Fishery Data Series No. 20-27

Northern Cook Inlet Chinook Salmon Marine Harvest Stock Composition, 2016–2017

by

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and

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December 2020

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

Symbols and Abbreviations

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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.)
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

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ABSTRACT

Genetic tissue samples were collected from Chinook salmon harvested in the Northern District commercial set gillnet fishery and the Tyonek subsistence fishery during 2016–2017 to determine stock composition of marine harvests in Northern (Upper) Cook Inlet. Samples from the commercial harvest represented all (100%) of the commercial harvests in both 2016 and 2017. Samples from the subsistence harvests represented 98% of the subsistence harvest in 2016 and 100% of the subsistence harvest in 2017. Genetic mixed-stock analysis produced stock composition and stock-specific harvest estimates for each fishery by 6 reporting groups: (1) *West*, (2) *Susitna*, (3) *Deshka*, (4) *Yentna*, (5) *Knik-Turnagain*, and (6) *Kenai Peninsula*. For the General Subdistrict–south, harvest contributions were 34–36% *Susitna* in both 2016 and 2017, 24% *West* in 2016, followed by 19% *Yentna* and 14% *Deshka*. In 2017, harvest contributions were similar among *West* (19%), *Yentna* (17%), and *Deshka* (18%). For the General Subdistrict–north, harvest contributions were most (66–72%) from *Knik-Turnagain* in both years. For the Eastern Subdistrict, harvest contributions in both years were greatest from *Knik-Turnagain* (48–60%), followed by *Susitna* (21–23%). Overall, Northern District commercial harvest contributions in 2016 and 2017 were greatest from *Knik-Turnagain* (32–35%), followed by *Susitna* (27–28%). Remaining harvest contributions were similar among *West* (13–14%), *Deshka* (11–14%), and *Yentna* (12–13%). In the 2016 Tyonek subsistence fishery, the largest contributions to harvest were from *Susitna* (32%) and *West* (29%), followed by *Yentna* (17%), *Deshka* (12%), and *Knik-Turnagain* (10%). In 2017, the Tyonek subsistence harvest was dominated by *Susitna* (38%), followed by *Yentna* (18%), *West* (17%), and *Knik-Turnagain* (16%); *Deshka* contributed 10%. In 2016 and 2017, harvest contributions of the Kenai Peninsula reporting group ranged from 0–2% across all 3 commercial areas and across commercial and subsistence fisheries.

Keywords: Chinook salmon, *Oncorhynchus tshawytscha*, genetic tissue, mixed-stock analysis, Northern District of Upper Cook Inlet, set gillnet, subsistence, Tyonek

INTRODUCTION

Chinook salmon (*Oncorhynchus tshawytscha*) returning to Cook Inlet, Alaska streams are harvested in mixed-stock marine fisheries in Northern Cook Inlet (NCI), primarily by the Tyonek subsistence set gillnet and Northern District commercial set gillnet fisheries (Figure 1). There are 7 Chinook salmon stocks of concern[1] that are susceptible to harvest in NCI marine fisheries (Chuitna, Theodore, and Lewis Rivers, and Alexander, Willow, Goose, and Sheep Creeks). The *Northern District King Salmon Management Plan* (5 AAC 21.366) was created by the Alaska Board of Fisheries in 1986 and was most recently modified in 2014. The plan provides direction to the Alaska Department of Fish and Game (ADF&G) regarding management of the Northern District for the directed commercial harvest of Chinook salmon. The directed Chinook salmon commercial fishing season opens on the first Monday on or after May 25 and remains open for all Mondays through June 24. Fishing periods are 12 hours per day from 7:00 AM to 7:00 PM unless altered by emergency order. The commercial fishery is limited to an annual harvest not to exceed 12,500 Chinook salmon. Each permit holder is allowed to fish one 35-fathom, maximum 6-inch mesh set gillnet with a minimum separation of 1,200 feet between nets.

Under the *Northern District King Salmon Management Plan*, if sport fishing restrictions are imposed on the Theodore, Ivan, Lewis, Chuitna, or Deshka Rivers, time and area restrictions will be placed on the commercial fishery. The Northern District set gillnet fishery has been closed from the wood chip dock, adjacent to Tyonek, to the Susitna River due to a sport fishing closure on the Chuitna River since 2011 (Shields and Frothingham 2018). Following the directed Chinook salmon fishery, the set gillnet fishery in the Northern District opens by regulation on or after June 25 for regular Monday and Thursday 12-hour periods to target other salmon species. This fishery is managed primarily by the *Northern District Salmon Management Plan* (5 AAC 21.358).

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[1] Salmon stocks can be designated "stocks of concern" by Alaska Board of Fisheries action, which mandates more conservative management.

Under the statewide subsistence fishery regulations for Upper Cook Inlet (5 AAC 01.560), the Tyonek subsistence fishery is open for 2 seasons per year. The early season, May 15 through June 15, is open 3 days per week (Tuesday, Thursday, and Friday) for 16 hours per day (4:00 AM to 8:00 PM). The late season, June 16 through October 15, is open for 1 day per week (Saturday) for 12 hours (6:00 AM to 6:00 PM). Subsistence fishing targeting Chinook salmon occurs from May 15 until approximately June 30. The fishery extends from a point 1 mile south of the southern edge of the Chuitna River to the easternmost tip of Granite Point (Figure 1).

Genetic mixed-stock analysis (MSA) has been used to estimate the stock composition of sockeye salmon in the Cook Inlet commercial fishery since the 1990s (Seeb et al. 2000; Habicht et al. 2007; Barclay et al. 2010a, 2010b, 2013, 2014). With the development of comprehensive genetic baselines for Upper Cook Inlet Chinook salmon (Barclay et al. 2012; Barclay and Habicht 2015), MSA has more recently been used to estimate the stock composition of Chinook salmon harvested in the Upper Subdistrict set gillnet fishery (Eskelin 2013; Eskelin and Barclay 2015, 2016) and the Cook Inlet marine sport fishery (Barclay et al. 2016).

For the first time, stock composition estimates of the Tyonek subsistence and Northern District commercial set gillnet Chinook salmon fisheries were produced from harvest samples collected during 2014 and 2015 using the Barclay and Habicht (2015) baseline (St. Saviour et al. 2019). Four groups of populations (reporting groups) were chosen for MSA:

1) *UCI Northwest* (West Cook Inlet and Yentna River populations)
2) *Susitna-Matanuska* (Susitna River mainstem and Matanuska River populations)
3) *Knik-Turnagain* (Knik Arm and Turnagain Arm populations)
4) *Kenai Peninsula* (Kenai Peninsula populations from the Kenai River south to the Anchor River)

Although the estimates for the 4 reporting groups represented the finest scale possible and the best available information at the time, estimates were needed for Yentna River, West Cook Inlet, Susitna River, and Deshka River to more precisely manage the sport and commercial fisheries of NCI. The inability of the Barclay and Habicht (2015) baseline to distinguish fine-scale NCI Chinook salmon reporting groups prompted an effort to improve the baseline with additional populations and genetic markers.

In 2016, the Pacific States Marine Fisheries Commission (PSMFC) appropriated Cook Inlet disaster relief funding for a collaborative study between the University of Washington and ADF&G with the primary objective of increasing the genetic differentiation of Chinook salmon reporting groups in the Cook Inlet baseline. This was done by developing a higher resolution baseline with hundreds of genetic markers and a subset of key populations. In addition to the Cook Inlet disaster relief funding, the previous MSA project (St. Saviour et al. 2019; Alaska Sustainable Salmon Fund project 44908) was leveraged by using remaining project funds to genotype additional baseline populations and the 2016 Tyonek subsistence and Northern District commercial samples for the same set of single nucleotide polymorphisms (SNPs). The genotypic data from both projects was combined and analyzed to produce a new baseline of 67 populations genotyped for 413 SNPs with the capability of distinguishing finer-scale reporting groups in NCI (Barclay et al. 2019). This new baseline made it possible to produce the fine-scale reporting group estimates for this PSMFC project (16-107G). All methods used to produce estimates are detailed below.

OBJECTIVES

Primary Objectives

1) Estimate the proportion of Chinook salmon harvested in the Tyonek subsistence fishery and Northern District set gillnet commercial fishery by reporting group (*West*, *Susitna*, *Deshka, Yentna, Knik-Turnagain*, and *Kenai Peninsula*) for each geographic stratum such that the estimated proportions are within 10 percentage points of the true values 90% of the time.
2) Estimate the age composition of Chinook salmon harvested by the Tyonek subsistence and Northern District set gillnet commercial fisheries such that the estimates are within 10 percentage points of the true values 95% of the time.

Secondary Objectives

1) Sample a minimum of 100 Chinook salmon per stratum harvested in the Northern District commercial set gillnet fishery and the Tyonek subsistence fishery for tissue, age, sex, and length in proportion to reported harvest.
2) Estimate the number of Chinook salmon harvested by the Tyonek subsistence and Northern District set gillnet commercial fisheries by reporting group (*West*, *Susitna*, *Deshka, Yentna, Knik-Turnagain*, and *Kenai Peninsula*) for each geographic stratum.
3) Estimate the sex and length compositions of Chinook salmon harvested in the Tyonek subsistence and Northern District set gillnet commercial fisheries.

METHODS

SAMPLE COLLECTION

Genetic tissue samples and age, sex, and length data were collected from Chinook salmon harvested in the Northern District set gillnet commercial fishery and the Tyonek subsistence fishery in 2016 and 2017 to estimate stock composition of marine harvest in NCI. Samples were collected at ports, processors, buying stations, and set gillnet sites in Anchorage, Tyonek, and the Soldotna area during and after fishery openings. To meet sample size requirements, crews were directed to maximize the number of samples collected by intercepting fish deliveries during and after fishery openings and by sampling every fish encountered. Sample sizes were a minimum of 100 fish per spatiotemporal stratum within each fishery in proportion to reported harvest.

Four targeted Chinook salmon commercial fishing periods occurred in 2016 and 2017 during May 29–June 20; each was intensively sampled. The first 2 "regular" commercial fishing periods (June 26–30), which target primarily sockeye salmon but incidentally harvest a small number of Chinook salmon, were opportunistically sampled.

In 2016 and 2017, 14 and 16 Tyonek subsistence fishing periods occurred, respectively, during May16–June 25. All 14 subsistence fishing periods were sampled in 2016; 14 of the 16 subsistence fishing periods were sampled in 2017. The vast majority of samples (> 99%) were collected during peak harvest May 24–June 15.

Tissue Sampling

Tissue samples were preserved for DNA analysis by stapling them onto numbered Whatman (GE Healthcare Life Sciences) paper cards in numbered grid locations; cards were then placed in an airtight case with desiccant beads to preserve samples. The Whatman paper card and grid numbers were recorded on data sheets. Genetic tissues were sent to the ADF&G Gene Conservation Laboratory (GCL) for long-term storage and genetic analysis.

Age, Sex, and Length Sampling

Sampled fish were measured from mid eye to tail fork (METF) to the nearest 5 mm. Sex was determined by external physical characteristics, such as kype development (males) or a protruding ovipositor (females). When sex could not be determined by external characteristics, samplers requested permission to make a small incision from the vent forward and sex was determined by inspection of gonads.

During both commercial and subsistence sampling, 4 scales were removed from the preferred area of each fish and placed on an adhesive-coated card (Clutter and Whitesel 1956; Welander 1940). Impressions from scales mounted on the adhesive-coated cards were made in cellulose acetate as described in Clutter and Whitesel (1956) and Scarnecchia (1979). The impressions were magnified 40×, viewed on a microfiche reader, and the ages were determined from growth patterns of the circuli. Ages were recorded in European notation (Jearld Jr. 1983). All age data were recorded on the same data sheets described in the previous "Tissue Sampling" section and entered into electronic spreadsheets.

Laboratory Analysis

Assaying Genotypes

Genomic DNA was extracted from tissue samples using a NucleoSpin 96 Tissue Kit (Macherey-Nagel).

Samples were genotyped for 588 amplicons as reported in Barclay et al. (2019). These amplicons were partitioned into 2 panels hereafter referred to as the UW (289 amplicons) and CRITFC (299 amplicons) panels. Of the 289 UW amplicons, 230 contained 1 SNP locus and 59 contained 2–4 SNP loci (366 SNPs total) (Dann et al. 2018; McKinney et al. 2019). All 299 CRITFC amplicons contained 1 SNP locus (Janowitz-Koch et al. 2019). For each panel, sequencing followed the GT-seq methods described in Campbell et al. (2014) other than the following deviations: during PCR2, the volume was increased to 2 µL of 10 µM well-specific i5 tag primers per well, bringing the final reaction volume to 11 µL; and during the purification step with magnetic beads, the final elution volume was increased to 17 µL and no additional TE (pH 8.0 with 1% TWEEN 20) was added.

The quantification by qPCR was completed using triplicate dilutions of 1:1000, 1:5000, and 1:10000. Four microliters of each dilution were used as template in a 10 µL reaction using the 6 µL Kapa Library Quantification Kit - Illumina/ROX Low (Kapa Biosystems). The qPCRs were performed in 384-well plates on a QuantStudio 12K Flex Real-Time PCR System (Life Technologies). Final dilutions of each plate library were normalized to 4 nM.

The final pooled library went through an additional purification step via magnetic beads. This involved adding 46.4 µL of Agencourt AMPure XP magnetic beads to 58 µL of pooled library in a 1.5 mL tube. The tube was incubated at room temperature for 7 minutes, placed in a magnetic stand for 5 minutes, and the supernatant was discarded. A double wash of 80% ETOH was performed, each for 30 seconds. The tube incubated at room temperature for 5 minutes to evaporate residual ETOH. The elution was performed with 30 µL of 1X Low-EDTA TE, pH 8.0, and incubated for 5 minutes before final transfer to a new 1.5 mL tube. The elution product was quantified for DNA yield via the manufacturer's direction for the Qubit 3.0 (Thermo Fisher Scientific). The final pooled library was sequenced at a final concentration of 3.5 pM on an Illumina NextSeq 500 with single-end read flow cells using 150 cycles.

Locus genotypes (single SNPs or microhaplotypes) for each sample were called using the GTscore software (https://github.com/csjalbert/GTscore_ADFG) with 1 modification (likelihood threshold p-value <0.001; McKinney et al. 2019). Single SNPs not conforming to expected allelic ratios (e.g., polyploid or off-target amplification) were removed before allele calls were assigned. Alleles from multiple SNPs known to be linked (i.e., on the same amplicon) were combined to form microhaplotype loci. Genotypes were imported and archived in the GCL Oracle database, LOKI. From this point forward, each single SNP or microhaplotype is referred to as a locus.

Laboratory Failure Rates and Quality Control

Quality control (QC) analyses were conducted to identify laboratory errors[2] and to measure the background discrepancy[3] rate of the genotyping process. Separate QC methods were used for the 2016 samples, which had been genotyped previously using TaqMan SNP assays, and the 2017 samples, which had not been genotyped previously.

The QC protocol for the 2016 samples consisted of comparing old TaqMan SNP genotypes (old genotypes) in the database with the new GT-seq genotypes (new genotypes) for the same loci and individuals. Inconsistencies between the old and new genotypes were checked for laboratory errors, laboratory errors in the new genotypes were corrected, and the old genotypes were replaced with the new genotypes. The QC protocol for the 2017 samples consisted of re-extracting 8% of project fish and genotyping them following the GT-seq genotyping protocol above. 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.

For all genotyped samples (2016 and 2017), the overall genotyping failure rate was calculated by dividing the number of failed[4] single-locus genotypes by the number of assayed single-locus genotypes. Background discrepancy rates were calculated for the 2016 samples as the number of conflicting genotypes (after correcting laboratory errors) between the old (TaqMan) and new (GT-Seq) analyses divided by the total number of genotypes for the same loci and individuals. Background discrepancy rates were calculated for the 2017 samples as the number of conflicting genotypes (after correcting laboratory errors) between the original and QC analyses divided by the total number of genotypes compared. Assuming that discrepancies for the 2016 and 2017 samples were due equally to random errors during both genotyping events (new and old genotypes for 2016 and original and QC genotypes for 2017), and that these analyses are unbiased, the error rate in the genotyping was estimated as half the overall rate of discrepancies. This QC method is the best representation of the error rate of the GCL's current genotype production.

2 Human error can occur through the laboratory analysis and can result in the wrong samples being genotyped or samples being genotyped out of order.

3 Inconsistencies not attributable to laboratory error can occur between different genotyping events for the same sample if the DNA is low quality (i.e., degraded), in low concentration, or contaminated with DNA from another sample.

4 A genotype was considered a failure when no allele call was assigned by the GTscore software because the DNA sample either failed to amplify or amplified in such a way that the allele could not be determined.

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Genotypes were retrieved from LOKI and imported into *R*[5] with the *RJDBC* package[6]. Only the final set of 413 loci used in the Barclay et al. (2019) baseline were imported into *R*. All subsequent analyses were performed in *R*, unless otherwise noted. Prior to statistical analysis, 2 QC analyses were performed in *R* to confirm the quality of the data. First, the 80% rule (missing data at 20% or more of loci; Dann et al. 2009) was used to identify individuals missing substantial genotypic data. These individuals were removed from further analyses because the inclusion of individuals with poor quality DNA might introduce genotyping errors and reduce the accuracy of the MSA. The second analysis identified individuals with duplicate genotypes and removed them from further analyses. Duplicate genotypes, which can occur by sampling or extracting the same individual twice, were defined as pairs of individuals sharing the same alleles in 95% of screened loci. The sample with the most missing genotypic data from each duplicate pair was removed from further analyses. If both samples had the same amount of genotypic data, the first sample was removed from further analyses.

Stratification and Subsampling for Genetic Mixed-Stock Analysis

The commercial fishery was stratified into 3 geographic areas: (1) General Subdistrict–south[7], including stat areas 247-10 (Trading Bay) and 247-20 (Tyonek); (2) General Subdistrict–north, including stat areas 247-41 (Susitna Flats), 247-42 (Pt. McKenzie), and 247-43 (Fire Island); and (3) Eastern Subdistrict, including stat areas 247-70 (Pt. Possession), 247-80 (Birch Hill), and 247-90 (#3 Bay) (Figure 1).

In 2016, finer-scale temporal and geographic strata were used to produce MSA mixtures. This resolution was unnecessary for fisheries management and in 2017, mixtures were stratified at the subdistrict and annual scale.

The subsistence fishery for Chinook salmon only occurs in 1 geographic area so only 1 geographic stratum from the subsistence fishery was analyzed each year.

Genetic Baseline

The genetic baseline used in this analysis was derived from nearly 7,800 samples collected from Chinook salmon spawning locations throughout Cook Inlet. The baseline consisted of 413 genetic markers and 67 Cook Inlet populations, with a minimum sample size of 40 fish per population (Table 1 and Figure 2; Barclay et al. 2019). A Cook Inlet-only baseline was chosen because marine harvests in NCI are believed to contain only fish of Cook Inlet origin.

Mixed-Stock Analysis Reporting Groups

Six reporting groups of interest to management were chosen for the MSA in this study (Table 1 and Figure 2). These groups were as follows:

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5 R Development Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.

6 Urbanek, S. 2014. RJDBC: Provides access to databases through the JDBC interface. R package version 0.2-5. http://CRAN.R-project.org/package=RJDBC.

7 Stat area 247-30 (Beluga) is closed to commercial fishing for Chinook salmon.

1) *West* (Western Cook Inlet and Alexander Creek populations)
2) *Yentna* (Yentna River populations)
3) *Susitna* (Susitna River populations)
4) *Deshka* (the Deshka River population)
5) *Knik-Turnagain* (Cook Inlet populations from Turnagain Arm and Knik Arm)
6) *Kenai Peninsula* (Kenai Peninsula populations from the Kenai River south to the Anchor River)

The first 5 reporting groups were all tested in the Barclay et al. (2019) baseline study and were found to be sufficiently identifiable for MSA. Although the 6th reporting group was not tested as a single unit in the baseline study, the stocks from the Kenai Peninsula that make up this group (*Kenai tributary, Kenai mainstem, Kasilof tributary, Kasilof mainstem, South Kenai Peninsula*) were tested, and all stocks were found to be sufficiently identifiable for MSA.

Genetic Mixed-Stock Analysis

The stock composition of the geographically and temporally stratified commercial and subsistence fishery samples selected for MSA (mixtures) were estimated using the *R* package *rubias* (Moran and Anderson 2019). The *rubias* package is a Bayesian approach to the conditional genetic stock identification model based upon computationally efficient C code implemented in *R*. It uses cross-validation and simulation to quantify and correct for biases in reporting group estimates. Each mixture was analyzed for 1 Markov chain Monte Carlo (MCMC) chain with 25,000 iterations and the first 5,000 iterations were discarded to remove the influence of starting values. The prior parameters for each reporting group were defined to be equal (i.e., a flat prior). Within each reporting group, the population prior parameters were divided equally among the populations within that reporting group. Stock proportion estimates and 90% credibility intervals for the mixture were calculated by taking the mean and 5% and 95% quantiles of the posterior distribution from the single chain output. After the MCMC analysis, 100 parametric bootstrap simulations were performed to correct for biases in the stock proportion estimates.

Stock-Specific Harvest Estimates

Estimates of stock-specific harvest were derived by applying the stock composition proportions p_g to the fishery harvest H following methods of Habicht et al. (2012):

$$\widehat{H}_g = Hp_g \tag{1}$$

The estimate $\widehat{H}_g$ and distribution of stock-specific harvest for each reporting group (g) were obtained by Monte Carlo simulation. Independent realizations of the reporting-group–specific harvest $H_g^{(k)}$ were drawn randomly from the joint distribution of the harvest $H^{(k)}$ and stock composition $p_g^{(k)}$ for each fishery mixture (K observations):

$$H_g^{(k)} = H^{(k)}p_g^{(k)} \tag{2}$$

Descriptive statistics were estimated directly from the K observations of $H_g^{(k)}$ with the mean used as the estimate of stock specific harvest $\widehat{H}_g$ and the 5th and 95th quantiles determining the bounds of the 90% credibility interval.

Generation of stock-specific catch distributions required an estimate of the distribution of each component. The distributions of the stock compositions $p_g^{(k)}$ were the Bayesian posterior distributions of stock proportions from the mixed-stock analysis. The harvest $H^{(k)}$ from the Tyonek subsistence fishery was assumed to follow a lognormal distribution with the mean and SD supplied by the Division of Subsistence staff (D. S. Koster, Division of Subsistence, Research Analyst, ADF&G, Anchorage, personal communication).

Combining MSA Mixtures

Estimates from spatiotemporal mixtures in 2016 were combined into annual stock-specific harvest estimates for each commercial fishing subdistrict (General Subdistrict–south, General Subdistrict–north, and Eastern Subdistrict) and the Tyonek subsistence fishery by weighting them by their respective harvests (Table 2) following the methods of Dann et al. (2009). These harvest estimates, including their upper and lower bounds, were divided by the total harvest from each area to derive the overall proportion and credibility interval of each reporting group in the harvest. This same method was used to combine mixture estimates from each area into annual stock-specific harvest estimates for the entire Northern District in 2016 and 2017.

Age, Sex, and Length Composition of Harvest

Age, sex, and length composition estimates were calculated using standard statistical techniques as detailed in Eskelin and Barclay (2016).

RESULTS

SAMPLE COLLECTION

Tissue Sampling

Sampling rates were high because in past years crews had learned the best times and locations to intercept fish and build relationships with processors and fishers (St. Saviour et al. 2019). In 2016, a total of 1,458 samples were collected from the commercial fishery and 289 were collected from the subsistence fishery (Table 2). In 2016, 68.2% of reported commercial harvest was sampled and 28.5% of estimated subsistence harvest was sampled (Table 2). The minimum sample size of 100 fish was met for all spatiotemporal strata and ranged from 128 to 267 samples. After laboratory QC procedures and subsampling for MSA, the lowest number of genetic samples used for an individual stratum was 125 for the General Subdistrict–north (Table 2).

In 2017, a total of 1,786 samples were collected from the commercial fishery and 252 were collected from the subsistence fishery (Table 2). In 2017, 83.0% of reported commercial harvest was sampled and 19.3% of estimated subsistence harvest was sampled (calculated from Table 2). The minimum sample size of 100 fish was met for all spatiotemporal strata and ranged from 252 to 994 samples. After laboratory QC procedures and subsampling for MSA, the lowest number of genetic samples used for an individual stratum was 247 for the Tyonek subsistence fishery (Table 2).

Age, Sex, and Length

Commercial

In 2016, the most abundant age category in the entire Northern District commercial set gillnet fishery was age 1.3 (56.9%, SE 1.2%), followed by age 1.2 (34.1%, SE 1.1%). The least abundant age category was age 1.1 (1.4%, SE 0.2%), followed by age 1.4 (7.5%, SE 0.7%); there were no age-1.5 fish. Average length-at-age ranged from 506 mm (SE 16 mm) for age 1.1 to 878 mm (SE 8 mm) for age 1.4. The estimated sex ratio of sampled Chinook salmon was 41.5% (SE 1.2%) female (Table 3).

In 2017, the most abundant age category in the entire Northern District commercial set gillnet fishery was age 1.3 (51.3%, SE 0.9%), followed by age 1.2 (25.8%, SE 0.8%) and age 1.4 (17.8%, SE 0.7%). The least abundant age categories were age 1.0 (0.2%, SE 0.1%) and age 1.5 (0.2%, SE 0.1%) followed by age 1.1 (4.7%, SE 0.4%). Average length-at-age ranged from 330 mm (SE 3 mm) for age 1.0 to 912 mm (SE 49 mm) for age 1.5. The estimated sex ratio of sampled Chinook salmon was 42.9% (SE 1.0%) female (Table 4).

Age, sex, and length estimates by area for the commercial fishery can be found in Tables 5–10.

Subsistence

In 2016, the most abundant age category in the Tyonek subsistence set gillnet fishery (Table 11) was age 1.3 (63.0%, SE 3.0%), followed by age 1.2 (18.0%, SE 2.4%) and age 1.4 (13.3%, SE 2.1%). The least abundant age category was age 1.5 (0.5%, SE 0.4%), followed by age 1.1 (5.2%, SE 1.4%). Average length-at-age ranged from 595 mm (SE 15 mm) for age 1.1 to 900 mm (SE 0 mm) for age 1.5. The estimated sex ratio of sampled Chinook salmon was 53.1% (SE 3.1%) female (Table 11).

In 2017, the most abundant age category in the Tyonek subsistence set gillnet fishery (Table 12) was age 1.3 (50.0%, SE 3.4%), followed by age 1.4 (30.2%, SE 3.2%) and age 1.2 (18.1%, SE 2.7%). The least abundant age category was age 1.1 (1.6%, SE 0.9%); there were no age-1.5 fish. Average length-at-age ranged from 552 mm (SE 52 mm) for age 1.1 to 912 mm (SE 9 mm) for age 1.4. The estimated sex ratio of sampled Chinook salmon was 53.3% (SE 3.4%) female (Table 12).

LABORATORY ANALYSIS

Assaying Genotypes

Of the 3,785 fish sampled from the 2016 and 2017 Northern District commercial and Tyonek subsistence fisheries harvests, 2,940 fish (2,401 commercial and 539 subsistence fish) were genotyped for 665 SNP markers.

Laboratory Failure Rates and Quality Control

Genotyping failure rates among the 2016 and 2017 commercial and subsistence collections ranged from 2.74% to 3.74%. For the 2016 samples, background discrepancy rates between old and new analyses were 0.04% for commercial and 0.10% for subsistence fisheries. Assuming equal error rates in the old and new analyses, estimated laboratory error rate in the 2016 samples is half of the discrepancy rate (0.02% and 0.05%). For the 2017 samples, background discrepancy rates between original and QC analyses were 2.74% for commercial and 2.91% for subsistence fisheries. Assuming equal error rates in the original and the QC analyses, estimated laboratory error rate in the 2017 samples is half of the discrepancy rate (1.37% and 1.46%).

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Genotypic data from the 2016 and 2017 Northern District commercial and Tyonek subsistence fisheries harvest samples for the final 413 baseline markers was read into *R*. Thirty-four of the genotyped samples (1.16%) were removed from further analyses based upon the 80% rule. Seven samples were identified as duplicates and were removed from further analyses. After removing fish based on the 80% rule and duplicates, 2,899 fish were available to subsample for MSA.

Subsampling for Genetic Mixed-Stock Analysis

Of the 2,899 genotyped fish available (from 2016 and 2017), 2,702 were subsampled in proportion to harvest to create 13 mixtures for MSA: 10 commercial and 3 subsistence mixtures comprising all annual and geographic strata (Table 2 and Figure 3). Enough samples ($n \geq 100$) were available to represent annual harvest by commercial fishing subdistrict (General Subdistrict–south, General Subdistrict–north, and Eastern Subdistrict) and fishery (Northern District commercial and Tyonek subsistence).

Genetic Mixed-Stock Analysis

MSA was performed on the 13 mixtures created during the subsampling process to produce stock composition and stock-specific harvest estimates (Tables 13–16, Appendices A1–A3, and B1). Stock composition and stock-specific harvest estimates were produced for finer-scale temporal strata (i.e., mixtures) for the 2016 Northern District commercial and Tyonek subsistence harvests (Table 2); however, for consistency with the 2017 estimates, only the fishery subdistrict and district scale estimates are reported in the results section of this report. The estimates for fine-scale 2016 mixtures can be found in Appendices A1–A3, and B1.

Figure 3 illustrates the levels of strata used in the MSA and how the fine-scale strata were combined into fishery subdistrict- and district-scale estimates using the stratified estimator. This figure also guides the reader to the tables containing results for each level of analysis. The 2016 MSA estimates from the fine-scale MSA mixtures were combined to produce annual stock composition and stock-specific harvest estimates for the General Subdistrict–south, General Subdistrict–north, Eastern Subdistrict, and the entire Tyonek subsistence fishery (Figure 3). The MSA estimates from the 3 commercial subdistrict MSA mixtures were combined to produce stock composition and stock-specific harvest estimates for the entire Northern District commercial fishery for both 2016 and 2017 (Figure 3). The estimates reported in the following sections include these fishery subdistrict and district scale results.

Commercial Estimates by Subdistrict

In 2016 and 2017, annual Chinook salmon harvests in the General Subdistrict–south area (Trading Bay and Tyonek commercial) were 1,150 and 1,188, respectively (Tables 2, 13, and 14). Stock composition point estimates were greatest for the *Susitna* reporting group (33.7% in 2016 and 35.8% in 2017). The *West* reporting group had the second highest harvest contribution in 2016 at 24.4%, with similar contributions by *Yentna* (18.6%) and *Deshka* (14.4%). In 2017, harvest contributions were similar among *West* (18.9%), *Yentna* (16.5%), and *Deshka* (18.4%). Harvest contributions for the *Knik-Turnagain* reporting group were 8.9% in 2016 and 10.2% in 2017 (Tables 13 and 14, Figure 4).

In 2016 and 2017, annual Chinook salmon harvests in the General Subdistrict–north were 464, and 545, respectively (Tables 2, 13, and 14). Harvests were dominated by the *Knik-Turnagain* reporting group (71.5% in 2016 and 65.9% in 2017). The remaining harvests were represented by smaller contributions of *Susitna* (18.1% in 2016 and 16.0% in 2017), *Deshka* (5.5% in 2016 and 7.5% in 2017), *Yentna* (2.7% in 2016 and 6.3%in 2017), and *West* (2.3% in 2016 and 4.3% in 2017; Tables 13 and 14, Figure 4.).

In 2016 and 2017, annual Chinook salmon harvests in the Eastern Subdistrict were 523 and 418, respectively (Tables 2, 13, and 14). Harvest contributions were greatest from the *Knik-Turnagain* reporting group (60.3% in 2016 and 47.7% in 2017), followed by *Susitna* (20.9% in 2016 and 23.2% in 2017). Remaining harvest contributions were similar among *West* (2.3% in 2016 and 9.7% in 2017), *Deshka* (7.9% in 2016 and 9.9% in 2017), and *Yentna* groups (8.2% in 2016 and 7.7% in 2017; Tables 13 and 14, Figure 4).

The *Kenai Peninsula* reporting group contributed less than 2% to the harvests in all 3 commercial areas in 2016 and 2017 (Tables 13 and 14, Figure 4).

Annual Northern District Commercial Estimates

In 2016 and 2017, overall annual Chinook salmon harvests in the Northern District commercial fishery were 2,137 and 2,151, respectively (Table 15). In both 2016 and 2017, *Knik-Turnagain* was the largest contributor to the harvest (35.1% and 31.6%, respectively), followed by *Susitna* reporting group (27.2% and 28.3%, respectively). The remaining harvest was made up of similar contributions from *West* (14.3% and 13.4%, respectively), *Deshka* (10.9% and 14.0%, respectively), and *Yentna* (12.6% and 12.2%, respectively) reporting groups. The *Kenai Peninsula* reporting group contributed less than 1% to overall annual harvests in both years (Table 15, Figure 5).

Annual Tyonek Subsistence Estimates

In 2016 and 2017, estimated annual Chinook salmon harvests by Tyonek subsistence users during sampling periods were 1,013 and 1,304 fish, respectively (Tables 2 and 16). In 2016, the *Susitna* and *West* reporting groups were the largest contributors to harvest with point estimates of 32.3% and 28.8%, respectively (Table 15, Figure 6). *Yentna* contributed 17.1%, followed by *Deshka* (11.6%) and *Knik-Turnagain* (9.9%). In 2017, *Susitna* was the dominant stock present in Tyonek subsistence harvest at 38.3%. *West* (16.5%), *Yentna* (17.9%), and *Knik-Turnagain* (16.0%) all contributed similarly, with *Deshka* (10.4%) contributing less. The *Kenai Peninsula* reporting group contributed less than 1% to annual harvests in both years (Table 16, Figure 6). Credibility intervals were greater for the Tyonek subsistence estimates than the commercial estimates because, in addition to genetic error, error from the subsistence harvest estimates was also incorporated (commercial harvests are considered 100% reported on fish tickets whereas subsistence harvests are not).

DISCUSSION

This report includes the MSA of harvest samples collected from the Northern District commercial and Tyonek subsistence fisheries in 2016 and 2017. These results represent the second MSA of Chinook salmon harvested in NCI fisheries (St. Saviour et al. 2019).

REPRESENTATION OF HARVESTS

Only 17 out of 1,030 fish harvested in the 2016 Tyonek subsistence fishery could not be represented by the MSA analysis because they fell outside of the sampled date range or dates of harvest were unknown (D. Koster, Research Analyst, ADF&G Subsistence Division, personal communication, September 20, 2019). All other NCI harvests were fully represented in all strata analyzed in 2016 and 2017. Due to the small harvests of the Northern District commercial and Tyonek subsistence Chinook salmon fisheries relative to other commercial fisheries sampled by ADF&G, acquiring samples in proportion to daily harvests was sometimes difficult to achieve. To reach harvest-representative sample size goals, we allowed the use of surplus samples from one collection day to represent harvest on other days provided it was within 7 days and within the same stratum. The general stability in stock composition estimates over entire season gave us confidence that this procedure accurately represented harvest (St. Saviour et al. 2019).

MAKING INFERENCES OUTSIDE STUDY YEARS

These analyses are derived from samples collected during a specific period of time during particular environmental and fishery conditions. Nonetheless, this study can be used to inform future scientific and regulatory activities. Currently, these results are derived from the most comprehensive data set available to examine stock composition of Chinook salmon captured in the Northern District commercial and Tyonek subsistence fisheries. Along with the previous study (St. Saviour et al. 2019), this 2-year data set provides some measure of interannual variability in stock compositions; however, some caution must be exercised when extrapolating these results to unanalyzed years because changes in relative abundance among reporting groups, prosecution of fisheries, or migratory behavior due to ocean conditions might affect the distribution of stock-specific harvests by time and area.

RELATIVE SIZE OF STOCKS AND UNKNOWN HATCHERY CONTRIBUTION

In this and the previous study (St. Saviour et al. 2019), there were some unexpected results in harvest by reporting group. The relative magnitude of abundance for Chinook salmon originating from the Susitna River basin including Susitna, Yentna, and Deshka Rivers is thought to be considerably greater than those originating from Knik and Turnagain Arms (Bosch 2010; Oslund et al. 2017; Baumer and Blain-Roth 2020; DeCovich et al. 2020, *In prep*). Yet harvests of the *Knik-Turnagain* reporting group were similar to or greater than the *Susitna*, *Deshka*, or *Yentna* reporting groups in 2016 and 2017 (Figure 5).

Chinook salmon escapements to the Susitna, Deshka, and Yentna Rivers have been monitored by relatively precise mark–recapture or weir projects in recent years (Oslund et al. 2017; DeCovich et al. 2020, *In prep*). The Chinook salmon–producing systems of the *Knik-Turnagain* reporting group are more numerous and much smaller in size. Escapements to most of these systems are monitored by relatively less-precise foot surveys or not at all (Baumer and Blain-Roth 2020). Additionally, unknown numbers of adult Chinook salmon of hatchery origin return to Ship Creek and the Eklutna Tailrace. These fish would have allocated to the *Knik-Turnagain* reporting group and probably contributed a substantial but unknown proportion of harvest.

To assist future Chinook salmon stock identification work in NCI, there should be increased escapement monitoring of stocks in the *Knik-Turnagain* reporting group and identification and quantification of hatchery-produced Chinook salmon in the NCI harvest. Vegetative cover and glacial turbidity can interfere with escapement monitoring in some cases, but comprehensive aerial surveys may increase our understanding of the relative population size of the *Knik-Turnagain* reporting group. The proportion of hatchery-produced Chinook salmon in NCI harvests could be estimated by collection of thermally marked otoliths or coded wire tags. Collecting all otoliths could be challenging for samplers due to time constraints imposed by fisherman and due to market forces that give preference to fully intact Chinook salmon. Adipose fin clips administered to hatchery smolt would aid in identifying which fish to sample for otoliths or coded wire tags.

As an alternative to the collection of coded wire tags, the updated baseline reported in Barclay et al. (2019) now allows for the identification of hatchery stocks through parentage-based tagging techniques (Anderson and Garza 2006). This technique involves collecting samples from fishery harvests and hatchery broodstock from potential brood years contributing to the fishery and genotyping them. Genotypes from the broodstock samples (parents) could then be used to identify hatchery fish in a harvest sample by assigning hatchery fish to their parents through genetic parentage analysis. Genetic tissue samples are collected each year from hatchery brood stocks in Cook Inlet, and GCL has archived tissue samples from Cook Inlet hatchery brood stocks dating back to 2012.

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TABLES

Table 1.–Populations of Chinook salmon in the Upper Cook Inlet genetic baseline, including the sampling location, collection years, number of individuals included in baseline from each population (*n*), and reporting groups for mixed-stock analysis of the Tyonek subsistence fishery and Northern District commercial fishery harvests.

Pop. no.	Reporting group	Geographic region	Location	Collection year(s)	*n*
1	*West*	West Side Cook Inlet	Straight Creek	2010	93
2			Nikolai Creek	2012, 2013	81
3			Chuitna River	2009	92
4			Coal Creek	2009, 2010, 2011	119
5			Theodore River	2010, 2011, 2012	119
6			Lewis River	2011, 2012, 2014	96
7			Sucker Creek	2011, 2012	144
8	*Susitna*	Susitna River	Cheechako Creek	2014	57
9			Portage Creek	2009, 2010, 2011, 2013	164
10			Indian River	2013, 2014	98
11			Chulitna River east fork	2013, 2014	97
12			Chulitna River middle fork	2009, 2010, 2013	229
13			Honolulu Creek	2013, 2014	106
14			Pass Creek	2013, 2014	104
15			Byers Creek	2013, 2014	109
16			Spink Creek	2013, 2014	74
17			Bunco Creek	2013	103
18			Troublesome Creek	2013, 2014	119
19			Talkeetna River - no name #1	2013, 2014	84
20			Talkeetna River - no name #2	2013, 2014	53
21			Prairie Creek	2008, 2013	142
22			Iron Creek	2013, 2014	102
23			Disappointment Creek	2013, 2014	133
24			Chunilna Creek	2009, 2012, 2013	104
25			Montana Creek	2009, 2010	120
26			Sheep Creek	2013, 2014	60
27			Kashwitna River	2013, 2014	62
28			Little Willow Creek	2013, 2014	104
29			Willow Creek	2005	70
30			Deception Creek	2009	100
31	*Deshka*		Deshka River	1995, 2005, 2012, 2015	302
32	*Yentna*	Yentna River	Red Creek	2012, 2013	111
33			Happy River	2012, 2014	45
34			Hayes River	2012, 2013, 2014	74
35			Canyon Creek	2012, 2013	91
36			Talachulitna River	2008, 2010	120
37			Sunflower Creek	2009, 2011	123
39	*Knik-Turnagain*	Knik Arm	Little Susitna River	2009, 2010	125
40			Granite Creek	2013, 2014, 2015	83
41			Moose Creek	1995, 2009, 2012	120

-continued-

Table 1.–Page 2 of 2.

Pop. no.	Reporting group	Geographic region	Location	Collection year(s)	*n*
42	*Knik-Turnagain*	Knik Arm	Eagle River	2009, 2011, 2012	78
43			Ship Creek	2009	172
44		Turnagain Arm	Campbell Creek	2011, 2012	96
45			Bird Creek	2009, 2011, 2015	83
46			Carmen River	2011, 2012, 2013	74
47			Resurrection Creek	2010, 2011, 2012	98
48			Chickaloon River	2008, 2010, 2011	74
49	*Kenai Peninsula*		Grant Creek	2011, 2012, 2013	87
50		Kenai River	Quartz Creek	2006, 2008, 2010, 2011	82
51			Crescent Creek	2006	165
52			Russian River	2005, 2006, 2007, 2008	211
53			Juneau Creek	2005, 2006, 2007	116
54			Kenai River - upper mainstem	2009	92
55			Benjamin Creek	2005	54
56			Killey River	2005, 2006	167
57			Funny River	2005, 2006	128
58			Kenai River - middle mainstem	2003, 2004, 2006	299
59			Kenai River - lower mainstem	2010, 2011	125
60			Slikok Creek	2004, 2008	81
61		Kasilof River	Kasilof River - middle mainstem	2005	190
62			Kasilof River - lower mainstem	2005	132
63			Crooked Creek	1992, 2005, 2011	305
64		Coastal Kenai Peninsula	Ninilchik River	2010, 2015	144
65			Deep Creek	2010	41
66			Stariski Creek	2011, 2012	106
67			Anchor River	2006, 2010	145

Note: Populations and reporting groups match those in Figure 2.

Table 2.–Chinook salmon collection details by time and area used in genetic mixed-stock analysis (MSA) of northern Cook Inlet marine fisheries, 2016–2017.

			Harvest		Sampled		Analyzed for MSA	
Year	Geographic area[a]	Date range	Reported	Estimated[b]	Number	Proportion	Number	Proportion
2016								
	Trading Bay	May 29–June 30	581	–	202	34.8%	143	24.6%
	Tyonek commercial	May 29–June 12	346	–	198	57.2%	193	55.8%
	Tyonek commercial	June 13–30	223	–	212	95.1%	156	70.0%
	General Subdistrict–south	May 29–June 30	1,150	–	612	53.2%	492	42.8%
	General Subdistrict–north	May 29–June 12	166	–	128	77.1%	125	75.3%
	General Subdistrict–north	June 13–27	298	–	267	89.6%	216	72.5%
	General Subdistrict–north	May 29–June 27	464	–	395	85.1%	341	73.5%
	Eastern Subdistrict	May 29–June 12	257	–	196	76.3%	186	72.4%
	Eastern Subdistrict	June 13–30	266	–	255	95.9%	218	82.0%
	Eastern Subdistrict	May 29–June 30	523	–	451	86.2%	404	77.2%
	Commercial subtotals, averages	May 29–June 30	2,137	–	1,458	68.2%	1,237	57.9%
	Tyonek subsistence	May 16–31	362	412	140	34.0%	137	33.3%
	Tyonek subsistence	June 1–25	525	601	149	24.8%	142	23.6%
	Tyonek subsistence[c]	May 16–June 25	887	1,013	289	28.5%	279	27.5%
	Totals, averages		3,024	–	1,747	57.8%	1,516	86.8%
2017								
	General Subdistrict–south	May 29–June 29	1,188	–	994	83.7%	423	35.6%
	General Subdistrict–north	May 29–June 19	545	–	423	77.6%	257	47.2%
	Eastern Subdistrict	May 29–June 29	418	–	369	88.3%	259	62.0%
	Tyonek subsistence	May 16–June 24	825	1,304	252	19.3%	247	18.9%
	Totals, averages		3,455	–	2,038	59.0%	1,186	58.2%

Note: Gray highlighted rows indicate mixture samples analyzed in the *rubias* R package. Nonhighlighted rows are the overall totals for General Subdistrict–south, General Subdistrict–north, Eastern Subdistrict, and Tyonek subsistence in 2016. An en dash means not applicable.

[a] Refers to the Northern District commercial fishery unless subsistence is explicitly stated.

[b] Commercial landings are entirely reported so no estimate is necessary. Subsistence harvest is estimated based on reported and unreported permits.

[c] Fifteen reported fish and 17 estimated fish were excluded from season totals reported in Jones and Koster (2018) and Fall et al. (2020) because they fell outside of the sampled date range or dates of harvest were unknown and therefore could not be accurately represented in MSA.

Table 3.–Age, sex, and length composition of Chinook salmon harvested in the entire Northern District commercial set gillnet fishery, 2016.

		Age class					
Sex	Parameter	1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Sample size by age	0	39	332	37	0	408
	Age composition (%)	0.0	4.1	33.2	4.1	0.0	41.5
	SE (%)	0.0	0.5	1.1	0.5	0.0	1.2
	Harvest by age	0	89	710	88	0	887
	SE (harvest by age)	0	11	24	11	0	25
	Mean length (mm METF)	NA	646	789	878	NA	783
	SE (mm)	NA	6	3	10	NA	4
Males							
	Sample size by age	17	334	243	30	0	624
	Age composition (%)	1.4	30.0	23.7	3.4	0.0	58.5
	SE (%)	0.2	1.0	1.0	0.5	0.0	1.2
	Harvest by age	30	641	506	73	0	1250
	SE (harvest by age)	5	22	22	10	0	25
	Mean length (mm METF)	506	620	773	877	NA	694
	SE (mm)	16	3	4	13	NA	4
Both							
	Sample size by age	17	373	575	67	0	1,032
	Age composition (%)	1.4	34.1	56.9	7.5	0.0	100.0
	SE (%)	0.2	1.1	1.2	0.7	0.0	0.0
	Harvest by age	30	730	1,217	161	0	2,137
	SE (harvest by age)	5	23	25	15	0	0
	Mean length (mm METF)	506	623	782	878	NA	731
	SE (mm)	16	2	2	8	NA	3

Note: NA means not applicable; METF is mid eye to tail fork.

Table 4.–Age, sex, and length composition of Chinook salmon harvested in the entire Northern District commercial set gillnet fishery, 2017.

		Age class						
Sex	Parameter	1.0	1.1	1.2	1.3	1.4	1.5	All ages
Females								
	Sample size by age	0	1	48	382	119	1	551
	Age composition (%)	0.0	0.1	4.0	29.4	9.4	0.1	42.9
	SE (%)	0.0	0.0	0.4	0.9	0.6	0.0	1.0
	Harvest by age	0	1	86	632	203	1	924
	SE (harvest by age)	0	1	9	19	13	1	21
	Mean length (mm METF)	NA	590	640	793	886	1,005	799
	SE (mm)	NA	0	7	3	6	0	4
Males								
	Sample size by age	3	60	281	277	109	2	732
	Age composition (%)	0.2	4.7	22.0	21.6	8.5	0.1	57.2
	SE (%)	0.1	0.4	0.7	0.7	0.5	0.1	0.9
	Harvest by age	5	100	473	466	184	3	1,231
	SE (harvest by age)	2	8	16	16	11	1	19
	Mean length (mm METF)	330	518	613	804	899	866	720
	SE (mm)	3	8	3	4	6	3	5
Both								
	Sample size by age	3	61	329	659	228	3	1,283
	Age composition (%)	0.2	4.7	25.8	51.3	17.8	0.2	100.0
	SE (%)	0.1	0.4	0.8	0.9	0.7	0.1	0.0
	Harvest by age	5	102	554	1,103	382	5	2,151
	SE (harvest by age)	2	8	17	19	15	2	0
	Mean length (mm METF)	330	519	617	797	892	912	754
	SE (mm)	3	8	2	2	4	49	3

Note: NA means not applicable; METF is mid eye to tail fork.

Table 5.–Age, sex, and length composition of Chinook salmon harvested in the Eastern Subdistrict of Northern District commercial set gillnet fishery, 2016.

		Age class					
Sex	Parameter	1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Sample size by age	0	9	105	7	0	121
	Age composition (%)	0.0	2.4	28.4	1.9	0.0	32.7
	SE (%)	0.0	0.4	1.3	0.4	0.0	1.3
	Harvest by age	0	13	148	10	0	171
	SE (harvest by age)	0	2	7	2	0	7
	Mean length (mm METF)	NA	673	787	911	NA	785
	SE (mm)	NA	7	4	8	NA	5
Males							
	Sample size by age	10	154	81	4	0	249
	Age composition (%)	2.7	41.6	21.9	1.1	0.0	67.3
	SE (%)	0.5	1.4	1.2	0.3	0.0	1.3
	Harvest by age	14	218	114	6	0	352
	SE (harvest by age)	2	7	6	2	0	7
	Mean length (mm METF)	489	616	773	896	NA	667
	SE (mm)	23	3	5	48	NA	6
Both sexes							
	Sample size by age	10	163	186	11	0	370
	Age composition (%)	2.7	44.1	50.3	3.0	0.0	100.0
	SE (%)	0.5	1.4	1.4	0.5	0.0	0.0
	Harvest by age	14	230	263	16	0	523
	SE (harvest by age)	2	7	7	3	0	0
	Mean length (mm METF)	489	619	781	906	NA	706
	SE (mm)	23	3	3	17	NA	5

Note: NA means not applicable; METF is mid eye to tail fork.

Table 6.–Age, sex, and length composition of Chinook salmon harvested in the General Subdistrict–north of Northern District commercial set gillnet fishery, 2016.

		Age class					
Sex	Parameter	1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Sample size by age	0	6	65	3	0	74
	Age composition (%)	0.0	2.6	28.4	1.3	0.0	32.3
	SE (%)	0.0	0.8	2.1	0.5	0.0	2.2
	Harvest by age	0	12	132	6	0	150
	SE (harvest by age)	0	3	10	2	0	10
	Mean length (mm METF)	NA	639	781	865	NA	773
	SE (mm)	NA	29	5	30	NA	7
Males							
	Sample size by age	5	87	61	2	0	155
	Age composition (%)	2.2	38.0	26.6	0.9	0.0	67.7
	SE (%)	0.7	2.3	2.1	0.4	0.0	2.2
	Harvest by age	10	176	124	4	0	314
	SE (harvest by age)	3	11	10	2	0	10
	Mean length (mm METF)	507	614	771	840	NA	675
	SE (mm)	33	5	8	15	NA	8
Both sexes							
	Sample size by age	5	93	126	5	0	229
	Age composition (%)	2.2	40.6	55.0	2.2	0.0	100.0
	SE (%)	0.7	2.3	2.3	0.7	0.0	0.0
	Harvest by age	10	188	255	10	0	464
	SE (harvest by age)	3	11	11	3	0	0
	Mean length (mm METF)	507	616	776	855	NA	707
	SE (mm)	33	5	5	18	NA	7

Note: NA means not applicable; METF is mid eye to tail fork.

Table 7.–Age, sex, and length composition of Chinook salmon harvested in the General Subdistrict–south of Northern District commercial set gillnet fishery, 2016.

		Age class					
Sex	Parameter	1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Sample size by age	0	24	162	27	0	213
	Age composition (%)	0.0	5.5	37.4	6.2	0.0	49.2
	SE (%)	0.0	0.9	1.8	0.9	0.0	1.9
	Harvest by age	0	64	430	72	0	566
	SE (harvest by age)	0	10	21	11	0	22
	Mean length (mm METF)	NA	642	792	875	NA	785
	SE (mm)	NA	6	4	12	NA	5
Males							
	Sample size by age	2	93	101	24	0	220
	Age composition (%)	0.5	21.5	23.3	5.5	0.0	50.8
	SE (%)	0.3	1.6	1.6	0.9	0.0	1.9
	Harvest by age	5	247	268	64	0	584
	SE (harvest by age)	3	18	18	10	0	22
	Mean length (mm METF)	550	627	774	878	NA	721
	SE (mm)	10	5	7	14	NA	7
Both sexes							
	Sample size by age	2	117	263	51	0	433
	Age composition (%)	0.5	27.0	60.7	11.8	0.0	100.0
	SE (%)	0.3	1.7	1.9	1.2	0.0	0.0
	Harvest by age	5	311	698	135	0	1,150
	SE (harvest by age)	3	19	21	14	0	0
	Mean length (mm METF)	550	630	785	876	NA	753
	SE (mm)	10	4	3	9	NA	5

Note: NA means not applicable; METF is mid eye to tail fork.

Table 8.–Age, sex, and length composition of Chinook salmon harvested in the Eastern Subdistrict of Northern District commercial set gillnet fishery, 2017.

		Age class						
Sex	Parameter	1.0	1.1	1.2	1.3	1.4	1.5	All ages
Females								
	Sample size by age	0	1	7	99	31	0	138
	Age composition (%)	0.0	0.4	2.5	34.9	10.9	0.0	48.6
	SE (%)	0.0	0.2	0.5	1.6	1.0	0.0	1.7
	Harvest by age	0	1	10	146	46	0	203
	SE (harvest by age)	0	1	2	7	4	0	7
	Mean length (mm METF)	NA	590	649	793	880	NA	804
	SE (mm)	NA	0	5	5	10	NA	6
Males								
	Sample size by age	1	14	53	57	20	1	146
	Age composition (%)	0.4	4.9	18.7	20.1	7.0	0.4	51.4
	SE (%)	0.2	0.7	1.3	1.3	0.9	0.2	1.7
	Harvest by age	1	21	78	84	29	1	215
	SE (harvest by age)	1	3	5	6	4	1	7
	Mean length (mm METF)	300	502	610	802	880	880	711
	SE (mm)	0	15	7	9	14	0	12
Both sexes								
	Sample size by age	1	15	60	156	51	1	284
	Age composition (%)	0.4	5.3	21.1	54.9	18.0	0.4	100.0
	SE (%)	0.2	0.8	1.4	1.7	1.3	0.2	0.0
	Harvest by age	1	22	88	230	75	1	418
	SE (harvest by age)	1	3	6	7	5	1	0
	Mean length (mm METF)	300	508	614	796	880	880	756
	SE (mm)	0	15	6	4	8	0	7

Note: NA means not applicable; METF is mid eye to tail fork.

Table 9.–Age, sex, and length composition of Chinook salmon harvested in the General Subdistrict–north of Northern District commercial set gillnet fishery, 2017.

		Age class						
Sex	Parameter	1.0	1.1	1.2	1.3	1.4	1.5	All ages
Females								
	Sample size by age	0	0	13	79	24	0	116
	Age composition (%)	0.0	0.0	4.1	24.8	7.5	0.0	36.4
	SE (%)	0.0	0.0	0.7	1.6	1.0	0.0	1.7
	Harvest by age	0	0	22	135	41	0	198
	SE (harvest by age)	0	0	4	8	5	0	9
	Mean length (mm METF)	NA	NA	627	783	891	NA	788
	SE (mm)	NA	NA	11	5	8	NA	8
Males								
	Sample size by age	1	20	85	68	29	0	203
	Age composition (%)	0.3	6.3	26.6	21.3	9.1	0.0	63.6
	SE (%)	0.2	0.9	1.6	1.5	1.0	0.0	1.7
	Harvest by age	2	34	145	116	50	0	347
	SE (harvest by age)	1	5	9	8	6	0	9
	Mean length (mm METF)	340	514	612	811	926	NA	712
	SE (mm)	0	17	5	7	12	NA	10
Both sexes								
	Sample size by age	1	20	98	147	53	0	319
	Age composition (%)	0.3	6.3	30.7	46.1	16.6	0.0	100.0
	SE (%)	0.2	0.9	1.7	1.8	1.3	0.0	0.0
	Harvest by age	2	34	167	251	91	0	545
	SE (harvest by age)	1	5	9	10	7	0	0
	Mean length (mm METF)	340	514	614	796	910	NA	740
	SE (mm)	0	17	4	5	8	NA	7

Note: NA means not applicable; METF is mid eye to tail fork.

Table 10.–Age, sex, and length composition of Chinook salmon harvested in the General Subdistrict–south of Northern District commercial set gillnet fishery, 2017.

		Age class						
Sex	Parameter	1.0	1.1	1.2	1.3	1.4	1.5	All ages
Females								
	Sample size by age	0	0	28	204	64	1	297
	Age composition (%)	0.0	0.0	4.1	30.0	9.4	0.1	43.7
	SE (%)	0.0	0.0	0.5	1.2	0.7	0.1	1.2
	Harvest by age	0	0	49	356	112	2	519
	SE (harvest by age)	0	0	6	14	9	1	15
	Mean length (mm METF)	NA	NA	645	796	885	1,005	801
	SE (mm)	NA	NA	8	3	7	0	5
Males								
	Sample size by age	1	26	143	152	60	1	383
	Age composition (%)	0.1	3.8	21.0	22.4	8.8	0.1	56.3
	SE (%)	0.1	0.5	1.0	1.0	0.7	0.1	1.2
	Harvest by age	2	45	250	266	105	2	669
	SE (harvest by age)	1	6	12	12	8	1	15
	Mean length (mm METF)	350	529	615	802	891	855	727
	SE (mm)	0	9	4	5	8	0	7
Both sexes								
	Sample size by age	1	26	171	356	124	2	680
	Age composition (%)	0.1	3.8	25.1	52.4	18.2	0.3	100.0
	SE (%)	0.1	0.5	1.1	1.3	1.0	0.1	0.0
	Harvest by age	2	45	299	622	217	3	1,188
	SE (harvest by age)	1	6	13	15	12	2	0
	Mean length (mm METF)	350	529	620	799	888	930	759
	SE (mm)	0	9	3	3	5	0	4

Note: NA means not applicable; METF is mid eye to tail fork.

Table 11.–Age, sex, and length composition of Chinook salmon harvested in the Tyonek Subsistence set gillnet fishery, 2016.

Sex	Parameter	Age class 1.1	1.2	1.3	1.4	1.5	All ages
Females							
	Sample size by age	2	12	78	19	1	112
	Age composition (%)	0.9	5.7	37.0	9.0	0.5	53.1
	SE (%)	0.6	1.4	3.0	1.8	0.4	3.1
	Harvest by age	10	58	375	91	5	538
	SE (harvest by age)	7	16	35	20	5	38
	Mean length (mm METF)	670	667	797	842	900	790
	SE (mm)	10	20	6	26	0	8
Males							
	Sample size by age	9	26	55	9	0	99
	Age composition (%)	4.3	12.3	26.1	4.3	0.0	46.9
	SE (%)	1.2	2.0	2.7	1.2	0.0	3.1
	Harvest by age	43	125	264	43	0	476
	SE (harvest by age)	14	23	31	14	0	37
	Mean length (mm METF)	579	635	794	906	NA	743
	SE (mm)	13	11	10	16	NA	12
Both							
	Sample size by age	11	38	133	28	1	211
	Age composition (%)	5.2	18.0	63.0	13.3	0.5	100.0
	SE (%)	1.4	2.4	3.0	2.1	0.4	0.0
	Harvest by age	53	183	639	135	5	1,014
	SE (harvest by age)	15	27	38	24	5	30
	Mean length (mm METF)	595	645	796	862	900	768
	SE (mm)	15	10	5	19	0	7

Note: NA means not applicable; METF is mid eye to tail fork.

Table 12.–Age, sex, and length composition of Chinook salmon harvested in the Tyonek subsistence set gillnet fishery, 2017.

		Age class						
Sex	Parameter	1.0	1.1	1.2	1.3	1.4	1.5	All ages
Females								
	Sample size by age	0	1	15	49	32	0	97
	Age composition (%)	0.0	0.5	8.2	26.9	17.6	0.0	53.3
	SE (%)	0.0	0.5	1.9	3.1	2.6	0.0	3.4
	Harvest by age	0	7	107	351	229	0	695
	SE (harvest by age)	0	7	26	43	36	0	49
	Mean length (mm METF)	NA	655	642	824	911	NA	823
	SE (mm)	NA	0	18	8	14	NA	11
Males								
	Sample size by age	0	2	18	42	23	0	85
	Age composition (%)	0.0	1.1	9.9	23.1	12.6	0.0	46.7
	SE (%)	0.0	0.7	2.1	2.9	2.3	0.0	3.4
	Harvest by age	0	14	129	301	165	0	609
	SE (harvest by age)	0	10	28	40	32	0	49
	Mean length (mm METF)	NA	500	599	806	913	NA	784
	SE (mm)	NA	15	13	10	12	NA	14
Both								
	Sample size by age	0	3	33	91	55	0	182
	Age composition (%)	0.0	1.6	18.1	50.0	30.2	0.0	100.0
	SE (%)	0.0	0.9	2.7	3.4	3.2	0.0	0.0
	Harvest by age	0	21	236	652	394	0	1,304
	SE (harvest by age)	0	12	37	49	44	0	29
	Mean length (mm METF)	NA	552	618	816	912	NA	804
	SE (mm)	NA	52	11	6	9	NA	9

Note: NA means not applicable; METF is mid eye to tail fork.

Table 13.–Stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the General Subdistrict–south, General Subdistrict–north, and Eastern Subdistrict of the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
General Subdistrict–south, *n* = 492								
	West	24.4	20.1	28.9	2.7	281	231	332
	Susitna	33.7	29.3	38.1	2.6	388	337	438
	Deshka	14.4	11.4	17.5	1.8	166	131	202
	Yentna	18.6	15.0	22.2	2.2	214	173	256
	Knik-Turnagain	8.9	6.4	11.5	1.6	102	73	132
	Kenai Peninsula	0.0	0.0	0.3	0.2	0	0	3
Harvest represented						1,150		
Harvest not represented						0		
Total harvest						1,150		
General Subdistrict–north, *n* = 341								
	West	2.3	0.3	4.8	1.4	11	1	22
	Susitna	18.1	14.6	21.8	2.2	84	68	101
	Deshka	5.5	3.5	8.0	1.4	25	16	37
	Yentna	2.7	1.2	4.6	1.0	12	6	21
	Knik-Turnagain	71.5	67.2	75.6	2.5	332	312	351
	Kenai Peninsula	0.0	0.0	0.6	0.3	0	0	3
Harvest represented						464		
Harvest not represented						0		
Total harvest						464		
Eastern Subdistrict, *n* = 403								
	West	2.7	0.7	5.1	1.4	14	4	27
	Susitna	20.9	17.5	24.2	2.0	109	92	127
	Deshka	7.9	5.5	10.3	1.5	41	29	54
	Yentna	8.2	5.9	10.7	1.5	43	31	56
	Knik-Turnagain	60.3	56.1	64.3	2.5	315	294	336
	Kenai Peninsula	0.1	0.0	0.7	0.3	0	0	4
Harvest represented						523		
Harvest not represented						0		
Total harvest						523		

Note: Sample sizes (*n*), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

Table 14.–Stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the General Subdistrict–south, General Subdistrict–north, and Eastern Subdistrict of the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2017.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
General Subdistrict–south, n = 423								
	West	18.9	15.2	22.7	2.2	224	181	270
	Susitna	35.8	31.7	39.9	2.5	425	377	474
	Deshka	18.4	15.2	21.6	1.9	219	181	257
	Yentna	16.5	13.2	20.1	2.1	196	156	239
	Knik-Turnagain	10.2	7.8	12.8	1.5	122	92	152
	Kenai Peninsula	0.2	0.0	0.7	0.2	3	0	8
Harvest represented						1,188		
Harvest not represented						0		
Total harvest						1,188		
General Subdistrict–north, n = 257								
	West	4.3	1.6	7.7	1.8	24	9	42
	Susitna	16.0	11.9	20.2	2.5	87	65	110
	Deshka	7.5	4.8	10.4	1.7	41	26	57
	Yentna	6.3	3.8	9.3	1.7	34	21	51
	Knik-Turnagain	65.9	60.5	71.0	3.2	359	330	387
	Kenai Peninsula	0.0	0.0	0.3	0.2	0	0	2
Harvest represented						545		
Harvest not represented						0		
Total harvest						545		
Eastern Subdistrict, n = 259								
	West	9.7	5.9	13.9	2.5	41	25	58
	Susitna	23.2	18.7	28.3	2.9	97	78	118
	Deshka	9.9	6.7	13.5	2.0	42	28	57
	Yentna	7.7	4.8	11.2	2.0	32	20	47
	Knik-Turnagain	47.7	42.3	53.2	3.3	199	177	223
	Kenai Peninsula	1.7	0.5	3.3	0.9	7	2	14
Harvest represented						418		
Harvest not represented						0		
Total harvest						418		

Note: Sample sizes (n), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

Table 15.–Annual stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016 and 2017.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
Year 2016, *n* =1,236								
	West	14.3	11.8	16.9	1.5	306	252	360
	Susitna	27.2	24.6	29.8	1.6	581	525	637
	Deshka	10.9	9.1	12.8	1.1	232	194	273
	Yentna	12.6	10.5	14.6	1.3	269	224	312
	Knik-Turnagain	35.1	33.1	37.0	1.2	749	707	791
	Kenai Peninsula	0.0	0.0	0.3	0.1	0	0	6
Harvest represented						2,137		
Harvest not represented						0		
Total harvest						2,137		
Year 2017, *n* = 939								
	West	13.4	11.2	15.8	1.4	289	241	340
	Susitna	28.3	25.7	31.0	1.6	609	554	667
	Deshka	14.0	12.0	16.0	1.2	301	258	345
	Yentna	12.2	10.2	14.3	1.3	262	219	308
	Knik-Turnagain	31.6	29.4	33.9	1.3	680	633	728
	Kenai Peninsula	0.5	0.1	0.9	0.2	10	3	18
Harvest represented						2,151		
Harvest not represented						0		
Total harvest						2,151		

Note: Estimates were calculated using a stratified estimator for combined area strata. Within each year, sample sizes (*n*), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

Table 16.–Annual stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the Tyonek subsistence set gillnet fishery of Cook Inlet, Alaska, in 2016 and 2017.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
Year 2016, *n* = 279 [a]								
	West	28.8	23.4	35.0	3.5	292	237	355
	Susitna	32.3	27.1	37.8	3.4	327	274	384
	Deshka	11.6	8.1	15.4	2.2	118	82	156
	Yentna	17.1	12.8	21.8	2.8	174	130	221
	Knik-Turnagain	9.9	7.0	13.2	1.9	100	71	134
	Kenai Peninsula	0.2	0.0	0.9	0.4	2	0	9
Harvest represented						1,013		
Harvest not represented[a]						17		
Total harvest						1,030		
Year 2017, *n* = 247								
	West	16.5	11.6	21.9	3.2	216	152	285
	Susitna	38.3	32.4	44.3	3.7	499	422	577
	Deshka	10.4	7.0	14.2	2.2	136	92	185
	Yentna	17.9	13.3	22.9	2.9	234	174	298
	Knik-Turnagain	16.0	11.8	20.3	2.6	208	154	265
	Kenai Peninsula	0.8	0.0	2.1	0.7	11	1	27
Harvest represented						1,304		
Harvest not represented						0		
Total harvest						1,304		

Note: Within each year, sample sizes (*n*), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

[a] Seventeen fish were not represented in 2016 because they fell outside of the sampled date range or dates of harvest were unknown and therefore could not be accurately represented in MSA.

FIGURES

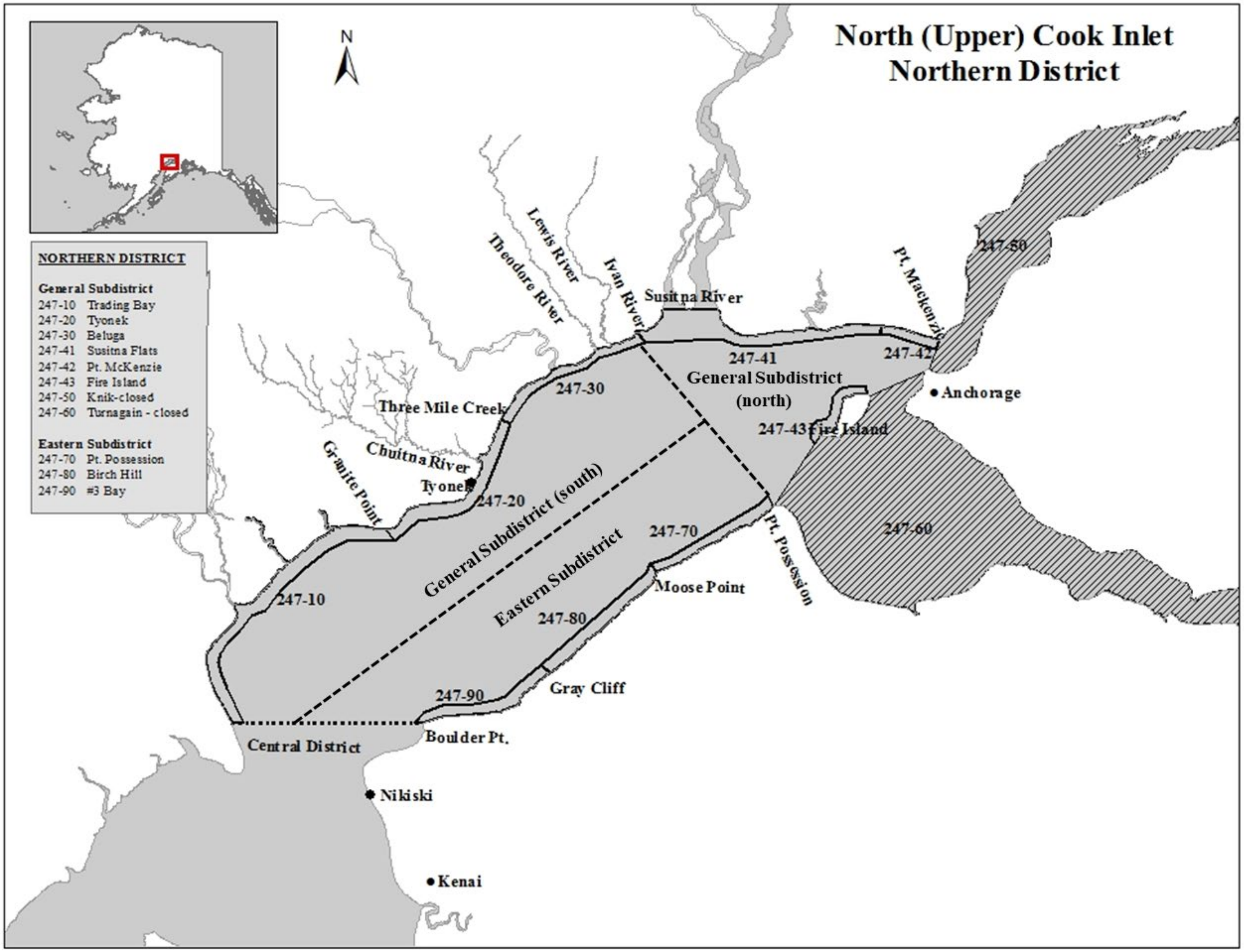

Figure 1.–Map of statistical areas for set gillnet commercial fishing in the Northern District of Upper Cook Inlet.

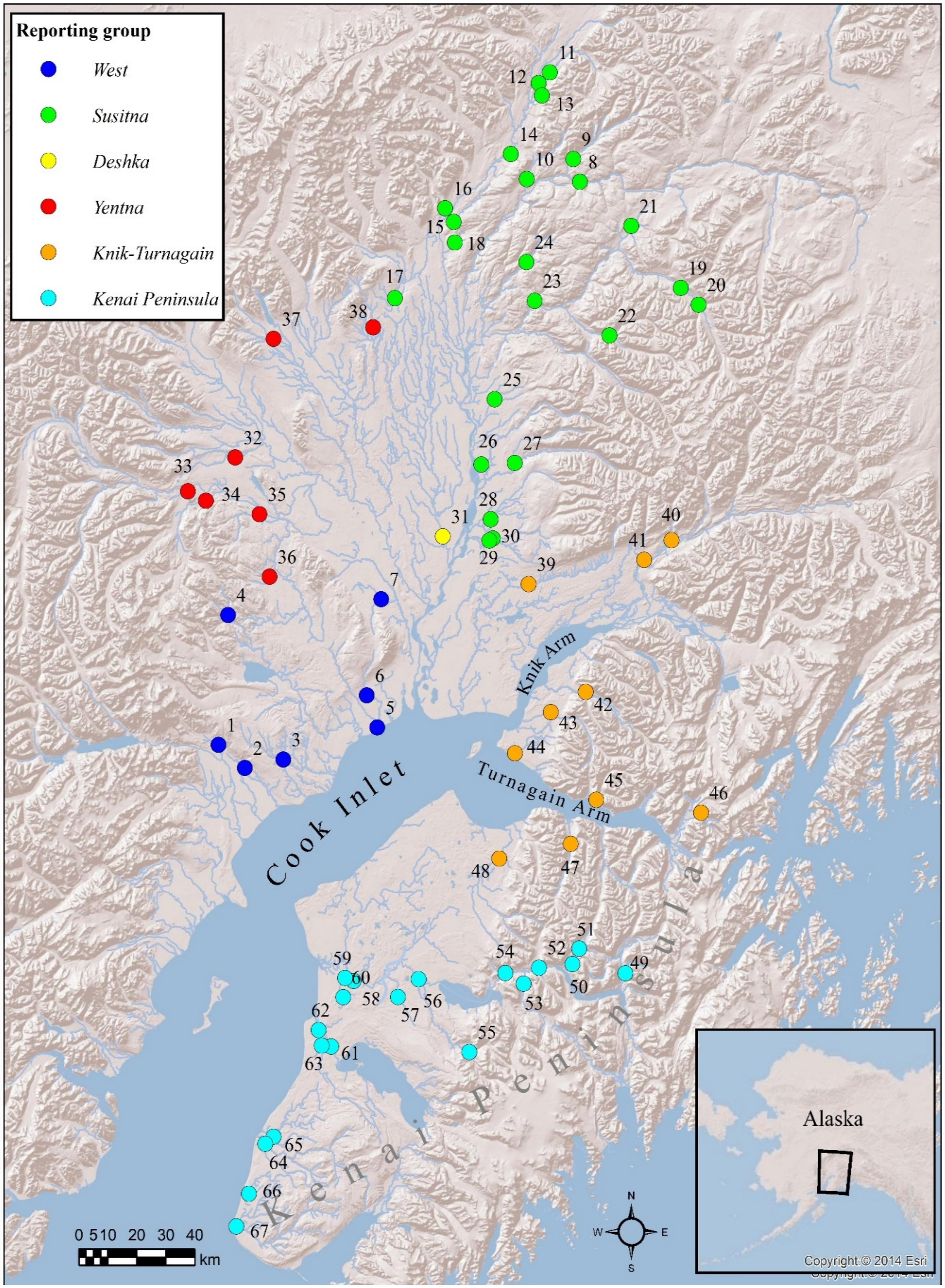

Figure 2.–Sampling locations for Chinook salmon populations from Cook Inlet included in the Cook Inlet genetic baseline.

Note: Numbers correspond to map numbers in Table 1. Location dot color matches reporting group assignment.

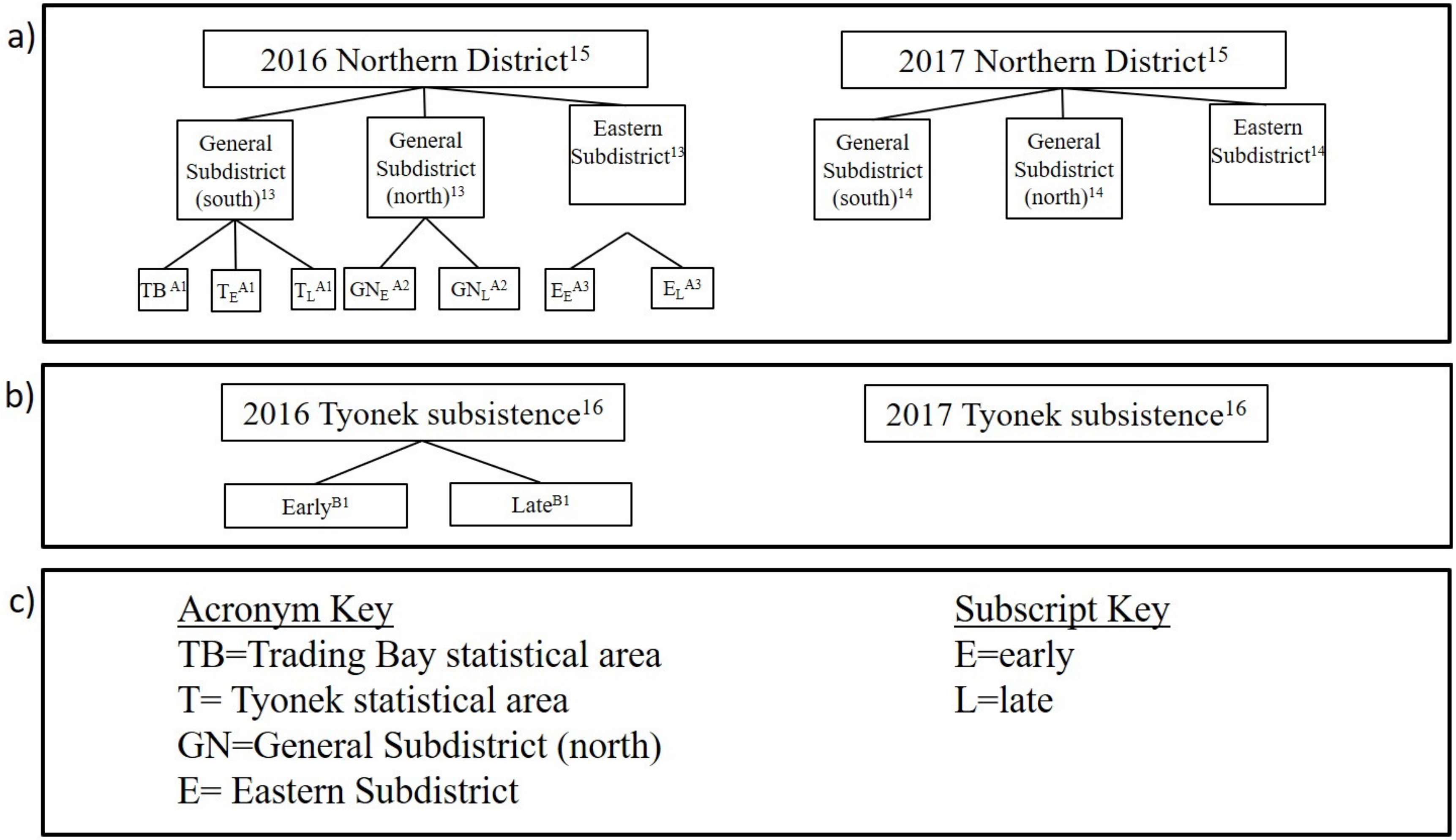

Figure 3.–Graphical depictions of temporal and area strata (boxes) in the a) Northern District set gill net and b) Tyonek Subsistence set gillnet fisheries, in which stock composition and stock-specific harvest were estimated, and c) keys for acronyms of each area stratum and subscripts used to indicate temporal strata. Lines connecting smaller strata to larger strata indicate which estimates were stratified to calculate larger strata.

Note: Superscript numbers next the name or acronym of each temporal and area stratum indicate the table number or appendix where their estimates can be found.

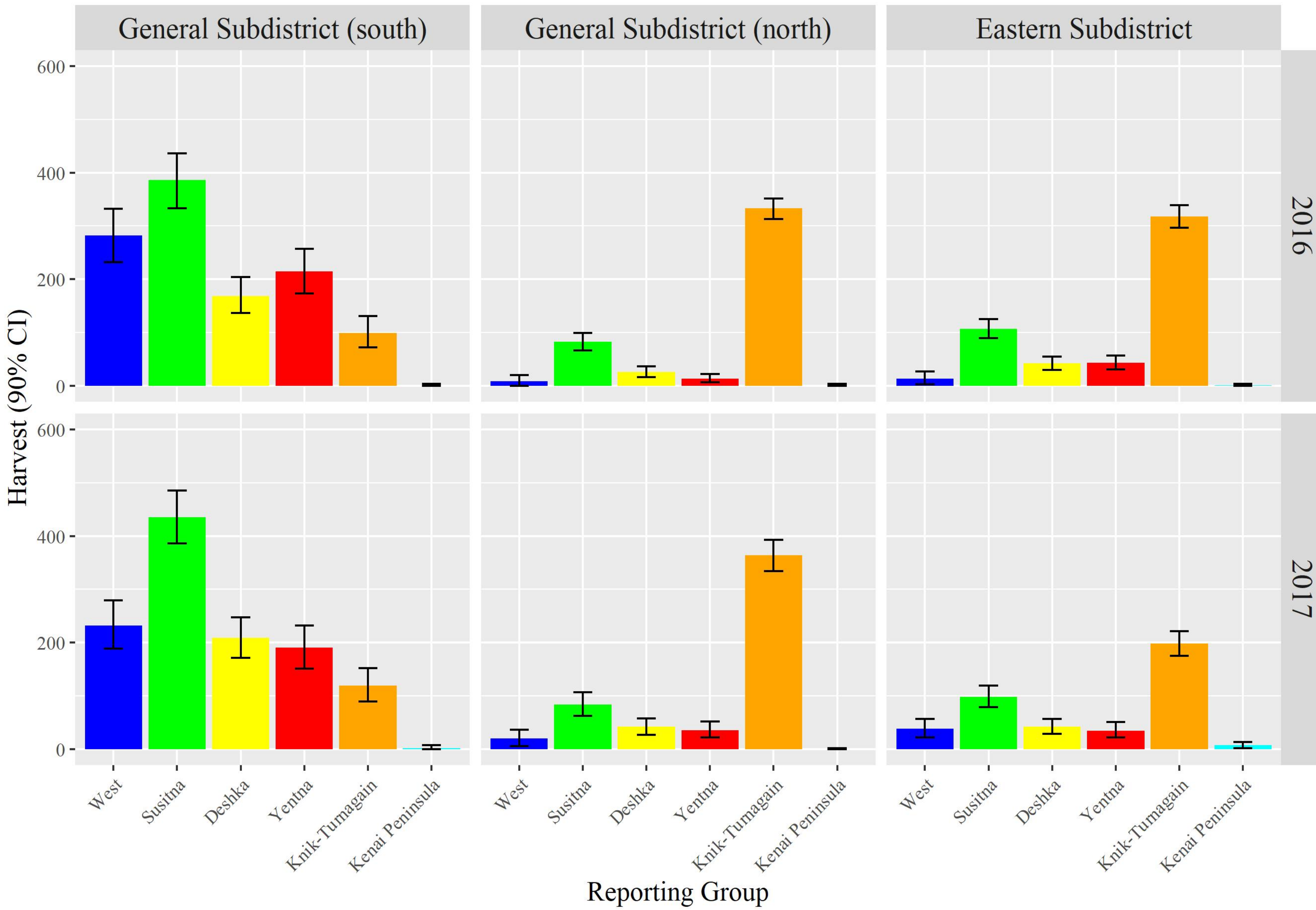

Figure 4.–Annual stock-specific harvest estimates and 90% credibility intervals based on genetic data for Chinook salmon harvested in the General Subdistrict–south, General Subdistrict–north, and Eastern Subdistrict of the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016 and 2017.

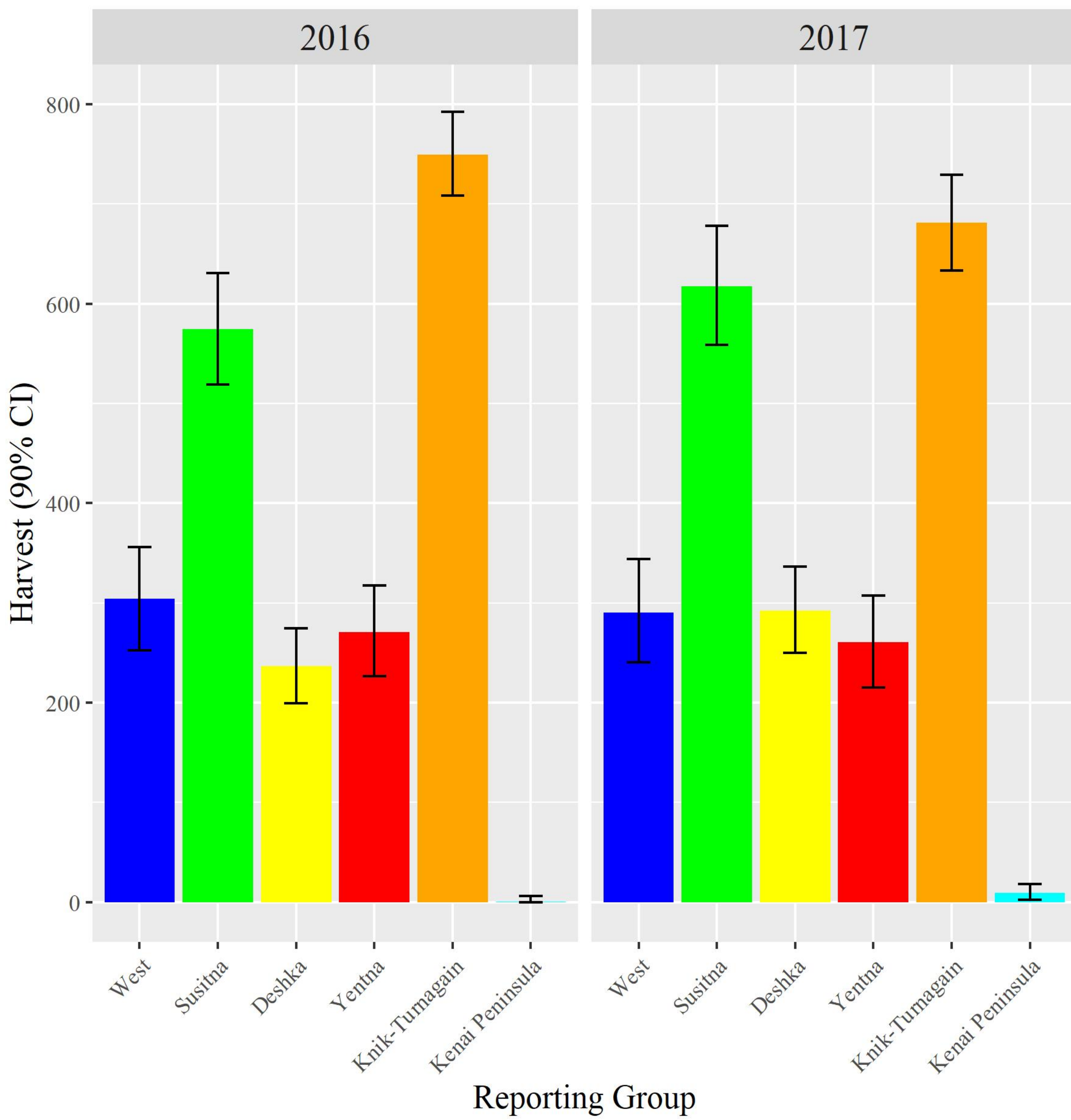

Figure 5.–Annual stock-specific harvest estimates and 90% credibility intervals based on genetic data for Chinook salmon harvested in the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016 and 2017.

Note: Estimates were calculated using a stratified estimator for combined area strata.

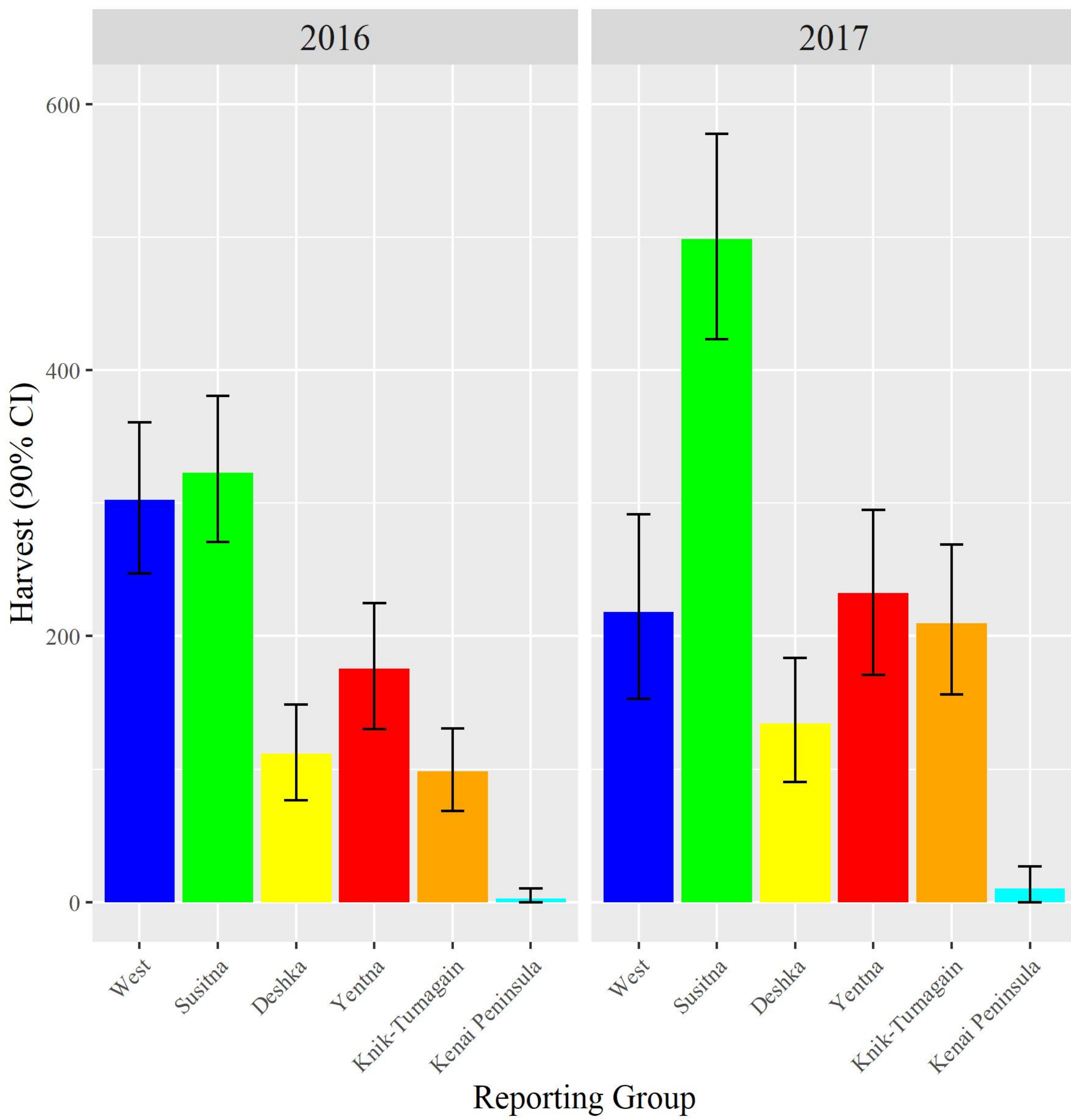

Figure 6.–Annual stock-specific harvest estimates and 90% credibility intervals based on genetic data for Chinook salmon harvested in the Tyonek subsistence set gillnet fishery of Cook Inlet, Alaska, in 2016 and 2017.

APPENDIX A: STOCK COMPOSITION AND STOCK-SPECIFIC HARVEST ESTIMATES OF FINE-SCALE TEMPORAL STRATA, 2016 COMMERCIAL FISHERIES

Appendix A1.–Stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the Trading Bay and Tyonek statistical areas of the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
Trading Bay, May 29–June 30, n = 143								
	West	25.1	17.8	32.9	4.5	146	103	191
	Susitna	39.0	31.5	46.4	4.6	226	183	269
	Deshka	11.2	6.8	16.0	2.9	65	39	93
	Yentna	15.0	9.4	21.0	3.5	87	55	122
	Knik-Turnagain	9.7	5.7	14.5	2.7	56	33	84
	Kenai Peninsula	0.0	0.0	0.5	0.3	0	0	3
Harvest represented						581		
Harvest not represented						0		
Total harvest						581		
Tyonek, May 29–June 12, n = 193								
	West	20.5	14.7	26.3	3.6	71	51	91
	Susitna	30.5	24.4	36.5	3.7	105	84	126
	Deshka	16.6	12.1	21.7	2.9	57	42	75
	Yentna	22.2	16.8	28.0	3.5	77	58	97
	Knik-Turnagain	10.3	6.4	14.8	2.5	35	22	51
	Kenai Peninsula	0.0	0.0	0.3	0.2	0	0	1
Harvest represented						346		
Harvest not represented						0		
Total harvest						346		
Tyonek, June 13–30, n = 156								
	West	28.5	21.5	36.2	4.5	64	48	81
	Susitna	25.1	19.0	31.6	3.8	56	42	70
	Deshka	19.4	13.6	25.6	3.6	43	30	57
	Yentna	22.3	15.7	29.2	4.0	50	35	65
	Knik-Turnagain	4.7	2.0	8.1	1.9	10	4	18
	Kenai Peninsula	0.0	0.0	0.5	0.3	0	0	1
Harvest represented						223		
Harvest not represented						0		
Total harvest						223		

Note: Sample sizes (n), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

Appendix A2.–Stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the General Subdistrict–north area of the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
General Subdistrict–north, May 29–June 12, *n* = 125								
	West	6.1	1.6	11.4	2.9	10	3	19
	Susitna	26.2	19.9	33.1	4.0	43	33	55
	Deshka	8.2	4.4	12.8	2.6	14	7	21
	Yentna	2.4	0.0	6.4	2.0	4	0	11
	Knik-Turnagain	57.1	49.5	64.2	4.5	95	82	107
	Kenai Peninsula	0.0	0.0	1.1	0.5	0	0	2
Harvest represented						166		
Harvest not represented						0		
Total harvest						166		
General Subdistrict–north, June 13–27, *n* = 216								
	West	0.2	0.0	2.7	1.3	1	0	8
	Susitna	13.5	9.4	18.0	2.6	40	28	54
	Deshka	4.0	1.8	6.8	1.6	12	5	20
	Yentna	2.8	1.2	4.8	1.1	8	4	14
	Knik-Turnagain	79.5	74.4	84.3	3.1	237	222	251
	Kenai Peninsula	0.0	0.0	0.8	0.3	0	0	2
Harvest represented						298		
Harvest not represented						0		
Total harvest						298		

Note: Sample sizes (*n*), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

Appendix A3.–Stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the Eastern Subdistrict area of the Northern District set gillnet fishery of Cook Inlet, Alaska, in 2016.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting Group	Mean	5%	95%	SD	Mean	5%	95%
Eastern Subdistrict, May 29–June 12, *n* = 186								
	West	0.3	0.0	4.1	2.0	1	0	11
	Susitna	25.9	20.7	31.5	3.3	67	53	81
	Deshka	9.0	5.5	12.7	2.2	23	14	33
	Yentna	10.1	6.4	14.2	2.4	26	16	37
	Knik-Turnagain	54.7	48.7	60.6	3.7	141	125	156
	Kenai Peninsula	0.0	0.0	0.4	0.2	0	0	1
Harvest represented						257		
Harvest not represented						0		
Total harvest						257		
Eastern Subdistrict, June 13–30, *n* = 218								
	West	5.0	2.1	8.5	1.9	13	6	23
	Susitna	16.0	12.1	20.3	2.5	43	32	54
	Deshka	6.8	3.9	10.1	1.9	18	10	27
	Yentna	6.3	3.7	9.4	1.8	17	10	25
	Knik-Turnagain	65.7	60.2	71.3	3.4	175	160	190
	Kenai Peninsula	0.2	0.0	1.3	0.6	0	0	4
Harvest represented						266		
Harvest not represented						0		
Total harvest						266		

Note: Sample sizes (*n*), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

APPENDIX B: STOCK COMPOSITION AND STOCK-SPECIFIC HARVEST ESTIMATES OF FINE-SCALE TEMPORAL STRATA, 2016 TYONEK SUBSISTENCE FISHERY

Appendix B1.–Stock composition (%) and stock-specific harvest estimates based on genetic data for Chinook salmon harvested in the Tyonek subsistence set gillnet fishery of Cook Inlet, Alaska, in 2016.

		Stock composition (%)				Stock-specific harvest		
			90% CI				90% CI	
Harvest	Reporting group	Mean	5%	95%	SD	Mean	5%	95%
Tyonek subsistence, May 16–31, *n* = 137								
	West	29.2	21.4	37.5	4.9	120	88	155
	Susitna	32.9	24.9	41.2	5.0	136	103	170
	Deshka	7.3	3.3	12.2	2.7	30	14	50
	Yentna	21.3	14.8	28.5	4.2	88	61	117
	Knik-Turnagain	8.6	4.7	13.3	2.6	36	20	55
	Kenai Peninsula	0.5	0.0	2.0	0.8	2	0	8
Harvest represented						412		
Harvest not represented[a]						0		
Total harvest						412		
Tyonek subsistence, June 1–25, *n* = 142								
	West	28.6	21.0	37.2	4.8	172	126	224
	Susitna	31.9	24.7	39.4	4.5	191	149	237
	Deshka	14.5	9.5	20.1	3.2	87	57	121
	Yentna	14.3	8.5	21.1	3.8	86	51	127
	Knik-Turnagain	10.8	6.8	15.4	2.6	65	41	93
	Kenai Peninsula	0.0	0.0	0.5	0.3	0	0	3
Harvest represented						601		
Harvest not represented[a]						0		
Total harvest						601		

Note: Sample sizes (*n*), means, 90% credibility intervals (CI), and standard deviation of the proportions (SD) are provided.

Note: Stock-specific harvest estimates may not sum to the total harvest represented due to rounding error and their 90% credibility intervals may not include the point estimate for the very low stock-specific harvest numbers because fewer than 5% of iterations had values above zero.

[a] Seventeen fish were not represented in 2016 because they fell outside of the sampled date range or dates of harvest were unknown and therefore could not be accurately represented in MSA.