and geographic stratum. Numbers within parentheses are 95% confidence limits. Harvest estimates for the June 24 opportunity were calculated based on historical effort collected on June 24, 2018.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/3-4/2020	Chinook	0 (0-0)	20 (0-60)	160 (30-380)	0 (0-0)	180 (50-410)
	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)	20 (0-60)	160 (30-380)	0 (0-0)	180 (50-410)
6/6-7/2020	Chinook	0 (0-0)	80 (40-130)	400 (210-640)	100 (50-150)	570 (370-830)
	Chum	0 (0-0)	10 (0-20)	60 (20-110)	10 (10-30)	90 (50-140)
	Sockeye	0 (0-0)	0 (0-10)	10 (0-30)	0 (0-10)	20 (0-40)
	Total	0 (0-0)	90 (50-140)	470 (270-720)	110 (70-170)	680 (460-940)
6/9-10/2020	Chinook	0 (0-0)	60 (50-80)	570 (420-750)	30 (20-40)	670 (520-840)
	Chum	0 (0-0)	10 (0-10)	80 (30-120)	0 (0-10)	90 (40-140)
	Sockeye	0 (0-0)	0 (0-10)	20 (0-50)	0 (0-0)	20 (0-50)
	Total	0 (0-0)	70 (50-100)	670 (480-880)	40 (30-50)	780 (590-980)
6/12/2020	Chinook	0 (0-10)	0 (0-10)	40 (20-70)	40 (20-70)	90 (60-130)
	Chum	0 (0-0)	0 (0-0)	0 (0-10)	0 (0-10)	0 (0-10)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	0 (0-10)	0 (0-10)	40 (20-70)	40 (20-70)	100 (70-130)

Table continues below

Table 6 Continued.

Opener	Species	Geographic Stratum[1]				Total
		A	B	C	D	
6/15/2020	Chinook	10 (0-10)	10 (0-10)	100 (40-180)	30 (10-40)	150 (70-230)
	Chum	0 (0-0)	0 (0-0)	20 (0-30)	0 (0-10)	20 (10-40)
	Sockeye	0 (0-0)	0 (0-0)	10 (0-20)	0 (0-0)	10 (0-20)
	Total	10 (0-20)	10 (0-20)	130 (60-220)	30 (10-50)	180 (100-270)
6/18/2020	Chinook	10 (10-20)	10 (10-20)	140 (70-200)	10 (10-20)	180 (110-240)
	Chum	0 (0-10)	0 (0-10)	30 (0-60)	0 (0-10)	40 (10-70)
	Sockeye	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Total	20 (10-20)	20 (10-20)	180 (80-230)	20 (10-20)	230 (130-280)
6/24/2020*	Chinook	0 (0-0)	20 (10-40)	140 (70-230)	50 (20-80)	210 (130-310)
	Chum	0 (0-0)	10 (0-10)	30 (10-50)	10 (0-20)	50 (30-70)
	Sockeye	0 (0-0)	10 (0-20)	60 (10-140)	20 (0-50)	90 (30-170)
	Total	0 (0-0)	40 (20-70)	230 (110-400)	80 (40-130)	340 (200-540)
All Openers	Chinook	20 (10-40)	200 (110-350)	1,550 (860-2,450)	260 (130-400)	2,050 (1,310-2,990)
	Chum	0 (0-10)	30 (0-50)	220 (60-380)	20 (10-90)	290 (140-470)
	Sockeye	0 (0-0)	10 (0-40)	100 (10-240)	20 (0-60)	140 (30-280)
	Total	30 (10-50)	250 (130-420)	1,880 (1,050-2,900)	320 (180-490)	2,490 (1,600-3,550)

[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 openers on 6/12 in all years where in-season 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**	**Average**
Drift Effort	524	523	466	446	406	473
Total Salmon Harvest	5,100	5,420	6,500	8,650	3,820	5,898
Total Salmon/Boat	10	10	14	19	9	12
Chinook Harvest	4,290	2,240	4,590	8,040	3,240	4,480
Chinook/Boat	8	4	10	18	8	10
Chum/Sockeye Harvest	810	3,180	1,910	600	590	1,418
Chum/Sockeye/Boat	2	6	4	1	2	3
Species Ratio	0.2	1.4	0.4	0.1	0.2	0.5

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

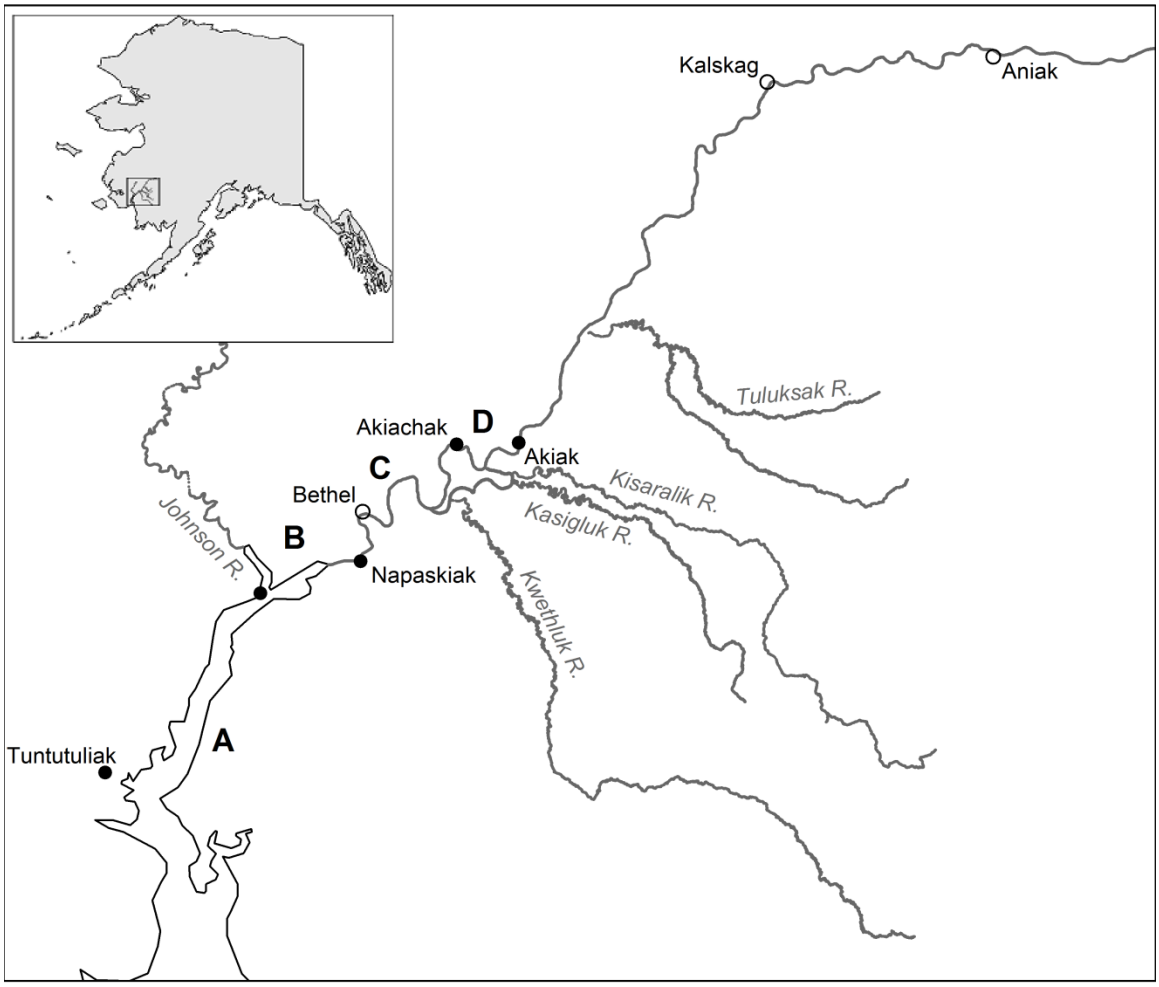
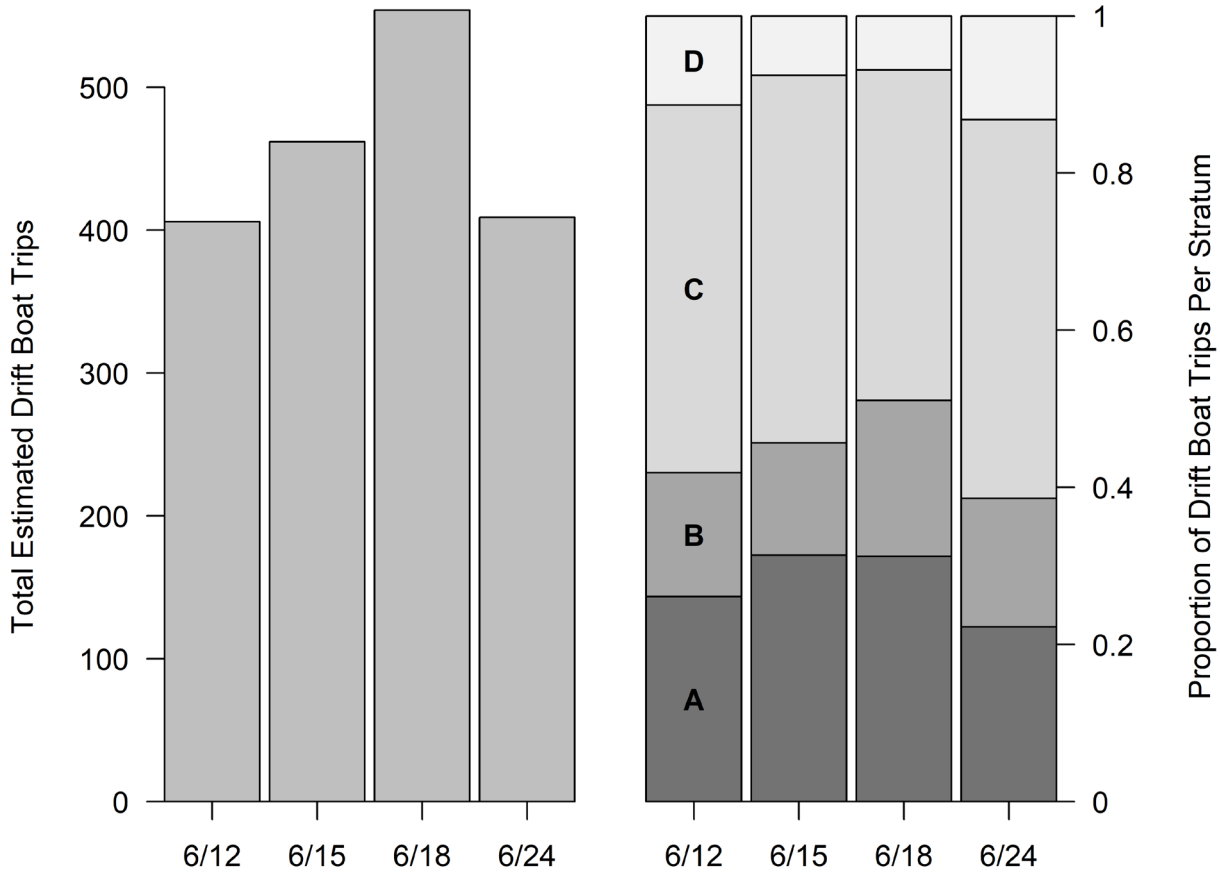
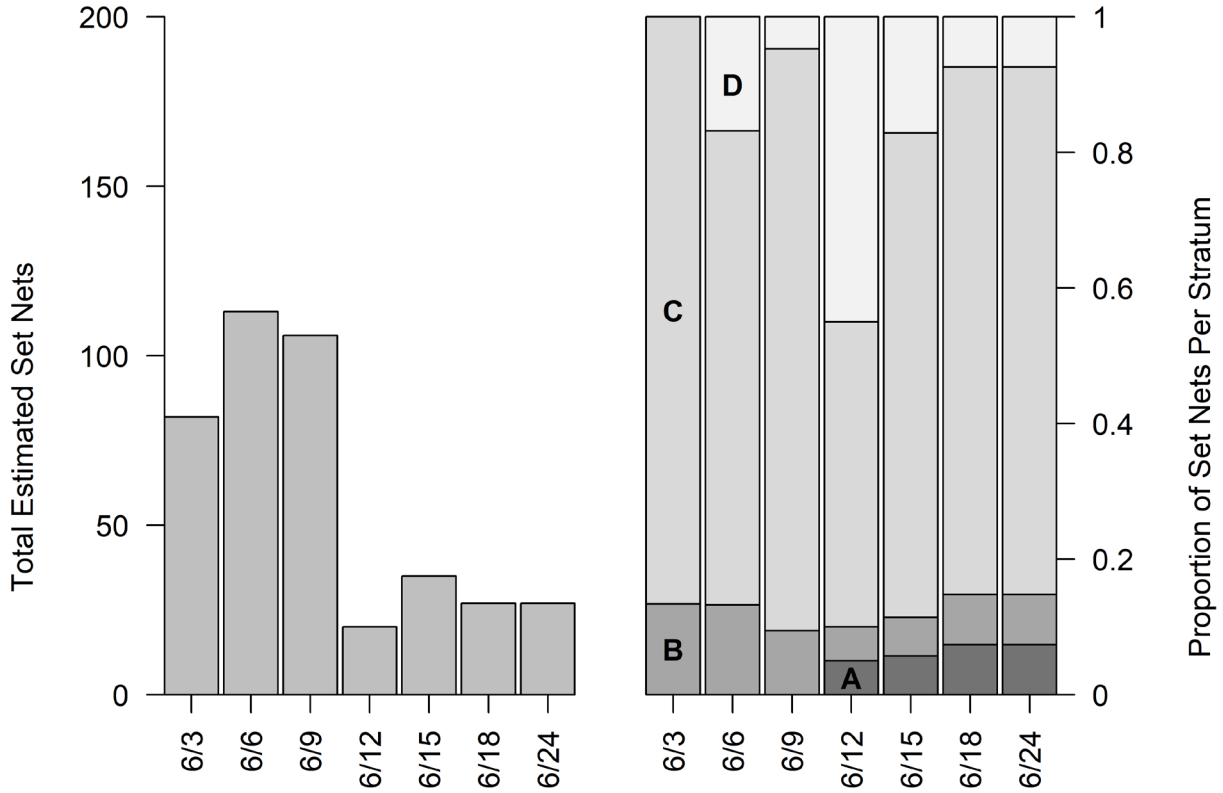


Figure 2. *Left*: Total estimated drift boat trips by opener. *Right*: the proportion of all estimated trips that occurred in each geographic stratum[1] by opener. This figure does not show drift net effort before June 11 because only set net opportunities occurred prior to that date.



[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:* opportunities before June 11 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 (when available) and set nets.

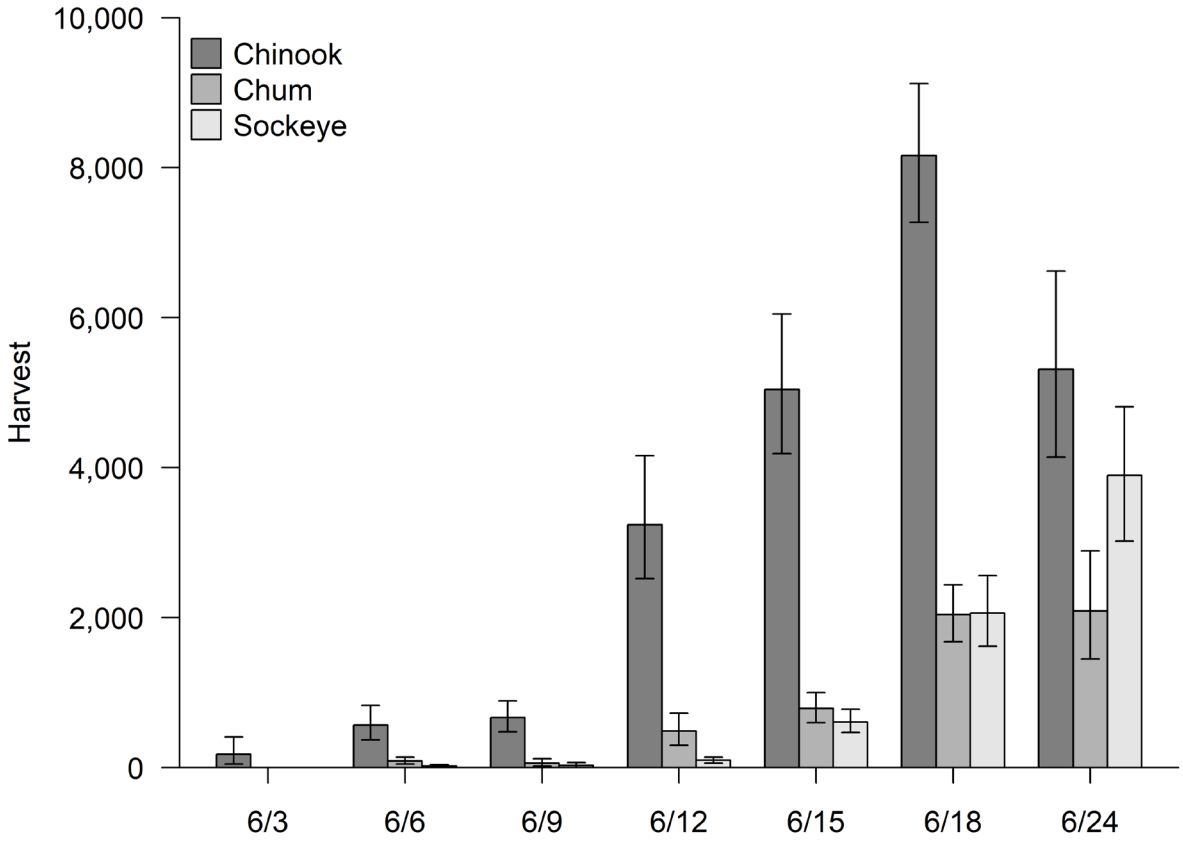
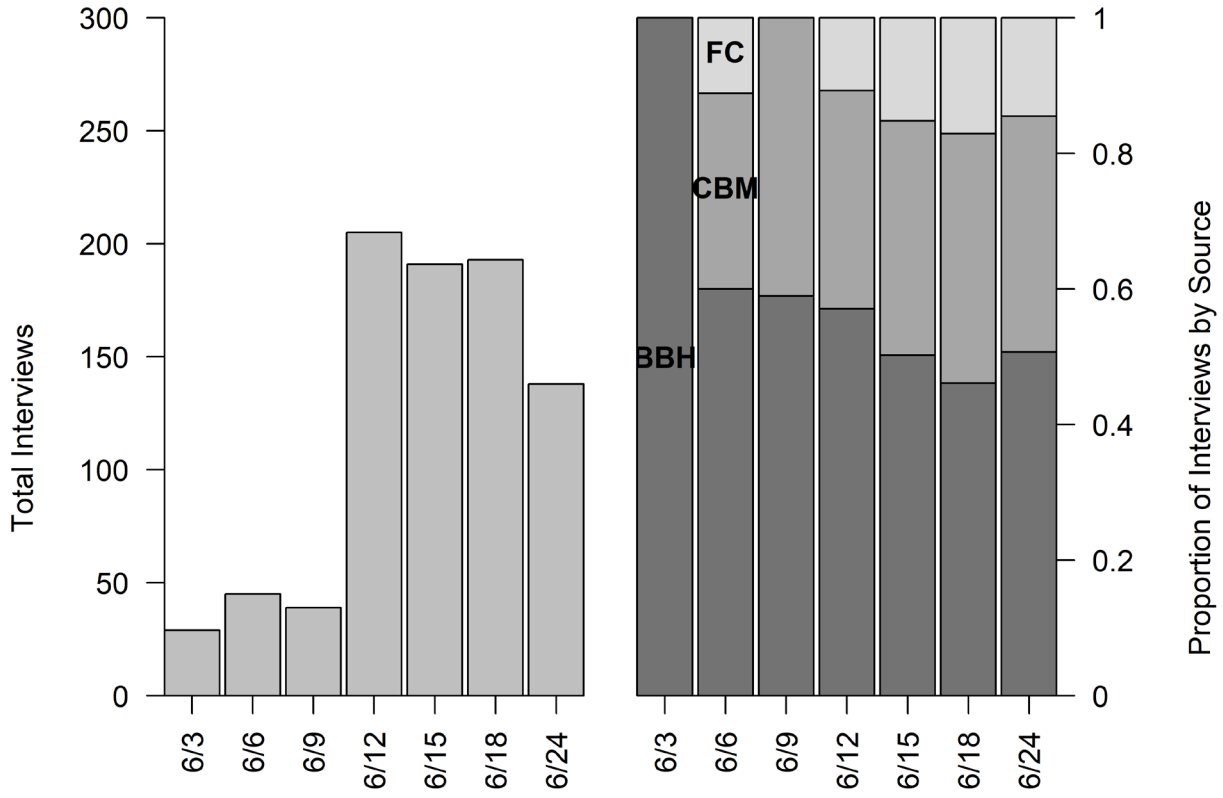
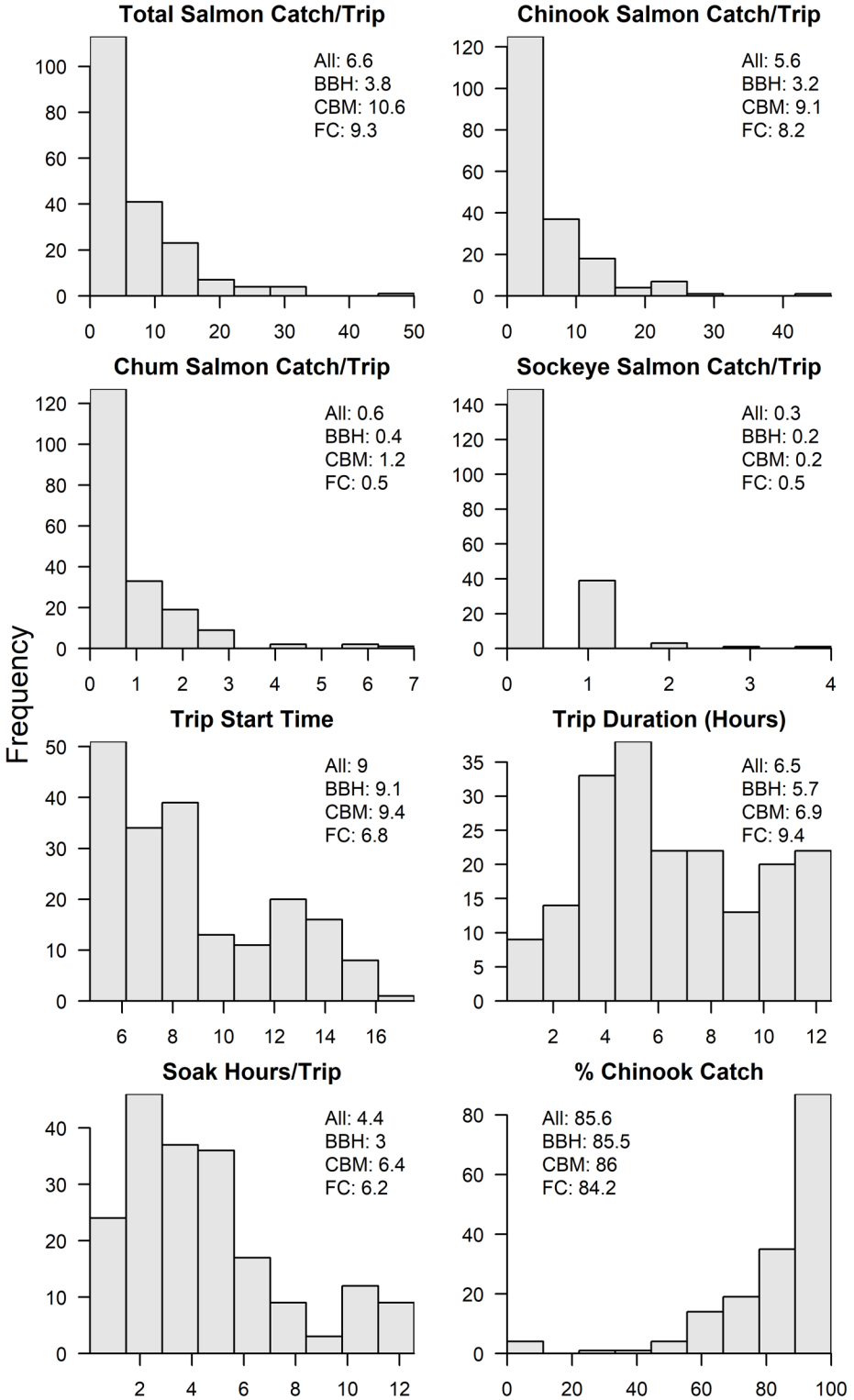


Figure 5. *Left*: Total number of interviews used to inform the harvest estimates from each opener. *Right*: The proportion of all interviews that came from each source[1] by opener. *Note:* FC and CBM did not begin interviews until the June 6-7, 2020 opportunity.



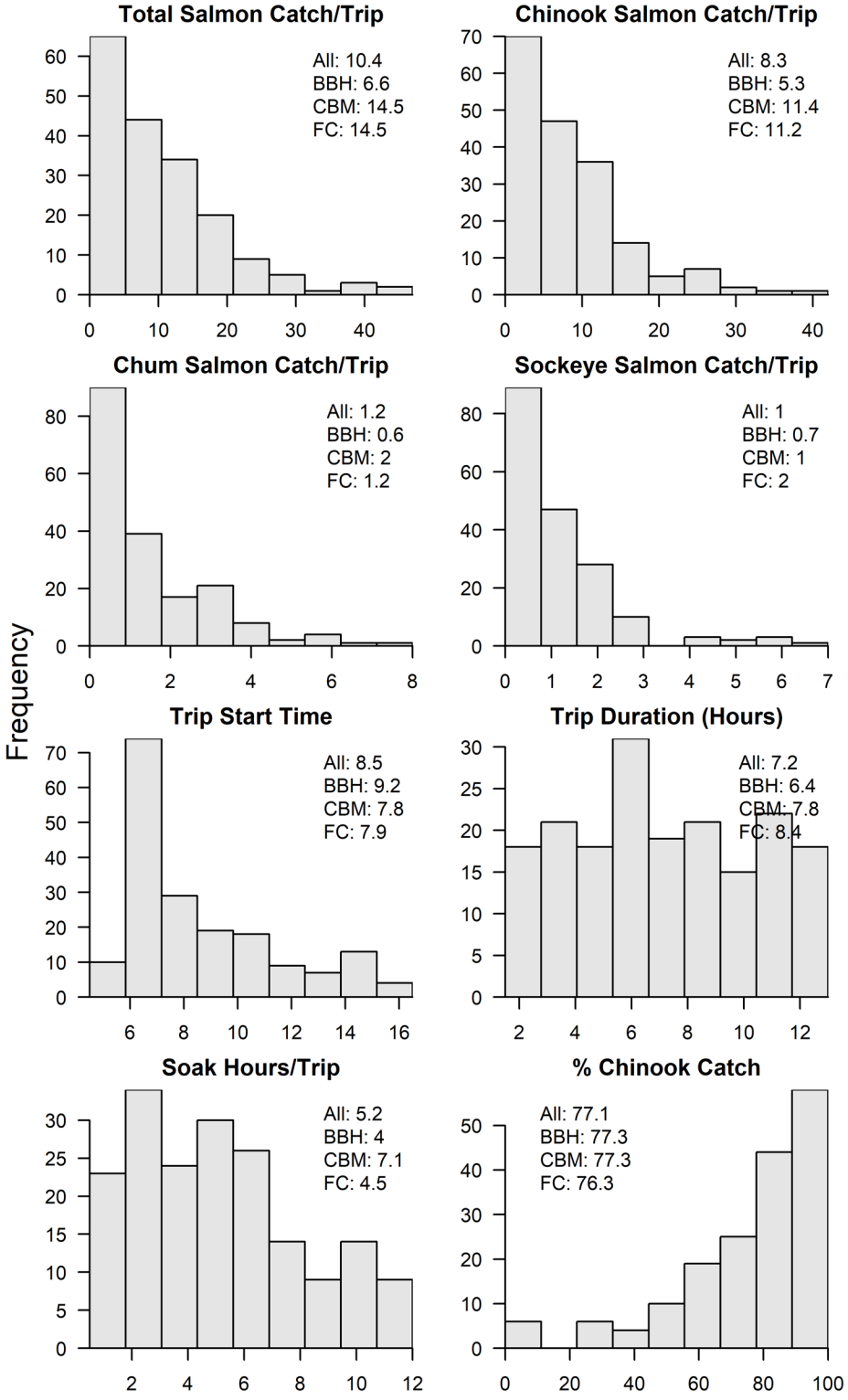
[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA)

Figure 6. Distribution of relevant quantities from completed drift boat trip interviews during the first drift gillnet opener (6/12/2020), with means for all available interviews and by data source[1].



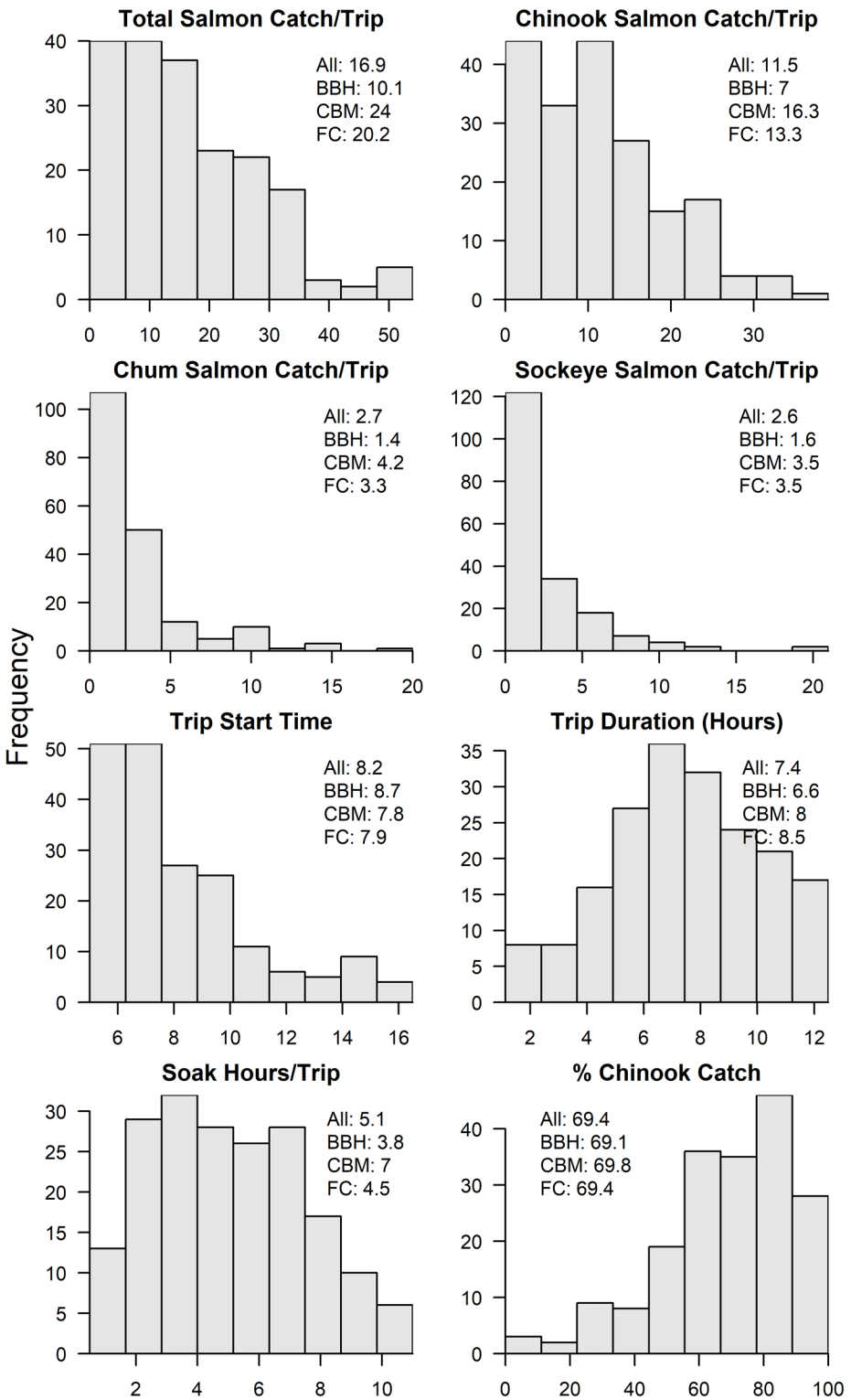
[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA).

Figure 7. Distribution of relevant quantities from completed drift boat trip interviews during the second drift gillnet opener (6/15/2020), with means for all available interviews and by data source[1].



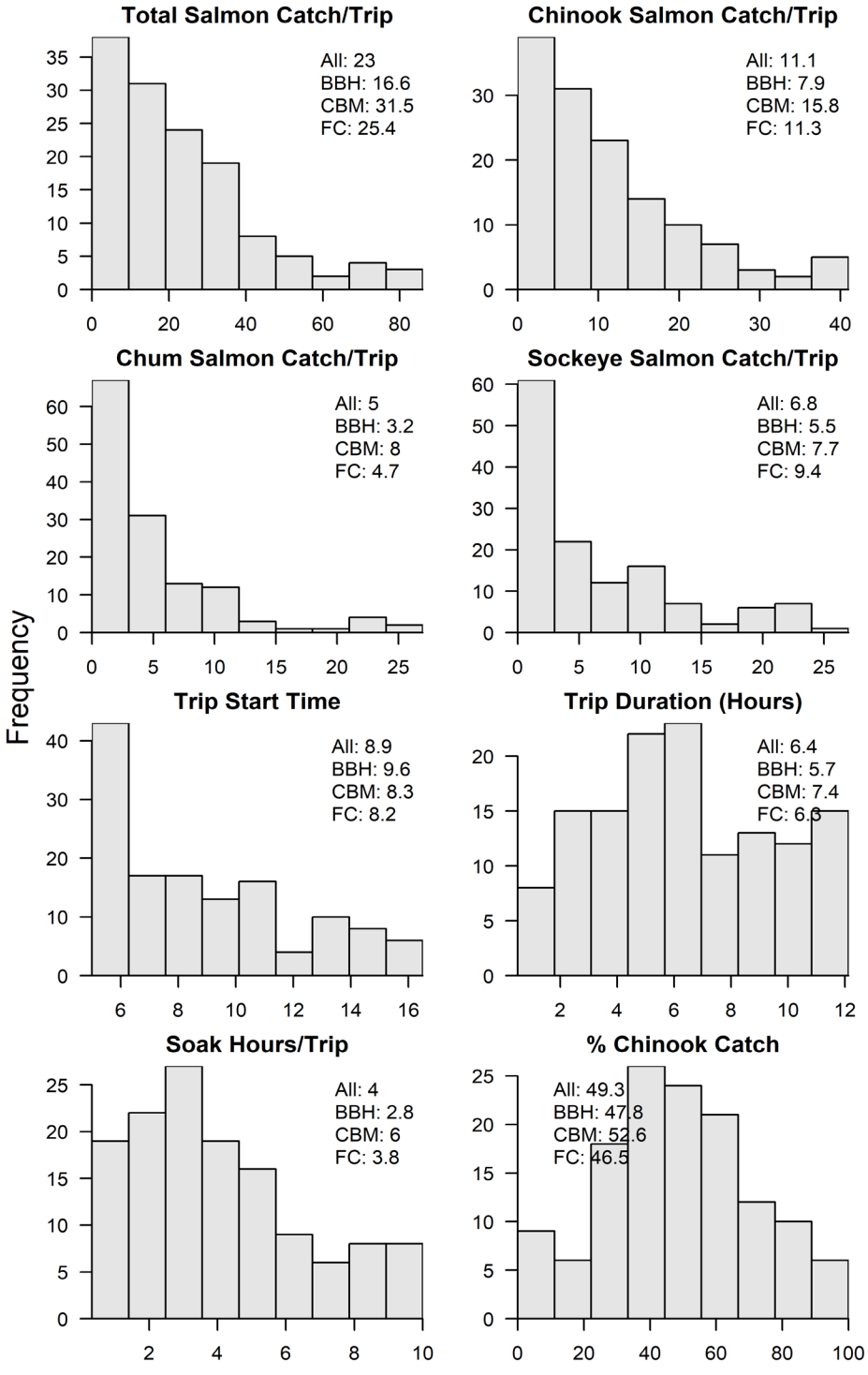
[1]Data source: BBH = Bethel boat harbor (ONC), FC = Bethel area fish camps (ONC), and CBM = community-based monitoring (BSFA).

Figure 8. Distribution of relevant quantities from completed drift boat trip interviews during the third drift gillnet opener (6/18/2020), 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 (6/24/2020), with means for all available interviews and by data source[1]. This information is independent of historical effort information utilized to produce harvest estimate.



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

Figure 10. Total salmon harvest by species across all seven openers combined between drift nets and set nets. Total harvest estimates include harvest estimates calculated with historical effort for the June 24, 2020 opportunity.

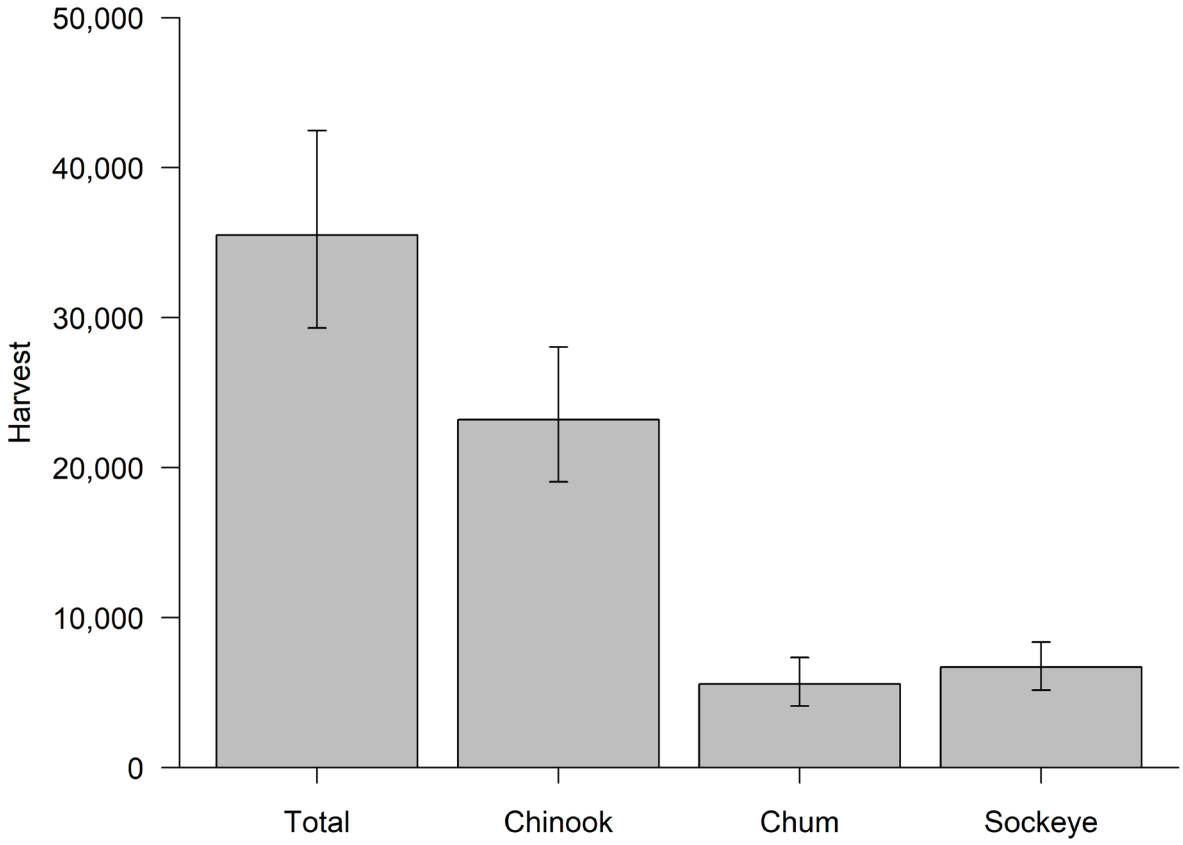
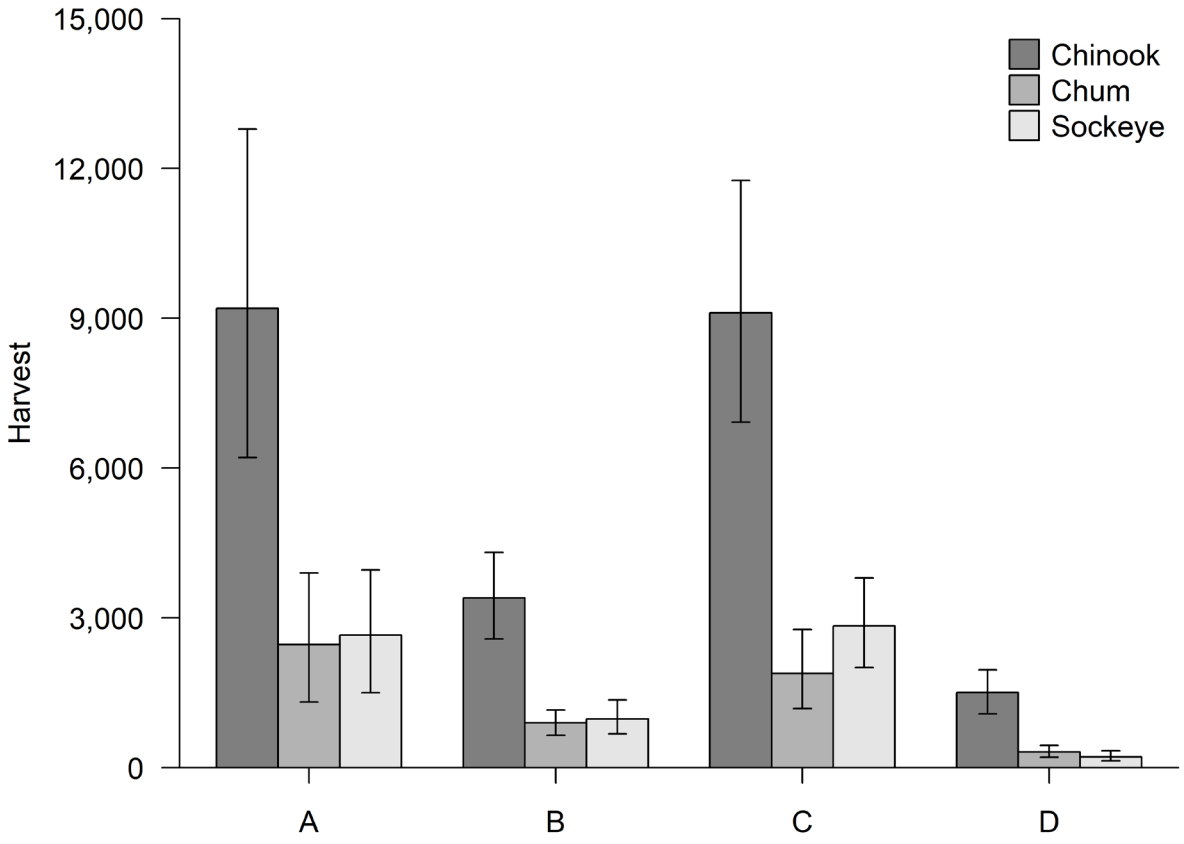


Figure 11. Total estimated salmon harvest by species and geographic stratum across all seven openers combined between drift nets and set nets. Total harvest estimates include harvest estimates calculated with historical effort for the June 24, 2020 opportunity.



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