Fishery Data Series No. 19-18

Age, Sex, and Length Composition of Chinook Salmon Harvested in the 2016–2017 Lower Kuskokwim River Subsistence Fishery

Final Report for Study 16-301

USFWS Office of Subsistence Management

Fisheries Resource Monitoring Program

by

Zachary W. Liller

Kathryn E. Froning

Nicholas J. Smith

and

Janessa Esquible

June 2019

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure 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. state	use two-letter abbreviations (e.g., AK, WA)

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

FISHERY DATA SERIES NO. 19-18

AGE, SEX, AND LENGTH COMPOSITION OF CHINOOK SALMON HARVESTED IN THE 2016 AND 2017 LOWER KUSKOKWIM RIVER SUBSISTENCE FISHERY

by
Zachary W. Liller, Kathryn E. Froning and Nicholas J. Smith
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

and

Janessa Esquible
Orutsararmiut Native Council, Bethel

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

June 2019

This investigation was partially financed by USFWS Office of Subsistence Management (Project 16-301) Fisheries Resource Monitoring Program under Cooperative Agreement F16AC00238.

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review.

Zachary W. Liller, Kathryn E. Froning, Nicholas J. Smith, and J. Esquible,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Rd, Anchorage, AK 99518-1599, USA

This document should be cited as follows:
Liller, Z. W., K. E. Froning, N. J. Smith, and J. Esquible. 2019. Age, sex, and length composition of Chinook salmon harvested in the 2016 and 2017 Lower Kuskokwim River subsistence fishery. Alaska Department of Fish and Game, Fishery Data Series No. 19-18, Anchorage.

The Alaska Department of Fish and Game (ADF&G) administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act (ADA) of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility please write:
ADF&G ADA Coordinator, P.O. Box 115526, Juneau, AK 99811-5526
U.S. Fish and Wildlife Service, 4401 N. Fairfax Drive, MS 2042, Arlington, VA 22203
Office of Equal Opportunity, U.S. Department of the Interior, 1849 C Street NW MS 5230, Washington DC 20240

The department's ADA Coordinator can be reached via phone at the following numbers:
(VOICE) 907-465-6077, (Statewide Telecommunication Device for the Deaf) 1-800-478-3648,
(Juneau TDD) 907-465-3646, or (FAX) 907-465-6078

For information on alternative formats and questions on this publication, please contact:
ADF&G, Division of Sport Fish, Research and Technical Services, 333 Raspberry Rd, Anchorage AK 99518 (907) 267-2375

TABLE OF CONTENTS

Page

LIST OF TABLES ii

LIST OF FIGURES ii

LIST OF APPENDICES ii

ABSTRACT 1

INTRODUCTION 1

OBJECTIVES 3

METHODS 3

Study Area 3

Study Design 4

Recruiting and Training Participants 4

Community-Based Monitoring 5

Data Collection 5

Age Determination 6

Data Summaries and Analysis 6

RESULTS AND DISCUSSION 6

Sample Collection and Distribution 6

Annual ASL Harvest Composition 7

ACKNOWLEDGEMENTS 8

REFERENCES CITED 8

TABLES AND FIGURES 11

APPENDIX A: AGE, SEX, LENGTH BY GILLNET MESH SIZE 19

APPENDIX B: AGE, SEX, LENGTH BY TIME STRATA 23

APPENDIX C: SAMPLE DATA FORM AND TRAINING MATERIAL 27

APPENDIX D: HISTORICAL PARTICIPATION, GEAR USAGE, AND ASL COMPOSITION 31

APPENDIX E: SUMMARY OF SUPPLEMENTAL SUBSISTENCE HARVEST SAMPLES COLLECTED FROM MCGRATH IN 2017 35

APPENDIX F: AGE COMPOSITION COMPARISON BETWEEN SUBSISTENCE HARVEST AND TOTAL RUN 37

LIST OF TABLES

Table		Page
1	Summary of harvest opportunity provided by U.S. Fish and Wildlife Service in the Lower Kuskokwim River, 2016.	12
2	Summary of harvest opportunity provided by U.S. Fish and Wildlife Service in the Lower Kuskokwim River, 2017.	12
3	Alaska Department of Fish and Game efforts to recruit subsistence samplers by village, 2016–2017.	12
4	Samples by community used to represent the age, sex, and length composition of Chinook salmon harvested in the Lower Kuskokwim River subsistence fishery, 2016–2017.	13
5	Samples collected outside the study area that were not used to represent the age, sex, and length composition of Chinook salmon harvested in the Lower Kuskokwim River subsistence fishery, 2016–2017.	13
6	Percent of samples collected by gillnet mesh size in the Lower Kuskokwim River Chinook salmon subsistence fishery, 2016.	13
7	Percent of samples collected by gillnet mesh size in the Lower Kuskokwim River Chinook salmon subsistence fishery, 2017.	14
8	Number of samples collected and available harvest opportunities by date, 2016–2017.	14
9	Summary of Chinook salmon age, sex, and length samples collected from Lower Kuskokwim Chinook salmon subsistence fishery, 2016–2017.	15
10	Aging errors for Chinook salmon scale samples collected in the Kuskokwim Subsistence ASL project, 2016–2017.	15
11	Age, sex, and length (mm) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery, 2016–2017.	16

LIST OF FIGURES

Figure		Page
1	Map of the Kuskokwim River drainage highlighting communities in the lower, middle, and upper river, commercial fishing District 1, and select tributaries.	17
2	Map of Lower Kuskokwim River communities, highlighting communities that provided subsistence harvest samples during the 2016 or 2017 season.	18

LIST OF APPENDICES

Appendix		Page
A1	Age, sex, and length (mm, mid-eye to tail-fork) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery by gillnet mesh size, 2016.	20
A2	Age, sex, and length (mm, mid-eye to tail-fork) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery by gillnet mesh size, 2017.	21
B1	Age, sex, and length (mm, mid-eye to tail-fork) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery over time, 2016.	24
B2	Age, sex, and length (mm, mid-eye to tail-fork) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery over time, 2017.	25
C1	Sample data form used in the Chinook salmon subsistence harvest age, sex, length sampling program, 2016–2017.	28
C2	Sample instruction form used in Chinook salmon subsistence harvest age, sex, length sampling program, 2016–2017.	29
D1	Historical participation in the Lower Kuskokwim River subsistence Chinook salmon age, sex, length sampling program and resulting sample sizes, 2001–2017.	32
D2	Percent of Chinook salmon age, sex, and length samples collected from large, intermediate, and small mesh gillnets by Lower Kuskokwim River subsistence fishermen, 2001–2017.	33

LIST OF APPENDICES (Continued)

Appendix		Page
D3	Estimated age and sex composition and mean length of Chinook salmon sampled from the Lower Kuskokwim River subsistence harvest, 2001–2017.	34
E1	Age, sex, and length (mm) composition of Chinook salmon sampled from the McGrath subsistence fishery, 2017.	36
E2	Summary of Chinook salmon age, sex, and length samples collected from McGrath Chinook salmon subsistence fishery, 2017.	36
E3	Percent of samples collected by gillnet mesh size in the McGrath Chinook salmon subsistence fishery, 2017.	36
F1	Age composition of the total return of Chinook salmon to the Kuskokwim River and the component of the return harvested by the subsistence fishery, 2016–2017.	38

ABSTRACT

The Kuskokwim River Chinook salmon *Oncorhynchus tshawytscha* subsistence fishery has been one of the largest in Alaska and collection of age, sex, and length (ASL) data from the subsistence harvest has been an important component of the Kuskokwim Area stock biology program. The Alaska Department of Fish and Game, Division of Commercial Fisheries, the Orutsararmiut Native Council, and the Bering Sea Fishermen's Association partnered to recruit local residents to collect ASL data from subsistence-caught Chinook salmon during the 2016 and 2017 fishing seasons, for the purpose of characterizing the annual composition of the Lower Kuskokwim River harvest. Participation in this program was voluntary. Nine individuals participated in 2016 and 12 participated in 2017. Residents from the community of Bethel participated in both years, and residents from Kwethluk and Akiak participated in 2017. A total of 261 lower river samples were collected in 2016 and 174 were collected in 2017. Sample collection by gillnet mesh size and harvest time were consistent with the fishing opportunities provided in both years. Available samples were considered representative of the total harvest and were used to characterize the ASL composition of the Lower Kuskokwim River Chinook salmon subsistence harvest. In both years, age-1.2 and age-1.3 fish comprised the majority of samples collected. The majority of sampled fish were male. The average length of Chinook salmon sampled was 653 mm in 2016 and 668 mm in 2017. Overall, the ASL composition of the samples collected from the subsistence harvest in 2016 and 2017 contained higher percentages of young (e.g., age-1.2) fish, male, and small fish compared to historical samples. This shift in ASL composition of the harvest was presumably due to requirements for subsistence fishermen to use small mesh gillnets, which are selective for small fish that also tend to be younger age and male.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, subsistence, age, sex, length, ASL composition, gillnet, harvest timing, Kuskokwim River

INTRODUCTION

The purpose of this study was to characterize the age, sex, and length (ASL) composition of the Chinook salmon *Oncorhynchus tshawytscha* subsistence harvest that occurred in the lower portion of the Kuskokwim River (Figure 1). Annual efforts to characterize the ASL composition of the subsistence harvest of Chinook salmon have been an important component of the broader Kuskokwim Area Stock Biology Program (e.g., Liller et al. 2016), which collects ASL data from harvest and escapement monitoring projects throughout the Kuskokwim Management Area. The subsistence fishery has accounted for the majority of total inriver harvest of Kuskokwim River Chinook salmon and annual sampling was needed to evaluate the total effect of harvest removals by age, size, and sex on the resulting escapement. In addition, harvest composition was combined with escapement data to construct a brood table for Kuskokwim River Chinook salmon and to evaluate spawner-recruit relationships and trends in population productivity (e.g., Bue et al. 2012; Hamazaki et al. 2012).

Historically, the Kuskokwim River Chinook salmon subsistence fishery has been one of the largest in Alaska (Fall et al. 2018). The Alaska Board of Fisheries determined that a harvest of 67,200–109,800 Chinook salmon was considered the amount reasonably necessary to meet customary and traditional needs of Kuskokwim River subsistence users. From 1990 to 2011, annual subsistence harvests averaged about 84,000 Kuskokwim River Chinook (Sheldon et al. 2016). That level of historical harvest accounted for nearly 50% of the statewide subsistence harvest of Chinook salmon (Fall et al. 2018) and nearly 90% of the total annual inriver harvest of Chinook salmon (Poetter and Tiernan 2017). Approximately 85% of the annual subsistence harvest of Chinook salmon occurs throughout the Lower Kuskokwim River (Shelden et al. 2016), particularly near Bethel, the largest population center in the area.

The subsistence sampling program has evolved substantially over time. Prior to 1985, subsistence harvest was generalized using commercial harvest samples (Huttunen 1986; Molyneaux and Samuelson 1992; Anderson 1995) – a practice that was considered appropriate

given the similarity in harvest timing, location, and gear type. After 1985, the commercial fishery was restricted to gillnets using mesh sizes ≤6 inches, and commercial harvest samples were no longer representative of the subsistence harvest, which primarily used large mesh gillnets (≥8 inches). To address the need for representative samples, Alaska Department of Fish and Game (ADF&G) staff opportunistically sampled subsistence-caught Chinook salmon using a variety of inefficient and, in some cases, inappropriate methods (e.g., Anderson 1991; DuBois and Molyneaux 2000). Since 2001, ADF&G has partnered with Orutsararmiut Native Council (ONC) and implemented a standardized approach to sample the subsistence harvest. That approach involved collaboration with paid subsistence fishermen to collect representative samples from their own harvests. From 2001 to 2003, separate projects were operated in the upper, middle, and lower portions of the Kuskokwim River (Dubois et al. 2002; Molyneaux et al. 2004a, 2004b). Due largely to budget limitations, the middle and upper river projects were discontinued in 2004, and only the Lower Kuskokwim River project has continued (Molyneaux et al. 2005; Molyneaux et al. 2010; Liller et al. 2013). Detailed descriptions of the Kuskokwim River Chinook salmon fishery and historical ASL sampling programs are provided in past reports (e.g., Dubois et al. 2002; Molyneaux et al. 2004a, 2004b, 2005, 2010; Liller et al. 2013).

Historically, Chinook salmon run sizes in the Kuskokwim River were large enough to allow unrestricted subsistence fishing; however, recent consecutive years of low run abundance resulted in unprecedented annual subsistence restrictions beginning in 2012. Subsistence restrictions in recent years included early season fishing closures, mesh size restrictions, area closures, and shorter periods of fishing opportunities (Staton and Coggins 2016, 2017; Poetter and Tiernan 2017). Total subsistence harvests of Kuskokwim River Chinook salmon declined from a 1990–2011 average harvest of 84,000 to a 2015–2015 average harvest of 24,200. Harvest restrictions resulted in widespread use of small mesh gillnets (≤6 inches) instead of the more conventional use of large mesh (≥8 inches) gillnets. As a result, the ASL composition of the 2012–2015 harvest was comprised mostly of small Chinook salmon, which were a younger age and predominately male compared to the harvest composition from prior years when no restrictions were in place (Liller et al. 2016). Continued low run abundances were forecasted for Kuskokwim River Chinook salmon in 2016 and 2017 and conservative management and subsistence harvest restrictions were again required to meet escapement needs (ADF&G 2016, 2017). Subsistence harvest sampling in 2016 and 2017 was a critical step to evaluate the effect of harvest restrictions on the ASL composition of the subsistence catch.

Harvest restrictions in recent years led to a decline in voluntary participation in the ASL sampling program compared to years with no restriction (Liller et al. 2016), and programmatic changes were initiated in 2016 to increase participation and sample sizes. ADF&G and ONC dedicated nearly all recruitment effort on the community of Bethel and immediate surrounding areas. This decision was based on an informal cost-benefit analysis conducted in 2015, which highlighted: 1) Bethel residents contributed nearly 60% of the historical (2001–2014) ASL samples collected through the subsistence sampling program; 2) the age composition of samples collected by Bethel area residents was not significantly different than the total sample composition in 11 of 14 years; and 3) the percent difference between each age class represented in the Bethel and total age compositions was not greater than 4% in any project year. As such, ADF&G and ONC felt that increased recruitment within the community of Bethel would have the highest likelihood of boosting participation while also yielding a sample dataset that would reasonably represent the lower river subsistence harvest. In 2017, ADF&G and ONC collaborated with the Bering Sea Fisherman's Association (BSFA) to develop a CBM program

and conduct focused ASL sampling in select lower and upper river communities. ADF&G provided sampling supplies and worked with other entities to provide training to inseason samplers. Finally, ADF&G and ONC conducted additional sampling at the Bethel boat harbor during discrete fishing opportunities in order to boost sample size.

In 2016 and 2017, most Chinook salmon harvests occurred within the Lower Kuskokwim River on federal waters encompassed by the Yukon Delta National Wildlife Refuge through fishing opportunities provided by the U.S. Fish and Wildlife Service (USFWS) in collaboration with the Kuskokwim River Intertribal Fish Commission (KRITFC) via delegated authority from the Federal Subsistence Board. In both years, USFWS provided 4 discrete fishery openers (Tables 1 and 2) within the mainstem portions of the Kuskokwim River that flowed through the Yukon Delta National Wildlife (Staton and Coggins 2016, 2017). All mainstem fishing was limited to ≤6 inches mesh gillnets. Subsistence fishing in salmon spawning tributaries was closed in both years. Although USFWS and ADF&G provided opportunities to harvest non-salmon species for subsistence use, these opportunities resulted in some incidental harvest of Chinook salmon. In both years, USFWS allowed unrestricted subsistence fishing within lower river tributaries that did not support spawning salmon. The lower 100 yards of these tributaries were closed to subsistence fishing in an attempt to protect migrating adult Chinook salmon. In 2017, ADF&G provided 3 opportunities to use set gillnets with ≤4 inch mesh to target whitefish and other non-salmon species during the regulatory early season salmon fishing closure through June 11. These opportunities were provided on May 27, June 3, and June 10, 2017.

This report details the results of the subsistence ASL sampling program for project years 2016–2017, which was conducted in collaboration with ADF&G Division of Commercial Fisheries, ONC, and BSFA.

OBJECTIVES

1. To estimate the annual age, sex, and length composition of Chinook salmon in the Lower Kuskokwim River subsistence harvest during the 2016 and 2017 fishing seasons.

In addition, the ASL composition of Chinook salmon were sampled each year by gillnet mesh size and time strata (Appendices A and B) and then summarized to fulfill Cooperative Agreement F16AC00238 with U.S. Fish and Wildlife Service Office of Subsistence Management Fisheries Resource Monitoring Project 16-301 (*Lower Kuskokwim River subsistence Chinook salmon harvest ASL composition*).

METHODS

STUDY AREA

The study area was District 1 of the Kuskokwim Management Area, defined as that portion of the Kuskokwim River upstream from the mouth of the Kuskokwim River to the confluence of Bogus Creek at river kilometer 203. More specifically, the study area included communities within District 1 along the mainstem Kuskokwim River, and the following tributaries: Eek, Kwethluk, and Tuluksak Rivers (Figures 1 and 2). The entire study area is contained within the Yukon Delta National Wildlife Refuge.

STUDY DESIGN

Consistent with previous years of this project, the ASL composition of the Lower Kuskokwim River Chinook salmon subsistence harvest was estimated using samples collected by local residents. Anyone who desired to sample subsistence-caught Chinook salmon within the study area was permitted to participate. No constraints were placed on the number of participants and it was assumed that all participants had equal motivation to collect samples regardless of when, where, and how they harvested. No constraints were placed on the number of samples collected by any individual and participants were encouraged to sample all fish harvested throughout the fishing season. Maximum recruitment efforts and sample collection was intended to yield a sample dataset that was reasonably representative of the harvest across gear, time, and area. A more formal statistical sampling design was not used due to the voluntary nature of participation.

Several assumptions are explicit in this design:

(1) The ASL composition of the samples collected was a function of the gear types used and timing of harvest;
(2) Recruitment of participating fishermen was independent of fishing preferences such as gear types used and timing of harvest;
(3) The participating fishermen employed harvest methods with respect to gear types used and timing of harvest that were proportional to the unknown true distribution of methods used by the collective Lower Kuskokwim River Chinook salmon subsistence fleet; and
(4) Samples pooled across gear type, time, and area were representative of the true ASL composition of the total season harvest for the Lower Kuskokwim River reporting area.

RECRUITING AND TRAINING PARTICIPANTS

Recruiting and training participants was coordinated by ADF&G and ONC. Recruitment efforts were prioritized within the community of Bethel and surrounding areas. Staff from ONC traveled to fish camps within the greater Bethel area (Figure 2). In 2016, that area extended from approximately the community of Napaskiak (rkm 97) upriver to the mouth of the Gweek River (rkm 135), and in 2017, the downriver extent was abbreviated and did not include the community of Napaskiak. This decision was made in coordination with the CBM program, which endeavored to recruit in select communities downriver from Bethel. During fish camp visits, ONC staff solicited participation while concurrently conducting weekly inseason subsistence salmon harvest surveys (e.g., Chavez and Shelden 2014). Both ADF&G and ONC contacted and encouraged prior year participants to continue their involvement in the program. In 2017, ONC also initiated recruitment efforts at Glady's Jung Elementary and Bethel Regional High School through several classroom presentations. Beginning in late May of 2017, ADF&G conducted limited recruitment throughout the remaining portions of the study area by contacting village councils, city offices, and tribal organizations in select lower river communities that had participated in recent years (Table 3). ADF&G requested flyers be posted in appropriate public venues as a means to notify community members of the opportunity.

Participation in this program was voluntary and participants were paid for each sample collected. Anyone who was interested in participating was responsible for notifying ADF&G or ONC, which resulted in a pool of "self-selected" samplers. A maximum participation goal of 50

samplers was set for planning purposes; however, recruitment success during earlier years of this project (Liller et al. 2013, 2016) indicated that this maximum goal would probably not be achieved. As such, anyone who expressed interest in participating during the 2016 and 2017 seasons was provided sampling materials and training.

All participants received formal training in sampling techniques by ADF&G or ONC staff. Training was based on ADF&G salmon ASL sampling procedures (e.g., Eaton 2015; Liller 2016). Training workshops were organized in Bethel on June 10, 2016, and June 2, 2017 (Table 3). In addition, ONC staff provided onsite training for all interested individuals identified during fish camp visits and provided follow-up support and guidance as needed during subsequent weekly visits. ADF&G and ONC staff was accessible from Bethel to provide additional guidance to samplers throughout the season. Following training, each participant was provided a sampling kit, which included data forms (Appendix C1), detailed instructions (Appendix C2), a clipboard, forceps, scale cards, wax paper inserts, pencils, and a meter stick. Participants were instructed to collect as many samples as possible from all harvest gears they used and from throughout the entire harvest period.

COMMUNITY-BASED MONITORING

In 2017, BSFA expanded the subsistence ASL sampling program with CBM in the communities of Tuntutuliak, Napakiak, Kwethluk, and Akiak in the lower river and McGrath in the upper river. Samplers focused on interviews to collect inseason harvest data (Staton and Coggins 2017) with a secondary focus of Chinook salmon ASL sampling. ADF&G and ONC provided training and data management support to BSFA in 2017. The ASL samples collected through the CBM program were submitted to ADF&G for aging, data processing, and archiving. The lower river CBM samples were incorporated with data from ADF&G and ONC to characterize the composition of lower river subsistence harvests of Kuskokwim River Chinook salmon.

DATA COLLECTION

For each fish sampled, participants recorded the harvest date, location, and gear type on standardized data forms (Appendix C1). Participants also recorded whether the samples came from their own harvest or the harvest of another person. Sex was determined by cutting the abdomen and internally inspecting for the presence of ovaries or testes. Length was measured to the nearest mm from mid-eye to tail-fork (METF) using a straight edge meter stick. Three scales were collected from each fish for later use in age determination by ADF&G staff. Scales were removed from the preferred area of the fish (INFPC 1963) and mounted on scale cards (Appendix C2). Sampled fish were numbered sequentially by the participant, and sex and length data were paired by date with the corresponding scale samples from each fish. Samples received by participants were assigned a unique code generated by ADF&G that allowed staff to match samples to participants for quality control and to determine payment as required. The identity of participants remains confidential and not included in the ADF&G database.

Scale cards and data forms were returned to ADF&G staff in several ways: (1) during weekly fish camp visits, ONC staff opportunistically retrieved samples to be delivered to ADF&G on the participant's behalf; (2) CBM samples were submitted to CBM project leaders then delivered to ADF&G.

AGE DETERMINATION

Scales, mounted on gum cards, were impressed in clear cellulose acetate using methods described by Clutter and Whitesel (1956). Scale impressions were magnified with a microfiche reader, and age was estimated by counting the number of annuli. Ages were reported using European notation, which consists of 2 digits separated by a decimal. The digit to the left of the decimal refers to the number of freshwater annuli, and the digit to the right of the decimal refers to the number of marine annuli. Total age, which begins at the time the egg is deposited, is equal to the sum of the 2 digits, plus 1 to account for the period prior to the beginning of scale formation.

DATA SUMMARIES AND ANALYSIS

Data describing the sample collection effort were summarized by location based on participant's community of residence; for example, if the participant resided in Bethel, all samples collected by that individual were categorized as Bethel samples regardless of where the harvest occurred. The decision to categorize samples in this way was based on several factors: 1) the observation that most participants collected samples near the area of residence; 2) actual fishing locations were often poorly documented; and 3) other Kuskokwim Area subsistence harvest studies categorize harvest in this way (e.g., Shelden et al. 2016).

Only complete samples that included estimated age and sex and length data were used for analysis. Estimates of the annual ASL compositions were based on pooled samples from all gear types, locations, and time periods. Only a summary of the samples collected was provided. Samples collected were not weighted by actual harvest.

RESULTS AND DISCUSSION

SAMPLE COLLECTION AND DISTRIBUTION

Recruitment efforts resulted in a similar level of participation each year. The number of participants was 9 in 2016 and 12 in 2017 (Table 4). Within the study area, samples were collected by residents from Bethel (rkm 106), Kwethluk (rkm 132), and Akiak (rkm 161), although Bethel was the only community represented in both years. The total number of samples collected each year was 261 in 2016 and 174 in 2017 (Table 4). Bethel participants provided 100% of the samples collected in 2016 and 66% in 2017. Participation and number of samples collected in both years were similar to recent years (2012–2015), which also had substantial restrictions to subsistence fishing opportunity (Appendix D1).

In addition to the samples collected from the Lower Kuskokwim River subsistence harvest, 2 samples were collected in 2016 from a resident of Quinhagak while fishing in Kuskokwim Bay and 57 samples were collected from a resident of McGrath in the Upper Kuskokwim River (Table 5). The samples from Quinhagak were not used, but they were archived by ADF&G. The samples from McGrath were not used to characterize the lower river harvest, but they were summarized separately (Appendix E) and provided some insight into the composition of Chinook salmon harvested near McGrath.

Samples collected by gear type were consistent with the Chinook salmon harvest opportunities provided in the Lower Kuskokwim River. In both years nearly all samples collected were from small mesh (≤6 inches) gillnets, which was consistent with the maximum mesh size allowed for

Chinook salmon in the mainstem portions of the Kuskokwim River. In 2016, 100% of the samples were from small mesh (≤6 inch) gillnets (Table 6). In 2017, 94% of samples were from small mesh gillnets (Table 7). In 2017, 3% of the samples were from large mesh (≥8 inch) gillnets, which seemed reasonable given that use of large mesh gillnets was permitted in select non-salmon spawning tributaries and subsistence fishermen reported harvesting some number of Chinook salmon in those areas. The remaining 3% of samples in 2017 were from gear using an unknown mesh size. The predominant use of small mesh gillnets in 2016 and 2017 was due to management actions taken in each year to restrict mesh size, and was in contrast to previous years of this study (2001–2011) when large mesh nets (≥8 inch) were the most commonly used (Appendix D2).

Samples collected by date were also consistent with the harvest opportunities provided (Table 8). In both years more than 90% of the samples were collected on dates when the USFWS allowed Chinook salmon directed fishing in the mainstem portions of the Yukon Delta National Wildlife Refuge. Most of the remaining samples were collected from incidental harvest of Chinook salmon that occurred in non-salmon spawning tributaries. For example, the 10 samples collected on June 18, 2016, when the mainstem was closed, were from fish harvested using small mesh gillnets in the Johnson River, which was a non-salmon spawning tributary and was open to unrestricted subsistence fishing all season long. Similarly, the 17 samples collected on June 19, 2017 were harvested using a mixture of small and large mesh gear from the Kialik River, which was a non-salmon spawning tributary open to unrestricted subsistence fishing all season long.

Not all samples were used to represent the composition of the lower river subsistence harvest. A sample was considered complete and used in the summary if the age could be estimated from the scale samples provided and a valid sex and length was provided (Table 9). The number of complete samples was 225 in 2016 (86%) and 127 in 2017 (73%). In both years, a small number of fish sampled were missing sex and or length information. However, the primary reason samples were incomplete was due to scales that could not be aged. Age errors occurred for several reasons (Table 10), but the most common reason was the collection of scales that are missing age information near the center of the scale, which prevented the estimation of the freshwater age.

ANNUAL ASL HARVEST COMPOSITION

Age-1.2 and age-1.3 Chinook salmon were the most abundant age classes represented each year in the Lower Kuskokwim River subsistence harvest samples. Combined age-1.2 and age-1.3 accounted for 91% of all samples aged in 2016 and 82% in 2017 (Table 11). Age-1.3 was the dominant age class in 2016 (42%) and in 2017 (45%). The 2016 and 2017 age samples contained a relatively large percentage of age-1.2 Chinook salmon and few age-1.4 Chinook salmon compared to the reconstructed total run age composition, which was based on weighted samples from all harvest and escapement monitoring locations (Appendix F1). This finding was considered reasonable given the widespread use of small mesh gillnets, which were selective for smaller fish that also tend to be younger age.

Males accounted for 89% of the samples collected in 2016 and 78% of the samples in 2017 (Table 11). Males made up 98% of the age-1.2 fish sampled in 2016 and 85% in 2017. Age-1.3 fish were 87% male in 2016 and 77% in 2017. The ratio of males to females was almost even for the age-1.4 fish sampled; however, males made up more than 50% of the samples in both years.

The average length of sampled subsistence-caught Chinook salmon was 653 mm in 2016 and 668 mm in 2017. In both years the average length of sampled females was larger than males, although the number of sampled females was small. In 2017, sampled females were consistently larger, on average, than males for all age classes represented except age-1.4 (Table 11).

Overall, the ASL composition of the samples collected from the subsistence harvest in both years contained higher percentages of young (e.g., age-1.2) fish, males, and small fish, compared to historical samples (Appendix D3). This shift in ASL composition of the harvest was presumably due to requirements for subsistence fishermen to use small mesh gillnets, which were selective for smaller fish that also tend to be younger age and male.

ACKNOWLEDGEMENTS

We thank the Orutsararmiut Traditional Native Council crew who were instrumental in this project. We would like to acknowledge and thank Bering Sea Fishermen's Association for their proactive efforts to expand the subsistence ASL sampling program through a collaborative community-based monitoring program. Specifically, we thank Joe Spaeder, Bill Bechtol, LaMont Albertson, and Orrie Reich. Gary Decossas and Pippa Kenner assisted with preseason orientation and training of field crews tasked with conducting harvest surveys and recruitment related to this project. Gary Decossas served as the project officer for U.S. Fish and Wildlife Service Office of Subsistence Management and provided review of this report. We thank him for his support and guidance. Most importantly, we thank those that served as subsistence samplers and all those that allowed participants to collect samples from their subsistence catch. This project could not have been possible without their support and the support of local communities.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 2016. 2016 Kuskokwim River Chinook salmon outlook. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/652424562.pdf

ADF&G (Alaska Department of Fish and Game). 2017. 2017 Kuskokwim River Chinook salmon outlook. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/773602162.pdf

Anderson, C. J. 1991. Kuskokwim Management Area salmon catch and escapement statistics, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report No. 91-04, Juneau.

Anderson, C. J. 1995. Kuskokwim Management Area salmon catch and escapement statistics, 1988. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Technical Fishery Report No. 95-08, Juneau.

Bue, B. G., K. L. Schaberg, Z. W. Liller, and D. B. Molyneaux. 2012. Estimates of the historic run and escapement for the Chinook Salmon stock returning to the Kuskokwim River, 1976–2011. Alaska Department of Fish and Game, Fishery Data Series No. 12-49, Anchorage.

Chavez, R., and C. A. Shelden. 2014. Inseason subsistence salmon harvest monitoring, Lower Kuskokwim River, 2013. Alaska Department of Fish and Game, Fishery Management Report No. 14-36, Anchorage.

Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International North Pacific Fisheries Commission 9.

DuBois, L., and D. B. Molyneaux. 2000. Salmon age, sex and length catalog for the Kuskokwim area, 1999 progress report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-18, Anchorage.

DuBois, L., D. B. Molyneaux, G. Roczicka, W. Morgan, and T. Williams. 2002. Age, sex, and length composition of Chinook salmon from the Kuskokwim River subsistence fishery, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-33, Anchorage.

REFERENCES CITED (Continued)

Eaton, S. M. 2015. Salmon age, sex, and length (ASL) sampling procedures for the Arctic-Yukon-Kuskokwim Region. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A15-04, Anchorage.

INPFC (International North Pacific Fisheries Commission). 1963. Annual report, 1961. International North Pacific Fisheries Commission, Vancouver, British Columbia.

Fall J. A., A. Godduhn, G. Halas, L. Hutchinson-Scarbrough, B. Jones, E. Mikow, L. A. Sill, A. Trainor, A. Wiita, T. Lemons. 2018. Alaska subsistence and personal use salmon fisheries 2015 Annual Report. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 440, Anchorage.

Hamazaki T., M. J. Evenson, S. J. Fleischman, and K. L. Schaberg. 2012. Escapement goal recommendation for Chinook salmon in the Kuskokwim River drainage. Alaska Department of Fish and Game, Fishery Manuscript Series No. 12-08, Anchorage.

Huttunen, D. C. 1986. Abundance, age, sex, and size of salmon (Oncorhynchus spp.) catches and escapements in the Kuskokwim Area, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report No. 186, Juneau.

Liller, Z. W., A. R. Brodersen, T. R. Hansen, D. B. Molyneaux, and E. Patton. 2013. Age, sex, and length composition of Chinook salmon harvested in the 2008–2011 Lower Kuskokwim River subsistence fishery. Alaska Department of Fish and Game, Fishery Data Series No. 13-10, Anchorage.

Liller, Z. W., A. B. Brodersen, and K. E. Froning. 2016. Salmon age, sex, and length catalog for the Kuskokwim Area, 2014. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A16-02, Anchorage.

Molyneaux, D. B., and K. T. Samuelson. 1992. Kuskokwim Management Area salmon catch and escapement statistics, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report No. 92-18, Juneau.

Molyneaux, D. B., D. Folletti, L. DuBois, G. Roczicka, and W. Morgan. 2004a. Age, sex, and length composition of Chinook salmon from the 2002 Kuskokwim River subsistence fishery. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-13, Anchorage.

Molyneaux, D. B, D. L. Folletti, L. K. Brannian, and G. Roczicka. 2004b. Age, sex, and length composition of chinook salmon from the 2003 Kuskokwim River subsistence fishery. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-23, Anchorage.

Molyneaux, D. B, D. L. Folletti, L. K. Brannian, and G. Roczicka. 2005. Age, sex, and length composition of Chinook salmon from the 2004 Kuskokwim River subsistence fishery. Alaska Department of Fish and Game, Fishery Data Series No. 05-45, Anchorage.

Molyneaux, D. B., A. R. Brodersen, D. L. Folletti, Z. W. Liller, and G. Roczicka. 2010. Age, sex, and length composition of Chinook salmon in the 2005–2007 Kuskokwim River subsistence fishery. Alaska Department of Fish and Game, Fishery Data Series No. 10-39, Anchorage.

Poetter, A. D., and A. Tiernan. 2017. 2016 Kuskokwim area management report. Alaska Department of Fish and Game, Fishery Management Report No. 17-50, Anchorage.

Shelden, C. A., T. Hamazaki, M. Horne-Brine, and G. Roczicka. 2016. Subsistence salmon harvests in the Kuskokwim area, 2015. Alaska Department of Fish and Game, Fishery Data Series No. 16-55, Anchorage.

Staton, B. A., and L. G. Coggins. 2016. Inseason harvest and effort estimates for 2016 Kuskokwim River subsistence salmon fisheries during block openers. U.S. Department of Interior, Fish and Wildlife Service, Yukon Delta National Wildlife Refuge, Bethel, AK.

Staton, B. A., and L. G. Coggins. 2017. Inseason harvest and effort estimates for the 2017 Kuskokwim River subsistence salmon fisheries during block openers. U.S. Department of Interior, Fish and Wildlife Service, Yukon Delta National Wildlife Refuge, Bethel, AK.

TABLES AND FIGURES

Table 1.–Summary of harvest opportunity provided by U.S. Fish and Wildlife Service in the Lower Kuskokwim River, 2016.

Date	Management agency	Mesh size	Duration	Estimated harvest [a]
6/12/2016	USFWS	6 inch	12 hours	4,460
6/16–6/17/2016	USFWS	6 inch	24 hours	8,481
6/21–6/24/2016	USFWS	6 inch	72 hours	13,130
6/29–7/2/2016	USFWS	6 inch	72 hours	1,948

Note: ADF&G resumed management of the Lower Kuskokwim River on July 6, 2016. No subsistence samples were collected after July 2, 2016.

[a] Inseason estimates of harvest in the Lower Kuskokwim River were produced by USFWS staff.

Table 2.–Summary of harvest opportunity provided by U.S. Fish and Wildlife Service in the Lower Kuskokwim River, 2017.

Date	Management agency	Mesh size	Duration	Estimated harvest [a]
6/12/2017	USFWS	6 inch	12 hours	2,400
6/24/2017	USFWS	6 inch	12 hours	4,550
7/1/2017	USFWS	6 inch	6 hours	990
7/3/2017	USFWS	6 inch	12 hours	690

Note: ADF&G resumed management of the Lower Kuskokwim River on July 7, 2016. No subsistence samples were collected after July /3, 2016.

[a] Inseason estimates of harvest in the Lower Kuskokwim River were produced by USFWS staff.

Table 3.–Alaska Department of Fish and Game efforts to recruit subsistence samplers by village, 2016–2017.

					Training [c]		
Year	Village	Letter to Traditional council [a]	Recruitment flier [a]	Individual contact [b]	Date	No. of participants	Sample packets distributed
2016	Eek	–	–	2	–	–	–
	Tuntutuliak	–	–	5	–	–	–
	Napakiak	–	–	2	–	–	–
	Bethel[d]	–	–	9	6/10/2016	2	4
	Kwethluk	–	–	2	–	–	–
	Tulaksak	–	–	1	–	–	–
	Aniak	–	–	2	–	–	–
2017	Eek	5/24/2017	5/24/2017	1	–	–	–
	Kasigluk	5/24/2017	5/24/2017	–	–	–	–
	Atmauthluak	5/24/2017	5/24/2017	–	–	–	–
	Kongiganak	5/24/2017	5/24/2017	–	–	–	–
	Bethel[d]	–	–	5	6/2/2017	11	10
	Tuluksak	5/24/2017	5/24/2017	–	–	–	–

[a] Date that recruitment information was faxed or mailed to Tribal Council office or similar community organization.

[b] Number of individual subsistence fishermen contacted by ADF&G staff. Most were past samplers. Contact was made to solicit continued involvement and renew sampling materials as needed.

[c] Recruitment effort was in addition to the extensive outreach and training conducted by Orutsaramuit Native Council.

[d] Because of similarity between samples collected from Bethel residents and the rest of the lower river, training was coordinated in Bethel without travel to outlying communities.

Table 4.–Samples by community used to represent the age, sex, and length composition of Chinook salmon harvested in the Lower Kuskokwim River subsistence fishery, 2016–2017.

Year	Community	rkm [a]	Number of samplers [b]	Sample size [c]	Personal harvest % [d]	Additional harvest % [e]
2016	Bethel	106	9	261	80.0%	20.0%
2017	Akiak	161	1	31	29.0%	71.0%
	Bethel	106	9	114	67.5%	32.5%
	Kwethluk	132	2	29	82.8%	17.2%
	Total		12	174		

[a] River kilometer. Distance from the mouth of the Kuskokwim River.

[b] Samples were collected by community residents.

[c] Sample sizes include Chinook salmon whose age could not be determined.

[d] Participant sampled his or her own harvest.

[e] Participant sampled someone else's harvest in addition to their own. Participants were encouraged to sample from as many households as possible.

Table 5.–Samples collected outside the study area that were not used to represent the age, sex, and length composition of Chinook salmon harvested in the Lower Kuskokwim River subsistence fishery, 2016–2017.

Year	Community	Number of samplers [a]	Harvests sampled [b]	Sample size [c]
2016	Quinhagak [d]	1	1	2
2017	McGrath [e]	1	9	57

[a] Samples were collected by community residents.

[b] Participants were encouraged to sample from as many households as possible.

[c] Sample sizes include Chinook salmon whose age could not be determined.

[d] Samples were collected from Kuskokwim Bay and were not used in analysis.

[e] Samples were collected from an Upper Kuskokwim River community and were not used in analysis.

Table 6.–Percent of samples collected by gillnet mesh size in the Lower Kuskokwim River Chinook salmon subsistence fishery, 2016.

Mesh size[a]	Number of samples	Percent
5.5 inch	14	5%
5.75 inch	19	7%
6 inch	228	88%
Total	261	100%

Note: Sample sizes include Chinook salmon whose age could not be determined.

[a] Drift and set gillnets combined.

Table 7.–Percent of samples collected by gillnet mesh size in the Lower Kuskokwim River Chinook salmon subsistence fishery, 2017.

Mesh size [a]	Number of samples	Percent
Small (≤6 inch)		
4.0	11	6%
5.25	1	1%
5.375	17	10%
5.5	18	10%
5.75	3	2%
5.875	10	6%
6.0	103	59%
Subtotal	163	94%
Large		
8.0	6	3%
Unknown	5	3%
Total	174	100%

Note: Sample sizes include Chinook salmon whose age could not be determined.

[a] Drift and set gillnets combined.

Table 8.–Number of samples collected and available harvest opportunities by date, 2016–2017.

	2016			2017			
Date	Number of samples	Mainstem [a]	Non-salmon tributaries [b]	Number of samples	Mainstem [a]	Non-salmon tributaries [b]	4" Gillnet opportunity [c]
10 Jun	8		X	6		X	X
12 Jun	45	X	X	56	X	X	
16 Jun	74	X	X	1		X	
17 Jun	22	X	X			X	
18 Jun	10		X			X	
19 Jun			X	17		X	
21 Jun	27	X	X			X	
22 Jun	25	X	X			X	
23 Jun	15	X	X	2		X	
24 Jun			X	65	X	X	
29 Jun	10	X	X			X	
30 Jun	9	X	X			X	
1 Jul	9	X	X	22	X	X	
2 Jul	7	X	X			X	
3 Jul			X	5	X	X	

Note: X indicated dates when a particular fishing opportunity was available.

[a] Chinook salmon harvest was allowed for at least some portion of the day in the mainstem Kuskokwim River within the Yukon Delta National Wildlife Refuge.

[b] Subsistence harvest was allowed within non-salmon spawning tributaries draining the Yukon Delta National Wildlife Refuge.

[c] ADF&G provided opportunity to use set gillnets with mesh size ≤4 inches to target non-salmon species.

Table 9.–Summary of Chinook salmon age, sex, and length samples collected from Lower Kuskokwim Chinook salmon subsistence fishery, 2016–2017.

Year	Age samples [a]	Number aged [b]	Number sexed [c]	Number lengths [d]	Complete samples [e]
2016	261	227	259	260	225
2017	174	146	153	169	127

[a] Number of fish for which scales were collected for age estimation.

[b] Number of fish for which total age was successfully estimated from scale samples.

[c] Number of fish for which a sex determination was based on internal inspection of gonads.

[d] Number of fish for which length was measured from mideye to tail-fork.

[e] Number of fish with age, sex, and length.

Table 10.–Aging errors for Chinook salmon scale samples collected in the Kuskokwim Subsistence ASL project, 2016–2017.

Year	Number aged	Number age errors	% Age errors	Illegible [a]	Inverted [b]	Missing [c]	Resorbed [d]	Regenerated [e]
2016	261	34	13%	1	8			25
2017	174	28	16%					28

Note: More than 1 age error may apply to a single scale.

[a] Illegible scales have debris or scratches on the gummed card or acetate that obscure the circuli.

[b] Inverted scales are mounted on the gummed card so that their circuli are facing the gummed paper, and an impression cannot be made.

[c] Missing scales were collected but fell off of the gummed card before an impression was made.

[d] Resorbed scales show deterioration along the outer edge and are missing age information necessary for estimating saltwater age.

[e] Regenerated scales have missing or inadequate age information near the center inhibiting estimation of freshwater age. As a general rule, scales with an area of regeneration >10 mm in diameter were not aged.

Table 11.–Age, sex, and length (mm) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery, 2016–2017.

			Age class					
Year	Sample size [a]	Sex	1.1	1.2	1.3	1.4	Other [b]	Total
2016	226	Male	0%	42%	42%	4%	1%	89%
		Female	0%	1%	6%	4%	0%	11%
		Total	0%	42%	48%	8%	1%	100%
		Male mean length	390	578	694	732	–	
		SD	–	56	71	108	–	
		Range	390–390	470–805	540–930	553–840	–	
		n	1	93	95	9	–	
		Female mean length	–	787	724	839	–	
		SD	–	26	75	75	–	
		Range	–	768–805	530–860	715–949	–	
		n	–	2	14	8	–	
2017	127	Male	0%	31%	35%	9%	2%	78%
		Female	0%	6%	10%	6%	0%	22%
		Total	0%	37%	45%	16%	2%	100%
		Male mean length	–	569	680	801	–	
		SD	–	42	75	85	–	
		Range	–	490–660	505–852	684–945	–	
		n	–	40	44	12	–	
		Female mean length	–	598	773	801	–	
		SD	–	37	67	63	–	
		Range	–	550–660	608–880	685–890	–	
		n	–	7	13	8	–	

Note: Discrepancies in column totals are due to rounding.

[a] Sample size includes only Chinook salmon that were aged.

[b] Includes minor age classes: 0.1, 0.2, 1.5, 2.1, 2.2, 2.3, and 2.4.

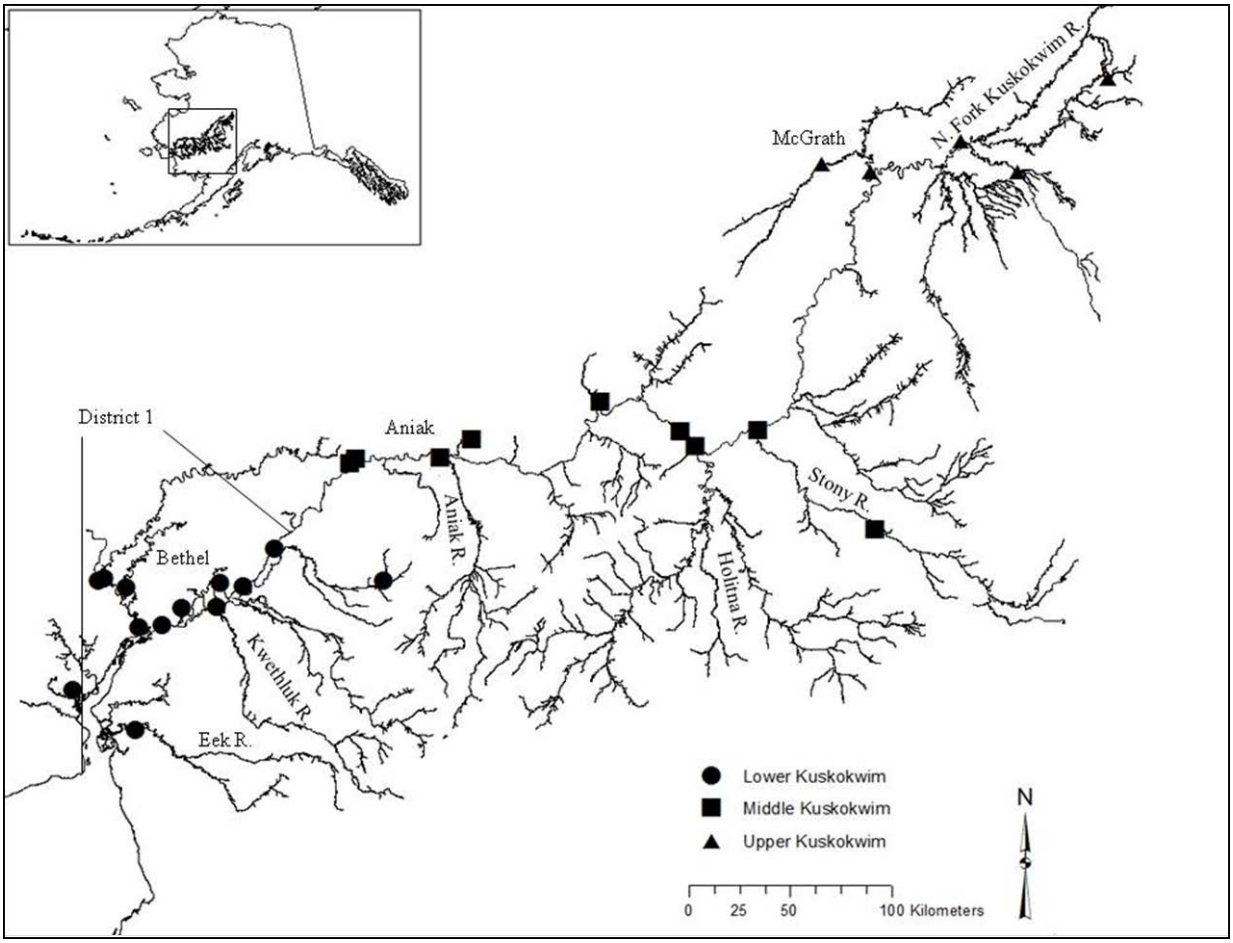


Figure 1.–Map of the Kuskokwim River drainage highlighting communities in the lower, middle, and upper river, commercial fishing District 1, and select tributaries.

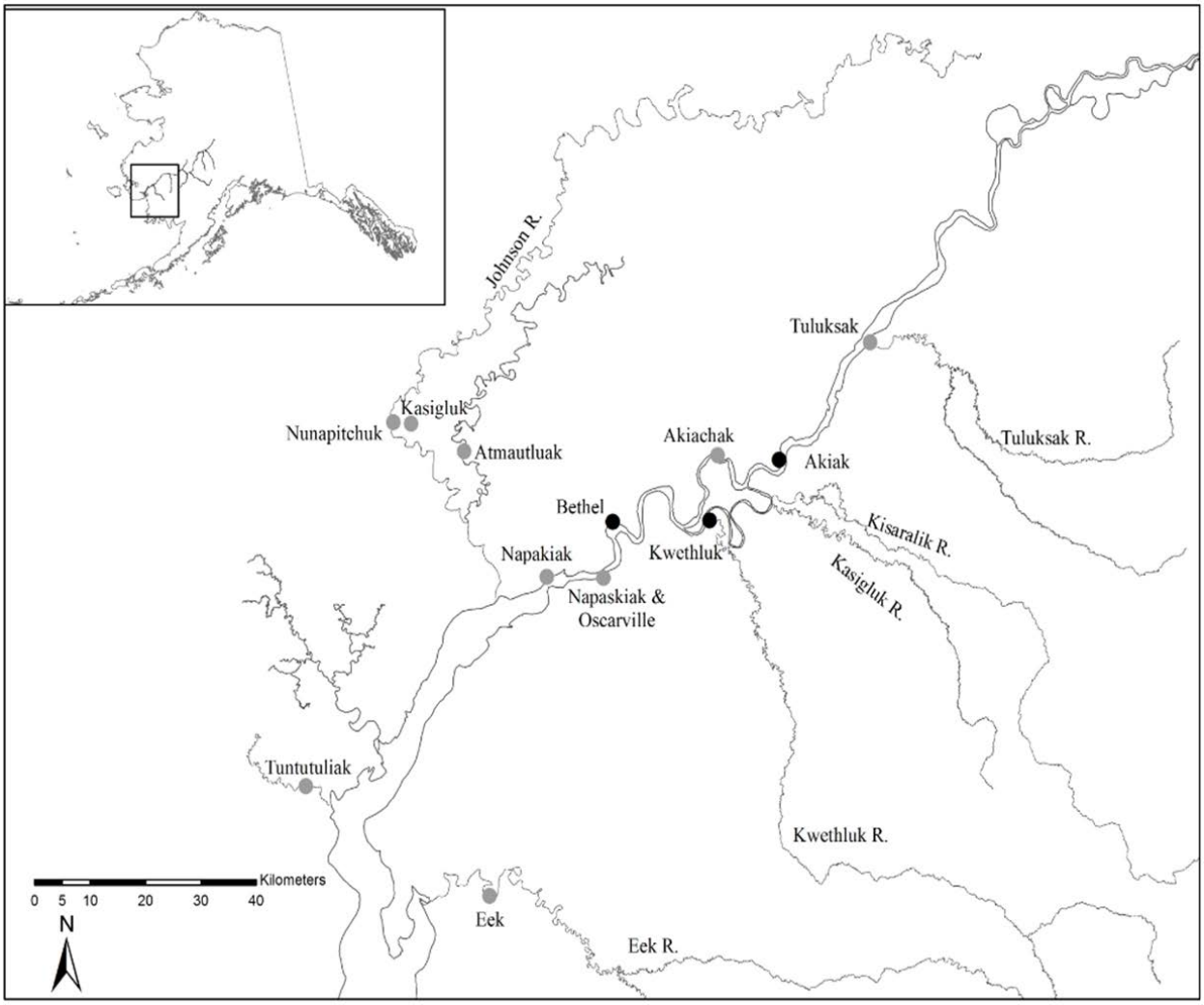


Figure 2.–Map of Lower Kuskokwim River communities, highlighting communities that provided subsistence harvest samples during the 2016 or 2017 season (black circles).

APPENDIX A: AGE, SEX, LENGTH BY GILLNET MESH SIZE

Appendix A1.–Age, sex, and length (mm, METF) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery by gillnet mesh size, 2016.

Mesh size [a]	Sample size [b]		Age class 1.1	1.2	1.3	2.2	1.4	2.3	Total
Intermediate 5.5-inch	12	Male	0%	33%	50%	0%	8%	0%	92%
		Female	0%	8%	0%	0%	0%	0%	8%
		Subtotal	0%	42%	50%	0%	8%	0%	100%
		Male mean length	–	523	675	–	630	–	
		SD	–	33	91	–	–	–	
		Range	–	476–552	575–782	–	–	–	
		n	–	4	6	–	1	–	
		Female mean length	–	768	–	–	–	–	
		SD	–	–	–	–	–	–	
		Range	–	768–768	–	–	–	–	
		n	–	1	–	–	–	–	
Intermediate 5.75-inch	16	Male	0%	69%	13%	0%	0%	13%	94%
		Female	0%	0%	0%	0%	6%	0%	6%
		Subtotal	0%	69%	13%	0%	6%	13%	100%
		Male mean length	–	560	667	–	–	682	
		SD	–	50	82	–	–	36	
		Range	–	501–638	609–725	–	–	656–707	
		n	–	11	2	–	–	2	
		Female mean length	–	–	–	–	914	–	
		SD	–	–	–	–	–	–	
		Range	–	–	–	–	–	–	
		n	–	–	–	–	1	–	
Intermediate 6-inch	198	Male	1%	40%	44%	1%	4%	0%	89%
		Female	0%	1%	7%	0%	4%	0%	11%
		Subtotal	1%	40%	51%	1%	8%	0%	100%
		Male mean length	390	583	695	550	745	–	
		SD	–	56	70	–	108	–	
		Range	–	470–805	540–930	–	553–840	–	
		n	1	78	87	1	8	–	
		Female mean length	–	805	724	–	828	–	
		SD	–	–	75	–	74	–	
		Range	–	–	530–860	–	715–949	–	
		n	–	1	14	–	7	–	

[a] Drift and set gillnets combined.

[b] Sample size includes only Chinook salmon that were aged.

Appendix A2.–Age, sex, and length (mm, METF) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery by gillnet mesh size, 2017.

Mesh size [a]	Sample size [b]		Age class 1.2	1.3	2.2	1.4	2.3	2.4	Total
Small 4-inch	8	Male	50%	0%	0%	13%	0%	0%	63%
		Female	38%	0%	0%	0%	0%	0%	38%
		Subtotal	88%	0%	0%	13%	0%	0%	100%
		Male mean length	570	–	–	730	–	–	
		SD	44	–	–	–	–	–	
		Range	520–620	–	–	–	–	–	
		n	4	–	–	1	–	–	
		Female mean length	600	–	–	–	–	–	
		SD	56	–	–	–	–	–	
		Range	550–660	–	–	–	–	–	
		n	3	–	–	–	–	–	
Intermediate 5–5.875-inch	38	Male	45%	24%	0%	11%	3%	0%	82%
		Female	0%	11%	0%	8%	0%	0%	18%
		Subtotal	45%	34%	0%	18%	3%	0%	100%
		Male mean length	566	706	–	787	719	–	
		SD	36	99	–	106	–	–	
		Range	490–624	546–852	–	720–945	–	–	
		n	18	9	–	4	1	–	
		Female mean length	–	804	–	788	–	–	
		SD	–	55	–	103	–	–	
		Range	–	749–880	–	685–890	–	–	
		n	–	4	–	3	–	–	
Intermediate 6-inch	75	Male	24%	41%	1%	9%	0%	1%	77%
		Female	5%	11%	0%	7%	0%	0%	23%
		Subtotal	29%	52%	1%	16%	0%	1%	100%
		Male mean length	575	671	574	820	–	809	
		SD	47	69	–	80	–	–	
		Range	505–660	505–840	–	684–910	–	–	
		n	18	31	1	7	–	1	
		Female mean length	596	752	–	809	–	–	
		SD	26	71	–	40	–	–	
		Range	560–618	608–850	–	743–850	–	–	
		n	4	8	–	5	–	–	
Large 8-inch	5	Male	20%	60%	0%	0%	0%	0%	80%
		Female	0%	20%	0%	0%	0%	0%	20%
		Subtotal	20%	80%	0%	0%	0%	0%	100%
		Male mean length	519	694	–	–	–	–	
		SD	–	67	–	–	–	–	
		Range	–	626–759	–	–	–	–	
		n	1	3	–	–	–	–	
		Female mean length	–	825	–	–	–	–	
		SD	–	–	–	–	–	–	
		Range	–	–	–	–	–	–	
		n	–	1	–	–	–	–	

[a] Drift and set gillnets combined.

[b] Sample size includes only Chinook salmon that were aged.

APPENDIX B: AGE, SEX, LENGTH BY TIME STRATA

Appendix B1.–Age, sex, and length (mm, METF) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery over time, 2016.

Stratum date	Sample size [a]		Age class 1.1	1.2	1.3	2.2	1.4	2.3	Total
6/10–6/12	47	Male	0%	43%	32%	2%	6%	21%	85%
		Female	0%	2%	2%	0%	11%	0%	15%
		Subtotal	0%	45%	34%	2%	17%	2%	100%
		Male mean length	–	556	678	550	671	656	
		SD	–	46	70	–	143	–	
		Range	–	476–630	540–810	–	553–830	–	
		n	–	20	15	1	3	1	
		Female Mean length	–	768	745	–	804	–	
		SD	–	–	–	–	63	–	
		Range	–	–	–	–	715–870	–	
		n	–	1	1	–	5	–	
6/16–6/18	94	Male	1%	44%	38%	0%	5%	1%	89%
		Female	0%	1%	9%	0%	1%	0%	11%
		Subtotal	1%	45%	47%	0%	6%	1%	100%
		Male mean length	390	575	687	–	747	707	
		SD	–	50	58	–	85	–	
		Range	–	490–743	570–782	–	600–805	–	
		n	1	41	36	–	5	1	
		Female mean length	–	805	739	–	914	–	
		SD	–	–	37.9	–	–	–	
		Range	–	–	690–814	–	–	–	
		n	–	1	8	–	1	–	
6/21–6/23	62	Male	0%	40%	50%	0%	2%	0%	92%
		Female	0%	0%	5%	0%	3%	0%	8%
		Subtotal	0%	40%	55%	0%	5%	0%	100%
		Male mean length	–	599	705	–	840	–	
		SD	–	49	44	–	–	–	
		Range	–	483–690	610–802	–	–	–	
		n	–	25	31	–	1	–	
		Female mean length	–	–	740	–	890	–	
		SD	–	–	104	–	84	–	
		Range	–	–	670–860	–	830–949	–	
		n	–	–	3	–	2	–	
6/29–7/2	23	Male	0%	35%	57%	0%	0%	0%	91%
		Female	0%	0%	9%	0%	0%	0%	9%
		Subtotal	0%	35%	65%	0.0.%	0%	0%	100%
		Male mean length	–	581	702	–	–	–	
		SD	–	108.88	133.37	–	–	–	
		Range	–	470–805	560–930	–	–	–	
		n	–	7	13	–	–	–	
		Female mean length	–	–	625	–	–	–	
		SD	–	–	134.35	–	–	–	
		Range	–	–	530–720	–	–	–	
		n	–	–	2	–	–	–	

[a] Sample size includes only Chinook salmon that were aged.

Appendix B2.–Age, sex, and length (mm, METF) composition of Chinook salmon sampled from the Lower Kuskokwim River subsistence fishery over time, 2017.

Stratum date	Sample size [a]		Age class 1.2	1.3	2.2	1.4	2.3	2.4	Total
	36	Male	39%	33%	3%	8%	0%	0%	85%
6/10–6/16		Female	0%	17%	0%	0%	0%	0%	17%
		Subtotal	39%	50%	3%	8%	0%	0%	100%
		Male mean length	562	654	574	747	–	–	
		SD	46	84	–	38	–	–	
		Range	490–631	505–770	–	720–790	–	–	
		n	14	12	1	3	–	–	
		Female mean length	–	783	–	–	–	–	
		SD	–	55	–	–	–	–	
		Range	–	727–880	–	–	–	–	
		n	–	6	–	–	–	–	
	65	Male	31%	31%	0%	8%	2%	2%	72%
6/19–6/24		Female	11%	8%	0%	9%	0%	0%	27%
		Subtotal	42%	39%	0%	17%	2%	2%	100%
		Male mean length	569	684	–	820	719	809	
		SD	40	80	–	91	–	–	
		Range	517–660	546–852	–	740–945	–	–	
		n	20	20	–	5	1	1	
		Female mean length	598	756	–	791	–	–	
		SD	37	86	–	71	–	–	
		Range	550–660	608–825	–	685–890	–	–	
		n	7	5	–	6	–	–	
	26	Male	23%	46%	0%	15%	0%	0%	85%
7/1–7/3		Female	0%	8%	0%	8%	0%	0%	15%
		Subtotal	23%	54%	0%	23%	0%	0%	100%
		Male mean length	587	700	–	819	–	–	
		SD	38	50	–	104	–	–	
		Range	540–640	650–840	–	684–910	–	–	
		n	6	12	–	4	–	–	
		Female mean length	–	790	–	830	–	–	
		SD	–	85	–	29	–	–	
		Range	–	730–850	–	810–850	–	–	
		n	–	2	–	2	–	–	

[a] Sample size includes only Chinook salmon that were aged.

APPENDIX C: SAMPLE DATA FORM AND TRAINING MATERIAL

Appendix C1.–Sample data form used in the Chinook salmon subsistence harvest age, sex, length sampling program, 2016–2017.

SUBSISTENCE KING SALMON SAMPLING FORM

SAMPLER INFORMATION

NAME: _____ Card Number(s): _____

ADDRESS: _____ Catch Date(s): _____

Phone Number: _____

SSN: _____

Sampler's fish camp location (ex. Straight Slough, or near the Old Bethel Air Port):

_____

If you sampled **someone else's** fish, where is their fish camp? (ex. Oscarville Slough):

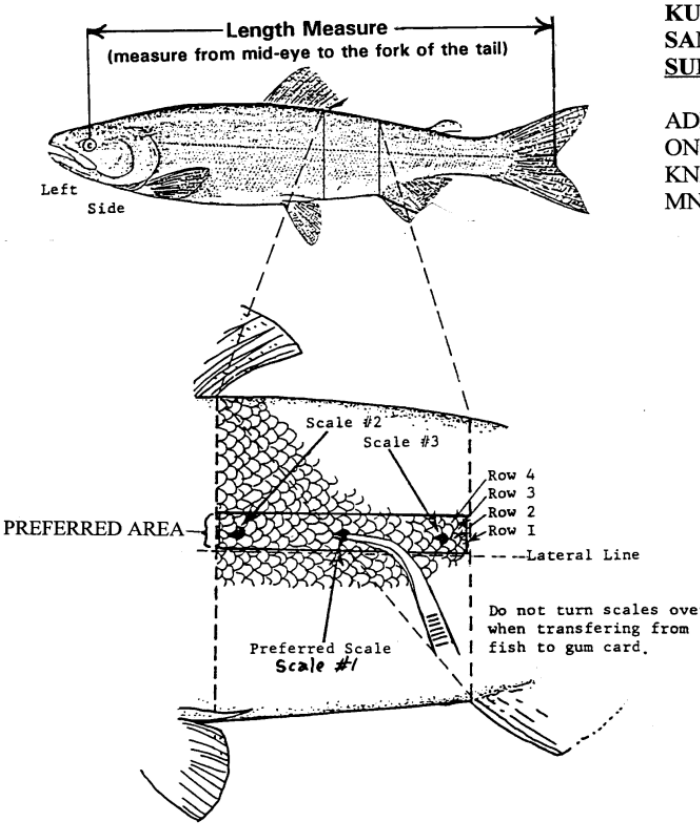
_____

Please Turn Over

FISH INFORMATION

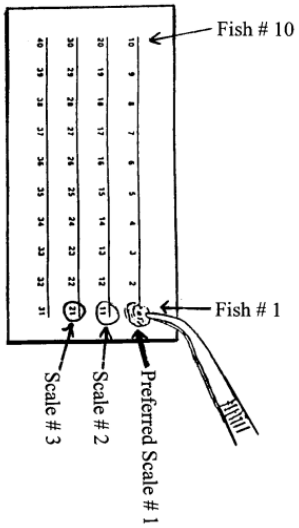
Catch Date	Card No.	Fish No.	Sex (Circle One)		Did you cut the fish to verify its sex? (Circle One)		Length (mm)	Mesh Size/Gear (ex. 5 inch, 8 inch / Drift gillnet, Set gillnet)	Was this **YOUR** fish, or someone else's fish? (Circle One)		Net Location (ex. Near the Kwethluk Y, Near the Johnson River)
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	
			M	F	Y	N			Y	N	

Appendix C2.–Sample instruction form used in Chinook salmon subsistence harvest age, sex, length sampling program, 2016–2017.



KUSKOKWIM RIVER SAMPLING PROGRAM FOR SUBSISTENCE KING SALMON

ADF&G (Bethel) 543-2433
ONC (Bethel) 543-2608
KNA (Aniak) 675-4384
MNVC (McGrath) 524-3023



Age-Sex-Length Sampling Instructions

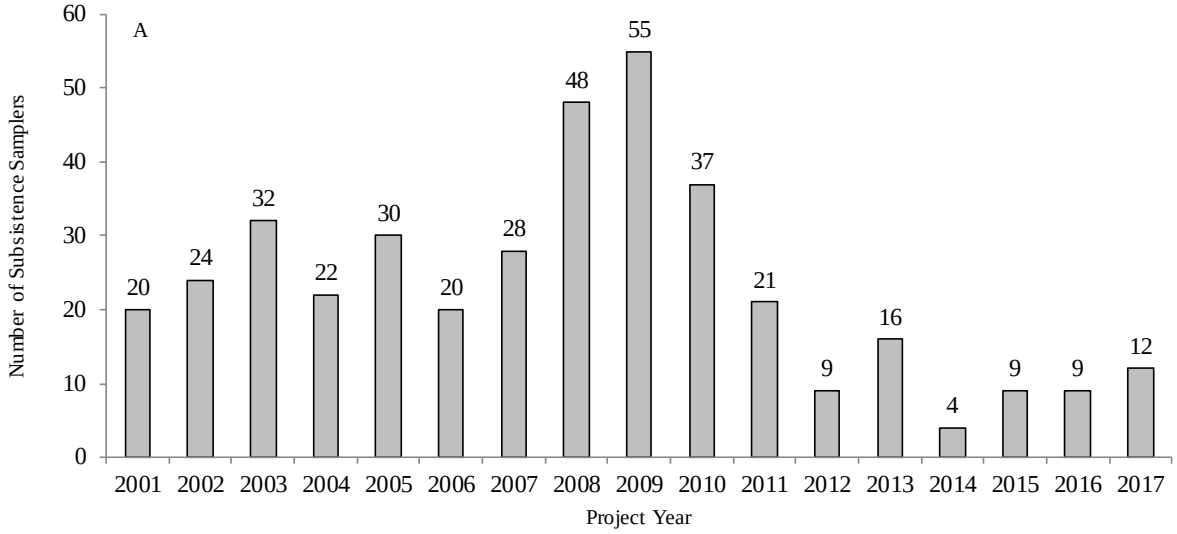
1) Position king salmon left side up.
2) Take preferred scale #1 located two rows above the lateral line and intersecting a diagonal line from the back of the dorsal fin to the front of the anal fin.
3) Clean scale by removing slime.
4) Place scale directly over number on gum card. Be careful to keep scale right side up and mount scale in same orientation.
5) Repeat above steps for scales # 2 and # 3 (see picture).
6) Measure length (mm) from mid-eye to fork of tail.
7) Cut fish belly and determine sex.

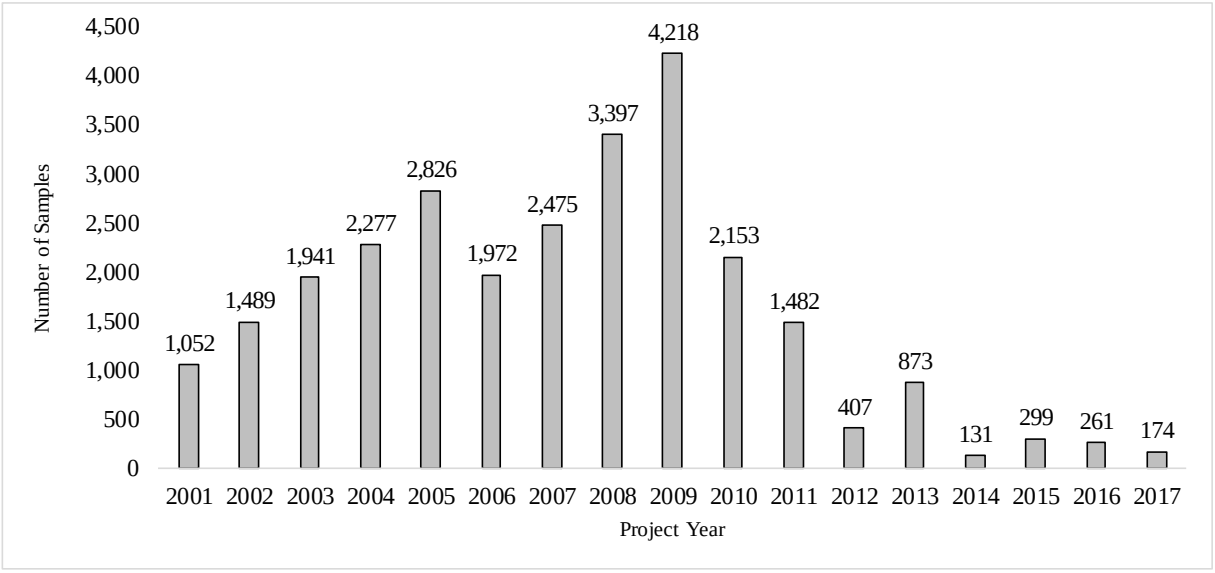
Payment requires the following information for each king salmon:

1) Three readable scales from each fish.
2) Sex of each fish.
3) Length of each fish.
4) Gear type and mesh size.
5) Date of capture.
6) Location of capture.
7) Your name on data form and scale card.

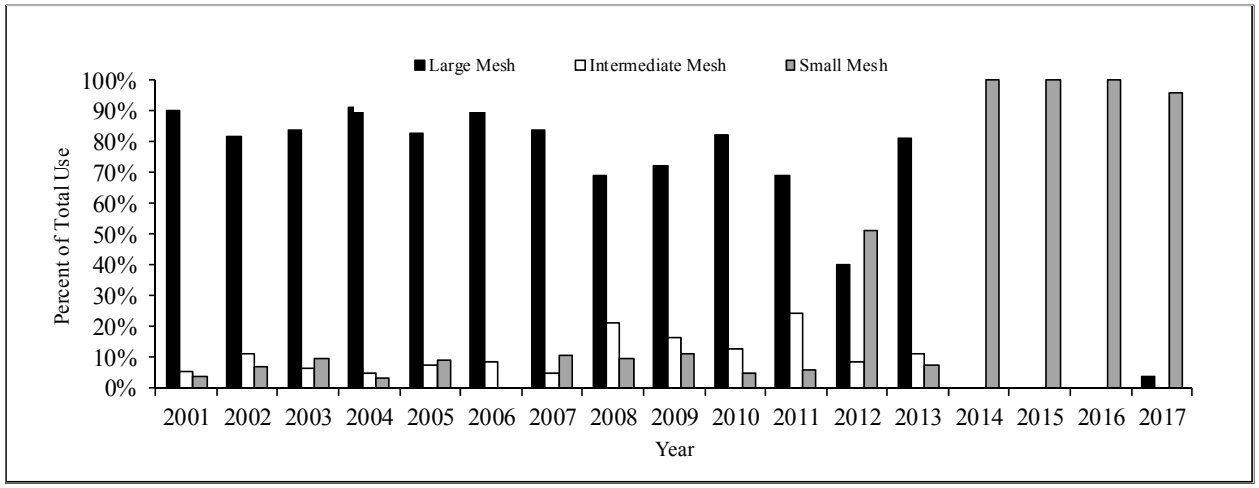
APPENDIX D: HISTORICAL PARTICIPATION, GEAR USAGE, AND ASL COMPOSITION

Appendix D1.–Historical participation in the Lower Kuskokwim River subsistence Chinook salmon age, sex, length sampling program and resulting sample sizes, 2001–2017.





Appendix D2.–Percent of Chinook salmon age, sex, and length samples collected from large (≥8 inch), intermediate (>6 inch and <8 inch), and small mesh (≤6 inch) gillnets by Lower Kuskokwim River subsistence fishermen, 2001–2017.



Appendix D3.–Estimated age and sex composition and mean length of Chinook salmon sampled from the Lower Kuskokwim River subsistence harvest, 2001–2017.

Year	Number of samplers	Sample size	Lower River harvest [a]	Total harvest [b]	Percent by age class													Percent females	Mean length
					(0.1)	(0.2)	(1.1)	(0.3)	(1.2)	(2.1)	(1.3)	(2.2)	(1.4)	(2.3)	(1.5)	(2.4)	(1.6)		
2001	20	1,052	67,082	78,174	0	0	0	0	4	0	29	0	62	0	4	0	0	34	780
2002	24	1,489	67,795	81,169	0	0	0	0	8	0	34	0	53	0	5	0	0	41	769
2003	32	1,941	58,624	67,737	0	0	0	0	7	0	44	0	43	0	6	0	0	37	770
2004	22	2,277	81,293	96,788	0	0	0	0	15	0	36	0	46	0	3	0	0	33	758
2005	30	2,826	73,872	85,863	0	0	0	0	5	0	50	0	43	0	2	0	0	37	775
2006	20	1,972	77,228	90,812	0	0	0	0	6	0	36	0	53	0	4	0	0	42	786
2007	28	2,475	81,914	94,898	0	0	0	0	7	0	38	0	52	0	3	1	0	41	782
2008	48	3,397	76,040	88,912	0	0	0	0	8	0	54	0	34	1	3	0	0	35	752
2009	55	4,218	68,181	79,896	0	0	0	0	10	0	35	0	54	0	1	0	0	38	769
2010	37	2,153	59,046	67,286	0	0	0	0	8	0	49	0	40	0	3	0	0	42	769
2011	21	1,482	53,142	62,366	0	0	0	0	14	0	48	0	37	0	2	0	0	33	749
2012	9	407	19,135	22,544	0	0	0	0	13	0	52	0	32	0	2	0	0	32	739
2013	16	873	42,026	47,113	0	0	0	0	6	0	30	0	62	1	1	0	0	42	779
2014	4	131	8,655	11,234	1	0	24	0	34	0	25	1	15	0	0	0	0	30	577
2015	9	299	14,136	16,124	0	0	2	0	34	0	36	0	26	1	0	0	0	38	677
2016	9	261	26,340	30,693	0	0	0	0	42	0	49	0	8	1	0	0	0	11	656
2017	12	174	14,191	16,380	0	0	0	0	35	0	46	0	17	0	0	0	0	24	679

Note: Age and sex percentages and mean length were calculated separately using all available samples and may differ from annual summaries that are based on a subset of samples with a complete record of paired age, sex, and length data. Errors in summation across age classes are attributed to rounding. Age-class estimates of 0% are rounded and in some cases represent percentages less than 0.5%. Samples were collected by subsistence fishermen who sampled their own harvests or the harvests of others. Mesh sizes used in the subsistence fishery have changed over time. Data was downloaded from AYKDBMS on August 30, 2018.

[a] Harvest occurring in the lower portion of the Kuskokwim River.

[b] Total harvest from the entire Kuskokwim River.

APPENDIX E: SUMMARY OF SUPPLEMENTAL SUBSISTENCE HARVEST SAMPLES COLLECTED FROM MCGRATH IN 2017

Appendix E1.–Age, sex, and length (mm) composition of Chinook salmon sampled from the McGrath subsistence fishery, 2017.

			Age class			
Year	Sample size [a]	Sex	1.2	1.3	1.4	Total
2017	41	Male	27%	24%	7%	59%
		Female	10%	29%	2%	42%
		Total	37%	54%	10%	100%
		Male mean length	552	751	833	
		SD	36	40	86	
		Range	520–624	702–838	751–922	
		n	11	10	3	
		Female mean length	589	726	730	
		SD	55	66	–	
		Range	540–648	655–845	–	
		n	4	12	1	

[a] Sample size includes only Chinook salmon that were aged.

Appendix E2.–Summary of Chinook salmon age, sex, and length samples collected from McGrath Chinook salmon subsistence fishery, 2017.

Year	Age samples [a]	Number aged [b]	Number sexed [c]	Number lengths [d]	Complete samples [e]
2017	56	49	48	48	41

[a] Number of fish for which scales were collected for age estimation.

[b] Number of fish for which total age was successfully estimated from scale samples.

[c] Number of fish for which a sex determination was based on internal inspection of gonads.

[d] Number of fish for which length was measured from mideye to tail fork.

[e] Number of fish with age, sex, and length.

Appendix E3.–Percent of samples collected by gillnet mesh size in the McGrath Chinook salmon subsistence fishery, 2017.

Mesh size[a]	5 inch	6 inch	Unknown	Total
(*n* = 57)	3.5%	38.6%	57.9%	100%

Note: Sample sizes include Chinook salmon whose age could not be determined.

[a] Drift and set gillnets combined.

APPENDIX F: AGE COMPOSITION COMPARISON BETWEEN SUBSISTENCE HARVEST AND TOTAL RUN

Appendix F1.–Age composition of the total return of Chinook salmon to the Kuskokwim River and the component of the return harvested by the subsistence fishery, 2016–2017.