Technical Paper No. 449

Inseason Estimation of Subsistence Salmon Fishing Effort and Harvest in the Lower Kuskokwim River, 2015–2018

by
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and
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June 2019

Alaska Department of Fish and Game **Division of Subsistence**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in Division of Subsistence reports. All others, including deviations from definitions listed below, are noted in the text at first mention, in the titles or footnotes of tables, and in figures or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly-accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly-accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures)	first three letters (Jan,...,Dec)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. states	two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance:	
population	Var
sample	var

TECHNICAL PAPER NO. 449

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The Division of Subsistence Technical Paper Series was established in 1979 and represents the most complete collection of information about customary and traditional uses of fish and wildlife resources in Alaska. The papers cover all regions of the state. Some papers were written in response to specific fish and game management issues. Others provide detailed, basic information on the subsistence uses of particular communities which pertain to a large number of scientific and policy questions.

Technical Paper series reports are available through the Alaska Resources Library and Information Services (ARLIS), the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and professional review.

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TABLE OF CONTENTS

TABLE OF CONTENTS, CONTINUED

LIST OF TABLES

LIST OF TABLES, CONTINUED

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The primary research question of this project concerned whether research agencies can successfully recruit subsistence fishers as collaborators in data collection for an inseason harvest monitoring project in the lower Kuskokwim River, and whether analysis of these data can provide an accurate estimate of subsistence Chinook salmon harvests in season. The principal goal of this project was to inform a process in which managers could develop a new research program in the Kuskokwim River that would provide accurate inseason harvest estimates through similar methods of sampling harvest. In 2015–2018, Alaska Department of Fish and Game Division of Subsistence staff recorded daily subsistence salmon harvest and effort information among a group of fishers from six lower Kuskokwim River communities. Fishing data were analyzed to calculate a total salmon harvest, average drift gillnet fishing duration, average catch per unit effort, and harvest ratio of Chinook salmon to chum and sockeye salmon. Daily sample sizes were too small to develop universal harvest and catch per unit effort estimates for the fishing fleet with statistical significance. However, study results indicate that the research methodology provided opportunities for necessary inseason outreach to communities and individual fishers in a region with a population that relies significantly on Chinook salmon and other salmon species as important sources of food. Division of Subsistence researchers provided opportunities for fishers to participate directly in the management process by recording salmon harvest and effort data and sharing those data with agencies and representative stakeholder groups to inform management decisions. Similar to other prior research, this study demonstrated the value of collaboration between management agencies and rural communities and the benefits of employing subsistence fishers for participation in inseason harvest assessment projects.

Key words: Catch per unit effort; Chinook salmon; chum salmon; inseason harvest estimation; Kuskokwim River; sockeye salmon; subsistence salmon fishing; Atmautluak, AK; Bethel, AK; Kasigluk, AK; Napakiak, AK; Nunapitchuk, AK; Oscarville, AK.

1. INTRODUCTION

Project Background

Kuskokwim River Chinook salmon *Oncorhynchus tshawytscha* abundance has been below average for at least the last decade, and particularly low run sizes have been observed since 2010 (Liller et al. 2018). During this time, a primary management goal of the Alaska Department of Fish and Game (ADF&G) and the U.S. Fish and Wildlife Service (USFWS) has been to reduce the harvest of Chinook salmon each season to meet escapement goals. These agencies have implemented a management approach with the goal of maximizing conservation of Chinook salmon. As a result, managers have enacted unprecedented closures to subsistence salmon fishing during the early part of the season when Chinook salmon are present in large numbers. Each year since 2012, Kuskokwim Management Area (Kuskokwim Area) fishery managers have scheduled the first fishing openings at least two to three weeks into the traditional subsistence salmon season. When those initial fishing opportunities arose early in the season, they were usually 6- or 12-hour openings no more than once or twice a week. Consequently, fishing households have experienced the lowest subsistence harvests of Chinook salmon observed since 1990. Additionally, although Kuskokwim River chum and sockeye salmon stocks are healthy, since 2012 fishers have had few opportunities to catch those fish during Chinook salmon runs. Each of these factors have challenged fishing households in their ability to get the salmon that they need for the year.

Residents of Kuskokwim River communities rely primarily on four species of Pacific salmon *Oncorhynchus spp.* for subsistence, and harvest occurs in the Kuskokwim River both within and upstream of the Yukon Delta National Wildlife Refuge. The subsistence salmon fisheries in the Kuskokwim Area are some of the largest in the state of Alaska in terms of the number of residents who participate and by the total number of fish harvested (Fall 2018). Since at least 1990, over 50% of Chinook salmon harvested under subsistence regulations have been taken in the Kuskokwim Area, mostly in the Kuskokwim River drainage. Between 2010 and 2014 (study years 2009–2013), the Division of Subsistence conducted comprehensive subsistence harvest and use surveys in 21 Kuskokwim Area communities. Results from these studies indicate that, on average, salmon contribute approximately 40% of the total wild resource harvest (in edible pounds) in lower Kuskokwim River communities, 60% in middle Kuskokwim River communities, and 41% in upper Kuskokwim River communities (Brown et al. 2012; 2013; Ikuta et al. 2014; 2016; Runfola et al. 2017). Communities on the Kuskokwim River rely extensively on annual returns of salmon not only for basic nutrition, but also for maintenance of cultural identity and cultural values. Furthermore, until as recently as 2016 when there were two commercial coho salmon fishing opportunities, many residents also relied upon commercial salmon fishing as a source of cash income and fish to retain for personal use (Andrews and Coffing 1986; Brown et al. 2012; 2013; Ikuta et al. 2014; 2016; Poetter and Tiernan 2017; Senecal-Albrecht 1998; 1990; Walker and Coffing 1993).

From 1990 through 2009, the Kuskokwim River supported annual average total Chinook salmon run sizes of 260,431 fish (Liller et al. 2018), average subsistence harvests of approximately 86,091 fish per year (Poetter and Tiernan 2017), and escapements that ranged from 60,908 to 287,004 Chinook salmon. However, in 2007 Chinook salmon runs began to decline from an estimated 244,625 fish to a 2012 low of 79,179 fish, the lowest run size ever recorded for the Kuskokwim River (Liller et al. 2018). Total Chinook salmon run sizes remained low through 2014 and began to increase in subsequent years. These lower run sizes resulted in severe restrictions to subsistence salmon fishing, which caused the lowest subsistence Chinook salmon harvests on record for Kuskokwim Area residents. Fishers residing in communities in the lower 125 miles of the river historically harvested an average of 87% of the annual subsistence catch (Bue et al. 2012; Carroll and Hamazaki 2012).

In its simplest terms, total Chinook salmon run abundance is equal to the sum of total harvest and total escapement. Accurate estimates of total annual Chinook salmon returns are essential in understanding productivity of the species and proper management of the fishery (Schaberg et al. 2012). Kuskokwim Area managers calculate an estimate of total Chinook salmon run abundance in the Kuskokwim River through a

Maximum Likelihood Estimation model that compiles escapement and harvest data from several individual run assessment projects simultaneously (Bue et al. 2012). Escapement is monitored by enumerating Chinook salmon passing through weirs located on several Kuskokwim River tributaries (Brazil et al. 2013; Schaberg et al. 2012). Managing agencies are limited in their ability to increase the coverage of spawning streams by both the high costs and logistical barriers of operating more weirs in the area. Furthermore, although each weir generally provides a reliable count of spawning adult abundance, weir operations can be compromised during occasional unexpected events when it is difficult or impossible to count fish passing upriver (e.g., high water at weir sites, wildland fires). Also, existing weirs do not monitor significant portions of the Kuskokwim River watershed, which prevents detection of severely depleted or extirpated stocks of Chinook salmon. These and other obstacles introduce potential sources of error into escapement estimates. As a result, ADF&G recognizes the limitations of expanding results merely from weir counts to represent total escapement (and, in turn, total run abundance) in the entire drainage (Bue et al. 2012).

In addition to escapement, managers must estimate total harvest of Chinook salmon to calculate total run abundance each season. Accurate estimates of total annual Chinook salmon returns are essential in managing the fishery for monitoring escapement goals and subsistence needs, but these estimates are difficult to assess in season in large and remote systems such as the Kuskokwim River (Brazil et al. 2013; Liller et al. 2018). Sources of harvest include fish sampled by ADF&G in the Bethel test fishery (BTF), as well as harvests from commercial, sport, and subsistence fisheries. Department technicians record all Chinook salmon harvested in the BTF each day; and when commercial fishing occurs, fish buyers report to ADF&G all deliveries of Chinook salmon through the commercial fish ticket system (Brazil et al. 2013). Since the elimination of a directed Chinook salmon commercial fishery in the Kuskokwim River in 1988, inseason commercial catch statistics for Chinook salmon have been limited to incidental harvests during targeted chum and sockeye salmon commercial fisheries. To protect Chinook salmon escapement and subsistence harvest, the chum and sockeye salmon commercial fisheries occur after the majority of Chinook salmon has migrated through the area (Francisco et al. 1991); and, as such, commercial fish buyers are prohibited from purchasing incidentally harvested Chinook salmon. Instead, commercial fishers retain them for personal use; however, buyers must record retained fish on their commercial fish tickets. Both the BTF and fish tickets are considered harvest data sources of high accuracy.

Total harvests of Chinook salmon from the sport fishery are estimated through implementation of surveys among a sample of sport fishing license holders. Harvest estimates from survey responses are typically available approximately one year after the harvests occur. This is due to the time required for sport fishers to return completed surveys and for the department to analyze the survey responses. In recent years sport fishers have harvested fewer than 1,000 Chinook salmon annually on average in the Kuskokwim River drainage (Chythlook 2012), often less than 1% of the total annual Kuskokwim Area harvest. Therefore, despite the lag time in receiving results, Kuskokwim Area managers are confident in adding this relatively small amount to their total harvest estimate each year.

The subsistence fishery harvest estimate is determined by completion of postseason household surveys in approximately 26 Kuskokwim River communities. Each autumn following the salmon fishing season, researchers complete surveys with a stratified sample of households in each community except in the smallest communities, where researchers attempt a census. Results from these samples are expanded to estimate total subsistence harvest. The accuracy of estimates is dependent largely upon the sample size achieved in each community and the ability and willingness of respondents to accurately recall their harvest amount from several months prior to the survey. After analysis, harvest data from post-season subsistence surveys are typically available within six months of the end of the Chinook salmon fishing season (see Shelden et al. 2016).

In addition to estimating total run abundance, the department is directed by State of Alaska statute to manage the fishery in a manner that supports the Alaska Board of Fisheries' (BOF) determination of what constitutes a reasonable opportunity for fishers to obtain an amount of salmon that is necessary for subsistence (ANS; AS 16.05.258). The BOF established that Chinook salmon are customarily and traditionally taken or used for subsistence in the Kuskokwim River drainage (5 AAC 01.286(a)(3)) and that the ANS for Chinook

salmon in the Kuskokwim River drainage ranges from 67,200 to 109,800 fish annually (5 AAC 01.286(b)(1)). The Federal Subsistence Board has also determined that permanent residents of the Kuskokwim Area have customary and traditional use of salmon in waters adjacent to Federal public lands in the Kuskokwim Area (50 CFR § 100.24(a)(2)). Under the department's current data-collection procedures as described herein, managers assess harvest levels after the close of the salmon fishing season and after all harvest data have been compiled and analyzed. A method of collecting harvest data in season would greatly improve the department's ability to assess progress toward achievement of ANS in the drainage each season, and give managers a more complete understanding of harvest in relation to stock abundance and run-timing data that are available in real time from the BTF and various qualitative sources.

Other than limited information from one inseason test fishery, stock assessment is based on data that are largely collected after the Chinook salmon fishing season is complete. Monitoring weirs typically do not begin collecting information on escapement until early July (Bue et al. 2012). Similarly, postseason subsistence harvest surveys do not collect information that can be used in developing an assessment of abundance until approximately three to four months after the majority of Chinook salmon have passed through the lower Kuskokwim River. Although data collection efforts in Kuskokwim River assessment projects are extensive, their usefulness to inseason management of the fishery is limited by these temporal constraints.

Particularly since the 2012 fishing season, fishers throughout the river have expressed widespread concern about being able to get the salmon their households needed for the year. Considering severe declines in Chinook salmon abundance and in response to this public concern, the Kuskokwim River Salmon Management Working Group (Working Group)[1], the Kuskokwim River Inter-Tribal Fish Commission (KRITFC)[2], ADF&G, and USFWS have committed significant time and effort into minimizing the harvest of Chinook salmon while maximizing the number of opportunities to harvest other salmon species. Chinook salmon conservation may be the principal factor driving the current management regime; however, an equally critical goal of these decision-making bodies is the fundamental need to provide subsistence fishing families with opportunities to get the food that they need for the year.

Study Objectives

The primary research question of this project concerned whether research agencies can successfully recruit subsistence fishers as collaborators in data collection for an inseason harvest monitoring project in the lower Kuskokwim River, and whether analysis of these data can provide an accurate estimate of subsistence Chinook salmon harvests in season. The principal goal of this project is to inform a process in which managers could develop a new research program in the Kuskokwim River that would provide accurate inseason harvest estimates through similar methods of sampling harvest. For several decades, information regarding Kuskokwim River subsistence fishing in season tended to be qualitative in nature. Although this information can be helpful for a broad understanding of run timing, relative abundance, and fisher satisfaction in season, its utility as an estimator of total harvest and total run abundance is negligible. Accurate inseason harvest estimates can support a more precise evaluation of the department's ability to provide for ANS in the Kuskokwim Area. They can also increase the understanding of use of Chinook salmon by Kuskokwim River fishers and distribution of harvest among the communities of the region. Furthermore, increased inseason harvest data collection may result in increased confidence in each season's harvest estimates, thereby decreasing the uncertainty of total run abundance estimates, as well as potentially

1. The Alaska Board of Fisheries established the Kuskokwim River Salmon Management Working Group (Working Group) in 1987 to provide opportunity for local stakeholders to participate in the process of managing Kuskokwim River salmon fisheries (Francisco et al. 1989).
2. The Kuskokwim River Inter-Tribal Fish Commission (KRITFC) is an organization composed of representatives from 33 Kuskokwim Area tribes that regularly meets with USFWS and ADF&G staff to provide advice and guidance on inseason management of the subsistence salmon fishery. Kuskokwim River Inter-tribal Fish Commission. n.d. "Kuskokwim River Inter-Tribal Fish Commission." Accessed March 26, 2019. www.kritfc.org.

providing an additional inseason index of run-timing, abundance, and fishers' progress toward their annual fishing goals.

This study had the following research objectives:

- Develop methods to calculate an inseason estimate of the subsistence harvest of Chinook salmon in a reach of the lower Kuskokwim River in season, and
- Test the efficacy of the project as an estimator of total Chinook salmon subsistence harvest in a reach of the lower Kuskokwim River.

Study results indicate that the research methods deployed provided opportunities for necessary inseason outreach to communities and individual fishers in a region with a population that relies significantly on Chinook salmon and other salmon species as important sources of food. Division of Subsistence researchers provided opportunities for fishers to participate directly in the management process by recording salmon harvest and effort data and sharing those data with agencies and representative stakeholder groups to inform management decisions. Similar to other prior research, this study demonstrated the value of collaboration between management agencies and rural communities and the benefits of employing local researchers—subsistence fishers in this context—for participation in inseason harvest assessment projects.

2. RESEARCH METHODS

Ethical Principles for the Conduct of Research

The project was guided by the research principles outlined in the Alaska Federation of Natives Guidelines for Research[1] and by the National Science Foundation, Office of Polar Programs in its Principles for the Conduct of Research in the Arctic[2], the Ethical Principles for the Conduct of Research in the North (Association of Canadian Universities for Northern Studies 2003), as well as the Alaska confidentiality statute (AS 16.05.815). These principles stress community approval of research designs, informed consent, anonymity or confidentiality of study participants, community review of draft study findings, and the provision of study findings to each study community upon completion of the research.

Project Planning and Approvals

In April and May 2015, ADF&G staff traveled to the study communities of Oscarville, Napakiak, and Nunapitchuk (Figure 2-1) and met with tribal councils to present project background (including justification and need, research goals, project objectives, and proposed timeline) and project methods, and to obtain the councils' approval to conduct research with volunteer members of their Alaska Native tribes. Division of Subsistence staff received approval from the Oscarville Traditional Council, Napakiak IRA[3] Council, and the Native Village of Nunapitchuk. In May 2018, staff also contacted and received approval from the Atmautluak Traditional Council and Kasigluk Traditional Council. The project principal investigator was David Runfola, a Fairbanks-based Subsistence Resource Specialist with the Division of Subsistence. Division community research leads included Odin Miller, Andrew Brenner, Jeffrey Park, Christopher McDevitt, Anna Godduhn, and Kathleen Roush, and were assisted by Daniel Gonzalez and DeAnne Lincoln.

2015, 2016, and 2017 Study Seasons

In May and June 2015, 2016, and 2017 research teams returned to Oscarville, Napakiak, and Nunapitchuk to recruit volunteer fishers for participation as data technicians or key respondents (KR) in the project. The tribal councils or their staff and ADF&G researchers collaborated to select KRs to record their fishing harvest and effort information while they fished during subsistence salmon fishing openings in the Kuskokwim River mainstem in June and July 2015, 2016, and 2017. Researchers recruited 43 KR fishers throughout the first 3 study years.[4] The KRs included 39 residents of the four study communities, three KRs who resided in Bethel, and one who resided in Napaskiak. Each season an ADF&G employee acted as the community lead for data collection and conducted an orientation and training session with KRs. Training included field data recording and data management techniques. The KRs were instructed to record date fished, net stretch-mesh size in inches, net length in feet, net depth in number of meshes, the location of each fishing drift by river section (i.e., A or B; Figure 2-2), individual drift start and stop times, and number of salmon harvested in each drift by species (i.e., Chinook, chum, or sockeye salmon); each time they deployed a drift gillnet to target salmon during a subsistence fishing opening in June through early July. Following training, each KR received several blank data collection log sheets printed on waterproof paper (Appendix A), a plastic folder in which to retain the log sheets, and several pencils. Each KR was paid a stipend of $350 in August 2015, 2016, and 2017 for each respective season during which he or she participated in orientation, training, and data collection efforts. All KRs chose to participate in field research voluntarily. Names of KRs were not shared with any individuals outside ADF&G Division of Subsistence research staff.

1. Alaska Federation of Natives. 2013. "Alaska Federation of Natives Guidelines for Research." Alaska Native Knowledge Network. Accessed March 15, 2018. http://www.ankn.uaf.edu/IKS/afnguide.html
2. National Science Foundation Interagency Social Science Task Force. 2012. "Principles for the Conduct of Research in the Arctic." Accessed March 15, 2018. http://www.nsf.gov/od/opp/arctic/conduct.jsp
3. Indian Reorganization Act.
4. Researchers contracted with 32 local research assistant fishers in 2015, 38 in 2016, and 40 in 2017. Several fishers participated in multiple years. In 2018 division staff did not contract with fishers to collect harvest and effort data; rather, local fishers completed dockside creel surveys.

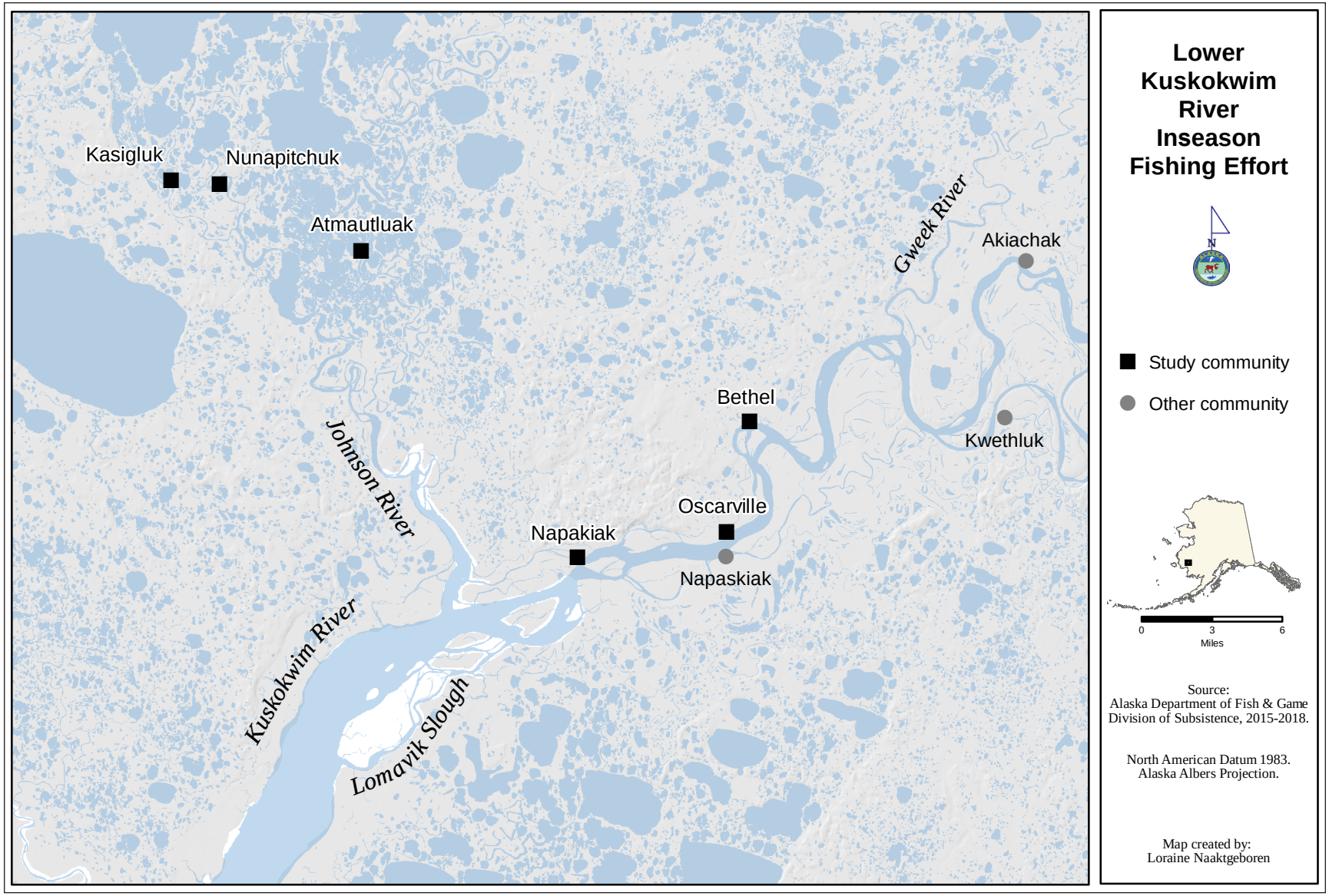

Figure 2-1.–Study communities, lower Kuskokwim River.

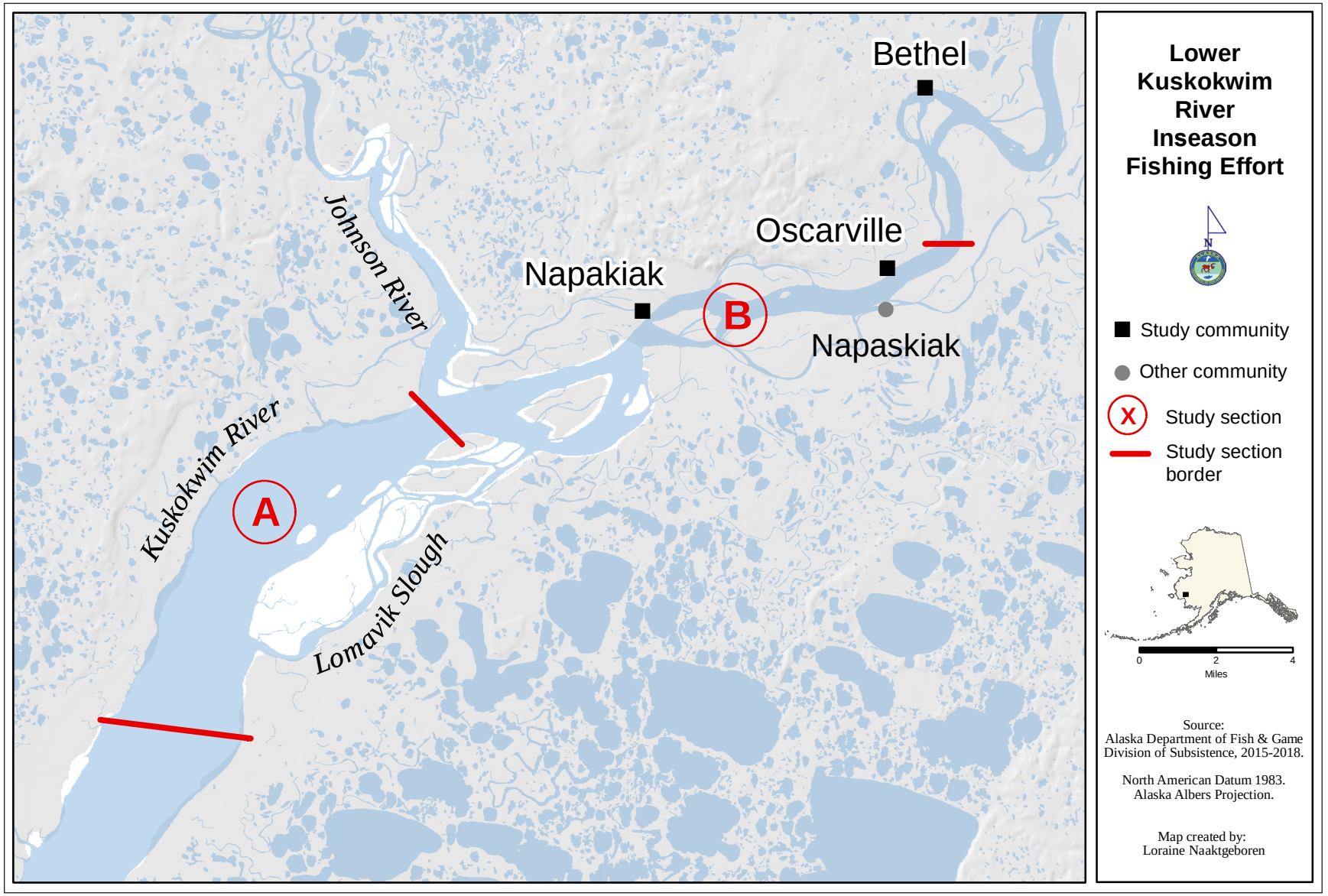

Figure 2-2.–Study sections, lower Kuskokwim River.

2018 Study Season

In 2018, ADF&G staff altered its method of harvest data collection to avoid duplication of effort and confusion with another project, a lower Kuskokwim River creel survey deployed cooperatively by the Kuskokwim River Inter-Tribal Fisheries Commission (KRITFC), Orutsararmiut Native Council (ONC), and U.S. Fish and Wildlife Service (USFWS) inseason harvest assessment project. The KRITFC, ONC, and USFWS operated that project in 2016, 2017, and 2018, when their research staff deployed dockside creel surveys to record data similar to those recorded in this study (Staton 2018). Through 2017, the KRITFC, ONC, and USFWS had obtained nearly all of its creel survey data from the Bethel boat harbor or at fish camps within three miles of Bethel; however, in 2018 their staff intended to expand data collection significantly in surrounding communities including Oscarville, Napakiak, and Nunapitchuk. That year, there was a distinct likelihood that ADF&G's cohort of KRs in Oscarville, Napakiak, and Nunapitchuk would have been contacted by KRITFC, ONC, or USFWS creel surveyors after making the effort to record data for ADF&G. Researchers for both inseason harvest and effort studies felt that the better option was for ADF&G to collaborate in the creel survey effort in communities that the KRITFC, ONC, and USFWS did not intend to survey.

Consequently, ADF&G ceased its contract relationships with Oscarville, Napakiak, and Nunapitchuk KRs in spring 2018, and instead contacted Atmautluak and Kasigluk traditional councils to seek approval to conduct voluntary dockside creel surveys with fishers in their communities. After receiving traditional council approval, ADF&G researchers deployed to Kasigluk and Atmautluak during each subsistence salmon fishing opening in June 2018. Researchers contracted one KR in each community to assist with surveys and, accompanied by KRs, attempted to contact all fishers as they returned to the community after fishing openings each day. There existed the possibility that while the KR and ADF&G field researcher were occupied conducting a creel survey with one returning fisher, they would fail to contact another fisher returning at the same time. In order to capture the fishing information that would otherwise be lost to such foregone survey opportunities, field researchers deployed a purposive sampling technique known as "chain referral sampling" or "snowball sampling" (Bernard 2006; Trotter II and Schensul 1998). With this technique, surveyors use information from key informants to identify other potential survey subjects. In this example, the KRs and fishers who completed a survey acted as key informants. The ADF&G researcher asked the KR and surveyed fishers to identify other individuals who had been fishing during the opening that day. By the nature of social relationships in the relatively small communities of Kasigluk (population 631 people) and Atmautluak (population 311 people),[5] and because fishers often saw each other or spoke by radio during a fishing opening, this technique greatly increased the likelihood that all fishers would be contacted. Thus, as Bernard (2006:193) explains, "eventually, the sampling frame [became] saturated—that is, no new names [were] offered." Participation in creel surveys was voluntary in 2018, and names of survey participants were not shared with any individuals outside ADF&G Division of Subsistence research staff. Fishers providing data in 2018 did not receive payment for completing a survey.

The 2018 creel surveys recorded date fished, net stretch-mesh size in inches, net length in feet, net depth in number of meshes, the location of fishing, fishing trip start and stop times, and number of salmon harvested for the trip by species (i.e., Chinook, chum, or sockeye salmon; Appendix B). The ADF&G researchers opted to implement a survey protocol identical to that administered in other communities by the cooperating agencies. Whereas the 2018 creel survey recorded fishers' total fishing time, participating fishers recruited by ADF&G in 2015, 2016, and 2017 recorded fishing start and stop time by drift.

5. Alaska Department of Commerce, Community, and Economic Development (ADCCED) Division of Community and Regional Affairs, Juneau. n.d. "Alaska Community Database Online" Accessed March 18, 2019. https://dcra-cdo-dcced.opendata.arcgis.com/

Data Analysis and Review

Data Collection, Reduction, and Analysis

In 2015, 2016, and 2017, ADF&G research staff provided KRs with their contact telephone numbers and instructed KRs to call the lead researcher or other designated ADF&G staff after a fishing opening or immediately after they had completed their fishing for the day and recorded all appropriate fishing data. Researchers contacted KRs telephonically or in person to transfer fishing harvest and effort data from log sheets to a master data sheet and into a Microsoft® Excel®[6] spreadsheet. In 2018, the ADF&G lead community researcher retained all completed creel surveys following a fishing opening and returned to Bethel with the original copies. Data recorded included date fished; net stretch-mesh size in inches; net length in feet; net depth in number of meshes; the location of each fishing drift by river section (i.e., A or B; Figure 2-2); individual drift start and stop times in 2015, 2016, and 2017; individual trip start and stop times in 2018; and number of salmon by species (i.e., Chinook, chum, or sockeye salmon) harvested in each drift or trip. Harvest quantities were transferred from participant fisher data logs to a Microsoft® Excel® spreadsheet and entered as number of Chinook salmon and the cumulative number of chum salmon and sockeye salmon. Recording harvest amounts in these two sets allowed for calculation of ratios of Chinook salmon harvest to all other salmon (i.e., chum salmon plus sockeye salmon) for each fishing opening. After initial data entry in the spreadsheet, data were imported into a Microsoft® Access® relational database. SPSS v21 was used to extract and analyze the data.

A catch per unit effort (CPUE) was calculated for Chinook salmon (*CHIN*) and for the cumulative number of chum salmon and sockeye salmon (*CHUM-SOCK*) harvested in each drift by each fisher in 2015, 2016, and 2017 and in each fishing trip by each fisher in 2018.[7] This was accomplished by converting differences in net length and mean fishing time of each drift to the number of fish caught by 300 feet of net (hereinafter *50 fathoms*) fished for 60 minutes in sections of river where regulation allowed for a maximum net length of 50 fm, or to the number of fish caught by 150 feet of net (hereinafter *25 fm*) fished for 60 min in river sections where regulation allowed for a maximum net length of 25 fm. This standardized net length and fishing time is used in gillnet test fisheries conducted by ADF&G. Each drift or set CPUE (I) was computed for sections of river where regulations allowed for a maximum net length of 50 fm

$$I = (50\ fm) \bullet (60\ min) \bullet C \bullet (LT)^{-1},$$

and for sections of river where regulation allowed for a maximum net length of 25 fm

$$I = (25\ fm) \bullet (60\ min) \bullet C \bullet (LT)^{-1},$$

where C is the catch of salmon (i.e., *CHIN* or *CHUM-SOCK*) in numbers of fish, L is the length in fathoms of the net fished, and T is the mean fishing time in minutes (see Molyneaux 1997, equation 1, page 6).

Each fishing opening mean CPUE indices for Chinook salmon (I_{iCHIN}) and *CHUM-SOCK* ($I_{iCHUM\text{-}SOCK}$) for the sample of fishers was calculated

$$I_{iCHIN} = n^{-1} \left(\sum_{j=1}^{n} I_{i,jCHIN} \right),$$

and,

$$I_{iCHUM\text{-}SOCK} = n^{-1} \left(\sum_{j=1}^{n} I_{i,jCHUM\text{-}SOCK} \right),$$

6. Product names are given because they are established standards for the State of Alaska or for scientific completeness; they do not constitute product endorsement.

7. Hereinafter, incorporation of total fishing trip time into harvest and effort calculations will be considered analogous to a single drift.

where $I_{i,j}$ is the drift CPUE from drift j of fisher i, and n is the number of applicable drifts throughout the sample (see Molyneaux 1997, equation 2, page 6).

Each fishing opening CPUE index sample variances (s^2) for Chinook salmon and *CHUM-SOCK* were calculated

$$s^2 = n^{-1} \sum_{j=1}^{n} (I_{i,j} - I_i)^2,$$

where $I_{i,j}$ is the CPUE from drift j of fisher i in a sample of n drift CPUEs and I_i is the mean CPUE index of the sample. Sample variance was used as an estimator of the relative spread of effort exhibited by the sample fishery each day for the purpose of determining whether a larger sample size or alternate sampling methods might need to be considered.

A harvest ratio (*HR*) of *CHUM-SOCK* to Chinook salmon was calculated for each fishing opening

$$HR = \sum_{k=1}^{n} (CHUM\text{-}SOCK_k)^{-1} \bullet \sum_{k=1}^{n} (CHIN_k),$$

where $CHUM\text{-}SOCK_k$ is the total cumulative chum and sockeye salmon harvest of fisher k in a sample of n fishers, and $CHIN_k$ is the total Chinook salmon harvest of fisher k in a sample of n fishers. The harvest ratio was used as an index of the progress of the Chinook salmon run relative to the progress of the later chum and sockeye salmon runs. By monitoring this fishery statistic, the harvest ratio allowed managers to determine at what point in the fishery less restrictive management techniques should be implemented. Managers typically felt confident to allow unrestricted subsistence fishing when the subsistence harvest ratio was approximately one Chinook salmon to ten other salmon per fishing opening.

Fishing-Boat Counting Surveys

During each fishing opening, ADF&G staff recorded the number of subsistence fishing boats in surface surveys by boat within a 38 km reach of the Kuskokwim River. This reach was selected because the majority of the lower Kuskokwim River fishing fleet is active in that section of river. The survey reach was divided into two sections (A and B; Figure 2-2) for which boat counts were completed during each opening. Section A extended from an east-to-west line passing through the midchannel of the mainstem river near the downriver point of the mouth of Lomavik Slough upriver to an east-to-west line passing through the midchannel of the mainstem river near the upriver point of the mouth of the Johnson River. Section B extended from the line at the upper end of Section A upriver to an east-to-west line passing through the midchannel of the mainstem river near Graveyard Point (locally known as Willie Petes). During each survey trip, researchers traveled by boat through each section. One staff member piloted the boat while one or two staff, depending on availability of personnel, counted all fishing skiffs they could see. During survey trips staff used tally counters and binoculars to observe boats. Counters assumed that all skiffs (typically 18–24 ft open aluminum boats with one to four passengers and a 50–25 fm drift gillnet) in the river were participants in the subsistence salmon fishery. Researchers did not count commercial, agency, and other nonfishing boats in their tallies. Boat pilots traveled at a steady pace that allowed for ease of counting and slowed the boat when counters signaled the pilots to do so. Each boat-counting survey trip extended from one end of the survey reach to the other. Thus, a round trip from the downriver end of section A to the upriver end of section B and back composed two boat-counting survey trips. Staff attempted to complete boat-counting survey round trips at least once every hour of a 6- to 12-hr subsistence fishing opening. This rate was reduced to six trips per day during 24-hr and 72-hr openings when they occurred. Boat counting survey crews were not deployed during times of dangerous boating conditions as determined by the research boat pilot.

Boat counts were recorded in field data sheets and transferred in Bethel to a Microsoft® Excel® spreadsheet. Average boat counts per section per opening were calculated and recorded in a Microsoft® Access® database. Average boat survey counts were reviewed as potential representatives of the universe of fishing boats during each opening. Fishing sample results were evaluated in comparison with the putative universe of fishing boats to determine the feasibility of using sample fishery statistics to estimate a total Chinook salmon harvest per opening.

Community Review Meetings

During the study seasons concurrent with subsistence salmon fishing activity, research staff shared fishing sample information, fishery statistics, and boat survey counts with ADF&G and USFWS management staff for review and discussion. Division staff also reported sample information and fishery statistics in public meetings with the Kuskokwim River Salmon Management Working Group and the KRITFC for their review and discussion. Research staff also maintained daily or weekly contact with tribal council staff in study communities, participating fishers, WG and KRITFC members, and other agency staff to inform them of research progress and to address any questions or concerns any had with the study or its results.

In June 2019, department staff returned to each community to conduct community review meetings. Research staff presented preliminary study findings and associated summary information during these meetings. They provided attendees with written and electronic copies of summaries of fishing harvest and effort estimates and showed each community a Microsoft® PowerPoint® presentation summarizing the results. During these visits, community leads gathered local comments and concerns to complement the summary data presentations. Any follow-up information was integrated into the overall analysis of subsistence salmon harvest and effort activities within each community.

Final Report Organization

This report summarizes the results of systematic subsistence salmon harvest and effort data collection by KRs and by staff from ADF&G, and it also documents resident feedback provided at community review meetings. The findings are organized by study season. The Results chapter includes tables that report findings on data recorded by KR fishers and ADF&G researchers as well as fishery statistics calculated from analysis of those data.

At community meetings in June 2019, ADF&G provided preliminary data to the study communities for residents' review and comment. After receipt of comments, the report was finalized. The ADF&G mailed a short (2-page) summary of the study findings to every household in the study communities of Oscarville, Napakiak, Nunapitchuk, Atmautluak, and Kasigluk.

3. RESULTS

The Fishing Sample

In study years 2015–2017, Division of Subsistence researchers collaborated with a sample of subsistence salmon fishers in Bethel, Oscarville, Napakiak, and Nunapitchuk (Figure 2-1). In 2015, 36 potential sample fishers participated in the project. Research staff collaborated with 32 fishers in 2016 and 42 fishers in 2017.

Each season, most fishers did not initiate telephone contact for data transfer. Instead, division staff called participants near the end of a fishing opening or immediately following the close of fishing. Staff typically did not retrieve fishing harvest and effort data from all fishers for each opening. Thus, subsistence salmon harvest and effort data samples for each opening represent only a portion of all fishers who agreed to participate in the research each season. This occurred mainly because not all participants fished during each opening. Staff's inability to retrieve data from all participants for each opening also frequently occurred because some participants did not answer phone calls or did not return phone calls when a researcher left a message on voicemail or with another person who answered the phone. Additionally, often the phone numbers that some participating fishers provided were either out of service or incorrect. Many fishers reported completing their fishing activity for the season before the final fishing opening. Research staff returned to the study communities several times throughout the 2015–2017 fishing seasons to maintain inperson contact with all fishers. When appropriate, staff updated contact information with participating fishers, answered their questions, addressed their concerns, and provided additional training.

During the 2018 season, two Division of Subsistence staff traveled to Atmautluak and Kasigluk (Figure 2-1) and administered a survey in each community to record the same fishing harvest and effort information that had been recorded by participating fishers in the previous study years. In 2018, researchers attempted to obtain a census of all fishers who had been active during each opening, typically by contacting them as they returned from fishing. Because USFWS analysts needed to process harvest and effort data to share with agency staff and the public within 24 hours, researchers did not have sufficient time to determine whether they obtained a census of fishers after each opening. Instead they relied on the expertise of local research assistants to identify all active fishers each survey day (see the Methods chapter of this report).

Researchers also traveled through the study areas (river sections A and B; Figure 2-2) by boat during 2018 fishing openings to count the number of boats actively fishing. The goal of these counts was to explore methods of expanding the sample of fishing harvest and effort data to calculate a total salmon harvest estimate for the observed fishing fleet each day. However, the number of fishers during each opening who provided fishing data for the daily fishing sample was too small to make statistically significant total harvest estimates for the fleet.

Data are presented here by study year for each opening and river study section. Data include number of sampled fishers; total sample harvest of Chinook, chum, and sockeye salmon; average soak time[1] for each fishing trip; average total harvest of Chinook, chum, and sockeye salmon per trip; average catches per unit effort (CPUE) of Chinook salmon and chum and sockeye salmon combined for a drift gillnet of the same length allowed by regulation for that day (i.e., 50 fm or 25 fm) and for one hour of fishing; average ratio of Chinook salmon to chum and sockeye salmon combined; and the average number of boats counted for each river study section.

Subsistence Salmon Harvest and Effort, and Boat Counts

2015 Season

During June 2015, subsistence fishers within the lower Kuskokwim River had three opportunities to fish for salmon in Section A and two opportunities to fish in Section B (Figure 2-2; Table 3-1). During all fishing

1. "Soak time" is commonly used to describe the amount of time during which a net is deployed into the water while fishing. It is identified as "fishing duration" in Table 3-2, Table 3-7, Table 3-12, and Table 3-17.

Table 3-1.–Subsistence salmon fishing opportunity by date and river section, lower Kuskokwim River, 2015.

Opening				
Date	River section	Max. allowed net length (fathoms)	Duration (hours)	Times
6/22/2015	A	50	4	1600–2000
6/26/2015	A	50	8	1400–2200
	B		4	1800–2200
6/30/2015	A	50	4	1400–1800
	B			

Source ADF&G Division of Subsistence, 2015.

openings in June 2015, subsistence salmon fishers were permitted to fish with a 50-fm (300 ft) drift gillnet with a stretch mesh of 6 in or less. The first subsistence salmon fishing opening occurred on June 22, 2015 in Section A from 4:00 p.m. to 8:00 p.m., a total of 4 hours. A second opening occurred on June 26 in Section A from 2:00 p.m. to 10:00 p.m. (8 hours fishing time) and in Section B from 6:00 p.m. to 10:00 p.m. (4 hours). On June 30 there was a fishing opening from 2:00 p.m. to 6:00 p.m. (4 hours) in both sections of the river.

On June 22, 2015, 7 fishers who fished in Section A reported their subsistence salmon harvest and effort in 21 total drifts during the opening (Table 3-2). The average boat harvested its catch in 3 drifts with a gillnet for a total soak time of 2.6 hours. The total sample harvest reported by all fishers was 63 Chinook salmon and 173 chum and sockeye salmon combined (Table 3-3). The average boat harvested 9 Chinook salmon and 25 chum and sockeye salmon per trip ratio of 1 Chinook salmon for every 2.7 chum and sockeye salmon combined. The average boat fished with a catch per unit effort (CPUE) of 4.9 Chinook salmon and 19.6 chum and sockeye salmon combined for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-4). No attempt to count boats occurred during the June 22 opening in Section A due to river conditions that were unsafe for boat travel (Table 3-5).

On June 26, 2015, 11 fishers who fished in Section A reported their subsistence salmon harvest and effort in 42 total drifts during the opening (Table 3-2). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.8 hr. The total sample harvest reported by all fishers was 41 Chinook salmon and 384 chum and sockeye salmon combined (Table 3-3). The average boat harvested 4 Chinook salmon and 35 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 9.4 chum and sockeye salmon combined. The average boat fished with a CPUE of 1.6 Chinook salmon and 15.1 chum and sockeye salmon combined for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-4). In boat-counting trips through Section A during the June 26 opening, researchers counted an average of 104 boats fishing in the section (Table 3-5).

Also on June 26, 5 fishers who fished in Section B reported their subsistence salmon harvest and effort in 13 total drifts during the opening (Table 3-2). The average boat harvested its catch in 3 drifts with a gillnet for a total soak time of 1.7 hr. The total sample harvest reported by all fishers was 14 Chinook salmon and 169 chum and sockeye salmon combined (Table 3-3). The average boat harvested 3 Chinook salmon and 34 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 12.1 chum and sockeye salmon combined. The average boat fished with a CPUE of 1.0 Chinook salmon and 38.8 chum and sockeye salmon combined for a 50-fm drift gillnet fishing for one hour in Section B (Table 3-4). In boat-counting trips through Section B during the June 26 opening, researchers counted an average of 29 boats fishing in the section (Table 3-5).

On June 30, 5 fishers who fished in Section A reported their subsistence salmon harvest and effort in 13 total drifts during the opening (Table 3-2). The average boat harvested its catch in 3 drifts with a gillnet for a total soak time of 2.2 hr. The total sample harvest reported by all fishers was 28 Chinook salmon and 138 chum and sockeye salmon combined (Table 3-3). The average boat harvested 6 Chinook salmon and

Table 3-2.–Reported fisher participation by date and river section, lower Kuskokwim River, 2015.

Opening		Fisher information			
Date	River section	Fishers contacted	Total drifts reported	Mean drifts per fisher	Mean fishing duration / fisher (hours)
6/22/2015	A	7	21	3	2.6
6/26/2015	A	11	42	4	2.8
6/26/2015	B	5	13	3	1.7
6/30/2015	A	5	13	3	2.2
6/30/2015	B	5	18	4	2.2

Source ADF&G Division of Subsistence inseason surveys, 2015.

Table 3-3.–Reported subsistence salmon catch by date, river section, and salmon species, lower Kuskokwim River, 2015.

Opening		Catch												
		Chinook salmon					Chum and sockeye salmon					Chinook : chum and sockeye		
Date	River section	Min.	Max.	Med.	Avg.	Tot.	Min.	Max.	Med.	Avg.	Tot.	Min	Max	Tot.
6/22/2015	A	2	33	5	9	63	6	57	20	24.7	173	1.2	10.0	2.7
6/26/2015	A	0	9	3	4	41	6	86	30	34.9	384	3.0	46.0	9.4
	B	0	10	1	3	14	6	53	42	33.8	169	4.3	42.0	12.1
6/30/2015	A	1	10	6	6	28	12	52	25	27.6	138	1.7	32.0	4.9
	B	2	12	11	9	43	21	111	51	58.2	291	3.1	10.5	6.8

Source ADF&G Division of Subsistence inseason surveys, 2015.

Table 3-4.–Catch per unit effort (CPUE) by date, river section, and salmon species, lower Kuskokwim River, 2015.

Opening		CPUE							
		Chinook salmon				Chum and sockeye salmon			
Date	River section	Min.	Max.	Med.	Avg.	Min.	Max.	Med.	Avg.
6/22/2015	A	0.8	10.5	4.4	4.9	2.5	54.3	8.3	19.6
6/26/2015	A	0.0	4.0	1.4	1.6	2.8	40.0	11.7	15.1
	B	0.0	3.2	0.7	1.0	2.8	128.6	21.2	38.8
6/30/2015	A	1.8	3.4	2.4	2.5	4.7	58.2	10.2	20.3
	B	2.9	7.2	3.4	4.0	9.5	34.9	30.6	26.4

Source ADF&G Division of Subsistence inseason surveys, 2015.

Table 3-5.–Boat counts by date and river section, lower Kuskokwim River, 2015.

Date	River section	Number of sample fishers contacted	Average number of boats counted
6/22/2015	A	7	*No data due to poor weather*
6/26/2015	A	11	104
	B	5	29
6/30/2015	A	5	67
	B	5	37

Source ADF&G Division of Subsistence inseason surveys, 2015.

28 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 4.9 chum and sockeye salmon combined. The average boat fished with a CPUE of 2.5 Chinook salmon and 20.3 chum and sockeye salmon combined for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-4). In boat-counting trips through Section A during the June 26 opening, researchers counted an average of 67 boats fishing in the section (Table 3-5).

Also on June 30, 5 fishers who fished in Section B reported their subsistence salmon harvest and effort in 18 total drifts during the opening (Table 3-2). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.2 hr. The total sample harvest reported by all fishers was 43 Chinook salmon and 291 chum and sockeye salmon combined (Table 3-3). The average boat harvested 9 Chinook salmon and 58 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 6.8 chum and sockeye salmon combined. The average boat fished with a CPUE of 4.0 Chinook salmon and 26.4 chum and sockeye salmon combined for a 50-fm drift gillnet fishing for one hour in Section B (Table 3-4). In boat-counting trips through Section B during the June 26 opening, researchers counted an average of 37 boats fishing in the section (Table 3-5).

2016 Season

During June and July 2016, subsistence fishers had four block openings to fish for salmon in both study sections A and B (Table 3-6). During all fishing openings, subsistence salmon fishers were permitted to fish with 6-inch or less stretch mesh drift gillnets with a maximum length of 50 fm in Section A and 25 fm in Section B. Also, both river sections were opened and closed to fishing at the same times throughout the season. The first block opening for subsistence salmon fishing occurred on June 12, 2016 for 12 hours from 12:00 p.m. to 11:59 p.m. The second block opening was for 24 hours and occurred from 12:00 p.m. June 16 until 12:00 p.m. June 17. From 12:00 P.M. June 21 through 12:00 PM June 24, there was a 72-hour subsistence salmon fishing opening in both river sections. Another 72-hour fishing opportunity opened at noon on June 29 and closed at noon on July 2. Because fishing conditions and fisher catch statistics can change rapidly each day, summary results for an opening that spans two or more days do not provide an accurate representation of the average sample fisher's experience. Thus, fisher data for 2016 are presented for each date during which fishing was permitted.

On June 12, 2016, 3 fishers who fished in Section A reported their subsistence salmon harvest and effort in 11 total drifts during the opening (Table 3-7). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 3.5 hr. The total sample harvest reported by all fishers was 10 Chinook salmon and 6 chum and sockeye salmon combined (Table 3-8). The average boat harvested 3 Chinook salmon and 2 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 0.6 chum and sockeye combined. The average boat fished with a CPUE of 1.3 Chinook salmon and 0.8 chum and sockeye combined for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-9). In boat-counting trips through Section A during the June 12 opening, researchers counted an average of 62 boats fishing in the section (Table 3-10).

Also on June 12, 4 fishers who fished in Section B reported their subsistence salmon harvest and effort in 22 total drifts during the opening (Table 3-7). The average boat harvested its catch in 6 drifts with a gillnet

Table 3-6.–Subsistence salmon fishing opportunity by date and river section, lower Kuskokwim River, 2016.

Opening					
Full opening dates and duration	Day of opening	River section	Max. allowed net length (fathoms)	Duration per day (hours)	Times
6/12/2016 (12 hours)	6/12/2016	A	50	12	1200–2359
		B	25		
6/16–17/2016 (24 hours)	6/16/2016	A	50	12	1200–2359
		B	25		
	6/17/2016	A	50	12	0000–1200
		B	25		
6/21–24/2016 (72 hours)	6/21/2016	A	50	12	1200–2359
		B	25		
	6/22/2016	A	50	24	0000 – 2359
		B	25		
	6/23/2016	A	50	24	0000 – 2359
		B	25		
	6/24/2016	A	50	12	0000 – 1200
		B	25		
6/29–7/2/2016 (72 hours)	6/29/2016	A	50	12	1200–2359
		B	25		
	6/30/2016	A	50	24	0000–2359
		B	25		
	7/1/2016	A	50	24	0000–2359
		B	25		
	7/2/2016	A	50	12	0000–1200
		B	25		

Source ADF&G Division of Subsistence, 2016.

Table 3-7.–Reported fisher participation by date and river scetion, lower Kuskokwim River, 2016.

Opening		Fisher information			
Date	River section	Fishers contacted	Total drifts reported	Mean drifts per fisher	Mean fishing duration / fisher (hours)
6/12/2016	A	3	11	4	3.5
	B	4	22	6	5.3
6/16/2016	A	1	5	N/A	3.8
	B	8	32	4	3.1
6/17/2016	B	7	26	4	2.8
6/21/2016	A	1	6	N/A	4.1
	B	8	35	4	2.9
6/22/2016	B	7	22	3	2.8
6/23/2016	B	7	15	2	1.5
6/24/2016	B	1	2	N/A	1.8
6/29/2016	B	3	8	3	1.9
6/30/2016	B	3	8	3	1.8
7/1/2016	B	5	14	3	2.3

Source ADF&G Division of Subsistence inseason surveys, 2016.

Table 3-8.–Reported subsistence salmon catch by date, river section, and salmon species, lower Kuskokwim River, 2016.

Opening		Catch												
		Chinook salmon					Chum and sockeye salmon					Chinook : chum and sockeye		
Date	River section	Min.	Max.	Med.	Avg.	Tot.	Min.	Max.	Med.	Avg.	Tot.	Min	Max	Tot.
6/12/2016	A	3	4	3	3	10	1	3	2	2.0	6	0.3	1.0	0.6
	B	2	25	8	11	43	1	7	2	3.0	12	0.1	1.0	0.3
6/16/2016	A	11	11	11	11	11	8	8	8	8.0	8	0.7	0.7	0.7
	B	2	21	8	9	69	1	15	4	6.3	50	0.2	1.3	0.7
6/17/2016	B	3	29	5	8	59	1	9	3	4.0	28	0.2	1.6	0.5
6/21/2016	A	4	4	4	4	4	10	10	10	10.0	10	2.5	2.5	2.5
	B	4	22	8	9	75	10	40	21	23.8	190	0.5	6.0	2.5
6/22/2016	B	1	26	5	9	63	6	83	30	30.3	212	0.7	32.0	3.4
6/23/2016	B	1	17	7	8	57	11	36	19	20.6	144	0.6	22.0	2.5
6/24/2016	B	5	5	5	5	5	7	7	7	7.0	7	1.4	1.4	1.4
6/29/2016	B	3	6	3	4	12	25	49	43	39.0	117	4.2	16.3	9.8
6/30/2016	B	0	3	1	1	4	13	55	28	32.0	96	18.3	28.0	24.0
7/1/2016	B	0	6	2	3	13	11	93	44	41.8	209	5.5	22.0	16.1

Source ADF&G Division of Subsistence inseason surveys, 2016.

Table 3-9.–Catch per unit effort (CPUE) by date, river section, and salmon species, lower Kuskokwim River, 2016.

Opening		CPUE							
	River	Chinook salmon				Chum and sockeye salmon			
Date	section	Min.	Max.	Med.	Avg.	Min.	Max.	Med.	Avg.
6/12/2016	A	0.5	2.3	1.2	1.3	0.3	1.5	0.5	0.8
	B	0.9	3.9	1.6	2.0	0.2	1.3	0.7	0.7
6/16/2016	A	2.9	2.9	2.9	2.9	2.1	2.1	2.1	2.1
	B	0.7	10.5	3.8	4.2	0.9	4.5	1.8	2.5
6/17/2016	B	0.5	12.0	3.0	4.7	0.3	3.0	2.1	1.9
6/21/2016	A	2.0	2.0	2.0	2.0	4.9	4.9	4.9	4.9
	B	1.2	16.0	4.7	5.6	1.7	44.0	8.3	15.2
6/22/2016	B	0.7	7.5	2.0	3.0	4.5	21.3	6.5	11.0
6/23/2016	B	0.5	18.5	4.9	7.1	10.2	28.5	12.0	15.0
6/24/2016	B	2.7	2.7	2.7	2.7	3.8	3.8	3.8	3.8
6/29/2016	B	1.4	2.6	2.4	2.2	10.0	43.2	20.6	24.6
6/30/2016	B	0.0	1.0	0.8	0.6	14.7	28.0	15.3	19.4
7/1/2016	B	0.0	3.0	0.8	1.4	8.9	46.5	15.3	20.5

Source ADF&G Division of Subsistence inseason surveys, 2016.

for a total soak time of 5.3 hr. The total sample harvest reported by all fishers was 43 Chinook salmon and 12 chum and sockeye salmon combined (Table 3-8). The average boat harvested 11 Chinook salmon and 3 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 0.3 chum and sockeye salmon combined. The average boat fished with a CPUE of 2.0 Chinook salmon and 0.7 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9). In boat-counting trips through Section B during the June 12 opening, researchers counted an average of 71 boats fishing in the section (Table 3-10).

One fisher who fished in Section A on June 16 reported subsistence salmon harvest and effort during the opening (Table 3-7). Eight fishers active in Section B reported their subsistence salmon harvest and effort in 32 total drifts during the opening. The average boat in Section B harvested its catch in 4 drifts with a gillnet for a total soak time of 3.1 hr. The total sample harvest reported by all fishers was 80 Chinook salmon and 58 chum and sockeye salmon combined (Table 3-8). The average boat in Section B harvested 9 Chinook salmon and 6 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 0.7 chum and sockeye combined. The average boat in Section B fished with a CPUE of 4.2 Chinook salmon and 2.5 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour (Table 3-9). In boat-counting trips through the study sections during the June 16 opening, researchers counted an average of 88 boats fishing in Section A and 41 boats fishing in Section B (Table 3-10).

On June 17, no participants reported fishing in Section A; however, 7 fishers active in Section B reported their subsistence salmon harvest and effort in 26 total drifts during the opening (Table 3-7). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.8 hr. The total sample harvest reported by all fishers was 59 Chinook salmon and 28 chum and sockeye salmon combined (Table 3-8). The average boat harvested 8 Chinook salmon and 4 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 0.5 chum and sockeye combined. The average boat fished with a CPUE of 4.7 Chinook salmon and 1.9 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour (Table 3-9). In boat-counting trips through Section B during the June 17 opening, researchers counted an average of 29 boats fishing in the section (Table 3-10).

One fisher who fished in Section A on June 21 reported subsistence salmon harvest and effort during the opening (Table 3-7). No fishing in Section A was reported for the remainder of the 2016 fishing season. Eight fishers active in Section B on June 21 reported their subsistence salmon harvest and effort in 35 total drifts during the opening. The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.9 hr. The total sample harvest reported by all fishers was 75 Chinook salmon and 190 chum and sockeye salmon combined (Table 3-8). The average boat harvested 9 Chinook salmon and 24 chum and

Table 3-10.–Boat counts by date and river section, lower Kuskokwim River, 2016.

Date	River Section	Number of sample fishers contacted	Average number of boats counted
6/12/2016	A	3	62
	B	4	71
6/16/2016	A	1	88
	B	8	41
6/17/2016	B	7	29
6/21/2016	A	1	27
	B	8	18
6/22/2016	B	7	20
6/23/2016	B	7	14
6/24/2016	B	1	16
6/29/2016	B	3	20
6/30/2016	B	3	9
7/1/2016	B	5	12

Source ADF&G Division of Subsistence inseason surveys, 2016.

sockeye salmon per trip at a ratio of one Chinook salmon for every 2.5 chum and sockeye combined. The average boat fished with a CPUE of 5.6 Chinook salmon and 15.2 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9). In boat-counting trips through both river sections during the June 21 opening, researchers counted an average of 27 boats fishing in Section A and 18 boats fishing Section B (Table 3-10).

On June 22 in Section B, 7 fishers reported their subsistence salmon harvest and effort in 22 total drifts during the opening (Table 3-7). The average boat harvested its catch in 3 drifts with a gillnet for a total soak time of 2.8 hr. The total sample harvest reported by all fishers was 63 Chinook salmon and 212 chum and sockeye salmon combined (Table 3-8). The average boat harvested 9 Chinook salmon and 30 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 3.4 chum and sockeye combined. The average boat fished with a CPUE of 3 Chinook salmon and 11 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9). In boat-counting trips through Section B during the June 22 opening, researchers counted an average of 20 boats fishing in the section (Table 3-10).

On June 23 in Section B, 7 fishers reported their subsistence salmon harvest and effort in 15 total drifts during the opening (Table 3-7). The average boat harvested its catch in 2 drifts with a gillnet for a total soak time of 1.5 hr. The total sample harvest reported by all fishers was 57 Chinook salmon and 144 chum and sockeye salmon combined (Table 3-8). The average boat harvested 8 Chinook salmon and 21 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 2.5 chum and sockeye combined. The average boat fished with a CPUE of 7.1 Chinook salmon and 12 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9). In boat-counting trips through Section B during the June 23 opening, researchers counted an average of 14 boats fishing in the section (Table 3-10).

One fisher who fished in Section B on June 24 reported subsistence salmon harvest and effort during the opening (Table 3-7). In boat-counting trips through Section B during the June 24 opening, researchers counted an average of 16 boats fishing in the section (Table 3-10).

On June 29, the first day of fishing in the final block opening of the 2016 season, 3 fishers reported their subsistence salmon harvest and effort in 8 total drifts in Section B (Table 3-7). The average boat harvested its catch in 3 drifts for a total soak time of 1.9 hr. The total sample harvest reported by all fishers was 12 Chinook salmon and 117 chum and sockeye salmon combined (Table 3-8). The average boat harvested 4 Chinook salmon and 39 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 9.8 chum and sockeye salmon combined. The average boat fished with a CPUE of 2.2 Chinook salmon and 24.6 chum and sockeye salmon combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9).

In boat-counting trips through Section B during the June 29 opening, researchers counted an average of 20 boats fishing in the section (Table 3-10).

On June 30, again 3 fishers reported their subsistence salmon harvest and effort in 8 total drifts in Section B (Table 3-7). The average boat harvested its catch in 3 drifts for a total soak time of 1.8 hr. The total sample harvest reported by all fishers was 4 Chinook salmon and 96 chum and sockeye salmon combined (Table 3-8). The average boat harvested 1 Chinook salmon and 32 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 24 chum and sockeye salmon combined. The average boat fished with a CPUE of 0.6 Chinook salmon and 19.4 chum and sockeye salmon combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9). In boat-counting trips through Section B during the June 30 opening, researchers counted an average of 9 boats fishing in the section (Table 3-10).

On July 1, 5 fishers reported their subsistence salmon harvest and effort in 14 total drifts in Section B (Table 3-7). The average boat harvested its catch in 3 drifts for a total soak time of 2.3 hr. The total sample harvest reported by all fishers was 13 Chinook salmon and 209 chum and sockeye salmon combined (Table 3-8). The average boat harvested 3 Chinook salmon and 42 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 16 chum and sockeye salmon combined. The average boat fished with a CPUE of 1.4 Chinook salmon and 20.5 chum and sockeye salmon combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-9). In boat-counting trips through Section B during the July 1 opening, researchers counted an average of 12 boats fishing in the section (Table 3-10).

2017 Season

In June and July 2017, lower Kuskokwim River fishers active within the two study sections had four block openings to fish for salmon for subsistence with drift gillnets (Table 3-11). During the first opening, on June 12 for 12 hours from noon to 11:59 p.m., fishers could deploy a 50-fm drift gillnet in Section A and a 25-fm drift gillnet in Section B. For the remaining three openings, fishers were permitted to use a 25-fm drift gillnet in both sections of river. These openings occurred on June 24 for 12 hours from noon to 11:59 p.m., July 1 for 6 hours from 3 p.m. to 9 p.m., and for 12 hours on July 3 from 12:00 p.m. to 11:59 p.m.

On June 12, 2017, 8 fishers who fished in Section A reported their subsistence salmon harvest and effort in 28 total drifts during the opening (Table 3-12). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.8 hr. The total sample harvest reported by all fishers was 21 Chinook salmon and 32 chum and sockeye salmon combined (Table 3-13). The average boat harvested 3 Chinook salmon and 4 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 1.5 chum and sockeye salmon combined. The average boat fished with a CPUE of 2.3 Chinook salmon and 3.8 chum and sockeye combined for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-14). In boat-counting trips through Section A during the June 12 opening, researchers counted an average of 74 boats fishing in the section (Table 3-15).

Also on June 12, 11 fishers who fished in Section B reported their subsistence salmon harvest and effort in 45 total drifts during the opening (Table 3-12). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.4 hr. The total sample harvest reported by all fishers was 26 Chinook salmon and 54 chum and sockeye salmon combined (Table 3-13). The average boat harvested 2 Chinook salmon and 5 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 2.1 chum and sockeye salmon combined. The average boat fished with a CPUE of 1.2 Chinook salmon and 2.0 chum and sockeye salmon combined for a 25-fm drift gillnet fishing for one hour in Section B (Table 3-14). In boat-counting trips through Section B during the June 12 opening, researchers counted an average of 65 boats fishing in the section (Table 3-15). No other fishers reported fishing in Section B for the remainder of the season.

On June 24, 22 fishers who fished in Section A reported their subsistence salmon harvest and effort in 82 total drifts during the opening (Table 3-12). The average boat harvested its catch in 4 drifts with a gillnet for a total soak time of 2.6 hr. The total sample harvest reported by all fishers was 104 Chinook salmon and 1,171 chum and sockeye salmon combined (Table 3-13). The average boat harvested 5 Chinook salmon and 53 chum and sockeye salmon per trip at a ratio of one Chinook salmon for every 11.3 chum and sockeye salmon combined. The average boat fished with a CPUE of 3.1 Chinook salmon and 41.4 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour in Section A (Table 3-14). In boat-counting trips

Table 3-11.–Subistence salmon fishing opportunity by date and river section, lower Kuskokwim River, 2017.

Opening				
Date	River section	Max. allowed net length (fathoms)	Duration (hours)	Times
6/12/2017	A	50	12	1200–2359
	B	25		
6/24/2017	A	25	12	1200–2359
	B			
7/1/2017	A	25	6	1500–2100
	B			
7/3/2017	A	25	12	1200–2359
	B			

Source ADF&G Division of Subsistence, 2017.

Table 3-12.–Reported fisher participation by date and river section, lower Kuskokwim River, 2017.

Opening		Fisher information			
Date	River section	Fishers contacted	Total drifts reported	Mean drifts per fisher	Mean fishing duration / fisher (hours)
6/12/2017	A	8	28	4	2.8
6/12/2017	B	11	45	4	2.4
6/24/2017	A	22	82	4	2.6
7/1/2017	A	7	12	2	0.9
7/3/2017	A	10	15	2	0.9

Source ADF&G Division of Subsistence inseason surveys, 2017.

Table 3-13.–Reported subistence salmon catch by date, river section, and salmon species, lower Kuskokwim River, 2017.

Opening		Catch												
		Chinook salmon					Chum and sockeye salmon					Chinook : chum and sockeye		
Date	River section	Min.	Max.	Med.	Avg.	Tot.	Min.	Max.	Med.	Avg.	Tot.	Min	Max	Tot.
6/12/2017	A	0	8	3	3	21	0	10	4	4.0	32	0.3	6.0	1.5
	B	1	7	2	2	26	0	11	4	4.9	54	0.0	8.0	2.1
6/24/2017	A	0	21	4	5	104	10	111	59	53.2	1,171	3.1	41.5	11.3
7/1/2017	A	0	4	0	1	7	24	118	75	76.7	537	29.5	91.0	76.7
7/3/2017	A	0	2	0	0	3	5	130	44	50.0	500	19.0	37.5	166.7

Source ADF&G Division of Subsistence inseason surveys, 2017.

Table 3-14.–Catch per unit effort (CPUE) by date, river section, and salmon species, lower Kuskokwim River, 2017.

Opening		CPUE							
		Chinook salmon				Chum and sockeye salmon			
Date	River section	Min.	Max.	Med.	Avg.	Min.	Max.	Med.	Avg.
6/12/2017	A	0.0	8.0	0.9	2.3	0.0	20.0	1.1	3.8
	B	0.1	3.2	0.6	1.2	0.0	6.4	1.4	2.0
6/24/2017	A	0.0	18.0	1.2	3.1	4.5	180.0	19.1	41.4
7/1/2017	A	0.0	3.5	0.0	0.9	35.5	514.3	102.6	170.9
7/3/2017	A	0.0	4.0	0.0	0.5	13.3	225.6	75.0	80.5

Source ADF&G Division of Subsistence inseason surveys, 2017.

Table 3-15.–Boat counts by date and river section, lower Kuskokwim River, 2017.

Date	River Section	Number of sample fishers contacted	Average number of boats counted
6/12/2017	A	8	74
	B	11	65
6/24/2017	A	22	26
7/1/2017	A	7	15
7/3/2017	A	10	1

Source ADF&G Division of Subsistence inseason surveys, 2017.

through Section A during the June 24 opening, researchers counted an average of 26 boats fishing in the section (Table 3-15).

On July 1, 7 fishers who fished in Section A reported their subsistence salmon harvest and effort in 12 total drifts during the opening (Table 3-12). The average boat harvested its catch in 2 drifts with a gillnet for a total soak time of 0.9 hr. The total sample harvest reported by all fishers was 7 Chinook salmon and 537 chum and sockeye salmon combined (Table 3-13). The average boat harvested 1 Chinook salmon and 77 chum and sockeye salmon per trip, which was also the catch ratio of Chinook salmon to chum and sockeye salmon combined. The average boat fished with a CPUE of 0.9 Chinook salmon and 170.9 chum and sockeye combined for a 25-fm drift gillnet fishing for one hour in Section A (Table 3-14). In boat-counting trips through Section A during the July 1 opening, researchers counted an average of 15 boats fishing in the section (Table 3-15).

Following the July 3 opening, ten fishers who fished in Section A reported their subsistence salmon harvest and effort in 15 total drifts during the opening (Table 3-12). The average boat harvested its catch in 2 drifts with a gillnet for a total soak time of 0.9 hr. The total sample harvest reported by all fishers was 3 Chinook salmon and 500 chum and sockeye salmon combined (Table 3-13). The average boat harvested no Chinook salmon and 50 chum and sockeye salmon per trip. The overall catch ratio for the sample was one Chinook salmon for every 167 chum and sockeye salmon combined. The average boat fished with a CPUE of 0.5 Chinook salmon and 80.5 chum and sockeye salmon combined for a 25-fm drift gillnet fishing for one hour in Section A (Table 3-14). In boat-counting trips through Section A during the July 1 opening, researchers counted an average of one boat fishing in the section (Table 3-15).

2018 Season

Subsistence salmon fishers in the two river sections of the lower Kuskokwim River had five opportunities to fish with drift gillnets in 2018 (Table 3-16). For all five openings in both river sections, fishers could deploy a 50-fm drift gillnet in Section A and a 25-fm gillnet in Section B. Subsistence salmon fishing openings occurred June 12, 2018 for 12 hours from 10:00 a.m. to 10:00 p.m. and again for the same hours on June 16 and June 24. On June 29, subsistence drift gillnet fishers could fish for 6 hours from noon to 6:00 p.m. and on July 5 for 12 hours from 9:00 a.m. to 9:00 p.m.

During June and July 2018, Division of Subsistence staff conducted dockside creel surveys in Kasigluk and Atmautluak. Surveys recorded respondents' subsistence salmon harvest and effort for each opening. During the same time, researchers of various other agencies working in multiple lower Kuskokwim River communities conducted creel surveys identical to those that division staff deployed in Kasigluk and Atmautluak (see the Methods chapter of this report). In order to maintain consistency in data collection methods among all agencies conducting creel surveys, division researchers altered methods from previous study years by recording total soak time for all survey respondents. Thus, Table 3-17 presents total soak time as a single drift for each respondent during each opening.

On June 12, 2018, Division of Subsistence staff conducted dockside creel surveys with ten fishers in Kasigluk and Atmautluak, all of whom who fished in Section A (Table 3-17). The average boat fished with a drift gillnet for a total soak time of 5.0 hr. The total sample harvest reported by all fishers was 157 Chinook salmon and 59 chum and sockeye salmon combined (Table 3-18). The average catch was 16 Chinook salmon and 6 chum and sockeye salmon combined per trip. The overall catch ratio for the sample was one Chinook salmon for every 0.4 chum and sockeye salmon combined. The average boat fished with a CPUE of 8.6 Chinook and 3.7 chum and sockeye salmon for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-19). During the June 12 opening in Section A, researchers counted an average of 61 boats actively fishing through the section (Table 3-20). No respondents reported fishing in Section B that day.

On June 16, 2018, division staff conducted dockside creel surveys with 6 fishers in Kasigluk and Atmautluak who fished in Section A (Table 3-17). The average boat fished with a drift gillnet for a total soak time of 5.2 hr. The total sample harvest reported by all fishers in Section A was 29 Chinook salmon and 48 chum and sockeye salmon combined (Table 3-18). The average catch was 5 Chinook salmon and 8 chum and sockeye salmon combined per trip. The overall catch ratio for the sample was one Chinook salmon for every 1.7

Table 3-16.–Subsistence salmon fishing opportunity by date and river section, lower Kuskokwim River, 2018.

Opening				
Date	River section	Max. allowed net length	Duration (hours)	Times
6/12/2018	A	50	12	1000–2200
	B	25		
6/16/2018	A	50	12	1000–2200
	B	25		
6/24/2018	A	50	12	1000–2200
	B	25		
6/29/2018	A	50	6	1200–1800
	B	25		
7/5/2018	A	50	12	0900–2100
	B	25		

Source ADF&G Division of Subsistence, 2018.

Table 3-17.–Reported fisher participation by date and river section, lower Kuskokwim River, 2018.

Opening		Fisher information			
Date	River section	Fishers contacted	Total drifts reported	Mean drifts per fisher	Mean fishing duration / fisher (hours)
6/12/2018	A	10	10	1	5.0
6/16/2018	A	6	7	1	5.2
	B	1	1	N/A	0.5
6/24/2018	A	16	16	1	4.0
	B	1	1	N/A	2.5
6/29/2018	A	16	16	1	2.1
	B	1	1	N/A	6.0
7/5/2018	A	2	2	1	3.5

Source ADF&G Division of Subsistence inseason creel surveys, 2018.

Table 3-18.–Reported subsistence salmon catch by date, river section, and salmon species, lower Kuskokwim River, 2018.

Opening		Catch												
		Chinook salmon					Chum and sockeye salmon					Chinook : chum and sockeye		
Date	River section	Min.	Max.	Med.	Avg.	Tot.	Min.	Max.	Med.	Avg.	Tot.	Min	Max	Tot.
6/12/2018	A	6	32	16	16	157	1	13	6	5.9	59	0.2	0.7	0.4
6/16/2018	A	0	11	3	5	29	0	34	2	8.0	48	0.0	3.1	1.7
	B	7	7	7	7	7	4	4	4	4.0	4	0.6	0.6	0.6
6/24/2018	A	2	34	19	18	292	25	154	59	65.0	1,040	1.0	25.0	3.6
	B	10	10	10	10	10	26	26	26	26.0	26	2.6	2.6	2.6
6/29/2018	A	1	11	4	5	84	39	195	75	84.4	1,350	5.5	100.0	16.1
	B	5	5	5	5	5	60	60	60	60.0	60	12.0	12.0	12.0
7/5/2018	A	0	4	2	2	4	35	98	67	66.5	133	24.5	24.5	33.3

Source ADF&G Division of Subsistence inseason creel surveys, 2018.

chum and sockeye salmon combined. The average boat fished with a CPUE of 0.7 Chinook and 1.0 chum and sockeye salmon for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-19). During the June 16 opening in Section A, researchers counted an average of 66 boats fishing in the section (Table 3-20). Also on June 16, division staff conducted dockside a creel survey with 1 fisher in Kasigluk who fished in Section B, where staff counted an average of 36 boats for the day.

On June 24, division staff conducted dockside creel surveys with 16 fishers in Kasigluk and Atmautluak who fished in Section A (Table 3-17). The average boat fished with a drift gillnet for a total soak time of 4 hr. The total sample harvest reported by all fishers was 292 Chinook salmon and 1,040 chum and sockeye salmon combined (Table 3-18). The average catch was 18 Chinook salmon and 65 chum and sockeye salmon combined per trip. The overall catch ratio for the sample was one Chinook salmon for every 3.6 chum and sockeye salmon combined. The average boat fished with a CPUE of 14.6 Chinook salmon and 33.9 chum and sockeye salmon for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-19). During the June 24 opening in Section A, researchers counted an average of 44 boats fishing in the section (Table 3-20). Also on June 24, 1 survey respondent reported fishing in Section B, where staff counted an average of 27 boats for the day.

On June 29, division staff conducted dockside creel surveys with 16 fishers in Kasigluk and Atmautluak who fished in Section A (Table 3-17). The average boat fished with a drift gillnet for a total soak time of 2.1 hr. The total sample harvest reported by all fishers was 84 Chinook salmon and 1,350 chum and sockeye salmon combined (Table 3-18). The average catch was 5 Chinook salmon and 84 chum and sockeye salmon combined per trip. The overall catch ratio for the sample was one Chinook salmon for every 16.1 chum and sockeye salmon combined. The average boat fished with a CPUE of 4.4 Chinook salmon and 92.0 chum and sockeye salmon for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-19). During the June 29 opening in Section A, researchers counted an average of 39 boats fishing for the day in Section A (Table 3-20). One survey respondent reported fishing in Section B, where staff counted an average of 19 boats for the day.

On July 5, the final day of block openings for 2018 subsistence salmon fishing in the lower Kuskokwim River, division staff conducted dockside creel surveys with 2 fishers in Kasigluk and Atmautluak who fished in Section A (Table 3-17). The average boat fished with a drift gillnet for a total soak time of 3.5 hr. The total sample harvest reported by all fishers was 4 Chinook salmon and 133 chum and sockeye salmon combined (Table 3-18). The average catch was 2 Chinook salmon and 67 chum and sockeye salmon combined per trip. The overall catch ratio for the sample was one Chinook salmon for every 33.3 chum and sockeye salmon combined. The average boat fished with a CPUE of 0.5 Chinook salmon and 18.1 chum and sockeye salmon for a 50-fm drift gillnet fishing for one hour in Section A (Table 3-19). No surveys were conducted with fishers who had fished in Section B. Research staff were not available to count boats fishing in either section during the July 5 opening (Table 3-20).

Table 3-19.–Catch per unit effort (CPUE) by date, river section, and salmon species, lower Kuskokwim River, 2018.

Opening		CPUE							
	River	Chinook salmon				Chum and sockeye salmon			
Date	section	Min.	Max.	Med.	Avg.	Min.	Max.	Med.	Avg.
6/12/2018	A	1.0	41.2	2.7	8.6	0.2	20.6	1.3	3.7
6/16/2018	A	0.0	1.3	0.5	0.7	0.0	3.2	0.5	1.0
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/24/2018	A	1.0	154.4	4.7	14.6	6.5	251.6	17.5	33.9
	B	4.0	4.0	4.0	4.0	10.4	10.4	10.4	10.4
6/29/2018	A	0.5	20.0	3.2	4.4	11.1	390.0	35.6	92.0
	B	0.8	0.8	0.8	0.8	10.0	10.0	10.0	10.0
7/5/2018	A	0.0	1.0	0.5	0.5	11.7	24.5	18.1	18.1

Source ADF&G Division of Subsistence inseason creel surveys, 2018.

Table 3-20.–Boat counts by date and river section, lower Kuskokwim River, 2018.

Date	River Section	Number of sample fishers contacted	Average number of boats counted
6/12/2018	A	10	61
6/16/2018	A	6	66
	B	1	36
6/24/2018	A	16	44
	B	1	27
6/29/2018	A	16	39
	B	1	19
7/5/2018	A	2	*No data due to absence of staff*

Source ADF&G Division of Subsistence inseason creel surveys, 2017.

4. DISCUSSION AND CONCLUSIONS

Discussion of Study Outcomes

The goal of this study was to assess the feasibility of estimating harvest in a section of the lower Kuskokwim River during subsistence salmon fishing openings. During study years 2015–2017, research staff recruited a cohort of participating fishers to act as field research technicians while they fished with drift gillnets during subsistence salmon fishing openings in the Kuskokwim River from near the communities of Oscarville and Napaskiak to a point approximately 26 miles downstream. Participating fishers recorded the dimensions of their drift gillnets, the amount of time of each drift, and the number of Chinook, chum, and sockeye salmon they harvested in each drift. Researchers contacted participants following fishing openings and recorded fishers' harvest information. Researchers then calculated average effort statistics as CPUE for the sample for each opening. Staff also counted fishing boats during subsistence salmon fishing openings and calculated an average boat count. The intent of the boat counts was to estimate the fleet size during each day of fishing and evaluate an estimate of total salmon harvest by expanding the effort statistics of the sample to the total fleet.

The proposed objective of estimating total harvest for the study area was not achieved with these methods. The number of sample fishers in contact with researchers after each fishing opening was not sufficient to provide reliable harvest estimates for each opening. Broad confidence intervals in harvest estimates demonstrated the low likelihood that results were statistically significant. This aspect of the study results remained inconclusive, and thus, the study results were not applicable to inseason management decisions that may have required robust harvest estimates.

The small samples of fishers obtained for each opening demonstrate the methods' poor feasibility. Small samples were achieved for a number of reasons, all of which elucidate the challenges experienced with the study. Immediately prior to the 2015, 2016, and 2017 fishing seasons in May of each year, research staff made several trips to study communities to recruit participating fishers for harvest and effort data collection. The first recruitment trips of the season typically resulted in a cohort of approximately 20 to 30 volunteers among all communities. Staff made additional trips to recruit more volunteers with the understanding that despite each participating fisher's intentions to commit to inseason data collection, many volunteers would drop out of the study or be unable to provide the necessary data for a variety of reasons. Research staff discovered that by the first fishing opening many fishers either did drop out of the study or could not be contacted. Furthermore, as was expected, not every participant would be able or would choose to fish during any given opening. Some could not fish due to a job or family schedule that conflicted with the fishing schedule. Others experienced equipment failures or did not have the resources to go fishing for every opening. Many fishers either stopped fishing after two or three fishing opportunities, or substantially reduced their effort as the season progressed. Nonetheless, given sufficient overall fisher participation in the study, these factors affecting individual participation would not have been a limitation on developing harvest estimates.

A portion of the recruited fishers continued to participate as expected both by successfully fishing and by recording harvest and effort data as instructed. However, most fishers did not follow instructions to proactively contact research staff to transfer their recorded data after they were done fishing each opening. Therefore, research staff took the initiative to call participating fishers at the end of each day that they could have fished. When staff were unable to contact all fishers, the potential sample size diminished further. Despite sufficient training prior to the fishing season and despite the requirement that all participants provide a valid phone number to research staff, many fishers chose not to return phone calls and many telephone numbers were found to be either disconnected from service or for a telephone belonging to another person, usually a family member. Within approximately 24 to 48 hours following a fishing opportunity, research staff had obtained all possible data from participants who could be contacted. The number of successful contacts was usually a small fraction of the full list of potential fishers.

Other Division of Subsistence studies have evaluated methods of inseason community-based harvest assessment in rural Alaska communities. In 2007, the division completed a study to evaluate the effectiveness of community-based inseason harvest surveys for the Alaska Migratory Bird Co-Management Council annual bird harvest survey throughout rural Alaska (Naves et al. 2008). Naves et al. (2008) determined that survey technicians performed best when researchers implemented effective and efficient training protocols, among other recommendations. These needed to be accompanied by a clear chain of supervision from agency researcher to community survey technician with consistent and reliable communication between the two. In an inseason salmon harvest assessment study similar to the study discussed in this report, division staff trained local research assistants in two Yukon River communities to complete household salmon harvest surveys immediately following each fishing opening during the 2013 and 2014 salmon fishing seasons (Brown and Jallen 2019). Although the methodology between Yukon and Kuskokwim river inseason harvest assessment projects differed significantly, they shared the same principal approach of training local technicians to complete all data collection tasks independently during or immediately following each fishing opportunity. None of the technicians in either study were agency employees; rather, they were under contract with representatives of ADF&G whose responsibility was to train local technicians in data collection methods in person and then supervise their efforts remotely.

Researchers in Yukon River communities noted several critical factors that affected the quality of survey results under these circumstances. Training in survey techniques was critical to the success of data collection efforts. Not only do technicians need effective instruction in how to ask all survey questions properly and to accurately record responses, they must also be trained to understand how the individual survey questions relate to the objectives and scope of the research project. Without clear understanding of the purpose of recording the data requested, technicians were much more likely to misinterpret questions or exclude information that they believed to be unnecessary for completion of their tasks. Technicians also needed to anticipate challenging circumstances that can disrupt the survey process. For example, technicians must be prepared to address common misunderstandings that respondents may experience when interpreting and answering survey questions. Technicians should anticipate that unexpected problems will arise occasionally, and they must be able to troubleshoot and find solutions in the field without immediate guidance from their ADF&G research supervisor. Typically, a community-based harvest assessment project operated by a government agency or a local nonprofit organization has limited time and funding resources, which prevents researchers from effectively training all local technicians, regardless of their ability level, to the point of mastery of the required survey administration and data management skills.

An additional concern with community-based harvest assessment is the difficulty in maintaining consistency of data collection techniques and data quality. High variability in the skills of local technicians will result in inconsistent survey quality. Technicians with good reading and comprehension skills and who possess an initiative to engage frequently and positively with respondents will be most likely to show consistently high quality in their data collection. The same is also true for technicians who are reliably available to work, often on an irregular schedule. Some technicians were challenged by data collection techniques or, as was not unusual in the Kuskokwim River project, were unlikely to initiate the critical step of transferring data to ADF&G researchers for analysis immediately following a fishing opening. In both the Yukon and Kuskokwim river projects, poor comprehension of data collection techniques and lack of adherence to essential data collection and data management protocols resulted in data of poor quality or the absence of data. For both projects, researchers experienced higher data quality results when veteran technicians returned in subsequent fishing seasons to continue participation in the study. These individuals consistently improved their data collection skills and exhibited a good capacity to complete all assigned tasks accurately and efficiently. Still, several participants in the 2015, 2016, and 2017 data collection efforts showed great enthusiasm for the project and an ability to complete all expected tasks while fishing. These individuals tended to be higher harvesters who were providing fish for multiple households. They also typically expressed a sincere interest in the value of the research objectives as an important public service to which they could contribute.

In 2018, Division of Subsistence staff shifted its research target to the new study communities of Atmautluak and Kasigluk (see Methods chapter of this report). Staff conducted creel surveys in these communities and again achieved small sample sizes. Atmautluak is a very small community with relatively few fishers, so

there was little potential for completion of many surveys.[1] Kasigluk is a relatively large community for the region, but sample sizes there were small due to unexpected tragic events that transpired there during the fishing season. These important community events affected most of the households in Kasigluk and prevented many fishers from participating in the fishery in 2018. Thus, creel survey sample sizes in Kasigluk were also very small, despite the preseason expectation that many fishers would be active participants.

Although ADF&G staff experienced multiple challenges, the study accomplished a number of important successes. One clear benefit of the project was that, despite small sample sizes, fisher data were able to supplement other sources of information that managers and stakeholders needed to consider during management meetings. Any source of demonstrably reliable, albeit potentially not universally representative, catch data had the potential to provide an index of the average fisher's experience, regardless of whether the data were expanded to broader harvest estimates. This study recorded real harvest amounts of actual fishers and calculated their CPUE and catch ratio values, which although possibly not statistically significant, still provided an insight into fishing that day. Catch ratios can be particularly informative, especially when paired with other inseason data sources that track run timing throughout the drainage such as the test drift gillnet fisheries operated at Bethel and Aniak. Run timing estimates informed by catch ratios are critical to managers when they need to determine the point at which the average fisher is likely to catch multiple chum and sockeye salmon and only a very small number of Chinook salmon. When this point in the concurrent runs is detected, managers can relax fishing restrictions and expect that fishers will catch their personal daily limits of fish without jeopardizing Chinook salmon conservation efforts. Such an application of Chinook salmon to chum and sockeye salmon catch ratios from inseason harvest monitoring surveys has been implemented in critical management decisions since at least 2015.[2]

Perhaps a greater success arose with the development of excellent working relationships with the communities of Oscarville, Napakiak, and Nunapitchuk over the first three study years. Each year, staff conducted long, informal community approval meetings during which they encouraged community members to discuss all aspects of the project. Discussions at these community meetings often expanded into broad conversations about community concerns regarding the state of subsistence salmon fishing in the Kuskokwim River. This gave ADF&G staff many opportunities to provide much-needed outreach, education, and support for remote communities that rarely consult directly with management agencies. Staff answered questions and clarified important management and regulatory actions related to fishing. Community members were also able to provide their recommendations for managers.

Similar outreach and education opportunities occurred with individual participating fishers, as well. Research staff developed strong working relationships with many participating fishers, particularly those who chose to volunteer for multiple seasons. Their participation in the study gave them an opportunity to engage directly in the management process by contributing useful data. Many of these fishers increased their awareness of the utility of harvest data collection, its importance in managing fisheries, and the value of stakeholder participation in efforts to improve fishery management.

Outreach to fishers was not limited to staff's work in communities. Researchers also provided information and assistance to fishers while they were on the river during boat-counting surveys. Research staff avoided disturbing active fishers mainly out of respect for fisher privacy and also to avoid interfering in the normal operation of the fishery. However, by being available and present during openings, much like the social science method of participant-observation, on numerous occasions staff experienced opportunities to have positive interactions with fishers while on the water. Sometimes these interactions were friendly conversations about the day's fishing; other times staff provided fishers pertinent information about current fishing regulations. The value of building positive relationships between department staff and fishers should not be understated.

1. Although a small number of surveys in Atmautluak may have provided a representative sample of that community's fishing harvest and effort each opening, the relative contribution of those few surveys to a sample of all fishing households in the study was negligible.
2. Aaron Tiernan, ADF&G Division of Commercial Fisheries, Kuskokwim Area Management Biologist, Personal communication with author, April 17, 2019.

Comparison with a Similar and Concurrent Study

Historically, Kuskokwim Area fishery managers have not directly applied a comprehensive and quantitative inseason estimate of subsistence harvests from consecutive salmon fishing openings in their decisions whether to allow for additional fishing openings. Since 2012, consistently lower than average Chinook salmon run sizes have resulted in a fishery management regime with the primary goal of Chinook salmon conservation, particularly during the early part of the season when migrating adults of that species are most abundant in the mainstem Kuskokwim River where the majority of fishing occurs. Therefore, decisions to allow fishing have primarily been based upon management agencies' putative knowledge of Chinook salmon run strength in season. Management's assessments of run strength are based upon various sources of information. These sources include a preseason Chinook salmon run size forecast projected from a maximum likelihood quantitative run reconstruction model (Liller et al. 2018) and inseason assessment projects that estimate run strength and run timing. The primary inseason assessment projects are ADF&G's Bethel Test Fishery and qualitative interviews of subsistence fishers conducted in the Bethel area by Orutsararmiut Native Council (ONC) technicians in cooperation with ADF&G (Lipka and Tiernan 2018). These sources of information are supplemented by other qualitative assessments of harvest and run timing by subsistence fishers during inseason meetings with the Working Group and KRITFC.

At the time of publication of this report, ADF&G had not implemented a systematic inseason harvest assessment research program in the Kuskokwim Area; however, since 2015 and noted in the Methods chapter of this report, USFWS in collaboration with KRITFC had deployed a quantitative harvest estimation project in a portion of the lower Kuskokwim River within the boundaries of the Yukon Delta National Wildlife Refuge (YDNWR; Staton 2018). Justification for the USFWS inseason harvest estimation project came following Federal Special Actions (FSA) enacted by the Federal Subsistence Board (FSB) beginning in 2014 that directed the USFWS to assume management of the Chinook salmon subsistence fishery in the Kuskokwim River within the boundaries of the YDNWR. The FSB's rationale for the FSAs was that years of lower than average Chinook salmon returns and subsequent unprecedented salmon fishing restrictions had prevented subsistence fishers from meeting their annual needs for salmon. Under the Alaska National Interest Lands Conservation Act (ANILCA; 16 U.S. Code § 51), each year the FSAs required the USFWS to ensure that federally qualified rural subsistence users had a priority over all other fishers to harvest Kuskokwim River Chinook salmon, the species for which management agencies deemed special conservation measures were necessary.

From 2015 through 2018, USFWS deployed a project that included dockside fisher creel surveys and aerial boat-counting surveys during each fishing opening. The ADF&G study described in this report assisted with those creel surveys in 2018 in Atmautluak and Kasigluk. Surveys provided a harvest and effort sample from fishers contacted primarily at the Bethel boat harbor as well as several outlying communities. The aerial boat-counting surveys provided a sample of the fishing fleet size in sections of the lower Kuskokwim River during each opening. In the simplest of terms, fisher harvest and effort data from USFWS creel surveys were used to calculate an average salmon catch per boat per opening. The average catch was expanded to an estimated total fleet size to calculate an estimated total salmon catch per opening. For a complete description of the USFWS creel survey project methods, results, and conclusions see Staton (2018). In 2016 and 2017, USFWS and KRITFC utilized Chinook salmon harvest estimates to determine fisher progress toward a total harvest target for the season. The two organizations had set this harvest target and a Chinook salmon escapement target prior to the 2016 and 2017 fishing seasons. They determined that these targets were their primary management goals each season.

With a large staff of creel surveyors that included employees of USFWS, the KRITFC, and ONC, that project had the capacity to contact several hundred fishers during each opening. This critical factor provided the sample sizes necessary to make statistically significant harvest estimates with reasonably narrow confidence intervals. As a result of the reliable harvest estimates and the ability to apply those estimates to a specific harvest target, the managers have generally considered the USFWS and KRITFC collaborative study to be a success. However, that project also faced some challenges. For example, each study year the majority of creel surveys resulted from fisher contacts in the Bethel boat harbor. Bethel households tend to catch fewer

Chinook salmon than fishing households in other lower Kuskokwim River communities (Runfola et al. 2017).[3] Thus, a survey sample biased in favor of Bethel respondents potentially underestimated total harvest. Expanding survey efforts to outlying communities is necessary, but difficult. Some communities have been unable to provide local staff to survey fishers, which requires that agency staff travel to remote locations for one- or two-day survey trips. Other practical challenges arise in small communities. For example, many lack a central harbor or a boat dock, which often results in fishers landing at multiple locations throughout the community when they return from fishing. Surveyors then must attempt to contact fishers who are dispersed throughout the community, increasing the likelihood of missing a number of potential survey respondents. In 2018, ADF&G staff addressed this issue by deploying a snowball sampling technique to identify and contact as many fishers as possible.

USFWS and KRITFC efforts to expand creel survey data collection from Bethel into other smaller and more remote lower Kuskokwim River communities faced the same pitfalls that division researchers experienced in this study, as well as in the ADF&G Division of Subsistence inseason migratory bird and inseason salmon harvest assessment studies discussed earlier in this chapter (Brown and Jallen 2019; Naves et al. 2008). The USFWS and KRITFC training methods may not have effectively prepared a large enough corps of capable and reliable community-based data technicians to work in communities other than Bethel. Although in some remote communities data collection was relatively successful, in other communities technicians provided very small numbers of completed surveys after each opening or failed to record any fishing data at all. Researchers from USFWS, KRITFC, other tribal organizations, and the project's funding organization conducted survey training workshops each year in Bethel prior to the fishing season. Survey technicians from all participating communities attended. A Division of Subsistence researcher was also invited to meetings in 2017 and 2018 and attended. Division staff observed that several topics in the training agenda focused primarily on background information about the project's goals and need, the role of tribal organizations in the management process, and justification for social science research in fishery management. These were all important and valuable points of discussion, especially because trainers also desired to develop their staff's awareness of these issues as a way to motivate and inspire young technicians to choose careers in fisheries management, an essential and laudable service to the subsistence fishing communities that the organizations represent. However, a noticeable portion of the instruction was not directly applicable to the skill development needed for successful harvest data collection inseason.

The experiences described in Naves et al. (2008) and Brown and Jallen (2019) and experiences of multiple other survey projects completed by Division of Subsistence staff demonstrate the need for efficient and effective survey technician training methods that focus on the following critical aspects of quality data collection: 1) knowledge and comprehension of the survey questionnaire; 2) effective methods of asking survey questions and recording survey responses in a manner that is consistently precise and accurate; 3) ability to anticipate and appropriately respond to unexpected difficulties when conducting surveys and interacting with respondents; and 4) development of logistical and organizational skills for survey implementation and data management in the field. Although project background is important for understanding the purpose and scope of a study, it should be discussed briefly and with the goal of providing technicians with the information they will need to explain the purpose and scope of the project to survey respondents, particularly when disclosing the ways in which respondent harvest data will be applied to management and regulation.

Creel surveys are commonly deployed in many fisheries worldwide, which suggests their value as an inseason management tool (Jones and Pollock 2012). Fishery managers have also utilized these methods in many artisanal commercial and subsistence fisheries worldwide (see McCluskey and Lewison 2008; Padilla and Trinidad 1995; Pelletier and Ferraris 2000). However, in North America creel surveys are most often deployed in recreational fisheries, and respondents are unlikely to be contacted by researchers on more than one occasion. When creel surveys are deployed in the lower Kuskokwim River during multiple subsistence fishing openings each season, fishers are likely to be contacted by a surveyor each day they return home or

3. Lipka, C., D.S. Koster, M. Horne-Brine. *In prep.* Subsistence salmon harvests in the Kuskokwim Area, 2017. Alaska Department of Fish and Game Fishery Data Series, Anchorage.

to a boat harbor after fishing. This can result in survey fatigue among respondents, which can bias survey results in favor of people who possess the will to withstand multiple surveys or even increase the chance that respondents will become annoyed and give incomplete, misleading, or even false information in order to end the survey quickly or avoid it altogether. Survey fatigue can also diminish the likelihood that fishing households will agree to participate in the equally important postseason household harvest survey project that occurs each year in the Kuskokwim Area. The USFWS inseason harvest assessment project provides harvest estimates that quantify and track Chinook salmon catches roughly through the end of the Chinook salmon season. Recently that has been the point in the season when USFWS has ended the FSA to manage the salmon fishery, and management authority in YDNWR waters returns to ADF&G. The USFWS project has not coordinated with postseason survey efforts; for example, by storing inseason data by household identifiers to be retrieved during a postseason survey and shared with respondents to assist them with recall.

Both the ADF&G harvest and effort project that recruited volunteer fishers and the USFWS project that deployed creel surveys encountered challenges in their research. Both were labor intensive projects that required multiple staff to contribute hundreds of person-hours in a 24- to 48-hour period to obtain data from each opening. Boat-counting surveys required expensive and potentially dangerous travel by airplane or boat for several hours each opening. Also, to the extent the inseason survey design worked, it was dependent upon a limited number of open fishing periods. Increasing these in number or length would call for more staff effort, time, and funding for monitoring; or managers would need to develop some alternative sampling strategy. Furthermore, an ideal inseason survey project would need to anticipate unpredictable fishing schedules and adapt to them efficiently and effectively.

Overall, managers consider the USFWS creel survey project a success in meeting its objectives to provide robust harvest estimates during each subsistence salmon fishing opening and to achieve the goal of tracking Chinook salmon catches until fishers reach a target harvest amount within the boundaries of the YDNWR, a subset of the total salmon fishery (Staton 2018). However, this goal understandably cannot accommodate the need for an estimate of a total drainagewide harvest of all salmon species. The USFWS creel survey results are not currently included as part of ADF&G's annual run size estimation methods (Liller et al. 2018). Thus, the value of USFWS results is currently only realized in season and cannot be applied to achieving ADF&G's more comprehensive goal of estimating total harvest to inform annual run size estimation, which in turn allows for evaluation of escapement goal achievement, annual run forecasts, and long-term assessment of drainagewide salmon population and harvest trends. If managers and researchers are to evaluate the overall feasibility of studies similar to those discussed herein, they must consider the fundamental limitations of less than comprehensive harvest assessment goals that are solely applied to inseason harvest estimation. If a drainagewide inseason creel survey project were to be considered as part of a future research program that supports the entire scope and goals of salmon fishery management in the Kuskokwim Area, its results would need to be applicable to a comprehensive annual run size estimate. Additionally, this would likely replace the postseason household harvest survey program, a long-standing program with consistency in methods that ask selected respondents to complete one brief survey for their entire household each year. However, a drainagewide inseason creel survey project would likely be cost prohibitive and result in survey respondent fatigue, each of which would reduce such a program's effectiveness and efficiency.

Despite some recent successes in inseason harvest assessments, many Kuskokwim Area fishery stakeholders still feel disenfranchised by the lack of fishing opportunities, a confusing regulatory system, and the challenge of engaging in the public process of fishery management when they live in remote communities distant from fishery management and regulatory forums. The ADF&G study was successful in developing collaborative relationships in subsistence fishing communities—relationships that establish foundations upon which researchers can improve inseason harvest assessment projects that have widespread community support and stakeholder involvement. This result is critical to the development of more comprehensive and precise fishery assessment projects and management strategies and is a fundamental step toward better fisher engagement in management and regulation.

Conclusions and Recommendations

Quantification of subsistence salmon harvests, particularly for Chinook salmon, has become a critical part of the management process in the Kuskokwim Area each year. Implementation of projects such as that deployed by the USFWS is likely to continue during seasons when conservation of Chinook salmon is the primary concern of fishery managers. A more practical and possibly more effective creel survey program would begin with better coordination among all research partners. The status of communication among state and federal agencies and stakeholder groups has potential to improve so that all partners can collaborate on development of common project objectives and goals, agree to efficient divisions of labor and assist in effective techniques of consulting with tribal partners. Confusion between two similar but distinct projects in 2018 prevented that from occurring, at no fault of either project's partners or principal investigators.

Managers and researchers must carefully consider the effects of multiple survey contacts on the willingness of fishers to participate and share fishing information. Not only can data collection methods result in biased samples, but researchers, particularly those employed by the state and federal governments, can also fail to meet stakeholder expectations that they will minimize intrusion into the personal lives of the fishing public while protecting their privacy and confidentiality. A possible solution to the potential problem of excessive surveys by government agencies would be a permit system linked with a harvest calendar or recording form that allows fishers to report total harvest once at the end of the fishing season through an internet website or in the mail. Similar successful systems currently in place include hunting harvest ticket reports and subsistence and personal use salmon harvest reporting programs for fishers active in Bristol Bay, the Chignik Area, and the Copper River. However, it is also unlikely that the postseason harvest survey program would be discontinued, due to its demonstrated effectiveness in supporting salmon run size estimation and the management decision-making process. Rather, inseason harvest sampling methods could be refined to support or verify the postseason survey results while providing reliable inseason information for managers. If a permit system were implemented, it could not immediately replace the postseason surveys, which have a high level of participation and general reliability; however, the surveys could potentially be used to evaluate the effectiveness and accuracy of a permit system before committing to one as a primary harvest reporting system. More widespread use of harvest calendars by fishing households could also reduce the likelihood that managers would need to consider implementation of harvest permits.

Finally, another possible solution is a community-based harvest monitoring program that employs residents of fishing communities to collect harvest and effort data directly from fishers, as demonstrated by Staton (2018). The most successful and sustainable inseason harvest assessment program will work with tribes to develop a system of community-based harvest monitors while addressing the significant challenges discussed in this chapter. Agency staff and stakeholder groups must facilitate the research process by traveling to fishing communities to provide training of data collection technicians, data management and analysis services, and logistical support. In addition to providing employment opportunities for residents of fishing communities, a project that relies on community-based harvest monitors will improve local engagement in fishery management and likely result in more reliable data. In order to develop better collaboration with tribes and fishers, managers and researchers must increase their time spent in communities and among fishers directly engaging with the public during the salmon fishing season, as did Division of Subsistence staff during this study. As an important admonition, this final point is a prospect that would require significantly increased funding of agency staff for inseason fieldwork.

One of the goals of this project was to evaluate whether reliable harvest estimates could be based on inseason sampling. This would be done by determining the size of the fleet each day and applying the average harvest to unsurveyed boats day by day. For this to produce reliable estimates, a representative sample must be obtained on each of those days. Based on historical sampling efforts in subsistence fisheries, the division relies on the assumption that either 30 households or 50% of a population, depending on community size, must be sampled in order to produce reliable estimates. In this case, researchers were unable to contact enough households throughout the observed openings to calculate estimates or draw any

definitive conclusions about the total estimate of the fleet for any given day. Further, many dates sampled contain only one or two observations. This is inadequate for calculation of variability statistics because n-1 degrees of freedom must be applied.

The information that researchers were able to collect suggests, however, that any fisher in the river for a given day and section is roughly as productive as the other fishers, regardless of their overall harvest levels throughout the whole fishing season. That is, daily individual productivity may have low variability. This indicates that a relatively small sample may be adequate to develop reliable estimates; however, without larger samples researchers were unable to apply statistical tests to substantiate this observation. Again, in the cases where a single sample was obtained, any estimate produced would be done without the possibility of knowing variability. Research conducted by other agencies that was concurrent with the study described in this report did investigate methods of estimating fleet size with statistically robust methods (Staton 2018). Staton (2018) also obtained a relatively large sample of active fishers during each block opening partly due to creel survey sampling efforts in the Bethel boat harbor where most subsistence salmon fishers of the lower Kuskokwim River are based. Additionally, Staton (2018) had the support of USFWS aircraft for reliably frequent, reliably consistent, and comprehensive boat-counting surveys, as well as a large staff from multiple research and tribal agencies deployed in various communities to conduct creel surveys. Staton's research suggests that future efforts to assess and estimate salmon harvests in season could follow USFWS methodology if adequate funding were available; however, Division of Subsistence staff research described herein also demonstrated the value of developing better communications and collaborations with tribal council staff, residents, and community-based data technicians in communities more remote than Bethel. This additional objective supports community investment into inseason research to inform management decisions by providing more and better fishery information to the general public and by engaging them directly in data collection activities.

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APPENDIX A–DAILY FISHER DATA COLLECTION LOG SHEET

ADF&G Subsistence Harvest Study 2015

Write down information from each drift in one line across. When you're done fishing for the day call **Fish and Game** in Bethel at **543-3100** to report your fishing, or if you have any questions.

								Harvest Amounts		
Date	**Drift No.**	**Mesh size (inches)**	**Net Length (feet)**	**Net depth (# meshes)**	**Location**	**Drift start time (HH:MM)**	**Drift stop time (HH:MM)**	**Kings**	**Chums**	**Reds**

APPENDIX B–ADF&G LOWER KUSKOKWIM RIVER CREEL SURVEY, AMAUTLUAK AND KASIGLUK, 2018

LOWER KUSKOKWIM RIVER COMMUNITY-BASED MONITORING INTERVIEW FORM

AK Department of Fish & Game – Division of Subsistence

☐ **CHECK if DATA TRANSFERRED**

Village Monitor (Name and Village): _____

Interview Date (MM/DD): _____ / _____ / 2018 Interview number this date: _____

Where is the person you are interviewing? ☐VILLAGE ☐FISH CAMP ☐BOAT LAUNCH ☐OTHER: _____

Date Trip Started (MM/DD): _____ / _____ Fishing Location Zone (code from map): _____
If location "O", use O and write location name on line.

Time Trip Started (hh:mm): _____ / _____ Time Trip Ended (hh:mm): _____ / _____

Net Type (*ONLY ONE TYPE PER SURVEY. If 2 types fill out 2 surveys.*): ☐ Drift net ☐ Set net

Net Length: _____ How is length recorded? ☐Feet ☐Fathoms ☐Shackles

Mesh size (inches):

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐ _____
4	5	5 1/8	5 ¼	5 3/8	5 ½	5 5/8	5 ¾	5 7/8	6	OTHER *(Specify)*

Time with net in water fishing: _____ : _____
(hours colon nearest 15 minutes; e.g., 2:30 is 2 hours and 30 minutes)

Number **KINGS** harvested _____ How close are you to meeting your **king salmon** harvest goal this year?
☐Not at all ☐Under half ☐Half ☐Over half ☐Goal met

Number **CHUMS** harvested _____ How close are you to meeting your **chum salmon** harvest goal this year?
☐Not at all ☐Under half ☐Half ☐Over half ☐Goal met

Number **SOCKEYE** harvested _____ How close are you to meeting your **sockeye salmon** harvest goal this year?
☐Not at all ☐Under half ☐Half ☐Over half ☐Goal met

Number of **SHEEFISH** harvested _____

Number of **OTHER WHITEFISH** harvested _____

Thank you for your help. This process is designed to contribute to in-season management decisions based on community-based monitoring. Is there any other information or questions you would like to share, or any suggestions to improve the survey or comments to fishery managers?

_____

_____

Interviewer's Comments:

_____

_____