Fishery Data Series No. 13-56

Genetic Stock Identification of Upper Cook Inlet Sockeye Salmon Harvest, 2010

by

Andrew W. Barclay,

Christopher Habicht,

Terri Tobias,

and

T. Mark Willette

December 2013

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

FISHERY DATA SERIES NO. 13-56

GENETIC STOCK IDENTIFICATION OF UPPER COOK INLET SOCKEYE SALMON HARVEST, 2010

by
Andrew W. Barclay, Christopher Habicht,
Division of Commercial Fisheries, Gene Conservation Laboratory, Anchorage

and

Terri Tobias, T. Mark Willette,
Division of Commercial Fisheries, Soldotna

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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

Andrew W. Barclay
Christopher Habicht
Alaska Department of Fish and Game, Division of Commercial Fisheries, Gene Conservation Laboratory,
333 Raspberry Road, Anchorage, AK 99518, USA

Terri Tobias
T. Mark Willette,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
43961 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669, USA

This document should be cited as:
Barclay, A. W., C. Habicht, T. Tobias, and T. M. Willette. 2013. Genetic stock identification of Upper Cook Inlet sockeye salmon harvest, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 13-56, Anchorage.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Mixed stock analysis based on genetic data has been used to estimate the stock compositions of sockeye salmon *Oncorhynchus nerka* harvested in commercial fisheries in Upper Cook Inlet (UCI), Alaska, since 2005. Here we report the analysis of the 2010 commercial drift and set and test drift gillnet fisheries in the Central and Northern districts of UCI. Samples from the offshore test fishery were also analyzed. Postseason analyses were performed using a previously reported baseline of 69 populations and 96 single nucleotide polymorphic markers. The commercial fishery samples represented 97% of the harvest. Some patterns of stock proportions in the commercial fishery were similar to results from previous years: 1) Kenai River fish were present later in the season than Kasilof River fish; 2) eastern fisheries generally captured higher proportions of Kenai and Kasilof river fish than western and northern fisheries; 3) the closer set gillnet fisheries were to either the Kenai or Kasilof river mouths, the higher the proportion of the catch originating from those rivers; and 4) within the northeastern and southwestern portions of the General Subdistrict (Northern District), Fish Creek and Knik/Turnagain/Northeast stocks comprised the greatest proportion in the northeastern area, and West Cook Inlet, Judd/Chelatna/Larson lakes, and the Susitna/Yentna rivers comprised the greatest proportion in the southwestern area. Other patterns differed from previous years; for example, we did not observe lower proportions of Kasilof River fish in the Cohoe/Ninilchik Subsection. When comparing overall harvest in the UCI fishery with the 5 previously reported years, we observed above average harvests for some stocks (West Cook Inlet, Susitna/Yentna rivers, Fish Creek, Knik/Turnagain/Northeast, and Kenai River), and below average harvest for other stocks (Crescent and Kasilof rivers). The offshore test fishery showed a similar pattern as previous years for relative proportions of Kenai and Kasilof river fish through the season (higher Kasilof River proportions early; higher Kenai River proportions late), but different patterns in relative proportions of Kenai and Kasilof river fish across stations in the test fishery.

Key words Cook Inlet, sockeye salmon, *Oncorhynchus nerka*, genetic stock identification, mixed stock analysis, MSA, commercial fishery, single nucleotide polymorphism, SNP

INTRODUCTION

BACKGROUND

Sockeye salmon *Oncorhynchus nerka* are the most important species to the commercial fishery in the Upper Cook Inlet (UCI) Management Area, with an average yearly exvessel value of $17.4 million over the past 10 years (Shields 2010). The Alaska Department of Fish and Game (department), Division of Commercial Fisheries (division), is responsible for managing the commercial fisheries in UCI under the sustained yield principle. Application of the sustained yield principle requires an understanding of the relationship between the number of fish that spawn in a drainage (stocks) and the number of their offspring that make it to reproductive adulthood (i.e., brood table). The number of offspring that return for each stock is calculated by adding the number of spawners in the drainage to the number of stock-specific fish harvested before reaching the spawning grounds for each of the 5 major sockeye salmon-producing drainages including: Crescent River, Susitna River, Fish Creek, Kenai River, and Kasilof River (Figure 1). The harvest estimate is especially important in UCI where sockeye salmon are harvested at rates from 50% to 75% in mixed-stock fisheries [calculated from Tobias and Willette (2004) and Shields (2010)]. Most of this harvest occurs in the commercial fishery in various UCI districts, subdistricts, and sections (Figures 2 and 3) by both set gillnet and drift gillnet commercial fisheries (Shields 2010). An offshore test fishery provides inseason forecasts of the total UCI sockeye salmon run and the sockeye salmon run to the Kenai River. The Kenai River late-run sockeye salmon management plan specifies 3 tiers for the inriver sockeye salmon escapement goal and changes in allowable commercial fishing time that are based upon the inseason Kenai sockeye salmon forecast derived from the offshore test fishery.

A key component to develop the brood tables and to assess the offshore test fishery catches is an estimation of the stock composition of these catches. A review of previous methods (including a weighted age-composition model and early genetic methods) to allocate catches to stocks within the UCI fishery is detailed in Barclay et al. (2010a). Since 2005, the department has used mixed stock analysis (MSA) using genetic data to estimate stock compositions of sockeye salmon collected in selected periods of the Central and Northern district commercial fisheries and from the offshore test fishery (Figure 4; results from 2005 to 2009 in Barclay et al. 2010a, 2010b). Among the findings were that the greatest harvests of Kenai River fish occurred in the drift gillnet fishery and the greatest harvest of Kasilof River fish occurred in the set gillnet fishery. In the Kasilof Section harvest, within a half mile of shore, the combined contribution of Kenai and Kasilof river fish was 97% to 98%. In the northeastern area of the General Subdistrict (Northern District) set gillnet fishery, fish from Knik and Turnagain Arms contributed the most to the harvest and Susitna River fish contributed very little. In the southwestern area of the General Subdistrict, western Cook Inlet and Susitna River fish had the biggest contributions to the harvest. Interannual deviations in stock composition estimates were also observed. For example, in 2009 (Barclay et al. 2010b) above-average harvests of Crescent River, western Cook Inlet, and Fish Creek fish were observed compared to the 4 years (2005–2008) reported in Barclay et al. (2010a). The most recent report includes the most detailed and precise estimates to date: analyzed strata represented 99% of the commercial harvest and the 90% credibility intervals for the most abundant stocks (Kenai and Kasilof rivers) captured in the largest fisheries (Central District drift gillnet and Upper Subdistrict set gillnet) were within 5% of the point (best) estimate (Barclay et al. 2010a). Within the offshore test fishery, the most prominent pattern in stock composition estimates has been the greater proportion of Kenai River fish in the easternmost station declining gradually toward the westernmost station, although this pattern varies in strength across years.

In 2012, a new coastwide baseline was published for the Western Alaska Salmon Stock Identification Program (WASSIP; Dann et al. 2012). This baseline doubled the number of markers screened for sockeye salmon populations from Cape Suckling to Kotzebue Sound. This baseline also incorporated new baseline samples (from additional sampling years and populations) and implemented improved methods to detect and handle linked loci. Since the last baseline upgrade, additional test mixtures were also used to evaluate baseline performance for MSA in UCI. Taking advantage of these new data and methods, a new baseline was developed for MSA in UCI, which contains 69 populations representing 10,001 fish screened for 96 SNP loci (Barclay and Habicht 2012). Populations were assigned into reporting groups (stocks) and tested for MSA performance. The following 8 reporting groups (Figure 1) met or exceeded the MSA performance metrics: 1) the largest producer of sockeye salmon on the west side (Crescent River; *Crescent*), 2) the remaining West Cook Inlet producers (*West*), 3) the lakes monitored by weirs in the Susitna/Yentna rivers (Judd/Chelatna/Larson lakes) with the addition of the Mama and Papa Bear Lakes and Talkeetna Sloughs population (*JCL*), 4) the remaining producers in the Susitna/Yentna rivers (*SusYen*), 5) the only major creek monitored with a weir in the Knik/Turnagain/Northeast Cook Inlet area (Fish Creek; *Fish*), 6) the remaining Knik/Turnagain/Northeast Cook Inlet producers (*KTNE*), 7) the composite of all populations within the Kenai River (*Kenai*), and 8) the composite of all populations within the Kasilof River (*Kasilof*). Hereafter, when the terms *Crescent*, *West*, *JCL*, *SusYen*, *Fish*, *KTNE*, *Kenai*, and *Kasilof* are used as nouns, they refer to reporting groups (stocks: see definitions).

Here we use a new baseline as reported in Barclay and Habicht (2012) and analyzed samples collected in 2010 from time and area strata that represented 98.7% of the UCI sockeye commercial catch.

DEFINITIONS

To reduce confusion associated with the methods, results, and interpretation of this study, basic definitions of commonly used genetic and salmon management terms are offered here.

Allele. Alternative form of a given gene or DNA sequence.

Brood (year). All salmon in a stock spawned in a specific year.

Credibility Interval. In Bayesian statistics, a credibility interval is a posterior probability interval. Credibility intervals are a direct statement of probability: i.e. a 90% credibility interval has a 90% chance of containing the true answer. This is different than the confidence intervals used in frequentist statistics.

District. Waters open to commercial salmon fishing. Commercial fishing districts, subdistricts and sections in Cook Inlet are defined in Alaska Administrative Code (5 AAC 21.200).

Escapement (or Spawning Abundance or Spawners). The annual estimated size of the spawning salmon stock; quality of escapement may be determined not only by numbers of spawners, but also factors such as sex ratio, age composition, temporal entry into the system, and spatial distribution with the salmon spawning habitat (from 5 AAC 39.222(f)).

Gametic Disequilibrium. A state that exists in a population when alleles at different loci are not distributed independently in the population's gamete pool, often because the loci are physically linked.

Genetic Marker. A known DNA sequence that can be identified by a simple assay.

Genotype. The set of alleles for one or more loci for an individual.

Hardy-Weinberg Equilibrium (H-W). The genotype frequencies that would be expected from given allele frequencies assuming: random mating, no mutation (the alleles don't change), no migration or emigration (no exchange of alleles between populations), infinitely large population size, and no selective pressure for or against any traits.

Harvest. The number of salmon or weight of salmon taken from returning salmon prior to escapement as a result of fishing activities.

Harvest Rate. The fraction of returning salmon harvested.

Locus (plural, loci). A fixed position or region on a chromosome.

Linked Markers. Markers showing gametic disequilibrium.

Mixed Stock Analysis (MSA). Method using allele frequencies from populations and genotypes from mixture samples to estimate stock compositions of mixtures.

Population. A locally interbreeding group that has little interbreeding with other spawning aggregations other than the natural background stray rate, is uniquely adapted to a spawning habitat, and has inherently unique attributes (Ricker 1958) that result in different productivity rates (Pearcy 1992; NRC 1996). This population definition is analogous to the spawning aggregations described by Baker et al. (1996) and the demes by NRC (1996).

Reporting Group. A group of populations in a genetic baseline to which portions of a mixture are allocated during mixed stock analyses; constructed based on a combination of management needs and genetic distinction. See definition for *Salmon Stock* for breakdown of reporting groups (stocks) in Upper Cook Inlet.

Run. The total number of salmon of a stock surviving to adulthood and returning to the vicinity of the natal stream in any calendar year. The annual run is composed of both the harvest of adult salmon and the escapement in any calendar year. With the exception of pink salmon, the run is composed of several age classes of mature fish from the stock, derived from the spawning of a number of previous brood years (from 5 AAC 39.222(f)).

Single nucleotide polymorphism (SNP). A DNA sequence variation occurring when a single nucleotide (A, T, C, or G) differs among individuals or within an individual between paired chromosomes.

Salmon Stock. A locally interbreeding group of salmon (population) that is distinguished by a distinct combination of genetic, phenotypic, life history, and habitat characteristics or an aggregation of 2 or more interbreeding groups (populations) which occur within the same geographic area and is managed as a unit (from 5 AAC 39.222(f)). For purposes of this study, stocks in Upper Cook Inlet were delineated based on the major population or aggregation of populations for which the department estimates escapement or for a population or aggregation of populations which occur in a geographic area for which the department does not estimate escapement. Upper Cook Inlet stocks are defined as: 1) the largest producer on the west side (Crescent River; *Crescent*), 2) the remaining West Cook Inlet producers (*West*), 3) the lakes with weirs in the Susitna/Yentna rivers (Judd/Chelatna/Larson lakes) and the Mama and Papa Bear Lakes and Talkeetna Sloughs population (*JCL*), 4) the remaining producers in the Susitna/Yentna rivers (*SusYen*), 5) the only major creek with a weir in the Knik/Turnagain/Northeast Cook Inlet area (Fish Creek; *Fish*), 6) the remaining Knik/Turnagain/Northeast Cook Inlet producers (*KTNE*), 7) the composite of all populations within the Kenai River (*Kenai*), and 8) the composite of all populations within the Kasilof River (*Kasilof*).

MANAGEMENT OF UPPER COOK INLET SOCKEYE SALMON

Management Strategy

UCI commercial fisheries are managed to achieve salmon escapement goals. Salmon are commercially harvested in UCI using drift and set gillnets. Drift gillnet fisheries occur in Central District only; whereas set gillnet fisheries occur in both the Central and Northern districts on both eastern and western shores (Figure 2). During the season, regularly scheduled fishery openings occur for 12 hours on Mondays and Thursdays beginning at 7:00 a.m. Additional fishing time may be allowed via emergency orders depending on catches, escapements, and the projected run size of sockeye salmon. The season generally begins in late June and runs through early August for a total of about 14 regularly scheduled fishery openings.

To achieve escapement goals, drift and set gillnet fisheries are sometimes restricted to smaller portions of the district to reduce the harvest of specific salmon stocks (Table 1; Figures 2 and 3). These area restrictions vary throughout the season and across years. Drift gillnet fisheries are sometimes restricted to areas south of the northern or southern tip of Kalgin Island, or only the Kenai or Kasilof corridor along the eastside beaches, usually to reduce harvest of Susitna/Yentna rivers or Kenai River sockeye salmon. Drift and set gillnet fisheries may be restricted to only the Kasilof River Special Harvest Area near the mouth of the Kasilof River to harvest Kasilof River sockeye salmon in excess of escapement needs, while minimizing harvests of Kenai River sockeye salmon (Barclay et al. 2010a). The Kenai, East Forelands, and Kasilof sections of Upper Subdistrict are managed as separate units. Set gillnet fisheries are sometimes restricted to harvest within a half-mile of shore in the Kasilof Section and closed in the Kenai and East Forelands sections to reduce harvests of Kenai River populations. Descriptions of the management plans governing these fisheries and details of these restrictions for specific years can be found in the UCI Annual Management Reports (Shields 2010) and in reports to the Alaska Board of Fisheries. These area restrictions need to be considered when evaluating genetic stock composition estimates in this report because some of the variability in these estimates results from the areas where the fish were caught. All genetic stock composition estimates in this report are linked to information about these area restrictions.

Description of Fishery

In 2010, the preseason forecast for the total sockeye salmon run (3.6 million) was below average, with below average Kasilof (901,000), Kenai (1,672,000), and Susitna (542,000) forecasts (Eggers et al. 2010). Since the Kenai forecast was for a run of less than 2 million sockeye salmon, ADF&G started the season managing for an inriver Kenai sockeye salmon goal range of 650,000 to 850,000 counted by sonar, with 24 hours of additional fishing time allowed in the Upper Subdistrict set gillnet fishery. Inseason projections in late July indicated run timing was early and the Kenai run was greater than 2 million, triggering a higher inriver goal range of 750,000 to 950,000. In addition, 51 hours of additional fishing time in the Upper Subdistrict set gillnet fishery were allowed with 2 closed periods (windows) each week. To minimize the harvest of Northern District salmon, the Central District drift gillnet fishery was restricted to drift area 1 on July 19 and drift areas 1 and 2 on July 29. At the end of the season, the Kasilof sockeye salmon escapement (267,000 Bendix sonar[1] units) was slightly below the upper optimal escapement goal (300,000), and the Kenai escapement (971,000 Bendix sonar units) exceeded the inriver goal range (750,000–950,000). Overall, the total sockeye salmon run (5.3 million) was 47% above the preseason forecast, and the run was 1 day early (Shields 2010).

OBJECTIVES

1) Collect sockeye salmon tissue samples for genetic analysis throughout the 2010 fishing season from the UCI commercial drift and set gillnet fisheries and offshore test drift gillnet fishery.
2) Subsample tissues in proportion to catch within spatial and temporal strata.
3) Analyze selected tissues for 96 single nucleotide polymorphism markers.
4) Estimate stock proportions of sockeye salmon for each stratum.
5) Estimate stock-specific harvest of sockeye salmon for each stratum and for combined strata.

---

[1] Product and company names used in this publication are included for completeness but do not constitute an endorsement. The Alaska Department of Fish and Game does not endorse or recommend any specific company or their products.

METHODS

TISSUE SAMPLING

Tissue Handling

Tissue samples for genetic analysis were collected from sockeye salmon caught in the commercial catch without regard to size, sex, or condition following the methods outlined in Barclay et al. (2010a). Briefly, an axillary process was excised from individual fish and placed in ethanol in either an individually labeled 2 ml plastic vial or a single well in a 48 deep-well plate. For data continuity, tissue samples were paired with age, sex, and length information collected from each fish. These data were collated and archived by division staff at the department office in Soldotna.

Offshore Test Fishery

Field sampling

Offshore test fishery harvests were sampled using the same sampling design used in Barclay et al. (2010b) for the 2009 harvest. Genetic samples were collected, generally daily, from offshore test fishery harvests of sockeye salmon taken at 6 fixed stations along a transect from Anchor Point to Red River delta in July of 2010 (Figure 4). Genetic samples were taken from fish harvested at each station. If less than 50 fish were harvested at a station, all were sampled. If more than 50 fish were harvested at a station, a maximum of 50 were randomly sampled. Consecutive daily samples from all stations were combined to form temporal mixtures with a sample size goal of 400 individuals. Samples were also combined across all test fishery days by station to form 6 additional mixtures. The target sample size within strata was set at 400 fish to provide point estimates that are within 5% of the true stock composition 90% of the time (Thompson 1987).

Commercial Drift and Set Gillnet Fisheries

Field sampling

Commercial fishery harvests were sampled using the same stratified systematic sampling design that was used in Barclay et al. (2010a) for the 2008 harvest. Area strata were determined *a priori* using established fishery districts and subdistricts (Table 2). Temporal stratification was determined postseason to best represent the harvest, based on catch patterns in each fishery and the number of samples collected. Because samples could not be collected each day, samples collected on individual days were often used to represent harvests over several adjacent days. In general, samples collected from a given area were only used to represent harvests within about 1 week of the sampling date. For each area, the first and last temporal strata were sometimes several days long because harvests were low and either building or tapering off during these periods (Shields 2009). Samples representing these strata were generally collected during peak harvests within each stratum, which typically occurred near the end of the first stratum or beginning of the last stratum. Drift and set gillnet harvests were oversampled in proportion to expected harvest to allow for composite samples to be constructed in proportion to actual harvest postseason. Sampling was conducted over 7 weeks.

Drift gillnet sampling

In general, sampling methods follow those reported in Barclay et al. (2010b) for the 2009 harvest. Sampling was conducted in proportion to expected daily harvest, and samples were collected from as many boats as possible throughout the delivery period for each fishery opening. The proportion of the catch to sample from each boat was estimated based on the number of boats expected to deliver at each processor and their expected average catch estimated by the processor. Many different restrictions were in effect during these harvest periods (Table 2).

Set gillnet sampling

Two areas were established for sampling in the Upper Subdistrict set gillnet harvests: one north of the Blanchard Line which includes the Kenai and East Forelands sections (Kenai/EF sections) and one south of the line (Kasilof Section; Figure 2). The subsections within these 2 areas were recombined as follows: the Kenai/EF sections were divided into the combined North/South Salamatof subsections and North Kalifornsky (K.) Beach Subsection, while Kasilof Section was divided into South K. Beach Subsection and the combined Cohoe/Ninilchik subsections (Figure 2).

Sampling methods for the Upper, Western, and Kalgin subdistricts (Central District) and Eastern Subdistrict (Northern District) follow methods described in Barclay et al. (2010b) for the 2009 harvest. Upper Subdistrict (Central District) set gillnet harvests were oversampled to allow composite samples to be constructed postseason in proportion to actual harvest. We determined substratum sample sizes based on the highest proportion of catch observed in each substratum over the last 5 years. Genetic samples were randomly collected at buying stations on the beaches and at processors. Crews attempted to sample from all the buying stations twice during a period, obtaining half their sample after the high tide and half after the low tide.

Western and Kalgin Island subdistricts harvests were sampled after each period, when possible. Goals of 48 to 96 fish were set for each sampling period based on the timing of historical harvests, with the objective of sampling enough fish in each sampling period to construct a sample of 400 fish postseason (weighted by the actual harvest in each period) that would represent the total season harvest.

Eastern Subdistrict (Northern District) harvests were delivered mainly to the Ocean Beauty processing plant in Nikiski. Genetic samples were taken from harvests each period when possible.

General Subdistrict (Northern District) samples were collected at Kenai Peninsula processors from tenders that pick up fish from statistical areas 247-10, 247-20, and 247-30 and in Anchorage at the Ship Creek dock or from Copper River Seafoods where fish from statistical areas 247-30, 247-41, 247-42, and 247-43 were usually delivered (Figure 2).

Drift gillnet subsampling for analysis

Composite samples were constructed from subsamples collected at 1 or more processors located in the Kenai/Kasilof area and from Icicle Seafoods tenders. Temporal strata were identified postseason, and composite random samples were constructed in proportion to the actual substratum (fishery/processor) harvests with a stratum goal of 400 fish. Fishery restrictions were incorporated into defining temporal strata.

Set gillnet subsampling for analysis

Samples taken within the Upper Subdistrict set gillnet fishery were analyzed 2 ways. First, samples were partitioned by section (Kenai/EF and Kasilof) and time. Postseason, random samples (n = 400) were constructed for the Kasilof and Kenai/EF sections in proportion to the actual harvests in each subsection/period. Secondly, the samples were partitioned by subsection (Cohoe/Ninilchik and South K. Beach, North K. Beach, and North/South Salamatof).

For the Western, Kalgin Island, and Eastern subdistricts, sockeye salmon were subsampled to construct a sample of 400 fish postseason (weighted by the actual harvest in each period) that would represent the majority of the season harvest (Western and Eastern subdistricts) or the total season harvest (Kalgin Island Subdistrict).

For the General Subdistrict, two harvest-weighted samples of 400 were constructed to represent the northeastern (statistical areas 247-41, 247-42, and 247-43) and southwestern (statistical areas 247-10, 247-20, and 247-30) areas of the subdistrict (Tables 1 and 2; Figure 2).

LABORATORY ANALYSIS

Assaying Genotypes

Genomic DNA was extracted following the methods of Barclay and Habicht (2012) using DNeasy ® 96 Tissue Kits by QIAGEN® (Valencia, CA). All baseline and commercial fishery samples were screened for 96 sockeye salmon SNP markers (3 mitochondrial and 93 nuclear DNA) following the methods of Barclay and Habicht (2012).

Laboratory Failure Rates and Quality Control

Genotyping failure rate calculations and quality control measures follow those reported in Barclay et al. (2010a), where they report results for a representative set of baseline collections. Briefly, 8% of all individuals were re-extracted and genotyped from all collections. Here we report on the failure rates and quality control measures for the 2010 commercial and offshore test fishery samples.

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Methods for data retrieval and quality control are reported in Barclay et al. (2010a). In that report a threshold of 80% scorable markers per individual was established and all individuals that did not meet this threshold were excluded from MSA. This rule (referred to as the “80% rule”) was used to filter samples with poor quality DNA and missing data from analyses to decrease errors and reduce estimate variances. We applied this same rule to the 2010 mixture individuals. Baseline development methods are reported in Barclay and Habicht (2012) and included tests for Hardy-Weinberg equilibrium and linkage disequilibrium, methods for pooling collections into populations, testing for temporal stability, and visualizing population structure.

Mixed Stock Analysis

We estimated the stock composition of all test fishery and commercial fishery mixtures using the same BAYES protocol as reported in Barclay and Habicht (2012) for the baseline evaluation tests except for defining the informative Dirichlet priors and analysis of mixtures with non-converging chains. Informative Dirichlet priors were defined using a similar “step-wise” prior protocol as reported in Barclay et al. (2010a) except, that for the first time stratum within a fishery, the prior parameters were the posterior means from the first period of the same fishery from 2009 (Barclay et al. 2010b; Table 3). For the analysis of the offshore test fishery by station, the informative prior was defined as the average of all 2009 offshore test fishery by station posterior distributions (Barclay et al. 2010b).

We assessed the within- and among-chain convergence of these estimates using the Raftery-Lewis (within-chain) and Gelman-Rubin (among-chain) shrink factor. These compare variation of estimates among iterations within a chain (Raftery and Lewis 1996) and within a chain to the total variation among chains (Gelman and Rubin 1992). If a shrink factor for any stock group estimate was greater than 1.2 and Raftery-Lewis estimate suggested a chain had not converged to stable estimates, we reanalyzed the mixture with 80,000-iteration chains following the same protocol. If the chains still failed to converge, we did not report the estimates.

Total Stock-Specific Harvest of Sampled Strata

Methods for applying stock proportions to catch to calculate total stock-specific harvest of sampled strata are the same as reported in Barclay et al. (2010a).

RESULTS

TISSUE SAMPLING

Offshore Test Fishery

Field sampling

Tissues suitable for genetic analysis were sampled and analyzed from a total of 2,086 fish from the offshore test fishery harvests of sockeye salmon from July 1 to 29, 2010 (July 15 and 21 not sampled; Tables 4 and 5; Figure 4).

Commercial Drift and Set Gillnet Fisheries

Field sampling

Tissues suitable for genetic analysis were sampled from a total of 18,284 fish from commercial catches throughout the UCI Central and Northern districts in 2010. These fish represented 116 individual collections (Table 2). Two collections from July 18 from the Kasilof Section set gillnet (Central District, Upper Subdistrict) fishery were used to represent harvests in 2 fishing periods (July 7–17 and July 18–24). These collections contained 96 individuals from the Cohoe/Ninilchik Subsection, and 72 individuals from the South K. Beach Subsection. Because of this, the total number of fish collected and the number of collections in Table 2 will not add up to totals stated above.

Drift gillnet subsampling for analysis

A total of 7 composite random samples of 400 fish each were constructed representing over 98% of the drift gillnet fishery total season harvest (Table 2). The majority of the unrepresented harvest (over 99%) was from periods restricted to the corridor only.

Set gillnet subsampling for analysis

For set gillnet subsampling for analysis of the Upper Subdistrict set gillnet fishery, 6 and 4 composite random samples of 400 fish each were constructed for the Kasilof (6) and Kenai/EF

(4) sections, representing the total Upper Subdistrict season harvest (Table 2). Partitioning of these samples by subsection resulted in samples sizes of 1,591 (Cohoe/Ninilchik), 718 (South K. Beach), 321 (North K. Beach), and 1,279 (North/South Salamatof) fish (Table 6).

For the Kalgin Island, Western, and Eastern subdistricts set gillnet fisheries, composite random samples of 400 fish were constructed for each subdistrict representing 100% (Kalgin Island), 98% (Western), and 81% (Eastern) of the total season harvests (Table 2).

For the General Subdistrict set gillnet fishery, composite random samples of 400 fish were constructed for both the Northeastern and Southwestern areas representing 99% (Northwestern) and 75% (Southwestern) of the season harvests.

LABORATORY ANALYSIS

Laboratory Failure Rates and Quality Control

A total of 8,708 fish were genotyped from the 2010 collections. For the offshore test fishery and commercial harvest samples, failure rates among collections ranged from 0.00% to 1.01% and discrepancy rates were uniformly low and ranged from 0.00% to 0.31%. Assuming equal error rates in the original and the quality-control analyses, estimated error rates in the samples is half of the discrepancy rate (0.00–0.16%).

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Data retrieval and quality control results for the baseline collections are reported in Barclay and Habicht (2012). Based upon the 80% scorable marker rule, 0.14% of individuals were removed from commercial harvest and 0.19% were removed from test fishery collections before stock composition estimates were calculated.

Mixed Stock Analysis

Offshore test fishery

A total of 2,086 fish captured in the offshore test fishery were genotyped (Tables 4 and 5). Samples were divided into 5 temporal strata ranging between 4 and 7 days. We observed a consistent pattern in the distribution of stocks over time: the proportion of Kasilof (range: 2–14%) decreased, and the proportion of Kenai (range: 46–78%) increased (Figure 5). The proportion of West was higher in the first 2 time strata (July 1–10; range: 16–17%) and then dropped slightly in the last 3 time strata (July 11–29; range: 11–13%). The proportion of Fish was highest in the first two strata (range: 6–9%), dropped to 1% in the third stratum (July 11–16), and dropped below 1% in the last 2 strata (July 17–29). The proportions of Crescent, JCL, and SusYen remained relatively constant and each group ranged from 2% to 5% across strata. The proportion of KTNE remained at 5% for the first 2 strata then decreased over the last 3 strata (July 11–29; range: 1–4%).

When the samples were divided into 6 mixtures by station, patterns were observed from the east (station 4) to the west (station 8) side of Cook Inlet (Figure 6). Kenai (range: 58–69%) comprised the highest proportion of the 8 reporting groups at all stations. The proportion of Kenai was 63% at station 4, increased to 69% at station 5, dropped back to 63% at station 6, and decreased from station 6.5 to 8 (range: 64–58%). West (range: 10–15%) comprised the second highest proportion of the 8 reporting groups at all stations, and increased from east to west. The proportion of Crescent was 5% at station 4, decreased to 2% at stations 5 and 6, and then increased from station 6.5 to 8 (range: 1–9%). The proportions of JCL (range: 1–4%), SusYen (range: 1–4%), Fish (range: 2–5%), KTNE (range: 3–5%), and Kasilof (range: 6–8%) had no discernible pattern.

Commercial drift and set gillnet fisheries

From the 118 collections sampled, 8,800 fish were subsampled to create 22 mixtures for which the stock composition and stock-specific harvest were estimated (Table 2). Analyzed mixtures had sample sizes ranging between 397 and 400 fish. In the reanalysis of the data by subsection of the Kenai/EF sections and Kasilof Section set gillnet fisheries (Central District, Upper Subdistrict), the 4 mixtures had sample sizes ranging between 321 and 1,587 fish.

Drift gillnet

For the Central District drift gillnet fishery, we analyzed samples representing harvests from June 21 to August 12 (Table 2). We observed a pattern of increasing proportions of Kenai (range: 24–82%) in the first 6 periods (June 21–July 29; Figure 7; Appendix A1). However in the final period (August 2) the proportion of Kenai decreased from 82% to 76%. In general, the proportion of Kasilof decreased throughout the season (range: 2–41%); however, in periods 3 through 6 (July 12–29) the proportion of Kasilof fluctuated between 4% and 6% before decreasing to 2% in the final period. The final period represented only 3% of the drift gillnet harvest. The proportion of West (range: 5–16%) had a similar pattern to Kasilof; however, in the final period it was greater than the July 5–8 period. The proportions of SusYen (range: 2–4%) and JCL (range: 2–4%) were relatively constant and within 1% of each other. The proportion of KTNE (range: 1–5%) and Fish (range: 1–7%) generally decreased throughout the season except for the July 19–25 period where KTNE increased from 2% to 3% and the July 5–8 period where Fish increased from 6% to 7%. The proportion of Crescent was greatest during the June 21 to July 1 period (2%) then ranged from 0% to 1% from July 5 to August 12.

Set gillnet

For the Upper Subdistrict set gillnet fishery, we analyzed samples representing harvests from June 27 to August 12 in Kasilof Section and from July 8 to August 12 in the Kenai/EF sections (Table 2; Appendices A2 and A3). We observed a pattern of generally decreasing proportions of Kasilof and generally increasing proportions of Kenai through time in the Kasilof Section, except for the last time stratum, as was observed in the drift gillnet fishery (Figure 7; Appendix A2). Kasilof (range: 18–83%) steadily decreased over time and Kenai (range: 12–77%) increased over time through the July 25–31 period. In the final period (August 2–12), Kasilof increased from 18% to 21% and Kenai decreased from 77% to 71%. The proportion of West ranged between 2% and 5% for all periods except for the July 18–24 period, where it increased to 11%. The proportion of KTNE (range: 0–2%) was less than 2% in all periods except for the first (June 27–July 3) and last (August 2–12) periods, where it was 2%. The proportion of Fish ranged between 0% and 1% in all periods except the July 5–10 period where it was 2%. The combined contribution of Crescent, JCL, and SusYen never exceeded 2%.

A similar pattern for Kasilof was observed in the Kenai/EF section; however, Kenai decreased slightly through the season (Figure 7; Appendix A3). The last strata represented only 7% of the Kasilof Section and 13% of the Kenai/EF sections harvest. Kenai (range: 81–86%) comprised the largest proportion of the 8 reporting groups in all periods. During the first period, the proportion of Kenai decreased from 86% to 83% (July 8 and 24), then the ranged between 81% and 83% for the remaining 3 periods. Kasilof (range: 3–11%) was the second largest contributor in the first (July 8–15) and last (August 2–12) periods, but was exceeded by Fish in the July 19–24 period and both West and KTNE in the July 25–31 period. The proportion of KTNE was 1% in the first period and then steadily increased to 6% over the next three periods (July19–August 12). The proportion of Fish (range: 1–6%) was <3% in all periods except the July 19–24 period where it was 6%. The proportion of West (range: 0–5%) was <2% in all periods except for the July 25–31 period were it was 5%. The proportions of JCL and SusYen were generally the same in all periods and their combined contribution ranged between 0% and 4%. The proportion of Crescent never exceeded 1%.

In the analysis of the Upper Subdistrict set gillnet by subsection, we observed a pattern of generally increasing Kenai abundance from south to north (Table 6; Figure 8). However, in the South K. Beach subsection the proportion of Kenai was smaller and the proportion of Kasilof was larger than in the Cohoe\Ninilchik subsection. Larger proportions of Kenai fish were captured in subsections bordering the Kenai River mouth (North K. Beach and North/South Salamatof). However, in the subsections that border the Kasilof River, more Kasilof fish were captured in the South K. Beach subsection and more Kenai fish were captured in the Cohoe/Ninilchik subsection. The most southerly (Cohoe/Ninilchik) and northerly (North/South Salamatof) subsections contained higher proportions of non-Kenai and non-Kasilof fish; we observed a 10% (non-Kenai) and 13% (non-Kasilof) combined contribution of these groups.

For the Kalgin Island Subdistrict set gillnet fishery (Central District), we analyzed samples representing harvests from June 2 to August 16 (Table 2). West was the dominant reporting group at 57% (Appendix A4). Kenai and Kasilof were the next dominant reporting groups, with proportions of 30% for Kenai and 8% for Kasilof. The combined contribution of all other reporting groups did not exceed 5%.

For the Western Subdistrict set gillnet fishery (Central District), we analyzed samples representing harvests from June 21 to August 9 (Table 2). In the BAYES analysis the Crescent, West, and SusYen reporting groups had Gelman-Rubin shrink factors >1.2, indicating lack of convergence among chains. After augmenting the analysis from 40,000 to 80,000 iterations, Crescent and West still had shrink factors exceeding 1.2. Due to lack of convergence among chains no estimates are reported.

For the Eastern Subdistrict set gillnet fishery (Northern District), we analyzed samples representing harvest from July 5 to August 16 (Table 2). KTNE, Kenai, and Fish made up the largest portions of the harvest at 37% (KTNE), 23% (Kenai), and 23% (Fish; Appendix A5). West (7%), JCL (4%), SusYen (4%), and Kasilof (1%) were the main contributors to the rest of the harvest. Crescent contributed <1% to the harvest.

For the General Subdistrict set gillnet fishery (Northern District), we analyzed a subset of samples representing harvest from July 5 to August 16 for the northeastern area and from July 15 to August 16 in the southwestern area (Table 2). We observed large differences in reporting groups that made up the largest portion of the harvest between the northeastern and southwestern collections (Appendix A6). Fish (74%) and KTNE (22%) made up the largest portion of the northeastern harvest with contributions. JCL (2%), SusYen (1%), and West (1%) were the next largest contributors. The combined contribution of Kenai, Kasilof, and Crescent was <1%. In the southwestern collection, West (61%), JCL (19%), and SusYen (14%) were the largest contributors to the harvest. Fish (4%) and Kenai (2%) were the next largest contributors to the harvest. The combined contribution Kenai, Kasilof, and Crescent was <1%.

Total Stock-Specific Harvest of Sampled Strata

As expected, the stratified estimates for combined temporal strata within years produced the same point estimates of harvest as the summed individual time strata, but with narrower credibility intervals (Tables 7 and 8). The relative error, as measured by credibility intervals, was smaller for larger harvest estimates (2% for Kenai and 4% for Kasilof) and greater for smaller harvest estimates (20% for SusYen, 18% for JCL, and 15% for KTNE; Table 8).

Central District drift gillnet (excluding corridor-only periods that were not sampled)

Over 99% of the Central District drift gillnet harvest (excluding corridor-only periods that were not sampled) was represented by MSA samples (Table 2). In the represented strata, harvest was greatest for Kenai (1,105,191 fish) followed by Kasilof (120,306 fish; Table 7). The combined harvest of western stocks (Crescent and West) was the next highest at 131,658 fish, followed by the combined harvest of northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) at 106,456 fish. Finally, the Susitna and Yentna river stocks (SusYen and JCL), made up the remainder of the harvest at 93,568 fish.

Central District drift gillnet (corridor-only periods that were not sampled)

Less than 2% of the Central District drift gillnet harvest was from corridor-only periods that were not sampled (28,716 fish; Table 2). None of these periods were represented by MSA samples, so stock-specific harvest numbers could not be calculated.

Central District, Upper Subdistrict set gillnet

All of the Upper Subdistrict set gillnet (Central District) harvest was represented by MSA samples (Table 2). Harvests were greatest for Kenai (692,977 fish) and Kasilof (297,628 fish; Table 7). The combined harvest of the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) was the next highest at 48,452 fish, followed by the combined harvest of western stocks (Crescent and West) at 32,425 fish. The combined harvest of Susitna and Yentna stocks (SusYen and JCL) made up the remainder of the harvest at 14,307 fish.

Central District, Western and Kalgin Island subdistricts set gillnet

Over 95% of the Central District, Western and Kalgin Island subdistricts set gillnet harvest was represented by MSA samples (Table 2). In the represented strata, the combined harvest of western stocks (Crescent and West) was greatest at 39,231 fish (Table 7). The combined harvest of Kenai and Kasilof stocks was the next highest at 25,573 fish. The combined harvest of Susitna and Yentna river stocks (SusYen and JCL) and the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) made up the remainder of the harvest with 2,194 fish.

Northern District, Eastern and General subdistricts set gillnet

Over 82% of the set gillnet harvest in the Northern District, Eastern and General subdistricts was represented by MSA samples (Table 2). In the represented strata, northern stocks (JCL, SusYen, Fish, and KTNE) accounted for 21,997 fish (Table 7). The combined harvest of western stocks (Crescent and West) was the next highest at 8,223 fish. The combined harvest of Kenai and Kasilof made up the remainder of the harvest with 3,124 fish.

All strata combined

Over 97% of total commercial harvest was represented by MSA in 2010 (Table 8). In the represented strata, harvest estimates were greatest for Kenai (1,821,552 fish) and Kasilof (423,248 fish). Harvest of northern stocks (JCL, SusYen, Fish, and KTNE) was the next highest at 286,973 fish. The combined harvest of western stocks (Crescent and West) made up the remainder of the harvest with 251,383 fish. Relative errors of stock-specific harvest estimates were greatest for small harvests (i.e., 20% for SusYen) and least for large harvests (i.e., 2% for Kenai).

DISCUSSION

This report used genetic data from a previously reported sockeye salmon baseline (Barclay and Habicht 2012) and samples collected in selected periods of the Central and Northern Cook Inlet district commercial fisheries in 2010 to estimate the stock composition of the harvest. Here we report on the evaluation of results from harvest sampling for 2010 looking at temporal and spatial distributions of stocks in the harvest.

DIFFERENCES IN FISHERY SAMPLING DESIGNS AMONG YEARS

The fishery sampling design was the same as used from 2006 to 2009, but differed from the sampling design followed in 2005, as discussed in Barclay et al. (2010a).

APPLICATION OF DATA TO BROOD TABLE REFINEMENT

The primary goal of this project was to accurately estimate the stock composition of the 2010 commercial harvest in UCI. Knowledge of the composition of the mixed-stock catch is critical to determine the total run of each stock, especially because sockeye salmon stocks in UCI can be exploited by the commercial fleet at rates from 50% to 75% [calculated from Tobias and Willette (2004) and Shields (2009)]. The previous age-composition method for estimating stock composition and developing brood tables probably underestimated the productivity of some stocks and overestimated the productivity of other stocks. This directly affects fisheries management in postseason during the development of escapement goals and the calculation of exploitation rates.

The stock composition estimates available from MSA are improving our understanding of stock productivity as more accurate data are incorporated into brood tables. Some aspects of these new data will require care when using the information to estimate stock productivity. These include: 1) recognizing that the relative error of the estimates are correlated with the size of the stock, which introduces uncertainty into spawner-recruit analyses, 2) estimating stock composition by age class may be necessary to build brood tables, and 3) adjustments will be necessary to account for unsampled strata. In the 2011 review of Kenai and Kasilof sockeye salmon escapement goals (Fair et al. 2010), brood tables were constructed using the weighted age composition model beginning with brood year 1969, and MSA estimates were used to estimate stock composition of harvests from 2006 to 2009. A comparison of MSA and weighted age-composition estimates (2006–2009) indicated that historical stock composition estimates and brood tables could not be readily adjusted using MSA data. Beginning in 2014, we plan to conduct genetic analyses of archived scales and develop a run reconstruction model (Cunningham et al. 2012) to better estimate stock composition of historical harvests and adjust brood tables. This effort will likely take several years to complete.

Relative Errors Across Stocks

As expected, relative errors of stock-specific harvest estimates were generally lower for stocks comprising high proportions of mixtures and higher for stocks comprising low proportions of mixtures (Tables 7 and 8). For example, a stock composition estimate of 4% with a credibility interval of ± 2% represents a relative error of ±50%, whereas a stock composition estimate of 80% with the same credibility interval represents a relative error of ±2.5%. This affected estimates for northern stocks (JCL/SusYen/Fish/KTNE), which generally had low proportions in UCI fishery mixtures.

As reported in Barclay et al. (2010a), relative errors of stock-specific harvest estimates were generally greater for individual fishery estimates (Table 7) and lower for pooled annual totals (Table 8). For example, relative errors of Kenai harvest estimates in individual fisheries ranged from 2% in the Central District drift gillnet fishery to 16% in the Eastern and General subdistricts in 2010 (Table 7), whereas relative error of the Kenai harvest estimate in the total commercial harvest was 2% (Table 8). Similar patterns can be seen when examining the relative errors of harvest estimates for other stocks. In 2010, relative error rates were generally lower in the total commercial harvest for all stocks, with the exception of Crescent, compared to rates for 2005 to 2009. This observation is due to the higher proportions of the less numerous stocks (non-Kenai and Kasilof) in 2010 compared with 2005 to 2009 (Table 8).

Accounting for Unsampled and Unrepresented Strata

Despite efforts to sample all strata, a small number of strata were not sampled due to logistical reasons or because the strata represented small harvests. The strata not sampled in 2010 due to logistical reasons represented relatively small harvests: less than 3% of the total harvest. This is in contrast to the unsampled strata from 2005 to 2008 where the unsampled fractions of the total harvest were 22% (2005), 7% (2006), 5% (2007), and 6% (2008; Barclay et al. 2010a). However, this is an increase from 2009, where the unsampled fraction was < 1% of the harvest (Barclay et al. 2010b). As in previous years, most of the unsampled strata in 2010 were also for fisheries conducted in the corridor section of the Central District drift gillnet fishery (Table 2). However, harvest not represented in the corridor in 2010 was much higher (28,716 fish) than in 2009 (7,251 fish; Barclay et al. 2010b), but lower than 2005 to 2008 (46,228–859,345 fish). Harvest not represented in the Central District drift gillnet (excluding corridor-only unsampled periods) in 2010 was much lower (206 fish) than 2005 to 2009 (1,138–19,573 fish). The harvest not represented from unsampled strata in the Kalgin Island and Western subdistricts increased slightly from 2009 (118 fish) to 2010 (739 fish), but the actual unrepresented harvest in 2010 was much higher (45,167 fish) because the harvest estimates for the Western Subdistrict could not be calculated due to lack of convergence among chains in the BAYES analysis. The Northern District also saw an increase in unrepresented harvest between 2009 (1,290 fish) and 2010 (6,833 fish). It is beyond the scope of this report to extrapolate the stock compositions of harvest in sampled strata to harvest in unsampled strata.

Strata with Nonconverging Chains

In the stock composition analysis of the 2010 fishery strata, only one stratum (Western Subdistrict set gillnet June 10–August 9) had nonconverging chains (Table 2). Because the issue of nonconvergence among chains could not be resolved by additional iterations, the proportional and harvest estimates for this stratum are not provided in this report. There is indication that the nonconvergence is due to individuals in the harvest sample that aren't represented by a baseline population (extra stocks; Pella and Masuda 2001). Genetically distinct population(s) present in the fishery sample but missing from the baseline could cause the individuals in the sample to allocate to different reporting groups among BAYES chains depending on initial starting values. For example, if the starting values for a given chain are higher for populations in the West reporting group, then the unrepresented fish are more likely to allocate to the West reporting group. Because the chains failed to converge only for the West and SusYen reporting group estimates it is likely that the missing population is located either on the west side of Cook Inlet or in the Susitna and Yentna river drainages. Additional baseline collections from these regions will be sought in future years. Once the baseline is updated, this stratum will be reanalyzed. If chains converge in the reanalysis, results will be presented in a future Cook Inlet sockeye MSA report.

PATTERNS IN FISHERY STOCK COMPOSITIONS AND HARVESTS

As in past years, the distribution of stock-specific harvest across fisheries varied (Barclay et al. 2010a, 2010b). The largest harvests of Kenai sockeye salmon occurred in the drift gillnet fishery (Table 7). The largest harvests of Kasilof sockeye salmon occurred in the Upper Subdistrict set gillnet fishery, with the majority of Kasilof fish being harvested in the Kasilof Section (Table 7; Appendix A2). The largest harvests of Susitna and Yentna (SusYen and JCL) sockeye salmon occurred in the drift gillnet fishery (excluding corridor-only periods that were not sampled; Table 7).

Within the offshore test fishery, the same temporal pattern in stock composition was observed in the as previous years—a decreasing trend in the proportion of Kasilof fish and an increasing trend in the proportion of Kenai fish as the season progressed (Table 5). This pattern was expected given the early run timing of Kasilof relative to Kenai sockeye salmon. Stock composition estimates from the offshore test fishery compiled in this study cannot be used to estimate total run by stock because genetic samples were not collected in proportion to abundance. In the test fishery, genetic samples were collected from all sockeye salmon harvested when the catch was less than 50, but when the catch exceeded 50, only 50 samples were collected. Because catches tended to be higher near the center of the transect (Shields and Willette 2007), this sampling protocol resulted in stock composition estimates that gave insufficient weight to samples taken within the primary migratory pathway. In 2010, catch exceeded 50 fish in 16 sets comprising about 13% of the total number of sets. Stock composition estimates will be weighted by CPUE in the future to correct for harvest size.

This report provides a second year of by-station reporting of stock compositions based on genetic data for the offshore test fishery samples. In 2009, a pattern of Kenai fish peaking at station 4 on the east side and declining to station 8 on the west side was observed (Barclay et al. 2010b). A similar pattern was observed in 2010; however, the peak of Kenai at station 4 was not observed and station 5 had the greatest proportion of Kenai fish (Table 6; Figure 6). One notable pattern that was observed in this report that was not observed in 2009 was a steady increase in the proportion of West fish from station 4 to station 8. Although these stock proportions suggest that Kenai fish enter UCI more toward the east side and West fish enter more toward the west side, the product of stock proportions and total CPUE (stock-specific CPUE) at each station indicated Kenai fish were most abundant at station 6.5 and least abundant at stations 4 and 8 (Shields and Willette 2011). A similar pattern might be expected for Kasilof, but here the proportion of Kasilof remained relatively constant across stations and the product of the stock proportions and

CPUE at each station indicated that the abundance of Kasilof fish increased from stations 4 to 7 and dropped at station 8.

Within the Central District drift gillnet fishery, some of the patterns observed in 2010 were similar patterns observed in Barclay et al. (2010b) for the 2009 fishery. For example, an increase in the proportion of Kenai and a corresponding decrease of Kasilof sockeye salmon in drift gillnet fishery harvests (excluding corridor-only periods that were not sampled) during the season occurred in both years (Appendix A1). The estimated peak harvest date of Kenai sockeye salmon was also in concordance with observations in 2009, i.e., peak harvests of Kenai sockeye salmon were July 13–16 in 2009 and July 12 in 2010.

Within the Upper Subdistrict (Central District) set gillnet fishery, we observed a pattern of decreasing proportions of Kasilof and increasing proportions of Kenai sockeye salmon in July in the Kasilof Section (Appendix A2). This was similar to the patterns observed in the Kenai/EF sections and the Kasilof Section in 2009 (Barclay et al. 2010b). However, this pattern was not observed in the Kenai/EF sections where, instead of increasing throughout the season, the proportion of Kenai sockeye salmon decreased slightly. Consistent with findings from 2009 (Barclay et al. 2010b), most of the catch in the Upper Subdistrict was comprised of either Kenai or Kasilof fish (Figure 5; Appendix A2 and A3).

Within the Kenai/EF and Kasilof sections, by subsection we observed the same pattern of higher proportions of non-Kenai and -Kasilof stocks in subsections farthest from the Kenai and Kasilof river mouths as was observed in the 2009 fishery (Barclay et al. 2010b). However, we did not observe a higher proportion of Kasilof fish in the Cohoe/Ninilchik Subsection as was observed in previous years (Barclay et al. 2010a, 2010b).

Within the northeastern and southwestern portions of the General Subdistrict set gillnet fishery we observed similar patterns of stock composition that were observed in 2009 (Barclay et al. 2010b); Fish and KTNE stocks comprised greatest proportion in the northeastern area and West, and JCL and SusYen comprised the greatest proportion in the southwestern area (Appendix A6). This report provides the second set of stock composition estimates separately for the northeastern and southwestern portions of the General Subdistrict set gillnet fishery (Northern District; Figure 2).

When comparing overall harvest in the UCI fishery in 2010 with the 5 previously reported years (2005–2009; Barclay et al. 2010a; Barclay et al. 2010b), we observed above average harvests for some stocks and below average harvest for other stocks (Table 8; Figure 9). Among the stock with above average harvests (West, SusYen, Fish, KTNE, and Kenai), West, Fish, and KTNE had larger harvests than have been observed in the 5 prior years. The estimated harvest of Fish Creek sockeye salmon in 2010 (93,903 fish) was over double that of 2009 (37,648), which corresponds to the nearly doubling of the estimated run to Fish Creek from 2009 (121,965 fish) to 2010 (227,690 fish; Shields 2010). The estimated harvest of Crescent and Kasilof stocks in the fishery was the lower than prior years. The low harvest estimate for Crescent is likely due to the Western Subdistrict being unrepresented in the overall harvest estimates because chains failed to converge in the BAYES analysis. In the previous 5 years, the estimated proportion of Crescent fish in Western Subdistrict harvest samples ranged from 51% to 86% (Barclay et al. 2010a, 2010b). Because the sockeye salmon harvest in the immediate area around the Crescent River terminus was the 6th highest observed since 1990, a large portion of the Western Subdistrict harvest samples are likely to be from fish of Crescent River origin (Shields 2010).

ACKNOWLEDGEMENTS

This study, from concept to completion, required the efforts of a large number of dedicated people. The authors acknowledge the work of the people in the department's Gene Conservation Laboratory including: Eric Lardizabal, Judy Berger, Lisa Fox, Tara Harrington, Serena Rogers Olive, Heather Liller, Zac Grauvogel, Paul Kuriscak, and Wei Cheng. Samples for this study were collected by a large number of dedicated staff who performed this task in addition to their many other duties. Specifically, we would like to thank Rhonda McGrady, Kelsey Shields, Tim Elder, Cassie Wilcox, Rustin Hitchcock, Jerry Strait, Sheldon Hallmark, Frieda Ware, Dallas Baldwin, and Katie Thorton from the Soldotna commercial fishery sampling crew for their tireless work that enabled us to collect 18,284 fishery samples. Additionally, we would like to thank the Soldotna staff from the department's Commercial Fisheries and Sport Fish divisions for collecting many of the baseline fish for this study. Finally, we would like to thank Bill Templin for reviewing and Erica Chenoweth for editing this report.

Laboratory and statistical analyses were funded by the State of Alaska. The project relied heavily on the tissue samples and knowledge gained from Restoration Studies 9305 and 94255 funded by *Exxon Valdez* Oil Spill Trustee Council and the SNP marker development work funded by North Pacific Research Board Grant #0303, Northern Boundary Restoration and Enhancement Fund Project NF-2005-I-13, and the Alaska Sustainable Salmon Fund project # 45866. Finally, the development and analysis of additional markers to create the 96-SNP baseline for Cook Inlet populations were funded, in part, by the Western Alaska Salmon Stock Identification Program.

REFERENCES CITED

Baker, T. T., A. C. Wertheimer, R. D. Burkett, R. Dunlap, D. M. Eggers, E. I. Fritts, A. J. Gharrett, R. A. Holmes and R. L. Wilmot. 1996. Status of Pacific salmon and steelhead in Southeastern Alaska. Fisheries 21:6–18.

Barclay, A. W., C. Habicht, W. D. Templin, H. A. Hoyt, T. Tobias, and T. M. Willette. 2010a. Genetic stock identification of Upper Cook Inlet sockeye salmon harvest, 2005–2008, Alaska Department of Fish and Game, Fishery Manuscript No. 10-01, Anchorage.

Barclay, A. W., C. Habicht, T. Tobias, and T. M. Willette. 2010b. Genetic stock identification of Upper Cook Inlet sockeye salmon harvest, 2009. Alaska Department of Fish and Game, Fishery Data Series No. 10-93, Anchorage.

Barclay, A. W., and C. Habicht. 2012. Genetic baseline for Upper Cook Inlet sockeye salmon: 96 SNPs and 10,000 fish. Alaska Department of Fish and Game, Fishery Manuscript Series No. 12-06, Anchorage.

Cunningham, C. J., R. Hilborn, J. Seeb, M. Smith, and T. Branch. 2012. Reconstruction of Bristol Bay sockeye salmon returns using age and genetic composition of catch. University of Washington, School of Aquatic and Fishery Sciences, SAFS-UW-1202.

Dann, T. H., C. Habicht, J. R. Jasper, E. K. C. Fox, H. A. Hoyt, H. L. Liller, E. S. Lardizabal, P. A. Kuriscak, Z. D. Grauvogel, and W. D. Templin. 2012. Sockeye salmon baseline for the Western Alaska Salmon Stock Identification Program. Alaska Department of Fish and Game, Special Publication No. 12-12, Anchorage.

Eggers, D. M., M. D. Plotnick, and A. M. Carroll. 2010. Run forecasts and harvest projections for 2010 Alaska salmon fisheries and review of the 2009 season. Alaska Department of Fish and Game, Special Publication No. 10-12, Anchorage.

Fair, L. F., T. M. Willette, J. W. Erickson, R. J. Yanusz, and T. R. McKinley. 2010. Review of salmon escapement goals in Upper Cook Inlet, Alaska, 2011. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10-06, Anchorage.

Gelman, A., and D. B. Rubin. 1992. Inference from iterative simulation using multiple sequences. Statistical Science 7:457–511.

NRC (National Research Council). 1996. Upstream: Salmon and society in the Pacific Northwest. Committee on Protection and Management of Pacific Northwest Salmonids. National Academy Press, Washington, D.C.

Pearcy, W. 1992. Ocean ecology of North Pacific salmonids. University of Washington Press, Seattle.

Pella, J., and M. Masuda. 2001. Bayesian methods for analysis of stock mixtures from genetic characters. Fishery Bulletin 99:151–167.

Raftery, A. E., and Lewis, S. M. 1996. Implementing MCMC. Pages 115–130 [*In*] W. R. Gilks, S. Richardson, and D. J. Spiegelhalter, editors. Markov chain Monte Carlo in practice. Chapman and Hall, Inc., London.

Ricker, W. E. 1958. Maximum sustained yields from fluctuating environments and mixed stocks. Journal of the Fisheries Research Board of Canada 15:991–1006.

Shields, P. 2009. Upper Cook Inlet commercial fisheries annual management report, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-32, Anchorage.

Shields, P. 2010. Upper Cook Inlet commercial fisheries annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-54, Anchorage.

Shields, P., and M. Willette. 2007. Migratory timing and abundance estimates of sockeye salmon into Upper Cook Inlet, Alaska, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07-39, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-39.pdf

Shields, P., and M. Willette. 2011. Migratory timing and abundance estimates of sockeye salmon into Upper Cook Inlet, Alaska, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 11-74, Anchorage.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41:42–46.

REFERENCES CITED (Continued)

Tobias, T. M., and M. Willette. 2004. An estimate of total return of sockeye salmon to Upper Cook Inlet, Alaska 1976–2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A04-11, Anchorage.

TABLES AND FIGURES

Table 1.–Descriptions of fishery restrictions and coordinates (decimal degrees, WGS1984) to corresponding map points and lines on Figures 2 and 3.

Restriction #	Area Common Name	Description (Common Name)	Map Figure #	Map Point	Map Line	Latitude	Longitude
1	N/A	No restrictions	N/A				
2	Kasilof Corridor	Statistical Area 244-61	2				
3	Kenai Corridor	Statistical Area 244-51	2				
4	Area 1	Northern boundary (Latitude of the southern point of Kalgin Island)	3		a	60.3405	
		Southern boundary (Latitude of the Anchor Point light)			b	59.7698	
5	Area 2	Southwest point	3	1		60.3405	-151.9138
		Northwest point		2		60.6847	-151.6500
		Northeast point		3		60.6847	-151.4000
		Eastern midpoint (Blanchard Line corridor boundary)				60.4517	-151.4283
		Southeast point		5		60.3405	-151.4758
6	N/A	Miscellaneous areas representing small catches including; drift Areas 3 and 4 and Chinitna Bay. See Shields (2010).	4 N/A				
7	N/A	Within 1/2 mile of shore	N/A				
8	N/A	Fishing with set gillnets in the portion of the Western Subdistrict (Central District) south of the latitude of Redoubt Point.	2		c	60.2871	
9	N/A	One set gillnet no more than 35 fathoms in length	N/A				
10	N/A	Statistical Areas 247-41, 42, 43	2				
11	N/A	Statistical Areas 247-10, 20, 30	2				

Table 2.–Details for commercial fishery openings for sockeye salmon in Upper Cook Inlet with corresponding information for tissue sampling for genetic analysis in 2010.

District strata	Restrictions[a] /Subsection[b]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Sample Size Analyzed	Sample Size Collected
Central District drift gillnet (excluding corridor-only periods that were not sampled)								
	1	6/21	3,135	6/21	3,135	6/21–7/1	10	48
	1	6/24	5,452	6/24	5,452		29	169
	1	6/28	12,376	6/28	12,376		116	480
	1,2	7/1	44,171	7/1	44,171		245	480
	1	7/5	110,212	7/5	110,212	7/5-7/8	99	480
	1	7/8	243,891	7/8	243,891		301	480
	2,3,4	7/12	332,324	7/12	332,324	7/12	400	516
	2,3,4	7/15	246,973	7/15	246,973	7/15	400	542
	2,3,4	7/19	181,110	7/19	181,110	7/19–25	250	491
	2,3	7/21	31,485	7/21,7/24–25	45,406		28	144
	1	7/22	124,656	7/22	124,656		122	498
	1,2,3	7/26	89,635	7/26	89,635	7/26, 7/29	197	452
	2,3,4,5	7/29	76,218	7/29	76,218		203	490
	1,2,3	8/2	24,785	8/2	24,785	8/2–12	216	480
	1	8/5	13,387	8/5	13,387		174	480
	1,2,3	8/9	2,867	8/9	2,867		9	129
	1	8/12	580	8/12	580		1	32
	6			8/16-9/9	206		-	-
Central District drift gillnet (corridor-only periods that were not sampled)								
	2			6/27	66		-	-
	2			6/30	2,728		-	-
	2			7/3	2,293		-	-
	2			7/6	3,793		-	-
	2			7/7	721		-	-
	2,3			7/28	14,050		-	-
	2,3			7/31	3,357		-	-
	2,3			8/3	377		-	-
	2,3			8/4	1,168		-	-
	2,3			8/8	124		-	-
	2,3			8/10	39		-	-

-continued-

District strata	Restriction[a] /Subsectio[b]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Sample Size Analyzed	Collected
Kasilof Section set gillnet (Central District, Upper Subdistrict)								
	1a	6/28	11,700	6/27–28	30,694	6/27–7/3	111	192
	1b	6/28	3,112	6/27–28	8,628		31	96
	1a	7/1	11,388	6/30–7/3	52,165		188	192
	1b	7/1	4,354	6/30–7/3	19,333		70	96
	1a	7/5	17,107	7/5–6	26,209	7/5–10	151	192
	1b	7/5	5,885	7/5–6	8,202		47	144
	1a	7/8	8,808	7/7–8	17,618		102	192
	1b	7/8	2,119	7/7–8	6,589		38	144
	7a	7/10	6,637	7/10	6,637		38	96
	7b	7/10	4,110	7/10	4,110		24	48
	1a	7/12	27,595	7/12	27,595	7/12–17	77	240
	1b	7/12	16,027	7/12	16,027		44	192
	1,7a	7/15	20,964	7/14–15	32,748		91	240
	1,7b	7/15	21,102	7/14–15	25,860		72	192
	7a	7/18	21,379	7/17	34,133		95	96
	7b	7/18	8,909	7/17	7,590		21	72
	7a	7/18	21,379	7/18	21,379	7/18–24	89	96
	7b	7/18	8,909	7/18	8,909		38	72
	1a	7/19	15,072	7/19	15,072		64	240
	1b	7/19	6,271	7/19	6,271		26	192
	1a	7/22	4,831	7/21–24	26,750		113	192
	1b	7/22	6,431	7/21–24	16,635		70	192
	1a	7/26	12,304	7/25–26	17,543	7/25–31	113	192
	1b	7/26	5,842	7/25–26	8,633		55	144
	1a	7/29	9,364	7/28–31	25,351		162	192
	1b	7/29	3,449	7/28–31	10,923		70	144
	1a	8/2	7,714	8/2–3	12,486	8/2–12	139	192
	1b	8/2	2,128	8/2–3	3,577		40	144
	1a	8/5	1,564	8/4–5	7,911		88	187
	1b	8/5	756	8/4–5	3,204		35	96
	1a	8/9	1,650	8/8–12	5,499		61	96
	1b	8/9	1,248	8/8–12	3,309		37	48

-continued-

Table 2.–Page 3 of 5.

District strata	Restrictions[a] /Subsection[b]	Date(s) sampled	Harvest on sample date	Represent ed date(s)	Harvest represented	Mixture date(s)	Sample Size Analyzed	Sample Size Collected
Kenai/EF sections set gillnet (Central District, Upper Subdistrict)								
	1c	7/8	2,224	7/8	2,224	7/8–15	5	144
	1d	7/8	11,594	7/8	11,594		27	240
	1c	7/12	17,958	7/12	17,958		41	144
	1d	7/12	42,868	7/12	42,868		98	240
	1c	7/15	15,834	7/15	15,834		36	144
	1d	7/15	84,017	7/15	84,017		193	300
	1c	7/19	14,851	7/19	14,851	7/19–24	27	144
	1d	7/19	87,027	7/19	87,027		160	300
	1c	7/22	6,942	7/21–24	21,245		39	96
	1d	7/22	33,102	7/21–24	94,353		174	300
	1c	7/26	6,170	7/25–26	9,816	7/25–7/31	60	96
	1d	7/26	9,173	7/25–26	17,926		199	240
	1c	7/29	5,712	7/28–31	13,409		33	96
	1d	7/29	15,289	7/28–31	58,621		108	192
	1c	8/2	4,501	8/2	4,501	8/02–12	24	48
	1d	8/2	31,272	8/2	31,272		163	192
	1c	8/5	1,249	8/3–5	7,895		41	48
	1d	8/5	5,711	8/3–5	18,136		95	144
	1c	8/9	1,099	8/8–12	2,803		15	48
	1d	8/9	2,966	8/8–10	9,675		51	144
	1d	8/12	2,174	8/12	2,174		11	48
Kalgin Island Subdistrict set gillnet (Central District)								
	1	6/2	2,047	6/2–4	3,662	6/2–8/16	22	96
	1	6/7	2,839	6/7–11	5,107		30	96
	1	6/18	1,053	6/14–23	5,557		33	96
	1	6/28	890	6/28	890		5	96
	1	7/1	2,023	7/1–5	4,369		26	96
	1	7/12	1,550	7/8–12	3,611		22	144
	1	7/15	4,730	7/15	4,730		28	96
	1	7/19	4,877	7/19	4,877		29	96
	1	7/22	7,536	7/22	7,536		45	96
	1	7/26	5,656	7/26	5,656		34	96
	1	7/29	7,155	7/29–31	10,188		61	96
	1	8/2	2,283	8/2–5	4,656		28	96
	1	8/9	2,597	8/7–16	6,160		37	48

-continued-

Table 2.–Page 4 of 5.

District Strata	Restrictions[a] / Subsection[b]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Sample Size Analyzed	Sample Size Collected
Western Subdistrict set gillnet (Central District)								
				6/02–6/17	588		-	-
	1,8	6/28	1,728	6/21–29	4,474	6/21–8/9	38	48
	8	7/1	1,888	6/30–7/2	4,522		43	48
	8	7/5	3,223	7/3–7/6	9,485		85	96
	8	7/8	1,621	7/7–11	6,352		57	96
	8	7/15	2,379	7/12–15	7,690		69	96
	8	7/19	1,598	7/19–23	7,381		67	96
	8	7/26	325	7/24–28	2,810		25	48
	1,8	8/2	454	7/29–8/9	1,714		16	48
				8/12–19	151		-	-
Eastern Subdistrict set gillnet (Northern District)								
				5/31–7/01	2,579		-	-
	1	7/5	1,467	7/5	1,467	7/05–8/16	40	48
	1	7/8	516	7/8	516		25	48
	1	7/12	713	7/12	713		23	96
	1	7/15	1,876	7/15	1,876		62	96
	1	7/19	3,157	7/19	3,157		104	144
	9	7/22	1,421	7/22	1,421		47	96
	9	7/26	401	7/26	401		13	47
	9	7/29	793	7/29	793		26	48
	9	8/2	889	8/2	889		29	48
	9	8/5	245	8/5	245		12	48
	1	8/9	125	8/9–16	701		19	25
				8/19–9/13	293		-	-

-continued-

Table 2.–Page 5 of 5.

District strata	Restrictions[a] / Subsection[b]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Sample Size Analyzed	Sample Size Collected
General Subdistrict (Northeastern) set gillnet (Northern District)								
	1,10			5/31–6/28	39		-	-
	1,10	7/5	204	7/5	204	7/5–8/16	9	20
	1,10	7/12	1,101	7/8–12	1,556		66	76
	1,10	7/15	1,098	7/15	1,098		47	64
	1,10	7/19	1,510	7/19	1,510		64	144
	9,10	7/22	2,673	7/22	2,673		111	176
	9,10	7/26	757	7/26	757		34	104
	9,10	7/29	787	7/29	787		33	77
	9,10	8/2	577	8/2	577		11	11
	9,10	8/5	188	8/5	188		21	48
	1,10	8/9	26	8/9–16	73		4	6
				8/19–26	15		-	-
General Subdistrict (Southwestern) set gillnet (Northern District)								
	1,11			5/31–7/12	3,860		-	-
	1,11	7/15	2,474	7/15	2,474	7/15–8/16	84	96
	1,11	7/19	3,049	7/19	3,049		104	144
	9,11	7/22	2,502	7/22–26	2,834		97	144
	9,11	7/29	668	7/29	668		23	96
	9,11	8/2	1,352	8/2	1,352		46	48
	1,11	8/9	539	8/5–16	1,365		46	48
				8/19–26	47		-	-

Note: Corresponding restrictions to the fisheries and substrata are provided when applicable. Harvest numbers are given for all strata, including those that were not analyzed for stock composition.

[a] For description of restrictions see Table 1 and Figures 2 and 3.

[b] a) Cohoe/Ninilchik; b) South K. Beach; c) North K. Beach; d) North and South Salamatof.

Table 3.–Predetermined priors based on the best available information for the first stratum within each Upper Cook Inlet district, subdistrict, section, subsection, and test fishery in 2010. See text for methods used for determining priors.

		Reporting Group							
Gillnet fishery	Date	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Central District drift	June 21–July 1	0.02	0.18	0.01	0.01	0.01	0.04	0.24	0.49
Kasilof Section set	June 27–July 3	0.01	0.01	0.01	0.01	0.01	0.01	0.09	0.84
Kenai/EF sections set	July 8–15	0.01	0.01	0.01	0.01	0.02	0.02	0.69	0.22
Cohoe/Ninilchik Subsection set	June 27–August 12	0.01	0.05	0.01	0.01	0.01	0.01	0.35	0.55
South K. Beach Subsection set	June 27–August 12	0.01	0.01	0.01	0.01	0.01	0.02	0.39	0.54
North K. Beach Subsection set	July 8–August 12	0.01	0.01	0.01	0.01	0.01	0.01	0.50	0.44
North/South Salamatof Subsection set	July 8–August 12	0.01	0.02	0.01	0.03	0.03	0.08	0.74	0.07
Kalgin Island Subdistrict set	June 2–August 16	0.01	0.51	0.01	0.01	0.01	0.01	0.32	0.13
Western Subdistrict set	June 21–July 23	0.82	0.08	0.01	0.01	0.01	0.01	0.01	0.04
Eastern Subdistrict set	July 5–August 16	0.01	0.06	0.06	0.01	0.21	0.34	0.23	0.09
General Subdistrict set (Northeast)	July 5–August 16	0.01	0.01	0.01	0.03	0.55	0.37	0.01	0.01
General Subdistrict set (Southwest)	July 5–August 16	0.01	0.60	0.16	0.18	0.02	0.01	0.01	0.01
Offshore Test Fishery	July 1–4	0.02	0.24	0.02	0.01	0.03	0.04	0.33	0.31
Offshore Test Fishery (station 4)	July 1–26	0.03	0.08	0.06	0.03	0.05	0.04	0.68	0.03
Offshore Test Fishery (station 5)	July 1–29	0.02	0.18	0.04	0.05	0.01	0.03	0.52	0.15
Offshore Test Fishery (station 6)	July 1–28	0.06	0.13	0.02	0.04	0.02	0.03	0.53	0.16
Offshore Test Fishery (station 6.5)	July 2–29	0.04	0.19	0.04	0.06	0.02	0.01	0.49	0.15
Offshore Test Fishery (station 7)	July 1–29	0.08	0.18	0.04	0.02	0.01	0.04	0.48	0.15
Offshore Test Fishery (station 8)	July 2–28	0.26	0.18	0.01	0.06	0.01	0.03	0.38	0.06

Note: All priors for subsequent strata are based upon the posterior distribution (i.e., stock composition estimates) of preceding strata from the same district, subdistrict, section, subsection, or test fishery. See *Methods* for details. Priors for a given stratum may not sum to 1 due to rounding error.

Table 4.–Reporting group stock composition estimates including mean, standard deviation (SD), 90% credibility intervals (CI), sample size (n), and effective sample size (n_{eff}) for temporally grouped mixtures of sockeye salmon captured in the Cook Inlet offshore test fishery in 2010.

	Dates: 7/1–7/4; n = 358; n_{eff} = 357				Dates: 7/5–7/10; n = 464; n_{eff} = 464				Dates: 7/11–7/16; n = 448; n_{eff} = 448			
			90% CI				90% CI				90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	SD	5%	95%	Mean	SD	5%	95%
Crescent	0.05	0.01	0.03	0.07	0.02	0.01	0.01	0.03	0.03	0.01	0.02	0.04
West	0.16	0.02	0.11	0.20	0.17	0.02	0.14	0.21	0.13	0.02	0.10	0.16
JCL	0.03	0.01	0.01	0.04	0.04	0.01	0.02	0.05	0.03	0.01	0.02	0.04
SusYen	0.03	0.01	0.01	0.06	0.05	0.01	0.03	0.07	0.04	0.01	0.02	0.05
Fish	0.09	0.02	0.07	0.12	0.06	0.01	0.04	0.08	0.01	0.01	0.01	0.03
KTNE	0.05	0.01	0.03	0.07	0.05	0.01	0.03	0.07	0.04	0.01	0.02	0.05
Kenai	0.46	0.03	0.41	0.51	0.50	0.02	0.45	0.54	0.68	0.02	0.64	0.72
Kasilof	0.14	0.02	0.11	0.17	0.12	0.02	0.09	0.15	0.05	0.01	0.03	0.07

	Dates: 7/17–7/23; n = 390; n_{eff} = 389				Dates: 7/24–7/29; n = 426; n_{eff} = 426			
			90% CI				90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	SD	5%	95%
Crescent	0.04	0.01	0.02	0.06	0.03	0.01	0.02	0.05
West	0.12	0.02	0.10	0.15	0.11	0.02	0.09	0.14
JCL	0.05	0.01	0.03	0.07	0.02	0.01	0.01	0.03
SusYen	0.03	0.01	0.02	0.05	0.02	0.01	0.01	0.03
Fish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
KTNE	0.03	0.01	0.01	0.04	0.01	0.01	0.00	0.02
Kenai	0.71	0.02	0.67	0.75	0.78	0.02	0.74	0.81
Kasilof	0.02	0.01	0.01	0.04	0.03	0.01	0.01	0.04

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). Proportions for a given mixture may not sum to 1 due to rounding error.

Table 5.–Reporting group stock composition estimates including mean, standard deviation (SD), 90% credibility intervals (CI), sample size (n), and effective sample size (n_{eff}) for spatially grouped mixtures of sockeye salmon captured in the Cook Inlet offshore test fishery from July 1–29 2010.

	Station 4; n = 222; n_{eff} = 222				Station 5; n = 296; n_{eff} = 296				Station 6; n = 487; n_{eff} = 486			
			90% CI				90% CI				90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	SD	5%	95%	Mean	SD	5%	95%
Crescent	0.05	0.02	0.03	0.08	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.03
West	0.10	0.02	0.06	0.14	0.10	0.02	0.07	0.14	0.13	0.02	0.11	0.16
JCL	0.04	0.01	0.02	0.06	0.02	0.01	0.01	0.03	0.04	0.01	0.03	0.06
SusYen	0.04	0.02	0.02	0.07	0.04	0.01	0.02	0.06	0.04	0.01	0.02	0.06
Fish	0.04	0.01	0.02	0.06	0.02	0.01	0.01	0.04	0.05	0.01	0.03	0.07
KTNE	0.03	0.01	0.01	0.06	0.04	0.01	0.02	0.06	0.03	0.01	0.02	0.05
Kenai	0.63	0.03	0.58	0.69	0.69	0.03	0.64	0.74	0.63	0.02	0.59	0.66
Kasilof	0.07	0.02	0.04	0.10	0.07	0.02	0.05	0.10	0.06	0.01	0.04	0.08

	Station 6.5; n = 528; n_{eff} = 528				Station 7; n = 381; n_{eff} = 380				Station 8; n = 172; n_{eff} = 172			
			90% CI				90% CI				90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	SD	5%	95%	Mean	SD	5%	95%
Crescent	0.01	0.01	0.00	0.02	0.05	0.01	0.03	0.07	0.09	0.02	0.05	0.13
West	0.15	0.02	0.12	0.18	0.15	0.02	0.12	0.19	0.15	0.03	0.10	0.21
JCL	0.04	0.01	0.03	0.06	0.02	0.01	0.01	0.04	0.01	0.01	0.00	0.03
SusYen	0.04	0.01	0.02	0.05	0.04	0.01	0.02	0.05	0.01	0.01	0.00	0.04
Fish	0.04	0.01	0.02	0.05	0.02	0.01	0.01	0.04	0.03	0.01	0.01	0.06
KTNE	0.03	0.01	0.02	0.04	0.03	0.01	0.02	0.05	0.05	0.02	0.02	0.09
Kenai	0.64	0.02	0.60	0.67	0.60	0.03	0.56	0.65	0.58	0.04	0.52	0.65
Kasilof	0.06	0.01	0.04	0.08	0.08	0.02	0.06	0.11	0.06	0.02	0.03	0.10

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). Proportions for a given mixture may not sum to 1 due to rounding error.

Table 6.–Reporting group stock composition estimates including mean, standard deviation (SD), 90% credibility intervals (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the Kenai/EF sections and Kasilof Section set gillnet fisheries (Central District, Upper Subdistrict) analyzed by subsection in 2010.

	Cohoe/Ninilchik				South K. Beach			
	Dates: 6/25–8/10				Dates: 6/26–8/10			
	n = 1591; n_{eff} = 1587				n = 718; n_{eff} = 718			
			90% CI				90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	SD	5%	95%
Crescent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West	0.07	0.01	0.06	0.08	0.02	0.01	0.01	0.03
JCL	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
SusYen	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Fish	0.01	0.00	0.01	0.02	0.01	0.00	0.00	0.01
KTNE	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.01
Kenai	0.48	0.01	0.46	0.50	0.42	0.02	0.39	0.45
Kasilof	0.42	0.01	0.40	0.44	0.55	0.02	0.52	0.59

	North K. Beach				North/South Salamatof			
	Dates: 7/10–8/10				Dates: 7/10–8/10;			
	n = 321; n_{eff} = 321				n = 1279; n_{eff} = 1278			
			90% CI				90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	SD	5%	95%
Crescent	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West	0.00	0.01	0.00	0.02	0.02	0.00	0.01	0.03
JCL	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.02
SusYen	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.02
Fish	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.04
KTNE	0.00	0.00	0.00	0.01	0.05	0.01	0.04	0.07
Kenai	0.78	0.02	0.73	0.81	0.84	0.01	0.82	0.86
Kasilof	0.22	0.02	0.18	0.26	0.03	0.00	0.02	0.03

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). Proportions for a given mixture may not sum to 1 due to rounding error.

Table 7.–Stock-specific harvest, standard deviation (SD), and 90% credibility intervals calculated using a stratified estimator (see text) for combined temporal strata in the Central (4 area strata) and Northern (1 area stratum) districts and based on genetic analysis of mixtures of sockeye salmon harvested in the Upper Cook Inlet in 2010.

Area strata	Reporting Group	Harvest	SD	90% CI 5%	90% CI 95%	Relative Error
Central District drift gillnet (excluding corridor-only periods that were not sampled)						
	Crescent	8,767	2,825	4,698	13,888	52%
	West	122,890	10,349	106,305	140,382	14%
	JCL	45,917	5,897	36,645	56,041	21%
	SusYen	47,651	6,826	36,957	59,422	24%
	Fish	61,092	6,881	50,212	72,804	18%
	KTNE	45,364	6,644	35,072	56,808	24%
	Kenai	1,105,191	15,888	1,078,815	1,131,071	2%
	Kasilof	120,306	9,084	105,803	135,616	12%
	Harvest represented	1,557,178				
	Harvest unanalyzed	206				
	Total harvest	1,557,384				
Central District drift gillnet (corridor-only periods that were not sampled)						
	Harvest unanalyzed	28,716				
Central District, Upper Subdistrict set gillnet						
	Crescent	1,076	799	172	2,640	115%
	West	31,350	3,035	26,512	36,490	16%
	JCL	7,191	1,605	4,793	10,015	36%
	SusYen	7,115	2,003	4,128	10,649	46%
	Fish	21,883	3,096	17,076	27,250	23%
	KTNE	26,569	3,055	21,774	31,795	19%
	Kenai	692,977	8,027	679,713	706,122	2%
	Kasilof	297,628	6,792	286,508	308,888	4%
	Harvest represented	1,085,789				
	Harvest unanalyzed	0				
	Total harvest	1,085,789				
Central District, Western[a] and Kalgin Island subdistricts set gillnet						
	Crescent	1,129	487	443	2,020	70%
	West	38,102	1,737	35,226	40,942	7%
	JCL	305	306	0	896	147%
	SusYen	715	695	26	2,201	152%
	Fish	772	374	268	1,463	77%
	KTNE	402	355	40	1,116	134%
	Kenai	20,359	1,605	17,751	23,047	13%
	Kasilof	5,214	938	3,761	6,839	30%
	Harvest represented	66,999				
	Harvest unanalyzed	45,167[a]				
	Total harvest	112,166				

-continued-

Table 7.–Page 2 of 2.

Area strata	Reporting Group	Harvest	SD	90% CI 5%	95%	Relative Error
Northern District, Eastern and General subdistricts set gillnet						
	Crescent	1	6	0	4	195%
	West	8,222	358	7,635	8,812	7%
	JCL	2,238	250	1,839	2,660	18%
	SusYen	2,943	294	2,474	3,440	16%
	Fish	10,156	385	9,524	10,792	6%
	KTNE	6,660	403	6,007	7,333	10%
	Kenai	3,025	285	2,567	3,505	16%
	Kasilof	99	61	19	212	98%
	Harvest represented	33,344				
	Harvest unanalyzed	6,833				
	Total harvest	40,177				

Note: Harvest numbers of unrepresented strata (unanalyzed) and relative error rates are given.

[a] Harvest from the Western Subdistrict is not represented because the chains in the BAYES analysis failed to converge.

Table 8.–Stock-specific harvest, standard deviation (SD), and 90% credibility intervals calculated using a stratified estimator (see text) for combined temporal strata in all fishing area strata and based on genetic analysis of mixtures of sockeye salmon harvested in the Upper Cook Inlet, 2005-2010.

				90% CI		
Year	Reporting Group	Harvest	SD	5%	95%	Relative Error
2005	Crescent	14,569	8,876	64	30,065	103%
	West	33,352	8,588	21,097	48,742	41%
	JCL	27,178	6,600	17,361	38,890	40%
	SusYen	27,748	8,854	15,231	43,673	51%
	Fish	3,935	2,910	108	9,440	119%
	KTNE	14,820	5,975	6,866	26,026	65%
	Kenai	2,936,487	38,418	2,872,816	2,999,501	2%
	Kasilof	1,019,935	36,141	960,699	1,079,433	6%
	Harvest represented	4,078,024				
	Harvest unanalyzed[a]	1,157,465				
	Total harvest	5,235,489				
2006	Crescent	27,109	1,673	25,279	30,476	10%
	West	53,574	5,264	45,402	62,677	16%
	JCL	16,230	2,445	12,415	20,434	25%
	SusYen	28,231	4,075	21,944	35,250	24%
	Fish	333	503	7	1,248	186%
	KTNE	17,350	3,010	12,645	22,526	28%
	Kenai	577,512	11,902	558,050	597,296	3%
	Kasilof	1,324,611	11,635	1,305,342	1,343,687	1%
	Harvest represented	2,044,950				
	Harvest unanalyzed[a]	143,252				
	Total harvest	2,188,202				
2007	Crescent	54,001	4,772	46,973	62,559	14%
	West	153,205	14,739	129,922	178,433	16%
	JCL	134,100	13,723	112,161	157,216	17%
	SusYen	104,842	19,335	74,128	137,684	30%
	Fish	8,199	3,192	3,955	14,181	62%
	KTNE	74,235	11,628	55,825	94,015	26%
	Kenai	1,920,986	30,389	1,870,844	1,970,492	3%
	Kasilof	687,091	25,806	645,072	730,015	6%
	Harvest represented	3,136,659				
	Harvest unanalyzed[a]	177,662				
	Total harvest	3,314,321				

-continued-

Table 8.–Page 2 of 2.

Year	Reporting Group	Harvest	SD	90% CI 5%	90% CI 95%	Relative Error
2008	Crescent	20,145	2,359	16,499	24,243	19%
	West	63,717	5,880	54,582	73,860	15%
	JCL	66,315	6,848	55,472	77,926	17%
	SusYen	47,092	8,162	34,396	61,204	28%
	Fish	3,516	1,490	1,471	6,181	67%
	KTNE	47,826	5,582	39,180	57,511	19%
	Kenai	875,430	19,876	842,868	908,403	4%
	Kasilof	1,111,226	19,076	1,079,760	1,142,403	3%
	Harvest represented	2,235,267				
	Harvest unanalyzed[a]	142,378				
	Total harvest	2,377,645				
2009	Crescent	59,630	4,182	54,305	67,836	11%
	West	163,460	10,286	147,142	181,011	10%
	JCL	45,224	6,127	35,567	55,619	22%
	SusYen	57,296	9,153	42,976	72,923	26%
	Fish	37,648	5,514	29,186	47,195	24%
	KTNE	54,198	6,080	44,734	64,676	18%
	Kenai	943,784	18,379	913,625	974,061	3%
	Kasilof	670,243	15,395	645,021	695,614	4%
	Harvest represented	2,031,483				
	Harvest unanalyzed[a]	9,797				
	Total harvest	2,041,280				
2010[b]	Crescent	10,973	2,964	6,634	16,280	44%
	West	200,564	10,959	182,817	218,966	9%
	JCL	55,651	6,129	45,988	66,083	18%
	SusYen	58,424	7,138	47,279	70,579	20%
	Fish	93,903	7,568	81,848	106,690	13%
	KTNE	78,995	7,317	67,453	91,510	15%
	Kenai	1,821,552	17,953	1,791,737	1,850,689	2%
	Kasilof	423,248	11,355	404,988	442,184	4%
	Harvest represented	2,743,310				
	Harvest unanalyzed[a]	80,922				
	Total harvest	2,824,232				

Note: Harvest numbers of unrepresented strata (unanalyzed) and relative error rates are given.

[a] Excludes unrepresented harvest from Kustatan (2005, 2,666 fish; 2006, 3,896 fish; 2007, 2,453 fish; 2008, 1,852 fish; 2009, 4,495 fish; and 2010, 2,553 fish) and Chinitna (2005, 13 fish; 2006, 108 fish; 2007, 4 fish; 2008, 4 fish; and 2009, 18 fish) subdistricts.

[b] Harvest from the Western Subdistrict is not represented because the chains in the BAYES analysis failed to converge.

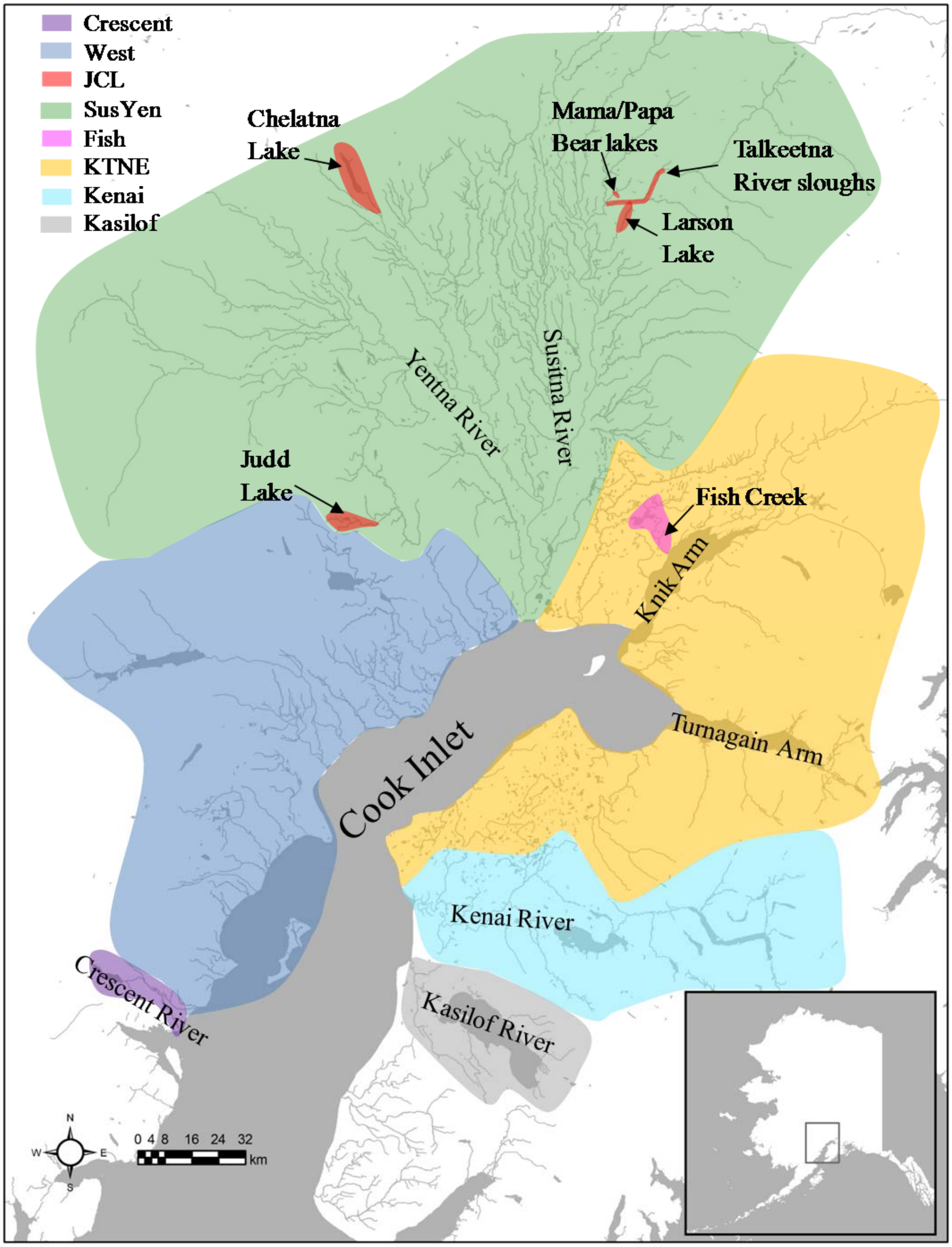

Figure 1.–Map of Upper Cook Inlet showing reporting group areas for mixed stock analysis using genetic markers for sockeye salmon.

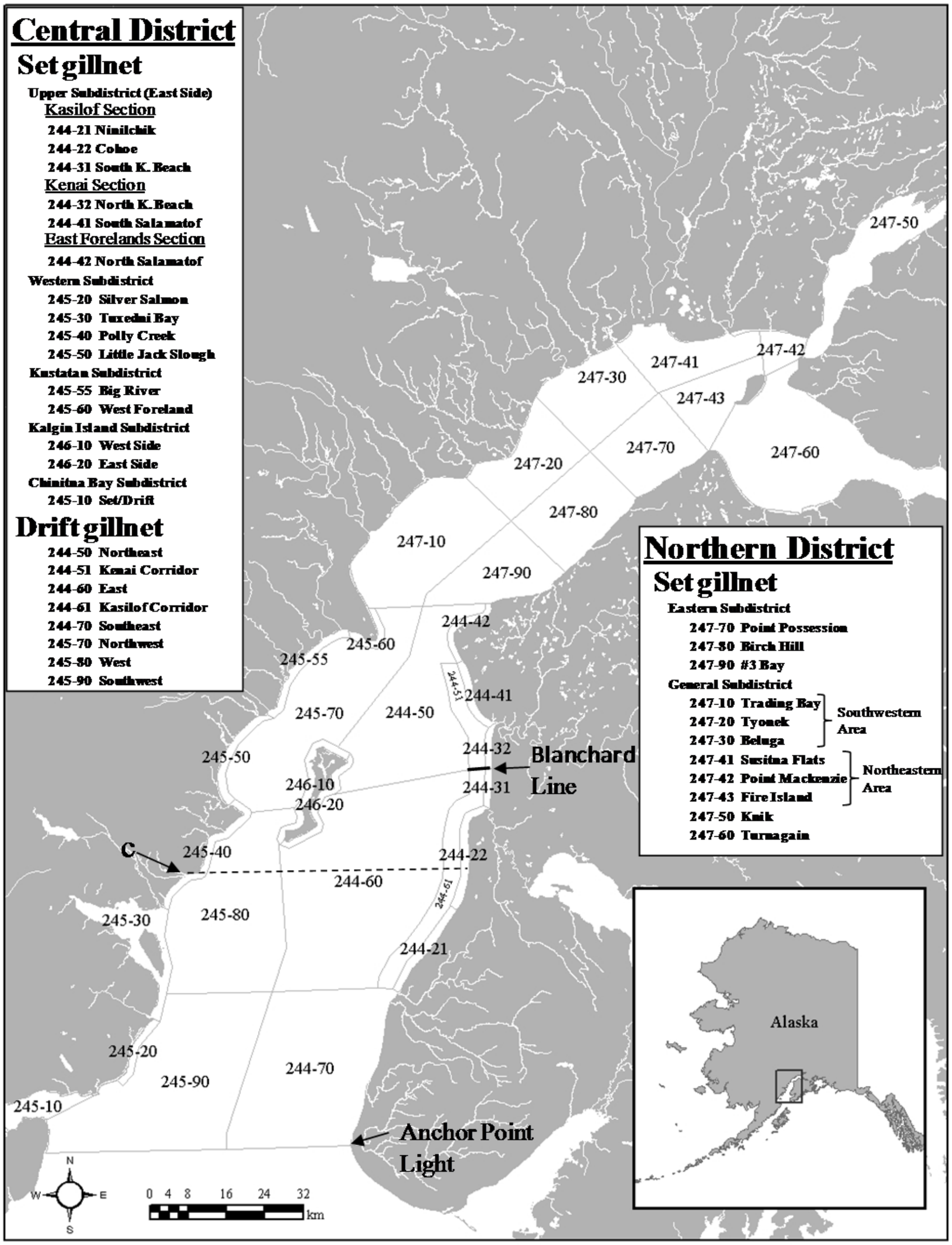

Figure 2.–Map of Upper Cook Inlet showing commercial fishing boundaries (statistical areas) for subdistricts and selected sections and subsections within the Northern and Central districts for both set and drift gillnet fisheries (see Table 1 for description of lines [letter]).

Note: Districts, subdistricts, and sections are defined in Alaska Administrative Code 21.200. For the purposes of this report the statistical areas in Upper Subdistrict (Central District) are referred to as subsections.

Figure 3.–Map of Upper Cook Inlet showing management fishing boundaries for the Central District drift gillnet fishery (see Table 1 for description of points [numbers] and lines [letters]).

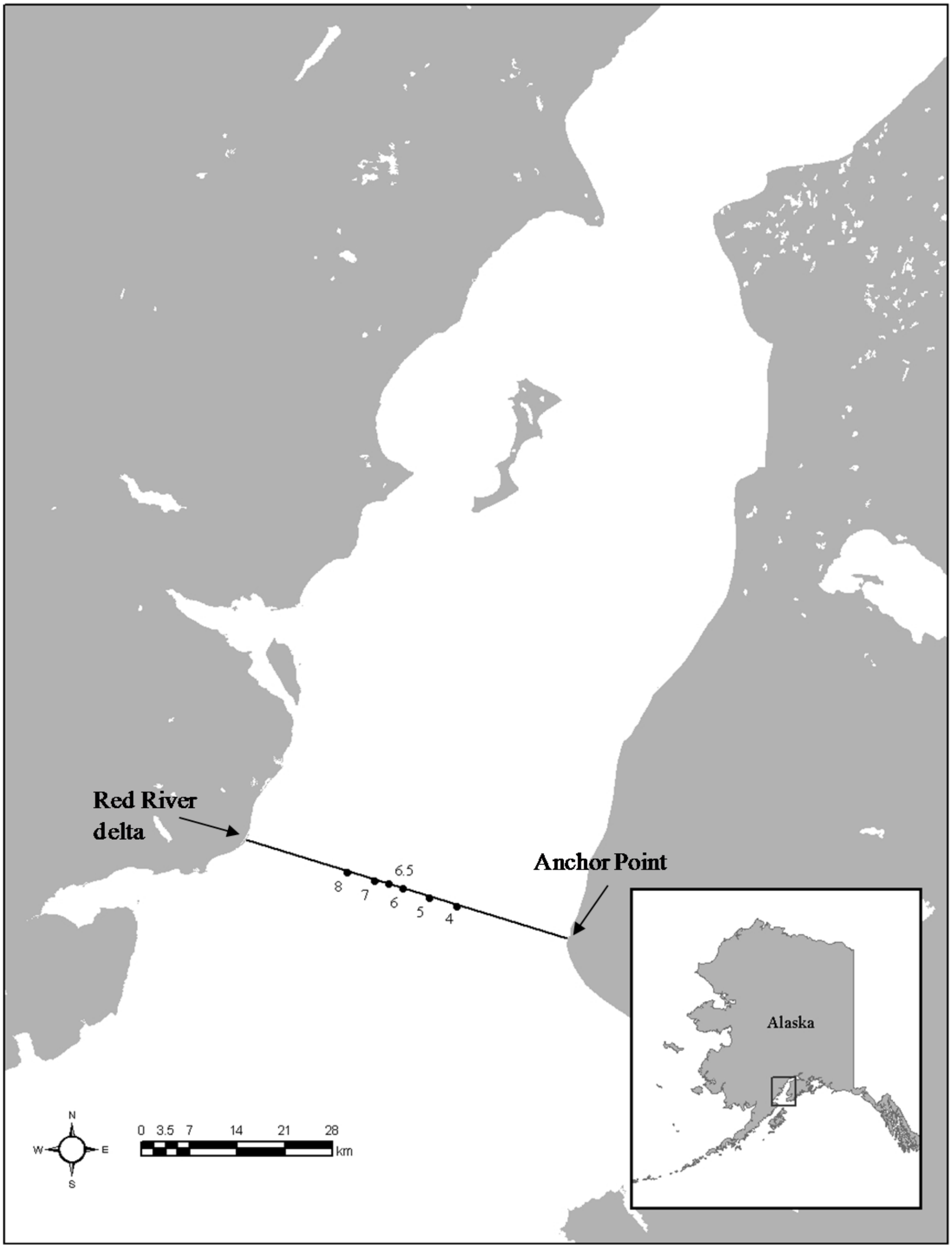

Figure 4.–Offshore test fishery stations for sockeye salmon migrating into Upper Cook Inlet, Alaska.

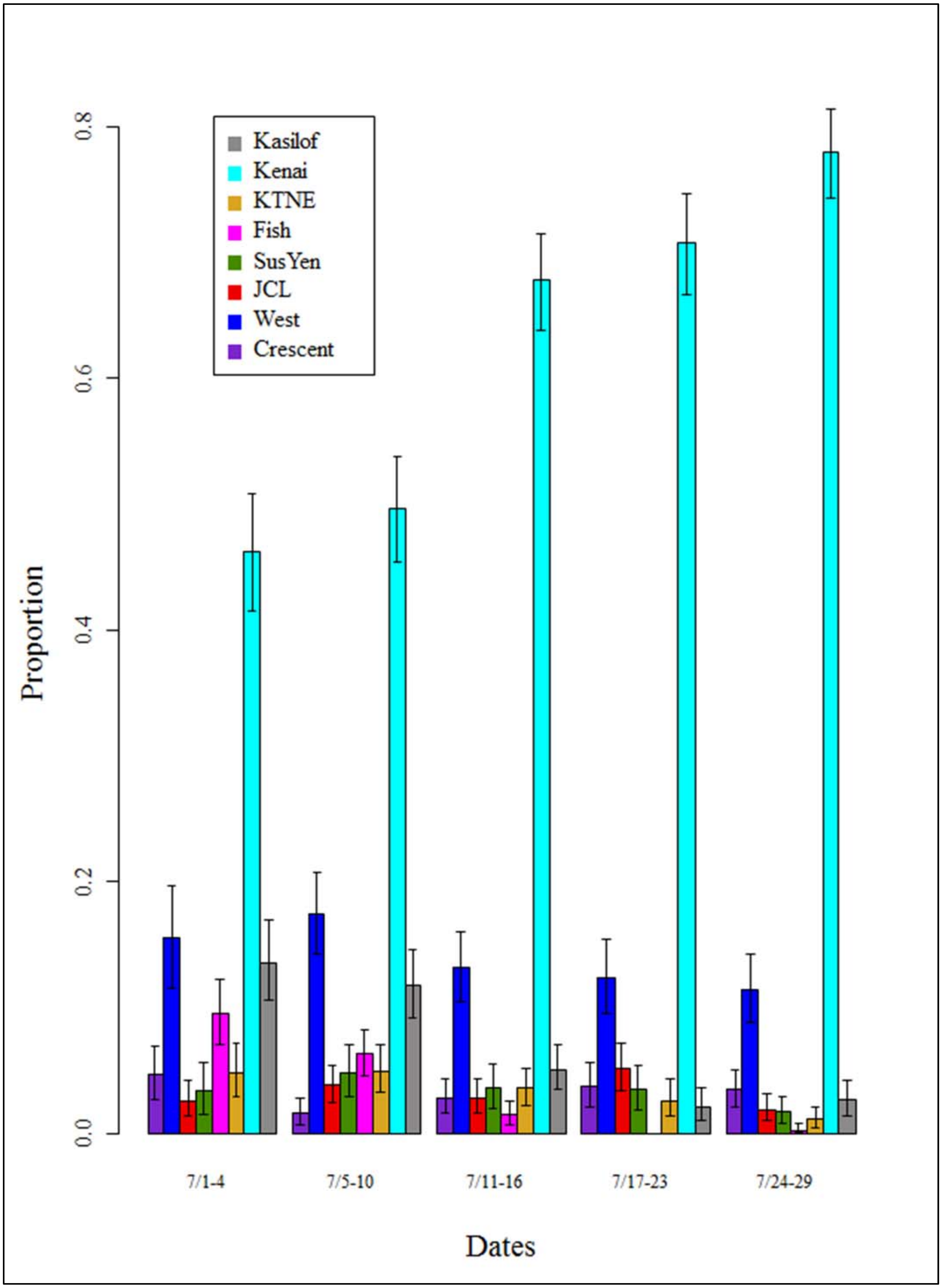

Figure 5.–Stock composition estimates and 90% credibility intervals by temporal stratum for the offshore test fishery from 2010.

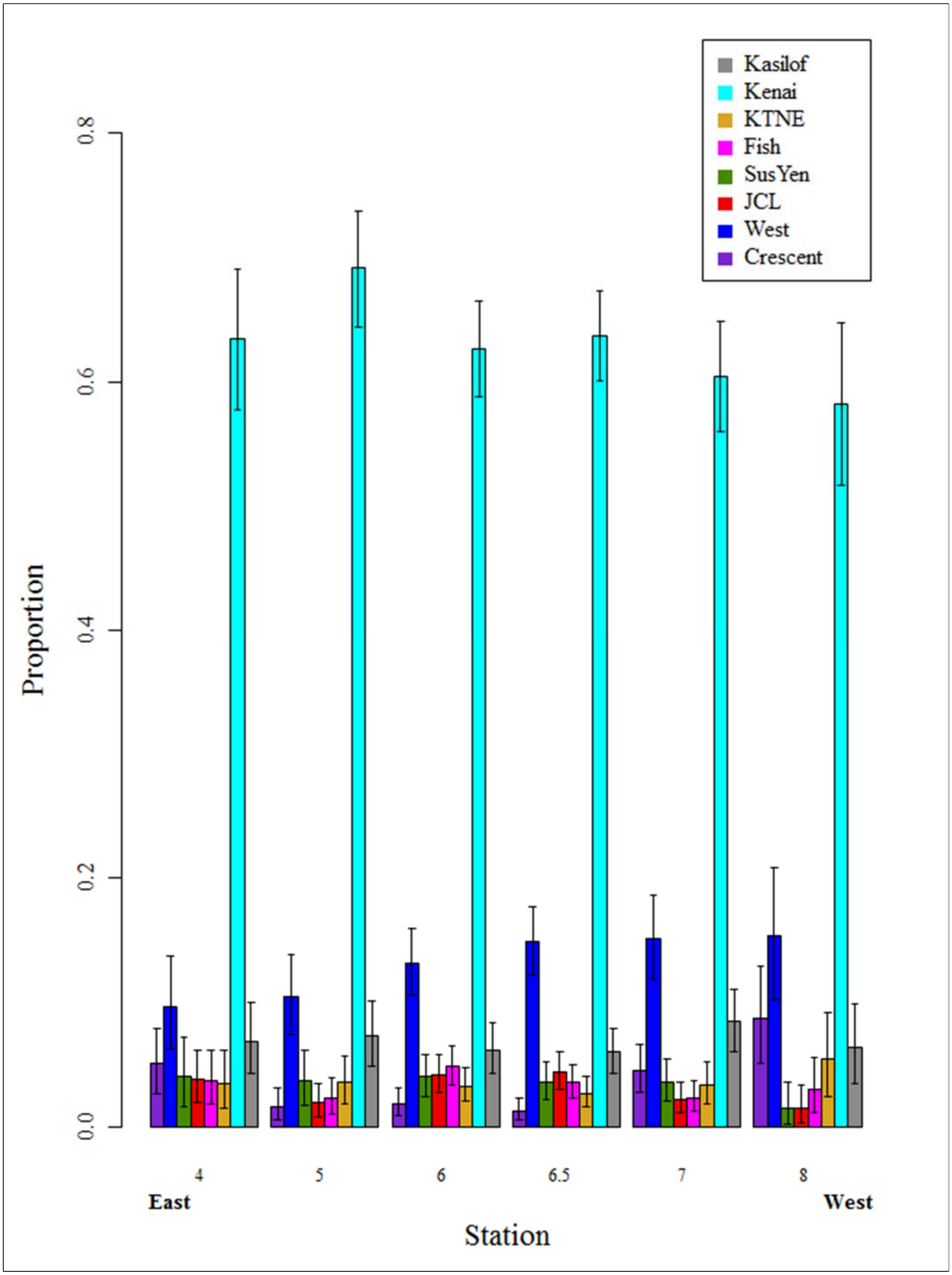

Figure 6.–Stock composition estimates and 90% credibility intervals by station for the offshore test fishery from 2010.

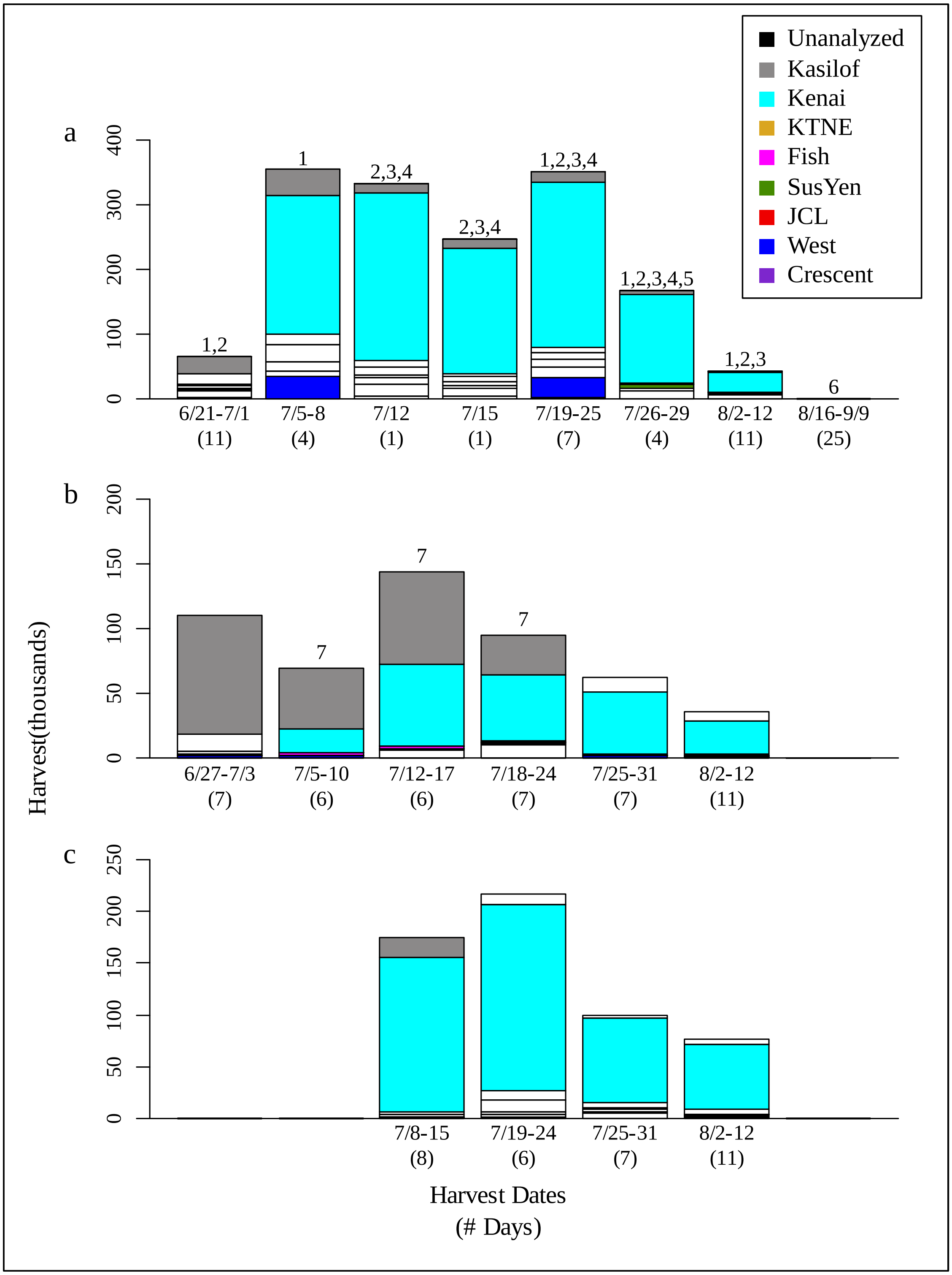

Figure 7.–Estimates of harvest by stock for the a) Central District drift gillnet fishery (excluding corridor-only periods that were not sampled); b) Kasilof Section set gillnet fishery (Central District, Upper Subdistrict); and c) Kenai/East Forelands sections set gillnet fishery (Central District, Upper Subdistrict) in 2010 for specified date ranges (number of days). Numbers above the bars indicate the fishery restrictions during temporal strata (see Tables 1 and 2). Only the drift gillnet fishery (a) contains unrepresented (unanalyzed) strata.

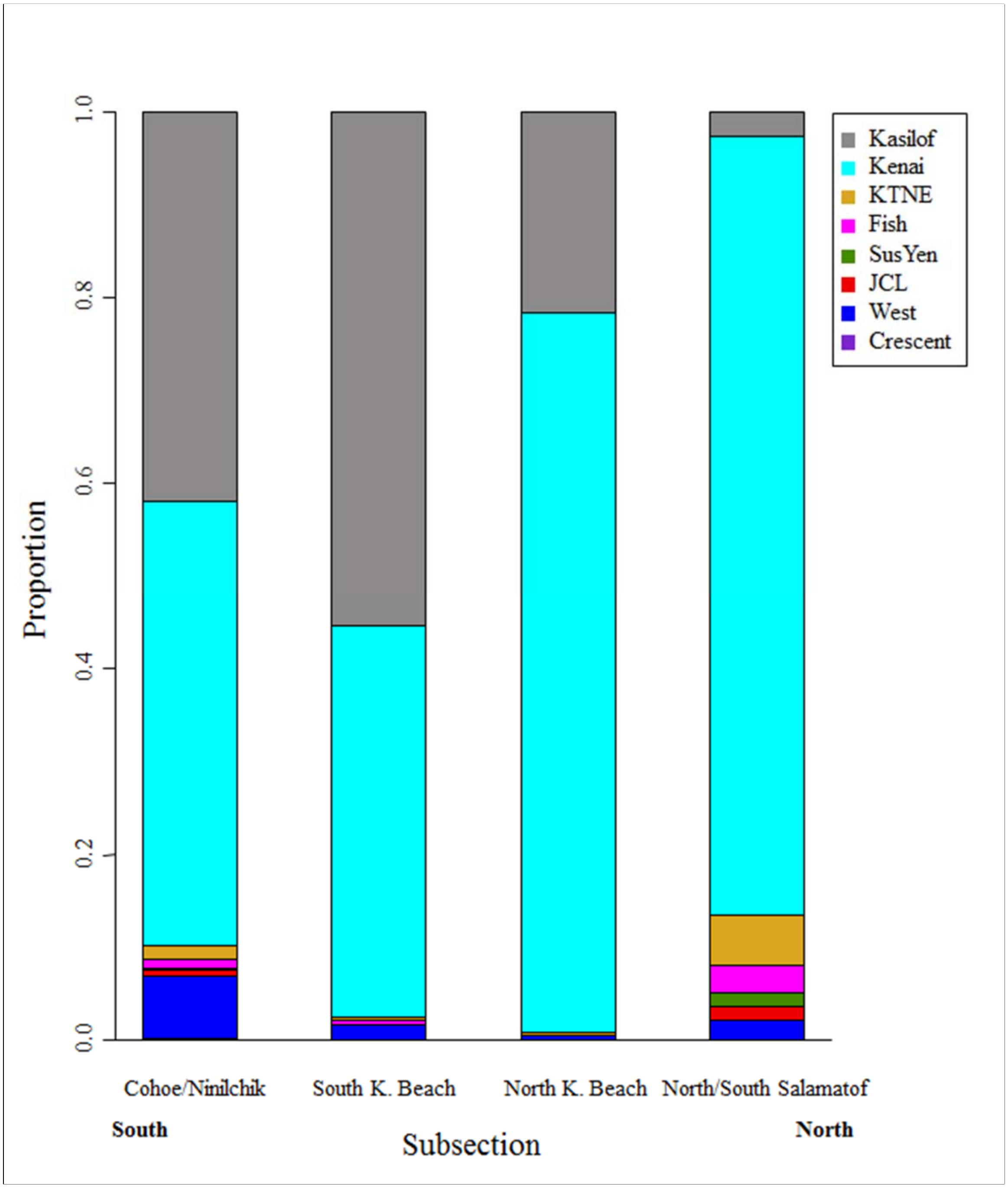

Figure 8.–Stock composition estimates for the Kasilof and Kenai/East Forelands sections set gillnet fisheries (Central District, Upper Subdistrict) in 2010 divided into subsections.

Note: There are 2 subdistricts for each section and they are displayed from south to north.

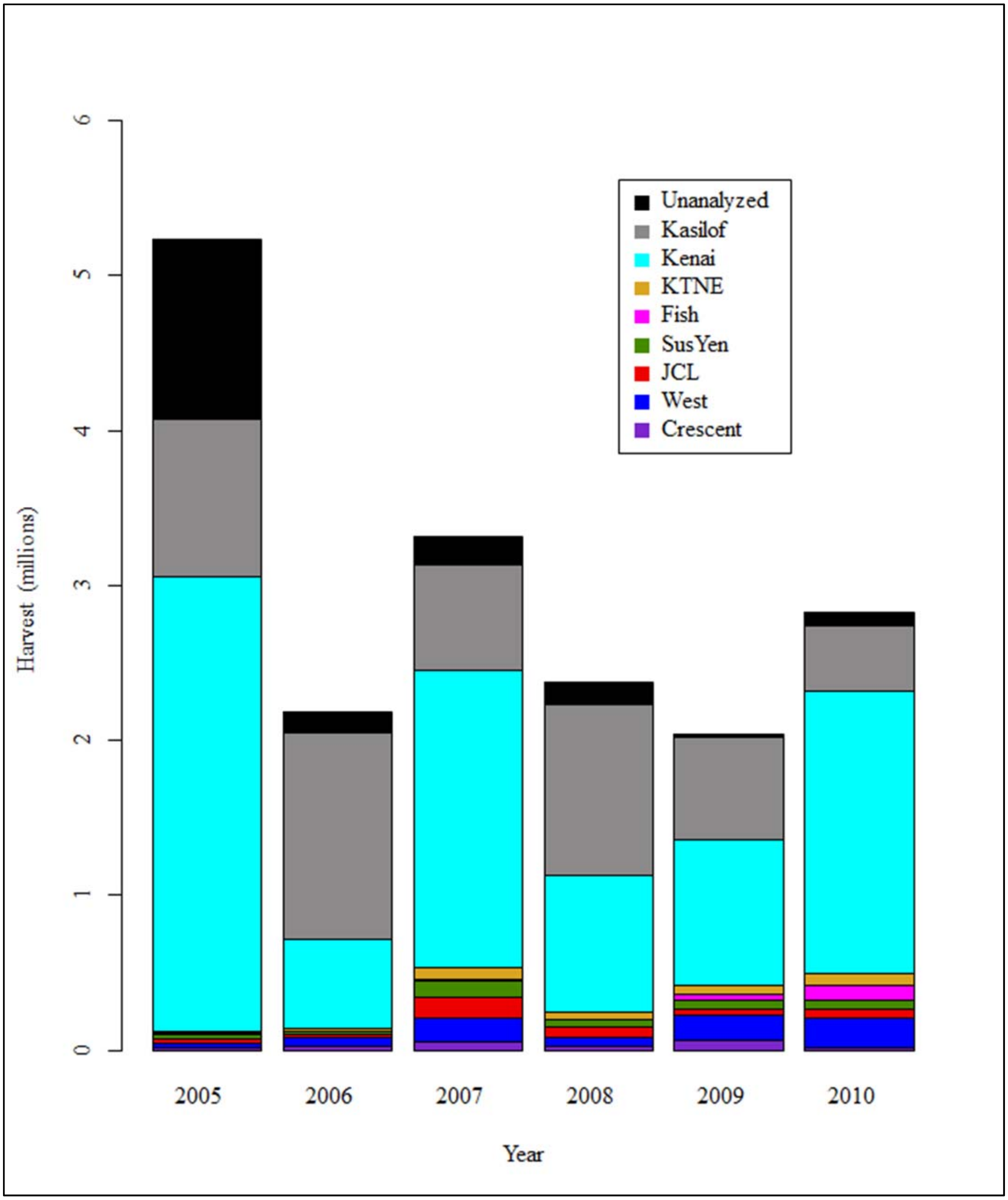

Figure 9.–Estimates of harvest by stock in the Upper Cook Inlet sockeye salmon fishery calculated using a stratified estimator for all strata within years from 2005 to 2010.

APPENDIX A

Appendix A1.–Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the Central District drift gillnet fishery (excluding corridor-only periods that were not sampled) in 2010.

Dates: 6/21–7/1	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 65,134		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.02	0.01	0.01	0.04	1,505	718	2,498
West	0.16	0.02	0.13	0.19	10,367	8,209	12,654
JCL	0.02	0.01	0.01	0.03	1,118	508	1,907
SusYen	0.03	0.01	0.02	0.04	1,856	990	2,917
Fish	0.06	0.01	0.04	0.08	3,909	2,704	5,285
KTNE	0.05	0.01	0.03	0.08	3,480	2,153	5,007
Kenai	0.24	0.02	0.21	0.28	15,940	13,530	18,438
Kasilof	0.41	0.03	0.37	0.46	26,958	24,250	29,690

Dates: 7/5–7/8	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 354,103		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	23	0	68
West	0.10	0.02	0.07	0.13	34,443	25,565	44,268
JCL	0.04	0.01	0.02	0.06	13,964	8,687	20,188
SusYen	0.02	0.01	0.01	0.04	8,727	4,374	14,258
Fish	0.07	0.01	0.05	0.10	25,757	18,583	33,771
KTNE	0.05	0.01	0.03	0.06	15,969	10,076	22,827
Kenai	0.61	0.03	0.56	0.65	214,795	199,834	229,425
Kasilof	0.11	0.02	0.09	0.14	40,424	31,227	50,425

Date: 7/12	Stock proportion (n = 400; n_{eff} = 399)				Harvest = 332,324		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.01	0.01	0.00	0.02	2,533	355	5,830
West	0.06	0.01	0.04	0.08	18,803	12,753	25,702
JCL	0.02	0.01	0.01	0.03	5,142	2,107	9,126
SusYen	0.03	0.01	0.02	0.05	10,569	5,405	16,885
Fish	0.04	0.01	0.02	0.05	12,123	7,284	17,863
KTNE	0.03	0.01	0.02	0.05	10,103	5,219	15,985
Kenai	0.78	0.02	0.74	0.81	258,558	246,057	270,472
Kasilof	0.04	0.01	0.03	0.06	14,491	8,652	21,397

-continued-

Date: 7/15	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 246,973		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.01	0.01	0.00	0.03	3,467	1,082	6,711
West	0.05	0.01	0.03	0.07	11,968	7,788	16,850
JCL	0.03	0.01	0.01	0.04	6,336	3,456	9,893
SusYen	0.02	0.01	0.01	0.03	4,207	1,511	8,335
Fish	0.03	0.01	0.02	0.05	8,028	4,592	12,106
KTNE	0.02	0.01	0.01	0.03	3,894	1,447	7,130
Kenai	0.78	0.02	0.75	0.82	193,473	184,453	202,090
Kasilof	0.06	0.01	0.04	0.09	15,599	10,691	21,153

Dates: 7/19–7/25	Stock proportion (n = 400; n_{eff} = 397)				Harvest = 351,172		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.01	1,230	60	3,673
West	0.09	0.02	0.06	0.12	31,132	20,397	42,415
JCL	0.04	0.01	0.02	0.05	13,016	7,897	19,113
SusYen	0.04	0.01	0.03	0.06	15,406	9,177	22,679
Fish	0.03	0.01	0.02	0.04	9,579	5,308	14,793
KTNE	0.03	0.01	0.01	0.05	9,658	4,641	16,474
Kenai	0.73	0.02	0.69	0.77	254,967	240,601	268,884
Kasilof	0.05	0.01	0.03	0.07	16,184	9,936	23,446

Dates: 7/26 and 7/29	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 165,853		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	5	0	1
West	0.07	0.01	0.05	0.09	11,192	7,941	14,889
JCL	0.03	0.01	0.02	0.04	4,541	2,537	6,985
SusYen	0.03	0.01	0.02	0.05	5,099	2,732	7,949
Fish	0.01	0.00	0.00	0.02	1,358	378	2,825
KTNE	0.01	0.01	0.00	0.02	1,812	631	3,459
Kenai	0.82	0.02	0.78	0.85	135,847	130,177	141,190
Kasilof	0.04	0.01	0.02	0.05	5,999	3,486	9,005

-continued-

Appendix A1.–Page 3 of 3.

Dates: 8/2–8/12	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 41,619		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	3	0	3
West	0.12	0.02	0.09	0.15	4,985	3,871	6,197
JCL	0.04	0.01	0.03	0.06	1,800	1,145	2,566
SusYen	0.04	0.01	0.03	0.06	1,785	1,044	2,645
Fish	0.01	0.00	0.00	0.02	337	93	702
KTNE	0.01	0.01	0.00	0.02	447	141	881
Kenai	0.76	0.02	0.72	0.80	31,611	30,043	33,108
Kasilof	0.02	0.01	0.01	0.03	651	244	1,190

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). The 90% credibility intervals of harvest estimates may not include the point estimate for the very low extrapolated harvest numbers because fewer than 5% of iterations had values above zero. Proportions for a given mixture may not sum to 1 due to rounding error.

Appendix A2.–Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the Kasilof Section set gillnet fishery (Central District, Upper Subdistrict) in 2010.

Dates: 6/27–7/3	Stock proportion (n = 400; n_{eff} = 399)				Harvest = 110,820		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.01	246	0	821
West	0.02	0.01	0.01	0.03	2,061	908	3,534
JCL	0.00	0.00	0.00	0.00	3	0	1
SusYen	0.00	0.00	0.00	0.00	3	0	1
Fish	0.01	0.00	0.00	0.02	796	189	1,717
KTNE	0.02	0.01	0.01	0.03	1,982	914	3,363
Kenai	0.12	0.02	0.10	0.15	13,782	10,763	17,072
Kasilof	0.83	0.02	0.80	0.86	91,946	88,292	95,383

Dates: 7/5–7/10	Stock proportion n = 400; n_{eff} = 399)				Harvest = 69,365		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.01	0.01	0.00	0.02	480	0	1,167
West	0.03	0.01	0.01	0.05	1,971	1,015	3,160
JCL	0.00	0.00	0.00	0.01	177	5	535
SusYen	0.00	0.00	0.00	0.00	6	0	3
Fish	0.02	0.01	0.01	0.04	1,656	860	2,637
KTNE	0.01	0.01	0.00	0.02	530	111	1,197
Kenai	0.26	0.02	0.22	0.30	17,790	15,131	20,549
Kasilof	0.67	0.03	0.63	0.71	46,755	43,869	49,569

Dates: 7/12–7/17	Stock proportion (n = 400; n_{eff} = 398)				Harvest = 143,953		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	5	0	2
West	0.05	0.01	0.03	0.07	6,878	4,363	9,820
JCL	0.00	0.00	0.00	0.00	20	0	70
SusYen	0.00	0.00	0.00	0.01	368	19	1,104
Fish	0.01	0.01	0.01	0.02	1,834	725	3,339
KTNE	0.00	0.00	0.00	0.01	367	19	1,089
Kenai	0.44	0.03	0.40	0.48	63,072	56,989	69,215
Kasilof	0.50	0.03	0.45	0.54	71,409	65,289	77,566

-continued-

Appendix A2.–Page 2 of 2.

Dates: 7/18–7/24	Stock proportion (n = 400; n_{eff} = 399)				Harvest = 95,016		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	5	0	2
West	0.11	0.02	0.09	0.14	10,891	8,288	13,706
JCL	0.00	0.00	0.00	0.01	310	0	949
SusYen	0.01	0.01	0.00	0.02	833	50	2,320
Fish	0.00	0.00	0.00	0.01	293	11	878
KTNE	0.01	0.01	0.01	0.02	1,259	488	2,309
Kenai	0.53	0.03	0.49	0.58	50,761	46,621	54,857
Kasilof	0.32	0.02	0.28	0.36	30,664	26,938	34,503

Dates: 7/25–7/31	Stock proportion (n = 400; n_{eff} = 399)				Harvest = 62,450		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	2	0	1
West	0.03	0.01	0.02	0.05	2,033	1,088	3,168
JCL	0.01	0.00	0.00	0.01	368	55	865
SusYen	0.00	0.00	0.00	0.01	56	0	390
Fish	0.01	0.00	0.00	0.01	320	57	759
KTNE	0.01	0.00	0.00	0.02	471	131	984
Kenai	0.77	0.02	0.74	0.81	48,238	45,905	50,463
Kasilof	0.18	0.02	0.14	0.21	10,961	8,972	13,074

Dates: 8/2–8/12	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 35,986		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	1	0	0
West	0.04	0.01	0.02	0.07	1,571	850	2,409
JCL	0.01	0.01	0.00	0.02	395	138	754
SusYen	0.00	0.00	0.00	0.00	3	0	2
Fish	0.00	0.00	0.00	0.00	1	0	0
KTNE	0.02	0.01	0.01	0.04	856	414	1,429
Kenai	0.71	0.02	0.67	0.75	25,721	24,277	27,119
Kasilof	0.21	0.02	0.17	0.24	7,439	6,216	8,722

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). The 90% credibility intervals of harvest estimates may not include the point estimate for the very low extrapolated harvest numbers because fewer than 5% of iterations had values above zero. Proportions for a given mixture may not sum to 1 due to rounding error.

Appendix A3.–Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the Kenai/East Forelands sections set gillnet fishery (Central District, Upper Subdistrict) in 2010.

Dates: 7/8–7/15	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 174,495		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	5	0	2
West	0.00	0.00	0.00	0.00	5	0	2
JCL	0.00	0.00	0.00	0.00	4	0	2
SusYen	0.00	0.00	0.00	0.01	426	0	1,571
Fish	0.02	0.01	0.01	0.03	2,680	1,142	4,715
KTNE	0.01	0.01	0.01	0.03	2,608	1,057	4,663
Kenai	0.86	0.02	0.83	0.89	149,837	144,368	154,906
Kasilof	0.11	0.02	0.08	0.14	18,930	14,395	23,872

Dates: 7/19–7/24	Stock proportion (n = 400; n_{eff} = 399)				Harvest = 217,476		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.01	318	0	1,694
West	0.00	0.00	0.00	0.00	169	0	1,065
JCL	0.01	0.01	0.00	0.02	2,689	1,042	4,934
SusYen	0.01	0.01	0.00	0.02	2,579	752	5,012
Fish	0.06	0.01	0.04	0.08	12,513	8,602	17,004
KTNE	0.04	0.01	0.02	0.05	8,167	5,021	11,890
Kenai	0.83	0.02	0.79	0.86	179,866	172,637	186,675
Kasilof	0.05	0.01	0.03	0.07	11,174	7,243	15,697

Dates: 7/25–7/31	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 99,772		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	11	0	6
West	0.05	0.01	0.03	0.07	4,807	2,925	6,976
JCL	0.02	0.01	0.01	0.04	2,355	1,153	3,847
SusYen	0.02	0.01	0.00	0.03	1,539	429	3,309
Fish	0.01	0.01	0.00	0.02	1,062	368	2,033
KTNE	0.05	0.01	0.04	0.08	5,396	3,580	7,499
Kenai	0.81	0.02	0.78	0.85	81,302	77,786	84,617
Kasilof	0.03	0.01	0.02	0.05	3,300	1,888	4,998

-continued-

Dates: 8/2–8/12	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 76,456		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	2	0	1
West	0.01	0.01	0.00	0.02	964	315	1,904
JCL	0.01	0.01	0.00	0.02	870	278	1,672
SusYen	0.02	0.01	0.01	0.03	1,302	447	2,569
Fish	0.01	0.00	0.00	0.02	728	223	1,442
KTNE	0.06	0.01	0.05	0.09	4,932	3,448	6,620
Kenai	0.82	0.02	0.78	0.85	62,607	59,957	65,101
Kasilof	0.07	0.01	0.05	0.09	5,052	3,495	6,809

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). The 90% credibility intervals of harvest estimates may not include the point estimate for the very low extrapolated harvest numbers because fewer than 5% of iterations had values above zero. Proportions for a given mixture may not sum to 1 due to rounding error.

Appendix A4.– Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the Kalgin Island Subdistrict set gillnet fishery (Central District) in 2010.

Dates: 6/2–8/16	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 66,999		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.02	0.01	0.01	0.03	1,129	445	2,024
West	0.57	0.03	0.53	0.61	38,102	35,218	40,950
JCL	0.00	0.00	0.00	0.01	715	25	2,206
SusYen	0.01	0.01	0.00	0.03	305	0	895
Fish	0.01	0.01	0.00	0.02	772	268	1,462
KTNE	0.01	0.01	0.00	0.02	402	40	1,112
Kenai	0.30	0.02	0.26	0.34	20,359	17,752	23,037
Kasilof	0.08	0.01	0.06	0.10	5,214	3,765	6,829

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). The 90% credibility intervals of harvest estimates may not include the point estimate for the very low extrapolated harvest numbers because fewer than 5% of iterations had values above zero. Proportions for a given mixture may not sum to 1 due to rounding error.

Appendix A5.– Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the Eastern Subdistrict set gillnet fishery (Northern District) in 2010.

Dates: 7/5–8/16	Stock proportion (n = 400; n_{eff} = 399)				Harvest = 12,179		
			90% CI			90% CI	
Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Crescent	0.00	0.00	0.00	0.00	0	0	0
West	0.07	0.02	0.05	0.10	908	614	1,236
JCL	0.04	0.01	0.03	0.06	486	305	700
SusYen	0.04	0.01	0.02	0.06	500	290	750
Fish	0.23	0.02	0.19	0.27	2,797	2,350	3,257
KTNE	0.37	0.03	0.33	0.42	4,552	4,032	5,083
Kenai	0.23	0.02	0.20	0.27	2,842	2,406	3,297
Kasilof	0.01	0.00	0.00	0.02	94	17	206

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). The 90% credibility intervals of harvest estimates may not include the point estimate for the very low extrapolated harvest numbers because fewer than 5% of iterations had values above zero. Proportions for a given mixture may not sum to 1 due to rounding error.

Appendix A6.–Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon harvested in the northeastern and southwestern areas within the General Subdistrict set gillnet fishery (Northern District) in 2010 (Figure 2).

	Dates: 7/5–8/16	Stock proportion (n = 400; n_{eff} = 400)				Harvest = 9,423		
				90% CI			90% CI	
Area strata	Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Northeastern								
	Crescent	0.00	0.00	0.00	0.00	0	0	0
	West	0.01	0.01	0.00	0.03	106	5	242
	JCL	0.02	0.01	0.01	0.03	96	33	186
	SusYen	0.01	0.01	0.00	0.02	161	65	289
	Fish	0.74	0.03	0.69	0.78	6,948	6,534	7,337
	KTNE	0.22	0.03	0.18	0.27	2,107	1,718	2,523
	Kenai	0.00	0.00	0.00	0.00	0	0	0
	Kasilof	0.00	0.00	0.00	0.00	4	0	30

	Dates: 7/15–8/16	Stock proportion (n = 400; n_{eff} = 398)				Harvest = 11,742		
				90% CI			90% CI	
Area strata	Reporting Group	Mean	SD	5%	95%	Mean	5%	95%
Southwestern								
	Crescent	0.00	0.00	0.00	0.00	0	0	0
	West	0.61	0.03	0.57	0.65	7,207	6,719	7,687
	JCL	0.19	0.02	0.16	0.23	1,656	1,319	2,018
	SusYen	0.14	0.02	0.11	0.17	2,283	1,885	2,702
	Fish	0.04	0.01	0.02	0.05	412	247	609
	KTNE	0.00	0.00	0.00	0.00	1	0	0
	Kenai	0.02	0.01	0.01	0.03	183	67	343
	Kasilof	0.00	0.00	0.00	0.00	0	0	0

Note: Effective sample size (n_{eff}) is the number of samples successfully screened from each stratum after excluding individuals with <80% scorable markers (see text). The 90% credibility intervals of harvest estimates may not include the point estimate for the very low extrapolated harvest numbers because fewer than 5% of iterations had values above zero. Proportions for a given mixture may not sum to 1 due to rounding error.