Fishery Data Series No. 10-93

Genetic stock identification of Upper Cook Inlet sockeye salmon harvest, 2009

by

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

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

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 2009 commercial drift and set 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 59 populations and 41 SNP markers. The commercial fishery samples represented 99% of the harvest. Patterns of stock proportions through time in the fishery were similar to results from previous years: 1) Kenai River fish were present later in the season relative to Kasilof River fish; 2) eastern fisheries generally captured higher proportions of Kenai and Kasilof river fish than western and northern fisheries; and 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. Total commercial fishery catches of sockeye salmon in UCI were lower in 2009 than in any other year since 2005. The 2009 collections showed lower proportions of Kenai and Kasilof rivers fish than in previous years. As a result, the higher proportions of non-Kenai and Kasilof fish resulted in the lowest relative errors in stock composition observed to date.

Key words: Cook Inlet, sockeye salmon, *Oncorhynchus nerka*, genetic stock identification, mixed stock analysis, commercial fishery, SNP.

INTRODUCTION

BACKGROUND

Sockeye salmon *Oncorhynchus nerka* are the most important species to the commercial fishery in Upper Cook Inlet (UCI) Management Area, with an average yearly exvessel value of $16.8 million over the past 10 years (Shields 2010). The Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries (division), is responsible for managing the commercial fisheries in UCI under the sustained yield principle. The sustained yield principle requires an understanding of the relationship between the number of fish that spawn in a drainage and the number of their offspring that make it to reproductive adulthood (i.e., brood table). The number of offspring that return are calculated by adding the number of spawners to the number of 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). This is especially important in UCI where sockeye salmon are exploited at rates from 50% to 75% (calculated from Tobias and Willette 2004 and Shields 2009). Most of this harvest occurs in the commercial fishery in various UCI districts, subdistricts, sections, and special harvest areas (SHA; Figures 2 and 3) by both set gillnet and drift gillnet commercial fisheries (Shields 2009). 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. (2010).

In 2010, ADF&G reported a baseline analysis and stock composition estimates based on genetic data from sockeye salmon collected in UCI (Barclay et al. 2010). Baseline samples were collected from spawning populations of sockeye salmon by the department using gillnets and beach seines. Most collections were made in the 1990s and reported in Seeb et al. (2000) and Habicht et al. (2007). The baseline contains 59 populations represented by 9,712 fish. These populations represent the known genetic diversity both geographically (location) and temporally (early- and late-spawning) in sockeye salmon returning to Cook Inlet.

Stock compositions were estimated from samples collected in selected periods of the Central and Northern district commercial fisheries and from the offshore test fishery (Figure 4) between 2005 and 2008. These estimates of stock composition were the most detailed and precise to date.

Analyzed strata represented 77% of the commercial harvest in 2005 and between 93% and 95% of the total commercial harvest from 2006 through 2008. 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 (referred to as "East Side" in Barclay et al. (2010) and Habicht et al. (2007)) averaged within 7% of the best estimate.

Many of the findings in Barclay et al. (2010) confirmed patterns of fishery stock compositions observed in previous studies, but some new insights were also gained. For example, the patterns showing higher abundances of Kasilof River fish early and Kenai River fish later in the season observed in Barclay et al. (2010) within the Central District drift gillnet fishery were also observed by Seeb et al. (2000). On the other hand, the high interannual variability in the estimated peak harvest dates and total harvests of Susitna and Yentna river sockeye salmon in the drift gillnet fishery were first observed in this report. Within the Upper Subdistrict (Central District) set gillnet fishery, Barclay et al. (2010) did not observe a consistent pattern of decreasing proportions of Kasilof River and increasing proportions of Kenai River sockeye salmon in July as described by Bethe et al. (1980) using scale pattern analysis (SPA). Susitna and Yentna river sockeye salmon contributed to Upper Subdistrict set gillnet harvests from 2005 through 2008 at lower fractions than estimated using SPA in 1978 and 1983 (Bethe et al. 1980; Cross et al. 1986). Within the Upper Subdistrict, most of the catch was comprised of either Kenai or Kasilof fish, and higher proportions of these stocks were found in subsections that border their respective river mouths. Within the offshore test fishery, which is traditionally used to gauge return timing and abundance inseason (Shields and Willette 2010), the most prominent temporal pattern was the decreasing trend in the proportion of Kasilof fish and an increasing trend in the proportion of Kenai fish through the season.

Here we use the same baseline as reported in Barclay et al. (2010) and analyze samples collected in 2009 from time and area strata that represent 99.5% of the 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.

Allozyme. Variant form of a protein enzyme encoded at a given locus. Allozymes are usually distinguished by protein electrophoresis and histochemical staining techniques.

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 do not 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). A method that uses genetic information from populations and from harvest samples to estimate stock compositions of the harvest.

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 MSA. Groups are constructed based on a combination of management needs and genetic distinction and may be analogous to *stocks*. See definition for *Salmon Stock* for a breakdown of reporting groups (stocks) in UCI.

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). DNA sequence variation occurring when a single nucleotide (A, T, C, or G) at a specific locus 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 occurs within the same geographic area and is managed as a unit (from 5 AAC 39.222(f)). For purposes of this study, "stocks" in UCI were delineated based on the major population or aggregation of populations for which ADF&G estimates escapement or for a population or aggregation of populations that occur in a geographic area for which the department does not estimate escapement. UCI 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; “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 UCI 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 AM. 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 (KRSHA) 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. 2010). 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 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 2009, the preseason forecast for the total sockeye salmon run (4.3 million) was below average, with below average Kasilof (822,000), Kenai (2,441,000), and Susitna (669,000) forecasts (Nelson et al. 2008). Since the Kenai forecast was for a run greater than 2 million sockeye salmon, ADF&G started the season managing for an inriver Kenai sockeye salmon goal range of 750,000–950,000 counted by sonar, with 51 hours of additional fishing time and 2 mandated closed periods (windows) in the Upper Subdistrict set gillnet fishery. Inseason projections in late July indicated run timing was early and the Kenai run was less than 2 million, triggering a lower inriver goal range of 650,000–850,000. The Upper Subdistrict set gillnet and Central District drift gillnet fisheries targeting Kenai sockeye salmon were closed from July 24 through July 31 to provide for more escapement of sockeye salmon into the Kenai River. At the end of the season, the Kasilof sockeye salmon escapement (297,125 Bendix sonar units) was slightly below the upper optimal escapement goal (300,000), and the Kenai escapement (745,170 Bendix sonar units) was within the inriver goal range (650,000–850,000). Overall, the total sockeye salmon run (3.9 million) was 10% below the preseason forecast, and the run was 2 days early (Shields 2010).

OBJECTIVES

1) Collect sockeye salmon tissue samples for genetic analysis throughout the 2009 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 45 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.

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. (2010). 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 ADF&G office in Soldotna.

Offshore Test Fishery

Offshore test fishery harvests were sampled using the same sampling design used in Barclay et al. (2010) for the 2008 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 2009 (Figure 4). Genetic samples were taken from fish harvested at each station. If less than 50 individuals were harvested at a station, all were sampled. If more than 50 sockeye salmon 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.

Commercial Drift and Set Gillnet Fisheries

Commercial fishery harvests were sampled using the same stratified systematic sampling design that was used in Barclay et al. (2010) 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 (Table 2). 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 (Table 2) 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 over-sampled 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 (Table 2).

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). Composite samples were constructed in proportion to actual harvests within substrata using the best available harvest numbers as of September 16, 2009 to allow for immediate genetic analysis. Because harvest numbers were not final until April 29, 2010 some of the samples may not be in proportion to the final harvest numbers (Table 2).

Drift Gillnet Sampling

In general, sampling methods follow those reported in Barclay et al. (2010) for the 2008 harvest. Composite samples were constructed from subsamples collected at 1 or more processors located in the Kenai/Kasilof area and from Icicle Seafoods tenders. 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. Temporal strata were identified postseason, and composite random samples were constructed in proportion to the actual substratum (fishery/processor) harvests. Many different restrictions were in effect during these harvest periods (Table 2).

The only change from the methods used for the 2008 harvest collections was the minimum sample size per day. In 2008, sample sizes were set at a minimum of 250 fish from Kenai/Kasilof processors and 250 fish from Icicle Seafoods tenders per day (Barclay et al. 2010). For the 2009 harvest, sample size was set at a minimum of 240 fish from each processor/tender per day. This change was made to save on costs and storage space because the plates used to store samples hold 48 samples each, so an entire plate would not have to be used for 10 additional samples. This change in method seemed appropriate because in prior years (2007 and 2008) almost all subsamples required fewer than 240 samples (Barclay et al. 2010).

Set Gillnet Sampling

Nomenclature changes from Barclay et al. (2010) and Habicht et al. (2007) were made in this report to better reflect fishing areas under Alaska Administrative Code (5 AAC 21.200). What was referred to as “West Side” Subdistrict in Barclay et al. (2010) and Habicht et al. (2007), will be referred to as “Western” Subdistrict in this report. 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; combined these were referred to as

“Kenai Section” in Barclay et al. (2010) and Habicht et al. (2007)) 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. (2010) for the 2008 harvest. Upper Subdistrict (Central District) set gillnet harvests were over-sampled 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. Postseason, random samples (n=400) were constructed for the Kasilof and Kenai/EF sections in proportion to the actual harvests in each subsection/period.

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. Secondly, the samples were partitioned by subsection (Cohoe/Ninilchik and South K. Beach, North K. Beach, and North/South Salamatof).

For the Western and Kalgin Island subdistricts, sockeye salmon were sampled after each period, when possible. Goals of 48–96 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. The sample goal was modified from the 2008 methods in the Western and Kalgin subdistricts. The sample goal for each period in 2008 was 40–100 fish (Barclay et al. 2010), whereas in 2009, it was 48–96 fish. This change was made to accommodate the 48-well sample plates and avoid partial plates.

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). Postseason, 2 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 et al. (2010) using DNeasy kits. All baseline and commercial fishery samples were screened for 45 sockeye salmon SNP markers (3 mitochondrial and 42 nuclear DNA) following the methods of Barclay et al. (2010).

Laboratory Failure Rates and Quality Control

Genotyping failure rate calculations and quality control measures follow those reported in Barclay et al. (2010), 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 2009 commercial and offshore test fishery samples.

STATISTICAL ANALYSIS

Data Retrieval, Quality Control, and Baseline Development

Methods for data retrieval and quality control are reported in Barclay et al. (2010). 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 mixed stock analysis (MSA). This rule (referred to as the "80% rule") was used to filter samples from mixtures to decrease errors and estimate variances caused by poor quality DNA and missing data. We applied this same rule to the 2009 mixture individuals. Baseline development methods are reported in Barclay et al. (2010) and included tests for Hardy-Weinberg equilibrium and linkage disequilibrium, methods for pooling collections into populations, testing for temporal stability, and visualizing population structure.

Baseline Evaluation for MSA

Reporting group nomenclature

Populations were assigned into the following 8 reporting groups (stocks) as described in Barclay et al. (2010): 1) Crescent River; "Crescent", 2) "West", 3) Judd/Chelatna/Larson lakes; "JCL", 4) "Susitna/Yentna; "SusYen", 5) Fish Creek; "Fish", 6) Knik/Turnagain/Northeast Cook Inlet; "KTNE"), 7) "Kenai", and 8) "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).

Baseline testing

During estimation of stock composition, populations were maintained separately within these reporting groups as recommended by Wood et al. (1987). Reporting group estimates were calculated by summing population estimates. The ability of the baseline to identify these reporting groups for MSA applications with proof tests and escapement samples was detailed in Barclay et al. (2010). All baseline evaluation tests were conducted using the program BAYES (Pella and Masuda 2001). Methods for baseline evaluation tests using BAYES are reported in Barclay et al. (2010).

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 et al. (2010) except for defining the informative Dirichlet priors for 2 mixture sets: 1) Kasilof Section set harvest within a half-mile of shore and 2) offshore test fishery by station analyses (Table 4). In the analysis of the Kasilof Section set gillnet harvest within a half-mile of shore, the informative prior was defined as the average of the posterior distributions (i.e., the stock composition estimates) from the 2008 Kasilof Section set gillnet periods of July 14–17 and July 21–24 (Barclay et al. 2010). For the analysis of the offshore test fishery by station, the informative prior was defined as the average of all 2008 offshore test fishery posterior distributions (Barclay et al. 2010). For all other initial priors we used the posterior distribution of a similar time period from the same fishery in 2008.

Applying Stock Proportions to Catch

Methods for applying stock proportions to catch are the same as reported in Barclay et al. (2010).

RESULTS

TISSUE SAMPLING

Offshore Test Fishery

Tissues suitable for genetic analysis were sampled and analyzed from a total of 2,392 fish from the offshore test fishery harvests of sockeye salmon from July 1 to 30, 2009 (July 21, 26, and 29 not sampled; Tables 5 and 6, Figure 4).

Commercial Drift and Set Gillnet Fisheries

Tissues suitable for genetic analysis were sampled from a total of 17,007 fish from commercial catches throughout the UCI Central and Northern districts in 2009. These fish represented 120 individual collections (Tables 2 and 3).

LABORATORY ANALYSIS

Laboratory Failure Rates and Quality Control

A total of 10,142 fish were genotyped from the 2009 collections. For the offshore test fishery and commercial harvest samples, failure rates among collections ranged from 0.2% to 0.3% and discrepancy rates were uniformly low and ranged from 0.28% to 1.21%. Assuming equal error rates in the original and the quality-control analyses, estimated error rates in the samples is half of the discrepancy rate (0.14% to 0.60%).

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Data retrieval and quality control results for the baseline collections are reported in Barclay et al. (2010). Based upon the 80% scorable marker rule, 2.4% and 2.3% of individuals were removed from commercial harvest and test fishery collections, respectively, before stock composition estimates were calculated.

Mixed Stock Analysis

Offshore test fishery

A total of 2,392 fish captured in the offshore test fishery were genotyped (Tables 5 and 6). Samples were divided into 6 temporal strata that were shorter (3–5 days long) near the peak of the run when catches were higher, and longer (5–6 days long) near the beginning and end of the run when catches were lower. We observed a consistent pattern in the distribution of stocks over time: the proportion of Kasilof (range: 1–31%) decreased, and the proportion of Kenai (range: 33–72%) increased. The proportion of West was higher in the first 3 time strata (range: 18–24%) and then dropped slightly in the last 3 time strata (range: 10–13%). The proportion of Crescent (range: 2–7%) increased to 7% in the first 3 time strata and remained at 7% for the next 2 time strata between July 14 and 22, then dropped slightly to 5% in the last time stratum (July 23–30). The proportion of SusYen (range: 0–9%) was less than 1% in the first time stratum (July 1–5) and then remained relatively constant in the 4 time strata from July 6 to 22 (range: 6–9%) before dropping off to 2% in the final time stratum (July 23–30). The proportion of JCL (range: 2–5%) was similar to that of KTNE (range: 2–4%) in each stratum. The Fish reporting group comprised the smallest proportion of the 8 reporting groups (range: 0–3%) and was at or below 1% in all but the first time stratum (July 1–5) where it was at 3%.

When the samples were divided into 6 mixtures by station, patterns were observed from the east to the west side of Cook Inlet (stations 4 to 8, respectively). Kenai (range: 39–68%) comprised the highest proportion of the 8 reporting groups at all stations and decreased from east to west. The proportion of Crescent (range: 2–26%) generally increased from east to west. Both Fish (range: 0–5%) and JCL (range: 0–6%) had their highest proportions on the east side of Cook Inlet at station 4 (5% and 6%, respectively) and had their lowest proportions (<1%) on the west side at station 8. The proportion of Kasilof (range: 3–16%) was higher in the 4 middle stations where it ranged between 15% and 16%. The proportion of West (range: 8–19%) was lowest at station 4 and then increased and remained relatively constant from stations 5 to 8 where it ranged between 13% and 19%. The proportions of SusYen (range: 2–7%) and KTNE (range: 1–4%) had no discernable pattern.

Commercial fisheries

From the 120 collections sampled, 7,750 fish were subsampled to create 21 mixtures for which the stock composition and stock-specific harvest were estimated (Tables 7–15; Figure 5). Analyzed mixtures had sample sizes ranging between 251 and 400 fish. In the reanalysis 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 261 and 1,600 fish (Table 11).

Drift gillnet

For the Central District drift gillnet fishery, we analyzed samples representing harvests from June 22 to August 6 (Table 2). We observed a pattern of increasing proportions of Kenai (range: 24–79%) and decreasing proportions of Kasilof (range: 5–49%) in the first 4 periods between June 22 and July 23 (Table 7; Figure 5). However, in the final period (August 1–6), the proportion of Kenai decreased from 79% to 57% and Kasilof increased slightly from 5% to 7%. This last stratum represented less than 4% of the drift gillnet fishery harvest. The proportion of West (range: 6–23%) had a similar pattern to Kasilof; however, in the final period it was greater than the June 22–July 2 period. The proportion of SusYen (range: 1–6%) and JCL (range: 1–9%) increased after the June 22–July 2 period and their combined contribution in the 4 periods between July 6 and August 6 ranged between 8% and 13%. The proportion of KTNE ranged between 2% and 6%. The combined contribution of Crescent and Fish never exceeded 4% in the 3 periods from June 22 to July 16 and was less than 1% in the 2 periods from July 20 to August 6.

Set gillnet

For the Upper Subdistrict set gillnet fishery, we analyzed samples representing harvests from June 25 to August 10 in Kasilof Section and from July 9 to August 10 in the Kenai/EF sections (Table 2). In addition, we analyzed a subset of samples representing harvests from July 11 to 27 in Kasilof Section during periods when fishing was restricted to within half a mile from shore

(Table 3). We observed a pattern of generally decreasing proportions of Kasilof and generally increasing proportions of Kenai through time, except for the last time strata, as was observed in the drift gillnet fishery (Tables 8 and 9; Figure 5). These last strata represented only 2% and 8% of the Kasilof Section and the Kenai/EF sections harvest, respectively. In Kasilof Section, Kasilof (range: 26–87%) steadily decreased over time and Kenai (range: 10–72%) increased over time through the July 27 period. In the final period (August 1–10), Kasilof increased from 26% to 44% and Kenai decreased from 72% to 44%. The proportion of West (range: 0–12%) did not exceed 2% until the final period, where it increased to 12%. The proportion of KTNE (range: 0–3%) was <1% in all periods except for the 2 periods from July 6 to 19 where it was 3% and 2%, respectively. The proportion of Fish (range: 0–2%) only exceeded 1% in the July 6–12 period. The combined contribution of Crescent, JCL, and SusYen never exceeded 2%. For the Kasilof Section harvest within a half-mile of shore, Kasilof and Kenai contributed the most at 61% and 36%, respectively, whereas Crescent, West, and SusYen contributed 1% each, and all other groups (JCL/Fish/KTNE) contributed <1% (Table 10). In the Kenai/EF sections, Kenai (range: 63–80%) and Kasilof (range: 10–23%) were the largest contributors in all but the final period (August 1–10) where the proportion of KTNE (range: 2–13%) exceeded that of Kasilof, and the combined contribution of all other groups was 11% (Table 9). In July 9–16 and July 20–23 periods, the combined contribution of all other reporting groups was 4% and 10%, respectively.

In the analysis of the Upper Subdistrict set gillnet by subsection, we observed a pattern of increasing Kenai abundance from south to north (Table 11, Figure 6). Higher proportions of Kenai fish were captured in subsections bordering the Kenai River mouth (North K. Beach and North/South Salamatof) and more Kasilof fish were captured in subsections bordering the Kasilof River mouth (Cohoe/Ninilchik and South K. Beach). The most southerly and northerly subsections (Cohoe/Ninilchik and North/South Salamatof) contained higher proportions of non-Kenai and non-Kasilof fish; we observed an 8% and 18% combined contribution of these groups, respectively.

For the Kalgin Island Subdistrict set gillnet fishery (Central District), we analyzed samples representing harvests from June 1 to August 13 (Table 2). West was the dominant reporting group at 47% and 58% of the harvest in the early (June 1–24) and late period (June 25–August 13), respectively (Table 12). Kenai was the second most dominant reporting group at 38% and 27% for the early and late periods, respectively. The proportion of Kasilof was 13% in both periods. The combined contribution of all other reporting groups did not exceed 2%.

For the Western Subdistrict set gillnet fishery (Central District), we analyzed samples representing harvests from June 18 to August 13 (Table 2). Crescent made up the largest portion of the harvest within the Western Subdistrict set gillnet fishery (Central District) for the period analyzed (June 18 to August 13; 86%; Table 13). The contribution of West and Kasilof were the next largest contributors at 9% and 5%, respectively. The combined contribution of all other reporting groups was <1%.

For the Eastern Subdistrict set gillnet fishery (Northern District), we analyzed samples representing harvest from June 25 to August 13 (Table 2). KTNE, Kenai, and Fish made up the largest portion of the harvest at 34%, 23%, and 21%, respectively (Table 14). Kasilof, JCL, and West were the main contributors to the rest of the harvest at 9%, 6%, and 6%, respectively. Both Crescent and SusYen contributed <1% to the harvest.

For the General Subdistrict set gillnet fishery (Northern District), we analyzed a subset of samples representing harvest from July 9 to August 20 for the northeastern area and from July 2 to August 3 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 (Table 15). Fish and KTNE made up the largest portion of the northeastern harvest with contributions of 58% and 39%, respectively. SusYen was the next largest contributor at 3%. The combined contribution of all other reporting groups was <1%. In the southwestern collection, West, SusYen, and JCL were the largest contributors to the harvest at 62%, 18%, and 17%, respectively. Fish was the next largest contributor to the harvest at 2%. The combined contribution of all other reporting groups was <2%.

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 16 and 17). The relative error, as measured by credibility intervals, was smaller for larger harvest estimates (3% and 4% for Kenai and Kasilof, respectively) and greater for smaller harvest estimates (26%, 24%, and 22% for SusYen, Fish, and JCL, respectively; Table 17).

Central District drift gillnet (excluding corridor-only periods)

Over 99% of the Central District drift gillnet harvest (excluding corridor-only periods) was represented by MSA samples (Table 2). In the represented strata, harvest was greatest for Kenai followed by Kasilof at 570,553 and 151,556, respectively (Table 16). The combined harvest of Western stocks (Crescent and West) was the next highest at 107,602 fish, followed by the combined harvest of Susitna and Yentna river stocks (SusYen and JCL) at 84,675 fish. Finally, the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) made up the remainder of the represented harvest with a combined harvest of 45,283 fish.

Central District drift gillnet (corridor-only periods)

Less than 1% of the Central District drift gillnet harvest was from corridor-only periods (7,251 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 (including KRSHA set and drift gillnet)

All of the Central District, Upper Subdistrict set gillnet (including KRSHA set and drift gillnet) harvest was represented by MSA samples (Table 2). Harvests were greatest for Kenai and Kasilof at 348,626 and 505,719 fish, respectively (Table 16). The combined harvest of the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) was the next highest at 29,954 fish. The combined harvest of Susitna and Yentna stocks (SusYen and JCL) and western stocks (Crescent and West) were very similar at 10,811 and 10,742 fish, respectively.

Central District, Western and Kalgin Island subdistricts set gillnet

Over 99% 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 93,941 fish (Table 16). The combined harvest of Kenai and Kasilof stocks was the next highest at 31,867 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 793 fish.

Northern District, Eastern and General subdistricts set gillnet

Over 96% of the Northern District, Eastern, and General subdistricts set gillnet harvest was represented by MSA samples (Table 2). In the represented strata, Northern stocks (JCL/SusYen/Fish/KTNE) accounted for 22,851 fish (Table 16). Western stocks (Crescent and West) made up the remainder of the harvest, with a combined harvest of 10,805 fish. The combined harvest of Kenai and Kasilof stocks contributed 5,706 fish.

All strata combined

Over 99% of total commercial harvest was represented by MSA in 2009 (Table 17). In the represented strata, harvest estimates were greatest for Kenai and Kasilof at 943,784 and 670,243 fish, respectively. Harvest of western stocks (Crescent/West) was the next highest at 223,090 fish. The combined harvest of northern stocks (JCL/SusYen/Fish/KTNE) made up the remainder of the harvest with 194,366 fish. Relative errors of stock-specific harvest estimates were greatest for small harvests (i.e., 26% for SusYen) and least for large harvests (i.e., 3% for Kenai).

DISCUSSION

This manuscript used genetic data from a previously reported sockeye salmon baseline (Barclay et al. 2010) and samples collected in selected periods of the Central and Northern Cook Inlet district commercial fisheries in 2009 to estimate the stock composition estimate of harvest. Here we report on the evaluation of results from harvest sampling for 2009 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 2008, but differed from the sampling design followed in 2005, as discussed in Barclay et al. (2010).

APPLICATION OF DATA TO BROOD TABLE REFINEMENT

The primary goal of this project was to accurately estimate the stock composition of the 2009 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 underestimates the productivity of some stocks and overestimates the productivity of other stocks. This directly affects fisheries management in a postseason fashion through the development of escapement goals and the calculation of exploitation rates. We compare MSA estimates of stock composition from 2005 to 2009 with those obtained using the weighted age-composition catch allocation method to determine whether historical stock composition estimates and brood tables can be adjusted to more accurately estimate stock productivity.

The stock composition estimates available from MSA will improve 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.

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 16 and 17). 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. This phenomenon is not restricted to MSA.

As reported in Barclay et al. (2010), relative errors of stock-specific harvest estimates were generally greater for individual fishery estimates (Table 16) and lower for pooled annual totals (Table 17). For example, relative errors of Kenai harvest estimates in individual fisheries ranged from 4% in the Central District drift gillnet fishery to 18% in the Eastern and General subdistricts in 2009 (Table 16), whereas relative error of the Kenai harvest estimate in the total commercial harvest was 3% (Table 17). Similar patterns can be seen when examining the relative errors of harvest estimates for other stocks. In 2009, relative error rates were generally lower in the total commercial harvest for all stocks compared to rates for 2005–2008. This observation is due to the higher proportions of the less numerous stocks (non-Kenai and Kasilof) in 2009 compared with 2005–2008 (Table 17).

ACCOUNTING FOR UNSAMPLED 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 2009 due to logistical reasons represented relatively small harvests: less than 1% of the total harvest. This is in contrast to the unsampled strata in 2005–2008 where the unsampled fractions of the total harvest were 22%, 7%, 5%, and 6%, respectively (Barclay et al. 2010). As in 2005–2008, most of the unsampled strata in 2009 were also for fisheries conducted in the corridor section of the Central District drift gillnet fishery (Table 2). However, the harvest not represented in the corridor section in 2009 was much lower (7,251 fish; Table 2) compared to 2005–2008 (46,228–859,345 fish; Barclay et al. 2010). It is beyond the scope of this report to extrapolate the stock compositions of harvest in sampled strata to harvest in unsampled strata.

PATTERNS IN FISHERY STOCK COMPOSITIONS AND HARVESTS

As in past years, the distribution of stock-specific harvest across fisheries varied by stock (Barclay et al. 2010). The highest harvests of Kenai sockeye salmon occurred in the drift gillnet fishery (Table 7). The highest harvests of Kasilof sockeye salmon occurred in the set gillnet fishery (Kasilof Section; Table 8). The highest harvests of Susitna and Yentna (SusYen and JCL) sockeye salmon occurred in the drift gillnet fishery (excluding corridor-only periods; Table 7).

The same temporal pattern was observed in the offshore test fishery 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 <50, but when the catch was >50, only 50 samples were collected. Since 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 2009, >50 sockeye salmon were captured in 18 sets comprising about 10% of the total number of sets. Stock composition estimates will be weighted by catch per unit effort (CPUE) in the future to correct for harvest size.

This report provided the first by-station reporting of stock compositions based on genetic data for the offshore test fishery samples. The most prominent pattern in the stock composition estimates by station was the peak proportion of Kenai fish at station 4 on the east side declining gradually toward station 8 on the west side (Table 6; Figure 7). Although, these stock proportions suggested that Kenai fish enter UCI more toward the east side, the product of stock proportions and total CPUE (stock-specific CPUE) at each station indicated Kenai fish were most abundant at station 5 and least abundant at stations 4 and 8 (Shields and Willette 2010). A similar pattern might be expected for Kasilof, but here we observed a consistent proportion across the 4 middle stations.

Within the Central District drift gillnet fishery, some of the patterns observed in 2009 were similar to previous years. 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) during the season was common to all years (Table 7; Figure 5). The estimated peak harvest dates of Kenai sockeye salmon were also in concordance with previous observations, i.e., peak harvests of Kenai sockeye salmon were July 11–18 in 2005, July 16–19 in 2007, July 14–17 in 2008, and July 13–16 in 2009 (Table 7). In 2006, the return pattern of sockeye salmon to the Kenai River was late and the fishery was closed in late July. The estimated peak harvest date of Kenai sockeye salmon in 2006 was later than other years observed (July 31), which may be an artifact of period openings and restrictions. Estimated peak harvest dates and total harvests of sockeye salmon from the Susitna and Yentna rivers (SusYen and JCL) in the drift gillnet fishery (excluding corridor-only periods) have been highly variable among years (Barclay et al. 2010). Peak harvest dates for these reporting groups were June 27–July 7 in 2005, July 31 in 2006, July 16 in 2007, July 14–17 in 2008, and July 6–16 in 2009 (Table 7).

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 (Tables 8 and 9). This was similar to the patterns observed in the Kenai/EF sections in 2006 and 2008 and in Kasilof Section in 2005, 2007, and 2008 (Barclay et al. 2010).

In both the Central District drift gillnet and Kasilof Section set gillnet fisheries, we observed a decrease in the proportion of Kenai and an increase in the proportion of Kasilof fish in August (Tables 7 and 8). However, harvest numbers indicated a general decline for both stocks in August with the exception that harvests of Kasilof fish increased slightly in Kasilof Section. This report provides the first comprehensive estimates of stock composition using genetic data for fish harvested within a half-mile of shore in Kasilof Section. In 2009, a composite genetic sample was constructed solely from Kasilof Section harvest within a half-mile of shore sampled on July 11, 15, 19, 22, and 27 (Table 3), and analysis of this composite sample indicated that Kasilof and Kenai contributed 61% and 36%, respectively (97% combined; Table 10). A sample was also collected from the regular period Kasilof Section harvest within a half-mile of shore on July 27, 2009. Again, Kenai and Kasilof fish comprised a high proportion (72% and 26%, respectively) of this sample (98% combined; Table 8). The only other Kasilof Section half-mile fishery sample was collected on July 15, 2006. Kasilof and Kenai contributed 82% and 16%, respectively, in this sample (98% combined; Barclay et al. 2010). Although stock composition estimates from different years are not directly comparable due to differences in stock-specific run strengths, these data are consistent with a declining proportion of Kasilof and increasing proportion of Kenai fish in Kasilof Section harvest within a half-mile of shore as would be expected given differences in their run timing.

Consistent with findings from the previous 4 years (Barclay et al. 2010), most of the catch in the Upper Subdistrict was comprised of either Kenai or Kasilof fish (Tables 8 and 9; Figure 5). Similar to estimates from 2005 to 2008, SusYen and JCL sockeye salmon contributed to Upper Subdistrict set gillnet harvests (Tables 8 and 9) at lower fractions (0–7%) than estimated using SPA (i.e., 0–28%; Bethe et al. 1980; Cross et al. 1986). Our estimates were more similar to previous MSA estimates based on allozymes that indicated that SusYen and JCL sockeye salmon comprised 1–6% of Upper Subdistrict set gillnet harvests (Seeb et al. 2000).

When we examined stock composition of the Kenai/EF and Kasilof sections by subsection in 2009, the proportion of SusYen and JCL sockeye salmon harvested was higher in subsections farthest from the Kenai and Kasilof river mouths (Coho/Ninilchik and North/South Salamatof), but never above 8% (Table 11). This is concordant with previous estimates by subsection for 2005–2008 (Barclay et al. 2010).

This report provides the first set of stock composition estimates separately for the northeastern and southwestern portions of the General Subdistrict set gillnet fishery (Northern District; Figure 2). This separation was possible in 2009 because Northern District regulations changed and there were consistent harvests so tenders began to pick up fish from the statistical areas 247-10, 247-20, and 247-30 and deliver them to Kenai Peninsula processors (Figure 2). Sampling methods for General Subdistrict differed from 2008, because in 2008 tenders did not deliver to Kenai processors (Barclay et al. 2010). Samples collected in 2008 from the Anchorage processor only represented statistical areas 247-30, 247-41, 247-42, and 247-43 (Barclay et al. 2010). Because of this, General Subdistrict samples were not divided into northeastern and southwestern areas for analysis and only one harvest-weighted sample was constructed in 2008.

As expected in the General Subdistict set gillnet fishery, Fish (58%) and KTNE (39%) were the largest portions of the 6,290 sockeye salmon harvested in the northeastern area (Table 15). West (62%), SusYen (18%), and JCL (17%) comprised the largest portion of the southwestern area, a harvest of 15,872 fish. The very low harvests of SusYen and JCL fish (194) in the northeastern area suggested these stocks primarily migrated up the west side of Northern District and did not move east of the Susitna River in large numbers.

When comparing overall harvest in the UCI fishery with the 4 years reported in Barclay et al. (2010), we observed above average harvests for some stocks (Table 17, Figure 8). Crescent, West, and Fish had larger harvests than observed in the 4 prior years (Table 17), which corresponds with evidence suggesting higher-than-average returns to these drainages. The harvest of sockeye salmon by set gillnetters in the immediate area around the Crescent River terminus in 2009 was the largest observed in the past 21 years (Shields 2010). Although the sonar project did not operate at the Crescent River in 2009, observations from the lodge owner on Crescent Lake and ADF&G staff sampling at the lake indicate that escapement was well above average (Shields 2010). A lodge owner who regularly flies West Fork Coal Creek (Beluga River drainage) noted that the 2009 sockeye salmon return was much larger than normal (Mark Miller, Talaheim Lodge; personal communication). Finally, the escapement of Fish Creek sockeye salmon was nearly double that observed in 2005–2008 (Shields 2010).

INCORPORATING PATTERNS OF FISHERY STOCK COMPOSITIONS INTO FUTURE MANAGEMENT

Incorporation of patterns of sockeye salmon fishery stock compositions into future management of fisheries in UCI was presented in Barclay et al. (2010). In future years, the data gathered from these studies will be used to reconstruct total run and revise brood tables for the major UCI sockeye salmon stocks. This will greatly improve our understanding of stock productivity. However, many years of genetic data may be required to accurately revise brood tables for less numerous stocks (i.e., Susitna River and Fish Creek) because 1) the relative error of genetic stock composition estimates is greater for less numerous stocks, and 2) we may not be able to use historical age-composition catch allocation harvest estimates.

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Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

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TABLES AND FIGURES

Table 1.–Descriptions of fishery restrictions and coordinates (decimal degrees, WGS1984) to corresponding 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	Kenai Corridor	Statistical Area 244-51	2				
3	Kasilof Corridor	Statistical Area 244-61	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)		4		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).	N/A				
7	N/A	Within a half-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.–Tissue collections for genetic analysis from fish captured in the Upper Cook Inlet fisheries in 2009.

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)							
1	6/22	5,866	6/22	5,866		3	48
1,2	6/25	10,915	6/25	10,915	6/22-7/2	49	175
1,2	6/29	32,454	6/29	32,454		162	260
1	7/2	26,364	7/2	26,364		186	255
1	7/6	64,980	7/6	64,980	7/6-9	133	482
2,3,4	7/9	137,338	7/09	137,338		267	510
2,3,4	7/13	143,674	7/13	143,674	7/13-16	167	513
2,3,4,5	7/16	233,568	7/16	233,568		233	513
2,3,4,5	7/20	116,869	7/20	116,869	7/20-23	128	508
1,2,3	7/23	152,776	7/23	152,776		271	517
1	8/3	21,022	8/1-3	31,189	8/1-6	218	406
1,2,3	8/6	3,675	8/6	3,675		33	288
1,2,3			8/10	714		-	-
6			8/13-9/14	424		-	-
Central District drift gillnet (corridor-only periods)							
2			6/27	1,120		-	-
2			6/28	576		-	-
2			7/1	3,151		-	-
2			7/4	1,124			
2			7/7	916		-	-
2			7/8	364		-	-
Kasilof Section set gillnet (Central District, Upper Subdistrict)							
1a	6/25	45,861	6/25-27	76,898		118	144
1b	6/25	10,380	6/25-27	22,277		34	96
1a	6/29	37,684	6/28-7/1	80,320	6/25-7/4	121	192
1b	6/29	8,129	6/28-7/1	27,813		43	96
1a	7/2	23,073	7/2-4	38,610		57	240
1b	7/2	9,130	7/2-4	17,033		27	150

-continued-

Table 2.–Page 2 of 5.

Restrictions[a] /Subsection[b]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Sample Size	
						Analyzed	Collected
1a	7/6	17,424	7/6-7/7	27,764	7/6-12	81	288
1b	7/6	5,902	7/6-7/7	9,408		26	150
1a	7/9	28,942	7/8-7/9	39,068		108	288
1b	7/9	8,295	7/8-7/9	12,555		34	150
7a	7/11	24,100	7/11-12	37,583		106	120
7b	7/11	9,926	7/11-12	15,474		45	48
1a	7/13	27,938	7/13	27,938	7/13-19	80	288
1b	7/13	17,977	7/13	17,977		55	150
7a	7/15	11,498	7/15	11,498		37	120
7b	7/15	12,630	7/15	12,630		38	48
1a	7/16	15,165	7/16	15,165		43	287
1b	7/16	6,822	7/16	6,822		20	150
7a	7/19	6,799	7/17-19	25,438		79	96
7b	7/19	5,680	7/17-19	17,185		48	48
1,7a	7/20	8,321	7/20-21	20,386	7/20-23	108	240
1,7b	7/20	9,994	7/20-21	12,835		74	150
7a	7/22	15,237	7/22	15,237		77	96
7b	7/22	9,788	7/22	9,788		54	48
1a	7/23	9,579	7/23	9,579		63	240
1b	7/23	3,341	7/23	3,341		24	150
7a	7/27	10,618	7/27	10,618	7/27	264	300
7b	7/27	6,294	7/27	6,294		136	200
1a	8/3	3,198	8/1-3	6,280	8/1-10	184	240
1b	8/3	1,495	8/1-3	3,829		97	120
1a	8/6	1,346	8/6	1,346		30	143
1b	8/6	922	8/6	922		32	96
1a	8/10	676	8/10	676		38	95
1b	8/10	702	8/10	702		19	48

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Table 2.–Page 3 of 5.

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
Kenai/EF sections set gillnet (Central District, Upper Subdistrict)							
1c	7/9	4,436	7/9	4,436	7/9-16	14	120
1d	7/9	10,022	7/9	10,022		23	240
1c	7/13	26,072	7/13	26,072		63	120
1d	7/13	59,002	7/13	59,002		128	288
1c	7/16	9,879	7/16	9,879		24	120
1d	7/16	39,110	7/16	39,110		148	288
1c	7/20	10,905	7/20	10,905	7/20-23	46	120
1d	7/20	55,645	7/20	55,645		236	300
1c	7/23	5,447	7/23	5,447		21	120
1d	7/23	22,736	7/23	22,736		97	300
1c	8/3	1,482	8/1,8/3	3,506	8/1-10	66	120
1d	8/3	3,731	8/1,8/3	8,204		162	240
1c	8/6	1,109	8/6	1,109		15	88
1d	8/6	4,986	8/6	4,986		100	192
1c	8/10	427	8/10	427		12	48
1d	8/10	3,077	8/10	3,077		45	144
Kalgin Island Subdistrict set gillnet (Central District)							
1	6/1	1,800	6/1-5	6,665	6/1-24	92	92
1	6/8	2,729	6/8-10	5,917		83	96
1	6/15	1,777	6/12-17	4,681		64	96
1	6/24	1,542	6/19-24	4,280		61	96
1	6/25	1,170	6/25	1,170	6/25-8/13	8	48
1	6/29	4,629	6/29	4,629		37	96
1	7/2	1,399	7/2	1,399		11	96
1	7/6	3,186	7/6	3,186		26	96
1	7/9	1,696	7/9	1,696		14	96
1	7/13	5,199	7/13	5,199		42	96
1	7/16	5,326	7/16	5,326		43	96
1	7/20	4,160	7/20	4,160		84	96
1	7/23	4,431	7/23	4,431		36	80
1	7/27	3,746	7/27	3,746		30	96
1	7/30	1,953	7/30	1,953		16	96
1	8/3	1,854	8/1-3	3,302		26	48
1	8/6	1,555	8/6	1,555		12	48
1	8/13	547	8/10-13	1,959		15	48

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Table 2.–Page 4 of 5.

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)				
1	6/25	796	6/18-25	1,972		13	48
1,8	6/29	2,551	6/29-7/3	6,486		46	48
8	7/7	2,118	7/4-7/7	8,092		82	96
8	7/10	1,828	7/9-11	11,956		82	96
8	7/14	2,430	7/12-14	9,283	6/18-8/13	64	96
8	7/16	5,154	7/16-19	12,292		79	96
8	7/23	754	7/20-24	8,618		15	96
8	7/27	303	7/25-31	1,104		8	48
1	8/6	227	8/1-13	1,544		11	48
1			8/17-24	118		-	-
			Eastern Subdistrict set gillnet (Northern District)				
			5/25-6/8	294		-	-
1	7/2	886	6/25-7/2	1,716		38	48
1	7/6	1,505	7/6	1,505		44	96
1	7/9	706	7/9	706		16	48
1	7/13	1,002	7/13	1,002		25	96
1	7/16	3,023	7/16	3,023		68	144
9	7/20	2,294	7/20	2,294	6/25-8/13	54	96
9	7/23	496	7/23	496		8	25
9	7/27	2,689	7/27	2,689		58	96
9	7/30	2,035	7/30	2,035		47	96
9	8/3	596	8/3	596		11	52
9	8/6	655	8/6-13	1,138		31	48
			8/17-9/7	563		-	-

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Table 2.–Page 5 of 5.

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			06/1-25	29		-	-
1,10	7/9*	154	7/9	154	7/9-8/20	12	29
1,10	7/13	1,017	7/13	1,017		25	48
1,10	7/16	2,114	7/16	2,114		128	144
9,10	7/20	1,122	7/20	1,122		44	48
9,10	7/23	631	7/23	631		72	72
9,10	7/27	177	7/27	177		47	108
9,10	7/30	467	7/30	467		27	46
9,10	8/3	267	8/3	267		21	48
9,10	8/6	196	8/6	196		16	75
1,10	8/10	122	8/10	122		6	33
1,10	8/13	12	8/13-20	23		2	24
			8/24	3		-	-
General Subdistrict (Southwestern) set gillnet (Northern District)							
1,11			6/1-8	240		-	-
1,11	7/2	948	6/25-7/2	1,479	7/2-8/3	39	96
1,11	7/6	1,782	7/6	1,782		39	48
1,11	7/9	798	7/09-13	3,889		4	19
1,11	7/13	3,091	7/09-13			110	144
1,11	7/16	4,662	7/16-20	5,455		95	96
9,11	7/20	793	7/16-20			28	48
9,11	7/27	828	7/23-30	1,599		31	84
9,11	7/30	614	7/23-30			16	48
9,11	8/3	576	8/03-10	1,668		38	78
1,11			8/13-27	161		-	-

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. Dashes indicate no data.

[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.–Tissue collections for genetic analysis from the subset of fish captured within a half-mile of shore in the Kasilof Section set gillnet (Central District, Upper Subdistrict) fishery in 2009 shown in Table 2.

						Sample Size	
Subsection[a]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Analyzed	Collected
a	7/11	24,100	7/11-7/12	37,583	7/11-27	84	120
b	7/11	9,926	7/11-7/12	15,474		37	48
a	7/15	11,498	7/15, 7/17	28,396		66	120
b	7/15	12,630	7/15,7/17	19,911		47	48
a	7/19	6,799	7/18,7/19	8,541		19	96
b	7/19	5,680	7/18,7/19	9,904		22	48
a	7/22	10,195	7/21,7/22	27,127		56	96
b	7/22	9,788	7/21,7/22	12,629		29	48
a	7/27	10,618	7/27	10,618		26	300
b	7/27	6,294	7/27	6,294		14	200

Note: The date sampled, date-specific harvests, and numbers collected are the same as shown in Table 2. However, here we sub-sampled different numbers of fish, which sometimes represented different dates and harvests, in order to sample in proportion to catch only for fish captured within a half-mile of shore in 2009.

[a] a) Cohoe/Ninilchik; b) South K. Beach

Table 4.–Predetermined priors based on the best available information for the first stratum within each Upper Cook Inlet (UCI) district, subdistrict, section, subsection, and test fishery in 2009. See text for methods used for determining priors.

		Reporting Group							
Fishery	Date	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Central District drift	June 22 - July 2	0.02	0.04	0.05	0.05	0.00	0.04	0.18	0.63
Kasilof Section set	June 25 - July 2	0.00	0.02	0.01	0.01	0.00	0.02	0.05	0.89
Kasilof Section set (half-mile)	July 11 - 27	0.01	0.00	0.02	0.00	0.00	0.02	0.21	0.74
Kenai/EF sections set	July 9 - 16	0.00	0.00	0.03	0.01	0.00	0.02	0.77	0.17
Cohoe/Ninilchik Subsection set	June 25 - August 10	0.00	0.04	0.03	0.01	0.01	0.02	0.23	0.66
South K. Beach Subsection set	June 26 - July 24	0.00	0.02	0.01	0.00	0.00	0.00	0.04	0.93
North K. Beach Subsection set	July 10 - 24	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.52
North/South Salamatof Subsection set	July 10 - 24	0.00	0.00	0.02	0.01	0.00	0.01	0.96	0.00
Kalgin Island Subdistrict set	June 1 - 24	0.04	0.57	0.00	0.00	0.00	0.00	0.24	0.15
Western Subdistrict set	June 17 - July 13	0.51	0.12	0.01	0.00	0.00	0.28	0.03	0.05
Eastern Subdistrict set	June 25 - August 13	0.00	0.13	0.15	0.06	0.04	0.30	0.20	0.11
General Subdistrict set (Northeast)	July 9 - August 20	0.00	0.05	0.19	0.13	0.09	0.54	0.00	0.00
General Subdistrict set (Southwest)	July 2 - August 3	0.00	0.05	0.19	0.13	0.09	0.54	0.00	0.00
Offshore Test Fishery	July 1 - 5	0.03	0.11	0.05	0.04	0.01	0.03	0.27	0.45
Offshore Test Fishery (for all stations)	July 1 - 30	0.04	0.12	0.07	0.06	0.00	0.02	0.44	0.24

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 5.–Stock composition estimates, standard deviation (SD), and 90% credibility interval (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 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Start Date	07/01	Proportion	0.02	0.24	0.02	0.00	0.03	0.04	0.33	0.31
End Date	07/05	SD	0.01	0.03	0.01	0.00	0.01	0.01	0.03	0.03
n	401	Lower 90% CI	0.00	0.20	0.01	0.00	0.02	0.02	0.28	0.26
n_{eff}	392	Upper 90% CI	0.04	0.28	0.04	0.01	0.05	0.06	0.38	0.36
Start Date	07/06	Proportion	0.04	0.18	0.03	0.09	0.01	0.04	0.33	0.28
End Date	07/09	SD	0.01	0.03	0.02	0.03	0.01	0.01	0.03	0.03
n	445	Lower 90% CI	0.02	0.13	0.00	0.05	0.00	0.02	0.28	0.23
n_{eff}	431	Upper 90% CI	0.07	0.22	0.06	0.14	0.03	0.06	0.38	0.33
Start Date	07/10	Proportion	0.07	0.20	0.05	0.09	0.01	0.03	0.48	0.07
End Date	07/13	SD	0.02	0.03	0.02	0.03	0.01	0.01	0.03	0.02
n	407	Lower 90% CI	0.04	0.15	0.03	0.04	0.00	0.01	0.43	0.04
n_{eff}	398	Upper 90% CI	0.10	0.25	0.08	0.14	0.03	0.05	0.53	0.10

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Table 5.–Page 2 of 2.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Start Date	07/14	Proportion	0.07	0.13	0.03	0.06	0.01	0.02	0.63	0.05
End Date	07/16	SD	0.02	0.02	0.01	0.02	0.01	0.01	0.03	0.02
n	406	Lower 90% CI	0.04	0.09	0.01	0.04	0.00	0.01	0.58	0.03
n_{eff}	395	Upper 90% CI	0.10	0.16	0.05	0.09	0.03	0.03	0.68	0.08
Start Date	07/17	Proportion	0.07	0.10	0.02	0.07	0.01	0.02	0.67	0.04
End Date	07/22	SD	0.02	0.03	0.01	0.03	0.01	0.01	0.03	0.02
n	402	Lower 90% CI	0.05	0.06	0.01	0.02	0.00	0.01	0.62	0.01
n_{eff}	397	Upper 90% CI	0.10	0.15	0.04	0.11	0.02	0.04	0.72	0.07
Start Date	07/23	Proportion	0.05	0.12	0.04	0.02	0.00	0.03	0.72	0.01
End Date	07/30	SD	0.02	0.02	0.01	0.01	0.00	0.01	0.03	0.02
n	331	Lower 90% CI	0.03	0.09	0.02	0.01	0.00	0.01	0.67	0.00
n_{eff}	324	Upper 90% CI	0.08	0.16	0.06	0.05	0.00	0.05	0.77	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 6.–Stock composition estimates, standard deviation (SD), and 90% credibility interval (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 by station from July 1–30, 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Station 4		Proportion	0.03	0.08	0.06	0.03	0.05	0.04	0.68	0.03
		SD	0.02	0.03	0.02	0.02	0.02	0.02	0.04	0.03
n	188	Lower 90% CI	0.00	0.03	0.03	0.00	0.02	0.02	0.61	0.00
n_{eff}	183	Upper 90% CI	0.06	0.13	0.10	0.08	0.08	0.08	0.75	0.08
Station 5		Proportion	0.02	0.18	0.04	0.05	0.01	0.03	0.53	0.15
		SD	0.01	0.02	0.01	0.02	0.00	0.01	0.03	0.02
n	713	Lower 90% CI	0.01	0.15	0.03	0.02	0.00	0.02	0.49	0.12
n_{eff}	698	Upper 90% CI	0.03	0.21	0.06	0.08	0.01	0.04	0.57	0.18
Station 6		Proportion	0.06	0.13	0.02	0.04	0.02	0.03	0.53	0.16
		SD	0.02	0.02	0.01	0.02	0.01	0.01	0.03	0.03
n	388	Lower 90% CI	0.03	0.10	0.01	0.02	0.00	0.01	0.48	0.12
n_{eff}	378	Upper 90% CI	0.09	0.17	0.04	0.08	0.03	0.05	0.59	0.20

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Table 6.–Page 2 of 2.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Station 6.5		Proportion	0.04	0.19	0.04	0.06	0.02	0.01	0.49	0.15
		SD	0.01	0.02	0.02	0.02	0.01	0.01	0.03	0.02
n	493	Lower 90% CI	0.02	0.16	0.01	0.02	0.01	0.00	0.45	0.12
n_{eff}	481	Upper 90% CI	0.06	0.23	0.06	0.10	0.04	0.02	0.54	0.19
Station 7		Proportion	0.08	0.18	0.04	0.02	0.01	0.04	0.48	0.15
		SD	0.02	0.02	0.02	0.02	0.01	0.01	0.03	0.02
n	444	Lower 90% CI	0.06	0.14	0.01	0.00	0.00	0.03	0.43	0.11
n_{eff}	434	Upper 90% CI	0.11	0.22	0.06	0.05	0.02	0.06	0.53	0.19
Station 8		Proportion	0.26	0.19	0.00	0.07	0.00	0.03	0.39	0.06
		SD	0.04	0.05	0.00	0.03	0.00	0.02	0.05	0.02
n	166	Lower 90% CI	0.20	0.11	0.00	0.02	0.00	0.01	0.31	0.03
n_{eff}	163	Upper 90% CI	0.34	0.27	0.00	0.13	0.00	0.06	0.46	0.11

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 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) in 2009. No corridor-only periods were sampled in 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.02	0.18	0.01	0.01	0.01	0.04	0.24	0.49
Start Date	06/22	SD	0.01	0.03	0.01	0.01	0.01	0.01	0.03	0.03
End Date	07/02	Lower 90% CI	0.00	0.14	0.00	0.00	0.00	0.02	0.19	0.44
		Upper 90% CI	0.04	0.22	0.02	0.03	0.02	0.06	0.29	0.55
Harvest	75,599	Harvest	1,572	13,442	761	805	930	2,658	18,071	37,359
n	400	Lower 90% CI	330	10,409	139	0	255	1,375	14,488	33,329
n_{eff}	392	Upper 90% CI	3,073	16,665	1,570	2,543	1,869	4,301	21,831	41,346
		Proportion	0.01	0.16	0.09	0.04	0.03	0.06	0.35	0.27
Start Date	07/06	SD	0.01	0.02	0.02	0.02	0.01	0.01	0.04	0.03
End Date	07/09	Lower 90% CI	0.00	0.12	0.06	0.02	0.01	0.04	0.29	0.22
		Upper 90% CI	0.02	0.20	0.11	0.06	0.05	0.08	0.41	0.33
Harvest	202,318	Harvest	1,875	31,722	17,616	7,375	5,997	11,905	70,524	55,305
n	400	Lower 90% CI	0	24,896	12,338	3,043	2,951	7,644	58,900	43,885
n_{eff}	390	Upper 90% CI	4,601	39,518	23,241	12,833	9,770	16,986	83,016	66,745
		Proportion	0.01	0.09	0.02	0.06	0.03	0.02	0.66	0.11
Start Date	07/13	SD	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.02
End Date	07/16	Lower 90% CI	0.00	0.06	0.01	0.03	0.01	0.01	0.61	0.08
		Upper 90% CI	0.03	0.12	0.04	0.10	0.05	0.03	0.71	0.15
Harvest	377,242	Harvest	2,117	33,649	9,144	23,847	11,055	6,924	248,874	41,632
n	400	Lower 90% CI	0	23,007	3,471	12,988	5,003	2,568	229,930	29,143
n_{eff}	384	Upper 90% CI	9,574	45,939	16,182	36,117	18,479	12,789	267,598	55,206

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			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.06	0.03	0.05	0.00	0.02	0.79	0.05
Start Date	07/20	SD	0.00	0.01	0.01	0.01	0.00	0.01	0.03	0.02
End Date	07/23	Lower 90% CI	0.00	0.03	0.02	0.03	0.00	0.01	0.75	0.03
		Upper 90% CI	0.00	0.08	0.05	0.07	0.00	0.04	0.83	0.09
Harvest	269,645	Harvest	15	14,961	8,833	12,986	74	4,905	213,102	14,769
n	399	Lower 90% CI	0	8,868	4,716	7,125	0	1,518	200,897	7,380
n_{eff}	387	Upper 90% CI	5	22,104	13,815	19,875	336	10,080	224,754	22,983
		Proportion	0.00	0.23	0.05	0.04	0.00	0.02	0.57	0.07
Start Date	08/01	SD	0.01	0.04	0.02	0.03	0.00	0.01	0.04	0.02
End Date	08/06	Lower 90% CI	0.00	0.18	0.02	0.00	0.00	0.01	0.51	0.04
		Upper 90% CI	0.02	0.29	0.09	0.09	0.00	0.05	0.63	0.11
Harvest	34,864	Harvest	165	8,085	1,863	1,445	3	830	19,982	2,491
n	251	Lower 90% CI	0	6,224	542	0	0	299	17,808	1,291
n_{eff}	244	Upper 90% CI	786	10,234	3,157	3,044	1	1,580	22,131	3,867

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.

Table 8.–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 2009. Kasilof River Special Harvest Area was not used in 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.01	0.00	0.01	0.00	0.00	0.10	0.87
Start Date	06/25	SD	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.02
End Date	07/04	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.83
		Upper 90% CI	0.00	0.03	0.01	0.03	0.01	0.01	0.13	0.91
Harvest	262,951	Harvest	9	3,813	311	2,651	902	671	25,768	228,827
n	400	Lower 90% CI	0	1,208	0	0	0	0	17,684	218,642
n_{eff}	395	Upper 90% CI	4	7,215	1,907	6,621	3,761	3,897	35,023	238,018
		Proportion	0.00	0.00	0.01	0.01	0.02	0.03	0.23	0.69
Start Date	07/06	SD	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
End Date	07/12	Lower 90% CI	0.00	0.00	0.00	0.00	0.01	0.01	0.19	0.64
		Upper 90% CI	0.01	0.03	0.03	0.02	0.04	0.05	0.28	0.73
Harvest	141,852	Harvest	262	657	1,808	1,335	3,378	4,451	32,744	97,217
n	400	Lower 90% CI	0	0	0	0	1,340	2,076	26,670	90,425
n_{eff}	392	Upper 90% CI	1,896	3,568	3,733	3,465	5,947	7,198	39,188	103,780
		Proportion	0.00	0.02	0.00	0.00	0.01	0.02	0.29	0.66
Start Date	07/13	SD	0.00	0.02	0.00	0.00	0.01	0.01	0.03	0.03
End Date	07/19	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.24	0.62
		Upper 90% CI	0.00	0.05	0.00	0.00	0.02	0.04	0.33	0.71
Harvest	134,653	Harvest	44	2,031	6	30	1,260	3,020	38,734	89,526
n	400	Lower 90% CI	0	0	0	0	0	877	32,688	83,183
n_{eff}	394	Upper 90% CI	154	6,168	5	26	3,234	5,800	45,028	95,646

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Table 8.–Page 2 of 2.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.01	0.00	0.00	0.00	0.00	0.52	0.46
Start Date	07/20	SD	0.00	0.01	0.00	0.01	0.00	0.00	0.03	0.03
End Date	07/23	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.41
		Upper 90% CI	0.00	0.03	0.01	0.01	0.00	0.00	0.57	0.51
Harvest	71,166	Harvest	7	1,015	147	135	10	49	37,082	32,719
n	400	Lower 90% CI	0	265	0	0	0	0	33,391	28,976
n_{eff}	388	Upper 90% CI	4	2,096	614	1,033	10	328	40,870	36,352
		Proportion	0.01	0.00	0.01	0.00	0.00	0.00	0.72	0.26
Start Date	07/27	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
End Date	07/27	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.21
		Upper 90% CI	0.02	0.01	0.01	0.01	0.00	0.00	0.77	0.31
Harvest	16,912	Harvest	108	51	85	12	1	1	12,220	4,435
n	400	Lower 90% CI	17	2	0	0	0	0	11,401	3,636
n_{eff}	379	Upper 90% CI	254	155	229	96	1	0	13,035	5,244
		Proportion	0.00	0.12	0.00	0.00	0.00	0.00	0.44	0.44
Start Date	08/01	SD	0.00	0.02	0.00	0.00	0.00	0.01	0.03	0.03
End Date	08/10	Lower 90% CI	0.00	0.09	0.00	0.00	0.00	0.00	0.38	0.39
		Upper 90% CI	0.00	0.16	0.00	0.00	0.00	0.02	0.49	0.49
Harvest	13,755	Harvest	1	1,658	1	4	1	62	5,998	6,030
n	400	Lower 90% CI	0	1,183	0	0	0	0	5,280	5,338
n_{eff}	389	Upper 90% CI	0	2,164	0	3	0	308	6,735	6,719

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.

Table 9.–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/EF sections set gillnet fishery (Central District, Upper Subdistrict) in 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.00	0.00	0.00	0.02	0.02	0.72	0.23
Start Date	07/09	SD	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.03
End Date	07/16	Lower 90% CI	0.00	0.00	0.00	0.00	0.01	0.01	0.67	0.19
		Upper 90% CI	0.00	0.01	0.00	0.01	0.04	0.04	0.77	0.28
Harvest	148,521	Harvest	15	248	21	123	3,571	3,357	106,543	34,643
n	400	Lower 90% CI	0	0	0	0	1,538	1,458	99,133	27,932
n_{eff}	395	Upper 90% CI	8	1,191	89	762	6,143	5,792	113,736	41,649
		Proportion	0.00	0.00	0.00	0.03	0.03	0.04	0.80	0.10
Start Date	07/20	SD	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.02
End Date	07/23	Lower 90% CI	0.00	0.00	0.00	0.01	0.01	0.02	0.76	0.07
		Upper 90% CI	0.00	0.01	0.00	0.05	0.05	0.06	0.85	0.14
Harvest	94,733	Harvest	7	153	9	2,726	2,454	3,693	76,021	9,670
n	400	Lower 90% CI	0	0	0	1,214	923	1,972	71,689	6,239
n_{eff}	388	Upper 90% CI	2	1,050	4	4,600	4,326	5,799	80,169	13,439
		Proportion	0.01	0.02	0.04	0.03	0.01	0.13	0.63	0.12
Start Date	08/01	SD	0.01	0.01	0.01	0.02	0.01	0.02	0.03	0.02
End Date	08/10	Lower 90% CI	0.00	0.01	0.02	0.01	0.00	0.09	0.58	0.09
		Upper 90% CI	0.03	0.04	0.06	0.06	0.03	0.17	0.68	0.16
Harvest	21,309	Harvest	187	474	797	610	305	2,768	13,517	2,652
n	400	Lower 90% CI	0	157	415	161	82	2,000	12,443	1,933
n_{eff}	393	Upper 90% CI	568	909	1,257	1,190	616	3,610	14,583	3,416

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.

Table 10.–Stock composition estimates, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for the subset of the sockeye salmon that were harvested within a half-mile of shore in the Kasilof Section set gillnet fishery (Central District, Upper Subdistrict) in 2009 (Table 3).

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.01	0.01	0.00	0.01	0.00	0.00	0.36	0.61
Start Date	07/11	SD	0.01	0.01	0.01	0.01	0.01	0.00	0.03	0.03
End Date	07/27	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.57
		Upper 90% CI	0.03	0.03	0.01	0.02	0.02	0.01	0.40	0.66
Harvest	176,477	Harvest	1,574	1,105	562	1,258	576	317	62,770	108,316
n	400	Lower 90% CI	0	29	0	0	0	0	54,419	99,738
n_{eff}	396	Upper 90% CI	4,460	5,965	2,559	3,332	2,887	2,242	71,337	116,660

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.

Table 11.–Stock composition estimates, 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/EF sections and Kasilof Section set gillnet fisheries (Central District, Upper Subdistrict) analyzed by subsection in 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
					Cohoe/Ninilchik					
Start Date	06/25	Proportion	0.00	0.05	0.01	0.00	0.01	0.01	0.36	0.56
End Date	08/10	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.02
n	1594	Lower 90% CI	0.00	0.04	0.00	0.00	0.01	0.00	0.33	0.54
n_{eff}	1566	Upper 90% CI	0.00	0.06	0.01	0.01	0.02	0.01	0.39	0.59
					South K. Beach					
Start Date	06/26	Proportion	0.00	0.00	0.00	0.00	0.00	0.02	0.41	0.57
End Date	08/10	SD	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.02
n	806	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.38	0.53
n_{eff}	771	Upper 90% CI	0.00	0.01	0.00	0.00	0.00	0.03	0.45	0.60
					North K. Beach					
Start Date	07/10	Proportion	0.00	0.01	0.00	0.00	0.00	0.00	0.53	0.46
End Date	08/10	SD	0.00	0.01	0.00	0.00	0.00	0.01	0.04	0.04
n	261	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.40
n_{eff}	258	Upper 90% CI	0.00	0.03	0.00	0.00	0.00	0.02	0.59	0.52
					North/South Salamatof					
Start Date	07/10	Proportion	0.00	0.02	0.01	0.04	0.03	0.08	0.75	0.07
End Date	08/10	SD	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.01
n	939	Lower 90% CI	0.00	0.01	0.00	0.02	0.02	0.06	0.72	0.05
n_{eff}	918	Upper 90% CI	0.00	0.03	0.02	0.06	0.05	0.10	0.78	0.09

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 12.–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 2009.

			Reporting Group							
			Crescent	West	JCL	SusYent	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.47	0.00	0.00	0.01	0.00	0.38	0.13
Start Date	06/01	SD	0.00	0.03	0.00	0.01	0.01	0.01	0.03	0.02
End Date	06/24	Lower 90% CI	0.00	0.42	0.00	0.00	0.00	0.00	0.34	0.10
		Upper 90% CI	0.00	0.52	0.01	0.02	0.02	0.02	0.43	0.17
Harvest	21,543	Harvest	6	10,162	18	46	111	57	8,268	2,877
n	300	Lower 90% CI	0	9,094	0	0	0	0	7,219	2,074
n_{eff}	297	Upper 90% CI	29	11,234	136	399	522	338	9,354	3,725
		Proportion	0.01	0.58	0.00	0.00	0.00	0.00	0.27	0.13
Start Date	06/25	SD	0.01	0.04	0.00	0.00	0.00	0.01	0.03	0.03
End Date	08/13	Lower 90% CI	0.00	0.52	0.00	0.00	0.00	0.00	0.22	0.09
		Upper 90% CI	0.04	0.64	0.01	0.00	0.00	0.02	0.33	0.17
Harvest	43,711	Harvest	435	25,303	116	30	2	173	11,989	5,662
n	300	Lower 90% CI	0	22,612	0	0	0	0	9,685	3,904
n_{eff}	293	Upper 90% CI	1,725	27,859	518	204	1	905	14,380	7,565

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.

Table 13.–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 Western Subdistrict set gillnet fishery (Central District) in 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.86	0.09	0.00	0.00	0.00	0.00	0.00	0.05
Start Date	06/18	SD	0.02	0.02	0.00	0.00	0.00	0.01	0.00	0.01
End Date	08/13	Lower 90% CI	0.82	0.05	0.00	0.00	0.00	0.00	0.00	0.03
		Upper 90% CI	0.89	0.12	0.00	0.00	0.00	0.01	0.01	0.07
Harvest	61,347	Harvest	52,800	5,237	11	5	3	222	243	2,827
n	400	Lower 90% CI	50,546	3,317	0	0	0	0	8	1,799
n_{eff}	391	Upper 90% CI	54,895	7,326	24	2	1	889	818	4,015

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.

Table 14.–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 2009.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.06	0.06	0.00	0.21	0.34	0.23	0.09
Start Date	06/25	SD	0.00	0.02	0.01	0.01	0.02	0.03	0.02	0.02
End Date	08/13	Lower 90% CI	0.00	0.03	0.04	0.00	0.17	0.30	0.19	0.07
		Upper 90% CI	0.00	0.09	0.08	0.02	0.25	0.39	0.27	0.12
Harvest	17,200	Harvest	3	991	1,030	55	3,640	5,916	3,968	1,598
n	400	Lower 90% CI	0	470	662	0	2,987	5,077	3,275	1,126
n_{eff}	398	Upper 90% CI	1	1,581	1,434	320	4,334	6,770	4,694	2,117

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.

Table 15.–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 2009 (Figure 2).

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
						Northeastern				
		Proportion	0.00	0.00	0.00	0.03	0.58	0.39	0.00	0.00
Start Date	07/09	SD	0.00	0.01	0.00	0.01	0.03	0.03	0.00	0.00
End Date	08/20	Lower 90% CI	0.00	0.00	0.00	0.01	0.52	0.33	0.00	0.00
		Upper 90% CI	0.00	0.01	0.01	0.05	0.63	0.45	0.00	0.00
Harvest	6,290	Harvest	0	20	10	184	3,638	2,438	0	1
n	400	Lower 90% CI	0	0	0	72	3,277	2,085	0	0
n_{eff}	339	Upper 90% CI	0	93	50	323	3,989	2,803	0	0
						Southwestern				
		Proportion	0.00	0.62	0.17	0.18	0.02	0.01	0.01	0.00
Start Date	07/02	SD	0.00	0.03	0.03	0.03	0.01	0.01	0.01	0.00
End Date	08/03	Lower 90% CI	0.00	0.57	0.12	0.13	0.01	0.00	0.00	0.00
		Upper 90% CI	0.00	0.67	0.21	0.24	0.03	0.02	0.03	0.00
Harvest	15,872	Harvest	3	9,789	2,640	2,893	311	97	136	3
n	400	Lower 90% CI	0	9,009	1,902	2,109	137	6	0	0
n_{eff}	394	Upper 90% CI	2	10,571	3,328	3,743	534	266	456	3

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.

Table 16.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 strata) and Northern (1 stratum) districts and based on genetic analysis of mixtures of sockeye salmon harvested in the Upper Cook Inlet in 2009. Harvest numbers of unrepresented strata (unanalyzed) and relative error rates are given.

	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
Central District drift gillnet (excluding corridor-only periods)									
Harvest	5,744	101,858	38,216	46,458	18,060	27,222	570,553	151,556	1,138
SD	3,795	9,469	5,973	8,728	4,699	5,136	15,645	11,890	
Lower 90% CI	1,490	87,057	28,854	32,821	11,035	19,455	544,689	132,403	
Upper 90% CI	13,514	118,236	48,406	61,504	26,412	36,235	596,051	171,448	
Relative Error	105%	15%	26%	31%	43%	31%	5%	13%	
Central District drift gillnet (corridor-only periods)									
-	-	-	-	-	-	-	-	-	7,251
Central District, Upper Subdistrict set gillnet									
Harvest	641	10,101	3,185	7,626	11,882	18,072	348,626	505,719	0
SD	806	3,363	1,352	2,684	2,851	3,199	9,428	9,678	
Lower 90% CI	51	5,262	1,269	3,738	7,600	13,208	333,241	489,665	
Upper 90% CI	2,414	16,123	5,647	12,455	16,905	23,653	364,283	521,513	
Relative Error	184%	54%	69%	57%	39%	29%	4%	3%	

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Table 16.–Page 2 of 2.

	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
	Central District, Western, and Kalgin Island subdistricts set gillnet								
Harvest	53,240	40,701	144	80	116	452	20,500	11,366	118
SD	1,457	2,106	214	194	192	479	1,609	1,400	
Lower 90% CI	50,815	37,232	0	0	0	0	17,915	9,125	
Upper 90% CI	55,610	44,162	592	509	535	1,413	23,194	13,734	
Relative Error	5%	9%	205%	316%	231%	156%	13%	20%	
	Northern District, Eastern, and General subdistricts set gillnet								
Harvest	5	10,799	3,679	3,131	7,590	8,451	4,105	1,602	1,290
SD	28	587	494	521	481	563	459	303	
Lower 90% CI	0	9,845	2,855	2,308	6,818	7,532	3,367	1,126	
Upper 90% CI	23	11,780	4,486	4,022	8,399	9,387	4,880	2,119	
Relative Error	216%	9%	22%	27%	10%	11%	18%	31%	

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

Table 17.–Stock-specific harvest, standard deviation (SD), and 90% credibility intervals calculated using a stratified estimator (see text) for combined temporal strata in all fishing areas and based on genetic analysis of mixtures of sockeye salmon harvested in the Upper Cook Inlet in 2005, 2006, 2007, 2008, and 2009. Harvest numbers of unrepresented strata (unanalyzed) and relative error rates are given.

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

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Table 17.–Page 2 of 2

	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed[a]
				2008					
Harvest	20,145	63,717	66,315	47,092	3,516	47,826	875,430	1,111,226	142,378
SD	2,359	5,880	6,848	8,162	1,490	5,582	19,876	19,076	
Lower 90% CI	16,499	54,582	55,472	34,396	1,471	39,180	842,868	1,079,760	
Upper 90% CI	24,243	73,860	77,926	61,204	6,181	57,511	908,403	1,142,403	
Relative Error	19%	15%	17%	28%	67%	19%	4%	3%	
				2009					
Harvest	59,630	163,460	45,224	57,296	37,648	54,198	943,784	670,243	9,797
SD	4,182	10,286	6,127	9,153	5,514	6,080	18,379	15,395	
Lower 90% CI	54,305	147,142	35,567	42,976	29,186	44,734	913,625	645,021	
Upper 90% CI	67,836	181,011	55,619	72,923	47,195	64,676	974,061	695,614	
Relative Error	11%	10%	22%	26%	24%	18%	3%	4%	

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; and 2009, 4,495 fish) and Chinitna (2005, 13 fish; 2006, 108 fish; 2007, 4 fish; 2008, 4 fish; and 2009, 18 fish) subdistricts.

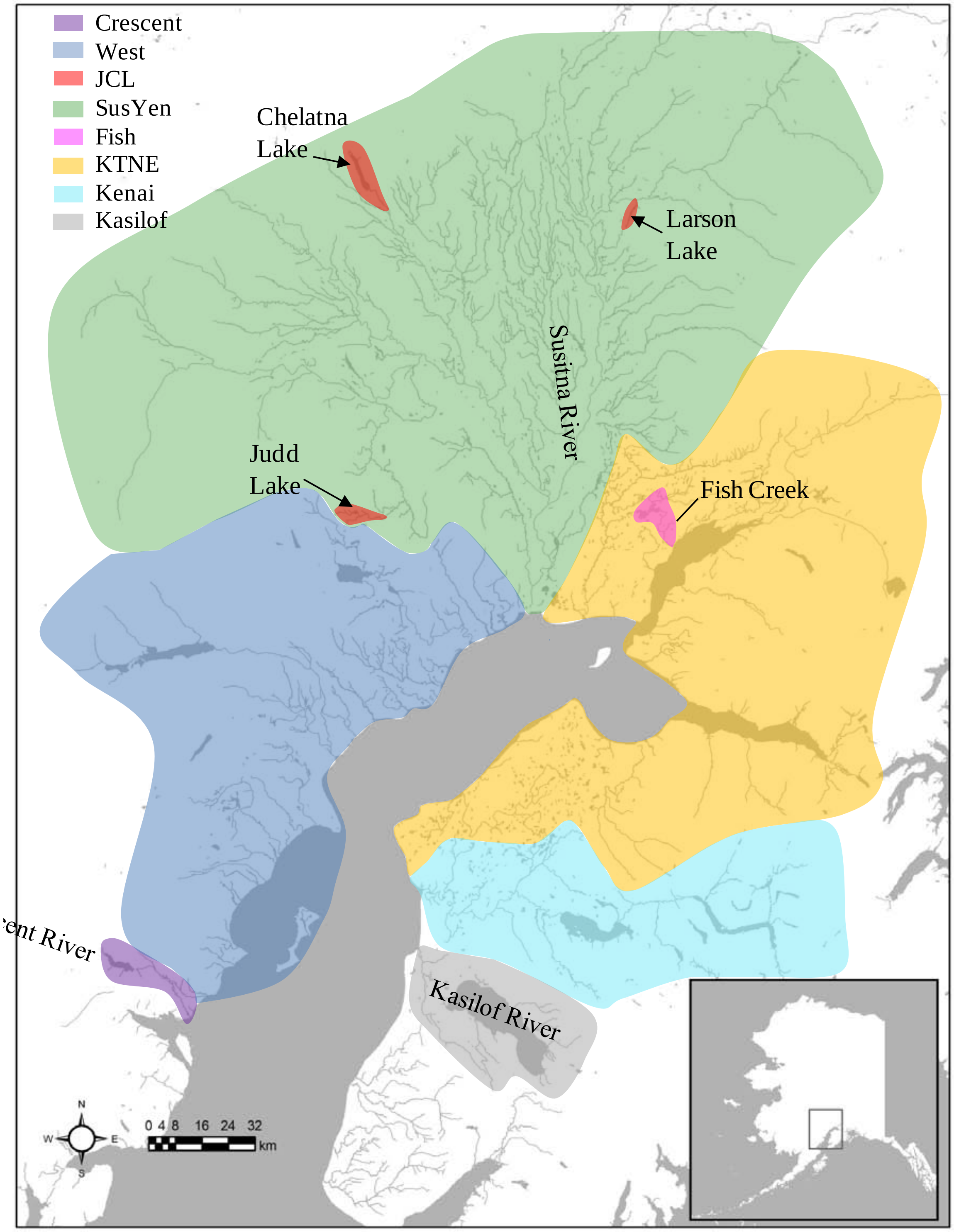
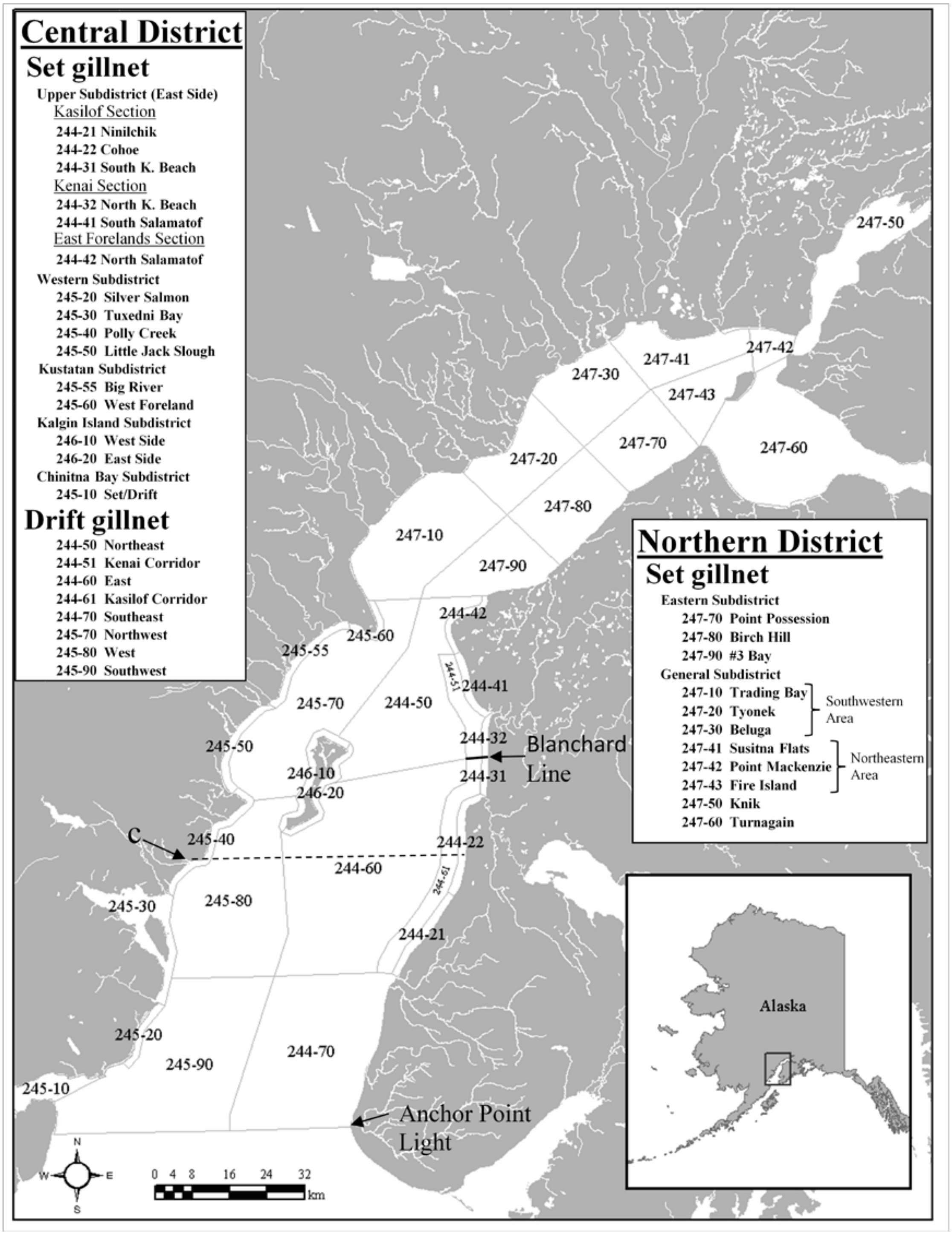


Figure 1.–Map of Upper Cook Inlet showing reporting group areas.



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 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]).

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]).

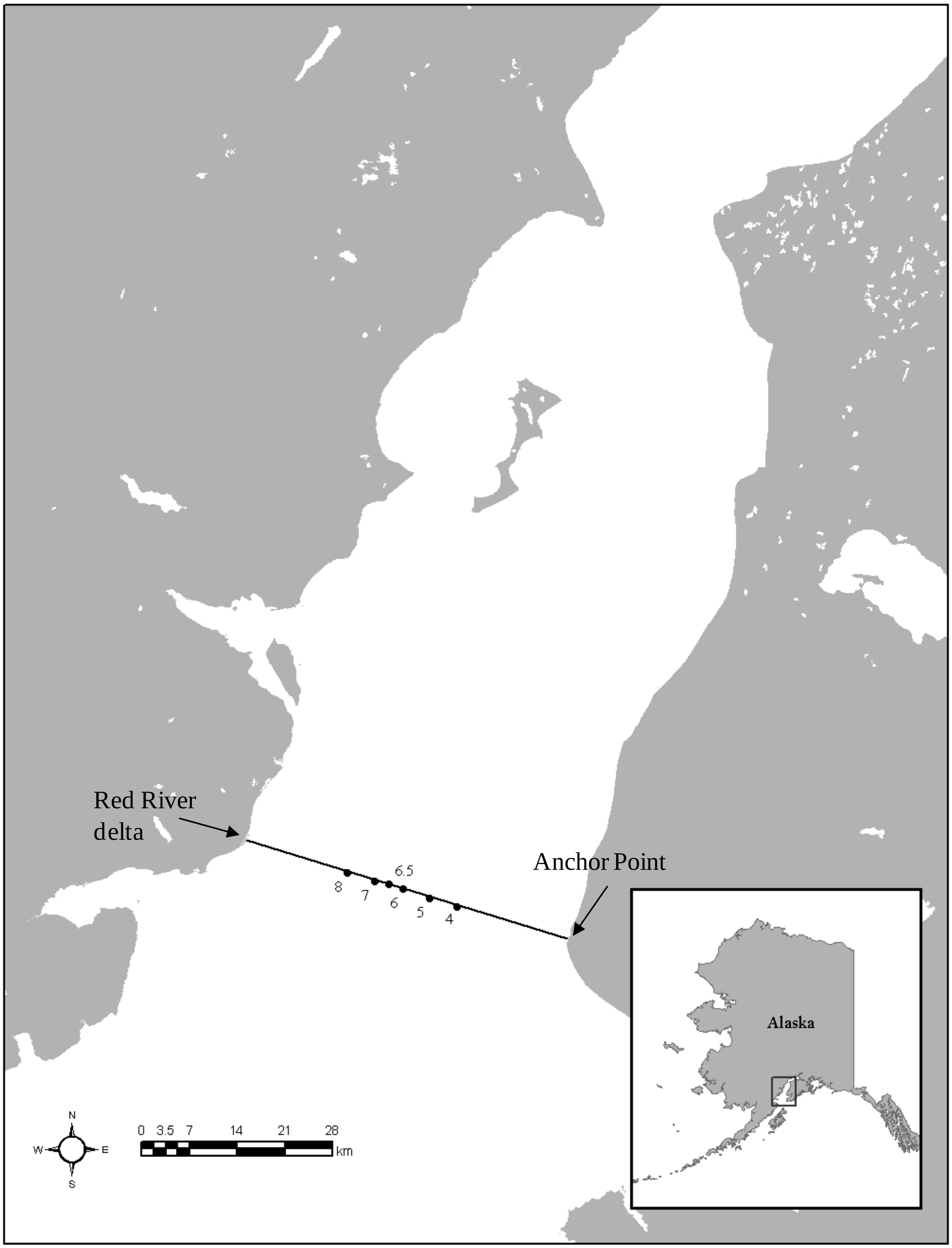


Figure 4.–Offshore test fishery stations for sockeye salmon migrating into Upper Cook Inlet, Alaska.

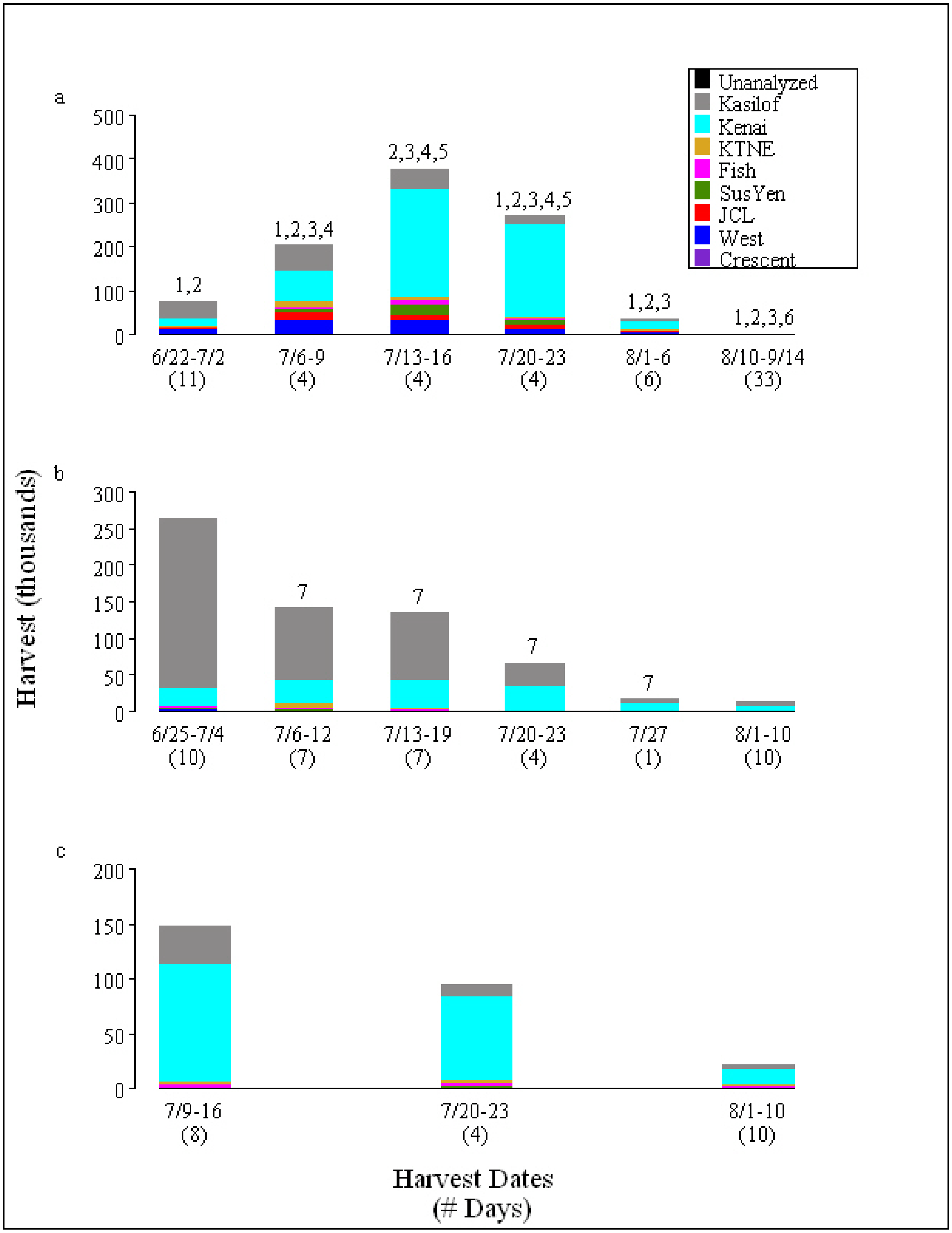
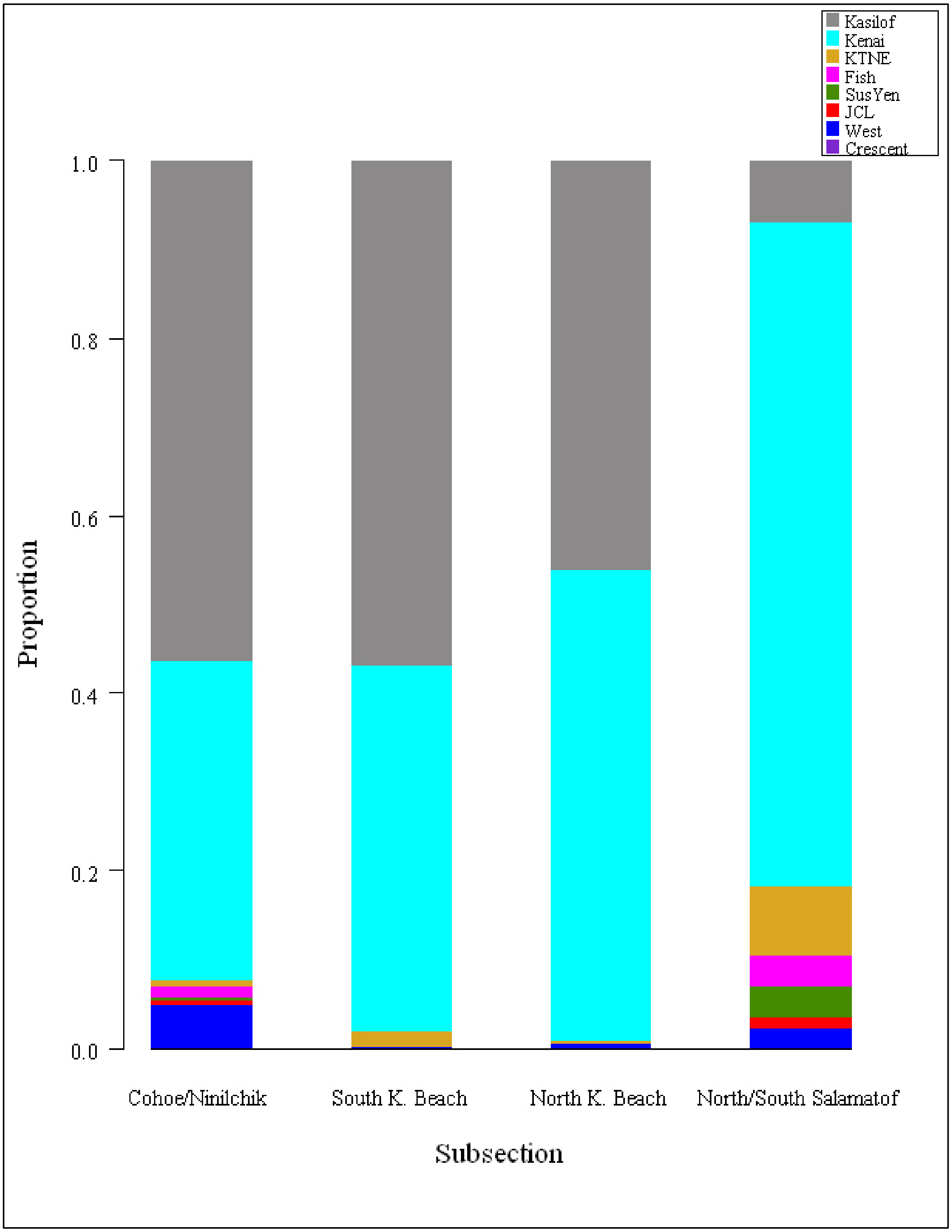


Figure 5.–Estimates of harvest by stock for the a) Central District drift gillnet fishery (excluding corridor-only periods), b) Kasilof Section set gillnet fishery (Central District, Upper Subdistrict), and c) Kenai/EF sections set gillnet fishery (Central District, Upper Subdistrict) in 2009. Numbers above the bars indicate that the fisheries were restricted to particular areas (see Tables 1 and 2). Only the drift gillnet fishery (a) contains unrepresented (unanalyzed) strata.



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

Figure 6.–Stock composition estimates for the Kasilof and Kenai/EF sections set gillnet fisheries (Central District, Upper Subdistrict) divided into subsections from 2009.

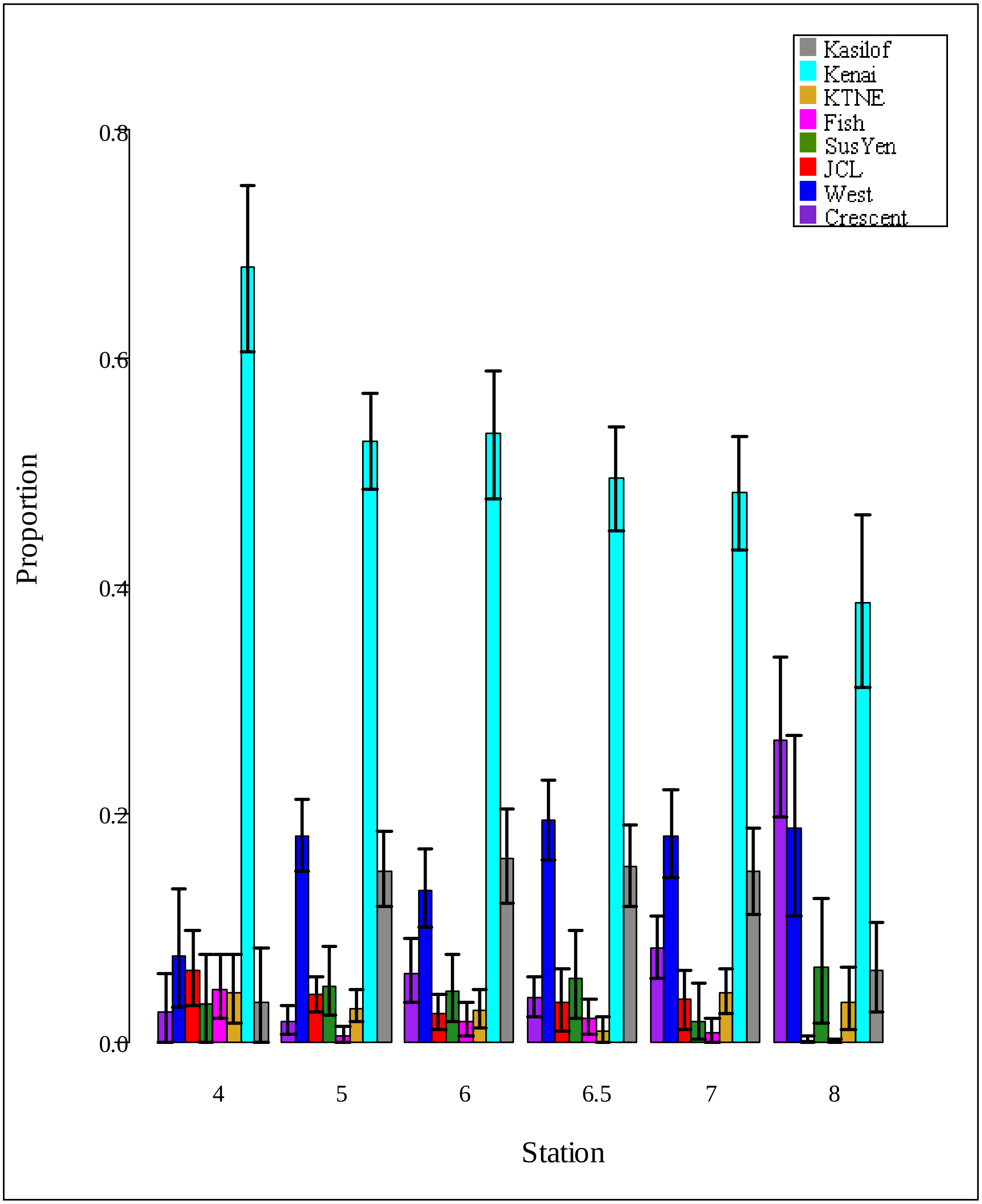


Figure 7.–Stock composition estimates and 90% credibility intervals by station for the Offshore Test fishery from 2009.

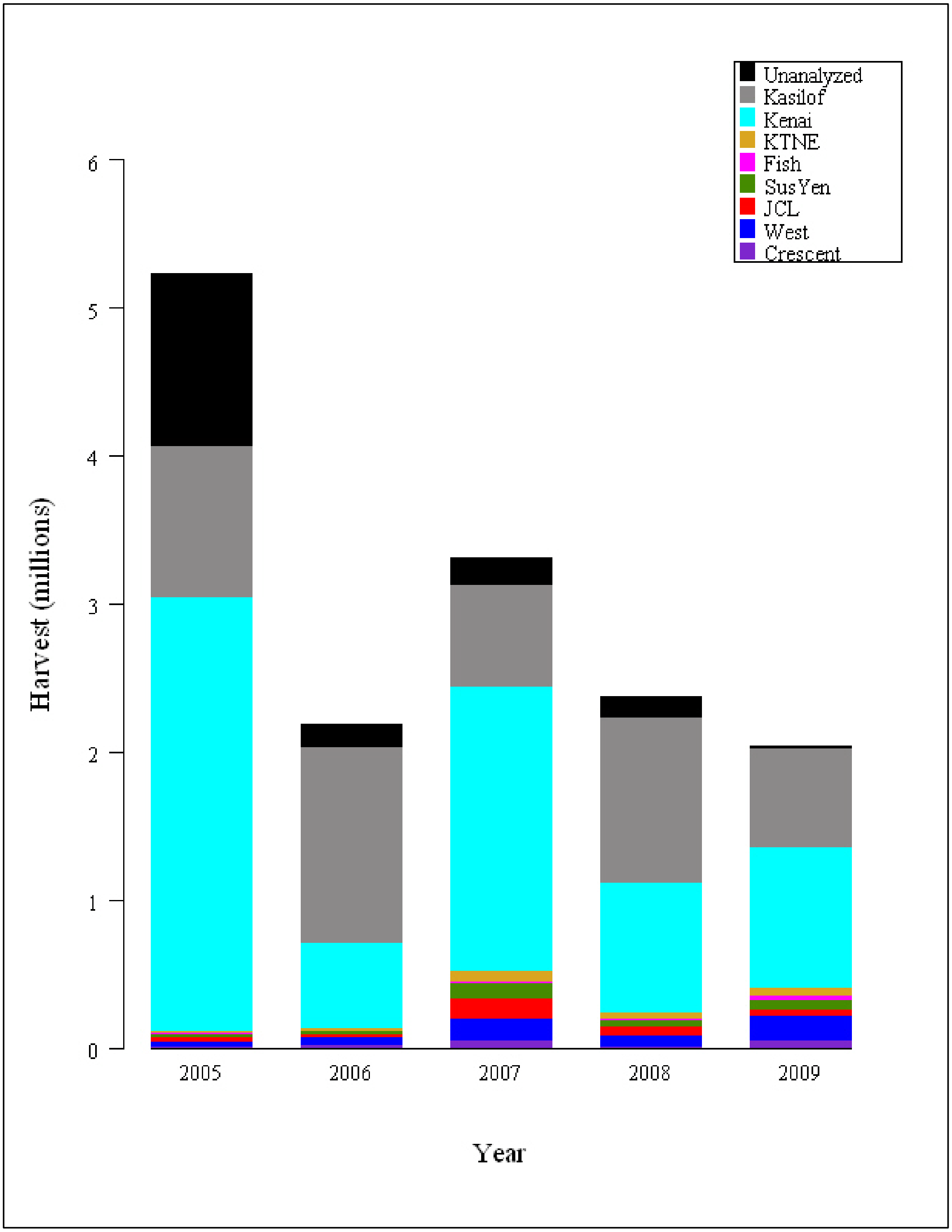


Figure 8.–Estimates of harvest by stock in the Upper Cook Inlet sockeye salmon fishery calculated using a stratified estimator for all strata within years from 2005 to 2009.