Fishery Data Series No. 25-33

A Retrospective Analysis of Chinook Salmon Genetic Stock Identification and Stock-Specific Passage at Pilot Station, 2005–2018

by

Joshua N. Clark

Elizabeth M. Lee

Dan Prince

Tyler H. Dann

Fred W. West

and

Hamachan Hamazaki

August 2025

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. 25-33

A RETROSPECTIVE ANALYSIS OF CHINOOK SALMON GENETIC STOCK IDENTIFICATION AND STOCK-SPECIFIC PASSAGE AT PILOT STATION, 2005–2018

by
Joshua. N. Clark, Elizabeth M. Lee, Dan Prince, Tyler H. Dann, Fred W. West, and Toshihide Hamazaki,
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

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

August 2025

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Joshua N. Clark, Elizabeth M. Lee, Dan Prince, Tyler H. Dann, Fred W. West, and Toshihide Hamazaki,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Rd., Anchorage AK, 99518, USA

This document should be cited as follows:
Clark, J. N., E. M. Lee, D. Prince, T. H. Dann, F. W. West, and T. Hamazaki. 2025. A retrospective analysis of Chinook salmon genetic stock identification and stock-specific passage at Pilot Station, 2005–2018. Alaska Department of Fish and Game, Fishery Data Series No. 25-33, Anchorage.

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ABSTRACT

Knowledge of the origin of Chinook salmon in Yukon River fisheries is important for successful fisheries management. Historically, genetic stock identification has been an effective tool used in fisheries management of Yukon River Chinook salmon *Oncorhynchus tshawytscha*, because significant genetic variation exists among populations of Chinook salmon within the Yukon River drainage. Since 2005, inseason genetic mixed stock analysis (MSA) has been used to estimate the stock compositions for temporal strata of Chinook salmon passing the Pilot Station sonar near the mouth of the Yukon River. Temporal strata are defined date ranges that mirror the major pulses of fish entering the river. Over time, both our understanding of Yukon River Chinook salmon runs and genetic methods have evolved, leading to methodological changes over the years. This report describes a retrospective analysis of the stock composition and stock-specific passage estimates of Yukon River Chinook salmon passing Pilot Station from 2005 to 2018. Currently available analytical knowledge was applied to archived genetic data to revise stratified and annual estimates of genetic stock composition and stock-specific passage of Chinook salmon at Pilot Station for Lower Yukon, Middle Yukon, and Canada stock reporting groups. Original and retrospective estimates of Canadian-origin Chinook salmon, as determined by genetics, differed by less than 4.81% across years, with variation primarily due to changes in the genetic MSA methods and re-stratification of samples within each year.

Keywords: Chinook salmon, *Oncorhynchus tshawytscha*, Yukon River, Pilot Station, stock composition, genetic mixed stock analysis, genetic baseline

INTRODUCTION

Effective management of Yukon River Chinook salmon *Oncorhynchus tshawytscha* stocks requires an understanding of the proportion of the total run that is Canadian-origin prior to substantial inriver harvest. Canadian-origin Chinook salmon migrate through approximately 1,900 kilometers of fisheries in the Alaska portion of the drainage. The Alaska Department of Fish and Game (ADF&G) manages the mixed stock Chinook salmon fishery on the Yukon River to achieve spawning escapement goals, which have been established to ensure sustained yields for subsistence and other uses. In addition, ADF&G manages the Canadian-origin component of the total run to achieve the interim management escapement goal plus the Canadian harvest share as defined in the *Yukon River Salmon Agreement* between the U.S. and Canada, as outlined in Appendix 2 of Chapter 8 of the *Pacific Salmon Treaty*. An estimate of the Canadian-origin Chinook salmon run strength and migration timing is vital to ensure appropriate management actions are taken to meet Alaska-Canada border objectives.

A sonar project near Pilot Station, in the lower portion of the Yukon River, provides a valuable platform to generate inseason and total run estimates of Chinook salmon stock composition. Inseason estimates of run size and stock composition are made for distinct pulses of Chinook salmon past the Pilot Station sonar, which are used to guide management. Postseason, sample groupings by pulse can be evaluated in the context of the entire run and stratified as needed to estimate stock composition for each temporal stratum of the run and the total run past the sonar.

The ADF&G Gene Conservation Laboratory (GCL) uses genetic mixed stock analysis (MSA) methods to generate inseason stock composition estimates using genotypes of samples from the Pilot Station sonar project test fishery (PSTF). This project provides fishery managers with an important inseason understanding of Canadian-origin Chinook salmon run strength and timing before those fish migrate through most Alaska fisheries. Without genetic MSA at the mainstem sonar project near Pilot Station, fishery managers lack a clear indication of Canadian-origin run strength and timing until fish arrive at a mainstem sonar project at Eagle, located near the Alaska-Canada border, when most of the run has already passed through 1,900 kilometers of fisheries within Alaska. Knowledge of Canadian-origin Chinook salmon run strength and timing early in the run and lower in the river allows more appropriate and timely management actions to ensure escapement and harvest sharing objectives are met each year. Postseason, additional analysis provides an estimate of stock-specific passage for the entire Chinook salmon run past the Pilot Station sonar. Methods used to apportion sonar counts to species at Pilot Station and methods to estimate stock-specific passage at Pilot Station have evolved over time (Pfisterer et al. 2017; Lozori 2020). Stock-specific passage estimates of Chinook salmon passing Pilot Station in the Lower Yukon River are used in conjunction with other data sources to inform estimates of total run, harvest, and escapement by stock reporting group (e.g., Lower Yukon, Middle Yukon, and Canada). Total run estimates of Chinook salmon are used to reconstruct the annual return of Chinook salmon and to update brood tables that inform stock-recruit relationships that form the foundation of future assessments of stock productivity and sustainable yield. This information ultimately allows managers to better model stock-specific abundance trends, spawner and recruitment relationships, and forecast future Chinook salmon runs.

Genetic baselines are the foundation of reliable and accurate MSA. When conducting MSA, stock of origin is estimated by comparing the genetic data of a fishery mixture sample to the known genetic data of a baseline to determine which populations the sample is most likely to have originated from. A baseline consists of both populations and genetic markers. The baseline must include adequate representation from all populations expected in mixture samples, as well as genetic markers that characterize genetic diversity among groups of populations (i.e., reporting groups or stocks). The baseline for Yukon River Chinook salmon has evolved over time in response to technological advancements and changing management needs. The first baseline was developed in the 1990s with allozyme markers (Wilmot et al. 1992; Templin et al. 2005), and in the early 2000s microsatellites and single nucleotide polymorphism (SNP) markers were explored for baseline improvement (Flannery et al. 2006). Genetic MSA was first conducted postseason on Chinook salmon samples collected in the 2002 and 2003 PSTF using the baseline of allozyme markers to determine the value of genetic methods for monitoring the Canadian-origin proportion of Chinook salmon at Pilot Station (Templin et al. 2005). Genetic MSA of Pilot Station Chinook salmon was refined and implemented as a Yukon River inseason tool in 2005 and 2006 using a baseline of microsatellite markers (Flannery et al. 2006; JTC 2006). Since 2007, the ADF&G GCL has conducted inseason and postseason MSA on PSTF Chinook salmon using a genetic baseline of SNP markers to determine the Canadian-origin proportion of Chinook salmon passage at Pilot Station (Smith et al. 2005a; Templin et al. 2006; DeCovich and Howard 2010; Templin et al. 2011; West and Dann 2019). This baseline of SNP markers was refined over several years as baseline evaluation methods improved and our understanding of Yukon River Chinook salmon stocks improved—populations were added and removed, markers were added and removed, and stock reporting groups were refined to more accurately reflect the genetic characterization of Yukon River Chinook salmon stocks. A major baseline update in 2014 resulted in a baseline of 41 SNP markers (Table 1) genotyped in 36 populations (Table 2) that allowed for accurate and precise reporting to 3 hierarchical reporting group levels when sample sizes are adequate: (1) country of origin (U.S. and Canada), (2) broad-scale (Lower Yukon, Middle Yukon, and Canada), and (3) fine-scale (Lower Yukon, Koyukuk, Tanana, Upper U.S. Yukon, and Canada). The 2014 baseline met the needs of Yukon River researchers and managers, and was subsequently used for Pilot Station Chinook salmon MSA from 2014 through 2018. However, in addition to changes in the baseline, the MSA methods utilizing the 2014 baseline were refined over time to better meet research and management needs—computer analysis software improved, data reproducibility improved, and statistical approaches changed. Overall, these changes in the genetic baseline and

MSA methods applied to the Pilot Station samples resulted in more accurate and precise Chinook salmon stock composition estimates in recent years.

This report revisits genotypic and sonar passage data collected from 2005 to 2018 as part of the Pilot Station sonar project to revise and compile the stock composition and stock-specific passage at Pilot Station. Pulses of Chinook salmon passing the Pilot Station sonar were reviewed within a historical context to standardize strata across years, when possible. Stock composition estimates were updated using the 2014 SNP baseline, standardized MSA methods, and 3 stock reporting groups for years where SNP data were available (2007–2018). The contributions of Lower Yukon, Middle Yukon, and Canada stock reporting groups were calculated for each year (2005–2018) using the best available stock composition estimates and sonar passage estimates to calculate stock-specific passage and a standardized statistical approach. It is important to note that 2005 and 2006 were not genetically reanalyzed, because SNP data were not available. Unpublished genetic MSA percentages from microsatellites were used in this reanalysis of stock-specific passage.

OBJECTIVE

The objective of this study was to retrospectively estimate the contribution of Lower Yukon, Middle Yukon, and Canada stock reporting groups to annual Chinook salmon passage at Pilot Station for all years with available data from 2005 to 2018.

METHODS

FISHERY SAMPLING

Chinook salmon tissue samples (axillary processes) were collected annually (2005–2018) from the test fishery and used to apportion Pilot Station sonar passage counts (PSTF). The Pilot Station sonar and test fishery are in a single channel environment at river kilometer 197 of the mainstem of the Yukon River (District 2) near the village of Pilot Station (Figure 1). The PSTF uses a suite of 8 different gillnet mesh sizes, ranging from 2.75 inches to 8.5 inches (stretch mesh), to apportion sonar counts by species, and was assumed to be representative of the entire run of Chinook salmon that passed the sonar site. The Andreafsky River is the only major Chinook salmon spawning tributary downstream of Pilot Station; therefore, the majority of Yukon River Chinook salmon total run passes the sonar site on the way to the spawning grounds upstream. All Chinook salmon caught in the test fishery were sampled. Therefore, genetic tissue samples were assumed to be collected in proportion to Chinook salmon passage, as estimated by the sonar. All collected tissue samples were used in genetic MSA when possible; however, in 2015 and 2016, a subset of PSTF samples was used for genetic analysis, selected in proportion to the estimated sonar passage. From 2007 to 2009, an additional sampling period was conducted regularly throughout the season using a gillnet with 8.5-, 7.5-, and 6.5-inch meshes drifted upstream of the Pilot Station sonar (Carroll and McIntosh 2011). The extra sampling was conducted to target all size classes of Chinook salmon and increase the Chinook salmon sample sizes for genetic MSA.

Originally, annual PSTF samples were divided into 2 to 4 temporal strata that mirrored the major pulses of Chinook salmon passing the Pilot Station sonar. For this retrospective reanalysis, the samples were re-stratified into 3 strata per year, where each stratum had an adequate sample size for MSA ($N > 100$) and represented major pulses of Chinook salmon passing Pilot Station. The 2005 and 2006 PSTF samples were not re-stratified, due to the methods of original data collection.

LABORATORY ANALYSIS

No new laboratory analyses were conducted for this retrospective reanalysis. We used the original genotypic data collected from the PSTF Chinook salmon samples for each year (2005–2018).

Briefly, genomic DNA was extracted from all selected tissue samples using a DNeasy 96 Tissue Kit by QIAGEN (Valencia, CA, USA) or NucleoSpin 96 Tissue Kit by Macherey-Nagel (Düren, Germany). The 2007 to 2018 samples were then genotyped for a set of SNP markers using Taqman chemistry (Applied Biosystems, Waltham, MA, USA). The 2007 samples were genotyped with 26 of the 41 SNP markers included in the 2014 baseline, and the 2008 to 2018 were genotyped all 41 SNP markers included the 2014 baseline (Templin et al. 2006a, 2006b, 2006c; DeCovich and Templin 2009; DeCovich and Howard 2010, 2011; West and Dann 2019; West and Prince 2019; ADF&G 2021). Laboratory quality control measures included reanalysis of 8% of the samples to ensure that genotypes were reproducible, identify laboratory errors, and measure rates of inconsistencies during repeated analyses. Genotypic data were stored in an Oracle database on a network drive maintained by ADF&G computer services.

The 2005 and 2006 PSTF samples were genotyped at 13 microsatellite markers by the U.S. Fish and Wildlife Service Conservation Genetics Lab following the methods described in Flannery et al. (2006). These genotypes were provided to the GCL and archived on an ADF&G server.

MIXED STOCK ANALYSIS

Archived genotypic data for the 2005 to 2018 PSTF Chinook salmon samples were retrieved from the ADF&G GCL database for this retrospective MSA. Prior to MSA, we conducted 2 statistical quality control analyses to ensure that only quality genotypic data were included in the estimation of stock compositions. First, we excluded individuals missing greater than 20% of genotypic data, because these individuals probably have poor-quality DNA. The inclusion of individuals with poor-quality DNA could introduce genotyping errors, thereby reducing the accuracy and precision of MSA. Second, individuals identified with duplicate genotypes were removed from further analyses. The individual with the most missing data from each duplicate pair was removed.

The stock compositions of the 2007 to 2018 Pilot Station strata were estimated using the 2014 genetic baselines of SNP markers (Tables 1 and 2) with the program BAYES (Pella and Masuda 2001). The Bayesian method of MSA estimates the proportion of stocks caught within each fishery using 4 pieces of information: (1) a baseline of allele frequencies for each population, (2) the grouping of populations into the reporting groups desired for MSA, (3) prior information about the stock proportions of the fishery, and (4) the genotypes of fish sampled from the fishery. The PSTF samples were grouped by strata within each year for MSA. For each sample mixture, 5 independent Markov Chain Monte Carlo chains of 40,000 iterations were run with different starting values, and the first 20,000 iterations were discarded to remove the influence of the initial start values. Gelman-Rubin shrink factors were computed for all stock groups in BAYES to assess among-chain convergence (Gelman and Rubin 1992). The last 20,000 iterations of each of the 5 chains were combined to form the posterior distribution of a total of 100,000 iterations from which means, medians, 90% CI (credibility interval), standard deviations, the probability that the group estimate is equal to zero ($P = 0$), and coefficient of variation (CV) were tabulated.

Stock compositions of the 2005 and 2006 PSTF strata were estimated using different baselines and MSA methods due to the original data collection methods (Flannery et al. 2006). PSTF samples from 2005 and 2006 were originally genotyped using microsatellite markers from a baseline of

13 microsatellite markers and 19 populations. MSA was conducted using these data with the software SPAM (Debevec et al. 2000) and following the methods described in Templin et al. (2006c).

Estimation of stock-specific passage and proportion

For each temporal stratum, stock compositions were reported to country of origin (U.S. and Canada) and 3 broad-scale reporting groups (Lower Yukon, Middle Yukon, and Canada) (DeCovich and Howard 2011), and the posteriors for each iteration were output to be combined with passage estimates.

Pilot Station sonar passage estimates, and associated uncertainties, were retrieved from annual project reports (Pfisterer et al. 2017; Lozori 2020).

Season total proportion and size of the *k-th* stock of Chinook salmon passage at Pilot Station sonar ($\widehat{P}_k$, $\widehat{N}_k$) were derived by applying a stratified estimation method as follows:

$$\widehat{P}_k = \frac{\sum_j (\widehat{N}_j \cdot \widehat{P}_{j,k})}{\sum_j \widehat{N}_j}, \text{ and} \tag{1}$$

$$\widehat{N}_k = \sum_j \widehat{N}_j \cdot \widehat{P}_{jk}, \tag{2}$$

where:

N_j: Sonar estimates of Chinook salmon passage at Pilot Station during the *j-th* period, and

$P_{j,k}$: The proportion of stock (*k*) during the period (*j*) derived from the MSA.

Mean, median, standard deviation, and 90% CI (credibility interval) of the passages and proportions were estimated by summarizing 10,000 bootstrap replicates ($N_{j,k}^b$,N_k^b,P_k^b) generated as follows.

Pilot Station sonar passage

Chinook salmon passage and variance during the period (*j*) were derived by summing daily Chinook salmon sonar passage and variance as:

$$N_j = \sum_d N_d \quad \sigma_j^2 = \sum_d \sigma_d^2. \tag{3}$$

From the above 10,000 parametric bootstrap samples of the Pilot Station passage during the *j-th* periods, (N_j^b) were drawn from a normal distribution with mean passage of N_j and standard deviation σ_j, $N_j^b \sim N(N_j, \sigma_j)$.

Stock proportion

Chinook salmon stock proportions during the period (*j*) provided by GCL differed between 2005 and 2006 (based on SPAM) and 2007–2018 (based on BAYES) periods. SPAM estimates provided only summary (e.g., mean stock proportion and standard error), whereas BAYES estimates provided 100,000 Bayesian posterior samples.

For the 2005 and 2006 stock proportions, 10,000 parametric bootstrap samples of stock proportions were generated from a multinomial distribution, $P_{j,k}^b \sim Mult(n_j, P_{j,1}, \ldots, P_{j,k})$, $0 \leq P_k \leq 1, \sum P_k = 1$, where n_j is the number of genetic samples collected during the period (*j*).

Because this approximation considers only sampling error and not identification error (i.e., assumes each stock was correctly identified), n_j was adjusted to 0.5 of the actual sample size collected. This generated standard errors comparable to those from SPAM.

For the 2007 to 2018 stock proportion, 10,000 samples of stock-specific proportion at *j-th* period ($P_{j,k}^{b}$) were randomly selected from 100,000 Bayesian posterior distributions of stock proportions from the MSA described above.

The 10,000 samples derived for each period (j) were combined using Equations 1 and 2 to generate 10,000 total passage and proportion samples (N_k^b, P_k^b).

The bootstrap procedure used for this analysis differed slightly from procedures used by the GCL to weight stock proportions based on the harvest or passage numbers for any stratum of interest based on mean and CV (Habicht et al. 2012). The only difference between GCL's conventional stratified estimator and the method described in this report is that GCL's method assumes a lognormal distribution for the harvest or passage number, whereas the method here assumes a normal distribution. The credibility interval produced under a normal distribution is more symmetrical around the mean, whereas a lognormal distribution produces a credibility interval that is longer on the right side of the mean.

RESULTS

TISSUE SAMPLING

Genetic tissue samples were successfully collected from 98.4% of the Chinook salmon caught in the PSTF from 2005 to 2018. Within each year, all collected samples were selected for MSA except for 2015 and 2016, which were subsampled in proportion to daily sonar passage during original analysis. In 2015, 385 of the 447 collected samples were selected, and in 2016, 643 of the 691 collected samples were selected. In 2007, 2008, and 2009, there were 370, 575, and 641 samples collected in the PSTF (respectively), but an additional 180, 150, and 228 samples (respectively) were collected throughout each season during the extra period of sampling and included in annual analyses. After removing samples during the quality control analyses, a final set of 7,588 Chinook salmon sampled in the PSTF from 2005 to 2018 were included in this retrospective MSA, with an average of 542 samples (range = 287–842) included in MSA per year (DeCovich and Templin 2009; DeCovich et al. 2010; DeCovich and Howard 2010, 2011; ADF&G 2021).

The PSTF samples from 2007 and 2018 were re-stratified within a historical context of annual Chinook salmon pulses and total passage past the Pilot Station sonar. Retrospective analysis of the 2005 and 2006 PSTF samples was limited by the original genotypic data and original strata delineations retained (Flannery et al. 2006; Templin et al. 2006c). PSTF samples were originally divided into 4 strata for 2006, 2009, 2017, and 2018, but stratum dates were adjusted for the retrospective analysis to only divide the season into 3 strata for these years, except 2006 (which remained at 4 strata and is therefore excluded from comparative analyses in this report). Similarly, the 2013 season was originally divided into 2 strata, but this year was split into 3 strata for this retrospective reanalysis.

MIXED STOCK ANALYSIS

Reanalysis of the 2005 and 2006 PSTF samples was limited by the available genotypic data; therefore, previously unpublished MSA methods, using microsatellites, were used for analysis

(Tables 3 and 4; Flannery et al. 2006; Templin et al. 2006c). However, the updated MSA was successfully completed for the 2007 to 2018 PSTF samples using archived genotypic data (Tables 5–16). Although previous Pilot Station MSA studies utilized several variations of the Yukon River baseline, this retrospective analysis standardized the use of the 2014 baseline for analysis of 3 strata mixtures per year from 2007 to 2018.

Estimates of stock composition for Chinook salmon passing Pilot Station during each stratum and year were reported by the GCL for country of origin (U.S. and Canada) and broad-scale reporting groups (Lower Yukon, Middle Yukon, and Canada) with summary statistics (Tables 3–16). Total season stock composition estimates were calculated for each year using the country-of-origin and broad-scale reporting groups. Across all years, the Chinook salmon season total from Lower Yukon-origin stocks averaged 32.6% (range = 20.7–42.7%), Middle Yukon-origin stocks averaged 28.0% (range = 16.9–37.8%), U.S.-origin stocks averaged of 60.6% (range = 50.0–68.9%), and Canadian-origin stocks averaged 39.4% (range = 31.1–50.0%; Figure 2). Each portion of the run was characterized by individual strata, which were compared across all years (except 2006, which had 4 strata and was therefore not directly comparable to other years). The first stratum of Chinook salmon passage occurred on average between June 4 and June 19, with average stock composition of 9.2% (range = 4.0–19.2%) Lower Yukon-origin fish, 39.3% (range = 19.2–49.4%) Middle Yukon-origin fish, and 51.5% (range = 40.5–74.4%) Canadian-origin fish (Tables 3 and 5–17, Figure 3). The second stratum of Chinook salmon passage occurred on average between June 20 and June 28 with average composition of 29.2% (range = 17.7–39.5%) Lower Yukon-origin fish, 31.1% (range = 18.5–41.4%) Middle Yukon-origin fish, and 39.6% (range = 33.3–51.7%) Canadian-origin fish (Tables 3 and 5–17, Figure 4). The third stratum of Chinook salmon passage occurred on average between June 29 and August 13 with average composition of 59.1% (36.8–73.1%) Lower Yukon-origin fish, 13.8% (range = 7.2–25.3%) Middle Yukon-origin fish, and 27.1% (range = 15.6–43.5%) Canadian-origin fish (Tables 3 and 5–17, Figure 5).

STOCK-SPECIFIC PASSAGE

Weighted estimates of stock-specific Chinook salmon passage are based on genetic MSA of fish sampled in the test fishery and passage by stratum at the sonar project near Pilot Station. Across all years, the Chinook salmon season total from Lower Yukon-origin stocks averaged 56,672 fish (range = 39,665–77,455), Middle Yukon-origin fish averaged 50,065 (range = 23,073–99,409), U.S.-origin fish averaged of 106,737 (range = 68,468–153,778), and Canadian-origin fish averaged 70,007 (range = 48,711–117,155; Figure 2). Similar to MSA percentage results, each portion of the run was characterized by individual strata, which were compared across all years (except 2006). Samples were stratified postseason, approximating pulses of fish moving past Pilot Station sonar, while still attempting to meet sample size objectives appropriately. The first stratum of Chinook salmon passage averaged 4,336 (range = 1,926–7,852) Lower Yukon-origin fish, 20,501 (range = 11,130–54,332) Middle Yukon-origin fish, and 26,673 (range = 12,951–51,998) Canadian-origin fish (Tables 3 and 5–17, Figure 6). The second stratum averaged 19,318 (range = 8,019–42,253) Lower Yukon-origin fish, 20,715 (range = 4,878–34,472) Middle Yukon-origin fish, and 25,992 (range = 11,673–51,925) Canadian-origin fish (Tables 3 and 5–17, Figure 7). The third stratum averaged 31,820 (range = 16,171–51,891) Lower Yukon-origin fish, 7,871 (range = 3,431–19,524) Middle Yukon-origin fish, and 15,516 (range = 6,725–33,346) Canadian-origin fish (Tables 3 and 5–17, Figure 8).

DISCUSSION

In this report, we present revised annual estimates of Chinook salmon stock composition and stock-specific passage at Pilot Station from 2005 to 2018 by applying standardized MSA methods to archived genetic data. Our retrospective perspective on a historical dataset allowed us to standardize the delineation of temporal inseason strata across years and re-stratify samples within each season, allowing for a better comparison of strata between years.

The original, historical percentages of Canadian-origin Chinook salmon were all within the 90% credibility interval of current estimates based upon the 2014 baseline (Figure 9). However, annual estimates between the 2 analyses varied by ≤4.81%, primarily due to changes to the genetic baseline, genetic methods, and re-stratification of samples. Differences in estimates for 2017 and 2018 were solely a result of re-stratification.

Although 2005 and 2006 Pilot Station stock composition estimates were produced with different methods than the rest of the time series, stock compositions from these years represent appropriate proxies for the stock compositions at Pilot Station during these years. Similarly, 2007 can be considered an appropriate proxy for the 2007 stock composition of Chinook salmon passage at Pilot Station, despite a reduced set of markers used for MSA in this year. However, the revised estimates for 2008 to 2018 presented in this report have greater accuracy and precision than the estimates for 2005 to 2007, due to differences in genetic baselines, genetic marker sets, and MSA methods.

The *Yukon River Panel United States/Canada Joint Technical Committee (JTC) Subcommittee on Stock Identification* has recommended specific criteria for the precision and accuracy of stock composition estimates used for the management of Yukon River Chinook salmon (JTC 1997). The JTC reporting recommendation for MSA that stock composition estimates of 20% or greater should have a CV of 20% or less was not met for all stock composition estimates reported through this reanalysis effort. Country-of-origin estimates that did not meet the JTC guideline included: the 2010 total season estimates, 2013 stratum 1 estimates, and 2018 stratum 3 estimates. Broad-scale estimates that did not meet the JTC guideline included: the 2010 total season and stratum 2 estimates, the 2015 stratum 2 estimates, and the 2017 stratum 2 estimates. For this retrospective analysis, standardized strata and stock reporting groups were prioritized over fulfilling the JTC recommendation for genetic stock composition estimates. This approach reduces missing data in the time series, allowing for more accurate historical comparisons across strata and years. However, the caveat that some estimates used to produce stock-specific passages estimates do not meet the JTC guidelines should be considered if these data are applied to Yukon River fisheries management needs. Stock composition estimates that did not meet this JTC guideline are labeled in Tables 3–16. The strata that did not meet JTC reporting guidelines had lower sample sizes ($n < 150$), which reduces the accuracy and precision of estimates produced with MSA.

The stock composition and stock-specific passages estimates presented here reflect the best available Pilot Station stock composition and stock-specific passage estimates to date. Moreover, this report compiles Pilot Station genetic stock composition estimates into a single published document. Previously, these estimates were spread across numerous external and internal reports. This report provides a valuable time series for Yukon River fisheries stakeholders that can be applied to future research and management needs.

ACKNOWLEDGMENTS

The authors would like to thank Paul Kuriscak, Heather Hoyt, Judy Berger, Eric Lardizabal, and the staff in the Gene Conservation Laboratory for producing high-quality genotypic data. Fred West reviewed drafts, Bobby Hsu provided biometric review, and Zachary Liller provided Region III editorial review.

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TABLES

Table 1.–Single nucleotide polymorphism markers used for this study.

Locus	Source	Locus	Source
Ots_GTH2B-550	Narum et al. 2008	*Ots_SWS1op-182*	Smith et al. 2005a
Ots_NOD1	Narum et al. 2008	*Ots_P450*	Smith et al. 2005b
Ots_E2-275	Smith et al. 2005a	*Ots_P53*	Smith et al. 2005b
Ots_AsnRS-60	Smith et al. 2005a	*Ots_Prl2*	Smith et al. 2005b
Ots_ETIF1A	Narum et al. 2008	*Ots_ins-115*	Smith et al. 2005a
Ots_FARSLA-220	Smith et al. 2007	*Ots_SClkF2R2-135*	Smith et al. 2005a
Ots_FGF6A	Narum et al. 2008	*Ots_SERPC1-209*	Smith et al. 2007
Ots_GH2	Smith et al. 2005b	*Ots_RFC2-558*	Smith et al. 2005a
Ots_GPDH-338	Smith et al. 2005a	*Ots_SL*	Smith et al. 2005b
Ots_GPH-318	Smith et al. 2007	*Ots_TAPBP*	Narum et al. 2008
Ots_GST-207	Smith et al. 2007	*Ots_Tnsf*	Smith et al. 2005b
Ots_hnRNPL-533	Smith et al. 2007	*Ots_u202-161*	Smith et al. 2005a
Ots_HSP90B-385	Smith et al. 2007	*Ots_u211-85*	Smith et al. 2005a
Ots_IGF-I.1-76	Smith et al. 2005a	*Ots_U212-158*	Smith et al. 2005a
Ots_Ikaros-250	Smith et al. 2005a	*Ots_u4-92*	Smith et al. 2005a
Ots_il-1racp-166	Smith et al. 2005a	*Ots_u6-75*	Smith et al. 2005a
Ots_LEI-292	Smith et al. 2007	*Ots_Zp3b-215*	Smith et al. 2005a
Ots_MHC1	Smith et al. 2005b	*Ots_RAG3*	Narum et al. 2008
Ots_MHC2	Smith et al. 2005b	*Ots_S7-1*	Narum et al. 2008
Ots_ZNF330-181	Smith et al. 2005a	*Ots_unkn526*	NWFSC[a]
Ots_LWSop-638	Smith et al. 2005a		

[a] Northwest Fisheries Science Center (NWFSC).

Table 2.–Chinook salmon collections from the Yukon River drainage, organized hierarchically into reporting groups for genetic mixed stock analysis.

Reporting groups					
Country	Broad scale	Fine scale	Population	Year(s) collected	Sample size
U.S.					
	Lower Yukon				
		Lower Yukon			
			Andreafsky River	2003	202
			Anvik River	2007	58
			Nulato River	2012	51
			Kateel River	2002, 2008, 2012	174
			Gisasa River	2001	78
			Tozitna River	2002, 2003	278
	Middle Yukon				
		Koyukuk			
			South Fork Koyukuk River	2003	49
			Henshaw Creek	2001, 2007	180
		Tanana			
			Kantishna River	2005	187
			Chatanika River	2001, 2007	43
			Chena River	2001	176
			Salcha River	2005	188
			Goodpaster River	2006, 2007, 2011	79
		Upper U.S. Yukon			
			Beaver Creek	1997	91
			Chandalar River	2002, 2003, 2004	162
			Sheenjek River	2002, 2004, 2006, 2011	69
			Colleen River	2011	24

-continued-

Table 2.–Page 2 of 2.

Reporting groups					
Country	Broad scale	Fine scale	Population	Year(s) collected	Sample size
Canada					
	Canada				
		Canada			
			Kandik River	2007, 2008, 2009, 2010, 2011	56
			Chandindu River	2001	146
			Klondike River	2001, 2003, 2007, 2010, 2011	144
			Porcupine River - Old Crow	2007	127
			Stewart River	1997, 2007	102
			Mayo River	1997, 2003, 2011	72
			Pelly River	1996, 1997	107
			Blind Creek	2003, 2007, 2008	218
			Tin Cup Creek	2003, 2009, 2010, 2011	132
			Mainstem at Minto	2007	97
			Tatchun Creek	1987, 1997, 2002, 2003	160
			Nordenskiold River	2003	55
			Little Salmon	1987, 1997, 2007, 2010	237
			Big Salmon	1987, 1997, 2007	176
			Nisutlin River	1987, 1997	55
			Teslin River	2007, 2009, 2010, 2011	198
			Morley River	1997, 2002, 2003, 2009, 2010	46
			Takhini River	1997, 2003	96
			Whitehorse Hatchery	1985, 1987, 1997, 2010	303
				Total	4,616

Table 3.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata, 2005.

	Reporting group		Stock composition						Stock-specific passage			
			90% CI						90% CI			
Strata dates and sample size	Country	Broad scale	0.05	0.95	$P = 0$	Mean	SD	CV	0.05	0.95	Mean	SD
Stratum 1	U.S.		36.1	47.8	0.00	43.0	3.4	8.0	31,362	47,187	39,138	4,807
6/04–6/17		Lower Yukon	2.7	9.2	0.00	4.0	2.0	50.5	1,294	6,375	3,628	1,565
N =271		Middle Yukon	30.4	42.2	0.00	39.0	3.6	9.3	28,119	43,302	35,510	4,604
	Canada		52.2	63.9	0.00	57.1	3.4	6.0	43,044	61,158	51,998	5,530
										Total	91,136	
Stratum 2	U.S.		50.5	61.2	0.00	56.4	3.3	5.8	52,289	83,779	67,682	9,503
6/18–7/03		Lower Yukon	30.5	40.9	0.00	35.2	3.2	9.2	31,248	54,230	42,253	6,955
N = 301		Middle Yukon	15.5	25.2	0.00	21.2	2.9	13.6	17,579	34,242	25,429	5,069
	Canada		38.4	48.9	0.00	43.3	3.2	7.5	39,487	65,523	51,925	7,905
										Total	119,607	
Stratum 3	U.S.		64.6	81.7	0.00	72.6	5.2	7.1	9,329	61,914	35,040	15,950
7/04–8/20		Lower Yukon	54.9	72.9	0.00	65.4	5.7	8.7	8,299	56,169	31,574	14,511
N = 99		Middle Yukon	3.4	16.5	0.00	7.2	4.0	55.8	282	8,025	3,466	2,458
	Canada		18.3	35.4	0.00	27.4	5.1	18.8	3,282	25,581	13,231	6,864
										Total	48,271	
Total	U.S.		49.5	59.7	0.00	54.8	3.1	5.7	111,018	173,793	141,860	19,296
6/04–8/20		Lower Yukon	23.1	35.9	0.00	29.9	3.9	13.2	51,572	104,481	77,455	16,229
N = 671		Middle Yukon	20.6	29.7	0.00	24.9	2.8	11.1	52,643	76,890	64,405	7,355
	Canada		40.3	50.5	0.00	45.2	3.1	6.9	98,167	136,869	117,155	11,801
										Total	259,014	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. The 90% credibility interval (CI), probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. The 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. The stock composition mean may not sum to 100% and the stock-specific passage mean may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 4.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata, 2006.

	Reporting group		Stock composition						Stock-specific passage			
			90% CI						90% CI			
Strata dates and sample size	Country	Broad scale	0.05	0.95	$P = 0$	Mean	SD	CV	0.05	0.95	Mean	SD
Stratum 1	U.S.		39.9	57.8	0.00	51.8	5.3	10.3	13,058	26,807	19,669	4,167
6/08–6/20		Lower Yukon	8.7	22.6	1.49	12.1	4.3	35.2	1,946	7,878	4,589	1,833
N =113		Middle Yukon	25.0	43.5	0.00	39.7	5.6	14.1	9,546	21,193	15,080	3,566
	Canada		42.2	60.1	0.00	48.2	5.3	11.1	12,164	25,208	18,317	3,982
										Total	37,986	
Stratum 2	U.S.		47.8	61.5	0.00	56.8	5.5	9.7	40,178	70,635	54,803	9,362
6/21–6/28		Lower Yukon	19.5	32.9	0.00	22.9	2.6	11.3	14,038	31,445	22,134	5,314
N = 186		Middle Yukon	22.2	35.5	0.00	33.8	2.9	8.5	22,332	44,407	32,669	6,720
	Canada		38.5	52.2	0.00	43.3	4.5	10.4	29,531	55,046	41,766	7,733
										Total	96,569	
Stratum 3	U.S.		54.4	71.2	0.00	64.0	5.0	7.8	28,691	45,763	37,070	5,151
6/29–7/03		Lower Yukon	38.1	55.5	0.00	46.5	5.3	11.5	19,633	34,714	26,954	4,604
N = 125		Middle Yukon	9.6	22.8	0.00	17.5	3.9	22.3	5,596	15,356	10,116	2,983
	Canada		28.8	45.6	0.00	36.0	5.0	13.9	14,530	27,963	20,870	4,142
										Total	57,940	
Stratum 4	U.S.		56.7	71.8		64.7	4.6		17,971	29,245	23,479	3,468
7/04–7/26		Lower Yukon	42.3	58.5	0.00	51.2	5.0	9.7	13,647	23,840	18,571	3,107
N = 127		Middle Yukon	7.4	20.1	0.00	13.5	3.9	28.7	2,424	7,808	4,908	1,658
	Canada		28.2	43.3	0.00	35.3	4.6	12.9	8,629	17,326	12,789	2,641
										Total	36,268	
Total	U.S.		53.9	64.1	–	59.0	3.1	5.2	115,714	155,157	135,021	11,978
6/08–8/05		Lower Yukon	26.8	36.4	–	31.6	2.9	9.2	59,603	85,562	72,247	7,884
N = 551		Middle Yukon	22.9	32.1	–	27.4	2.8	10.3	49,450	76,925	62,774	8,327
	Canada		35.9	46.1	–	41.0	3.1	7.5	77,746	110,666	93,742	10,046
										Total	228,763	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. The 90% credibility interval (CI), probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. The 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. The stock composition mean may not sum to 100% and the stock-specific passage mean may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate. An en dash represents *p*-values that could not be calculated for stock composition totals.

Table 5.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2007.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		47.3	37.9	58.6	0.00	47.7	6.3	13.2	23,524	15,431	33,231	23,876	5,496
6/06–6/19		Lower Yukon	7.9	4.3	12.6	0.00	8.1	2.5	31.2	3,880	1,932	6,729	4,076	1,493
$N = 213$		Middle Yukon	39.2	29.4	50.8	0.00	39.5	6.5	16.5	19,439	12,276	28,603	19,800	4,979
	Canada		52.7	41.4	62.1	0.00	52.3	6.3	12.0	25,960	17,033	36,502	26,207	5,979
												Total	50,083	
Stratum 2	U.S.		65.5	55.3	74.8	0.00	65.4	5.9	9.1	40,820	29,487	53,223	41,120	7,189
6/20–6/30		Lower Yukon	27.6	20.6	35.5	0.00	27.7	4.5	16.4	17,152	11,430	24,101	17,456	3,854
$N = 139$		Middle Yukon	37.6	27.4	48.0	0.00	37.6	6.2	16.6	23,267	15,351	32,902	23,664	5,345
	Canada		34.5	25.2	44.7	0.00	34.6	5.9	17.1	21,419	14,187	30,570	21,787	4,987
												Total	62,907	
Stratum 3	U.S.		80.5	73.9	86.7	0.00	80.4	3.9	4.9	46,027	35,224	57,314	46,053	6,718
7/01–8/16		Lower Yukon	73.1	66.9	79.0	0.00	73.1	3.7	5.0	41,804	31,940	51,885	41,832	6,107
$N = 195$		Middle Yukon	7.1	2.9	12.8	0.00	7.4	3.0	41.0	4,009	1,572	7,514	4,221	1,842
	Canada		19.5	13.3	26.1	0.00	19.6	3.9	19.9	11,071	7,018	15,939	11,203	2,749
												Total	57,256	
Total	U.S.		65.2	59.6	70.8	0.00	65.2	3.4	5.2	110,657	92,579	129,859	111,049	11,232
6/06–8/16		Lower Yukon	37.2	32.0	42.7	0.00	37.2	3.3	8.8	63,211	51,417	75,559	63,364	7,314
$N = 547$		Middle Yukon	27.8	22.4	33.7	0.00	28.0	3.5	12.4	47,196	35,824	60,522	47,685	7,572
	Canada		34.8	29.2	40.4	0.00	34.8	3.4	9.8	58,946	46,299	73,450	59,197	8,265
												Total	170,246	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. The stock composition median and mean may not sum to 100% and the stock-specific passage median and mean may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 6.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2008.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		51.2	44.6	64.9	0.00	52.3	6.0	11.5	21,194	16,550	27,839	21,615	3,421
6/01–6/23		Lower Yukon	14.4	10.9	18.5	0.00	14.5	2.3	16.1	5,907	4,201	8,041	6,003	1,170
$N = 321$		Middle Yukon	36.6	30.0	50.5	0.00	37.8	6.1	16.1	15,091	11,378	21,408	15,612	3,031
	Canada		48.8	35.1	55.4	0.00	47.7	6.0	12.6	19,792	13,843	24,916	19,679	3,285
												Total	41,294	
Stratum 2	U.S.		66.7	58.3	75.1	0.00	66.7	5.1	7.7	28,291	21,615	35,632	28,397	4,230
6/24–6/29		Lower Yukon	39.5	32.4	46.9	0.00	39.5	4.4	11.1	16,743	12,408	21,838	16,821	2,867
$N = 153$		Middle Yukon	27.0	19.3	36.0	0.00	27.2	5.1	18.7	11,326	7,664	16,136	11,576	2,621
	Canada		33.3	24.9	41.7	0.00	33.3	5.1	15.4	14,058	9,727	19,153	14,157	2,878
												Total	42,554	
Stratum 3	U.S.		66.4	59.9	72.5	0.00	66.3	3.8	5.8	60,425	47,437	73,978	60,467	8,069
6/30–9/06		Lower Yukon	56.9	50.7	63.1	0.00	56.9	3.8	6.6	51,723	40,578	63,941	51,891	7,120
$N = 218$		Middle Yukon	9.2	5.0	14.3	0.00	9.4	2.8	30.1	8,322	4,393	13,613	8,576	2,814
	Canada		33.6	27.5	40.1	0.00	33.7	3.8	11.3	30,570	22,828	39,532	30,731	5,084
												Total	91,198	
Total	U.S.		63.0	58.5	67.9	0.00	63.1	2.8	4.5	110,434	94,734	126,797	110,478	9,761
6/01–9/06		Lower Yukon	42.6	38.5	47.0	0.00	42.7	2.6	6.1	74,577	62,217	87,933	74,715	7,773
$N = 692$		Middle Yukon	20.3	16.4	24.9	0.00	20.4	2.6	12.7	35,396	28,068	44,296	35,763	4,952
	Canada		37.0	32.1	41.5	0.00	36.9	2.8	7.7	64,559	53,559	75,956	64,568	6,759
												Total	175,046	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) is shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 7.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2009.

	Reporting group		Stock composition							Stock-specific passage				
Strata dates and				90% CI							90% CI			
sample size	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		51.9	44.2	58.9	0.00	51.8	4.5	8.6	17,699	13,908	21,757	17,739	2,391
6/09–6/22		Lower Yukon	12.4	9.2	16.2	0.00	12.5	2.1	17.0	4,235	2,950	5,782	4,288	861
$N = 424$		Middle Yukon	39.4	31.6	46.6	0.00	39.3	4.6	11.7	13,419	10,099	16,945	13,451	2,089
	Canada		48.1	41.1	55.8	0.00	48.2	4.5	9.3	16,418	12,880	20,483	16,490	2,321
												Total	34,229	
Stratum 2	U.S.		65.0	57.3	71.8	0.00	64.8	4.4	6.8	54,196	43,360	66,008	54,376	6,866
6/23–6/29		Lower Yukon	26.8	20.7	33.3	0.00	26.8	3.8	14.3	22,310	16,280	29,483	22,518	3,999
$N = 273$		Middle Yukon	38.0	30.2	45.7	0.00	38.0	4.7	12.4	31,606	23,734	40,967	31,858	5,215
	Canada		35.0	28.2	42.7	0.00	35.2	4.4	12.6	29,222	22,052	37,906	29,490	4,831
												Total	83,866	
Stratum 3	U.S.		84.5	78.2	89.9	0.00	84.4	3.6	4.2	49,971	32,328	68,427	50,366	10,980
6/30–7/31		Lower Yukon	68.7	61.3	75.5	0.00	68.6	4.3	6.3	40,644	26,070	56,127	40,948	9,132
$N = 145$		Middle Yukon	15.6	9.8	22.4	0.00	15.8	3.8	24.4	9,017	4,933	14,883	9,418	3,079
	Canada		15.5	10.1	21.8	0.00	15.6	3.6	22.7	9,025	4,984	14,594	9,335	2,942
												Total	59,701	
Total	U.S.		68.9	63.9	73.3	0.00	68.9	2.8	4.1	122,025	101,002	143,898	122,481	13,012
6/09–7/31		Lower Yukon	38.0	32.4	43.4	0.00	38.1	3.4	8.8	67,439	51,376	84,006	67,753	9,930
$N = 842$		Middle Yukon	30.8	26.1	36.0	0.00	30.8	3.0	9.7	54,418	44,604	65,694	54,728	6,398
	Canada		31.1	26.7	36.1	0.00	31.1	2.8	0.1	55,100	45,806	65,603	55,315	6,068
												Total	177,796	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) is shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 8.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2010.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		46.9	35.9	58.8	0.00	47.1	7.0	14.8	13,440	9,364	18,448	13,604	2,772
6/12–6/21		Lower Yukon	6.2	2.2	12.7	0.00	6.7	3.3	49.1	1,769	623	3,847	1,926	996
$N = 99$		Middle Yukon	40.2	29.0	52.5	0.00	40.4	7.2	17.7	11,489	7,652	16,220	11,678	2,621
	Canada		53.1	41.2	64.1	0.00	52.9	7.0	13.2	15,175	10,616	20,375	15,281	2,964
												Total	28,885	
Stratum 2	U.S.		48.2	38.1	58.7	0.00	48.3	6.3	13.0	21,609	14,683	29,930	21,864	4,647
6/22–6/27		Lower Yukon [a]	17.1	10.0	27.4	0.00	17.7	5.4	30.2	7,648	4,126	13,118	8,019	2,770
$N = 132$		Middle Yukon [a]	30.3	19.5	42.3	0.00	30.6	6.9	22.7	13,552	7,932	20,899	13,845	3,914
	Canada		51.8	41.3	61.9	0.00	51.7	6.3	12.1	23,237	15,918	31,705	23,442	4,835
												Total	45,306	
Stratum 3	U.S.		72.8	65.4	79.4	0.00	72.6	4.3	5.9	46,031	2,045	89,775	46,273	26,789
6/28–9/05		Lower Yukon	47.3	38.8	56.0	0.00	47.4	5.2	11.0	29,553	1,291	59,350	30,167	17,680
$N = 143$		Middle Yukon	25.1	17.5	33.7	0.00	25.3	4.9	19.6	15,446	688	33,532	16,106	10,019
	Canada		27.2	20.6	34.6	0.00	27.4	4.3	15.6	16,870	743	34,774	17,435	10,489
												Total	63,708	
Total	U.S.[a]		59.0	47.2	66.0	0.00	59.3	15.0	25.4	81,507	36,413	126,580	81,740	27,400
6/12 –9/05		Lower Yukon [a]	28.5	13.8	37.0	0.00	29.1	23.1	79.4	39,685	10,844	69,825	40,112	17,948
$N = 374$		Middle Yukon [a]	30.4	24.4	37.8	0.00	30.2	9.6	31.7	41,125	24,127	60,753	41,629	11,091
	Canada[a]		41.0	34.0	52.8	0.00	40.7	15.0	36.9	55,616	36,951	76,113	56,159	11,970
												Total	137,899	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

[a] Denotes where estimates did not meet the 20/20 rule, which requires that stock composition estimates of 20% or greater will have a CV of 20% or less.

Table 9.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2011.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		44.7	36.4	53.9	0.00	44.9	5.3	11.8	13,869	9,398	19,271	14,028	3,031
6/01–6/18		Lower Yukon	9.1	5.4	13.8	0.00	9.3	2.6	27.7	2,794	1,505	4,692	2,897	971
$N = 190$		Middle Yukon	35.4	27.2	44.6	0.00	35.6	5.3	14.9	10,983	7,182	15,786	11,130	2,609
	Canada		55.3	46.1	63.6	0.00	55.1	5.3	9.6	17,083	11,604	23,208	17,245	3,515
												Total	31,273	
Stratum 2	U.S.		65.1	57.4	72.5	0.00	65.0	4.6	7.0	43,860	32,873	55,661	44,023	6,925
6/19–6/27		Lower Yukon	32.9	26.7	39.5	0.00	33.0	3.9	11.8	22,147	15,978	29,431	22,347	4,107
$N = 195$		Middle Yukon	31.9	24.2	40.2	0.00	32.0	4.8	15.1	21,484	14,768	29,351	21,676	4,473
	Canada		34.9	27.5	42.6	0.00	35.0	4.6	13.1	23,460	16,473	31,701	23,663	4,615
												Total	67,686	
Stratum 3	U.S.		84.5	78.9	89.3	0.00	84.3	3.2	3.8	41,985	34,183	49,913	42,035	4,764
6/28–8/07		Lower Yukon	72.9	65.5	79.8	0.00	72.8	4.4	6.0	36,120	29,097	43,729	36,273	4,454
$N = 177$		Middle Yukon	11.4	6.1	17.7	0.00	11.6	3.6	30.8	5,635	2,974	9,030	5,762	1,859
	Canada		15.5	10.7	21.1	0.00	15.7	3.2	20.2	7,658	5,044	10,998	7,803	1,826
												Total	49,838	
Total	U.S.		67.3	62.6	71.9	0.00	67.3	2.8	4.2	99,949	85,680	115,108	100,086	9,001
6/01–8/07		Lower Yukon	41.3	36.7	46.3	0.00	41.3	2.9	7.1	61,379	51,659	71,815	61,517	6,165
$N = 562$		Middle Yukon	25.9	21.4	30.6	0.00	25.9	2.8	11.0	38,412	29,882	48,099	38,568	5,516
	Canada		32.7	28.1	37.4	0.00	32.7	2.8	8.6	48,405	38,871	59,094	48,711	6,113
												Total	148,797	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 10.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2012.

	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
Strata dates and sample size	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		59.6	48.5	70.4	0.00	59.5	6.6	11.2	18,864	12,647	25,873	19,047	4,008
6/10–6/24		Lower Yukon	19.0	12.6	26.5	0.00	19.2	4.2	22.1	5,972	3,540	9,376	6,135	1,778
$N = 139$		Middle Yukon	40.3	29.2	51.8	0.00	40.4	6.9	17.1	12,675	7,963	18,356	12,912	3,182
	Canada		40.4	29.6	51.5	0.00	40.5	6.6	16.4	12,759	8,136	18,469	12,951	3,171
												Total	31,998	
Stratum 2	U.S.		55.7	48.4	62.9	0.00	55.7	4.4	8.0	35,409	27,595	44,042	35,456	4,955
6/25–7/02		Lower Yukon	27.2	21.4	33.4	0.00	27.3	3.7	13.4	17,235	12,541	22,632	17,359	3,091
$N = 196$		Middle Yukon	28.3	21.4	35.8	0.00	28.4	4.4	15.5	17,915	12,844	24,214	18,097	3,485
	Canada		44.3	37.1	51.6	0.00	44.3	4.4	10.0	27,951	21,366	35,523	28,192	4,311
												Total	63,648	
Stratum 3	U.S.		67.8	59.1	75.9	0.00	67.7	5.1	7.5	21,537	14,158	29,431	21,591	4,651
7/03–7/30		Lower Yukon	50.7	41.9	59.6	0.00	50.7	5.4	10.6	16,071	10,420	22,538	16,171	3,691
$N = 107$		Middle Yukon	16.7	10.3	24.5	0.00	17.0	4.3	25.4	5,225	2,916	8,691	5,420	1,783
	Canada		32.2	24.1	40.9	0.00	32.3	5.1	15.7	10,155	6,277	14,940	10,318	2,670
												Total	31,909	
Total	U.S.		59.7	54.6	64.8	0.00	59.7	3.1	5.2	76,007	63,393	89,286	76,094	7,850
6/10–7/30		Lower Yukon	31.0	26.5	35.8	0.00	31.1	2.8	8.9	39,575	31,448	48,334	39,665	5,112
$N = 442$		Middle Yukon	28.5	23.6	33.7	0.00	28.6	3.1	10.9	36,236	28,458	45,110	36,430	5,046
	Canada		40.3	35.2	45.4	0.00	40.3	3.1	7.7	51,223	41,928	61,477	51,461	5,977
												Total	127,555	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 11.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2013.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
	Country	Broad scale	Median	90% CI 0.05	90% CI 0.95	$P = 0$	Mean	SD	CV	Median	90% CI 0.05	90% CI 0.95	Mean	SD
Stratum 1	U.S.[a]		25.3	16.7	35.3	0.00	25.6	5.7	22.1	16,058	9,157	25,570	16,586	5,027
6/14–6/24		Lower Yukon	6.1	2.4	11.7	0.00	6.4	2.9	44.8	3,853	1,422	8,137	4,166	2,092
$N = 127$		Middle Yukon	18.9	10.2	29.1	0.00	19.2	5.8	30.3	11,801	5,706	20,699	12,421	4,626
	Canada[a]		74.7	64.7	83.3	0.00	74.4	5.7	7.6	48,164	30,992	66,328	48,244	10,625
												Total	64,830	
Stratum 2	U.S.		55.6	43.4	68.3	0.00	55.7	7.5	13.5	14,569	10,213	19,682	14,689	2,898
6/25–7/01		Lower Yukon	37.0	26.7	48.3	0.00	37.2	6.6	17.7	9,641	6,359	13,791	9,812	2,260
$N = 67$		Middle Yukon	17.9	8.6	30.4	0.00	18.5	6.6	35.9	4,685	2,194	8,374	4,878	1,885
	Canada		44.4	31.7	56.6	0.00	44.3	7.5	17.0	11,581	7,599	16,256	11,673	2,637
												Total	26,362	
Stratum 3	U.S.		81.8	73.8	88.4	0.00	81.5	4.5	5.5	37,138	18,148	57,148	37,192	11,944
7/02–8/02		Lower Yukon	69.0	59.3	77.9	0.00	68.9	5.6	8.2	31,314	15,204	48,514	31,417	10,268
$N = 93$		Middle Yukon	12.3	5.9	20.8	0.00	12.7	4.5	35.9	5,356	2,017	11,151	5,775	2,873
	Canada		18.2	11.6	26.2	0.00	18.5	4.5	24.1	8,098	3,533	14,449	8,421	3,369
												Total	45,613	
Total	U.S.		50.0	40.8	58.6	0.00	50.0	5.5	11.0	68,263	47,418	90,467	68,468	13,116
6/14–8/02		Lower Yukon	33.1	24.0	42.1	0.00	33.2	5.5	16.7	45,428	28,334	63,152	45,394	10,661
$N = 287$		Middle Yukon	16.6	11.3	23.0	0.00	16.9	3.6	21.1	22,520	14,398	33,301	23,073	5,767
	Canada		50.0	41.4	59.2	0.00	50.0	5.5	11.0	68,197	49,955	87,749	68,337	11,511
												Total	136,805	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

[a] Denotes where estimates did not meet the 20/20 rule, which requires that stock composition estimates of 20% or greater will have a CV of 20% or less.

Table 12.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2014.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		50.2	40.5	61.0	0.00	50.4	6.3	12.4	22,543	15,535	30,820	22,786	4,604
6/03–6/14		Lower Yukon	9.0	4.5	15.1	0.00	9.3	3.3	35.1	4,015	1,871	7,153	4,200	1,645
$N = 158$		Middle Yukon	40.8	31.0	52.2	0.00	41.1	6.4	15.7	18,279	12,153	25,869	18,586	4,169
	Canada		49.8	39.0	59.5	0.00	49.6	6.3	12.6	22,330	15,227	30,270	22,450	4,579
												Total	45,236	
Stratum 2	U.S.		58.4	51.1	65.6	0.00	58.4	4.4	7.6	47,846	38,640	57,718	47,948	5,789
6/15–6/24		Lower Yukon	32.1	26.4	38.2	0.00	32.2	3.6	11.1	26,318	20,406	32,922	26,431	3,811
$N = 218$		Middle Yukon	26.1	19.1	33.6	0.00	26.2	4.4	16.8	21,350	15,101	28,444	21,517	4,134
	Canada		41.6	34.4	48.9	0.00	41.6	4.4	10.6	34,105	26,584	42,648	34,198	4,888
												Total	82,146	
Stratum 3	U.S.		81.8	74.5	87.9	0.00	81.6	4.1	5.0	29,712	23,170	36,353	29,788	4,030
6/25–8/04		Lower Yukon	67.5	58.8	75.5	0.00	67.4	5.1	7.5	24,514	18,765	30,566	24,599	3,602
$N = 115$		Middle Yukon	14.0	8.0	21.4	0.00	14.2	4.1	28.7	4,986	2,796	8,125	5,189	1,646
	Canada		18.2	12.1	25.5	0.00	18.4	4.1	22.2	6,575	4,179	9,802	6,725	1,730
												Total	36,513	
Total	U.S.		61.3	56.2	66.4	0.00	61.3	3.1	5.0	100,344	86,602	114,476	100,522	8,431
6/03–8/04		Lower Yukon	33.7	29.2	38.2	0.00	33.7	2.7	8.1	55,052	46,338	64,674	55,230	5,547
$N = 491$		Middle Yukon	27.5	22.6	32.8	0.00	27.6	3.1	11.1	45,033	35,702	55,714	45,292	6,096
	Canada		38.7	33.6	43.8	0.00	38.7	3.1	8.0	63,368	52,483	75,259	63,373	6,904
												Total	163,895	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 13.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2015.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		50.7	41.7	59.9	0.00	50.8	5.5	10.8	15,451	10,981	20,603	15,539	2,953
5/30–6/17		Lower Yukon	6.9	3.3	12.0	0.00	7.2	2.7	37.0	2,093	959	3,843	2,211	902
$N = 139$		Middle Yukon	43.4	34.5	52.9	0.00	43.6	5.6	12.8	13,219	9,292	18,045	13,328	2,697
	Canada		49.3	40.1	58.3	0.00	49.2	5.5	11.2	15,047	10,550	20,060	15,061	2,906
												Total	30,600	
Stratum 2	U.S.		63.4	54.2	72.6	0.00	63.4	5.6	8.9	32,411	19,203	46,779	32,436	8,385
6/18–6/26		Lower Yukon[a]	21.8	14.6	30.2	0.00	22.0	4.7	21.6	10,936	5,797	17,910	11,253	3,710
$N = 137$		Middle Yukon[a]	41.3	30.7	52.7	0.00	41.4	6.7	16.2	20,908	11,791	32,323	21,183	6,214
	Canada		36.6	27.4	45.8	0.00	36.6	5.6	15.3	18,580	10,640	28,363	18,736	5,449
												Total	51,172	
Stratum 3	U.S.		67.4	57.8	75.9	0.00	67.2	5.5	8.2	43,312	28,073	60,216	43,735	9,734
6/27–8/17		Lower Yukon	50.5	41.2	59.7	0.00	50.5	5.6	11.1	32,501	20,553	45,977	32,862	7,760
$N = 104$		Middle Yukon	16.4	9.2	25.2	0.00	16.7	4.9	29.3	10,398	5,191	17,790	10,873	3,894
	Canada		32.6	24.1	42.2	0.00	32.8	5.5	16.8	20,923	12,744	31,584	21,352	5,747
												Total	65,087	
Total	U.S.		62.4	56.6	67.8	0.00	62.4	3.4	5.5	91,505	70,479	114,071	91,710	13,194
5/30–8/17		Lower Yukon	31.4	25.4	37.5	0.00	31.5	3.7	11.8	46,043	32,698	61,008	46,326	8,635
$N = 380$		Middle Yukon	30.9	24.9	37.4	0.00	30.9	3.8	12.3	45,114	33,273	59,004	45,384	7,819
	Canada		37.6	32.2	43.4	0.00	37.6	3.4	9.1	55,005	41,774	69,758	55,149	8,459
												Total	146,859	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

[a] Denotes where estimates did not meet the 20/20 rule, which requires that stock composition estimates of 20% or greater will have a CV of 20% or less.

Table 14.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2016.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		48.4	40.6	56.4	0.00	48.4	4.8	9.9	18,004	13,315	23,462	18,157	3,114
5/30–6/14		Lower Yukon	6.7	3.1	11.4	0.00	6.9	2.5	36.6	2,485	1,106	4,447	2,583	1,024
N = 178		Middle Yukon	41.5	33.4	49.9	0.00	41.5	5.0	12.1	15,375	11,179	20,504	15,575	2,882
	Canada		51.6	43.6	59.4	0.00	51.6	4.8	9.3	19,235	14,207	25,031	19,354	3,255
												Total	37,511	
Stratum 2	U.S.		65.5	58.8	73.3	0.00	65.7	4.4	6.6	56,662	46,599	68,195	56,944	6,528
6/15–6/25		Lower Yukon	25.7	20.3	32.2	0.00	25.9	3.6	14.0	22,275	16,770	29,216	22,472	3,815
N = 284		Middle Yukon	39.6	32.1	48.1	0.00	39.8	4.9	12.2	34,210	26,185	43,627	34,472	5,323
	Canada		34.5	26.7	41.2	0.00	34.3	4.4	12.8	29,569	22,102	37,578	29,678	4,675
												Total	86,622	
Stratum 3	U.S.		56.5	48.5	64.3	0.00	56.5	4.8	8.5	29,696	23,141	36,817	29,816	4,183
6/26–8/24		Lower Yukon	47.8	40.1	55.6	0.00	47.9	4.7	9.9	25,083	19,239	31,594	25,251	3,765
N = 147		Middle Yukon	8.3	4.1	14.2	0.00	8.7	3.1	36.0	4,334	2,107	7,784	4,565	1,746
	Canada		43.5	35.7	51.5	0.00	43.5	4.8	11.0	22,772	17,273	29,118	22,949	3,608
												Total	52,765	
Total	U.S.		59.3	54.8	64.1	0.00	59.3	2.8	4.8	104,611	91,638	119,290	104,917	8,375
5/30–8/24		Lower Yukon	28.4	24.5	32.7	0.00	28.4	2.5	8.8	50,129	41,750	59,645	50,305	5,462
N = 609		Middle Yukon	30.8	26.1	35.8	0.00	30.9	2.9	9.5	54,246	44,735	65,517	54,612	6,287
	Canada		40.7	35.9	45.2	0.00	40.7	2.8	7.0	71,828	61,013	83,246	71,981	6,743
												Total	176,898	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

Table 15.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2017.

	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
Strata dates and sample size	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		56.7	47.7	64.9	0.00	56.5	5.2	9.2	62,097	48,203	76,918	62,184	8,700
5/31–6/20		Lower Yukon	7.0	4.0	10.7	0.00	7.1	2.1	29.0	7,684	4,301	12,114	7,852	2,411
N = 279		Middle Yukon	49.5	40.4	58.0	0.00	49.4	5.3	10.8	54,175	41,459	68,292	54,332	8,196
	Canada		43.3	35.1	52.3	0.00	43.5	5.2	12.0	47,485	35,880	61,095	47,817	7,634
												Total	110,001	
Stratum 2	U.S.		59.6	49.6	69.3	0.00	59.5	6.0	10.1	41,187	29,871	53,762	41,320	7,288
6/21–6/25		Lower Yukon[a]	22.4	14.3	32.0	0.00	22.7	5.4	23.6	15,386	9,263	23,629	15,765	4,409
N = 115		Middle Yukon[a]	36.7	26.1	48.0	0.00	36.8	6.7	18.1	25,279	16,476	36,205	25,554	5,995
	Canada		40.4	30.7	50.4	0.00	40.5	6.0	14.9	27,708	18,877	38,100	28,072	5,878
												Total	69,392	
Stratum 3	U.S.		60.1	53.2	66.9	0.00	60.1	4.2	6.9	50,148	40,021	61,253	50,275	6,353
6/26–8/11		Lower Yukon	36.7	30.3	43.5	0.00	36.8	4.0	10.9	30,545	23,365	38,910	30,751	4,717
N = 192		Middle Yukon	23.2	17.3	30.0	0.00	23.3	3.8	16.5	19,327	13,712	26,121	19,524	3,790
	Canada		39.9	33.1	46.8	0.00	39.9	4.2	10.5	33,143	25,679	41,693	33,346	4,937
												Total	83,621	
Total	U.S.		58.6	53.5	63.3	0.00	58.5	3.0	5.2	153,678	132,890	175,489	153,778	12,959
5/31–8/11		Lower Yukon	20.6	17.0	24.5	0.00	20.7	2.3	10.9	54,082	43,636	66,213	54,369	6,877
N = 586		Middle Yukon	37.8	32.6	43.1	0.00	37.8	3.2	8.4	99,220	82,155	117,858	99,409	10,798
	Canada		41.4	36.7	46.5	0.00	41.5	3.0	7.3	108,865	92,062	127,606	109,236	10,901
												Total	263,014	

Note: The number of samples (*N*) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

[a] Denotes where estimates did not meet the 20/20 rule, which requires that stock composition estimates of 20% or greater will have a CV of 20% or less.

Table 16.–Stock composition (%) and stock-specific passage (number of fish) estimates of Yukon River Chinook salmon at Pilot Station sonar by temporal strata and reporting group, 2018.

Strata dates and sample size	Reporting group		Stock composition							Stock-specific passage				
				90% CI							90% CI			
	Country	Broad scale	Median	0.05	0.95	$P = 0$	Mean	SD	CV	Median	0.05	0.95	Mean	SD
Stratum 1	U.S.		53.1	45.2	61.6	0.00	53.2	5.0	9.4	38,345	30,905	47,010	38,578	4,876
6/02–6/24		Lower Yukon	8.7	5.5	12.5	0.00	8.8	2.1	24.3	6,256	3,939	9,331	6,405	1,657
N:290		Middle Yukon	44.2	36.2	52.9	0.00	44.3	5.1	11.5	31,976	25,019	40,025	32,174	4,597
	Canada		46.9	38.4	54.8	0.00	46.8	5.0	10.6	33,904	26,600	42,012	33,967	4,649
												Total	72,545	
Stratum 2	U.S.		59.9	52.5	67.2	0.00	59.9	4.5	7.5	34,076	25,730	43,043	34,181	5,241
6/25–7/03		Lower Yukon	32.5	25.5	40.2	0.00	32.6	4.5	13.7	18,451	13,039	24,843	18,632	3,617
N:175		Middle Yukon	27.1	19.8	35.1	0.00	27.2	4.7	17.1	15,342	10,363	21,424	15,549	3,389
	Canada		40.1	32.8	47.5	0.00	40.1	4.5	11.2	22,689	16,509	29,970	22,889	4,047
												Total	57,070	
Stratum 3	U.S.[a]		72.6	62.5	82.0	0.00	72.5	5.9	8.2	23,151	9,738	37,783	23,352	8,559
7/04–8/05		Lower Yukon	61.9	52.4	71.1	0.00	61.8	5.7	9.2	19,819	8,228	32,393	19,921	7,378
N:89		Middle Yukon	10.2	3.6	19.1	0.00	10.6	4.7	44.3	3,075	813	7,260	3,431	2,021
	Canada[a]		27.4	18.0	37.5	0.00	27.5	5.9	21.6	8,541	3,327	15,424	8,864	3,740
												Total	32,216	
Total	U.S.		59.3	54.1	64.6	0.00	59.4	3.2	5.4	96,103	78,172	115,016	96,111	11,181
6/02–8/05		Lower Yukon	27.7	22.0	33.2	0.00	27.8	3.4	12.3	44,793	31,614	59,258	44,958	8,439
N:554		Middle Yukon	31.6	26.2	37.5	0.00	31.6	3.5	11.0	50,891	41,466	61,477	51,153	6,075
	Canada		40.7	35.4	45.9	0.00	40.6	3.2	7.9	65,594	54,259	77,800	65,720	7,164
												Total	161,831	

Note: The number of samples (N) used to estimate stock composition is provided for each stratum. Median, 90% credibility interval (CI), the probability that the group estimate is equal to zero ($P = 0$), mean, standard deviation (SD), and coefficient of variation (CV) are shown for stock composition. Median, 90% credibility interval (CI), mean, and standard deviation (SD) are shown for stock-specific passage. Stock composition medians and means may not sum to 100% and stock-specific passage medians and means may not sum to the total passage due to rounding error. Annual estimates of stock-specific passage are weighted by and incorporate uncertainty associated with each stratum-specific passage estimate.

[a] Denotes where estimates did not meet the 20/20 rule, which requires that stock composition estimates of 20% or greater will have a CV of 20% or less.

Table 17.–Summary of the number of Yukon River Chinook salmon that passed the Pilot Station sonar by stratum, 2005–2018.

Year	Strata	Dates	Pilot Station sonar passage	Percent composition of run
2005	Stratum 1	06/04–06/17	91,136	35.2
	Stratum 2	06/18–07/03	119,607	46.2
	Stratum 3	07/04–08/20	48,271	18.6
	Total	06/04–08/20	259,014	100.0
2006	Stratum 1	06/08–06/20	37,986	16.6
	Stratum 2	06/21–06/28	96,569	42.2
	Stratum 3	06/29–07/03	57,940	25.3
	Stratum 4	07/04–07/26	36,268	15.9
	Total		228,763	100.0
2007	Stratum 1	06/06–06/19	50,083	29.4
	Stratum 2	06/20–06/30	62,907	37.0
	Stratum 3	07/01–08/16	57,256	33.6
	Total		170,246	100.0
2008	Stratum 1	06/01–06/23	41,294	23.6
	Stratum 2	06/24–06/29	42,554	24.3
	Stratum 3	06/30–09/06	91,198	52.1
	Total		175,046	100.0
2009	Stratum 1	06/09–06/22	34,229	19.3
	Stratum 2	06/23–06/29	83,866	47.2
	Stratum 3	06/30–07/31	59,701	33.6
	Total		177,796	100.0
2010	Stratum 1	06/12–06/21	28,885	20.9
	Stratum 2	06/22–06/27	45,306	32.9
	Stratum 3	06/28–09/05	63,708	46.2
	Total		137,899	100.0
2011	Stratum 1	06/01–06/18	31,273	21.0
	Stratum 2	06/19–06/27	67,686	45.5
	Stratum 3	06/28–08/07	49,838	33.5
	Total		148,797	100.0
2012	Stratum 1	06/10–06/24	31,998	25.1
	Stratum 2	06/25–07/02	63,648	49.9
	Stratum 3	07/03–07/30	31,909	25.0
	Total		127,555	100.0
2013	Stratum 1	06/14–06/24	64,830	47.4
	Stratum 2	06/25–07/01	26,362	19.3
	Stratum 3	07/02–08/02	45,613	33.3
	Total		136,805	100.0

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Table 17.–Page 2 of 2.

Year	Strata	Dates	Pilot Station passage	Percent composition of run
2014	Stratum 1	06/03–06/14	45,236	27.6
	Stratum 2	06/15–06/24	82,146	50.1
	Stratum 3	06/25–08/04	36,513	22.3
	Total		163,895	100.0
2015	Stratum 1	05/30–06/17	30,600	20.8
	Stratum 2	06/18–06/26	51,172	34.8
	Stratum 3	06/27–08/17	65,087	44.3
	Total		146,859	100.0
2016	Stratum 1	05/30–06/14	37,511	21.2
	Stratum 2	06/15–06/25	86,622	49.0
	Stratum 3	06/26–08/24	52,765	29.8
	Total		176,898	100.0
2017	Stratum 1	05/31–06/20	110,001	41.8
	Stratum 2	06/21–06/25	69,392	26.4
	Stratum 3	06/26–08/11	83,621	31.8
	Total		263,014	100.0
2018	Stratum 1	06/02–06/24	72,545	44.8
	Stratum 2	06/25–07/03	57,070	35.3
	Stratum 3	07/04–08/05	32,216	19.9
	Total		161,831	100.0
2005–2018 Average [a]				
	Stratum 1	06/04–06/19	51,509	29.1
	Stratum 2	06/20–06/28	66,026	38.3
	Stratum 3	06/29–08/13	55,207	32.6
	Total		176,744	100.0

[a] Stratum averages do not include 2006.

FIGURES

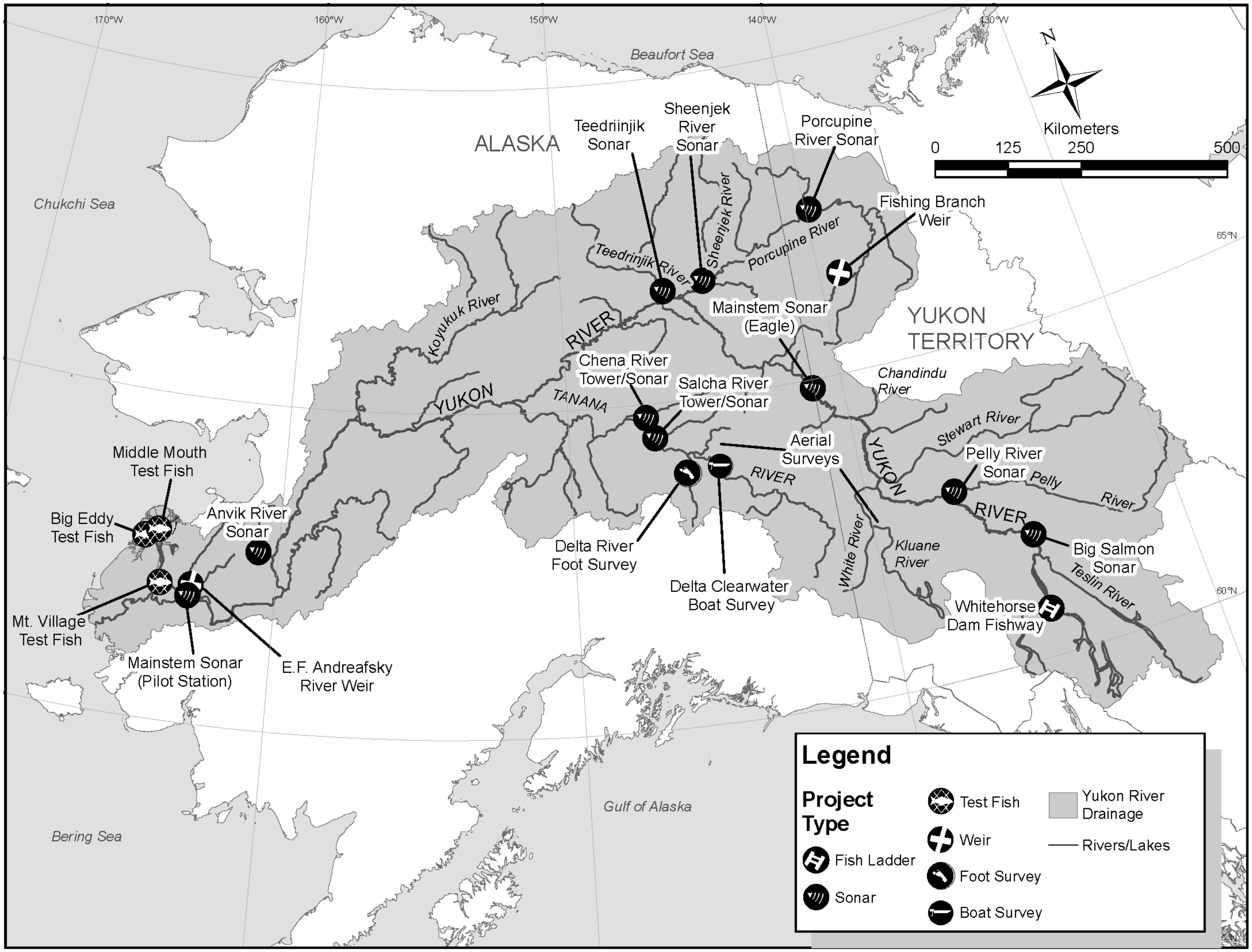

Figure 1.–The Alaska portion of the Yukon River and the location of assessment projects.

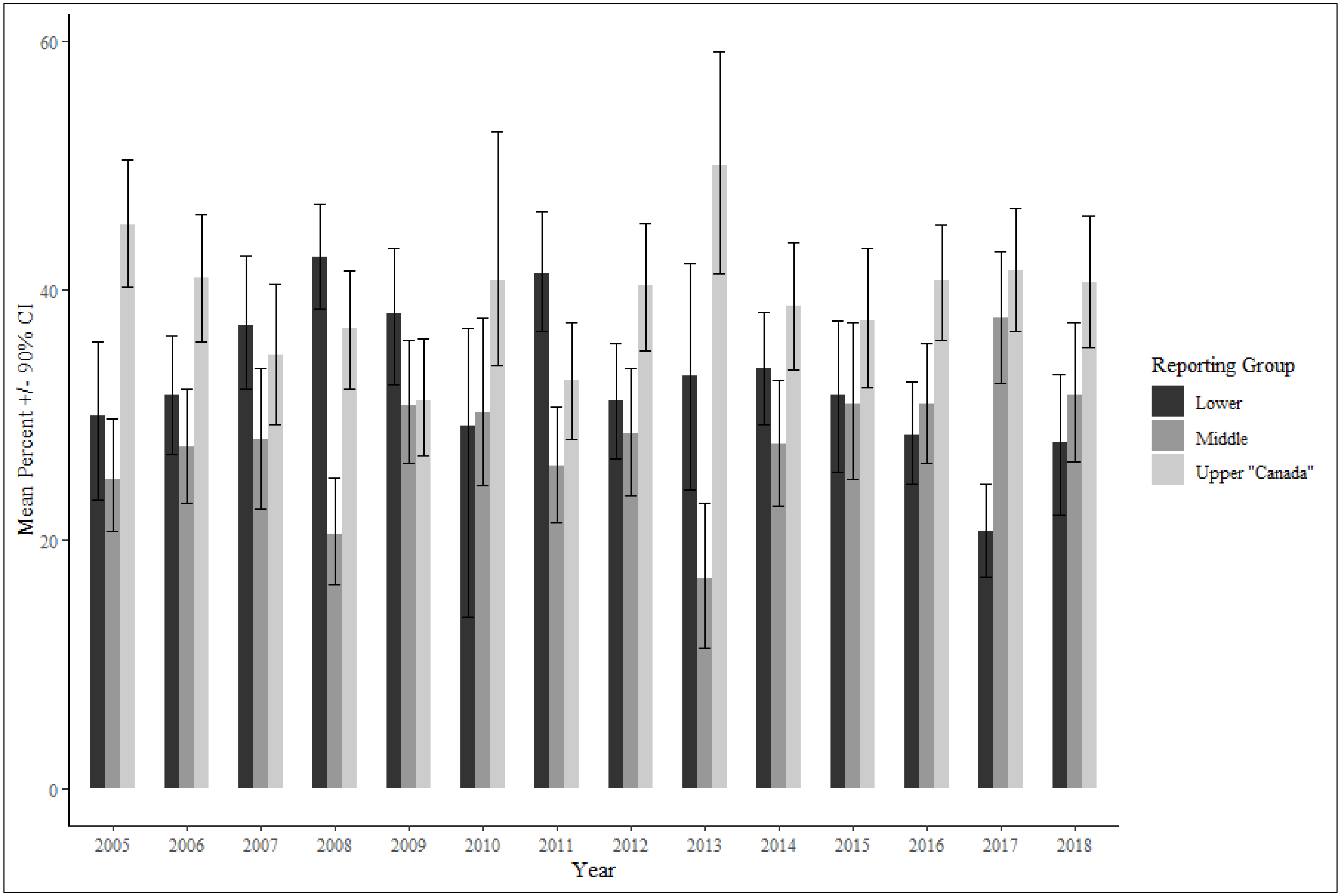

Figure 2.–Retrospective percentages of Yukon River Chinook salmon, 90% CI (credibility interval), by broad-scale genetic reporting group, as determined at Pilot Station sonar, 2005–2018.

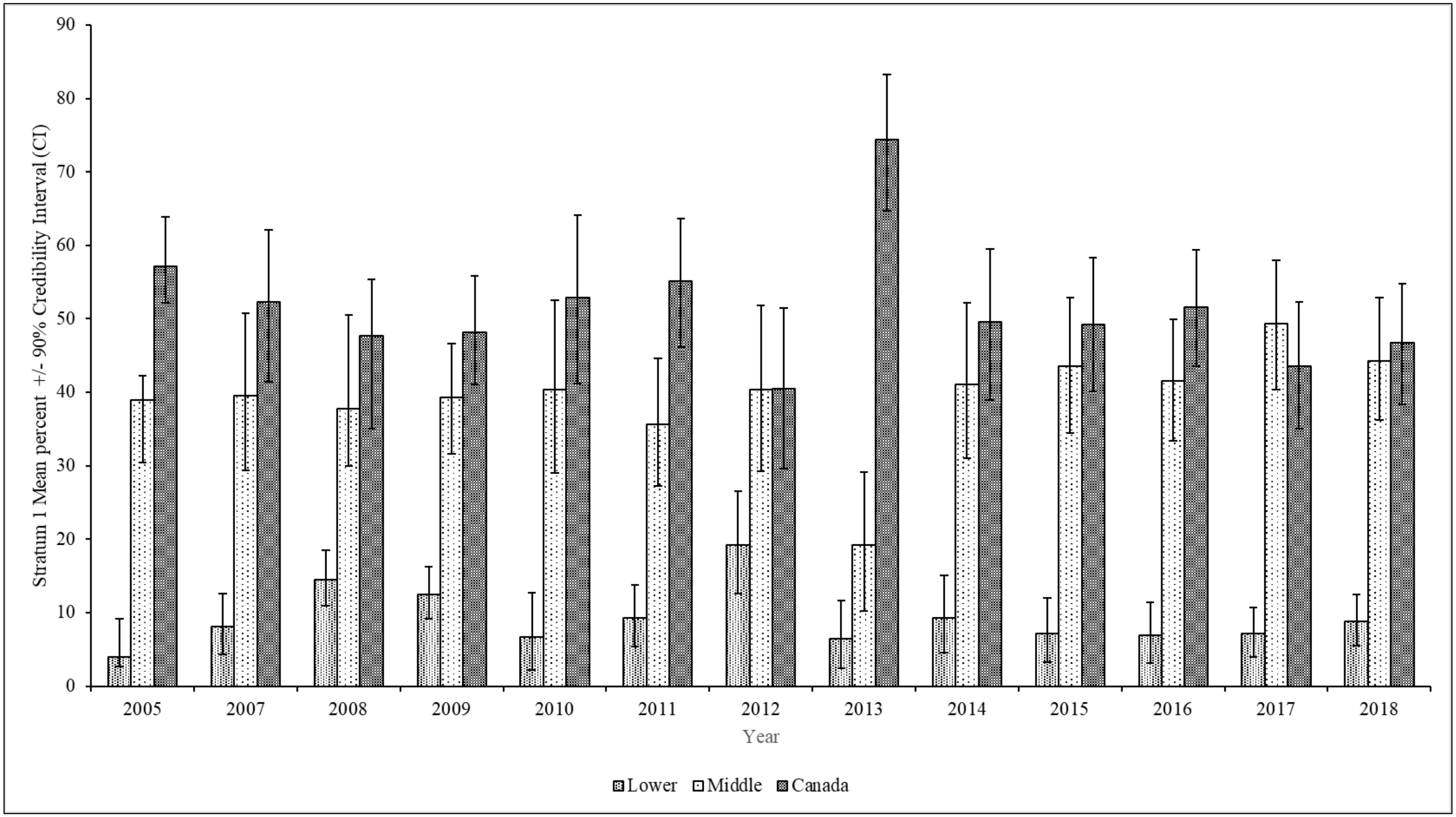

Figure 3.–Comparison of stratum 1 mean percent Chinook salmon (90% credibility interval [CI]) by origin using updated baseline for broad-scale reporting at Pilot Station sonar, 2005–2018.

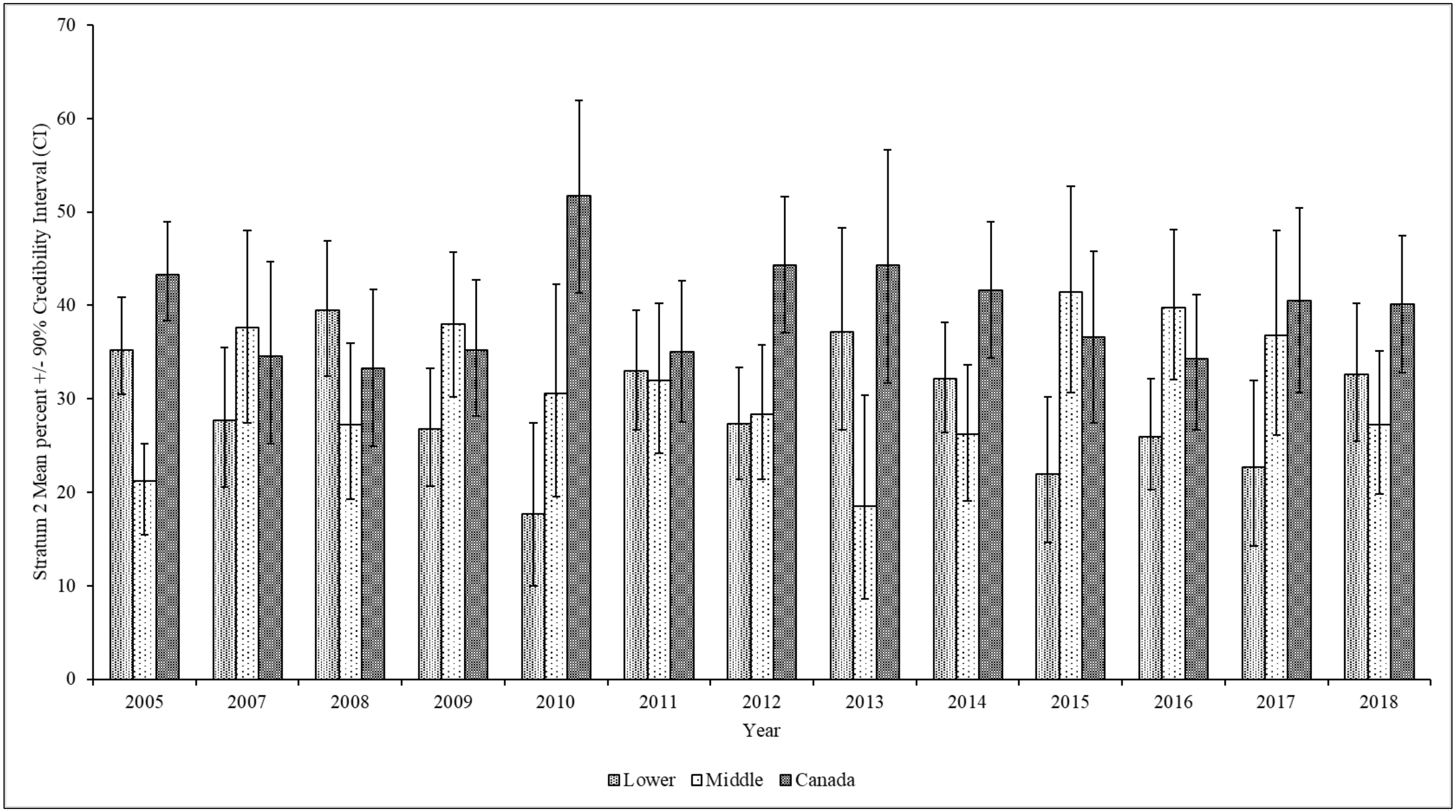

Figure 4.–Comparison of stratum 2 mean percent Chinook salmon (90% credibility interval [CI]) by origin using updated baseline for broad-scale reporting at Pilot Station sonar, 2005–2018.

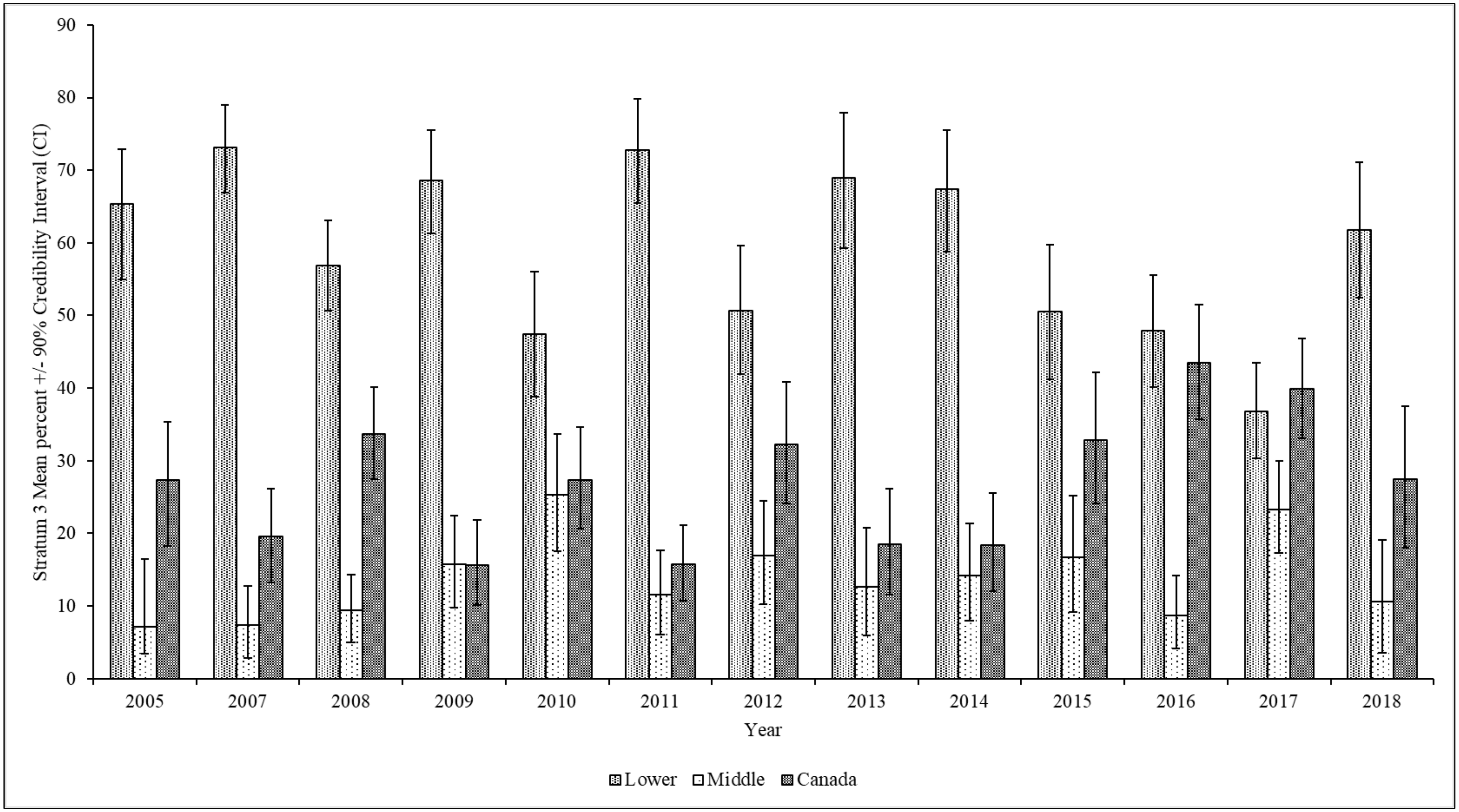

Figure 5.–Comparison of stratum 3 mean percent Chinook salmon (90% credibility interval [CI]) by origin using updated baseline for broad-scale reporting at Pilot Station sonar, 2005–2018.

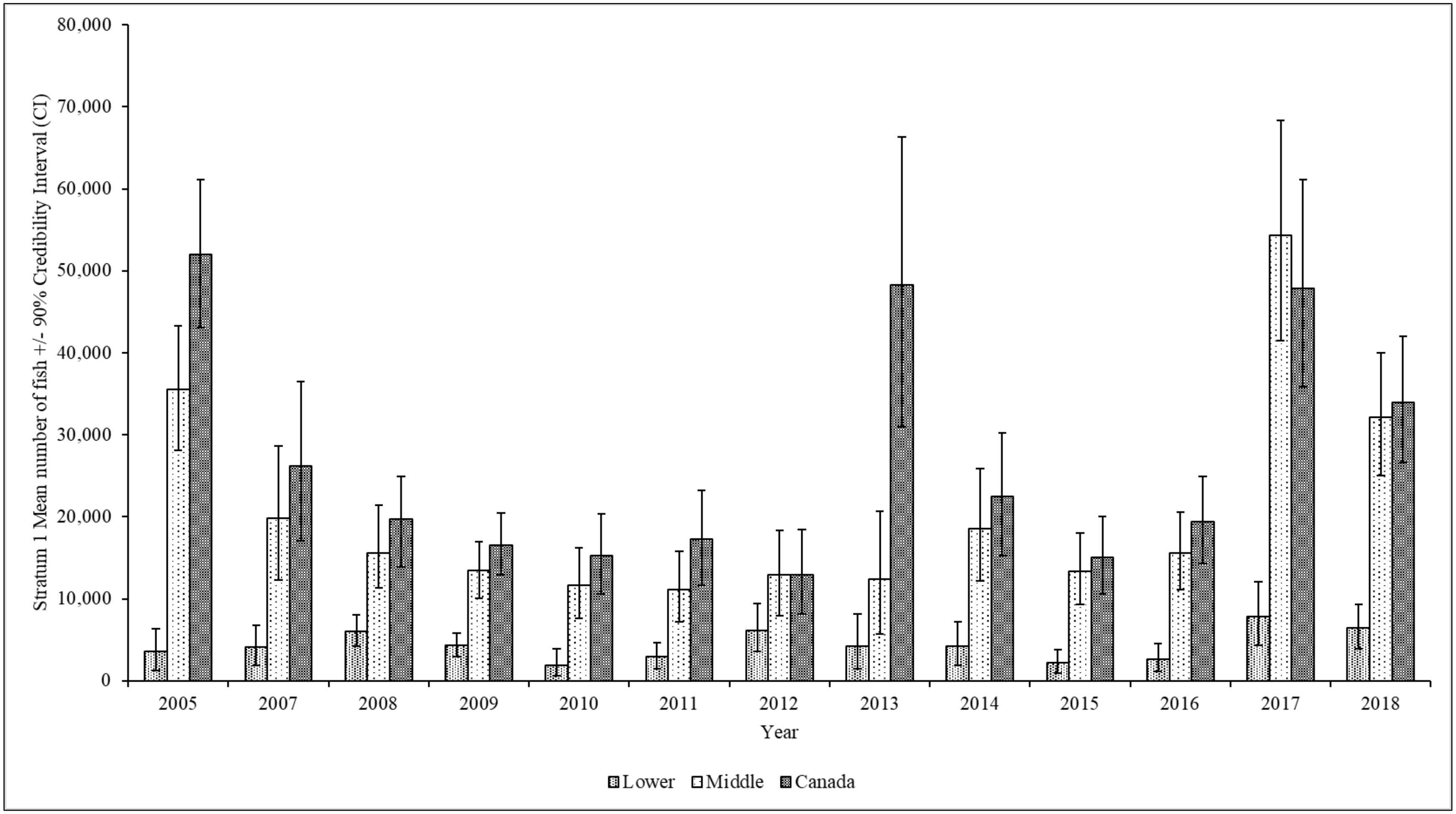

Figure 6.–Comparison of stratum 1 mean number of Chinook salmon (90% credibility interval [CI]) by origin using updated baseline for broad-scale reporting at Pilot Station sonar, 2005–2018.

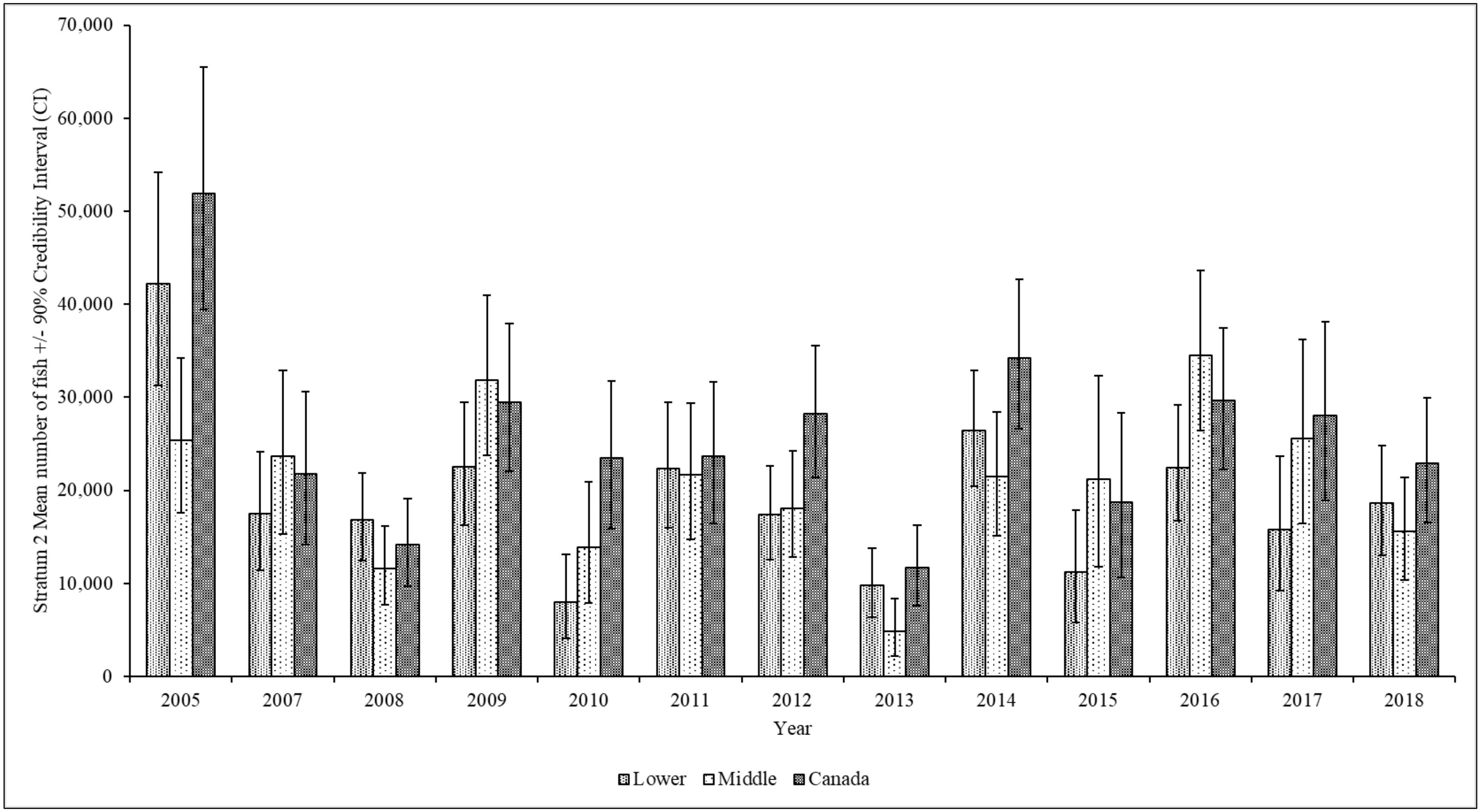

Figure 7.–Comparison of stratum 2 mean number of Chinook salmon (90% credibility interval [CI]) by origin using updated baseline for broad-scale reporting at Pilot Station sonar, 2005–2018.

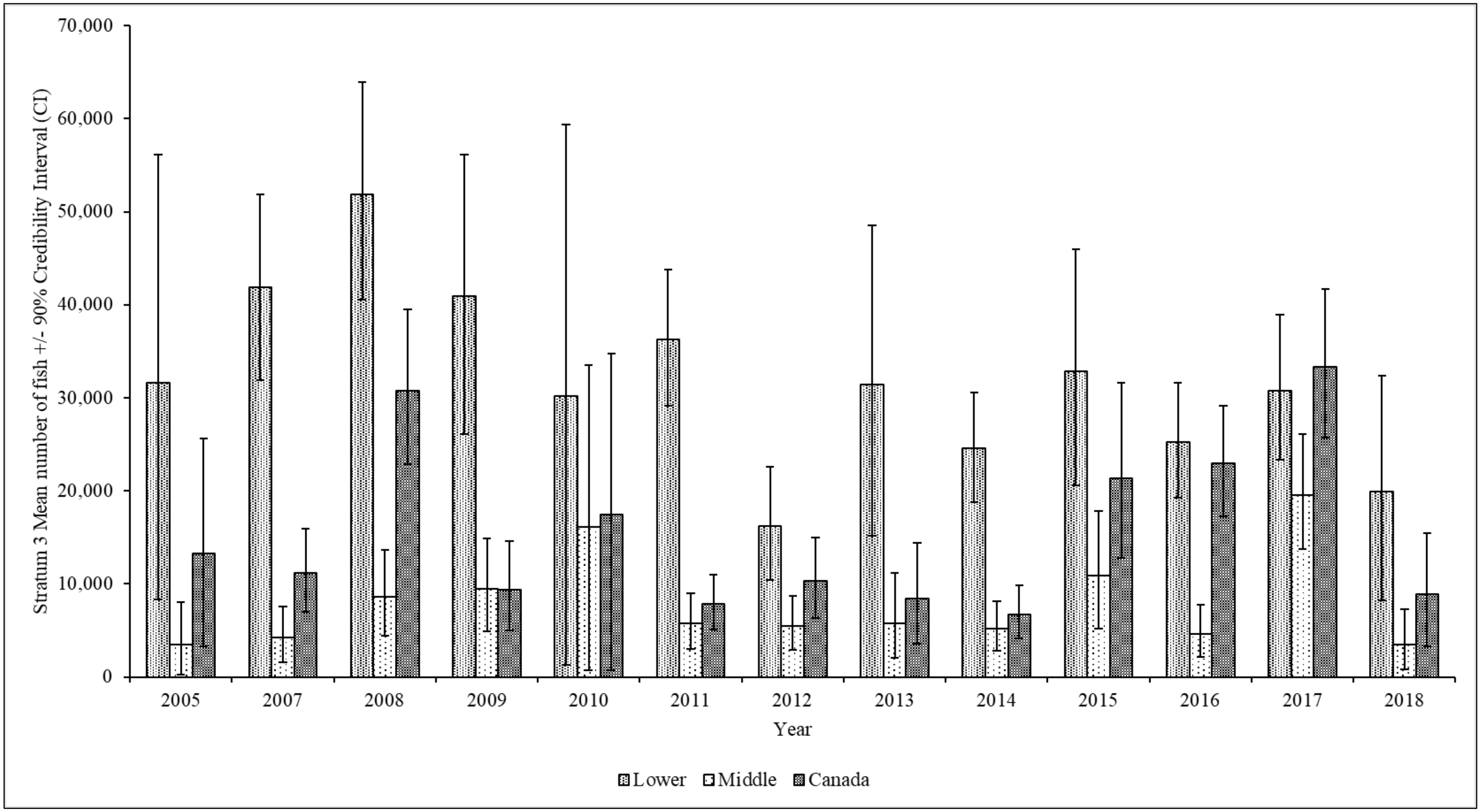

Figure 8.–Comparison of stratum 3 mean number of Chinook salmon (90% credibility interval [CI]) by origin using updated baseline for broad-scale reporting at Pilot Station sonar, 2005–2018.

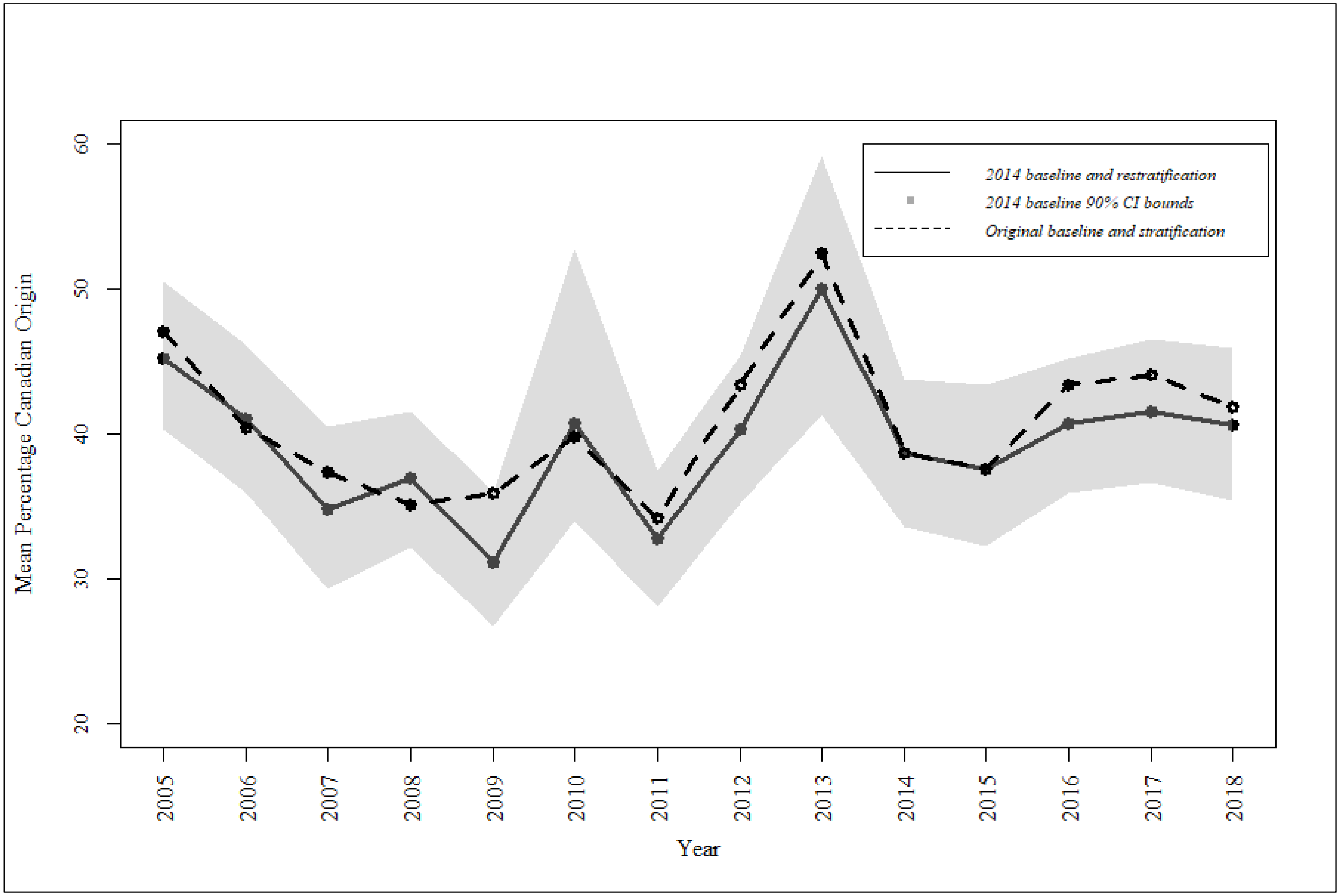

Figure 9.–A comparison of the (1) mean percentage of Canadian-origin Chinook salmon using the revised baseline (2014) and re-stratification, and (2) originally reported baseline and stratification used at the time of data collection, 2005–2018.

Note: CI = credibility interval.