Fishery Data Series No. 20-06

Eastside Set Gillnet Chinook Salmon Harvest Composition in Upper Cook Inlet, Alaska, 2019

Anthony Eskelin

and

Andrew W. Barclay

February 2020

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

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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. 20-06

EASTSIDE SET GILLNET CHINOOK SALMON HARVEST COMPOSITION IN UPPER COOK INLET, ALASKA, 2019

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ABSTRACT

Chinook salmon were sampled for genetic tissue and age, sex, and length from the Upper Cook Inlet Eastside set gillnet commercial fishery in 2019. Mixed-stock analysis (MSA) was conducted on tissue samples collected to represent harvest by date and area. Reported harvest was 2,245 Chinook salmon, with an estimated composition of 1,458 (65%) *Kenai River mainstem*, 714 (32%) *Kasilof River mainstem*, 49 (2%) *Kenai River tributaries*, and 25 (1%) *Cook Inlet other* fish. *Kenai River mainstem* fish have composed on average 71% of the harvest since 2010, ranging from 61% in 2014 to 79% in 2017. Estimated harvest of large (75 cm mid eye to tail fork and longer) *Kenai River mainstem C*hinook salmon in 2019 was 613 fish (27% of total harvest and 60% of large fish harvest). Large *Kenai River mainstem* fish have composed on average 35% of the total harvest since 2010 ranging from 23% in 2013 to 63% in 2017. Large *Kenai River mainstem* fish have composed on average 69% of the large fish harvest ranging from 60% in 2010 and 2019 to 79% in 2017. Age composition of the total harvest in 2019 was 14% age-1.1 (jacks), 33% age-1.2, 42% age-1.3, 11% age-1.4, and less than 1% age-1.5 fish. The percentage of age-1.4 fish (11%) in the harvest was the lowest observed since sampling began in 1987. Sex composition of the Chinook salmon harvest was 74% males and 26% females. The average mid eye to tail fork length was 715 mm in 2019, the 4th lowest ever observed.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Upper Cook Inlet, UCI, Kenai River, Kasilof River, late run, mixed-stock analysis, MSA, ASL, ESSN, Eastside set gillnet commercial fishery

INTRODUCTION

The commercial fishery in Cook Inlet is one of the largest within the state of Alaska in terms of limited entry salmon permits (Clark et al. 2006). Nearly 10% of all salmon permits issued statewide are in Upper Cook Inlet (UCI), and the harvest typically represents approximately 5% of the statewide catch (Shields and Frothingham 2018). The UCI commercial fisheries management area consists of that portion of Cook Inlet north of the Anchor Point Light (lat 50°46.15′N) and is divided into the Central and Northern districts (Figure 1). The Central District is approximately 75 miles long, averages 32 miles in width, and is divided into 6 subdistricts (Figure 1). Both set (fixed) and drift gillnets are used in the Central District, whereas only set gillnets are used in the Northern District.

Sockeye salmon (*Oncorhynchus nerka*) compose the majority of the commercial harvest in UCI but all other species of North American Pacific salmon are also harvested, including Chinook salmon (*O. tshawytscha*) (Shields and Frothingham 2018). Harvest statistics are monitored by the Alaska Department of Fish and Game (ADF&G) from fish tickets (Alaska Administrative Code 5 AAC 21.355). Harvest data are available and reported by 5-digit statistical areas (Shields and Frothingham 2018). Most of the UCI commercial Chinook salmon harvest occurs in the Upper Subdistrict of the Central District, commonly referred to as the Eastside set gillnet (ESSN) fishery, located along the eastern shore of Cook Inlet between Ninilchik and Boulder Point (Figures 1–2). On average since 1966, the ESSN fishery has accounted for 65% of all Chinook salmon harvested in UCI commercial fisheries (Table 1).

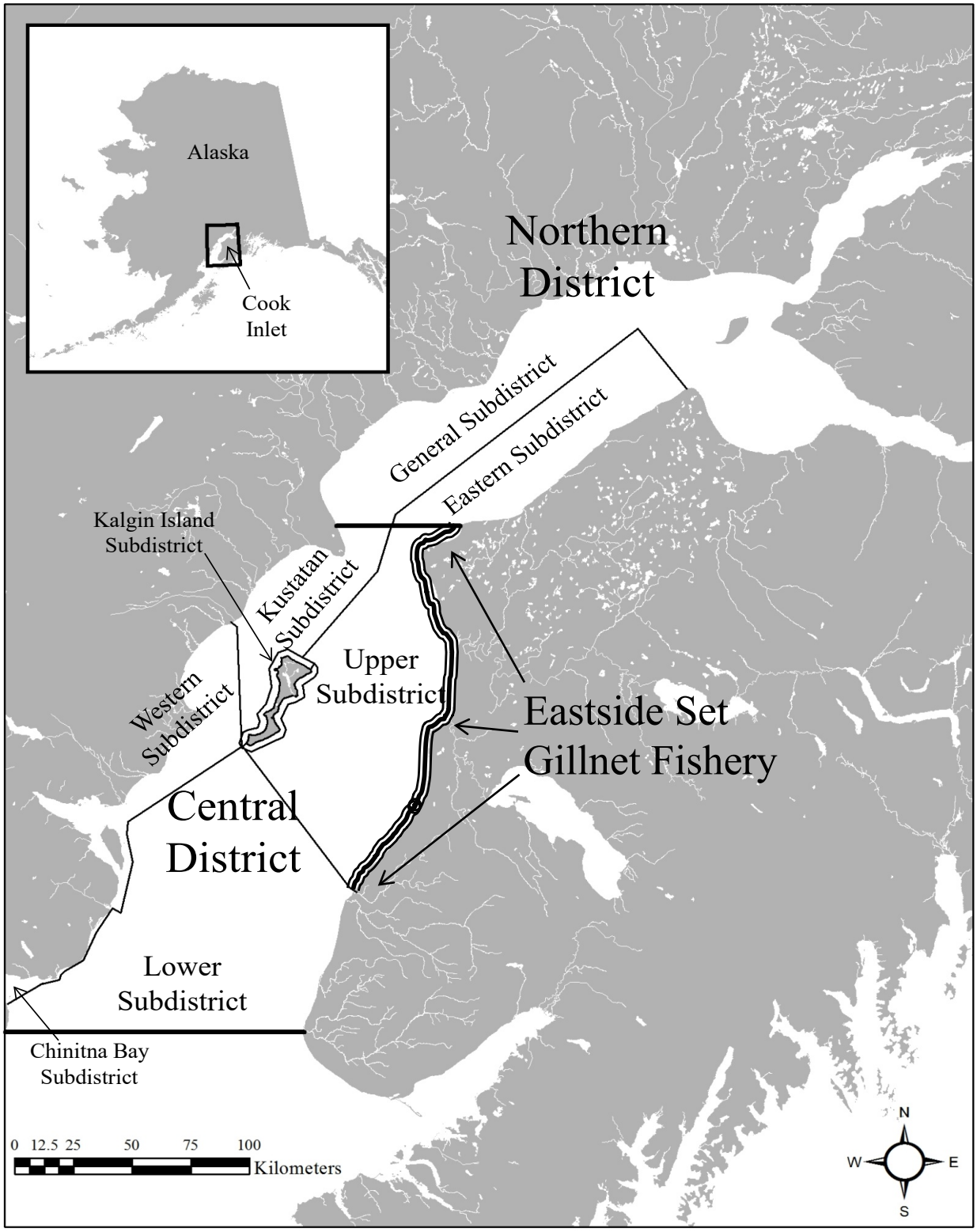

Figure 1.–Map of Upper Cook Inlet commercial fishing districts and subdistricts.

Note: Thick black lines indicate district borders and thin lines indicate subdistrict borders; the outlined thick black line near the eastern shore of Cook Inlet denotes the Eastside set gillnet fishery.

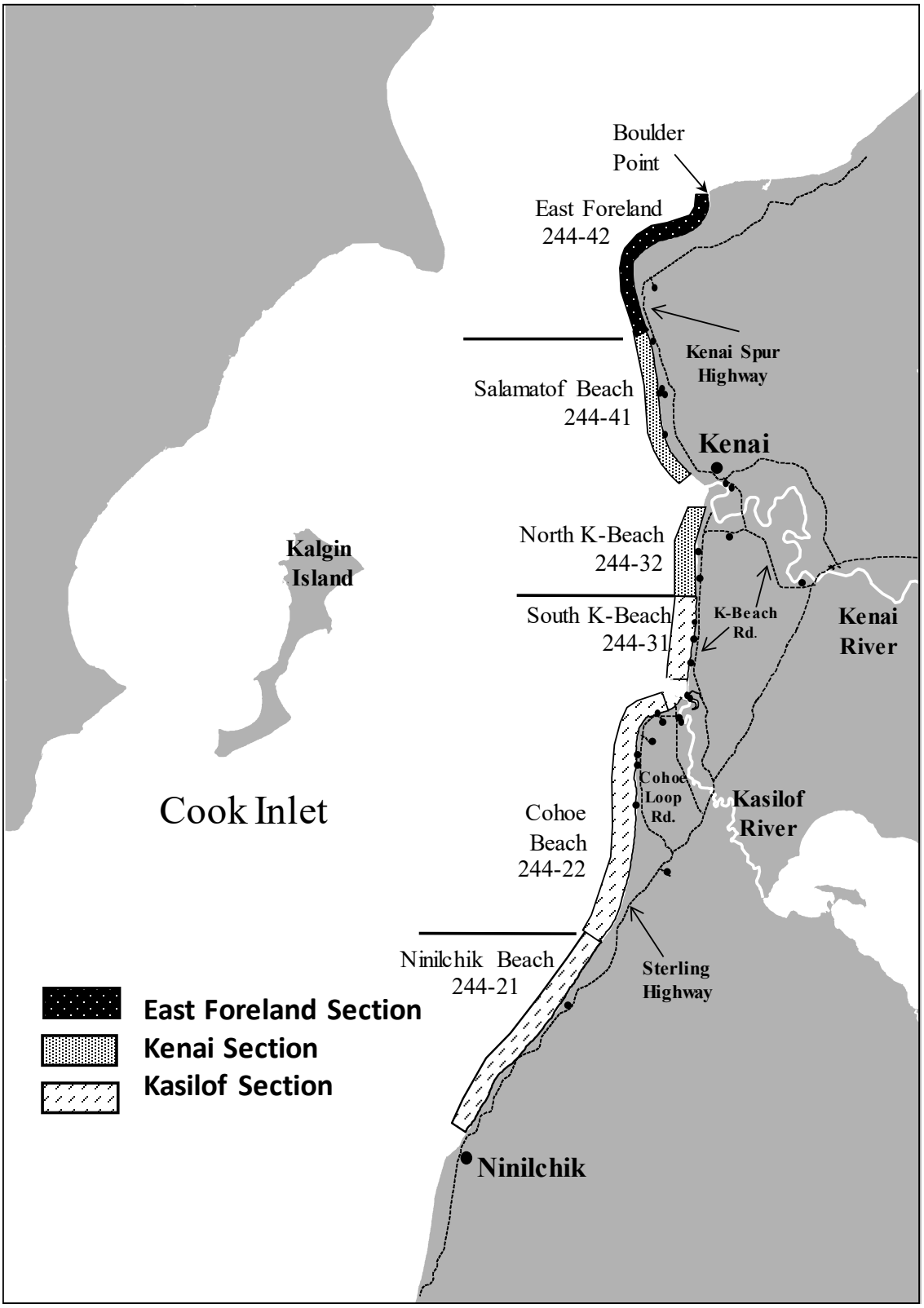

Figure 2.–Map of Upper Cook Inlet Eastside set gillnet commercial fishing statistical areas.

Note: Small circles represent approximate locations of processing plants or receiving sites. The Kasilof River Special Harvest Area (244-25) is located near the mouth of the Kasilof River.

Table 1.–Upper Cook Inlet commercial Chinook salmon gillnet harvest by gear type and area, 1966–2019.

	Central District								
	Eastside set		Drift		Kalgin–Westside set		Northern District set		
Year	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Total
1966	7,329	85.8	392	4.6	401	4.7	422	4.9	8,544
1967	6,686	85.1	489	6.2	500	6.4	184	2.3	7,859
1968	3,304	72.8	182	4.0	579	12.8	471	10.4	4,536
1969	5,834	47.1	362	2.9	3,286	26.5	2,904	23.4	12,386
1970	5,368	64.4	356	4.3	1,152	13.8	1,460	17.5	8,336
1971	7,055	35.7	237	1.2	2,875	14.5	9,598	48.6	19,765
1972	8,599	53.5	375	2.3	2,199	13.7	4,913	30.5	16,086
1973	4,411	84.9	244	4.7	369	7.1	170	3.3	5,194
1974	5,571	84.5	422	6.4	434	6.6	169	2.6	6,596
1975	3,675	76.8	250	5.2	733	15.3	129	2.7	4,787
1976	8,249	75.9	690	6.4	1,469	13.5	457	4.2	10,865
1977	9,730	65.8	3,411	23.1	1,084	7.3	565	3.8	14,790
1978	12,468	72.1	2,072	12.0	2,093	12.1	666	3.8	17,299
1979	8,671	63.1	1,089	7.9	2,264	16.5	1,714	12.5	13,738
1980	9,643	69.9	889	6.4	2,273	16.5	993	7.2	13,798
1981	8,358	68.3	2,320	19.0	837	6.8	725	5.9	12,240
1982	13,658	65.4	1,293	6.2	3,203	15.3	2,716	13.0	20,870
1983	15,042	72.9	1,125	5.5	3,534	17.1	933	4.5	20,634
1984	6,165	61.3	1,377	13.7	1,516	15.1	1,004	10.0	10,062
1985	17,723	73.6	2,048	8.5	2,427	10.1	1,890	7.8	24,088
1986	19,826	50.5	1,834	4.7	2,108	5.4	15,488	39.5	39,256
1987	21,159	53.6	4,552	11.5	1,029	2.6	12,700	32.2	39,440
1988	12,859	44.2	2,237	7.7	1,148	3.9	12,836	44.1	29,080
1989	10,914	40.8	0	0.0	3,092	11.6	12,731	47.6	26,737
1990	4,139	25.7	621	3.9	1,763	10.9	9,582	59.5	16,105
1991	4,893	36.1	246	1.8	1,544	11.4	6,859	50.6	13,542
1992	10,718	62.4	615	3.6	1,284	7.5	4,554	26.5	17,171
1993	14,079	74.6	765	4.1	720	3.8	3,307	17.5	18,871
1994	15,575	78.0	464	2.3	730	3.7	3,193	16.0	19,962
1995	12,068	67.4	594	3.3	1,101	6.2	4,130	23.1	17,893
1996	11,564	80.8	389	2.7	395	2.8	1,958	13.7	14,306
1997	11,325	85.2	627	4.7	207	1.6	1,133	8.5	13,292
1998	5,087	62.6	335	4.1	155	1.9	2,547	31.4	8,124
1999	9,463	65.8	575	4.0	1,533	10.7	2,812	19.6	14,383
2000	3,684	50.1	270	3.7	1,089	14.8	2,307	31.4	7,350
2001	6,009	64.6	619	6.7	856	9.2	1,811	19.5	9,295
2002	9,478	74.5	415	3.3	926	7.3	1,895	14.9	12,714
2003	14,810	80.1	1,240	6.7	770	4.2	1,670	9.0	18,490
2004	21,684	80.5	1,104	4.1	2,208	8.2	1,926	7.2	26,922
2005	21,597	78.1	1,958	7.1	739	2.7	3,373	12.2	27,667
2006	9,956	55.2	2,782	15.4	1,030	5.7	4,261	23.6	18,029

-continued-

Table 1.–Page 2 of 2.

	Central District								
	Eastside set		Drift		Kalgin–Westside set		Northern District set		
Year	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Total
2007	12,292	69.7	912	5.2	603	3.4	3,818	21.7	17,625
2008	7,573	56.8	653	4.9	1,124	8.4	3,983	29.9	13,333
2009	5,588	63.9	859	9.8	672	7.7	1,631	18.6	8,750
2010	7,059	71.3	538	5.4	553	5.6	1,750	17.7	9,900
2011	7,697	68.4	593	5.3	659	5.9	2,299	20.4	11,248
2012	704	27.9	218	8.6	555	22.0	1,049	41.5	2,526
2013	2,988	55.4	493	9.1	590	10.9	1,327	24.6	5,398
2014	2,301	49.4	382	8.2	507	10.9	1,470	31.5	4,660
2015	7,781	72.1	556	5.1	538	5.0	1,923	17.8	10,798
2016	6,759	67.4	606	6.0	460	4.6	2,202	22.0	10,027
2017	4,779	62.4	264	3.4	387	5.1	2,230	29.1	7,660
2018	2,312	67.8	507	14.9	447	13.1	143	4.2	3,409
Average									
1966–2018 [a]	9,141	65.0	932	6.6	1,186	9.2	2,966	19.2	14,225
2009–2018	4,797	60.6	502	7.6	537	9.1	1,602	22.7	7,438
2019	2,245	71.1	179	5.7	532	16.8	202	6.4	3,158

Source: Shields and Frothingham (2018); Marston and Frothingham (2019).

[a] Data from 1989 were not used in averages because the drift fleet did not fish due to the Exxon Valdez oil spill, which affected all other fisheries.

MANAGEMENT OF THE EASTSIDE SET GILLNET FISHERY

The ESSN fishery is divided into 3 sections (Kenai, Kasilof, and East Foreland) and 7 statistical areas: Ninilchik Beach (244-22), Cohoe Beach (244-22), South K-Beach (244-31), North K-Beach (244-32), Salamatof Beach (244-41), East Foreland Beach (244-42), and the Kasilof River Special Harvest Area (KRSHA, 244-25) (Figure 2). Fishery managers generally regulate the ESSN fishery by sections (groups of statistical areas). The Kasilof Section comprises Ninilchik Beach, Cohoe Beach, and South K-Beach. The Kenai Section comprises North K-Beach and Salamatof Beach. The East Foreland Section comprises East Foreland Beach and has historically been fished concurrently with the Kenai Section; however, new regulations (5 AAC 21.359[e][3]) allow for the decoupling of East Foreland Section from the rest of the Kenai Section. Chinook salmon harvest from East Foreland Beach is low; consequently, for this study, harvest from the East Foreland Section is combined with the Kenai Section.

The Kasilof Section opens by regulation on the first Monday or Thursday on or after 25 June unless ADF&G estimates that 50,000 sockeye salmon are in the Kasilof River prior to that date, at which time the commissioner may open the Kasilof Section by emergency order (EO); however, the Kasilof Section may not open earlier than 20 June (5 AAC 21.310 b. 2.C.[i]). The Kenai and East Foreland sections open by regulation on the first Monday or Thursday on or after 8 July (5 AAC 21.310). KRSHA can be opened separately at any time to concentrate harvest of Kasilof River sockeye salmon while minimizing harvest of other stocks. The ESSN fishery closes on 15 August. Marston and Frothingham (2019) give specific details regarding management of the ESSN fishery and the 2019 fishing season.

MIXED-STOCK ANALYSIS

Accurate estimation of adult salmon abundance requires stock-specific information on the escapement and inriver run as well as marine and freshwater harvests. For mixed-stock harvests from marine and freshwater fisheries, stock-specific harvest can be estimated using genetic information in a mixed-stock analysis (MSA). This analysis requires a comprehensive genetic baseline that includes genetic data from fish representing all potential populations that may contribute to the harvest. In addition, for available genetic markers, there must be enough genetic variation among baseline populations to accurately estimate the contribution of population groups (stocks) in an MSA. These groups of populations are referred to as reporting groups. Stock compositions and stock-specific harvest estimates refer to compositions and harvest by reporting group.

Baseline and Reporting Groups

A Chinook salmon genetic baseline for UCI was first developed in 2012 that included 30 populations and 38 genetically variant single nucleotide polymorphism (SNP) loci (Barclay et al. 2012). Since then, the baseline has been augmented with additional collections and previously unrepresented populations, and is now comprehensive, including 55 populations and 39 variant SNPs (Barclay and Habicht 2015). To minimize misallocation between MSA reporting groups, the Slikok Creek population from the Kenai River drainage was removed from the baseline because it represents a very small number of fish and is genetically similar to the Crooked Creek population from the Kasilof River drainage (Barclay et al. 2012). Therefore, the baseline used for the ESSN harvest sampling project in 2019 only includes 54 of the 55 populations reported in Barclay and Habicht (2015). For more specific details regarding the UCI Chinook salmon baseline, see Barclay and Habicht (2015) or past reports detailing MSAs for the ESSN Chinook salmon fishery since 2010 (Eskelin et al. 2013; Eskelin and Barclay 2015–2019).

Reporting groups apportioning the harvest were selected based on 1 or more of the following criteria: 1) the genetic similarity among populations, 2) the expectation that proportional harvest would be greater than 5%, or 3) the applicability for answering fishery management questions. The 4 reporting groups chosen to apportion the ESSN Chinook salmon harvest were as follows: *Kenai River mainstem* (Kenai River mainstem populations and Juneau Creek), *Kenai River tributaries* (Kenai River tributary populations excluding Juneau Creek), *Kasilof River mainstem* (the Kasilof River mainstem population), and *Cook Inlet other* (all remaining UCI baseline populations). Juneau Creek, a Kenai River tributary, was included in the *Kenai River mainstem* reporting group due to its genetic similarity with Kenai River mainstem populations (Barclay et al. 2012).

The results of baseline evaluation tests (proof tests) for the 4 reporting groups are reported in Eskelin et al. (2013). Since that report, 12 additional northern Cook Inlet populations have been added to the baseline. Because northern Cook Inlet populations are included in the *Cook Inlet other* reporting group, which represents a very small component of the ESSN Chinook salmon harvest, the previous proof test results are still a good indicator of the performance of the updated baseline for ESSN Chinook salmon reporting groups. Consequently, this report does not contain updated proof test results.

TISSUE, AGE, SEX, LENGTH, AND CODED WIRE TAG SAMPLING AND ANALYSES

Age, sex, and length (ASL) samples have been collected and analyzed for ASL composition from Chinook salmon harvested in the ESSN fishery since 1983 (Tobias and Willette 2010). The age compositions are used for Kenai River Chinook salmon run reconstruction (determining recruitments from brood years) which is then used in escapement goal analysis and forecasting future run size. Chinook salmon with a missing adipose fin (indicating both a hatchery fish and the possible presence of an implanted coded wire tag [CWT]) were collected and the heads were dissected to determine if a CWT was present.

Tissue samples for MSA were added to the collection effort beginning in 2010 even though the Upper Cook Inlet Chinook salmon genetic baseline was not fully developed until 2012. Stock composition and stock-specific harvest estimates were produced for 2010–2018, except for 2012 due to low sample size. Stock compositions and stock-specific harvest estimates have also been stratified by time and area since during those same years.

Since 2013, ASL compositions have been stratified by the same times and areas as the MSAs. In addition, the same individual fish have been selected for both ASL composition and MSA. Results from these studies can be found in Eskelin et al. (2013) and Eskelin and Barclay (2015–2019).

STOCK COMPOSITIONS AND STOCK-SPECIFIC HARVEST ESTIMATES STRATIFIED BY SIZE

Beginning in 2017, the data used for assessment and management of Kenai River Chinook salmon changed from sonar passage estimates of Chinook salmon of all sizes to those fish that are 75 cm from mid eye to tail fork (METF) and longer (Alaska Administrative Code 5 AAC 57.160). There are many reasons for this change, but the primary reason was that inriver sonar estimates of Kenai River Chinook salmon 75 cm METF and longer (hereafter referred to as "large fish") constitute the most reliable and accurate information available because large Chinook salmon don't overlap in size with other species, so species apportionment estimation is not necessary because all "large fish" are Chinook salmon. Furthermore, "large" Chinook salmon represent the majority of the stock's potential reproductive capacity because "large fish" include nearly all females. In contrast, inriver estimates of Chinook salmon less than 75 cm METF length (hereafter referred to as "small fish") were indirect, imprecise, time consuming, and difficult to obtain for effective inseason management because "small fish" are potentially composed of other species of overlapping size and are therefore difficult to enumerate accurately with species apportionment methods. Fleischman and Reimer (2017) give a more detailed explanation why management of Kenai River Chinook salmon fisheries are based on sonar estimates of large Chinook salmon.

In preparation for that change in assessment and management, methods to estimate stock composition and stock-specific harvest of ESSN Chinook salmon stratified by size (i.e., large and small fish) were developed in 2016 to analyze the 2016 harvest and to reanalyze the 2015 harvest (Eskelin and Barclay 2017). The 2017 and 2018 harvests were analyzed using the same methods (Eskelin and Barclay 2018, 2019) and also in 2018, the 2010, 2011, 2013, and 2014 harvests were reanalyzed to include large fish stock compositions and stock-specific harvests. With the inclusion of those years, we now have MSAs for all years of harvest dating back to 2010 (except 2012) analyzed by time, area, and size.

OBJECTIVES

PRIMARY OBJECTIVES

1) Estimate the proportion of Chinook salmon harvested in the ESSN fishery by reporting group (*Kenai River mainstem, Kasilof River mainstem, Kenai River tributaries, Cook Inlet other*) and size (large and small) for each temporal and geographic stratum, and for the entire season, such that the estimated proportions are within 13 percentage points of the true values 90% of the time.
2) Estimate the harvest of *Kenai River mainstem* and *Kasilof River mainstem* Chinook salmon in the ESSN fishery by size for each temporal and geographic stratum, and for the entire season, such that the estimates are within 30% of the true value 90% of the time[1].
3) Estimate the age composition of Chinook salmon harvested by the ESSN fishery such that the estimates are within 10 percentage points of the true values 95% of the time.

SECONDARY OBJECTIVES

1) Estimate the harvest of Chinook salmon by size for the reporting groups *Kenai River tributaries* and *Cook Inlet other* in the ESSN fishery for each temporal and geographic stratum, and for the entire season[2].
2) Examine sampled Chinook salmon harvested in the ESSN fishery for coded wire tags (CWT).
3) Estimate the age composition of the Chinook salmon harvest for each temporal and geographic stratum.
4) Estimate the sex and length compositions of Chinook salmon harvested in the ESSN fishery for each temporal and geographic stratum, and for the entire season.

METHODS

STUDY DESIGN

Chinook Salmon Harvest

ESSN fishery Chinook salmon harvests are required to be recorded on fish tickets whether fish were delivered to the processor or if they were kept for personal use (Alaska Administrative Code 5 AAC 21.355 *Reporting requirements*). In addition to the number of fish harvested, the tickets must include information on the date and location (statistical area) of the harvest. Fish ticket information was entered into the ADF&G fish ticket database and summarized in Marston and Frothingham (2019). Harvest information for the ESSN fishery was retrieved from the database after error checking was completed and final numbers were produced.

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[1] This criterion was for harvest estimates of stocks that account for at least 20% of the total harvest within a stratum. It is not necessary or realistic for harvest estimates that account for less than 20% to meet this criterion.

[2] Based on previous MSA results, it was anticipated that Chinook salmon harvest of reporting groups *Kenai River tributaries* and *Cook Inlet other* would be low (<150 fish) so no precision criteria were set for estimation of these reporting groups. Sample size was driven by Objectives 1 and 2.

Tissue and Age, Sex, and Length Sampling

During a fishery opening, fishermen generally pick fish from their nets after each tide and at the end of the fishing period when their gear is pulled from the water. Fishermen most often deliver their catch after each "pick" and after the end of a fishing period to intermediary receiving sites for fish processing plants that are located at or near their fishing operation. ADF&G personnel travelled to those receiving sites to sample harvested Chinook salmon for genetic tissue, scales, sex, length, and heads from fish without an adipose fin (indicating a potential CWT). The number and location of receiving sites can vary from year to year, but there are generally about 18 sampling locations (Figure 2). As many sites as possible were sampled during each fishing period, and many sites were sampled more than once if fishing occurred over multiple tides. Sampling began after the first round of deliveries to the receiving sites, generally starting at the southernmost receiving site near Ninilchik and progressing northward. Samplers attempted to collect as many Chinook salmon samples as possible while distributing sampling effort throughout the area. When feasible, additional Chinook salmon samples were collected at fish processing plants the day following each fishing period if the location (statistical area) of harvest could be determined. The sampling rate for each statistical area was monitored by the project biologist after every sampling period and, if necessary, adjustments were made to increase the sampling rate from statistical area(s) with the lowest numbers of samples or the lowest sampling rate.

Three scales were removed from the preferred area of each fish and placed on an adhesive-coated gum card (Welander 1940; Clutter and Whitesel 1956). Acetate impressions were made of each scale card, and scales were aged using a microfiche reader (Koo 1962). Sex was generally identified from external morphology (i.e., protruding ovipositor on females or a developing kype on males). If permission was granted by the processor or staff at receiving sites, some small fish that were difficult to sex were examined internally for positive sex identification by cutting a small slit in the anal opening using a plastic gut hook. A few large fish were also examined internally if the ADF&G sampler was not positive of sex from external morphometric characteristics. All data, including date, sampling location and statistical area of harvest were recorded on data sheets and then entered onto the project biologist's computer for analysis.

All fish sampled for scales, sex, and length were also sampled for genetic tissue. A 1⅓ cm (half-inch) piece of the axillary process was removed from each fish and placed on a Whatman[3] paper card in its own grid space, then stapled in place. Whatman cards with tissue samples were then placed in an airtight case with desiccant beads to preserve the tissue for DNA extraction. Each Whatman card had a unique barcode and a numbered grid. Card barcodes and grid position numbers were recorded on data sheets for each sample. Tissue samples were archived at the ADF&G Gene Conservation Laboratory and age, sex, and length data were archived at the Soldotna ADF&G office.

Sample Selection

Tissue samples were divided into 6 spatiotemporal strata: 1) Kasilof Section "Early," before the Kenai and East Foreland sections open, 2) Ninilchik Beach "Late," indicating after the Kenai and East Foreland sections open, 3) Cohoe Beach "Late," 4) South K-Beach "Late," 5) North K-Beach "Late," and 6) Salamatof and East Foreland beaches "Late." Few samples were collected during early August so those samples were included in the "Late" strata MSAs so that the entire harvest

[3] Product names used in this publication are included for completeness but do not constitute product endorsement.

could be represented by stock in the MSA. The sample size goal for MSA was 100 fish per stratum. Individual samples were selected to represent the harvest by statistical area, length, and date. Once the required number of samples was determined, samples were selected systematically by length from all available samples on each day and statistical area. When insufficient samples were collected to represent the harvest for a statistical area on a given day, samples from the next closest day(s) were used to create a "harvest-proportional" sample. Generally, those samples selected to represent the closest day were collected within 3 days of each other and were always within the same statistical area and temporal stratum. Samples from the same fish were selected for MSA and ASL compositions.

LABORATORY ANALYSIS

Assaying Genotypes

Genomic DNA was extracted from tissue samples using a NucleoSpin 96 Tissue Kit (Macherey-Nagel). DNA was screened for 39 SNP markers. To ensure that DNA concentrations were high enough with the dry sampling method used to preserve samples, preamplification was conducted before screening the DNA.

The concentration of template DNA from samples was increased using a multiplexed preamplification PCR of 42 screened SNP markers. Each reaction was conducted within a 10 µL volume consisting of 4 µL of genomic DNA, 5 µL of 2X Multiplex PCR Master Mix (Qiagen), and 1 µL each of 2 µM SNP unlabeled forward and reverse primers. Thermal cycling was performed on a Dual 384-Well GeneAmp PCR system 9700 (Applied Biosystems) at 95°C hold for 15 minutes followed by 20 cycles of 95°C for 15 seconds, 60°C for 4 minutes, and a final extension hold at 4°C.

The preamplified DNA was genotyped using Fluidigm 192.24 Dynamic Array Integrated Fluidic Circuits (IFCs), each of which systematically combines up to 24 assays and 192 samples into 4,608 parallel reactions. The components were pressurized into each IFC using the IFC Controller RX (Fluidigm). Each reaction was conducted in a 9 nL volume chamber consisting of a mixture of 20X Fast GT Sample Loading Reagent (Fluidigm), 2X TaqMan GTXpress Master Mix (Applied Biosystems), Custom TaqMan SNP Genotyping Assay (Applied Biosystems), 2X Assay Loading Reagent (Fluidigm), 50X ROX Reference Dye (Invitrogen), and 60–400 ng/µl DNA. Thermal cycling was performed on a Fluidigm FC1 Cycler using a Fast PCR protocol as follows: an initial "Hot-Start" denaturation at 95°C for 2 minutes followed by 40 cycles of denaturation at 95°C for 2 seconds and annealing at 60°C for 20 seconds, with a final "Cool-Down" at 25°C for 10 seconds. The IFCs were read on a Biomark or EP1 System (Fluidigm) after amplification and genotyped using Fluidigm SNP Genotyping Analysis software.

Genotypes were imported and archived in the Gene Conservation Laboratory's Oracle database, LOKI.

Laboratory Failure Rates and Quality Control

The overall failure rate was calculated by dividing the number of failed single-locus genotypes by the number of assayed single-locus genotypes. An individual genotype was considered a failure when a locus for a fish could not be satisfactorily scored.

Quality control (QC) measures were instituted to identify laboratory errors and to determine the reproducibility of genotypes. In this process, 8 of every 96 fish (1 row per 96-well plate) were

reanalyzed for all markers by staff not involved with the original analysis. Laboratory errors found during the QC process were corrected, and genotypes were corrected in the database. Inconsistencies not attributable to laboratory error were recorded, but original genotype scores were retained in the database.

Assuming the inconsistencies among analyses (original vs. QC genotyping) were due equally to errors in original genotyping and errors during the QC genotyping, and that these analyses are unbiased, error rates in the original genotyping were estimated as one-half the rate of inconsistencies.

DATA ANALYSIS

Data Retrieval and Quality Control

Genotypes were retrieved from LOKI and imported into *R* (R Core Team 2019)[4]. All subsequent genetic analyses were performed in *R* unless otherwise noted.

Prior to statistical analysis, 2 analyses were performed to confirm the quality of the data. First, individuals were identified that were missing a substantial amount of genotypic data—that is, those individuals missing data at 20% or more of loci (80% rule; Dann et al. 2009). These individuals were removed from further analyses because their samples were suspected to have poor-quality DNA. The inclusion of individuals with poor-quality DNA might introduce genotyping errors into the mixture samples and reduce the accuracies of MSA.

The second quality control analysis identified individuals with duplicate genotypes and removed them from further analyses. Duplicate genotypes can occur from sampling or extracting the same individual twice and were defined as pairs of individuals sharing the same alleles in 95% or more of loci screened. The individual with the most missing genotypic data from each duplicate pair was removed from further analyses. If both individuals had the same amount of genotypic data, the first individual was removed from further analyses.

Mixed Stock Analysis

The stock compositions of the ESSN mixtures were estimated using the software package *BAYES* (Pella and Masuda 2001). *BAYES* employs the Pella-Masuda model via Gibbs sampling algorithm to estimate the most probable contribution of the baseline populations to explain the combination of genotypes in the mixture sample. Within each iterate of the algorithm, each fish is stochastically assigned a hypothetical stock-of-origin based on the statistical likelihood of its genotype in each population. After all assignments are made, they are summarized, deriving the stock composition for that iterate. The process of assigning individuals and deriving stock compositions is repeated many times. *BAYES* outputs a summary of composition estimates by reporting group for each iteration (RGN output) and reporting group assignments for each fish at each iteration (CLS output). A total of 5 Markov chain Monte Carlo chains (MCMC) were run for each mixture with 40,000 iterations for each chain.

The prior distribution used in *BAYES* was based upon the best available information for each mixture analysis. For the 2019 ESSN mixtures, the best available information came from the stock composition estimates of similar strata from the analysis of the 2018 ESSN Chinook salmon

[4] R Core Team. 2019. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/ (Accessed January 9, 2019).

samples. The sum of the prior parameters was set equal to 1, thus minimizing the overall influence of the prior distribution. The chains were run until among-chain convergence was reached (shrink factor <1.2; Pella and Masuda 2001). To reduce the output file size, the *BAYES* output was thinned to include every 100th iteration, resulting in a final output of 400 iterations for each MCMC chain. The first 200 iterations from each MCMC chain were discarded to reduce the influence of the starting values and the remaining iterations from each chain were combined to form the posterior distribution (1,000 iterations). Stock composition estimates and 90% credibility intervals (CIs) for each stratum were calculated by taking the mean and 5% and 95% quantiles of the posterior distribution from the RGN output (Gelman et al. 2004). Credibility intervals differ from confidence intervals in that they are a direct statement of probability (e.g., a 90% credibility interval has a 90% chance of containing the true answer).

All-Fish Stock Compositions and Stock-Specific Harvest Estimates

Stock-specific harvest estimates and 90% CIs for each stratum were calculated by multiplying the reported harvest from that stratum by its unrounded estimates of reporting group proportions (obtained from MSA) and the upper and lower 90% bounds of that estimate. Results were rounded to the nearest fish. Due to uncertainty in estimates with low stock composition values and low stock-specific harvest estimates, only stock composition values greater than 0.05 and stock-specific harvest estimates with the lower end of the 90% CI at 1 or greater are reported in the results section. These low stock composition values and stock-specific estimates are included in the tables and figures, but caution should be used in interpretation due to their high uncertainty.

Stratified stock composition and stock-specific harvest estimates were obtained as follows: 1) Kasilof Section "Early" 27 June–4 July; 2) Kasilof Section "Late" 8 July–3 August; and 3) Kenai–East Foreland sections "Late" 8 July–3 August. Tissue samples collected from the Kasilof Section openings restricted to within one-half mile (13 July and 21 July) and to within 600 ft of the mean high tide mark (2 August) were included in the Kasilof Section "Late" stratum. Tissue samples collected from the North K-Beach fishing period restricted to within 600 ft of the mean high tide mark (13 July, 21 July, and 2 August) were included in the Kenai–East Foreland sections "Late" stratum.

Stock composition estimates from mixtures 1–6 were also combined to produce stratified stock-specific harvest estimates for the entire 2019 season by weighting them by their respective harvests (stratified estimator) following the methods of Dann et al. (2009). These harvest estimates, including their upper and lower bounds, were divided by the total harvest among combined strata to derive the overall proportion and credibility interval of each reporting group in the harvest. The stratified estimates $\hat{p}_g$ of the overall proportion of reporting group g fish within S strata were calculated with the following equation:

$$\hat{p}_g = \frac{\sum_{i=1}^{S} H_i \hat{p}_{g,i}}{\sum_{i=1}^{S} H_i} \tag{1}$$

where H_i is the overall harvest in stratum i and $\hat{p}_{g,i}$ is the proportion of reporting group g fish in stratum i. The caret symbol (^) denotes an estimated value in Equation 1 and all following equations.

To calculate credibility intervals for H_g (the overall harvest of reporting group g), its distribution was estimated via MCMC by resampling 100,000 draws of the posterior output from each of the constituent strata and applying the harvest to the draws according to this slight modification of Equation 1:

$$\hat{H}_g = \sum_{i=1}^{S} H_i \hat{p}_{g,i} \tag{2}$$

This method yielded the same point estimate for number of harvested fish within the fishery as would be obtained by simply summing the point estimates from each constituent stratum, but it produced a more appropriate credibility interval than simply summing the lower and upper bounds of the credibility intervals together (see Piston 2008). This method also accommodated nonsymmetrical CIs.

The thinned posterior distributions of the RGN and CLS outputs were used to estimate the stock composition by size (large fish ≥75 cm vs. small fish <75 cm) for each reporting group. Within each iterate, the number of fish (n_i) that were assigned to reporting group i were summarized first, along with the number of those that were large fish (b_i). The proportion of the stock of interest that was large fish (β_i) was then derived as a draw from a beta distribution with parameters $b_i + ½$ and $n_i - b_i + ½$ before it was multiplied by the reporting group's composition (p_i) in the same iterate. This produced the desired parameter ($s_i = p_i\beta_i$). The proportions (s_i) derived from each iterate were then summarized across iterates to provide estimates ($\hat{s}_i$) for both large and small fish for each reporting group.

MSA Comparisons of Similar Strata and Annual Estimates Across Years

MSA estimates from 2010, 2011, and 2013–2019 were compared across years by similar strata the annual estimates for fish of all sizes and for large fish. Comparisons were made for Kasilof Section "Early," Kasilof Section "Late," and Kenai–East Foreland sections "Late" strata for all years. Comparisons were also made for the Kasilof Section "August" (2015 and 2017) and Kenai–East Foreland sections strata (2014, 2015, 2017).

Large Kenai River Mainstem and Kasilof River Mainstem Fish Harvests Compared to Total Large Fish Harvest

The proportion of the total large fish harvested in the entire ESSN fishery by year for the dominant stocks (*Kenai River mainstem* and *Kasilof River mainstem*) was calculated to produce an average and a range of all years (2010, 2011, 2013–2019) of annual proportions by stock.

Age, Sex, and Length Composition

Age Composition

The age proportions of Chinook salmon harvested in the ESSN fishery by stratum were estimated as follows:

$$\hat{p}_i^{(z)} = \frac{n_i^{(z)}}{n_i} \tag{3}$$

where $\hat{p}_i^{(z)}$ is the estimated proportion of salmon of age category z from sampling stratum i, $n_i^{(z)}$ equals the number of fish sampled from sampling stratum i that were classified as age category z, and n_i equals the number of Chinook salmon age determinations from stratum i.

The variance of $\hat{p}_i^{(z)}$ was calculated as follows:

$$\operatorname{var}\left[\hat{p}_i^{(z)}\right] = \left(1 - \frac{n_i}{H_i}\right)\frac{\hat{p}_i^{(z)}\left(1 - \hat{p}_i^{(z)}\right)}{n_i - 1} \tag{4}$$

where H_i is the reported number of Chinook salmon harvested in stratum i.

The estimates of harvest by age category in each stratum were calculated as follows:

$$\hat{H}_i^{(z)} = H_i \hat{p}_i^{(z)} \tag{5}$$

with variance

$$\operatorname{var}\left[\hat{H}_i^{(z)}\right] = H_i^2 \operatorname{var}\left[\hat{p}_i^{(z)}\right] \tag{6}$$

The total Chinook salmon harvest by age category and its variance were estimated by the following summations:

$$\hat{H}^{(z)} = \sum_{i=1}^{S} \hat{H}_i^{(z)} \tag{7}$$

and

$$\operatorname{var}\left[\hat{H}^{(z)}\right] = \sum_{i=1}^{S} \operatorname{var}\left[\hat{H}_i^{(z)}\right] \tag{8}$$

where $S = 3$ is the number of sampling strata.

Finally, the total proportion of the ESSN Chinook salmon harvest by age category and its variance were estimated by the following:

$$\hat{p}^{(z)} = \frac{\hat{H}^{(z)}}{H} \tag{9}$$

and

$$\operatorname{var}\left[\hat{p}^{(z)}\right] = \frac{\operatorname{var}\left[\hat{H}^{(z)}\right]}{H^2} \tag{10}$$

where H is the total reported Chinook salmon harvest for 2019.

In addition, age composition of the ESSN Chinook salmon harvest was compiled from 1987 to 2018 and combined with 2019 estimates to discern any trends that may have occurred.

Sex Composition

Sex composition was estimated using the same equations (3–10) used to estimate age composition.

Length Composition

Mean length $\bar{l}_z$ of Chinook salmon in age class z was estimated as follows:

$$\bar{l}_z = \frac{1}{n_z}\sum_{i=1}^{n_z} l_i \tag{11}$$

where l_i is the length of fish i in sample n_z and n_z is the number of Chinook salmon of age class z.

The variance $var(\bar{l}_z)$ of the mean length-at-age class z was estimated as follows:

$$\mathrm{var}(\bar{l}_z) = \frac{1}{n_z} \frac{\sum_{i=1}^{n_z} (l_i - \bar{l}_z)^2}{n_z - 1} \tag{12}$$

In addition, average length by age was compiled for ESSN Chinook salmon harvest samples collected during 1987–2018 and compared to 2019 results.

HARVEST KEPT FOR PERSONAL USE

The number of harvested fish kept for personal use was retrieved from the commercial fisheries fish ticket database and tabulated for this project. We monitor harvest kept for personal use for this project because our goal is to collect a representative sample from the harvest, but very few personal use fish are sampled because many fish kept for personal use are not transferred to receiving stations.

CODED-WIRE-TAG RECOVERY

All fish sampled for tissue and age, sex, and length were also examined for the presence or absence of an adipose fin, which is indicative of the presence of a CWT in its snout. Heads of all sampled fish observed to be missing the adipose fin were removed and a numerical cinch strap was affixed to each head, placed in a plastic bag, and brought back to the Soldotna ADF&G office. All collected heads were shipped to the ADF&G Mark, Tag, and Age Laboratory in Juneau, Alaska for dissection and coded wire tag (CWT) recovery.

RESULTS

CHINOOK SALMON HARVEST SAMPLING

In 2019, the ESSN fishery opened on 27 June in the Kasilof Section and on 8 July in the Kenai and East Foreland sections. The entire Kasilof Section was opened for 15 days during 27 June–3 August. In addition, the Kasilof section was opened but restricted to within one-half mile of the mean high tide mark for 2 additional days (13 July and 21 July) and to within 600 ft of the mean high tide mark for 1 additional day (21 July). The entire Kenai and East Foreland sections were opened for 11 days. The North K-Beach statistical area of the Kenai Section was opened but restricted to within 600 feet of the mean high tide mark for 3 additional days (13 July, 21 July, and 2 August). All but 1 fishery opening was sampled.

The ESSN Chinook salmon harvest of 2,245 fish in 2019 was 75% below the historical (1966–2018) average harvest of 9,275 fish and the 2nd lowest ever observed (Table 1). Harvest was similar for the Kasilof section (1,172 fish, 52% of total), and the Kenai and East Foreland sections (1,073 fish; 48% of total) (Table 2).

A total of 1,024 tissue samples were collected and identified by statistical area in 2019, which was 46% of the total reported harvest (Table 2). The highest sampling rate was in the Kasilof Section "Early" stratum (mixture 1) with 129 samples collected from a harvest of 215 fish (60% of harvest). In the Kasilof Section "Late" stratum (mixtures 2, 3, and 4), 465 samples were collected from a harvest of 957 fish (48% of harvest), and in the Kenai and East Foreland sections "Late" stratum (mixtures 5 and 6), 439 samples were collected from a harvest of 1,073 fish (40% of harvest; calculated from Table 2).

Table 2.–Mixture number (Mix), time period (Date), reported Chinook salmon harvest number and proportion of fish sampled, number and proportion of harvest selected for MSA and ASL composition, and number of fish analyzed for each spatiotemporal stratum in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2019.

Mixture	Date	Geographic area and stratum	Harvest		Sampled		MSA		
			No.	Prop.[a]	No.	Prop.[b]	Sel.	Prop.[c]	Used
		Kasilof Section							
1	27 Jun–4 Jul	Kasilof Section "Early"	215	0.10	129	0.60	100	0.47	97
2	8 Jul–3 Aug	Ninilchik Beach "Late"	265	0.12	136	0.51	100	0.38	96
3	8 Jul–3 Aug	Cohoe Beach "Late"	312	0.14	114	0.37	100	0.32	98
4	8 Jul–3 Aug	South K-Beach "Late"	380	0.17	206	0.54	100	0.26	98
		Total	1,172	0.52	585	0.50	400	0.33	389
		Kenai and EF sections							
5	8 Jul–3 Aug	North K-Beach "Late"	317	0.14	148	0.47	100	0.32	99
6	8 Jul–3 Aug	Salamatof/EF "Late"	756	0.34	291	0.38	100	0.13	95
		Total	1,073	0.48	439	0.41	200	0.18	194
Total	27 Jun–3 Aug	All areas	2,245	1.00	1,024	0.46	600	0.27	583

Note: "EF" means East Foreland, "Sel." means number of fish selected, and "Used" means number of fish used in MSA.

[a] Proportion of total harvest.

[b] Proportion of harvest in stratum that was sampled.

[c] Proportion of harvest in stratum that was selected for MSA.

TISSUE SELECTION AND LABORATORY ANALYSIS

A total of 600 samples (27% of the total harvest) were selected and genotyped to represent the 2019 harvest for MSA in mixtures 1–6 (Table 2). The genotyping failure rate was 1.21% and the error rate was 0.21%.

DATA RETRIEVAL AND QUALITY CONTROL

Based on the 80% rule, 15 individuals were removed from the genotyped 2019 samples. In addition, 2 individuals were identified as duplicate samples and were removed from the genotyped samples. After removing these 17 individuals, 583 samples remained and were used in the MSA (Table 2).

ALL-FISH MSA

Mixtures by Beach for "Late" Time Period

Ninilchik Beach "Late"

The stock composition (proportion of stratum harvest) and stock-specific harvest estimates for the Ninilchik Beach "Late" stratum were greatest for *Kenai River mainstem* (0.62, 164 fish) followed by *Kasilof River mainstem* (0.38, 101 fish) (Table 3).

Cohoe Beach "Late"

The stock composition (proportion of stratum harvest) and stock-specific harvest estimates for the Cohoe Beach "Late" stratum were greatest for *Kasilof River mainstem* (0.64, 198 fish) followed by *Kenai River mainstem* (0.36, 113 fish) (Table 3).

South K-Beach "Late"

The stock composition (proportion of stratum harvest) and stock-specific harvest estimates for the South K-Beach "Late" stratum were greatest for *Kasilof River mainstem* (0.73, 278 fish) followed by *Kenai River mainstem* (0.27, 101 fish) (Table 3).

North K-Beach "Late"

The stock composition (proportion of stratum harvest) and stock-specific harvest estimates for the North K-Beach "Late" stratum were greatest for *Kenai River mainstem* (0.70, 221 fish) followed by *Kasilof River mainstem* (0.30, 95 fish) (Table 3).

Salamatof and East Foreland beaches "Late"

The stock composition (proportion of stratum harvest) and stock-specific harvest estimates for the Salamatof and East Foreland beaches "Late" stratum were essentially all *Kenai River mainstem* fish (0.99, 221 fish) (Table 3).

Table 3.–Stock compositions and stock-specific harvest estimates by beach, including mean and 90% credibility intervals (CI) for Chinook salmon harvested during the "late" time period in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2019.

Stratum			Stock composition			Stock-specific harvest		
				90% CI			90% CI	
Area	Date	Reporting group	Mean	5%	95%	Harvest	5%	95%
Ninilchik Beach	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.00	0	0	0
		Kenai River mainstem	0.62	0.48	0.75	164	127	198
		Kasilof River mainstem	0.38	0.25	0.52	101	67	137
		Cook Inlet other	0.00	0.00	0.00	0	0	0
Cohoe Beach	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.01	1	0	3
		Kenai River mainstem	0.36	0.23	0.51	113	70	158
		Kasilof River mainstem	0.64	0.49	0.77	198	153	241
		Cook Inlet other	0.00	0.00	0.01	0	0	2
South K-Beach	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.00	0	0	0
		Kenai River mainstem	0.27	0.16	0.38	101	60	144
		Kasilof River mainstem	0.73	0.62	0.84	278	235	320
		Cook Inlet other	0.00	0.00	0.00	0	0	0
North K-Beach	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.00	0	0	0
		Kenai River mainstem	0.70	0.57	0.82	221	180	259
		Kasilof River mainstem	0.30	0.18	0.43	95	58	137
		Cook Inlet other	0.00	0.00	0.00	0	0	0
Salamatof/ E.Foreland beaches	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.00	1	0	0
		Kenai River mainstem	0.99	0.93	1.00	749	707	756
		Kasilof River mainstem	0.00	0.00	0.00	0	0	0
		Cook Inlet other	0.01	0.00	0.06	6	0	49

Note: Stock-specific harvest within each stratum may not sum to overall stock-specific harvest due to rounding. Due to uncertainty in estimates with stock composition proportions less than 0.050 and stock-specific harvest estimates with the lower end of the 90% CI less than 1 fish, these estimates are not reported in the text and caution should be used in their interpretation.

Temporal Estimates by Section

Kasilof Section "Early"

The stock composition (proportion of stratum harvest) and stock-specific harvest estimates for the Kasilof Section "Early" 27 June–4 July stratum were greatest for *Kenai River mainstem* (0.51, 110 fish) followed by *Kenai River tributaries* (0.22, 47 fish), *Kasilof River mainstem* (0.19, 41 fish), and *Cook Inlet other* (0.08, 17 fish; Table 4).

Kasilof Section "Late"

The stock composition and stock-specific harvest estimates for the Kasilof Section "Late" 8 July–3 August stratum were greatest for *Kasilof River mainstem* (0.60, 577 fish) followed by *Kenai River mainstem* (0.39, 378 fish; Table 4).

Kenai–East Foreland sections "Late"

The stock composition and stock-specific harvest estimates for Kenai–East Foreland sections "Late" 8 July–3 August stratum was highest for *Kenai River mainstem* fish (0.90, 970 fish) followed by *Kasilof River mainstem* fish (0.09, 95 fish; Table 4).

Table 4.–Stock composition and stock-specific harvest estimates stratified by date and area, including mean and 90% credibility intervals (CI) calculated for Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2019

Stratum			Stock composition			Stock-specific harvest		
				90% CI			90% CI	
Area	Date	Reporting group	Mean	5%	95%	Harvest	5%	95%
Kasilof Section	27 Jun–4 Jul	Kenai River tributaries	0.22	0.06	0.39	47	13	83
		Kenai River mainstem	0.51	0.36	0.66	110	78	142
		Kasilof River mainstem	0.19	0.09	0.30	41	19	64
		Cook Inlet other	0.08	0.00	0.26	17	0	57
Kasilof Section	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.01	1	0	5
		Kenai River mainstem	0.39	0.33	0.46	378	313	445
		Kasilof River mainstem	0.60	0.53	0.67	577	511	642
		Cook Inlet other	0.00	0.00	0.01	1	0	5
Kenai and E. Foreland sections	8 Jul–3 Aug	Kenai River tributaries	0.00	0.00	0.00	1	0	5
		Kenai River mainstem	0.90	0.85	0.94	970	912	1,014
		Kasilof River mainstem	0.09	0.05	0.13	95	58	137
		Cook Inlet other	0.01	0.00	0.05	6	0	49

Note: Stock-specific harvest within each stratum may not sum to overall stock-specific harvest due to rounding. Due to uncertainty in estimates with stock composition proportions less than 0.050 and stock-specific harvest estimates with the lower end of the 90% CI less than 1 fish, these estimates are not reported in the text and caution should be used in their interpretation.

Annual "All Areas"

The annual stock composition and stock-specific harvest estimates for "All Areas" were greatest for *Kenai River mainstem* (0.65, 1,458 fish) followed by *Kasilof River mainstem* (0.32, 714 fish; Table 5). The *Kenai River tributaries* and *Cook Inlet other* reporting groups had low stock composition estimates (0.02 or less) and harvests of 50 fish or less (Table 5).

Table 5.–Overall stock compositions and stock-specific harvest estimates, including mean and 90% credibility intervals (CI) for Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2019.

Stratum			Stock composition			Stock-specific harvest		
				90% CI			90% CI	
Area	Date	Reporting group	Mean	5%	95%	Harvest	5%	95%
All areas	27 Jun–3 Aug							
		Kenai River tributaries	0.02	0.01	0.04	49	14	86
		Kenai River mainstem	0.65	0.61	0.69	1,458	1,366	1,545
		Kasilof River mainstem	0.32	0.28	0.35	714	631	795
		Cook Inlet other	0.01	0.00	0.03	25	0	71

MSA STRATIFIED BY SIZE

Large *Kenai River mainstem* fish were harvested (and composed the harvest) in each stratum as follows: 38 fish (0.18) from Kasilof Section "Early," 184 fish (0.19) from Kasilof Section "Late," 391 fish (0.36) from Kenai–East Foreland sections "Late" (Table 6).

Table 6.–Stock composition and stock-specific harvest estimates of Chinook salmon harvested in the Eastside set gillnet fishery, including mean and 90% credibility intervals (CI), stratified by size (large and small) for each temporal and geographic stratum, Upper Cook Inlet, Alaska, 2019.

Stratum				Stock composition [a]			Stock-specific harvest		
					90% CI			90% CI	
Area	Period	Size	Reporting group	Mean	5%	95%	Harvest	5%	95%
Kasilof Section	27 Jun–4 Jul	Large	Kenai R. tributaries	0.05	0.04	0.01	11	8	1
			Kenai R. mainstem	0.18	0.05	0.10	38	10	22
			Kasilof R. mainstem	0.07	0.03	0.02	15	8	4
			Cook Inlet other	0.02	0.03	0.00	4	5	0
		Small	Kenai R. tributaries	0.17	0.08	0.04	36	17	9
			Kenai R. mainstem	0.33	0.07	0.22	72	15	47
			Kasilof R. mainstem	0.12	0.05	0.05	26	10	11
			Cook Inlet other	0.06	0.08	0.00	14	16	0
Kasilof Section	8 Jul–3 Aug	Large	Kenai R. tributaries	0.00	0.00	0.00	0	0	2
			Kenai R. mainstem	0.19	0.14	0.24	184	138	233
			Kasilof R. mainstem	0.33	0.28	0.39	318	266	370
			Cook Inlet other	0.00	0.00	0.00	0	0	2
		Small	Kenai R. tributaries	0.00	0.00	0.00	0	0	3
			Kenai R. mainstem	0.20	0.15	0.25	194	146	242
			Kasilof R. mainstem	0.27	0.22	0.33	259	209	313
			Cook Inlet other	0.00	0.00	0.00	0	0	3
Kenai–East Foreland sections	8 Jul–3 Aug	Large	Kenai R. tributaries	0.00	0.00	0.00	0	0	2
			Kenai R. mainstem	0.36	0.30	0.43	391	320	459
			Kasilof R. mainstem	0.06	0.03	0.09	60	35	92
			Cook Inlet other	0.00	0.00	0.01	2	0	12
		Small	Kenai R. tributaries	0.00	0.00	0.00	1	0	2
			Kenai R. mainstem	0.54	0.48	0.60	579	510	640
			Kasilof R. mainstem	0.03	0.01	0.06	35	14	61
			Cook Inlet other	0.00	0.00	0.03	5	0	37

Note: Large fish are 75 cm METF and longer; small fish are less than 75 cm METF.

[a] Stock composition is mean proportion of all fish (large and small combined) for each stratum.

Overall, large *Kenai River mainstem* fish composed 0.27 (613 fish) and large *Kasilof River mainstem* fish composed 0.18 (393 fish) of the total ESSN harvest in 2019 (Table 7). Of *Kenai River mainstem* fish, 0.42 (613 out of 1,457 fish) were classified as large. Of *Kasilof River mainstem* fish, 0.55 (393 out of 713 fish) were classified as large. Overall harvest of large *Cook Inlet other* and *Kenai River tributaries* fish was negligible (0.01 or less).

The proportion of the total 2019 ESSN large *Kenai River mainstem* fish harvest (613 fish) by stratum was as follows: 0.64 Kenai–East Foreland sections "Late," 0.30 Kasilof Section "Late," and 0.06 Kasilof Section "Early" (calculated from Table 6).

Table 7.–Annual stock composition and stock-specific harvest estimates of Chinook salmon harvested in the Eastside set gillnet fishery, including mean and 90% credibility intervals (CI), stratified by size (large and small), Upper Cook Inlet, Alaska, 2019.

Stratum				Stock composition [a]			Stock-specific harvest		
					90% CI			90% CI	
Area	Period	Size	Reporting group	Mean	5%	95%	Harvest	5%	95%
All	27 Jun–3 Aug	Large	Kenai R. tributaries	0.01	0.00	0.01	12	2	28
			Kenai R. mainstem	0.27	0.23	0.31	613	526	695
			Kasilof R. mainstem	0.18	0.15	0.20	393	332	456
			Cook Inlet other	0.00	0.00	0.01	6	0	22
		Small	Kenai R. tributaries	0.02	0.00	0.03	37	9	66
			Kenai R. mainstem	0.38	0.34	0.41	844	759	925
			Kasilof R. mainstem	0.14	0.12	0.17	320	265	381
			Cook Inlet other	0.01	0.00	0.03	19	0	56

Note: Large fish are 75 cm METF and longer; small fish are less than 75 METF. Due to uncertainty in estimates with stock composition proportions less than 0.05 and stock-specific harvest estimates with the lower end of the 90% CI less than 1 fish, caution should be used in the interpretation of these estimates.

[a] Stock composition is mean proportion of all fish (large and small combined) for each stratum.

ALL-FISH MSA COMPARISONS OF SIMILAR STRATA ACROSS YEARS

There are now 9 years of geographically and temporally stratified stock composition and stock-specific harvest estimates with the addition of 2019 results. Stratification for MSA of the ESSN fishery has differed among years due to dates of commercial fishery openings, limitations due to insufficient number of samples collected by each time and area, and budgetary constraints. However, many strata have been similar enough in time and date that effective summaries and comparisons could be made with results across years dating back to 2010.

Kasilof Section "Early"

MSA of the Kasilof Section "Early" stratum harvest has been conducted each year from 2010 to 2019 (excluding 2012). The stratum beginning date has varied from 22 to 27 June and the ending date has varied from 4 to 9 July (Table 8). Since 2010, the composition of *Kenai River mainstem* fish relative to all fish harvested in this stratum has averaged 0.67 (range: 0.51–0.77), whereas *Kasilof River mainstem* fish have composed on average 0.21 of the harvest (range: 0.12–0.30; Table 8). *Cook Inlet other* fish have composed on average 0.08 of the harvest (range: 0.00–0.25), and the composition of K*enai River tributaries* fish in the harvest has been low (0.02 or less) in all years, except for 2018 and 2019 when *Kenai River tributaries* fish composed 0.11 and 0.22 of the harvest, respectively. On average, an estimated 515 *Kenai River mainstem* fish have been harvested annually in the Kasilof Section "Early" stratum since 2010 (range: 110–1,142 fish).

Estimated harvests of *Kasilof river mainstem* fish have averaged 174 fish annually (range: 41–392 fish). Estimated harvests of *Cook Inlet other* fish have averaged 55 fish (range: 1–200 fish) and estimated harvests of *Kenai River tributaries* fish have been low (15 fish or less) in all years except for 2018 and 2019 when 72 and 47 fish were harvested, respectively.

Kasilof Section "Late"

MSA of the Kasilof Section "Late" stratum harvest has been conducted each year from 2010 to 2019 (excluding 2012). The stratum beginning date was generally the same in all years, varying 4 days from 8 July to 11 July, whereas the stratum ending date was more variable, from 23 July to 3 August (Table 8). In this stratum, *Kenai River mainstem* fish have averaged 0.53 of the harvest (range: 0.37–0.73), and *Kasilof River mainstem* fish have averaged 0.46 of the harvest (range: 0.26–0.60). On average, an estimated 760 *Kenai River mainstem* fish have been harvested annually in the Kasilof Section "Late" stratum since 2010 (range: 283–1,477 fish). Estimated harvests of *Kasilof River mainstem* fish have averaged 738 fish (range: 230–1,620 fish). Estimated harvests of *Cook Inlet other* fish have been 17 fish or less in all years except for 2010 when 69 fish were harvested. Estimated harvest of *Kenai River tributaries* has been 5 or less fish every year except for 2010 (24 fish) and 2017 (23 fish) (Table 8).

Kasilof Section "August"

MSA of the Kasilof section "August" stratum harvest has been conducted for 2 years (2015 and 2017). Dates were 1–10 August in 2015 and 3–15 August in 2017. The harvest was composed of 0.44 and 0.37 *Kenai River mainstem* fish in 2015 and 2017, respectively (average 0.40); and 0.56 and 0.62 *Kasilof River mainstem* fish in 2015 and 2017, respectively (average 0.59) (Table 8). The estimated harvest was 187 *Kasilof River mainstem* fish in 2015 and 143 in 2017 (average 165 fish); and 146 *Kenai River mainstem* fish in 2015 and 85 in 2017 (average 116 fish).

Kasilof River Special Harvest Area

MSA of the KRSHA stratum harvest has been conducted for 3 years (2013–2015). Dates were 17 July–2 August in 2013, 16 July–2 August in 2014, and 7 July–2 August in 2015. *Kasilof River mainstem* fish have averaged 0.74 of the harvest (range: 0.66–0.79) and *Kenai River mainstem* fish have averaged 0.25 of the harvest (range 0.21–0.32) (Table 8). The average estimated harvest was 350 *Kasilof River mainstem* fish (range: 273–494 fish) and 116 *Kenai River mainstem* fish (range: 84–136 fish).

Kasilof Section 600 ft

MSA of the Kasilof Section restricted to within 600 feet of the high tide mark was conducted in 2015 (Table 8). The harvest was composed of 0.60 *Kasilof River mainstem* fish and 0.38 *Kenai River mainstem* fish.

Table 8.–All-fish stock compositions and stock-specific harvest estimates for Chinook salmon harvested in the Kasilof Section of Eastside set gillnet fishery by similar spatiotemporal strata across years, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

			Reporting group							
			Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Stratum	Dates	Year	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest
Kasilof Section	27 Jun–7 Jul	2010	0.01	6	0.68	603	0.30	266	0.02	14
"Early" [a]	25 Jun–9 Jul	2011	0.00	1	0.74	1,142	0.26	392	0.00	1
	27 Jun–6 Jul	2013	0.00	1	0.72	290	0.14	57	0.14	56
	23 Jun–7 Jul	2014	0.00	0	0.77	360	0.22	104	0.01	3
	22 Jun–6 Jul	2015	0.00	3	0.55	448	0.20	162	0.25	200
	23 Jun–9 Jul	2016	0.01	8	0.63	714	0.29	332	0.08	87
	24 Jun–8 Jul	2017	0.02	15	0.72	521	0.19	136	0.07	51
	25 Jun–7 Jul	2018	0.11	72	0.67	446	0.12	79	0.10	65
	27 Jul–4 Jul	2019	0.22	47	0.51	110	0.19	41	0.08	17
		Average	0.04	17	0.67	515	0.21	174	0.08	55
Kasilof Section	8–31 Jul	2010	0.01	24	0.37	994	0.59	1,576	0.03	69
"Late" [b]	11–31 Jul	2011	0.00	3	0.48	1,477	0.52	1,620	0.00	3
	8–23 Jul	2013	0.00	1	0.73	639	0.26	230	0.00	1
	9–23 Jul	2014	0.00	1	0.50	283	0.49	276	0.00	1
	9–30 Jul	2015	0.00	2	0.58	925	0.42	675	0.00	7
	11–28 Jul	2016	0.00	5	0.47	791	0.52	881	0.00	3
	10–31 Jul	2017	0.02	23	0.63	857	0.34	466	0.01	17
	9–28 Jul	2018	0.00	1	0.60	499	0.40	336	0.00	1
	8 Jul–3 Aug	2019	0.00	1	0.39	378	0.60	577	0.00	1
		Average	0.00	7	0.53	760	0.46	738	0.01	11

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			Reporting group							
			Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Stratum	Dates	Year	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest
Kasilof	1–10 Aug	2015	0.00	1	0.44	146	0.56	187	0.00	0
Section	3–15 Aug	2017	0.00	1	0.37	85	0.62	143	0.00	0
"August"		Average	0.00	1	0.40	116	0.59	165	0.00	0
Kasilof R.	17 Jul–2 Aug	2013	0.00	0	0.24	84	0.76	273	0.00	0
Special	16 Jul–2 Aug	2014	0.00	2	0.21	129	0.79	494	0.00	0
Harvest area	7 Jul–2 Aug	2015	0.02	7	0.32	136	0.66	282	0.00	0
		Average	0.01	3	0.25	116	0.74	350	0.00	0
Kasilof 600 [c]	15–31 Jul	2015	0.01	1	0.38	79	0.60	126	0.01	2

Note: The 90% credibility intervals of stock compositions and stock-specific harvest estimates for prior years can be found in Eskelin and Barclay (2016–2019) for 2010–2018 and Table 4 of this report for 2019.

[a] "Early" describes the portion of the fishery prior to the Kenai and East Foreland sections opening for the season.

[b] "Late" describes the portion of the fishery in July after the Kenai and East Foreland sections open for the season except for 2019 which also includes early August.

[c] Kasilof Section openings restricted to within 600 ft of the mean high tide mark.

Kenai–East Foreland Sections "Late"

MSA of the Kenai–East Foreland sections "Late" stratum has been conducted each year from 2010 to 2019 (excluding 2012), although dates have varied. The stratum beginning date was within 4 days (8–11 July) every year but the ending date was 23 July in 3 years (2013, 2014, and 2018), and on or after 28 July in the other 6 years, including as late as 3 August in 2019. In this stratum, *Kenai River mainstem* fish have averaged 0.96 of the harvest (range: 0.90–1.00) (Table 9). The composition of *Kasilof River* mainstem fish in the harvest within this stratum has been low and never exceeded 0.09, averaging 0.04 (range: 0.00–0.09) (Table 9). On average, an estimated 1,801 *Kenai River mainstem* fish have been harvested annually in the Kenai–East Foreland sections "Late" stratum since 2010 (range: 416–3,398). Harvest of *Kasilof River mainstem* fish averaged 70 fish (range: 2–195 fish) and harvest has been negligible (average 5 fish or less) for *Kenai River tributaries* and *Cook Inlet other* fish.

Kenai and East Foreland Sections "August"

MSA of the Kenai and East Foreland sections "August" stratum harvest has been conducted for 3 years (2014, 2015, and 2017), with dates ranging 2–6 August in 2014, 1–12 August in 2015, and 3–14 August in 2017. *Kenai River mainstem* fish have averaged 0.92 of the harvest (range: 0.83–0.97) and *Kasilof River mainstem* fish have averaged 0.08 of the harvest (range: 0.03–0.17) (Table 9). The average estimated harvest was 461 *Kenai River mainstem* fish (range: 214–855 fish) and 39 *Kasilof River mainstem* fish (range: 6–63 fish).

ALL-FISH MSA COMPARISONS OF ANNUAL ESTIMATES

Kenai River mainstem fish have dominated the ESSN harvest, averaging 0.71 of the harvest and ranging from 0.61 in 2014 to 0.79 in 2017 (Table 10). The average annual harvest of *Kenai River mainstem* fish was 3,482 fish (range: 1,400–5,988 fish). *Kasilof River mainstem* fish have averaged 0.27 of the harvest with estimates ranging from 0.19 (2017 and 2018) to 0.39 (2014). The average annual harvest of *Kasilof River mainstem* fish was 1,284 fish (range: 637–2,448 fish). *Cook Inlet other* and *Kenai River tributaries* fish have composed a small fraction (0.03 or less) of the harvest every year (Table 10). Estimated harvest of *Cook Inlet other* fish has averaged 77 fish (range: 4–211 fish) and the harvest of *Kenai River tributaries* fish has averaged 34 fish (range: 4–78 fish).

Table 9.–All-fish stock compositions and stock-specific harvest estimates for Chinook salmon harvested in the Kenai and East Foreland sections of the Eastside set gillnet fishery by similar temporal strata across years, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

			Reporting group							
			Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Stratum	Dates	Year	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest
Kenai–	8–31 Jul	2010	0.01	27	0.95	2,229	0.03	64	0.01	22
East Foreland	11–31 Jul	2011	0.00	1	1.00	2,140	0.00	2	0.00	1
sections "Late" [a]	8–23 Jul	2013	0.00	2	0.94	1,274	0.06	78	0.00	0
	9–23 Jul	2014	0.00	1	0.97	416	0.02	10	0.00	0
	9–30 Jul	2015	0.00	3	0.98	3,398	0.02	82	0.00	2
	11–28 Jul	2016	0.00	5	0.94	3,061	0.06	195	0.00	1
	10–31 Jul	2017	0.00	5	0.95	1,983	0.05	97	0.00	1
	9–23 Jul	2018	0.00	1	1.00	735	0.00	2	0.00	1
	8 Jul–3 Aug	2019	0.00	1	0.90	970	0.09	95	0.01	6
		Average	0.00	5	0.96	1,801	0.04	70	0.00	4
Kenai–	2–6 Aug	2014	0.00	1	0.97	214	0.03	6	0.00	0
East Foreland	1–12 Aug	2015	0.00	0	0.94	855	0.05	49	0.00	0
sections "August"	3–14 Aug	2017	0.00	0	0.83	316	0.17	63	0.00	0
		Average	0.00	0	0.92	461	0.08	39	0.00	0

Note: The 90% credibility intervals of stock compositions and stock-specific harvest estimates for prior years can be found in Eskelin and Barclay (2016–2019) for 2010–2018 and Table 4 of this report for 2019.

[a] "Late" describes the portion of the fishery in July after the Kenai and East Foreland sections open for the season except for 2019 which also includes early August.

Table 10.–All-fish stock compositions and stock-specific harvest estimates for Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

	Reporting group							
	Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Year	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest	Stock composition	Stock-specific harvest
2010	0.01	78	0.64	4,534	0.33	2,301	0.02	147
2011	0.00	7	0.68	5,228	0.32	2,448	0.00	14
2013	0.00	4	0.77	2,289	0.21	637	0.02	57
2014	0.00	4	0.61	1,400	0.39	892	0.00	4
2015	0.00	19	0.77	5,988	0.20	1,564	0.03	211
2016	0.00	24	0.74	4,972	0.25	1,667	0.01	96
2017	0.01	43	0.79	3,762	0.19	905	0.01	69
2018 [a]	0.03	77	0.75	1,710	0.19	428	0.03	69
2019	0.02	49	0.65	1,458	0.32	714	0.01	25
Average	0.01	34	0.71	3,482	0.27	1,284	0.02	77

Note: The 90% credibility intervals of stock compositions and stock-specific harvest estimates for prior years can be found in Eskelin and Barclay (2016–2019) for 2010–2018, and Table 5 of this report for 2019.

[a] Stock composition and stock-specific harvest estimates for 2018 do not include 28 fish harvested from KRSHA.

LARGE FISH MSA COMPARISONS OF SIMILAR STRATA ACROSS YEARS

Kasilof Section "Early"

In the Kasilof section "Early" stratum, large *Kenai River mainstem* fish composed 0.20 of the total harvest in that stratum on average (range: 0.08–0.47), whereas large *Kasilof River mainstem* fish composed 0.07 of the harvest on average (range: 0.01–0.13; Table 11). Large *Kenai River mainstem* fish harvest estimates have averaged 167 fish (range: 38–463 fish) across years. Large *Kasilof River mainstem* fish harvest estimates have averaged 59 fish (range: 7–176 fish), and large *Cook Inlet other* fish harvest estimates have averaged 15 fish (range: 0–44 fish). Very few large *Kenai River tributaries* fish (16 fish or less) have been harvested in this stratum annually.

Kasilof Section "Late"

In the Kasilof Section "Late" stratum, large *Kenai River mainstem* fish have composed 0.26 of the total harvest in that stratum on average (range: 0.19–0.49), whereas large *Kasilof River mainstem* fish have averaged 0.25 of the harvest (range: 0.07–0.39) (Table11). Harvest estimates have averaged 432 large *Kenai River mainstem* fish (range: 117–835 fish) and 440 large *Kasilof River mainstem* fish (range: 63–1,048 fish) across years.

Kasilof Section "August"

There was no commercial fishing in the Kasilof Section during August in 2019; however, there are 2 years (2015 and 2017) when there was an MSA that produced large fish stock compositions for the Kasilof Section "August" stratum. Large *Kasilof River mainstem* fish composed 0.46 and 0.57 of the total harvest in that stratum in 2015 and 2017, respectively (average 0.52; Table 11). The remainder of the large fish harvest in the Kasilof Section "August" stratum was composed of 0.34 and 0.33 large *Kenai River mainstem* fish in 2015 and 2017, respectively (average 0.34). The estimated harvests in the Kasilof Section "August" stratum were 155 large *Kasilof River mainstem*

fish in 2015 and 130 in 2017 (average 142 fish) and 115 large *Kenai River mainstem* fish in 2015 and 76 in 2017 (average 96 fish).

Kasilof River Special Harvest Area

There are 3 years (2013–2015) when MSA could be used to produce large fish stock compositions and stock-specific harvests for KRSHA. Large *Kasilof River mainstem* fish have composed on average 0.43 of the total harvest in that stratum (range: 0.31–0.49), whereas large *Kenai River mainstem* fish have averaged 0.14 of the harvest (range: 0.12–0.16) (Table 11). Estimated harvests of large *Kasilof River mainstem* fish averaged 204 fish (range: 132–305 fish) and large *Kenai River mainstem* fish have averaged 65 fish (range: 59–77 fish).

Kasilof Section 600 ft

MSA of the Kasilof section restricted to within 600 ft of the mean high tide mark was conducted in 2015. Large *Kasilof River mainstem* fish composed 0.26 of the total harvest in that stratum and large *Kenai River mainstem* fish composed 0.16 of the harvest (Table 11).

Kenai–East Foreland sections "Late"

In the Kenai–East Foreland sections "Late" stratum, large *Kenai River mainstem* fish have composed on average 0.45 of the total harvest in that stratum, but the composition has ranged considerably from 0.28 (2013) to 0.78 (2017) among years (Table 12). Harvest estimates for the Kenai–East Foreland sections "Late" stratum have averaged 968 large *Kenai River mainstem* fish (range: 162–1,836 fish) and 36 large *Kasilof River mainstem* fish (range: 1–112 fish).

Kenai–East Foreland sections "August"

There was limited fishing in the Kenai and East Foreland sections during the first 3 days of August in 2019 and the harvest was very low (25 fish), so harvest samples from early August were pooled with samples from the Kenai–East Foreland sections "Late" stratum to represent the harvest.

There were 3 years (2014, 2015, and 2017) when MSA could be used to produced large fish stock compositions relative to the total harvest for the Kenai–East Foreland sections "August" stratum. Large *Kenai River mainstem* fish have composed on average 0.67 of the harvest (range 0.62–0.73) (Table 12). The remainder of the large fish harvest in the Kenai–East Foreland sections "August" stratum was *Kasilof River mainstem* fish, averaging 0.06 (range: 0.02–0.14). Estimated harvests of large *Kenai River mainstem* fish have averaged 328 fish (range: 145–562 fish) and large *Kasilof River mainstem* fish have averaged 29 fish (range: 3–53 fish) in the Kenai–East Foreland sections "August" stratum.

Table 11.–Large (≥75 cm METF) fish stock compositions relative to all fish harvested and stock-specific large fish harvest estimates by year for Chinook salmon harvested in the Kasilof Section of the Eastside set gillnet fishery by temporal stratum, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

			Reporting group							
			Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Stratum	Dates	Year	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest
Kasilof Section "Early" [b]	27 Jun–7 Jul	2010	0.00	2	0.11	98	0.04	40	0.01	9
	25 Jun–9 Jul	2011	0.00	0	0.30	463	0.11	176	0.00	0
	27 Jun–6 Jul	2013	0.00	0	0.16	65	0.03	10	0.02	8
	23 Jun–7 Jul	2014	0.00	0	0.08	38	0.03	13	0.00	1
	22 Jun–6 Jul	2015	0.00	1	0.11	90	0.06	49	0.05	44
	23 Jun–9 Jul	2016	0.00	4	0.23	267	0.11	130	0.02	28
	24 Jun–8 Jul	2017	0.01	10	0.47	338	0.13	95	0.04	30
	25 Jun–7 Jul	2018	0.02	16	0.16	107	0.01	7	0.01	10
	27 Jun–4 Jul	2019	0.05	11	0.18	38	0.07	15	0.02	4
		Average	0.01	5	0.20	167	0.07	59	0.02	15
Kasilof Section "Late" [c]	8–31 Jul	2010	0.01	14	0.22	574	0.39	1,048	0.02	46
	11–31 Jul	2011	0.00	1	0.27	835	0.30	917	0.00	2
	8–23 Jul	2013	0.00	0	0.20	170	0.07	63	0.00	0
	9–23 Jul	2014	0.00	0	0.21	117	0.18	99	0.00	0
	9–30 Jul	2015	0.00	1	0.25	401	0.20	316	0.00	2
	11–28 Jul	2016	0.00	3	0.28	467	0.34	574	0.00	2
	10–31 Jul	2017	0.01	15	0.49	672	0.27	373	0.01	13
	9–28 Jul	2018	0.00	0	0.26	220	0.16	133	0.00	0
	8 Jul–3 Aug	2019	0.00	0	0.19	184	0.33	318	0.00	0
		Average	0.00	4	0.26	432	0.25	440	0.00	8

-continued-

Table 11.–Page 2 of 2.

			Reporting group							
			Kenai River tributaries		Kenai River Mainstem		Kasilof River mainstem		Cook Inlet other	
Stratum	Dates	Year	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest
Kasilof Section	1–10 Aug	2015	0.00	1	0.34	115	0.46	155	0.00	0
"August"	3–15 Aug	2017	0.00	1	0.33	76	0.57	130	0.00	0
		Average	0.00	1	0.34	96	0.52	142	0.00	0
Kasilof River Special	17 Jul–2 Aug	2013	0.00	0	0.16	59	0.49	174	0.00	0
Harvest Area	16 Jul–2 Aug	2014	0.00	1	0.12	77	0.49	305	0.00	0
	7 Jul–2 Aug	2015	0.01	3	0.14	60	0.31	132	0.00	1
		Average	0.00	2	0.14	65	0.43	204	0.00	0
Kasilof 600 ft [d]	15–31 Jul	2015	0.00	1	0.16	32	0.26	55	0.00	1

Note: The 90% credibility intervals of stock compositions and stock-specific harvest estimates for prior years can be found in Eskelin and Barclay (2016–2019) for 2010–2018 and Table 6 of this report for 2019.

[a] "Stock comp" means stock composition of large fish relative to the total harvest of all fish (large and small combined).

[b] "Early" describes the portion of the fishery prior to the Kenai and East Foreland sections opening for the season.

[c] "Late" describes the portion of the fishery in July after the Kenai and East Foreland sections open for the season, except in 2019 which also includes early August.

[d] Kasilof Section openings restricted to within 600 feet of the mean high tide mark.

Table 12.–Large (≥75 cm METF) fish stock compositions relative to all fish harvested and stock-specific large fish harvest estimates by year for Chinook salmon harvested in the Kenai and East Foreland sections of the Eastside set gillnet fishery by temporal stratum, Upper Cook Inlet, Alaska, 2010, 2011, 2013–2019.

			Reporting group							
			Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Stratum	Dates	Year	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest	Stock comp [a]	Stock-specific large fish harvest
Kenai–East Foreland sections "Late" [b]	8–31 Jul	2010	0.00	12	0.46	1,084	0.01	29	0.00	8
	11–31 Jul	2011	0.00	1	0.41	869	0.00	1	0.00	0
	8–23 Jul	2013	0.00	1	0.28	385	0.02	32	0.00	0
	9–23 Jul	2014	0.00	0	0.38	162	0.01	5	0.00	0
	9–30 Jul	2015	0.00	1	0.44	1,545	0.01	27	0.00	1
	11–28 Jul	2016	0.00	3	0.56	1,836	0.03	112	0.00	1
	10–31 Jul	2017	0.00	3	0.78	1,636	0.04	80	0.00	1
	9–23 Jul	2018	0.00	0	0.31	229	0.00	1	0.00	0
	8 Jul–3 Aug	2019	0.00	0	0.36	391	0.06	60	0.00	2
		Average	0.00	2	0.44	904	0.02	38	0.00	1
Kenai–East Foreland sections "August"	2–6 Aug	2014	0.00	0	0.66	145	0.02	3	0.00	0
	1–12 Aug	2015	0.00	0	0.62	562	0.03	31	0.00	0
	3–14 Aug	2017	0.00	0	0.73	276	0.14	53	0.00	0
		Average	0.00	0	0.67	328	0.06	29	0.00	0

Note: The 90% credibility intervals of stock compositions and stock-specific harvest estimates for prior years can be found in Eskelin and Barclay (2016–2019) for 2010–2018 and Table 6 of this report for 2019.

[a] "Stock comp" means stock composition of large fish relative to the total harvest of all fish (large and small combined).

[b] "Late" describes the portion of the fishery in July, except in 2019 which also includes early August.

ANNUAL LARGE FISH STOCK COMPOSITIONS AND STOCK-SPECIFIC HARVEST RELATIVE TO TOTAL HARVEST

There are 9 years of annual stock composition and stock-specific harvest estimates for large Chinook salmon relative to total harvest in the ESSN fishery dating back to 2010 (Table 13). Overall, *Kenai River mainstem* fish have composed the greatest proportion of the large fish harvest every year, averaging 0.35 of the total harvest of all fish sizes, ranging from 0.23 (2013) to 0.63 (2017). *Kasilof River mainstem* fish have averaged 0.15 of the total harvest (range: 0.06–0.21). The average harvest of large *Kenai River mainstem* was 1,794 fish (range: 555–2,998 fish) with 4 years of lower harvest (679, 706, 555, and 613 in 2013, 2014, 2018, and 2019, respectively), and 5 years of higher harvest (2,384, 2,499, 2,808, 2,906, and 2,998 fish in 2010, 2011, 2015, 2016, and 2017, respectively). The average harvest of large *Kasilof River mainstem* was 744 fish (range: 141–1,466 fish).

Table 13.–Large fish (≥75 cm METF) stock compositions relative to all fish harvested and stock-specific large fish harvest estimates by year for Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

	Reporting group							
	Kenai River tributaries		Kenai River mainstem		Kasilof River mainstem		Cook Inlet other	
Year	Stock comp. relative to all fish [a]	Stock-specific large fish harvest	Stock comp. relative to all fish [a]	Stock-specific large fish harvest	Stock comp. relative to all fish [a]	Stock-specific large fish harvest	Stock comp. relative to all fish [a]	Stock-specific large fish harvest
2010	0.01	44	0.34	2,384	0.21	1,466	0.01	96
2011	0.00	3	0.32	2,499	0.19	1,445	0.00	10
2013	0.00	1	0.23	679	0.09	279	0.00	8
2014	0.00	2	0.31	706	0.19	439	0.00	2
2015	0.00	8	0.36	2,808	0.10	764	0.01	48
2016	0.00	14	0.43	2,906	0.15	1,039	0.01	34
2017	0.01	29	0.63	2,998	0.15	730	0.01	44
2018 [b]	0.01	16	0.24	555	0.06	141	0.00	10
2019	0.01	12	0.27	613	0.18	393	0.00	6
Average	0.00	15	0.35	1,794	0.15	744	0.01	29

Note: The 90% credibility intervals of stock compositions and stock-specific harvest estimates for prior years can be found in Eskelin and Barclay (2016–2019) for 2010–2018, and Table 7 of this report for 2019.

[a] "Stock comp" means stock composition of large fish relative to the total harvest of all fish (large and small combined).

[b] Stock compositions and stock-specific harvest estimates for 2018 do not include large Chinook salmon harvested in the Kasilof River special harvest area.

STOCK COMPOSITION OF LARGE FISH HARVEST RELATIVE TO TOTAL LARGE FISH HARVEST

Large *Kenai River mainstem* fish have composed on average 0.69 of the total large fish harvest by year, ranging from 0.60 in 2010 and 2019 to 0.79 in 2017 (Table 14). In contrast, large *Kasilof River mainstem* fish have composed on average 0.29 of the total large fish harvest by year, ranging from 0.19 in 2017 to 0.38 in 2014 and 2019. Large *Kenai River tributaries* and *Cook Inlet other* fish have composed 0.02 or less of the total large fish harvest every year.

Table 14.–Total large (≥75 cm METF) fish harvest, large Kenai River mainstem and Kasilof River mainstem fish harvests, and proportions of total large fish harvests by year in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

		Reporting group			
		Kenai River mainstem		Kasilof River mainstem	
Year	Total large fish harvest	Stock-specific large fish harvest	Proportion of total large fish harvest	Stock-specific large fish harvest	Proportion of total large fish harvest
2010	3,990	2,384	0.60	1,466	0.37
2011	3,957	2,499	0.63	1,445	0.37
2013	967	679	0.70	279	0.29
2014	1,149	706	0.61	439	0.38
2015	3,628	2,808	0.77	764	0.21
2016	3,993	2,906	0.73	1,039	0.26
2017	3,801	2,998	0.79	730	0.19
2018 [a]	723	555	0.77	141	0.19
2019	1,025	613	0.60	393	0.38
Minimum	723	555	0.60	141	0.19
Maximum	3,993	2,998	0.79	1,466	0.38
Average	2,582	1,794	0.69	744	0.29

[a] Harvests and proportions for 2018 do not include large Chinook salmon harvested in the Kasilof River special harvest area.

AGE, SEX, AND LENGTH COMPOSITION

Age Composition

The Kasilof Section "Early" stratum in 2019 had the greatest percentage of age-1.1 fish (23%) across all strata (Figure 3; Appendices A1–A3). The stratum with the highest percentage of age-1.2 fish (37%) was the Kenai and East Foreland sections "Late" stratum.

The overall age composition of the 2019 ESSN Chinook salmon harvest was estimated as 14% age-1.1, 33% age-1.2, 42% age-1.3, 11% age-1.4, and less than 1% age-1.5 fish (Table 15). The percentage of age-1.4 fish (11%) was by far the lowest observed since 1987 (Appendices B1 and B2). The 2nd lowest percentage of age-1.4 fish in the annual harvest was in 2013 at 19% and the historical 1987–2019 average for age-1.4 fish is 36%. The percentage of jacks (age-1.1 fish) in 2019 was the 4th highest observed since 1987 and equivalent to 2015 (Appendix B1).

Sex Composition

Overall sex composition in 2019 was 74% males (1,664 fish) and 26% females (581 fish) (Table 15). The composition of males was highest in the Kenai and East Foreland section "Late" stratum (72%) and lowest in the Kasilof Section "Early" stratum (76%) (Appendices A1–A3).

Length Composition

Average METF length by age in 2019 was 440 mm for age-1.1, 601 mm for age-1.2, 827 mm for age-1.3, 981 mm for age-1.4, and 1,085 mm for age-1.5 fish (Table 15). Average METF length was 715 mm for all fish sampled. Overall average METF length by age in 2019 was the 4th lowest observed since sampling began in 1987 (Appendix B3).

Table 15.–All-fish age, sex, and mean mid eye to tail fork (METF) length composition of Chinook salmon harvested in the Eastside set gillnet fishery, 27 June–3 August, Upper Cook Inlet, Alaska, 2019.

		Age class					
Sex	Parameter	1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Harvest by age	3	57	420	101		581
	SE (harvest by age)	3	12	31	16		34
	Samples by age	1	17	127	25		170
	Age composition	<1%	3%	19%	5%		26%
	SE (age composition)	<1%	1%	1%	1%		2%
Males							
	Harvest by age	313	686	513	149	3	1,664
	SE (harvest by age)	27	36	33	20	3	34
	Samples by age	82	172	141	34	1	430
	Age composition	14%	31%	23%	7%	<1%	74%
	SE (age composition)	1%	2%	1%	1%	<1%	2%
Both sexes							
	Harvest by age	316	743	932	250	3	2,245
	SE (harvest by age)	27	37	39	25	3	0
	Samples by age	83	189	268	59	1	600
	Age composition	14%	33%	42%	11%	<1%	100%
	SE (age composition)	1%	2%	2%	1%	<1%	0%
	Mean length (mm METF)	440	601	827	981	1,085	715

Note: Values given by age and sex may not sum to totals due to rounding.

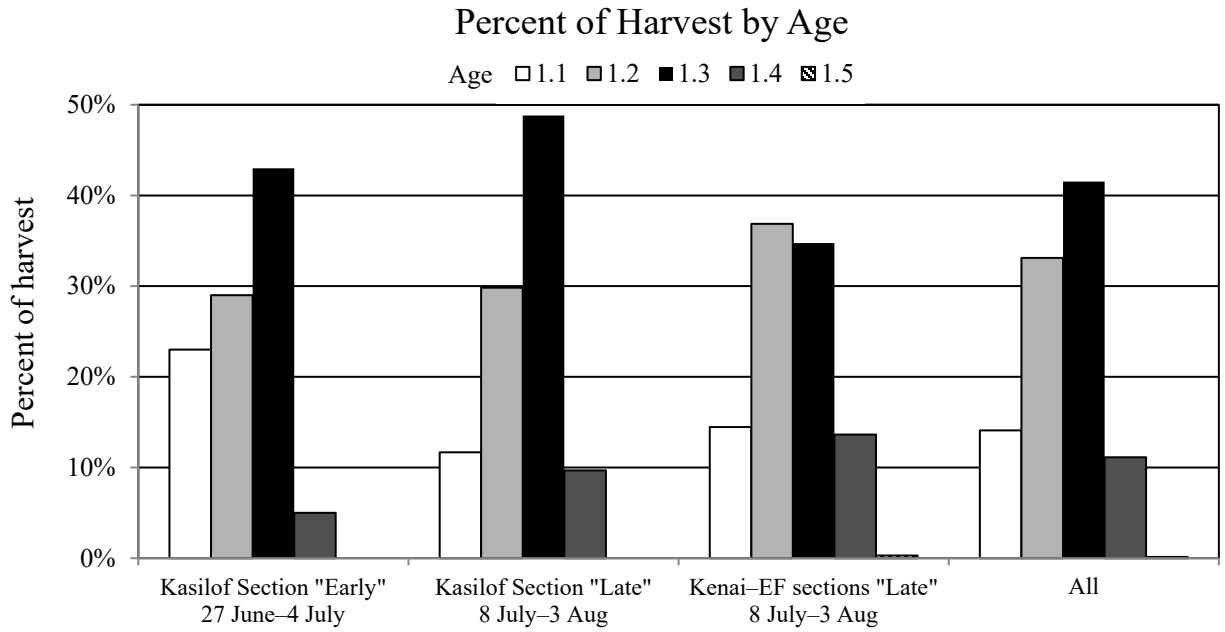

Figure 3.–Age composition estimates of Chinook salmon harvested in the Eastside set gillnet fishery by temporal and geographic stratum, Upper Cook Inlet, Alaska, 2019.

Note: "Kenai–EF" means Kenai and East Foreland sections.

Large Fish Age and Sex Composition in 2019

Overall, the age composition of large fish was approximately <1% age-1.2, 74% age-1.3, and 24% age-1.4 fish and <1% age-1.5 fish (Table 16). The sex composition of large fish was 55% males (559 fish) and 45% females (466 fish).

CODED WIRE TAG (CWT) RECOVERY

There were 16 sampled fish that did not possess an adipose fin and their heads were collected for CWT recovery. Fifteen of these fish were harvested during a 9-day period in the Kasilof Section from 27 June to 4 July, 9 of which possessed a CWT; 7 were from hatchery releases into Crooked Creek, a Kasilof River tributary; 1 was from a hatchery release into the Ninilchik River; and 1 was from a hatchery release into Deception Creek in Northern Cook Inlet. The other fish was harvested on 22 July but did not have a tag.

Table 16.–Age and sex composition of large (≥75 cm METF) Chinook salmon harvested in the Eastside set gillnet fishery, 27 June–3 August, Upper Cook Inlet, Alaska, 2019.

		Age class				
Sex	Parameter	1.2	1.3	1.4	1.5	All ages
Females						
	Harvest by age	3	362	101		466
	SE (harvest by age)	3	25	16		26
	Samples by age	1	107	25		133
	Age composition	<1%	35%	10%		45%
	SE (age composition)	<1%	2%	2%		3%
Males						
	Harvest by age	7	400	149	3	559
	SE (harvest by age)	4	26	18	3	26
	Samples by age	2	110	34	1	147
	Age composition	1%	39%	14%	<1%	55%
	SE (age composition)	<1%	2%	2%	<1%	3%
Both sexes						
	Harvest by age	10	762	250	3	1,025
	SE (harvest by age)	5	23	22	3	0
	Samples by age	3	217	59	1	280
	Age composition	1%	74%	24%	<1%	100%
	SE (age composition)	<1%	2%	2%	<1%	0%

Note: Values given by age and sex may not sum to totals due to rounding.

DISCUSSION

2019 MIXED-STOCK ANALYSIS

In 2019, 46% of the harvest was sampled, which met the primary objectives and established precision criteria goals for estimating stock compositions, stock-specific harvests, and age composition. Despite the low harvest, enough samples were collected to conduct MSAs for the 3 major strata (Kasilof Section "Early," Kasilof Section "Late," and Kenai–East Foreland sections "Late") that have been used in all previous years' MSAs dating back to 2010 (Eskelin et al 2013; Eskelin and Barclay 2015-2019). In addition, there were enough samples collected during the

"late" time period to stratify estimates by beach. These results provide good comparative information to assess variability of stock compositions and harvest by size through time each season and between seasons.

ANNUAL STOCK-SPECIFIC HARVEST PATTERNS ACROSS STUDY YEARS

There are 9 years (2010, 2011, and 2013–2019) of annual stock composition and stock-specific harvest estimates from MSA of the ESSN Chinook salmon harvest (Eskelin et al. 2013; Eskelin and Barclay 2015–2019). The annual "all-fish" stock composition estimates for each of the dominant stocks (*Kenai River mainstem* and *Kasilof River mainstem*) have not varied much, ranging from 0.61 to 0.79 for *Kenai River mainstem* fish and from 0.19 to 0.39 for *Kasilof River mainstem* fish (Table 17). By contrast, the proportion of fish in each reporting group that were large has varied much more, ranging from 0.30 to 0.80 for *Kenai River mainstem* fish and from 0.33 to 0.81 for *Kasilof River mainstem* fish. Yet the proportions of fish that were large in each reporting group were mostly similar between the two reporting groups each year (Table 17). Thus, the large fish stock compositions are probably more influenced by the relative size (large vs. small) of the harvests than the relative run strengths of each stock.

Table 17.–Stock composition by year and size (small and large) and over all sizes for *Kenai River mainstem* and *Kasilof River mainstem* reporting groups, and proportion of large fish relative to all-sized fish within a reporting group for *Kenai River mainstem* and *Kasilof River mainstem* Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 2010, 2011, and 2013–2019.

	Reporting group							
	Kenai River mainstem				*Kasilof River mainstem*			
	Proportion in harvest			Proportion large	Proportion in harvest			Proportion large
Year	Small	Large	All	in reporting group	Small	Large	All	in reporting group
2010	0.30	0.34	0.64	0.53	0.12	0.21	0.33	0.64
2011	0.34	0.32	0.67	0.49	0.14	0.19	0.33	0.57
2013	0.54	0.23	0.77	0.30	0.12	0.09	0.21	0.44
2014	0.30	0.31	0.61	0.50	0.20	0.19	0.39	0.49
2015	0.41	0.36	0.77	0.47	0.10	0.10	0.20	0.49
2016	0.31	0.43	0.74	0.58	0.09	0.15	0.25	0.62
2017	0.16	0.63	0.79	0.80	0.04	0.15	0.19	0.81
2018	0.51	0.24	0.75	0.32	0.13	0.06	0.19	0.33
2019	0.27	0.38	0.65	0.42	0.18	0.14	0.32	0.55
Minimum	0.16	0.23	0.61	0.30	0.04	0.06	0.19	0.33
Maximum	0.54	0.63	0.79	0.80	0.20	0.21	0.39	0.81
Average	0.36	0.35	0.71	0.49	0.12	0.15	0.27	0.55

Source: Eskelin and Barclay (2016–2019) for 2010–2018; and Table 7 for 2019.

Note: Large fish are 75 cm or greater METF; small fish are less than 75 cm METF.

Stock-Specific Harvest Patterns Stratified by Area and Date

The stratified MSAs have provided valuable information for fishery management. Very few *Kenai River tributaries* fish have been harvested since 2010, which has somewhat eased management concerns regarding the potential to harvest large numbers of *Kenai River tributaries* fish in the Kasilof Section during the early part of the fishery.

Nearly all the harvest in the Kenai–East Foreland sections has been composed of *Kenai River mainstem* fish (Table 9), although the proportion of *Kenai River mainstem* fish in 2019 was the

lowest observed at 0.90 of the total harvest in that stratum. More *Kenai River mainstem* fish have been harvested in the Kenai–East Foreland sections "Late" stratum (average of 1,801 fish; Table 9) than in the combined totals of the Kasilof Section "early" and "late" strata (calculated average is 1,275 fish; Table 8). The Kasilof Section "Late" stratum has had much greater variation in stock compositions among years (range: 0.37–0.73; Table 8) compared to the variation in stock compositions among years in the Kenai–East Foreland sections "Late" stratum (range: 0.90–1.00; Table 9).

The proportion of large fish in the harvest has been generally higher later in the season. For *Kenai River mainstem* fish, the proportion of large fish in the harvest was highest on average in the Kenai and East Forelands "August" stratum (0.67), followed by the Kenai and East Foreland sections "Late" stratum (0.44), then by the Kasilof section "August" stratum (0.34) and the Kasilof Section "Late" stratum (0.26) (Tables 11 and 12).

There were only 3 areas of the fishery opened during 2010–2019 where insufficient tissue samples were collected to conduct separate MSAs for any year: the Kasilof Section restricted to within one-half mile of the mean high tide mark, North K-Beach restricted to within 600 feet of the mean high tide mark, and the East Forelands Section. Openings for the Kasilof Section restricted to within one-half mile of the mean high tide mark have occurred occasionally since 2010, but tissue samples have always been pooled with unrestricted Kasilof Section openings due to insufficient sample size. The 2019 fishing season had openings in which the North K-Beach area was opened and restricted to within 600 feet of the mean high tide mark but Salamatof and East Foreland beaches were not open. Insufficient samples were collected to conduct a separate MSA, so the samples were selected and analyzed as part of the Kenai–East Foreland sections "Late" stratum. Harvest of Chinook salmon is low in the East Foreland section, and tissue samples collected from that area have always been pooled with the Kenai section samples.

AGE, SEX, AND LENGTH COMPOSITION

The Kasilof Section "Early" stratum had the highest proportion of jacks of any stratum (Figure 3), a pattern that has been consistent every year since 2013 (Eskelin et al. 2013; Eskelin and Barclay 2015–2019) when this project began using the same strata for age composition and MSA. The 2019 Kenai and East Foreland sections "Late" stratum had the highest percentage of age-1.2 fish (37%) of any stratum (Figure 3), which was also observed in 2018, but 2018 and 2019 were the only two years that this has occurred since 2013 (Eskelin et al. 2013; Eskelin and Barclay 2015–2019).

The percentage of age-1.4 fish (11%) in the harvest in 2019 was by far the lowest observed since sampling began in 1987 (Appendix B1). The historical average harvest of age-1.4 fish is 36% and the next lowest percentage of age-1.4 fish in the harvest was in 2013 at 19%.

The age-1.4 fish that returned in 2019 were from the 2013 brood year, a year in which returning adult Kenai River Chinook salmon abundance was low (Begich et al. 2017) and the age composition was known to be weighted toward younger Kenai River Chinook salmon (Perschbacher 2015; Eskelin and Barclay 2015). In the ESSN harvests, there were below-average proportions of age-1.1 fish in 2016, age-1.2 fish in 2017, age-1.3 fish in 2018, and age-1.4 fish in 2019 (Appendix B1), which make up the bulk of the 2013 brood year return, with the exception of age-1.5 fish that will return in 2020. In 2020, the age-1.4 fish returning will be from 2014, a brood year that also had low abundance and was weighted toward younger fish (Perschbacher and

Eskelin 2016; Lipka et al. 2020). Therefore, it is possible that Chinook salmon runs in 2020 may also have low abundance of age-1.4 fish.

The ESSN harvest in 2019 was predominately males (74%; Table 15), which has been somewhat consistent since 2010. The sex composition has ranged from 48% males in 2017 to 88% males in 2013 and has been highly variable during that time (Eskelin et al. 2013; Eskelin and Barclay 2015–2019). All jacks and nearly all age-1.2 fish in the harvest samples have been classified as males, so harvests in the future will likely have a high percentage of males if the age composition is skewed towards jacks and age-1.2 fish.

The average length (715 mm) in the 2019 harvest was higher than 2018 (685 mm) but still the 5th lowest ever observed (Appendix B3).

HARVEST KEPT FOR PERSONAL USE

By regulation, all salmon harvested in the ESSN fishery must be recorded on fish tickets, including those not sold but kept for personal use. However, most fish kept for personal use are not transferred to receiving stations, making it logistically challenging to collect samples from them. In most years dating back to 1993, fewer than 100 Chinook salmon in the ESSN harvest were reported as kept for personal use. The reported harvest kept for personal use has been as high as 867 fish in 2005; however, that year had the second highest total harvest (21,597 fish) of any year and the reported harvest kept for personal use was only 4% of the total harvest (Table 18). Overall, the percentage of Chinook salmon retained for personal use has trended upwards in recent year. For example, in 2019, the reported harvest kept for personal use was 7%, which was the second highest percentage observed, but the actual harvest was 157 fish. The harvest reported as kept for personal use has never exceeded 8% of total reported harvest and has ranged from 3.4% to 7.7% since 2012. During 1993–2011, harvest reported as kept for personal use was much lower and never exceeded 2% of the total harvest except in 2005, when personal use fish accounted for 4% of the harvest. At current levels, the number of fish that are kept for personal use and are not sampled does not prevent the collection of a representative sample of harvested Chinook salmon for this study. However, we will continue to monitor this aspect of the fishery and will make adjustments to the sampling protocol in future years if necessary.

RECOMMENDATIONS AND FUTURE STUDIES

An important goal of this study was to accurately assess harvest of large Chinook salmon by stock now that Kenai River Chinook salmon are managed for escapement of large fish. In addition to this study, a new project that began in 2018 assesses the inriver abundance of "large" *Kasilof River mainstem* Chinook salmon with sonar (Miller et al. 2018). Because "large" fish are now assessed in the Kenai and Kasilof rivers, size stratification of the ESSN harvest will continue into the foreseeable future. Results from this study will be used for Kenai River Chinook salmon run reconstruction, evaluation of escapement goals, informing management decisions, aiding in modifying UCI management plans by the UCI Alaska Board of Fisheries meeting, and further advancements of Kasilof River Chinook salmon stock assessment.

In 2020, we will be assessing the ESSN Chinook salmon harvest in a similar manner, collecting as many representative samples as possible, and providing the greatest possible resolution of stock compositions and stock-specific harvests by time, area, and size (small and large).

Table 18.–Number of Chinook salmon harvested and reported as kept for personal use in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 1993–2019.

Year	Chinook salmon harvest reported as kept for personal use (*n*)	Total reported Chinook salmon harvest (*N*)	Percent of harvest reported as kept for personal use
1993	110	14,079	0.8%
1994	13	15,575	0.1%
1995	36	12,068	0.3%
1996	43	11,564	0.4%
1997	44	11,325	0.4%
1998	48	5,087	0.9%
1999	73	9,463	0.8%
2000	33	3,684	0.9%
2001	105	6,009	1.7%
2002	14	9,478	0.1%
2003	48	14,810	0.3%
2004	255	21,684	1.2%
2005	867	21,597	4.0%
2006	38	9,956	0.4%
2007	38	12,292	0.3%
2008	26	7,573	0.3%
2009	56	5,588	1.0%
2010	40	7,059	0.6%
2011	97	7,697	1.3%
2012	39	705	5.5%
2013	122	2,988	4.1%
2014	177	2,301	7.7%
2015	507	7,781	6.5%
2016	237	6,759	3.5%
2017	164	4,779	3.4%
2018	130	2,312	5.6%
2019	157	2,245	7.0%

Source: ADF&G fish ticket database.

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APPENDIX A: AGE, SEX, AND LENGTH COMPOSITIONS OF CHINOOK SALMON HARVESTED IN THE EASTSIDE SET GILLNET FISHERY BY SPATIOTEMPORAL STRATA, 2019

Appendix A1.–All-fish age, sex, and length composition of Chinook salmon harvested in the Eastside set gillnet fishery, Kasilof Section "Early" stratum, 27 June–4 July, Upper Cook Inlet, Alaska, 2019.

		Age class				
Sex	Parameter	1.1	1.2	1.3	1.4	All ages
Females						
	Harvest by age		6	60	9	75
	SE (harvest by age)		1	3	1	8
	Samples by age		3	28	4	35
	Age composition		3%	28%	4%	35%
	SE (age composition)		1%	3%	1%	4%
Males						
	Harvest by age	49	56	32	2	140
	SE (harvest by age)	12	13	10	3	9
	Samples by age	23	26	15	1	65
	Age composition	23%	26%	15%	1%	65%
	SE (age composition)	6%	6%	5%	1%	4%
Both sexes						
	Harvest by age	49	62	92	11	215
	SE (harvest by age)	7	7	8	3	0
	Samples by age	23	29	43	5	100
	Age composition	23%	29%	43%	5%	100%
	SE (age composition)	3%	3%	4%	2%	0%

Note: Values given by age and sex may not sum to totals due to rounding.

Appendix A2.–All-fish age, sex, and length composition of Chinook salmon harvested in the Eastside set gillnet fishery, Kasilof Section "Late" stratum, 8 July–3 August, Upper Cook Inlet, Alaska, 2019.

		Age class				
Sex	Parameter	1.1	1.2	1.3	1.4	All ages
Females						
	Harvest by age	3	26	225	28	282
	SE (harvest by age)	3	7	19	8	21
	Samples by age	1	9	69	9	88
	Age composition	<1%	3%	23%	3%	29%
	SE (age composition)	<1%	1%	2%	1%	2%
Males						
	Harvest by age	109	260	242	64	675
	SE (harvest by age)	15	20	20	11	21
	Samples by age	35	83	73	21	212
	Age composition	11%	27%	25%	7%	71%
	SE (age composition)	2%	2%	2%	1%	2%
Both sexes						
	Harvest by age	112	286	467	93	957
	SE (harvest by age)	15	21	23	14	0
	Samples by age	36	92	142	30	300
	Age composition	12%	30%	49%	10%	100%
	SE (age composition)	2%	2%	2%	1%	0%

Note: Values given by age and sex may not sum to totals due to rounding.

Appendix A3.–All-fish age, sex, and length composition of Chinook salmon harvested in the Eastside set gillnet fishery, Kenai–East Foreland sections "Late" stratum, 8 July–3 August, Upper Cook Inlet, Alaska, 2019.

		Age class					
Sex	Parameter	1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Harvest by age		25	135	64		224
	SE (harvest by age)		10	23	16		28
	Samples by age		5	30	12		47
	Age composition		2.3%	12.5%	6.0%		20.8%
	SE (age composition)		1.0%	2.1%	1.5%		2.6%
Males							
	Harvest by age	155	371	238	82	3	849
	SE (harvest by age)	24	33	29	18	4	28
	Samples by age	24	63	53	12	1	153
	Age composition	14%	35%	22%	8%	<1%	79%
	SE (age composition)	2%	3%	3%	2%	<!%	3%
Both sexes							
	Harvest by age	155	396	373	146	3	1,073
	SE (harvest by age)	24	33	33	24	4	0
	Samples by age	24	68	83	24	1	200
	Age composition	14%	37%	35%	14%	<1%	100%
	SE (age composition)	2%	3%	3%	2%	<1%	0%

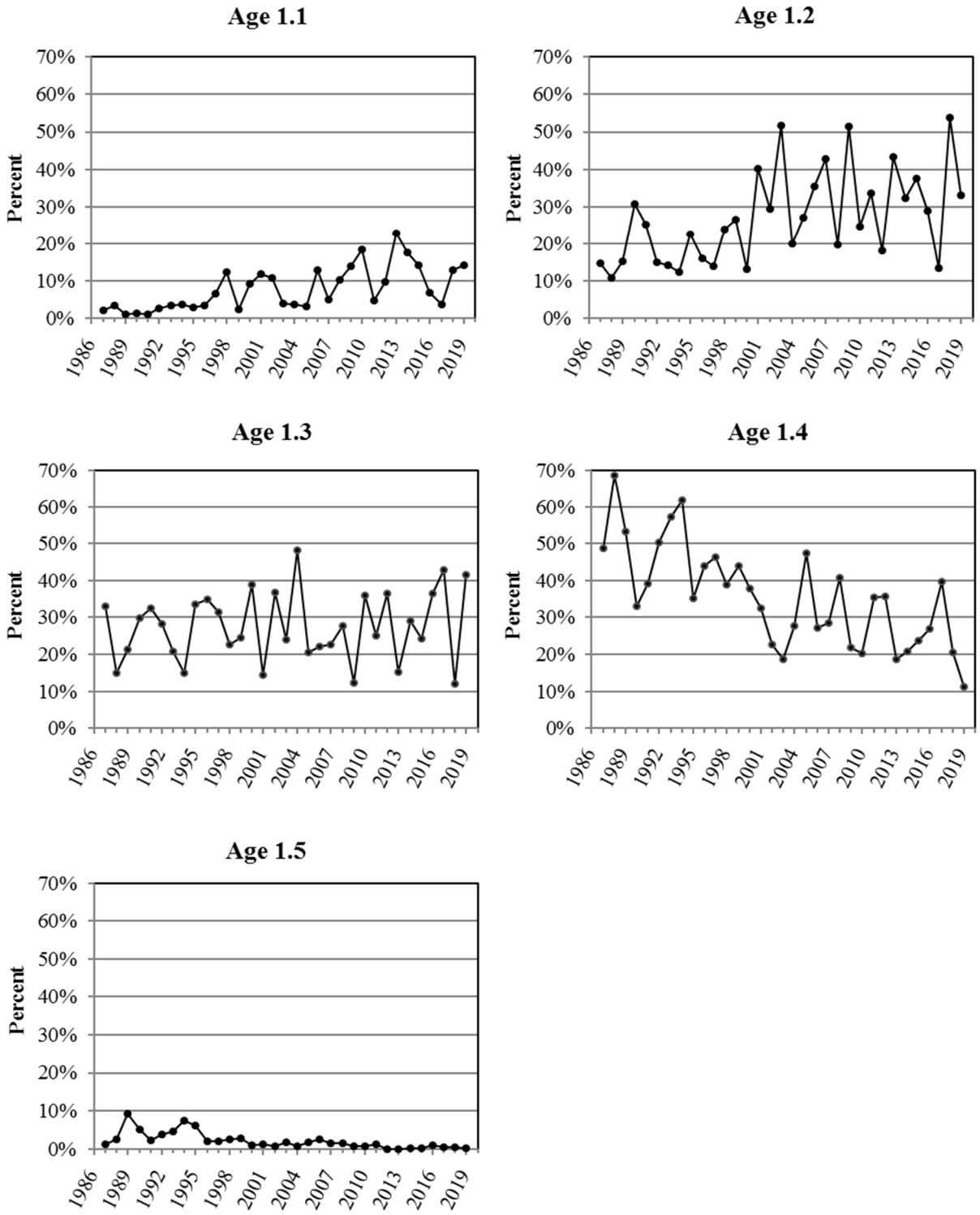
Note: Values given by age and sex may not sum to totals due to rounding.

APPENDIX B: HISTORICAL AGE AND LENGTH COMPOSITIONS OF HARVESTED CHINOOK SALMON IN THE EASTSIDE SET GILLNET FISHERY, UPPER COOK INLET, ALASKA, 1987–2019

Appendix B1.–Age composition of Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 1987–2019.

		Percent composition by age class (%)				
Year	Sample size	Age 3 (1.1, 0.2)	Age 4 (1.2, 2.1, 0.3)	Age 5 (1.3, 2.2, 0.4)	Age 6 (1.4, 2.3)	Age 7 (1.5, 2.4)
1987	1,212	2.1	14.8	33.2	48.8	1.2
1988	870	3.2	10.8	14.8	68.6	2.5
1989	854	0.9	15.1	21.3	53.3	9.4
1990	437	1.4	30.6	29.9	33.1	5.0
1991	446	0.9	25.1	32.5	39.2	2.2
1992	688	2.5	15.0	28.2	50.4	3.9
1993	992	3.3	14.0	20.9	57.3	4.5
1994	1,502	3.5	12.4	14.9	61.7	7.4
1995	1,508	2.7	22.4	33.6	35.1	6.1
1996	2,186	3.3	15.9	35.0	43.9	2.0
1997	1,691	6.4	13.8	31.4	46.4	2.1
1998	911	12.2	23.7	22.7	38.9	2.4
1999	1,818	2.4	26.5	24.5	43.9	2.8
2000	991	9.2	13.2	39.0	37.9	0.9
2001	989	11.7	40.0	14.5	32.5	1.2
2002	1,224	10.6	29.3	36.7	22.6	0.8
2003	678	3.8	51.8	23.9	18.7	1.8
2004	1,409	3.5	19.9	48.2	27.7	0.7
2005	482	3.1	27.0	20.6	47.5	1.9
2006	560	12.9	35.4	22.1	27.1	2.5
2007	789	4.8	42.7	22.6	28.5	1.4
2008	380	10.3	19.7	27.6	40.8	1.6
2009	487	13.8	51.3	12.3	22.0	0.6
2010	743	18.3	24.6	36.1	20.2	0.8
2011	1,187	4.6	33.7	25.2	35.4	1.2
2012	167	9.6	18.0	36.6	35.8	0.0
2013	668	22.7	43.4	15.2	18.6	0.0
2014	459	17.6	32.2	29.1	20.9	0.1
2015	610	14.2	37.4	24.3	23.8	0.3
2016	807	6.8	28.8	36.5	26.9	1.0
2017	881	3.6	13.3	43.0	39.7	0.4
2018	300	12.9	53.9	12.1	20.7	0.4
2019	600	14.1	33.1	41.5	11.1	0.1
Average 1987–2019	904	7.7	26.9	27.6	35.7	2.1

Source for prior years: 1987–2009, Shields and Dupuis (2013; Appendix A15); 2010–2013, Eskelin et al. (2013); and 2014–2018, Eskelin and Barclay (2015–2019).



Appendix B2.–Age composition estimates of Chinook salmon harvested in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 1987–2019.

Source for prior years: 1987–2009, Shields and Dupuis (2013; Appendix A15); 2010–2013, Eskelin et al. (2013); and 2014–2018, Eskelin and Barclay (2015–2019).

Appendix B3.–Average METF length in millimeters by age of Chinook salmon sampled in the Eastside set gillnet fishery, Upper Cook Inlet, Alaska, 1987–2019.

	Average METF length (mm) by age class					
Year	Age 3 (1.1, 0.2)	Age 4 (1.2, 2.1, 0.3)	Age 5 (1.3, 2.2, 0.4)	Age 6 (1.4, 2.3)	Age 7 (1.5, 2.4)	Overall average
1987	408	614	873	1,008	1,067	893
1988	399	647	820	992	957	909
1989	451	673	825	992	1,037	898
1990	560	611	773	979	979	798
1991	461	626	822	976	1,054	835
1992	442	613	784	974	1,052	855
1993	419	632	826	990	1,047	887
1994	420	662	866	898	1,088	934
1995	422	646	895	1,026	1,107	883
1996	410	625	871	1,018	1,098	883
1997	426	632	858	1,003	1,055	868
1998	443	644	838	994	1,045	806
1999	414	626	808	968	1,055	827
2000	413	631	846	989	1,064	832
2001	422	614	820	985	1,054	748
2002	422	640	871	989	1,057	784
2003	434	640	859	1,017	1,102	763
2004	428	645	866	1,010	1,093	848
2005	408	594	814	985	1,090	828
2006	440	581	806	978	1,102	733
2007	430	600	800	954	1,046	743
2008	424	593	825	982	1,097	806
2009	409	577	865	1,003	1,051	686
2010	430	611	850	984	1,102	743
2011	403	610	857	968	1,054	794
2012	399	560	870	1,006	[a]	818
2013	451	589	832	986	[a]	658
2014	431	626	795	954	1,240	712
2015	436	632	829	962	1,100	742
2016	446	625	800	903	1,078	759
2017	420	617	859	983	1,105	851
2018	448	574	846	1,020	1,115	685
2019	440	601	827	981	1,085	715
Average 1987–2019	483	578	781	943	1,054	804

Source for prior years: 1987–2008, Tobias and Willette (2010: Table 54); 2009, Tobias and Willette (2012); 2010–2013, Eskelin et al. (2013); and 2014–2018, Eskelin and Barclay (2015–2019).

[a] No age 7 fish were sampled in 2012 and 2013.