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Genetic stock identification of Upper Cook Inlet sockeye salmon harvest, 2005–2008

by

Andrew W. Barclay,

Christopher Habicht,

William D. Templin,

Heather A. Hoyt,

Terri Tobias,

and

T. Mark Willette

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

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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Andrew W. Barclay, Christopher Habicht, William D. Templin, Heather A. Hoyt,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
Gene Conservation Laboratory, Anchorage

and

Terri Tobias, T. Mark Willette,
Alaska Department of Fish and Game, Division of Commercial Fisheries, Soldotna

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

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

and

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

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ABSTRACT

This report updates previously reported analyses of genetic population structure and mixed-stock analysis of sockeye salmon *Oncorhynchus nerka* originating from all major spawning systems and harvested in commercial fisheries in Upper Cook Inlet, Alaska. The baseline was augmented with 40% more samples providing better representation of existing populations and adding 12 new populations. The fishery samples included additional late-season and 2008 collections and additional Central and Northern district areas. All individuals in the baseline and fishery were genotyped at 45 SNP markers representing 41 loci. These DNA-based markers revealed population structure similar to that observed in previous analyses. New reporting groups were defined to better incorporate stock composition information into stock-specific production models for evaluating escapement goals and forecasting future runs. These new reporting groups were identified in mixtures at high levels of precision and accuracy. Mixed-stock analyses using Bayesian methods were performed to estimate the proportion of source stocks in the harvest. The fishery samples represented 78%, 93%, 95%, and 94% of the harvest in 2005, 2006, 2007, and 2008, respectively. Patterns of stock proportions through time in the fishery were similar to previous results: Kenai River fish were present later in the season relative to Kasilof River fish; higher proportions of Kenai River fish were detected in years with higher Kenai River returns; eastern fisheries generally captured higher proportions of Kenai and Kasilof river fish than western and northern fisheries; and 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. High inter-annual variation in stock composition through space and time may be due to the unusual nature of the fisheries during the 4 years investigated.

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

INTRODUCTION

BACKGROUND

Sockeye salmon *Oncorhynchus nerka* are the most important species in Upper Cook Inlet (UCI) Management Area to the commercial fishery, with an average yearly exvessel value of $15.9 million over the past 10 years (Shields 2009). The UCI Management Area encompasses all waters in Cook Inlet north of Anchor Point Light (Figure 1). Sockeye salmon are harvested during their adult migration back to numerous natal streams and rivers that drain into these marine waters.

The Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries, is responsible for managing the commercial fisheries in UCI under the sustained-yield principle. To accomplish this general objective, ADF&G opens and closes fishing districts, sections, or subsections with the primary objective of achieving recognized spawning escapement goals. Sockeye salmon escapement goals are currently established for the Kenai River, Russian River, Kasilof River, Fish Creek, Judd Lake, Chelatna Lake, Larson Lake, Packers Creek, and Crescent River (Fair et al. 2007). In the Susitna drainage, escapement goals for Judd, Chelatna, and Larson lakes were established in 2009 to replace the escapement goal for the Yentna River due to uncertainties in sonar escapement estimates (Fair et al. 2009). Spawning escapement goals are developed based on the stock-specific relationship between the numbers of fish allowed to escape harvest and spawn, and the resulting number of fish that return. Escapement goal ranges were recently reviewed based on the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) and *Policy for Statewide Salmon Escapement Goals* (EGP; 5 AAC 39.223) (Fair et al. 2007 and 2009). These policies were adopted by the Alaska Board of Fisheries (BOF) to ensure that the state's salmon resources are conserved, managed, and developed using 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 numbers of fish that escape into the major drainages in UCI are counted using hydroacoustics on the Kenai, Kasilof, Yentna and Crescent rivers and weirs on the Russian River, Judd Lake, Chelatna Lake, Larson Lake, and Packers Creek. Beginning in 1979, side-looking sonars were used to enumerate sockeye salmon and fish wheels were used to collect scale samples on the Kenai, Kasilof, Yentna, and Crescent rivers (Westerman and Willette 2003). Although an escapement goal for Yentna River sockeye salmon is no longer in place, sonar and fish wheel research projects are continuing on the Yentna River to improve the accuracy of escapement estimates. The age composition of sockeye salmon harvests has been estimated annually using a stratified systematic sampling design (Tobias and Willette 2004a). A minimum sample (n=403) of readable scales has been used to estimate the age composition of sockeye salmon in each stratum within 5% of the true proportion 90% of the time (Thompson 1987). These various data sources have been used to construct brood tables for the major UCI sockeye salmon stocks beginning with brood year 1968 (Tarbox et al. 1983), but the most consistent methods have been applied since brood year 1979 (Tobias and Willette 2004b).

The number of offspring that return is calculated by adding the number of spawners and the number of fish harvested before reaching the spawning grounds. Accurately estimating the stock composition of catch within the fishing districts is critical to determining the total run of each stock, especially considering that UCI sockeye salmon stocks can be exploited at rates from 50–75% (calculated from Tobias and Willette 2004b and Shields 2009). Commercial fishery participants in each fishery are required to report their catch. This occurs at various processors or tenders for the drift gillnet fishery and at the buying stations, processors, or tenders for the set gillnet fishery. Although these reports provide overall enumeration of the commercial harvest, an estimate of stock composition (the proportion of fish in the harvest originating from each stock) of the catch is still required to develop brood tables and estimate escapement goals for specific stocks within the area.

A weighted age-composition allocation method has been used to estimate stock composition of commercial gillnet sockeye salmon harvests in UCI since 1968 (Tobias and Tarbox 1999). This method relies on 2 primary assumptions: 1) age-specific harvest rates are equal among stocks in the gillnet fisheries (Bernard 1983), and 2) harvests in specific fisheries are composed of nearby stocks, e.g. harvests in the East Side set gillnet fishery are assumed to be composed of stocks from the Kenai and Kasilof rivers. The age-composition catch allocation method utilizes 4 data sources: 1) commercial harvests, 2) escapements into major UCI river systems, 3) age composition of harvests, and 4) age composition of escapements. Historically, the weighted age composition method has been used to allocate commercial fishery harvests to 5 major UCI sockeye salmon stocks: 1) Kenai, 2) Kasilof, 3) Susitna, 4) Crescent, and 5) Fish Creek.

Although the weighted age-composition catch allocation method has provided the best information available, the associated assumptions may not always be valid, especially the assumption of equal exploitation among stocks. More scientifically defensible estimates of stock compositions are now available using mixed-stock analysis (MSA; see Definitions). The primary goal of the UCI sockeye salmon genetics project is to estimate stock composition of sockeye salmon harvests. Coupled with escapement estimation projects, the results of this project will ultimately provide reliable estimates of stock-specific total run (catch + escapement) for brood table development and escapement goal analyses.

Since the early 1990s ADF&G has actively developed and refined MSA applications to provide improved stock composition information for management of commercial fisheries. These efforts have encompassed nearly the entire State of Alaska with projects focusing on chum *O. keta*, Chinook *O. tshawytscha*, and sockeye salmon (e.g. Seeb et al. 2004; Templin et al. 2005; Habicht et al. 2007a; Habicht et al. 2007b; Dann et al. 2009). ADF&G now conducts MSA projects throughout the state and maintains extensive tissue archives from spawning populations for all 3 species.

One of the earliest MSA projects was initiated by ADF&G in 1992 for sockeye salmon in UCI following the *Exxon Valdez* oil spill using allozyme (protein) markers (Seeb et al. 1997). Building on the earlier genetic studies of Grant et al. (1980) and Wilmot and Burger (1985), the project was designed to detect the contribution of Kenai River sockeye salmon to the commercial harvest. Over the course of the project, ADF&G sampled approximately 8,300 sockeye salmon from 54 spawning populations between 1992 and 1997 and provided a detailed analysis of population structure of sockeye salmon in UCI using allozyme analyses (Seeb et al. 2000). The data revealed a substantial amount of genetic diversity among populations of UCI with the diversity distributed both within and among major drainages. The data supported a model of population structure generally organized around the lakes in which juvenile sockeye salmon rear (nursery lakes).

These allozyme data, paired with the MSA statistical methods available at that time, were able to differentiate among populations spawning in the major sockeye salmon-producing regions: Yentna/Susitna, Kenai, and Kasilof rivers, and groups of minor river drainages including those in West Cook Inlet, Northeast Cook Inlet, and Knik Arm. Single-region mixtures of simulated fish (based on population-specific allele frequencies) subjected to MSA allocated on average 91% to the correct region. However, when samples were taken from fish captured at fish wheels within the Kenai, Kasilof, Susitna, and Yentna rivers, allocations to the reporting group of origin averaged 85%. In addition, stock composition estimates from fish sampled in drift and set gillnet fisheries showed higher day-to-day variability than was expected by the fishery managers. This combination of results did not provide the managers with the confidence necessary to use these data for management decisions regarding UCI sockeye salmon.

Concurrent with these fishery monitoring activities, ADF&G actively focused on research to improve the techniques of MSA, including: 1) development and evaluation of genetic markers for improved resolution of stock identification, 2) development of statistical techniques for more accurate and precise estimation of stock composition, and 3) development of the infrastructure to support high-throughput and low-error genotyping.

In 2007, ADF&G released the first set of results of an initiative begun in July, 2005 to apply improved MSA techniques to estimate UCI sockeye salmon stock composition in commercial harvests for selected periods from 2005 through 2007 (Habicht et al. 2007b). This first set of results used the same reporting groups identified with the allozyme data. Since then, we modified reporting groups to better incorporate stock composition information into stock-specific production models for evaluating escapement goals, estimating exploitation rates, and forecasting future runs. Here we provide methods and results that differ from Habicht et al. (2007b) in 6 ways. This new analysis includes: 1) additional baseline samples that increase sample sizes for populations represented in previous analyses and add samples from populations not previously represented; 2) additional fishery mixtures that extend to the end of seasons and into the Northern District, 3) analyses from the 2008 fisheries, 4) modified reporting groups that more accurately represent management stock groupings, 5) exclusive use of Bayesian methodology for fishery mixture analyses, and 6) exclusion of a linked marker (see definitions).

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.

Bootstrapping. A method of resampling data with replacement to assess the variation of parameters of interest.

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 probablity: 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 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)).

F_{ST}. Fixation index is an estimate of the reduction in heterozygosity due to random genetic drift among populations; the proportion of the variation at a locus attributable to divergence among populations.

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 a fish.

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

Harvest. The number of salmon or weight of salmon taken from the run of a specific stock.

Harvest Rate. The fraction harvested from a stock taken in a fishery.

Heterozygosity. The proportion of individuals in a population that have 2 allele forms (are heterozygous) at a particular marker; a measure of variability.

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

Linked Markers. Markers showing gametic disequilibrium.

MSA. Mixed-stock analysis using genetic data. Method using allele frequencies from populations and genotypes from mixture samples to estimate stock compositions of mixtures.

PCR. The polymerase chain reaction or PCR amplifies a single or few copies of a locus across several orders of magnitude, generating millions of copies of the DNA.

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; constructed based on a combination of management needs and genetic distinction. See definition for Salmon Stock for breakdown of reporting groups (stocks) in Upper Cook Inlet.

Run. The total number of salmon in a stock surviving to adulthood and returning to the vicinity of the natal stream in any calendar year, composed of both the harvest of adult salmon plus the escapement; the annual run in any calendar year. With the exception of pink salmon the run would be 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)).

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

Salmon Stock. A locally interbreeding group of salmon (population) that is distinguished by a distinct combination of genetic, phenotypic, life history, and habitat characteristics or an aggregation of 2 or more interbreeding groups (populations) which occur within the same geographic area and is managed as a unit (from 5 AAC 39.222(f)). For purposes of this study, “stocks” in Upper Cook Inlet were delineated based on the major population or aggregation of populations for which ADF&G estimates escapement or for a population or aggregation of populations which occur in a geographic area for which the department does not estimate escapement. Upper Cook Inlet stocks are defined as: 1) the largest producer on the west side (Crescent River; “Crescent”), 2) the remaining West Cook Inlet producers (“West”), 3) the lakes with weirs in the Susitna/Yentna rivers (Judd/Chelatna/Larson lakes; “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”).

IMPROVEMENTS TO MSA TECHNIQUES

Development of Genetic Markers

A suite of genetic markers have been used over the years for MSA applications in Pacific salmon (reviewed in Habicht et al. 2007b). Single nucleotide polymorphisms (SNP) applications in MSA studies of Pacific salmon have become increasingly common (Smith et al. 2005b; Smith et al.

2007; Narum et al. 2008; Habicht et al. 2007b; Dann et al. 2009). ADF&G developed assays for SNP markers for sockeye salmon (Smith et al. 2005a; Elfstrom et al. 2006), and these markers are now used by U.S. laboratories for projects on sockeye salmon by the Pacific Salmon Commission in the Northern Boundary region. This same method has been used by ADF&G in Bristol Bay with sockeye salmon both inseason to estimate relative stock contributions passing through the Port Moller test fishing area, and postseason to estimate commercial-catch stock contributions in fisheries for brood tables used to establish escapement goals (Dann et al. 2009). This same set of SNP assays was used in UCI to analyze a subset of the samples reported in Habicht et al. (2007b) and in this study.

Statistical Developments

Different statistical methods have been developed over the years for MSA applications in Pacific salmon (reviewed in Habicht et al. 2007b). Conditional maximum likelihood methods (Pella and Milner 1987) have been used to directly estimate the stock composition of sockeye salmon mixtures in UCI, or to provide a prior for Bayesian analysis (Pella and Masuda 2001, Koljonen et al. 2005; reviewed in Habicht et al. 2007b). The latter use has been abandoned due to concerns that Bayesian analysis results might provide more optimistic measures of accuracy than is warranted due to the double use of mixture information. In the most recent reports, sockeye salmon mixture analyses rely solely on Bayesian methods (Dann et al. 2009).

Infrastructure Improvements

Genotyping technologies for SNPs have been developing at a rapid rate and are now faster than those for any other marker class (Ranade et al. 2001; Melton 2003; Wang et al. 2009). SNP genotypes can be assayed by a variety of methods, typically with exceedingly low error rates (Habicht et al. 2007b; Dann et al. 2009), and these assays are readily transferred and repeatable across instruments and laboratories. Recently, ADF&G installed highly automated technology to further reduce costs and increase throughput.

The movement to high-throughput analyses has also required ADF&G to develop a laboratory database and implement quality control measures to ensure data integrity and measure genotyping error rates. Both of these components were used and are reviewed in this study.

MANAGEMENT OF UCI SOCKEYE

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 the Central District only, whereas set gillnet fisheries occur in both the Central and Northern Districts on both eastern and western shores (Figure 1). 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 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 1–3). 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 east-side beaches, usually to reduce harvest of Susitna or Kenai sockeye salmon. Drift and set gillnet fisheries are 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. The Kenai and Kasilof sections of the East Side Subdistrict are managed as separate units. Set gillnet fisheries are sometimes restricted to within ½ mile from the beach in the Kasilof section and closed in the Kenai section 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 2009) 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 2005–2008

From 2005–2008, the years depicted in this report, sockeye salmon runs were very different from each other. Salmon run migration patterns and strengths typically vary from year to year. However, from 2005–2008, sockeye salmon runs were particularly atypical with 2 of the latest and 1 of the earliest runs observed since 1982.

In 2005, the estimated UCI commercial harvest of 5.2 million sockeye salmon was 25% above the preseason forecast, and the total run of sockeye salmon to UCI was 41% more than the preseason forecast (Sheilds 2006). Returns to all systems in UCI, with the exception of the Susitna River and Fish Creek, were stronger than expected in 2005. Based on weighted age-composition catch allocation method, the Kenai River sockeye salmon run was approximately 66% greater than the preseason forecast. The Kasilof River sockeye salmon run was approximately 27% greater than the preseason forecast. The total run to the Susitna River, however, was 66% lower than the forecast. With roughly two-thirds of the Susitna River run bound for the Yentna River, the escapement to the Yentna River was significantly short of its escapement goal. The midpoint of the sockeye salmon run was 7 days late in 2005, which was the latest run ever observed at that time. (Shields and Willette 2006).

In 2006, preseason forecasts of sockeye salmon runs to the Kenai and Susitna rivers were below average, and inseason projections in early July also indicated a weak run (Shields 2007a). As a result, the Central District drift gillnet fishery and the Kenai Section of the East Side Subdistrict set gillnet fishery were closed during late July, and the Northern District set gillnet fishery was closed after July 6. Based on the preseason forecast, ADF&G first managed for an inriver sonar goal range of 650,000–850,000 sockeye salmon in the Kenai River, but by August 7 the actual return to the Kenai River was projected to be between 2.2 and 2.5 million, so the inriver goal range was changed to 750,000–950,000 fish as required by the Kenai River late-run sockeye salmon management plan. The midpoint of the run in 2006 was more than 9 days late, by far the latest run timing ever observed in UCI. Nearly 530,000 fish passed the Kenai River sonar site after the commercial season ended on August 10, and a total of 860,000 sockeye salmon (or 57%) passed in August, the largest August component of sonar passage on record (Shields 2007a). The final inriver sonar estimate in the Kenai River was 1.5 million sockeye salmon, 550,000 fish over the upper end of the inriver goal range. With the Kasilof River exceeding escapement objectives early in the run, the KRSHA was used aggressively in an attempt to harvest surplus sockeye salmon above escapement needs. In 2006 approximately one-third of the entire Inlet harvest was taken within approximately 3 square miles in the Kasilof River terminus. The Kasilof River run was 77% over the forecast, and the Kenai River run was nearly 40% over the forecast. Because these 2 runs were larger than other systems within UCI, the UCI-wide run in 2006 was 38% larger than forecasted. Returns to systems other than the Kenai and Kasilof rivers were reasonably close to the forecasted returns.

The run timing in 2007 was fairly typical and, for the first time in many years, the Kenai River inriver goal remained within the same inriver goal range throughout the season (5 AAC 21.360). This meant the inriver goal for the Kenai River remained the same (750,000–950,000) throughout the season. Although run timing seemed normal, the migration of the fish once in the district was abnormal. For the first time since 1992, the drift gillnet fleet had back-to-back periods with a sockeye salmon catch per unit effort (CPUE; fish per boat per period) greater than 1,000. Since 1974, only 6 years experienced drift periods with a CPUE over 1,000. The CPUE for the July 16 and July 19 periods were the second and fifth highest in the fishery history. Even more unusual was that in both of these periods, the drift fleet was restricted to south of the southern tip of Kalgin Island, plus the Kenai and Kasilof Sections (corridor). The offshore test fishery (a program that samples sockeye salmon at 6 fixed stations from Anchor Point to Red River delta; Figure 4) had observed a large number of sockeye salmon entering the district for a few days prior to these openings. After these strong drift gillnet catches, it was anticipated that subsequent set gillnet catches would also increase as this large body of fish made its way to the Kenai and Kasilof rivers. But this did not happen; a “strong push” of sockeye salmon to the beaches never materialized.

In 2008, the preseason forecast for the total sockeye salmon run (5.6 million) was slightly below average with above average Kasilof (1,286,000), average Kenai (3,064,000), and below average Susitna (344,000) forecasts (Nelson et al. 2008). Due to the below average Susitna forecast, the commissioner restricted the drift gillnet fleet to the Kenai and Kasilof corridor on July 10 to reduce the exploitation rate on this stock. Inseason projections in late July indicated run timing was early and the Kenai run was weaker than forecast. With Kasilof escapements over the goal range and Kenai escapements lagging, the management strategy after July 27 focused on reducing Kasilof and increasing Kenai escapements. As a result, for the remainder of July and early August, drift gillnet fisheries were restricted to the western half of the Central District, and set gillnet fisheries in the Eastside Subdistrict were restricted to the KRSHA. At the end of the season, the Kasilof sockeye salmon escapement (301,469) was slightly above the upper optimal escapement goal (300,000), the Kenai escapement (614,946) was slightly below the lower inriver goal (650,000), and the Yentna escapement (90,146) was slightly above the lower sustainable escapement goal (90,000). Overall, the total sockeye salmon run (4.0 million) was 27% below the preseason forecast, and the run was 4 days early (Sheilds 2008).

METHODS

TISSUE SAMPLING

Baseline

Baseline samples for genetic analysis were collected from spawning populations of sockeye salmon by ADF&G using gillnets and beach seines (Table 2; Figure 5). Most collections were made in the 1990s and reported in Seeb et al. (2000) and Habicht et al. (2007b). These populations represent most of the known genetic diversity, influenced by both geographic (location) and temporal (early- and late-spawning) forces. Collections selected for inclusion in the current study represent all the populations previously identified in Habicht et al. (2007b) with additional collections made in 2007 and 2008 from unrepresented or underrepresented populations. Target sample size for baseline populations was 95 individuals across all years to achieve acceptable precision for the allele frequency estimates (Allendorf and Phelps 1981; Waples 1990a). Tissue samples were collected and subsequently either frozen (heart, muscle, liver and eye) or preserved in ethanol (axillary fin). Frozen tissues were sampled into individual vials and ethanol-preserved samples were placed collectively into 125–500ml containers, one container for each collection site for each year.

Mixtures

Fish wheels

Genetic samples were collected from sockeye salmon captured in fish wheels operating on the Yentna, Susitna, Kenai, and Kasilof rivers. Samples were generally collected in proportion to the fish wheel catch throughout the run. These fish wheels are all located below spawning sites in each river (Figure 5) and are thought to capture only fish destined to spawn within the rivers where the fish wheels operate.

Offshore test fishery

Genetic samples were collected, generally daily, from offshore test fishery harvests of sockeye salmon taken at 6 fixed stations from Anchor Point to Red River delta in July of each year. Genetic samples were taken from fish harvested at each station. In 2006 and 2007, if less than 30 individuals were harvested at a station, all were sampled. If more than 30 sockeye salmon were harvested at a station, a maximum of 30 were randomly sampled. In 2008, samples were collected similarly, but the maximum was set at 50 individuals per station to increase the potential temporal and spatial resolution of stock composition estimates. Consecutive daily samples from all stations were combined to form temporal mixtures with a sample size goal of 400 individuals. Thus, temporal strata were shorter (3–5 days long) near the peak of the run when catches were higher, and longer (7–13 days long) near the beginning and end of the run when catches were lower.

Commercial drift and set gillnet fisheries

Commercial fishery harvests were sampled using a stratified systematic sampling design. Area strata were determined *a priori* using established fishery districts and subdistricts. The UCI management area is divided into 2 districts, the Central and Northern districts, which are further subdivided into 8 subdistricts from which genetic samples were collected (Figure 1). Temporal stratification was determined postseason, based on catch patterns in each fishery and the number of samples collected, to best represent the harvest. Because samples could not be collected each day, samples collected on individual days were often used to represent harvests over several adjacent days (Table 3). Samples were generally only used to represent harvests in the same areas sampled within about one week of the sampling date. The first and last temporal strata in each season were sometimes several days long (Table 3), because harvests were low and either building or tapering off (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. In 2005, harvests were sampled for the purpose of obtaining one sample of at least 200 fish per stratum for either the entire season or for each fishing period, depending on the area and level of fishery management interest (Table 3). In 2006, 2007 and 2008, 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 post season. In 2005, sampling was conducted over 4 weeks, and in 2006, 2007 and 2008 sampling was conducted over 7 weeks (Table 3).

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). Note that this is strictly a statement regarding the point estimates and not the width of the resulting 90% credibility interval. Thompson's (1987) sample size estimator is both optimistic and pessimistic for different reasons. It is optimistic (provides smaller confidence intervals than true) because it only considers uncertainty from sampling error and not uncertainty from genetic assignment error. The estimator is pessimistic because it provides confidence statements about point estimates for the worst-case scenarios where stock proportions are intermediate (30–70%). Therefore, this expected level of precision is sometimes smaller (because it assumes perfect genetic identification) and sometimes larger (because many stock composition estimates are on the extreme ends of the range) than observed. Composite samples were generally constructed by combining samples from adjacent time and area substrata to achieve this sample size goal. In 2006–2008, composite samples were constructed in proportion to actual harvests within substrata. The original funding for MSA analysis of UCI sockeye salmon commercial harvests allowed for laboratory analyses of 8,000 samples per year, which limited the number of individual stratum estimates each year. Habicht et al. (2007b) reported results from samples selected for analyses from earlier fishing periods (mostly from late June through July), 2005–2007. In this report, we reanalyzed all the previously reported strata in addition to all the strata that were not previously analyzed from 2005–2007, and all strata sampled in 2008 using an improved baseline, different reporting groups and statistical methods, and excluding a linked marker (see definitions).

Drift gillnet sampling

In 2005, most of the drift gillnet fishery sampling was conducted at Inlet Salmon's 2 docks located on the Kenai and Kasilof rivers. Samples of 50–200 fish were taken during 9 regular drift gillnet fishery openings from July 4 through August 1 (Table 3). During each sample period, 10–20 boats were sampled and 5–10 samples were collected from each boat. Overall, 63 of the 472 different boats were sampled 1–6 times each. The total number of boats fishing varied among openings from 268 on July 30 to 448 on July 18. We analyzed samples representing harvest from June 27–August 8 (Table 3).

In 2006–2007, the drift gillnet fishery was sampled at 3 processors (Ocean Beauty, Inlet Salmon, and Icicle Seafoods), which historically accounted for about 60% of the total drift gillnet fishery harvest. At each processor, sampling was conducted in proportion to the harvest expected to be delivered. At Ocean Beauty and Inlet Salmon, as many boats as possible were systematically sampled (i.e., every other boat or every other pair of boats) 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. The target sample proportion for all processors for each period was set based on a target sample goal of 130 fish from the processor expected to receive the least catch. For example, if the smallest processor was expected to receive 26,000 fish from all boats, and we sampled from one half of the catch (i.e., 13,000 fish from sampling every other boat), then the sampling rate needed to be 1% to obtain 130 tissue samples. The same proportion of the catch was then sampled at all 3 processors resulting in a total sample greater than 400. During an unloading event, fish were removed from the boats, sorted by species, weighed and placed in plastic totes. Samples were randomly taken from the totes throughout the unloading of each boat. Because we were sampling in proportion to catch on each boat and sampling throughout the entire delivery period, any pattern in the delivery sequence of boats was correctly weighted. The sampling of the fish from Icicle Seafoods occurred on the day following each fishery period. Icicle Seafoods operated at least 2 tenders that collected sockeye salmon from commercial drift gillnet boats in UCI during and after the fishery. The tender unloaded in Homer the day after the fishery, and the fish were trucked to its Seward plant. Crews met the drift gillnet tenders at the dock and sampled at least 130 fish from whichever tenders were available. Since the tenders carried a mix of fish from various boats, samples were taken from as many totes as possible.

In 2008, composite samples were constructed from subsamples collected at one or more processors located in the Kenai/Kasilof area and from Icicle Seafoods tenders. Statistical analyses of drift gillnet data collected in 2006–2007 generally indicated no significant differences in stock composition estimates among processors (XinXian Zhang, Biometrician, ADF&G, Anchorage and M. T. Willette, Commercial Fisheries Biologist, ADF&G, Soldotna; personal communication). Therefore, to reduce sampling costs (i.e. eliminate one sampling crew), we limited sampling to Icicle Seafood, which tended to receive fish caught in the southern part of the Central District, and Kenai/Kasilof area processors, which tended to receive fish from southern and northern portions of the Central District. This sampling design was adopted to reduce costs while also sampling harvests that may have come from different areas within the Central District where we assumed stock compositions may have differed. In the Kenai/Kasilof area, sampling was conducted on the day of the fishery either at Inlet Salmon, Ocean Beauty, Snug Harbor Seafoods, or Salamatof Seafoods. Sample sizes were a minimum of 250 fish from Kenai/Kasilof processors and 250 fish from Icicle Seafoods tenders. The same 2006–2007 sampling procedure was employed, i.e. 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. The sampling the following day at Icicle Seafoods in Homer followed the same procedure as in 2006 and 2007, only with a sample size of 250 fish. Temporal strata were identified post season, and composite random samples were constructed in proportion to the actual substratum (fishery/processor) harvests. We analyzed samples representing harvests from June 19–August 11 in 2006, June 21–August 9 in 2007, and June 19–July 24 in 2008 (Table 3). Many different restrictions were in effect during these harvest periods (Table 3).

Set gillnet sampling

In 2005, East Side Subdistict (Central District) set gillnet harvests were sampled from July 4 to August 4. The harvests from both the Cohoe/Ninilchik and Salamatof Beach subsections were sampled at 50 fish per period throughout the season. The North K. Beach and South K. Beach subsection harvests were sampled at 200 fish per period during the peak of the season (July 11–21) and at 50 fish per period during early and late fishing periods (July 4–7 and July 25–August 4). Additional samples were collected from the North and South K. Beach subsections to compare harvest stock compositions from north and south of the Blanchard Line early and late in the season (Table 3; Figure 1). The West Side (Central District) and Kalgin Island (Central District) subdistricts were sampled once and the Eastern Subdistrict (Northern District) was sampled twice; a total of 100 fish were collected for each of these subdistricts. Samples collected from General Subdistrict (Northern District) harvests were not sufficient to estimate stock composition, because catches from this district were mixed with catches from other districts at the processors. We analyzed samples representing harvests from June 20–August 10 in the Kasilof Section and from July 11–August 10 in the Kenai Section (Table 3).

In 2006–2008, two sections were established for sampling of East Side Subdistrict set gillnet harvests: one north of the Blanchard Line (Kenai Section) and one south of the line (Kasilof Section; Figure 1). These 2 sections were further divided into 2 subsections each. Kenai Section was divided into the North/South Salamatof and the North Kalifornsky (K.) Beach subsections, while the Kasilof Section was divided into the South K. Beach and the Cohoe/Ninilchik subsections (Figure 1). East Side Subdistrict (Central District) set gillnet harvests were over-sampled to allow for composite samples to be constructed in proportion to actual harvest post season, because harvests delivered to buying stations were not known at the time of sampling. Harvests were sampled using the same strata and substrata that were used as in 2005. We determined substratum sample sizes based on the highest proportion of catch observed in each substratum over the last 5 years. For example, if the harvest in the Salamatof subsection was historically 3 times that in the North K. Beach subsection during a specific fishery period, then the sample sizes collected from the Salamatof and North K. Beach subsections would be 300 and 100, respectively. In some years, >90% of the harvest in the Kenai Section came from the North/South Salamatof subsection, so 400 samples were collected from this subsection to provide for postseason construction of composite samples in proportion to subsection harvests. Genetic samples were randomly collected at buying stations on the beaches and at processors. Fish were trucked to buying stations about an hour after being picked from the set gillnets at every high and low tide during a period. There were 4–6 buying stations near each beach (subsection), and each buying station received fish from different sites along the beach that were then mixed in totes. 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 sections in proportion to the actual harvests in each subsection/period. For 2006, we analyzed samples representing harvests from June 26–August 9 in the Kasilof Section and from July 10–August 9 in the Kenai Section (Table 3). The July 24–29 openings were restricted to the KRSHA (Table 3). For 2007, we analyzed samples representing harvests from June 25–August 9 in the Kasilof Section and from July 9–August 9 in the Kenai Section (Table 3). For 2008, we analyzed samples representing harvests from June 26–July 26 in the Kasilof Section and from July 10–24 in the Kenai Section.

In all years, samples taken within the East Side Subdistrict set gillnet were analyzed 2 ways. First, samples were partitioned by sections (Kenai and Kasilof) and time within years. Secondly, the samples were partitioned by subsection (Cohoe/Ninilchik and South K. Beach, North K. Beach and Salamatof Beach) within years. In 2005, a final analysis was conducted to examine temporal distribution of stock composition within subsections.

In 2005, one random sample of 100 sockeye salmon was taken from West Side Subdistrict harvests on July 21, and one sample of 100 fish was taken from Kalgin Island Subdistrict harvest on August 6. Harvests from the West Side and Kalgin Island subdistricts (Central District) were sampled at Pacific Star and Inlet Salmon processors where tenders from these areas were unloaded the morning after each fishery period.

From 2006–2008, sockeye salmon were sampled from the West Side and Kalgin Island subdistricts after each period when possible. Goals of 48–130 fish were set for each sampling period based on the timing of historic harvests with the objective of sampling enough fish in each sampling period to construct a sample of 400 fish post season (weighted by the actual harvest in each period) that would represent the total season harvest. In June 2008, an additional harvest-weighted sample (n=100) was taken from Kalgin Island.

Historically, samples from the General Subdistrict were taken when tenders delivered sockeye salmon to processors on the Kenai Peninsula. Samples taken from these tenders usually represented statistical areas 247-10, 247-20 and 247-30 (Figure 1). From 2005 through 2007, sampling from tenders was limited, due to low harvests or mixing of harvests among subdistricts before delivery. Processors on the Kenai Peninsula stopped buying General Subdistrict fish in 2006–2008. Only 30 samples from the General Subdistrict were obtained in 2005, and no samples were collected in 2006 and 2007. In 2008, genetic samples were collected in Anchorage at the Ship Creek dock, where fishermen delivered their harvest, and from Copper River Seafood's processing plant. Post season, a harvest-weighted sample of 400 was constructed to represent areas 247–41, 42 and 43 and 247–30. Sampling crews in Anchorage were not able to obtain samples from statistical areas 247–10 or 20.

Eastern Subdistrict harvests were processed mainly at the Ocean Beauty processing plant in Nikiski. In 2005, one sample of 100 fish was taken over 2 harvest periods mid-season. From 2006–2008, genetic samples were taken from harvests each period when possible. In 2006 a harvest-weighted sample of 397 was constructed post season to represent the end of the season harvest. In 2007, a harvest-weighted sample of 200 was constructed post season to represent the total season harvest. Sampling was increased again in 2008, and a harvest-weighted subsample of 400 was obtained. Eastern Subdistrict commercial openings generally start in late May, but genetic samples were not collected until July due to low early-season harvests in 2005, 2006, and 2007. Sampling for genetic tissues started on July 7 in 2008.

The KRSHA (Central District, East Side Subdistrict) was established at the mouth of the Kasilof River to target the harvest of Kasilof River sockeye salmon (Figure 3). Genetic samples were collected from the KRSHA harvests in 2006, 2007, and 2008. In 2006, combined set and drift gillnet harvests were sampled from July 17–July 23. From July 24–July 27, set and drift gillnet harvests were sampled separately. In 2007, combined set and drift gillnet harvests were sampled from the July 27 fishery. In 2008, combined set and drift gillnet harvests were sampled from July 28–August 7.

Tissue Handling

Tissue samples for genetic analysis were collected from sockeye salmon caught in the commercial catch were collected without regard to size, sex, or condition. An axillary process was excised from individual fish and placed in ethanol in either an individually labeled 2 ml plastic vial or a 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.

LABORATORY ANALYSIS

Assaying Genotypes

Genomic DNA was extracted using a DNeasy® 96 Tissue Kit by QIAGEN® (Valencia, CA)[1]. SNP markers for 45 sockeye salmon were assayed; 3 mitochondrial and 42 nuclear DNA. While baseline collections and the commercial catch samples collected in 2007 and 2008 were screened for all SNPs, commercial catch samples collected in 2005 and 2006 were screened for 40 of the 45 SNPs (Table 4). Genotypes for these SNPs were screened using 2 platforms, depending on when they were assayed and the performance of assays on the different platforms.

For some baseline collections and the commercial catch samples collected in 2005 and 2006, all SNP genotyping was performed in 384-well reaction plates. Each reaction was conducted in a 5µL volume consisting of 5–40ng of template DNA, 1x TaqMan® Universal PCR Master Mix (Applied Biosystems) and 1x TaqMan® SNP Genotyping Assay (Applied Biosystems). Thermal cycling was performed on a Dual 384-Well GeneAmp® PCR System 9700 (Applied Biosystems) as follows: an initial denaturation of 10 min at 95°C followed by 50 cycles of 92°C for 1s and annealing/extension temperature for 1.0 or 1.5 min. The plates were scanned on an Applied Biosystems Prism 7900HT Sequence Detection System after amplification and scored using Applied Biosystems' Sequence Detection Software (SDS) version 2.2.

SNP genotyping was accomplished as described above for only 2 assays on the remaining baseline collections and the commercial catch samples collected in 2007 and 2008. For the 2007 samples these assays were *One_MHC2_251* and *One_STC-410* and for the 2008 samples they were *One_MHC2_190* and *One_STC-410*. The additional 43 markers were genotyped using Fluidigm® 48.48 Dynamic Arrays (http://www.fluidigm.com). The Fluidigm® 48.48 Dynamic Array contains a matrix of integrated channels and valves housed in an input frame. On one side of the frame are 48 inlets to accept the sample DNA from each individual fish and on the other are 48 inlets to accept the assays for each SNP marker. Once in the wells, the components are pressurized into the chip using the IFC Controller MX (Fluidigm). The 48 samples and 48 assays are then systematically combined into 2,304 parallel reactions. In this study, 43 assays were loaded. Each reaction is a mixture of 4µl of assay mix (1x DA Assay Loading Buffer (Fluidigm), 10x TaqMan® SNP Genotyping Assay (Applied Biosystems), and 2.5x ROX (Invitrogen)) and 5µl of sample mix (1x TaqMan® Universal Buffer (Applied Biosystems), 0.05x AmpliTaq® Gold DNA Polymerase (Applied Biosystems), 1x GT Sample Loading Reagent (Fluidigm) and 60–400ng/µl DNA) combined in a 6.75nL chamber. Thermal cycling was performed on an Eppendorf IFC Thermal Cycler as follows: an initial denaturation of 10 min at 96°C followed by 40 cycles of 96°C for 15 s and 60°C for 1 min. The Dynamic Arrays were read on a BioMark™ Real-Time PCR System (Fluidigm) after amplification and scored using Fluidigm® SNP Genotyping Analysis software. Genotypes collected from both instruments were entered into the Gene Conservation Laboratory Oracle database, LOKI.

Laboratory Failure Rates and Quality Control

The overall failure rate was calculated by dividing the number of failed single-locus genotypes by the number of assayed single-locus genotypes. An individual genotype was considered a failure when a fish at a single locus was not given an allele call during the scoring process.

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

Quality control measures were instituted to identify laboratory errors and to determine the reproducibility of genotypes. The process involved the reanalysis of 8 out of every 96 fish (1 row per 96-well plate; 8%) for all markers by staff not involved with the original analysis. Assuming that the inconsistencies among analyses were due equally to errors in original genotyping and errors during the quality control, error rates in the original genotyping can be estimated as ½ the rate of inconsistencies. Because baseline collections were genotyped on many projects and have been subject to many quality control analyses, we report quality control results for 35 UCI baseline collections comprising 3,139 individuals (~32% of current baseline) that were genotyped as part of a recent baseline supplemental project. This project genotyped fish on the Fluidigm Dynamic Array platform, and was typical of our current genotyping process.

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Genotypic data were retrieved from LOKI and were imported into S-Plus (TIBCO Software Inc. 2005; Somerville, MA). Unless otherwise noted, all analyses were performed in S-Plus. Two quality control measures were conducted once genotypes were retrieved from LOKI. The first identified and excluded duplicate fish within baseline collections. Duplicate fish can occur as a result of sampling or extracting the DNA for the same fish twice and were detected and defined by identifying pairs of individuals sharing the same alleles in at least 37 out of the 45 loci screened. This criterion was chosen because the proportion of fish with identical genotypes decreases sharply with each additional locus screened and very few fish were expected to have identical genotypes at 37 loci. For each pair of duplicate fish, the fish with the most number of loci scored or, if both fish have equal number of scored loci, the first fish in the collection was retained for further analyses.

The second quality control analysis excluded mixture and baseline individuals with an excessive rate of unscorable markers, or dropouts. A threshold of 80% scorable markers per individual was established and all individuals that did not meet this threshold were excluded from MSA. This threshold was set to exclude individuals with poor quality DNA. Poor quality DNA leads to lower reproducibility and therefore adds error to the multi-locus genotype. The value of 80% was chosen based upon the observation that many individuals with high quality DNA had some dropouts, but generally less than 20% of markers, while those with poor-quality DNA had higher dropout rates. As a result, there was little difference in which individuals were excluded from analysis when picking the threshold as long as it was within the 70–90% range. 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. This approach was an attempt to balance the benefits from better data with the loss of power to estimate stock proportions accurately and precisely due to smaller sample sizes.

Baseline Development

Hardy-Weinberg and linkage disequilibrium

Observed heterozygosity (H_o), expected heterozygosity (H_e), and F_{ST} (Weir and Cockerham 1984) were calculated for all markers using the program GDA (Lewis and Zaykin 2001). Allelic frequencies for each locus were calculated, and tests for deviation from Hardy-Weinberg expectations (H-W) and gametic equilibrium (between all pairs of markers) were performed using GENEPOP (version 4.0; updated version of Raymond and Rousset 1995; Rousset 2008).

These tests were repeated once collections were pooled into populations. For H-W, critical values (α=0.05) were adjusted for multiple tests within markers among collections and multiple tests across markers within collections (Rice 1989).

All pairs of nuclear markers were tested for gametic disequilibrium within each population. We defined a pair of markers to be significantly out of gametic equilibrium if tests for gametic disequilibrium were significant (P<0.01) for greater than half of all populations. When gametic linkage was significant, we produced composite genotypes by ordering the alleles within each marker alphabetically and then stringing the alleles together by marker ordered alphanumerically. Markers that did not exhibit gametic disequilibrium with any other markers and markers that were combined were defined as loci for the remaining analyses. If the combined locus had a lower F_{ST} value than the one of the uncombined loci, the single locus with the higher F_{ST} was kept and the other was dropped from the analysis. All mtDNA markers were combined into a single locus.

Pooling collections into populations and testing for temporal stability

Collections taken at the same location at similar calendar days in different years were pooled as suggested by Waples (1990b). Samples taken at the same location, but on substantially different calendar days, and samples taken from geographically proximate locations were tested for homogeneity using a chi-square test of allele frequency distributions across all loci. Groups of collections that failed to demonstrate significant departures from homogeneity (P>0.01, not corrected for multiple tests) were pooled. The pooled and the remaining unpooled collections were defined as populations in further analyses.

We examined the temporal stability of allele frequencies with a 3-level Analysis of Variance (ANOVA) treating the temporal samples as sub-populations based on the method described in Weir (1996). Use of this method allows the quantification of the sources of total allelic variation and permits the calculation of the between-collection component of variance and assessment of its magnitude relative to the between-population component of variance. This analysis was conducted using the software package GDA (Lewis and Zaykin 2001) and included only those populations with multiple-year collections.

Populations structure visualization

To visualize genetic population structure, Nei's (1972) standard distances between all pairs of populations were calculated from allele frequencies with the program Gendist in the PHYLIP software (version 3.68; Felsenstein 2004). These distances were clustered in a Neighbor-Joining (N-J) tree with the program Neighbor in the PHYLIP software and plotted using the APE package (Paradis et al. 2004) in the program R (R Development Core Team 2008). The stability of the tree nodes were assessed by bootstrapping 1,000 replicate data sets and trees using the programs Seqboot and Consense in the PHYLIP software.

Baseline Evaluation for MSA

Reporting groups and reporting group nomenclature

We changed the reporting groups in this report from reporting groups presented earlier (Seeb et al. 2000; Habicht et al. 2007b) to: 1) groups of populations with escapement goals; and 2) regional groups of populations where escapements are not estimated. Populations were assigned into the following 8 reporting groups (stocks): 1) the largest producer of sockeye salmon on the west side (Crescent River; “Crescent”), 2) the remaining West Cook Inlet producers (“West”), 3) the lakes monitored by weirs in the Susitna/Yentna rivers (Judd/Chelatna/Larson lakes; “JCL”), 4) the remaining producers in the Susitna/Yentna rivers (“SusYen”), 5) the only major creek monitored with a weir in the Knik/Turnagain/Northeast Cook Inlet area (Fish Creek; “Fish”), 6) the remaining Knik/Turnagain/Northeast Cook Inlet producers (“KTNE”), 7) the composite of all populations within the Kenai River (“Kenai”), and 8) the composite of all populations within the Kasilof River (“Kasilof”). Hereafter, when the terms “Crescent”, “West”, “JCL”, “SusYen”, “Fish”, “KTNE”, “Kenai”, and “Kasilof” are used as nouns, they refer to reporting groups (stocks: see definitions).

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. We then assessed the potential of the baseline to identify these reporting groups for MSA applications with proof tests and escapement samples.

MSA statistical methods

The stock composition of all baseline evaluation tests were analyzed using the program BAYES (Pella and Masuda 2001). The Bayesian model implemented by BAYES places a Dirichlet distribution as the prior distribution for the stock proportions, and the parameters for this distribution must be specified. Prior parameters for each reporting group were defined to be equal (i.e., a “flat” prior) with the prior for a reporting group divided equally among populations within that reporting group for population prior parameters. We set the sum of all prior parameters to be 1 (prior weight), which is equivalent to adding one fish to each mixture (Pella and Masuda, 2001). We ran 3 independent Markov Chain Monte Carlo (MCMC) chains of 15,000 iterations with different starting values and discarded the first 7,500 iterations to remove the influence of the initial start values. Estimates and 90% credibility intervals were tabulated from the combined set of the second half of three 15,000 iteration chains. Credibility intervals differ from confidence intervals in that they are a direct statement of probability: i.e. a 90% credibility interval has a 90% chance of containing the true answer (Gelman et al. 2000). The credibility intervals reflect both sampling error and genetic assignment error. We repeated this procedure for each reporting group. A critical level of 90% correct allocation was used to determine if the reporting group was acceptably identifiable (Seeb et al. 2000).

We examined the adequacy of burn-in for each chain with the Rafferty and Lewis (1996) diagnostic. We did not extend the length of chains that this diagnostic suggested should be run further, but these were few (~5% of all chains run in the baseline evaluation tests and mixed stock analysis), and the focus of our concern was among-chain convergence. To ensure that the BAYES output was an acceptable approximation of the stationary posterior distribution and that the stock composition estimates were valid, we assessed the 3 independent (MCMC) chains for convergence among chains. We assessed among-chain convergence using the Gelman-Rubin shrink factors that are computed for all stock groups in the program BAYES. This shrink factor compared the variation within a chain to the total variation among chains (Gelman and Rubin, 1992). If a shrink factor for any stock group in a mixture was greater than 1.2 we reanalyzed the mixture with 30,000 iteration chains, discarding the first 15,000 iterations; if a shrink factor greater than 1.2 was observed in the reanalysis, we averaged the results and noted the non-convergent estimates in the tables. In cases where 1 of the 3 chains produced highly divergent results (very rare), we report estimates based the 2 convergent chains and noted these estimates in the tables.

Proof tests

Proof tests were used as the first examination of baseline performance for MSA. In these tests, we created a test mixture by sampling approximately 200 fish from one reporting group; we rebuilt the baseline excluding the sampled fish. These tests provided an indication of the power of the baseline for MSA assuming that all the populations were represented in the baseline.

Fish wheels

As a further test of the performance of the baseline, we analyzed fish captured in the fish wheels operating in the Kenai, Kasilof, Yentna, and Susitna rivers (Table 5; Figure 5). Because we changed the definitions of reporting groups in the Susitna and Yentna rivers from previous reports (Seeb et al. 2000; Habicht et al. 2007b), a combined mixture was created with fish captured in both Susitna and Yentna fish wheels. We used BAYES with a flat prior to estimate the composition of the fish wheel samples. Based on the geographic locations of the fish wheels within the rivers, we expected that all fish captured in the fish wheel were spawned within the particular drainage and that no fish from the fish wheels were strays or were "nosing in." This was the most challenging test of the method because fish may have originated from populations not represented in the baseline and the proportion of fish from each population was likely to be in proportion to the relative run strength of each population within the river drainage.

Mixed Stock Analysis

We estimated the stock composition of all test fishery and commercial fishery mixtures using the same BAYES protocol described above for the baseline evaluation tests except for the definition of prior parameters. We used an informative Dirichlet prior distribution based upon the best available information for each mixture analysis. We believe the best available information for the prior to be the results of MSA of similar mixtures. This information was not always available, so we developed what we termed a "step-wise" prior protocol to standardize our methodology. Our protocol was as follows:

1) For the first time strata within a fishery, the prior was based upon the area research biologist's best approximation of stock composition in specific areas given the preseason forecast adjusted for differences in run timing and anticipated migratory pathways among stocks (Table 6). This first time strata was generally the first time strata for 2005 (the first year of this study), but for statistical areas not analyzed in 2005, the first strata would have been in later years.
2) For subsequent time strata within the same statistical area in the same year, the priors were the posterior means (i.e., the stock composition estimates) of the previous time strata.
3) For the first time strata in subsequent years, the prior parameters were the posterior means from the first period of same fishery from the previous year.

For all priors we defined a minimum value of 0.01 for each reporting group. Reporting groups with estimates below this value were set to 0.01 by normalizing the sum of priors for all reporting groups to one after adjusting the value of the small proportion stocks. For all mixtures, the prior for a reporting group was divided equally to populations within that reporting group for population prior parameters.

Applying Stock Proportions to Catch

Stock proportion estimates and the 90% credibility intervals for each temporal stratum within each district within each year were calculated by taking the mean and 5% and 95% quantiles of the combined posterior distribution from the 3 chain outputs (Gelman et al. 2000). Harvest estimates and 90% credibility intervals for each temporal stratum were calculated by multiplying the harvest from that stratum by its unrounded reporting group stock proportion estimate and upper and lower bounds.

Temporal strata were combined within 5 areas into yearly estimates by weighting them by their respective harvests (stratified estimator). These 5 areas included: 1) Central District drift gillnet (excluding corridor-only periods; 2) Central District drift gillnet (corridor-only periods); 3) Central District, East Side Subdistrict set gillnet (including KRSHA set and drift gillnet; 4) Central District, West Side and Kalgin Island subdistricts set gillnet; 5) Northern District, Eastern and General subdistricts set gillnet). We also produced stratified estimates for each reporting group for all combined sampled strata within each year. The stratified estimators were calculated with the following equation:

$$p_{y,g} = \frac{\sum_{i=1}^{S} H_{y,i} p_{y,g,i}}{\sum_{i=1}^{S} H_{y,i}} \tag{1}$$

where $H_{y,i}$ was the harvest in year y and stratum i; $p_{y,g,i}$ was the proportion of reporting group g fish in year y and stratum i; and $p_{y,g}$ was the overall proportion of reporting group g fish in year y with S strata. To calculate confidence intervals for $H_{y,g}$, the overall harvest of reporting group g in year y, its distribution was estimated via Monte Carlo by re-sampling 100,000 draws of the posterior output from each of the constituent temporal strata and applying the harvest to the draws according to this slight modification of equation 1:

$$H_{y,g} = \sum_{i=1}^{S} H_{y,i} p_{y,g,i} \tag{2}$$

This method yielded the same point estimate for number of harvested fish within a district and year as would be obtained by simply summing the point estimates from each constituent temporal strata, but it produced a more appropriate credibility interval than simply summing the lower and upper bounds of credibility intervals together (c.f. Piston 2008). This method also accommodated non-symmetric credibility intervals.

Relative errors around the harvest estimate were calculated as follows:

$$RE_{y,g,i} = \frac{U_{y,g,i} - L_{y,g,i}}{2H_{y,g,i}} \tag{3}$$

Where RE is the relative error, U is the upper boundary and L is the lower boundary of the 90% credibility interval.

Stock proportion estimates were reported rounded to the nearest one-tenth of a percent. For convenience, we rounded harvest estimates to the nearest fish after all calculations were performed, recognizing that this level of precision is optimistic. Any discrepancies between the sum of the regional harvest estimates and the total harvest for each stratum were due to unavoidable rounding errors.

RESULTS

TISSUE SAMPLING

Baseline

Spawning populations of sockeye salmon were collected from throughout UCI (Table 2; Figure 5). The majority of collections (72) were made during the 1990s. Collection efforts resumed in 2005 and 38 collections were made between 2005 and 2008. A total of 9,712 fish collected over spawning areas were analyzed for the baseline. These fish represented 110 collections taken at 79 locations throughout UCI drainages; individuals from 24 of these locations were collected in multiple years.

Mixtures

Fish wheels

A total of 1,140 fish were sampled for tissues suitable for genetic analysis and analyzed from 6 collections sampled from fish captured in fish wheels (Table 7). These fish wheels samples were as subset of those reported in Habicht et al. (2007b) and included samples from 2 years taken from the Kasilof and Kenai rivers, and one year taken from the Yentna and Susitna rivers.

Offshore test fishery

A total of 5,235 fish were sampled for tissues suitable for genetic analysis and analyzed from the offshore test fishery harvests of sockeye salmon from July 1–August 1, 2006 (July 20 and 29 not sampled), July 1–August 2, 2007 (July 25 not sampled), and July 1–31, 2008 (July 24 not sampled) (Table 8, Figure 4).

Commercial drift and set gillnet fisheries

A total of 54,749 fish were sampled for tissue suitable for genetic analysis from commercial catches from throughout the UCI Central and Northern Districts in 2005, 2006, 2007 and 2008. These fish represented 322 individual collections (Tables 9–19).

LABORATORY ANALYSIS

Laboratory Failure Rates and Quality control

For the representative baseline project, the overall failure rate for UCI baseline genotypes at the 45 SNP markers was 2.8%. The quality control process demonstrated a low discrepancy rate of 0.8%. Assuming an equal error rate in the original and quality control genotyping process, and that this project accurately represents our genotyping process, our baseline collections were genotyped with a process that produced genotypes with an error rate of 0.4%.

For the offshore test fishery and commercial harvest samples, failure rates among years ranged from 0.9–3.0% and discrepancy rates were uniformly low and ranged from 0.00–0.25% (0.00–0.13% estimated error rate in the database). For the fish wheel samples, no discrepancies were observed for the 79 fish reanalyzed for all markers.

STATISTICAL ANALYSIS

Data Retrieval and Quality Control

Based upon the 37-loci criterion for detecting duplicate individuals, 0.12% of individuals were removed from baseline collections as duplicate individuals. Ninety-eight baseline collections (89%) had no duplicate individuals. Based upon the 80% rule, 1.2%, 1.6%, and 1.1% of individuals were removed for baseline, commercial harvest, and test fishery collections, respectively.

Baseline development

Hardy-Weinberg and linkage disequilibrium

Over all markers and locations, 38 of 4,788 H-W tests performed were significant ($P<0.01$) without adjusting for multiple tests. These were spread over 24 markers and no markers were out of H-W equilibrium in more than 5 collections. No collection was out of H-W equilibrium at more than 2 markers. After adjusting for multiple tests, only one collection (Swan Lake) was out of H-W equilibrium for only one marker (*One_MHC2_251*; $P<0.0002$).

Linkage disequilibrium within each population yielded significant results within some populations at 6 marker pairs (# of populations with significant values): *One_GPDH-201* and *One_GPDH2-187* (32); *One_IL8r_362* and *One_RAG3-93* (3); *One_MHC2_190* and *One_MHC2_251* (42); *One_RF112* and *One_RF295 (10)*; *One_TF_ex11-750* and *One_TF_in3-182* (16) and *One_Ots213-1* and *One_U503-170 4*). Of these, only *One_MHC2_190* and *One_MHC2_251* and *One_GPDH-201* and *One_GPDH2-187* were significantly out of linkage equilibrium for more than half of all populations (54% and 71%, respectively). These 2 sets of markers were pooled and treated as a composite-haplotype locus. After comparing F_{ST} values between the pooled and unpooled loci *One_GPDH2-187* was found to have a higher F_{ST} (0.092) than the pooled locus (0.069) so *One_GPDH-201* was dropped from the analysis.

Pooling collections into populations and testing for temporal stability

A total of 59 populations were identified after pooling collections taken from similar locations over multiple years and collections made at nearby sites that exhibited both similar phenotypes and genetic homogeneity (pooled collections and collections taken at different sites are referred to as "populations"; Table 2).

Twenty-four populations were included in the analysis of temporal stability of allele frequencies. Allele frequencies for all populations appeared to be temporally stable. Within populations, 10 pairs of collections were 10–14 years apart, and the remainder were 1–2 years apart (Table 2). The 3-level ANOVA indicated that the ratio of variation among temporal collections to the variation among populations was 2.8%. There was virtually no variation (<0.01%) among collections from the same populations across years relative to the variation among populations.

Populations structure visualization

Genetic relationships among baseline populations are shown in the N-J tree (Figure 6). Kenai River populations rear in numerous lakes within the drainage, and the genetic structure mirrors this complexity. Populations spawning above the falls on the Russian River clustered together (99% of bootstrap trees), a relationship previously described with allozymes (Seeb et al. 2000). Populations rearing in Trail Lake (Johnson, Railroad, and Moose creeks) clustered together in

92% of trees. The population spawning in the mainstem between Kenai and Skilak lakes (including Russian River below the falls) grouped with the Skilak Lake outlet spawning population in 53% of trees. Other populations spawning in the Kenai River appear to be more similar to populations within the drainage than to other populations outside the Kenai River except for the Kasilof River population which clustered below a weakly supported node with upper Kenai River populations (Johnson, Railroad, Moose, Quartz, and Ptarmigan creeks).

The rest of the reporting groups contained some populations that clustered together and others that did not. However, there were no well-supported nodes that included populations from multiple reporting groups outside of the same drainage. Some of the KTNE populations clustered below well-supported nodes: the Eska, Bodenburg and Jim creek populations in one cluster (64%) and Daniels Lake, Bishop Creek, and Swanson River in another cluster (73%). The 2 Fish Creek populations grouped together with good support (99%).

A couple of well-supported nodes clustered populations spawning in the Yentna and Susitna Rivers. One of these grouped 2 geographically proximate populations in the Susitna River drainage: Mama/Papa Bear Lakes and Talkeetna Sloughs with Larson Lake (97%). This cluster was also grouped with the Skwentna River Tributaries population (51%) in the Yentna River drainage.

The West reporting group had 2 well-supported nodes: Farros Lake and South Fork Big River clustered together (58%) and these populations clustered with Black Sand Creek (56%). The rest of the populations in this reporting group were below nodes with little support or were highly distinct (Little Jack Creek, Wolverine Creek, and Packers Lake). Finally, the 2 populations that make up the Crescent reporting group were on a well-supported node (71%).

Baseline Evaluation for MSA

Proof tests

Analyses of mixtures of sockeye salmon of known origin taken out of the baseline (proof tests) demonstrated higher than 93% correct allocations for every reporting group (Table 20). In these tests, mixtures created from approximately 200 genotypes from a single region showed correct allocations of 94% (JCL), 95% (SusYen), 96% (Fish), 98% (KTNE) and 99% (Crescent, Kenai, Kasilof, and West). All of the misallocation (6%) from JCL allocated to SusYen, and 4% of the misallocation from SusYen allocated to JCL. The only other misallocation above 3% was misallocation from Fish that allocated to KTNE.

Fish wheels

Stock composition estimates for these samples demonstrated higher than 94% correct allocations of populations inside the drainage where the fish wheels operated (Table 7). The Kenai River and Kasilof River fish wheel collections allocated above 98% to those reporting groups for both the samples collected in 1992–1994 and Kasilof River samples taken in 2005, while the 2005 Kenai River fish wheel sample allocated 95% to Kenai. The combined Susitna/Yentna rivers fish wheel samples allocated above 99% to the Susitna and Yentna rivers (9% to JCL and 90% to SusYen).

Mixed Stock Analysis

Offshore test fishery

A total of 5,235 fish captured in the offshore test fishery in 2006, 2007, and 2008 were genotyped (Table 8). The sets of individuals sampled each year were divided into 4 periods in

2006 (1,385 individuals), 5 periods in 2007 (2,089 individuals), and 4 periods in 2008 (1,761 individuals). In each of the 3 years, a consistent pattern was seen in the distribution of stocks over time: the proportion of Kasilof decreased, and the proportion of Kenai increased. The proportion of Crescent fluctuated between 0% and 5% with an exception of the early period in 2007 when it was 8%. Similarly, the percentage of West fluctuated between 2% and 13% with an exception of the early period in 2007 when it was 16%. The proportion of JCL (range: 1–10%) was similar to that of SusYen (range: 2–11%). KTNE was detected in all of the mixtures but at low levels (range: 1–5%). Fish comprised the smallest percentage of the 8 reporting groups (range: 0–2%) and were only detected in the first 2 periods in 2007 and the first period in 2008.

Commercial fisheries

From the 322 collections sampled, 27,192 fish from 315 collections were subsampled to create 75 mixtures for which the stock composition and stock-specific harvest were estimated (Tables 9–19; Figures 7–10). There were 7 collections not subsampled due to a lack of adequate sample sizes to represent strata. Analyzed mixtures had sample sizes ranging between 100 and 406 fish. There were 8 mixtures created for the Kenai and Kasilof sections in 2005 to estimate stock composition by subsection through time (Table 14). These mixtures had sample sizes ranging between 150 and 550 individuals. Finally, the 4 mixtures partitioned by subsection (Cohoe/Ninilchik, South K. Beach, North K. Beach, and Salamatof Beach) within each year had sample sizes ranging between 225 and 1,503 fish for 2005–2008 (Table 15).

Drift gillnet

We observed a general pattern of increasing proportions of Kenai and decreasing proportions of Kasilof in drift gillnet fishery harvests that excluded corridor-only periods within season for each of the 4 years (Table 9; Figure 7). However, the estimated percentage of Kenai in drift gillnet harvests varied tremendously among all years, from 21–71% during the first period in July to 62–88% during the last period sampled in each year (Table 9). Estimated harvests of Kenai peaked during July 14–August 1, depending on the year. The estimated percentage of SusYen (range: 0–10%) and JCL (range: 0–8%) varied from year to year. In 2005, 2006, and 2008 the percentage of West sockeye salmon in the harvest fluctuated from 1–9%, but in 2007 this reporting group accounted for 34% of the harvest at the beginning of the season (June 21–28) before falling back to near 6% two periods later (July 9–12). During all periods for the 4 years examined, the combined contribution Fish and KTNE did not exceed 4%.

Corridor-only periods occurred in all years and accounted for 7–34% of the harvest from the Central District drift gillnet fishery between 2005 and 2008, but were only sampled in 2006 (Table 3). These samples represented harvest dates from July 10–17 and were divided into 2 mixtures for analysis. The combined Kenai (range 20–40%) and Kasilof (range 55–75%) made up most of the harvest in both periods (95%), with West and SusYen accounting for up to 3% of the mixtures (Table 10). All other reporting groups accounted for less than 2% of either mixture.

Set gillnet

Kasilof dominated the harvest in the KRSHA (89–97%) with Kenai comprising most of the remainder (2–7%; Table 11).

Within the East Side set gillnet fishery, we did not observe a consistent pattern of decreasing abundance of Kasilof and increasing abundance of Kenai as was observed in the drift gillnet fishery (Tables 12 and 13; Figures 8 and 9). In Kasilof Section, the combined contribution of

Susitna River and Yentna River (SusYen and JCL) fish did not exceed 4% and the combined contribution of Crescent, Fish, and KTNE did not exceed 4%. The percentage of West in the Kasilof Section harvest in 2005, 2006, and 2008 ranged from 0–3% and in 2007 the percentage never dropped below 1% (range: 1–9%). In Kenai Section, the combined contribution of all reporting groups other than Kenai and Kasilof never exceeded 6%, except for the July 21–28, 2007 period when the contribution was 17% and was comprised of 4 reporting groups: West (4%), JCL (5%), SusYen (4%) and KTNE (4%).

The analysis of the East Side set gillnet by subsection across all years showed some consistent patterns (Table 15, Figure 10). Higher proportions of Kenai fish were captured in subsections bordering the Kenai River mouth (North K. Beach and Salamatof) and more Kasilof fish were captured in subsections bordering the Kasilof River mouth (Cohoe/Ninilchik and South K. Beach). The most southern and northern subsections (Cohoe/Ninilchik and Salamatof) contained higher proportions of non-Kenai and non-Kasilof fish. In the analysis of the 2005 East Side set gillnet fishery by subsection and time, we observed the spatial patterns described above for other years among subsections and temporal patterns of increasing Kenai and decreasing Kasilof within season within subsections (Table 14).

West was usually the dominant reporting group within the Kalgin Island set gillnet fishery (Central District) from 2006–2008, ranging from 39–68% of the harvest (Table 16). However, in the late mixture in 2007 (July 16–August 18) the percentage of Kenai fish (42%) was about equal to West (41%). With the exception of this one mixture, Kenai ranged from 7–28% of the harvest over the 3 years. The percentage of Kasilof in the harvest over the years ranged from 15–19%, with the exception of the late mixture (July 16–August 18) in 2007 where it was 6%. Crescent ranged from 4–12% of the harvest in 2007 and 2008, but was below 1% in 2006. The combined contribution of JCL, SusYen, and KTNE never exceeded 6% of the harvest in 2007 and 2008. However, in the single mixture from 2006 the contribution of JCL, SusYen, and KTNE made up 13% of the harvest (2%, 6%, and 5%, respectively).

Crescent made up the largest portion of the harvest within the West Side Subdistrict set gillnet fishery (Central District) from 2006–2008, ranging from 51–84% (Table 17). The contribution of West fluctuated over the years and ranged from 8–28%. Over the 3 years, Kasilof and Kenai ranged between 3–7% and 0–3% respectively. The contribution of KTNE was generally low (range 0–4%); however, in the late 2008 mixture this reporting group comprised 28% of the harvest. The combined contribution of JCL and SusYen never exceeded 1%. No contribution of Fish was detected in any of the West Side set gillnet mixtures.

Within the Eastern Subdistrict set gillnet fishery (Northern District) from 2006–2008, the combined contribution of Kenai (range 20–58%), KTNE (range 18–30%), and Kasilof (range 5–17%) contributed from 61–81% of the harvest (Table 18). Over the 3 years, the contribution of SusYen remained constant and ranged from 6–8%. The contribution of West and JCL fluctuated over the 3 years, and ranged from 2–13% and 5–15%, respectively. Crescent was only detected in the 2007 harvest (3%).

Within the General Subdistrict set gillnet fishery (Northern District) in 2008, KTNE contributed to 54% of the harvest (Table 19). The combined contribution of JCL (19%) and SusYen (13%) made up 32% of the harvest. West and Fish contributed 5% and 9% respectively. Crescent, Kenai, and Kasilof were each below 1%.

Total Stock-Specific Harvest of Sampled Strata

As expected, the stratified estimates for combined temporal strata within years produced the same point estimates of harvest as the summed individual time strata, but with narrower credibility intervals (Table 21). The relative error, as measured by credibility intervals, was greater for smaller harvest estimates.

Central District drift gillnet (excluding corridor-only periods)

Over 98% of the Central District drift gillnet (excluding corridor-only periods) harvest was represented by MSA samples each year. Harvests were greatest for Kenai followed by Kasilof in all years. Harvest numbers for these 2 stocks ranged from 191,189 to 1,404,054 for Kenai in 2006 and 2005, respectively and 102,223 to 285,556 for Kasilof in 2006 and 2008, respectively. Harvests of Susitna and Yentna river stocks (SusYen/JCL) were the next highest and combined ranged from 37,305 and 183,404 in 2006 and 2007, respectively. Harvests of Western stocks (Crescent and West) were the next highest and combined ranged from 26,375 and 86,271 in 2006 and 2007, respectively. Finally the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) made up the remainder of the represented harvest and combined ranged from 6,973 and 52,815 in 2006 and 2007, respectively.

Central District drift gillnet (corridor-only periods)

Harvest estimates for the Central District drift gillnet (corridor-only periods) were represented by MSA samples in 2006 only and for 29% of the harvest in that year. For unrepresented years, the harvests in this fishery were 859,345 in 2005, 131,888 in 2007, and 135,434 in 2008. In the 2006 represented strata, harvests of Kasilof followed by Kenai were greatest. The remainder of the represented harvest in 2006 was made up of Sustina and Yentna rivers (SusYen and JCL; 573 fish), northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE; 234 fish), and western stocks (Crescent and West; 156 fish).

Central District, East Side Subdistrict set gillnet (including KRSHA set and drift gillnet)

Over 96% of the Central District, East Side Subdistrict set gillnet (including KRSHA set and drift gillnet) harvest was represented by MSA samples each year. Harvests were greatest for Kenai in 2005 and 2007 and Kasilof in 2006 and 2008. Harvest numbers for these 2 stocks ranged from 367,196 to 1,532,433 for Kenai in 2006 and 2005, respectively and 405,904 to 1,202,888 for Kasilof in 2007 and 2006, respectively. Harvests of Susitna and Yentna river stocks (SusYen/JCL) were the next highest and combined ranged from 2,642 and 51,869 in 2006 and 2007, respectively. Harvests of western stocks (Crescent and West) were generally the next highest and combined ranged from 1,468 and 45,528 in 2005 and 2007, respectively. Finally the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) made up the remainder of the represented harvest and combined ranged from 5,713 and 27,206 in 2005 and 2007, respectively.

Central District, West Side and Kalgin Island subdistricts set gillnet

Between 74% and 100% of the Central District, West Side and Kalgin Island subdistricts set gillnet harvests were represented by MSA samples each year, except in 2005 when this fishery harvested 154,933 fish and no samples were collected. In the represented strata, harvests of western stocks (Crescent and West) were greatest accounting for between 43,335 and 75,110 fish in 2006 and 2007, respectively. Kenai and Kasilof stocks combined contributed between 13,861 and 28,257 in 2008 and 2007, respectively. Susitna and Yentna river stocks (SusYen/JCL) and the northern stocks, excluding Susitna and Yentna rivers, (Fish and KTNE) made up the remainder of the harvest with combined harvests ranging from 3,805 and 7,845 in 2007 and 2008, respectively.

Northern District, Eastern and General subdistricts set gillnet

Between 40% and 80% of the Northern District, Eastern and General subdistricts, set gillnet harvest was represented by MSA samples each year, except in 2005 when this fishery harvested 26,415 fish and no samples were collected. In the represented strata, harvests were greatest for Kenai in 2006 and 2007 and northern stocks (SusYen, JCL, Fish, and KTNE) in 2008. Kenai and Kasilof stocks combined contributed between 3,099 and 4,391 fish in 2006 and 2007, respectively. Northern stocks accounted for between 2,117 and 15,293 fish in 2006 and 2008, respectively. Western stocks (Crescent and West) made up the remainder of the harvest with combined harvests ranging from 311 and 2,046 fish in 2006 and 2008, respectively.

All strata combined per year

Between 78%, 93%, 95%, and 94% of total commercial harvests were represented by MSA samples in 2005, 2006, 2007 and 2008, respectively (Table 22). Harvest estimates were greatest for Kenai and Kasilof in all years. In the represented strata, harvests were greatest for Kenai in 2005 (2,936,487) and 2007 (1,920,986) and Kasilof in 2006 (1,324,611) and 2008 (1,111,226). Harvests of Susitna and Yentna river stocks (SusYen/JCL) were the next highest in 2005 (54,926), 2007 (238,943) and 2008 (113,407). Harvests of western stocks (Crescent and West) and other northern stocks (Fish and KTNE) made up the remainder of the harvest with combined harvests ranging from 66,676 and 289,640 fish in 2005 and 2007, respectively. Relative errors of harvest estimates were greatest for small harvests (i.e. 119% and 186% for Fish in 2005 and 2006, respectively, and 103% for Crescent in 2005) and least for large harvests (i.e. ranged between 1% and 6% for Kenai and Kasilof in all 4 years).

DISCUSSION

This manuscript updates previously reported analyses of Habicht et al. (2007b) and reports new analyses of genetic data collected from sockeye salmon originating from all major systems in UCI, Alaska (baseline), and collected in selected periods of the Central and Northern district commercial fisheries from 2005–2008. The updates include more comprehensive baseline and fishery sampling and modified statistical methods and reporting groups. The modified reporting groups should allow for better incorporation of stock composition information into stock-specific production models for evaluating escapement goals, estimating exploitation rates, and forecasting future runs.

Stock structure and composition results for comparable reporting groups and mixtures were highly concordant with previously reported analyses in Habicht et al. (2007b): 91% of the estimate comparisons were within 2% of each other, 4% were within 3–5% of each other, and 5% showed differences in stock composition estimates above 6%. Of the 245 estimate comparisons between the 2 reports, all but 5 had overlapping credibility intervals. The 2 largest deviations occurred in 1 mixture estimate and appear to be due to an analytical error reported in the first manuscript (estimates of the Kenai and Kasilof reporting groups for the Kenai Section set gillnet fishery; Table 13 in this report; Table 11 in Habicht et al. 2007b). Most of the other discrepancies between the 2 analyses had a similar pattern, with the new analysis estimating lower proportions assigned to SusYen and JCL, and higher proportions assigned to West and Crescent (19 of 21 discrepancies above 3%). This may best be explained by better representation of West populations in the new baseline (see BASELINE DEVELOPMENT below).

Here we report on the development and evaluation of the baseline and results from harvest sampling for the period from 2005 through 2008. ADF&G anticipates that this report will be the second in a series of MSA studies in UCI.

BASELINE DEVELOPMENT

The pattern of similarity between populations revealed by this baseline is similar to the pattern revealed by other baselines (Habicht et al. 2007b), including those based on other marker types (Seeb et al. 2000; Allendorf and Seeb 2000). Straying among spawning areas is usually higher within drainages than among drainages (Wood et al. 1994) which can result in similarity among salmon spawning within a drainage and higher differentiation among salmon spawning in different drainages. The populations from the Kenai and Kasilof rivers form a large cluster with internal structure. All markers surveyed have shown little genetic heterogeneity among populations spawning in the Kasilof River drainage (Burger et al. 1997), although phenotypic diversity was observed by Woody et al. (2000). While Burger et al. (1995) detected a distinct late run of river spawners at the outlet of Tustumena Lake, no outlet spawners were included in either the allozyme or SNP baselines. Within the Kenai River drainage 4 main groups were found: 1) Skilak and Kenai lakes, 2) Hidden Lake, 3) Ptarmigan and Quartz creeks and Tern Lake, and 4) Upper Russian lakes.

Variation was also found among the populations within the remaining regions: Susitna and Yentna rivers, Knik Arm, Northeast Cook Inlet, and West Cook Inlet. Unlike the Kenai and Kasilof drainages, there are no large nursery lakes that support multiple tributary-spawning populations within these regions. These systems tend to have a number of isolated smaller lakes. The close affinity of the Yentna and Susitna slough spawners may indicate common ancestry and a high level of historical gene flow similar to the “river-type” sockeye salmon described by Gustafson and Winans (1999).

This study contained both collections from the 1990s and collections made over the past 5 years at the same sites. This contrasted with the baseline of Habicht et al. (2007b), where the majority of baseline collections were made in the early 1990s, or 3 sockeye salmon generations ago. The increased baseline in this study allows for the test of temporal stability. Temporal stability of allele frequencies observed here is typical for selectively neutral genetic markers when population sizes are large (e.g. Beacham et al. 2006). Additional support comes from results from 10-year old fish wheel collections which correctly allocated to rivers in which the fish wheels operated (Table 7).

DIFFERENCES IN THE BASELINE AMONG ANALYSES

Currently, SNPs have been screened on 59 populations in this region with an average of 165 individuals per population. This baseline differs from the baseline reported in Habicht et al. (2007b) in that it contains samples from an additional 4 populations in West (67% increase), 6 from SusYen (43% increase), and 2 from KTNE (18% increase). This baseline also grouped some populations previously defined by Habicht et al. (2007b) into single populations due to a lack of differentiation (i.e. all the Tustumena Lake collections were grouped into a single population). Finally, this baseline contained larger sample sizes for 27 populations than in Habicht et al. (2007b). In all, this baseline is represented by 40% more fish than the previously reported baseline. It is the intent of ADF&G to continue to expand the baseline to achieve greater coverage. Although temporal stability of allele frequencies has been detected in all UCI sockeye salmon studies to date, we will continue to monitor for changes in SNP allele frequencies as the opportunities arise. In particular, we will monitor for changes at loci such as *MHC* that are likely influenced by selection (Miller et al. 2001; Aguilar and Garza 2007).

ADF&G fishery managers and researchers have delineated new reporting groups for MSA studies of sockeye in UCI that allow for better incorporation of stock composition information into stock-recruit models to provide a basis for calculating escapement goals. These new reporting groups need to be taken into account when making comparisons of results to the Habicht et al. (2007b) report. Stock compositions between these 2 reports can be made using the following method. 1) the old "West" reporting group is now divided into "Crescent" and the new "West" reporting group, 2) the old "Yentna" and "Susitna" reporting groups are now represented by the "Sus/Yen" and the "JCL" reporting groups, 3) the old "Knik" and "Northeast" reporting groups are now represented by the "Fish" and "KTNE" reporting groups, 4) both the Kenai and Kasilof reporting groups are the same in both reports. The performance of the baseline in allocating fish from proof tests and sampled at fish wheels (Tables 20 and 7) demonstrates that the genetic variation across the new reporting groups is adequate to produce highly accurate estimates.

DIFFERENCES IN FISHERY SAMPLING DESIGNS AMONG YEARS

After the 2005 season 4 sampling design changes were implemented to improve the accuracy and precision of stock composition estimates of the commercial catch. First, in the drift gillnet fishery, we sampled at 3 of the major processors and sampled every other boat throughout the period when fish were delivered to each processor to provide a representative sample of the entire drift fishery harvest. Second, we sampled the drift fishery harvest in proportion to the catch on each boat and throughout the unloading of each boat. This design should have correctly weighted any pattern in the delivery sequence among and within boats. Third, we attempted to sample all of the buying stations along the East Side beaches after the high and low tides to obtain samples throughout each statistical area and over time during each fishery opening. Fourth, we over-sampled the Central District drift and the East Side set gillnet fisheries and constructed random samples in proportion to harvest after the season when catches were known. This approach, coupled with sampling throughout the fishery by time and area, should have provided a more representative sample of these harvests. Finally, since we over-sampled the Central District drift and the East Side set gillnet fisheries, we have additional archived samples that can be analyzed in the future to investigate the effect of sampling error on our stock composition estimates in specific cases.

APPLICATION OF DATA TO BROOD TABLE REFINEMENT

The primary goal of this project was to accurately estimate the stock composition of commercial harvests in UCI for each year. Knowledge of the composition of the mixed-stock catch is critical to determine the total run of each stock, especially when sockeye salmon stocks in UCI can be exploited at rates from 50% to 75% (calculated from Tobias and Willette 2004b and Shields 2009). The current 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. We will compare our MSA estimates of stock composition from this 4-year study 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 primary management objective is to meet those escapement goals.

The stock composition estimates available from this project will allow for an improved understanding of stock productivity as more years of data become available for incorporation into brood tables. There are some aspects of these new data that will require care when incorporating the information into brood tables. These include: 1) recognizing the higher relative errors for minor-stock harvest estimates than for major-stock harvest estimates, which will introduce uncertainty into spawner-recruit analyses and subsequent escapement goals, 2) estimating stock composition of each age class in the harvest, which is needed to build brood tables and, 3) accounting for unsampled strata.

Relative errors across stocks

As expected, relative errors of harvest estimates were generally lower for stocks comprising high proportions of mixtures and higher for stocks comprising low proportions of mixtures (Tables 21 and 22). For example, a stock composition estimate of 4% with a CI ± 2%, represents a relative error of ±50%, whereas a stock composition estimate of 80% with the same CI, represents a relative error of ±2.5%). Stocks with consistently low proportions in these mixtures included all stocks except Kenai and Kasilof. Relative errors of stock-specific harvest estimates were generally greater for individual fishery estimates (Table 21) and lower for pooled annual totals (Table 22). For example, relative errors of Kenai harvest estimates in individual fisheries ranged from 3% in the Central District drift gillnet fishery in 2005 to 27% in the West Side and Kalgin Island subdistricts in 2008 (Table 21); whereas, relative errors of Kenai harvest estimates in the total commercial harvest ranged from 2% in 2005 to 4% in 2008 (Table 22). Similar patterns can be seen when examining the relative errors of harvest estimates for other stocks.

Estimating stock composition by age class

There are multiple approaches for estimating harvest stock composition by age. The following is one of the most likely approaches, although alternatives will be considered. Estimating stock composition by age class may be improved by first pooling temporal strata by year to increase the precision of stock-specific harvest estimates (e.g. Table 21). We would not expect the proportion of each stock in the catch from each district (area) to be constant, nor would we expect the exploitation rate to be the same each year. These should depend on the relative run size each year and the intensity of the fisheries. However, it seems reasonable to assume that the relative vulnerability to harvest is constant from year to year. These stock-specific vulnerabilities could be applied to the traditional age composition model, correcting the current assumption that each stock, by age class, is equally vulnerable. The analysis would need to be conducted over several years to evaluate whether stock-specific vulnerabilities within age classes in specific areas were consistent among years. The efficacy of this method would be limited by smaller sample sizes available to estimate stock composition within age classes in specific fisheries and subsequent effects on precision of stock-specific harvest estimates.

Accounting for unsampled strata

Despite efforts to sample all strata, some strata were not sampled due to logistical reasons or because the strata represented small harvests. Some of the strata not sampled for logistical reasons represented large harvests and resulted in the following fractions of the total harvest not sampled: 22% in 2005, 7% in 2006, 5% in 2007, and 6% in 2008. Most of the unsampled strata were for fisheries conducted in the corridor section of the Central District drift gillnet fishery (Table 3), especially in 2005. It is beyond the scope of this report to extrapolate the stock compositions of sampled strata to unsampled strata.

PATTERNS IN FISHERY STOCK COMPOSITIONS

Interannual variability in run strength and timing among stocks and environmental conditions contributed to the variability in these stock composition estimates. For example, the estimated Kenai River sockeye salmon run was 5.6 million in 2005, 2.5 million in 2006, 3.4 million in 2007, and 2.3 million in 2008 (Tobias and Willette *In prep*). Similarly, the run timing differed among years. During these 4 years, the dates when half the fish had passed the offshore test fishery transect was 4 days earlier to 9 days later than the long-term average (July 21 in 2005; July 24 in 2006; July 19 in 2007; and July 11 in 2008; Shields and Willette 2009). These run strength and run timing differences produced some of the patterns observed in the stock compositions of the harvest. For example, proportions of Kenai fish in all fisheries were lower in 2006 (weak, late run) and 2008 (weak, early run) compared with 2005 and 2007.

The distribution of stock-specific harvest across fisheries varied by stock. The highest harvests of Kenai sockeye salmon occurred in the drift gillnet fishery in 2005 and 2007 and in the set gillnet fishery (Kenai Section) in 2006 and 2008 (Tables 9–13). The highest harvests of Kasilof sockeye salmon occurred in the set gillnet fishery (Kasilof Section) in all 4 years of the study (Table 12). In 2006, 45% of the Kasilof sockeye salmon harvest was taken in the KRSHA, with only 5% of the Kenai sockeye salmon harvest taken in this same area (Tables 9–13 and 16–19). The highest harvests of Susitna and Yentna (SusYen and JCL) sockeye salmon occurred in the drift gillnet fishery (excluding corridor-only periods) in all 4 years of the study (Table 21).

Within the offshore test fishery, 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 (Table 8). This pattern might be expected based on the early run timing of the Kasilof fish relative to Kenai fish. Stock composition estimates from the offshore test fishery compiled in this study cannot be used to estimate total run by stock because of how the samples were selected for tissue collection. First, 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 <30 sockeye salmon, but when the catch was >30 sockeye salmon, only 30 samples were collected for genetic analysis. 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 harvests within the primary migratory pathway. Stock composition estimates will be weighted by CPUE in the test fishery in the future to correct for harvest size. Secondly, collections were only made in July, and stock compositions before (June) and after (August) the test fishery are unknown. Projections of stock compositions into June and August may introduce significant bias into any estimates of total run by stock, because no stock composition estimates are available from these time periods and a significant percentage of the total UCI run comes during August in some years (2005–20%; 2006–35%; 2007–17%; 2008–7%; Shields and Willette 2007, 2008, 2009a, 2009b). Test fishery and genetic data could be used to estimate total run by stock in the future, but sampling may need to begin in mid June and end in mid August and additional stations may need to be added closer to shore.

Within the Central District drift gillnet fishery, many of the patterns observed in this study and previously reported in Habicht et al. (2007b) were also observed by Seeb et al. (2000). For example, the observation of increasing proportions of Kenai and decreasing proportions of Kasilof sockeye salmon in drift gillnet fishery harvests (excluding corridor-only periods) during the season is common to all 3 studies (Tables 9 and10; Figure 7). The estimated peak harvest dates of Kenai sockeye salmon were also in concordance to those observed by Seeb et al. (2000), who observed peak harvests of Kenai sockeye salmon between July 15–20 in 1995 and 1996. Finally, both Seeb et al. (2000) and this study showed high variation in the estimated proportion of Kenai sockeye salmon in drift gillnet harvests among years.

Because harvest numbers were only multiplied by stock proportions if samples were collected within approximately one week of the harvest in each strata, stock-specific harvests were not estimated for a large proportion of the Central District drift gillnet fishery in some years (35% in 2005, 12% in 2006, 7% in 2007, and 14% in 2008). Since unrepresented harvests were nearly always corridor openings, the stock composition estimates for the represented Central District drift gillnet fishery should not be used directly to account for the unsampled corridor harvests. It is beyond the scope of this report to extrapolate to these unrepresented strata. However, relationships between stock composition estimates for proximate time periods within the Central District drift gillnet (excluding corridor-only periods) and within the East Side set gillnet fisheries along with information from the single corridor-only period drift gillnet (2006) could provide a basis for making extrapolations to estimate the stock compositions in unsampled strata.

Estimated peak harvest dates and total harvests of Susitna and Yentna river (SusYen and JCL) sockeye salmon in the drift gillnet fishery (excluding corridor-only periods) were highly variable among years (Tables 9 and 10; Figure 7). Peak harvest dates for these reporting groups were June 27–July 7 in 2005, July 31 in 2006, July 16 in 2007, and July 14–17 in 2008. The drift gillnet fishery was restricted to the corridor from July 10–17, 2006 (Table 3). The late peak date in 2006 observed in the Central District drift gillnet fishery (excluding corridor-only) may be an artifact of the period openings and restrictions (Table 3). Seeb et al. (2000) estimated that peak proportions and harvests of Susitna/Yentna sockeye salmon in the drift gillnet fishery occurred on July 10, 1995; July 15, 1996; and July 14, 1997. However, Seeb et al. (2000) estimated that Susitna/Yentna sockeye salmon comprised an average of 16% (range 3–35%) of drift gillnet harvests, whereas in our study Susitna and Yentna river (SusYen and JCL) sockeye salmon comprised an average of 8% (range 0–15%) of drift gillnet harvests. If anything, the SusYen and JCL proportions may be biased high in this study, because many of the corridor openings were not represented (Table 3), and these are likely to have lower SusYen and JCL proportions than the Central District drift gillnet fishery (excluding corridor-only; Tables 9 and 10). Higher estimated contributions for this stock in the 1990s may have been due to misclassification of Kenai River fish as Susitna/Yentna river fish as observed in the Kenai fish wheel samples using allozymes (Seeb et al. 2000), or higher relative abundance of this stock at that time (Tobias and Willette *In prep*). In the drift gillnet fisheries we sampled (excluding KRSHA), the estimated total harvests of SusYen and JCL sockeye salmon were 42,273 in 2005, 37,878 in 2006, 183,404 in 2007, and 97,234 in 2008 (Table 21). As with all stocks, estimated total harvest will increase after extrapolating to unsampled strata, which is beyond the scope of this report. Variation in the numbers of Susitna and Yentna river fish captured each year was likely due to several factors. A weak run in 2005 (Sheilds 2006) and a severely restricted fishery in 2006 (Shields 2007a) were consistent with the relatively low harvests of this stock in those years. The cause for the higher proportion of Susitna and Yentna river stocks in 2007 is unclear, but may be related to the abnormal run entry patterns discussed in the "Description of Fishery 2005–2008" section of the Introduction.

Within the KRSHA drift and set gillnet fisheries, the estimated stock composition of sockeye salmon harvested was dominated by Kasilof fish. The high proportions of Kasilof fish in this fishery were expected based on the proximity of the fishery to the mouth of the Kasilof River. Kenai sockeye salmon comprised a higher percentage of the set (6%) than drift (4%) gillnet harvests in this area (Table 11). A model based upon size and age data estimated a slightly lower percentage of Kenai sockeye salmon in the set (1%) and drift (3%) gillnet harvests in this area during this same time period (T. M. Willette, Commercial Fisheries Biologist, ADF&G, Soldotna; personal communication).

Within the East Side Subdistrict (Central District) set gillnet fishery, we did not observe a consistent pattern of decreasing proportions of Kasilof River and increasing proportions of Kenai sockeye salmon in July as described by Bethe et al. (1980) using scale pattern analysis (SPA). Such a pattern is somewhat evident in Kenai Section in 2006 and 2008 and in Kasilof Section in 2005, 2007 and 2008, but was not evident in Kenai Section in 2005 and 2007 or in Kasilof Section in 2006. There are 3 potential explanations for this lack of a consistent pattern: 1) differences in Kenai and Kasilof run sizes and timings among years; 2) the inefficacy of the SPA for estimating stock compositions of UCI sockeye salmon due to the highly variable freshwater rearing environments occupied by sockeye salmon in this area that results in inconsistent stock-specific growth patterns (Waltemyer 1995; Waltemyer et al. 1996); and 3) changes in fishing patterns between the 1970s and 2000s.

SusYen and JCL sockeye salmon contributed to East Side Subdistrict set gillnet harvests (Tables 12 and 13) at lower fractions (0–4%, except for one estimate of 9% for July 21–28, 2007 period in Kenai Section) than estimated using SPA (i.e., 0–28%; Bethe et al. 1980; Cross et al. 1986). Our estimates are more similar to previous MSA estimates based on allozymes that indicated that SusYen and JCL sockeye salmon comprised 1–6% of East Side Subdistrict set gillnet harvests (Seeb et al. 2000). In the one year we examined stock composition by subsection (2005), most of the SusYen and JCL sockeye salmon were harvested in the subsections farthest from the Kenai and Kasilof river mouths (Table 14). Since the estimated harvests of SusYen and JCL sockeye salmon in the East Side Subdistrict set gillnet fishery were highly variable over time, it is difficult to predict how this stock may be harvested in this fishery in the future.

Within East Side Subdistrict, most of the catch was comprised of either Kenai or Kasilof fish (Table 15; Figure 10). Higher proportions of Kenai fish were captured in subsections bordering the Kenai River mouth (North K. Beach and Salamatof) and more Kasilof fish were captured in subsections bordering the Kasilof River mouth (Cohoe/Ninilchik and South K. Beach). The most southern and northern subsections (Cohoe/Ninilchik and Salamatof) contained higher proportions of non-Kenai and non-Kasilof fish. In 2008, the proportion of Kasilof fish on South K. Beach and the proportion of Kenai fish on Salamatof beach were higher than in previous years (Table 15; Figure 10) suggesting a different run entry pattern with more fish moving toward their home stream from the north. Continued sampling will help us to determine whether such patterns are consistent and if so under what conditions.

INCORPORATING PATTERNS OF FISHERY STOCK COMPOSITIONS INTO FUTURE MANAGEMENT

Stock composition by time and area may be affected by multiple variables that are under management control, including the flood stage fished, geographic boundaries or restrictions within districts, and timing of fishing within the season. Understanding the relationship between stock compositions and these variables may provide information for managers to modify how the fisheries are prosecuted to achieve their goal of harvesting surplus production while meeting escapement goals for all stocks.

Both inter- and intra-annual variation in the stock composition of fisheries will need to be examined before clear relationships between management actions and stock composition of the harvest are realized. The interannual variation of stock compositions in the harvest over the 4 years analyzed in this project provide guidance on the range of inter-annual variability in stock compositions among the fishing strata. Specific experimental designs will be necessary to investigate each potential management action separately while controlling the other variables under management control. For example, to investigate how drift gillnet fishing restricted to the corridor affects stock composition of the harvest, the experimental design would require the analysis of fish caught in the corridor and in the full district during the same time periods both within years and over multiple years. These specific experimental designs will likely require a combination of commercial and test fishing coupled with MSA. If commercial catches are used in this experimental design, steps will be required to ensure the catch is coming from consistent locations within strata because fishing is often prosecuted differently within strata over time depending on where fishermen expect to gain the highest profit. Evaluation of multiple years will be required because of the inter-annual variability of stock-specific run strengths, run timings, and residence times of sockeye salmon in the district (Mundy et al. 1993). Here we have demonstrated that MSA methods have the potential to resolve these issues, but efficacy will be somewhat limited for minor stocks due to high relative errors of harvest estimates requiring more years of data to identify stock-specific harvest patterns.

To date, the funding for this project was targeted toward estimating the stock composition of the commercial harvest, as it was prosecuted, as a first step toward brood table refinement and evaluation of management strategies. Over the next few years, the data gathered from these studies will be used to reconstruct total run and brood tables for each sockeye salmon stock. This will greatly improve our stock productivity understanding within UCI.

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

REFERENCES CITED

Aguilar, A., and J. C. Garza. 2007. Patterns of historical balancing selection on the salmonid Major Histocompatibility Complex class II b gene. Molecular Evolution 65:34–43.

Allendorf, F. W., and S. R. Phelps. 1981. Use of allelic frequencies to describe population structure. Canadian Journal of Fisheries and Aquatic Sciences 38:1507–1514.

Allendorf, F. W., and L. W. Seeb. 2000. Concordance of genetic divergence among sockeye salmon populations at allozyme, nuclear DNA, and mitochondrial DNA markers. Evolution 54:640–651.

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

Beacham, T. D., B. McIntosh, C. MacConnachie, K. M. Miller, and R. E. Withler. 2006. Pacific rim population structure of sockeye salmon as determined from microsatellite analysis. Transactions of the American Fisheries Society 135:174–187.

Bernard, D. R. 1983. Variance and bias of catch allocations that use the age composition of escapements. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet No. 227, Anchorage.

Bethe, M. L., P. V. Krasnowski, and S. Marshall. 1980. Origins of sockeye salmon in the Upper Cook Inlet fishery of 1978 based on scale pattern analysis. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet No. 186, Juneau.

Burger, C. V., J. E. Finn, and L. Holland-Bartels. 1995. Pattern of shoreline spawning by sockeye salmon in a glacially turbid lake: evidence for subpopulation differentiation. Transactions of the American Fisheries Society 124:1–15.

Burger, C. V., W. J. Spearman, and M. A. Cronin. 1997. Genetic differentiation of sockeye salmon subpopulations from a geologically young Alaskan lake system. Transactions of the American Fisheries Society 126:926–938.

Cross, B. A., W. E. Goshert, and D. L. Hicks. 1986. Origins of sockeye salmon in the fisheries of Upper Cook Inlet, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 181, Juneau.

Dann, T. H., C. Habicht, J. R. Jasper, H. A. Hoyt, A. W. Barclay, W. D. Templin, T. T. Baker, F. W. West, and L. F. Fair. 2009. Genetic stock composition of the commercial harvest of sockeye salmon in Bristol Bay, Alaska, 2006–2008. Alaska Department of Fish and Game, Fishery Manuscript Series No. 09-06, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms09-06.pdf

Elfstrom, C. M., C. T. Smith, and J. E. Seeb. 2006. Thirty-two single nucleotide polymorphism markers for high-throughput genotyping of sockeye salmon. Molecular Ecology Notes 6:1255–1259.

Fair, F. F., R. A. Clark, and J. J. Hasbrouck. 2007. Review of salmon escapement goals in Upper Cook Inlet, Alaska, 2007. Alaska Department of Fish and Game, Fishery Manuscript No 07-06, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms07-06.pdf

Fair, F. F., T. M. Willette and J. W. Erickson. 2009. Escapement goal review for Susitna River sockeye salmon, 2009. Alaska Department of Fish and Game, Fishery Manuscript No 09-01, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms09-01.pdf

Felsenstein, J. 2004. PHYLIP (Phylogeny Inference Package) version 3.6. Distributed by the author. Department of Genome Sciences, University of Washington, Seattle.

Grant, W. S., G. B. Milner, P. Krasnowski, and F. M. Utter. 1980. Use of biochemical genetic variants for identification of sockeye salmon (*Oncorhynchus nerka*) stocks in Cook Inlet, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 37:1236–1247.

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

Gelman, A. B., J. S. Carlin, H. S. Stern, and D. B. Rubin. 2000. Bayesian Data Analysis. Chapman and Hall, Boca Raton, Florida.

REFERENCES CITED (Continued)

Gustafson, R. G., and G. A. Winans. 1999. Distribution and population genetic structure of river- and sea-type sockeye salmon in western North America. Ecology of Freshwater Fish 8:181–193.

Habicht, C., L. W. Seeb, and J. E. Seeb. 2007a. Genetic and ecological divergence defines population structure of sockeye salmon populations returning to Bristol Bay, Alaska, and provides a tool for admixture analysis. Transactions of the American Fisheries Society 136:82–94.

Habicht, C., W. D. Templin, T. M Willette, L. F. Fair, S. W. Raborn, and L. W. Seeb. 2007b. Post-season stock composition analysis of Upper Cook Inlet sockeye salmon harvest, 2005–2007. Alaska Department of Fish and Game, Fishery Manuscript No. 07-07, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms07-07.pdf

Koljonen, M. L., J. J. Pella, and M. Masuda. 2005. Classical individual assignments versus mixture modeling to estimate stock proportions in Atlantic Salmon (*Salmo salar*) catches from DNA microsatellite data. Canadian Journal of Fisheries and Aquatic Sciences 62:2143–2158.

Lewis, P. O., and D. Zaykin. 2001. Genetic data analysis: computer program for the analysis of allelic data. Version 1.0. URL http://lewis.eeb.uconn.edu/lewishome/software.html.

Melton, L. 2003. On the trail of SNPs. Nature 422: 917–923.

Miller, K. M., K. H. Kaukinen, T. D. Beacham, and R. E. Withler. 2001. Geographic heterogeneity in natural selection on an MHC locus in sockeye salmon. Genetica 111:237–257.

Mundy, P. R., K. K. English, W. J. Gazey, and K. E. Tarbox. 1993. Evaluation of the harvest management strategies applied to sockeye salmon populations of Upper Cook Inlet, Alaska, using run reconstruction analysis. Pages 107–139 [*in*]: G. Kruse, D. M. Eggers, R. J. Marasco, C. Pautzke, T. J. Quinn (editors) Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant College Program, University of Alaska, Fairbanks.

Narum, S. R., M. Banks, T. Beacham, R. Belllinger, M. Campbell, J. DeKoning, A. Elz, C. Guthrie, C. Kozfkay, K. Miller, P. Moran, R. Phillips, L. Seeb, C. Smith, K. Warheit, S. Young, and J. C. Garza. 2008. Differentiating salmon populations at broad and fine geographic scales with microsatellites and single nucleotide polymorphisms. Molecular Ecology (17)15:3464–3477.

Nei, M. 1972. Genetic distance between populations. American Naturalist 106:283–292.

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

Paradis, E., J. Claude, and K. Strimmer. 2004. APE: analyses of phylogenetics and evolution in R language. Bioinformatics 20: 289–290.

Pearcy, W. 1992. Ocean ecology of north pacific salmonids. University of Washington Press, Seattle.

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

Pella, J. J., and G. B. Milner. 1987. Use of genetic marks in stock composition analysis. Pages 247–276 [*in*]: N. Ryman and F. Utter, editors. Population Genetics and Fishery Management. Washington Sea Grant, University of Washington Press, Seattle.

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

Ranade, K., M.–S. Chang, C.–T. Ting, D. Pei, C.–F. Hsiao, M. Olivier, R. Pesich, J. Hebert, Y.–D. I. Chen, V. Dzau, D. Curb, R. Olshen, N. Risch, D. R. Cox, and D. Botstein. 2001. High-throughput genotyping with single nucleotide polymorphisms. Genome Research 11: 1262–1268.

Raymond, M., and F. Rousset. 1995. An exact test for population differentiation. Evolution 49:1280–1283.

Rice, W. R. 1989. Analyzing tables of statistical tests. Evolution 43:223–225.

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

Rousset, F. 2008. GENEPOP ' 007: a complete re-implementation of the GENEPOP software for Windows and Linux. Molecular Ecology Resources 8(1):103–106.

Seeb, L. W., P. A. Crane, C. M. Kondzela, R. L. Wilmot, S. Urawa, N. V. Varnavskaya, and J. E. Seeb. 2004. Migration of Pacific Rim chum salmon on the high seas: Insights from genetic data. Environmental Biology of Fishes 69:21–36.

Seeb, L. W., C. Habicht, W. D. Templin, K. E. Tarbox, R Z. Davis, L. K. Brannian, and J. E. Seeb. 2000. Genetic diversity of sockeye salmon of Cook Inlet, Alaska, and its application to management of populations affected by the Exxon Valdez oil spill. Transactions of the American Fisheries Society 129:1223–1249.

Seeb, L. W., W. D. Templin, K. E. Tarbox, R. Z. Davis, and J. E. Seeb. 1997. Kenai River sockeye salmon restoration, Restoration Project 96255-2 Final Report, *Exxon Valdez* Oil Spill Trustee Council, Anchorage.

Shields, P. 2006. Upper Cook Inlet commercial fisheries annual management report, 2005. Alaska Department of Fish and Game, Fishery Management Report No. 06-42, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/Fmr06-42.pdf

Shields, P. 2007a. Upper Cook Inlet commercial fisheries annual management report, 2006. Alaska Department of Fish and Game, Fishery Management Report No. 07-36, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/Fmr07-36.pdf

Shields, P. 2007b. Upper Cook Inlet commercial fisheries annual management report, 2007. Department of Fish and Game, Fishery Management Report No. 07-64, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/Fmr07-64.pdf

Shields, P. 2009. Upper Cook Inlet commercial fisheries annual management report, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-32 Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/Fmr09-32.pdf

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

Shields, P., and T. M. Willette. 2008. Migratory timing and abundance estimates of sockeye salmon into Upper Cook Inlet, Alaska, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 08-53, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds08-53.pdf

Shields, P., and T. M. Willette. 2009a. Migratory timing and abundance estimates of sockeye salmon into Upper Cook Inlet, Alaska, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 09-15, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds09-15.pdf

Shields, P., and T. M. Willette. 2009b. Migratory timing and abundance estimates of sockeye salmon into Upper Cook Inlet, Alaska, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 09-59, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds09-59.pdf

Smith C. T., A. Antonovich, W. D. Templin, C. D. Elfstrom, S. R. Narum, and L. W. Seeb. 2007. Impacts of marker class bias relative to locus-specific variability on population inferences in Chinook salmon; a comparison of SNPs to STRs and allozymes. Transactions of the American Fisheries Society 136:1674–1687.

Smith, C. T., C. M. Elfstrom, J. E. Seeb, and L. W Seeb. 2005a. Use of sequence data from rainbow trout and Atlantic salmon for SNP detection in Pacific salmon. Molecular Ecology 14:4193–4203.

Smith, C. T., W. D. Templin, J. E. Seeb, and L. W. Seeb. 2005b. Single nucleotide polymorphisms provide rapid and accurate estimates of the proportions of us and Canadian Chinook salmon caught in Yukon River fisheries. North American Journal of Fisheries Management 25:944–953.

REFERENCES CITED (Continued)

Tarbox, K. E., B. E. King, and D. L. Waltemyer. 1983. Cook Inlet sockeye salmon studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anadromous Fish Conservation Act Project Report No AFC-62, Anchorage.

Templin, W. D., R. L. Wilmot, C. M. Guthrie III, and L. W. Seeb. 2005. United States and Canadian Chinook salmon populations in the Yukon River can be segregated based on genetic characteristics. Alaska Fisheries Research Bulletin 11:44–60.

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

Tobias, T., and K. E. Tarbox. 1999. An estimate of total return of sockeye salmon to Upper Cook Inlet, Alaska 1976–1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A99-11, Anchorage.

Tobias, T. M., and T. M. Willette. 2004a. Abundance, age, sex and size of Chinook, sockeye, coho and chum salmon returning to Upper Cook Inlet, Alaska, in 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A04-10, Anchorage.

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

Tobias, T. M., and T. M. Willette. 2008. Abundance, age, sex and size of Chinook, sockeye, coho and chum salmon returning to Upper Cook Inlet, Alaska, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 08-10, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds08-10.pdf

Tobias, T. M., and T. M. Willette. *In prep*. An estimate of total return of sockeye salmon to Upper Cook Inlet, Alaska 1976-2008. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, Anchorage.

Waltemyer, D. L., B. G. Bue, and K. E. Tarbox. 1996. Evaluation of scale pattern analysis for Upper Cook Inlet sockeye salmon stocks. Alaska Fisheries Research Bulletin 3(2):69–80.

Waltemyer, D. L. 1995. Component analysis of Kenai River sockeye salmon in the commercial fisheries of Upper Cook Inlet in 1990 and 1991 based on scale patterns. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 95-03, Anchorage.

Wang, J., M. Lin, A. Crenshaw, A. Hutchinson , B. Hicks , M. Yeager , S. Berndt, W.–Y. Huang, R. B. Hayes, S. J. Chanock, R. C. Jones, and R. Ramakrishnan. 2009. High-throughput single nucleotide polymorphism genotyping using nanofluidic Dynamic Arrays. BMC Genomics 10:561.

Waples, R. S. 1990a. Conservation genetics of Pacific salmon. III. Estimating effective population size. Journal of Heredity 81(4):277–289.

Waples, R. S. 1990b. Temporal changes of allele frequency in Pacific salmon: implications of mixed-stock fishery analysis. Canadian Journal of Fisheries and Aquatic Sciences 47:968–976.

Weir, B. 1996. Genetic Data Analysis (second edition). Sinauer Associates, Inc, Sunderland, MA.

Weir, B. S. and C. C. Cockerham. 1984. Estimating F-statistics for the analysis of population structure. Evolution 38(6): 1358–1370.

Westerman, D. L., and T. M. Willette. 2003. Upper Cook Inlet Salmon Escapement Studies 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A04-03.

Wilmot, R. L., and C. V. Burger. 1985. Genetic differences among populations of Alaskan sockeye salmon. Transactions of the American Fisheries Society 114:236–243.

Wood, C. C., S. McKinnell, T. J. Mulligan, and D. A. Fournier. 1987. Stock identification with the maximum-likelihood mixture model: sensitivity analysis and application to complex problems. Canadian Journal of Fisheries and Aquatic Sciences 44:866–881.

REFERENCES CITED (Continued)

Wood, C. C., B. E. Riddell, D. T. Rutherford, and R. E. Withler. 1994. Biochemical genetic survey of sockeye salmon (*Oncorhynchus nerka*) in Canada. Canadian Journal of Fisheries and Aquatic Sciences 51:114–131.

Woody, C. A., J. Olsen, J. Reynolds, and P. Bentzen. 2000. Temporal variation in phenotypic and genotypic traits in two sockeye salmon populations, Tustumena Lake, Alaska. Transactions of the American Fisheries Society 129:1031–1043.

TABLES AND FIGURES

Table 1.–Descriptions of fishery restrictions and coordinates (decimal degrees, WGS1984) to corresponding points and lines on Figures 1, 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	1				
3	Kasilof Corridor	Statistical Area 244-61	1				
4	Area 1	Northern boundary (Latitude of the southern point of Kalgin Island)	2		c	60.3405	
		Southern boundary (Latitude of the Anchor Point light)			e	59.7698	
5	Area 2	Southwest point	2	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	Northern boundary (Latitude of Kalgin buoy)	2		d	60.0783	
		Southern boundary (Latitude of the Anchor Point Light)			e	59.7698	
7	N/A	Northern boundary (Latitude of Blanchard line)	2		b	60.4517	
		Southern boundary (Latitude of the Anchor Point Light)			e	59.7698	
8	N/A	Northern boundary (Latitude of Northwest corner of Kalgin Island)	2		a	60.5208	
		Southern boundary (Latitude of the Anchor Point Light)			e	59.7698	

-continued-

Table 1.–Page 2 of 2.

Restriction #	Area Common Name	Description (Common Name)	Map Figure #	Map Point	Map Line	Latitude	Longitude
9	N/A	Miscellaneous areas representing small catches including; drift gillnet Areas 3 and 4, pink salmon drift area, Chinitna Bay, and western half of Cook Inlet. See Shields 2006, 2007a, 2007b, and 2009.	N/A				
10	N/A	Northeast point (Collier's Dock)	2	6		60.6725	-151.3833
		Northern midpoint (northwest corner of Kalgin Island)		7		60.5208	-151.9292
		Northwest boundary (line "a" west of point 7 to Central District western boundary)			a	60.5208	
		Southern boundary (latitude of the Anchor Point Light)			e	59.7698	
11	Kasilof River Special Harvest Area	Southeast point (inside south beach)	3	8		60.3765	-151.3389
		Southwest point (outside south end)		9		60.3844	-151.3422
		Northwest point (outside north end)		10		60.4022	-151.3140
		Northeast point (inside north beach)		11		60.4025	-151.2953
12	N/A	Within 1/2 mile of shore	N/A				
13	N/A	One set gillnet no more than 35 fathoms in length	N/A				

Table 2.–Tissue collections of sockeye salmon in the Upper Cook Inlet genetic baseline including the year sampled, location and sublocation where samples were collected, and the number of individuals analyzed from each collection and sublocation (*N*) and their assigned reporting group for genetic stock identification.

Map No.	Pop. No.	Collection No.	Reporting Group	Location	Sublocation	Sample Year	*N*
1	1	1	Crescent	Crescent Lake	site 1	1994	48
1	1	2				1995	91
1	2	3			site 2	1994	47
2	2	4		Crescent River		1992	94
2	2	5				2005	94
3	3	6	West	Packers Lake		1992	95
3	3	7				1993	30
4	4	8		Little Jack Creek		2006	142
5	5	9		South Fork Big River		2007	207
6	6	10		Wolverine Creek		1993	95
7	7	11		Black Sand Creek		2007	124
8	8	12		Chilligan River		1992	95
8	8	13				1994	48
9	9	14		Chakachatna River		2008	94
10	10	15		Farros Lake		2007	155
11	11	16		McArthur River		1993	95
12	12	17		West Fork Coal Creek		1993	95
13	12	18		Lone King Creek		2006	29
13	12	19				2008	29
14	13	20	SusYen	West Fork Yentna River		1992	95
14	13	21				1993	99
15	14	22		Kichatna River	site 1	2007	103
16	14	23			site 2	2007	19
17	15	24		Moose Creek		2007	102
18	16	25		Puntilla Lake		2006	139
19	17	26		Red Salmon Lake		2006	127
20	18	27		Trimble River	site 1	2007	57
21	18	28			site 2	2007	47
22	19	29		Skwentna River		2007	108
23	19	30		Canyon Creek		2007	65
24	20	31	JCL	Judd Lake		1993	95
24	20	32				2006	93
25	21	33	SusYen	Trinity/Movie Lakes		1992	94
25	21	34				1993	95
26	22	35		Shell Lake		1993	94
26	22	36				2006	92

-continued-

Table 2.–Page 2 of 3.

Map No.	Pop. No.	Collection No.	Reporting Group	Location	Sublocation	Sample Year	*N*
27	23	37		Hewitt Lake		1992	49
27	23	38				2006	65
28	24	39	JCL	Chelatna Lake		1993	94
28	24	40				2006	93
29	25	41	SusYen	Susitna River Sloughs		1995	50
29	25	42				1996	6
29	25	43				1997	95
30	26	44		Byers Lake		1993	95
30	26	45				2007	92
31	27	46		Spink Creek		2007	28
31	27	47				2008	93
32	28	48		Swan Lake		2006	94
32	28	49				2007	47
33	29	50		Sheep River		2008	188
34	30	51		Stephan Lake		1993	95
34	30	52				2007	93
35	31	53	JCL	Larson Creek		1993	95
35	31	54				2006	94
36	32	55	SusYen	Mama and Papa Bear Lakes		1997	50
36	32	56				2007	52
37	32	57		Talkeetna River Slough		1997	79
38	33	58		Birch Creek		1993	66
38	33	59				2007	132
39	34	60	Fish	Big Lake		1992	95
39	34	61				1993	95
39	34	62				1994	93
40	35	63		Fish Creek		1992	94
40	35	64				2008	187
41	36	65	KTNE	Eska Creek		2006	95
42	37	66		Jim Creek		1997	95
43	38	67		Bodenburg Creek		2006	138
44	39	68		Wasilla Creek		1998	66
45	39	69		Cottonwood Creek		1993	95
46	40	70		Six Mile Creek		2008	95
47	41	71		Nancy Lake		1993	95
48	42	72		Williwaw Creek		2006	39
48	42	73				2007	69

-continued-

Table 2.–Page 3 of 3.

Map No.	Pop. No.	Collection No.	Reporting Group	Location	Sublocation	Sample Year	*N*
49	43	74		Swanson River		1997	95
50	44	75		Bishop Creek		1993	95
51	45	76		Daniels Lake		1993	95
52	46	77	Kenai	Johnson Creek		1997	88
53	46	78		Railroad Creek		1997	95
54	47	79		Moose Creek		1993	46
54	47	80				1994	95
55	48	81		Ptarmigan Creek		1992	43
55	48	82				1993	95
56	49	83		Tern Lake		1992	47
56	49	84				1993	95
57	50	85		Quartz Creek		1993	95
58	51	86		Kenai River, between Skilak and Kenai Lakes	site 1	1994	47
59	51	87			site 2	1994	48
60	52	88		Upper Russian River Early	Goat Creek	1997	95
61	52	89			Lower Lake Outlet	1992	96
62	53	90		Upper Russian River Late	Upper Lake Bear Creek	1997	94
63	54	91			Upper Lake South Shore	1999	95
64	55	92			Upper Lake North Shore	1999	95
65	56	93			Lower Lake Outlet	1993	95
66	51	94		Lower Russian River		1993	93
67	51	95		Kenai River, between Skilak and Kenai Lakes		1993	90
68	51	96			site 3	1994	143
69	51	97			site 4	1994	48
70	51	98			site 5	1994	95
71	57	99		Hidden Creek		1993	95
71	57	100				2008	92
72	58	101		Skilak Lake outlet		1992	96
72	58	102				1994	265
72	58	103				1995	47
73	59	104	Kasilof	Glacier Flats Creek		1994	95
74	59	105		Moose Creek		1992	96
75	59	106		Bear Creek		1993	95
76	59	107		Nikolai Creek		1992	95
77	59	108		Seepage Creek		1994	95
78	59	109		Tustumena Lake	site A	1994	48
79	59	110			site B	1994	48

Note: Map numbers (Map No.) correspond to sampling sites on Figure 5, unique population numbers (Pop. No.) represent all the collections that contribute to a single population.

Table 3.–Tissue sample collections for genetic analysis from fish harvested in the Upper Cook Inlet fisheries in 2005, 2006, 2007, and 2008.

Restrictions[a] / Subsection[b]	Date(s) sampled	Harvest on sample date	Represented date(s)	Harvest represented	Mixture date(s)	Sample Size	
						Analyzed	Collected
Central District drift gillnet (Excluding corridor-only periods)							
2005							
1			6/20	1,759		-	-
1,2			6/23	10,552		-	-
1,2			6/27	20,384	6/27-7/7	-	-
1,2			6/30	30,723		-	-
1,2	7/4	63,795	7/4	63,795		100	100
1,2	7/7	112,174	7/7	112,174		200	200
2,3,4	7/11	244,130	7/11	244,130	7/11-14	200	200
2,3,4	7/14	176,127	7/14	176,127		200	400
2,3,4,5	7/18	230,353	7/18	230,353	7/18	200	200
6	7/21	142,653	7/21	142,653	7/21-8/8	200	200
2,3,7	7/25	127,842	7/25	127,842		50	50
2,3,8	7/28	262,056	7/28	262,056		50	50
2,3,7			7/30	95,034		-	-
2,3,7	8/1	38,493	8/1	38,493		50	50
1,2,3			8/4	48,811		-	-
1,2,3			8/8	29,515		-	-
9			8/11-29	7,262		-	-
2006							
1			6/19	2,674	6/19-29	-	-
1			6/22	3,748		-	-
1	6/26	13,352	6/26	13,352		135	460
1,2	6/29	25,083	6/29	25,083		265	448
1,2	7/3	35,007	7/3	35,007	7/3-6	192	538
1	7/6	32,491	7/6	32,491		208	600
2,3,7	7/31	89,680	7/31	89,680	7/31	399	507
2,3,8	8/2	56,418	8/2	56,418	8/2	399	520
1,2[b],3[b]			8/5	37,871	8/5-11	-	-
1,2[b],3[b]	8/7	19,154	8/7	19,154		109	520
1			8/9	29,110		-	-
1	8/10	13,928	8/10	13,928		291	513
1			8/11	5,550		-	-
9			8/14 - 9/11	6,320		-	-
2007							
1			6/21	3,788	6/21-28	-	-
1	6/25	5,772	6/25	5,772		109	412
1,2	6/28	16,445	6/28	16,445		291	460

-continued-

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
1,2	7/2	22,276	7/2	22,276	7/2-5	105	455
1,2	7/5	63,019	7/5	63,019		295	466
2,3,4	7/9	104,709	7/9	104,709	7/9-12	156	530
2,3,4	7/12	190,505	7/12	190,505		244	499
2,3,4	7/16	481,204	7/16	481,204	7/16	400	611
2,3,4	7/19	451,216	7/19	451,216	7/19	400	526
2,3,7	7/23	126,001	7/23	126,001	7/23-26	234	460
2,3,7	7/26	63,008	7/26	63,008		166	460
2,3,8	7/30	78,552	7/30	78,552	7/30-8/9	202	413
2,3,10	8/2	35,434	8/2	35,434		62	404
2,3,10	8/6	16,232	8/6	16,232		47	368
1,2,3	8/9	26,585	8/9	26,585		67	419
9			8/13-9/10	2,184		-	-
2008							
1			6/19	1,034	6/19-7/3	-	-
1			6/23	3,988		-	-
1	6/26	7,199	6/26	7,199		27	500
1	6/30	30,999	6/30	30,999		88	478
1,2	7/3	122,499	7/3	122,499		285	419
1,2	7/7	135,787	7/7	135,787	7/7-10	387	531
2	7/8	2,150	7/8	2,150		4	138
2,3	7/10	2,550	7/10	2,550		9	240
2,3,4	7/14	208,918	7/14	208,918	7/14-17	223	500
2,3,4,5	7/17	139,791	7/17	139,791		177	472
2,3,4,5	7/21	131,863	7/21	131,863	7/21-24	328	500
1	7/24	41,915	7/24	41,915		72	502
9			8/4-9/11	1,802		-	-
Central District drift gillnet (corridor-only periods)							
2005							
2			6/21-7/9	12,331		-	-
2,3			7/12-13	51,435		-	-
2			7/15	71,455		-	-
2,3			7/16-24	408,539		-	-
2,3			7/26-8/10	315,585		-	-

-continued-

Table 3.–Page 3 of 11.

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
				2006			
2			6/30-7/1	2,102		-	-
2			7/7	455		-	-
2			7/8	1,201		-	-
2,3	7/10	1,650	7/10	1,650		154	400
2			7/12	119	7/10-13	-	-
2,3	7/13	1,544	7/13	1,544		46	152
2,3	7/17	15,370	7/17	15,370	7/17	300	589
2,3			8/1	8,949		-	-
2,3			8/3-8	33,521		-	-
				2007			
2			6/29-7/14	12,748		-	-
2,3			7/21-8/10	119,140		-	-
				2008			
2			6/28-7/12	135,434		-	-
Kasilof River Special Harvest Area drift gillnet (Central District, East Side Subdistrict)							
				2006			
11	7/24	118,160	7/24	118,160		187	200
11	7/25	54,078	7/25	54,078	7/24-29	56	200
11	7/26	14,196	7/26	14,196		21	100
11	7/27	16,432	7/27-29	23,665		36	200
Kasilof River Special Harvest Area drift/set gillnet (Central District, East Side Subdistrict)							
				2005			
11			7/7-30	97,199		-	-
				2006			
11			6/27-7/10	60,131		-	-
11	7/17	21,094	7/11-7/17	82,681		80	100
11	7/19	4,651	7/18-19	16,483		18	100
11	7/20	36,275	7/20-21	74,408	7/11-23	100	100
11	7/22	21,929	7/22	21,929		83	100
11	7/23	39,415	7/23	39,415		99	100
				2007			
11	7/27	3,668	7/27-8/10	20,290		-	100
				2008			
11	7/28	8,964	7/27-29	22,081	7/27-29	400	459
11	7/31	9,583	7/30-8/1	29,394	7/30-8/1	399	399

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Table 3.–Page 4 of 11.

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
11	8/4	3,670	8/2-5	21,282	8/2-7	340	460
11	8/7	1,943	8/6-7	4,067		60	150
Kasilof River Special Harvest Area set gillnet (Central District, East Side Subdistrict)							
2006							
11	7/24	68,098	7/24	68,098	7/24-29	182	200
11	7/25	51,199	7/25	51,199		93	200
11	7/26	24,510	7/26	24,510		51	100
11	7/27	21,393	7/27-29	38,619		74	200
Kasilof Section set gillnet (Central District, East Side Subdistrict)							
2005							
1a	7/4	17,375	6/20-7/4	267,398	6/20-7/9	50	50
1b	7/4	11,033	6/20-7/4	127,378		50	50
1a	7/7	19,433	7/6-9	58,873		50	50
1b	7/7	9,763	7/6-9	26,398		50	50
1a	7/11	26,345	7/10-15	71,035	7/10-15	50	50
1b	7/11	12,692	7/10-12	27,858		200	200
1b	7/14	2,011	7/13-15	15,253		156	156
1a	7/18	19,241	7/16-7/21	63,369	7/16-21	50	50
1b	7/18	27,504	7/16-19	61,013		200	200
1b	7/21	7,111	7/20-23	26,392	7/20-23	200	200
1a	7/25	14,331	7/23-7/28	154,327	7/23-8/10	50	50
1b	7/25	8,860	7/24-26	32,114		50	50
1b	7/28	11,564	7/27-8/1	50,846		50	50
1a	8/1	27,344	7/30-8/10	110,472		50	50
1b	8/4	6,635	8/3-10	46,409		50	50
2006							
1a	6/26	19,285	6/26	19,285	6/26-7/1	66	200
1b	6/26	8,270	6/26	8,270		81	100
1a	6/29	26,514	6/29-7/1	57,440		193	200
1b	6/29	10,371	6/29-7/1	29,772		60	60
1a	7/3	13,625	7/2-3	17,752	7/2-8	67	200
1b	7/3	5,951	7/2-3	6,992		44	130
1a	7/6	16,563	7/6-8	45,909		169	200
1b	7/6	7,642	7/6-8	31,858		120	120
1a	7/10	13,979	7/10	13,979	7/10-13	142	200
1b	7/10	3,290	7/10	3,290		34	200
1a	7/13	5,056	7/12-13	15,984		200	200
1b	7/13	806	7/12-13	2,840		24	67

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Table 3.–Page 5 of 11.

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
12a	7/15	80,250	7/15	80,250	7/15-16	177	300
12b	7/15	34,416	7/15-16	63,467		131	250
12a	7/16	45,690	7/16	45,690		92	200
1a	7/17	17,110	7/17	17,110	7/17-22	50	200
1b	7/17	10,701	7/17	10,701		27	200
12a	7/20	17,700	7/19-22	54,600		179	200
12b	7/20	21,888	7/19-22	52,781		144	210
1a	7/31	6,901	7/30-8/1	9,906	7/30-8/9	55	130
1b	7/31	6,955	7/30-8/1	10,461		53	130
1a	8/2	3,826	8/2-5	14,334		89	130
1b	8/2	6,662	8/2-5	26,145		126	130
1a	8/7	1,440	8/6-9	4,707		24	200
1b	8/7	3,970	8/6-9	11,767		53	130
			2007				
1a	6/25	6,471	6/25	6,471	6/25-7/5	23	200
1b	6/25	1,901	6/25	1,901		7	118
1a	6/28	19,838	6/28-30	45,747		160	200
1b	6/28	3,233	6/28-30	8,934		35	130
1a	7/2	16,957	7/2	16,957		58	200
1b	7/2	2,533	7/2	2,533		9	130
1a	7/5	13,060	7/4-5	28,557		93	200
1b	7/5	2,068	7/4-5	4,215		15	130
1a	7/9	28,581	7/9-11	77,980	7/9-14	170	200
1b	7/9	3,531	7/9-11	7,935		17	188
1a	7/12	16,504	7/12-14	43,486		95	200
1b	7/12	1,127	7/12-14	8,240		18	200
1a	7/16	19,128	7/16-18	58,137	7/16-21	97	250
1b	7/16	3,776	7/16-18	27,115		46	187
1a	7/19	54,885	7/19-21	120,095		193	250
1b	7/19	7,533	7/19-21	40,469		64	200
1a	7/23	11,052	7/22-25	46,831	7/22-28	151	250
1b	7/23	5,320	7/22-25	23,309		78	200
1a	7/26	12,551	7/26-28	29,334		93	200
1b	7/26	14,085	7/26-28	22,980		78	200
1a	7/30	9,521	7/30-8/1	27,385	7/30-8/9	83	130
1b	7/30	6,610	7/30-8/1	16,758		56	130
1a	8/2	5,492	8/2-5	13,438		50	130
1b	8/2	1,883	8/2-5	3,249		21	130
1a	8/6	6,567	8/6-7	10,655		73	130
1b	8/6	4,211	8/6-7	7,119		30	130
1a	8/9	8,271	8/8-9	10,435		47	130
1b	8/9	7,169	8/8-9	8,607		40	130

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Table 3.–Page 6 of 11.

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
			2008				
1a	6/26	41,691	6/26-28	81,474	6/26-7/5	111	200
1b	6/26	19,504	6/26-28	43,188		59	100
1a	6/30	20,652	6/29-7/1	69,857		94	300
1b	6/30	9,839	6/29-7/1	28,942		40	130
1a	7/3	13,318	7/2-5	50,461		79	264
1b	7/3	2,748	7/2-5	12,786		17	130
1a	7/7	27,013	7/7-9	57,160	7/7-12	202	299
1b	7/7	7,284	7/7-9	11,656		42	130
1a	7/10	9,354	7/10-12	34,188		117	300
1b	7/10	2,877	7/10-12	11,048		39	100
1a	7/14	59,621	7/13-16	121,671	7/13-19	148	300
1b	7/14	70,952	7/13-16	138,886		162	200
1,12a	7/17	22,262	7/17-19	38,467		50	250
1,12b	7/17	21,388	7/17-19	32,923		40	250
1,12a	7/21	23,402	7/20-23	58,223	7/20-26	156	250
1,12b	7/21	21,055	7/20-23	54,144		140	247
1,12a	7/24	18,145	7/24-26	24,985		71	247
1,12b	7/24	4,638	7/24-26	11,720		33	91
			Kenai Section set gillnet (Central District, East Side Subdistrict)				
			2005				
1c	7/11	26,686	7/11-12	40,134	7/11-12	200	200
1d	7/11	42,926	7/11-12	100,348		50	50
1c	7/14	4,818	7/13-15	14,712	7/13-15	200	200
1d	7/14	12,084	7/13-15	27,137		50	50
1c	7/18	48,613	7/16-19	92,841	7/16-19	200	200
1d	7/18	69,180	7/16-19	129,636		50	50
1c	7/21	7,947	7/20-23	27,702	7/20-26	200	200
1d	7/21	45,865	7/20-23	169,488		50	50
1c	7/25	7,574	7/24-26	22,676		50	50
1c	7/28	14,849	7/27-30	27,630	7/27-8/10	50	50
1d	7/28	26,615	7/24-30	218,506		50	50
1c	8/1	9,718	7/31-8/2	25,298		50	50
1c	8/4	10,805	8/3-10	60,552		50	50
1d	8/4	39,832	7/31-8/10	360,139		50	50
			2006				
1c	7/10	2,833	7/10	2,833	7/10-13	67	200
1d	7/10	6,960	7/10	6,960		165	403
1c	7/13	975	7/13	975		25	106
1d	7/13	6,058	7/13	6,058		143	272

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Table 3.–Page 7 of 11.

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
1c	7/17	7,939	7/17	7,939	7/17	97	200
1d	7/17	21,789	7/17	21,789		303	400
1c	7/31	12,393	7/31-8/1	18,026	7/31-8/9	31	130
1d	7/31	52,147	7/31-8/1	82,070		129	130
1c	8/2	7,406	8/2-5	29,492		38	130
1d	8/2	39,187	8/2-5	77,670		117	130
1c	8/7	4,272	8/6-9	12,468		19	130
1d	8/7	12,698	8/6-9	41,550		65	200
2007							
1c	7/9	1,712	7/9	1,712	7/9-12	62	100
1d	7/9	5,104	7/9	5,104		193	300
1c	7/12	783	7/12	783		30	100
1d	7/12	3,026	7/12	3,026		115	300
1c	7/16	1,380	7/16	1,380	7/16-19	10	100
1d	7/16	8,169	7/16	8,169		64	300
1c	7/19	5,390	7/19	5,390		40	100
1d	7/19	36,684	7/19	36,684		286	300
1c	7/23	6,955	7/21-24	32,268	7/21-28	30	100
1d	7/23	40,087	7/21-24	189,781		215	350
1c	7/26	22,463	7/26-28	25,831		31	100
1d	7/26	54,290	7/26-28	91,105		124	300
1c	7/30	8,504	7/30-31	13,670	7/30-8/9	27	130
1d	7/30	35,469	7/30-31	52,598		104	130
1c	8/2	1,655	8/1-2	5,534		8	130
1d	8/2	14,102	8/1-2	44,726		83	130
1c	8/6	4,033	8/5-7	9,027		19	130
1d	8/6	25,351	8/5-7	51,955		84	130
1c	8/9	8,243	8/8-9	9,585		11	130
1d	8/9	20,669	8/8-9	30,576		51	130
2008							
1c	7/10	1,067	7/10	1,067	7/10-17	2	100
1d	7/10	3,347	7/10	3,347		5	299
1c	7/14	61,879	7/14	61,879		93	100
1d	7/14	78,558	7/14	78,558		125	299
1c	7/17	20,743	7/17	20,743		39	100
1d	7/17	86,418	7/17	86,418		136	300
1c	7/21	20,680	7/21	20,680	7/21-24	76	100
1d	7/21	64,899	7/21	64,899		238	299
1c	7/24	4,050	7/24	4,050		15	50
1d	7/24	19,317	7/24	19,317		71	300

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Table 3.–Page 8 of 11.

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
Kalgin Island Subdistrict set gillnet (Central District)							
2005							
1	8/6	11,756	6/1-9/8	105,180		-	100
2006							
1			6/2-21	14,644		-	-
1	6/26	1,229	6/23-26	2,867	6/23-8/17	31	109
1	6/29	1,291	6/29	1,291		15	117
1	7/3	1,375	7/3	1,375		16	100
1	7/6	560	7/6	560		6	77
1	7/10	861	7/10	861		9	112
1	7/13	471	7/13	471		5	53
1	7/17	1,656	7/17	1,656		18	101
1	7/20	1,434	7/20	1,434		16	112
1	7/24	3,271	7/24	3,271		37	118
1	7/27	2,690	7/27	2,690		35	80
1	7/31	4,503	7/31	4,503		56	85
1	8/3	4,130	8/3	4,130		47	93
1	8/10	2,201	8/7-10	6,106		69	100
1	8/16	1,646	8/14-17	3,731		40	100
1			8/21-9/11	501		-	-
2007							
1			6/1-6/20	12,799		-	-
1	6/25	2,659	6/22-25	2,754	6/22-7/12	76	100
1	6/28	2,814	6/28	2,814		65	100
1	7/2	2,642	7/2	2,642		73	100
1	7/5	2,894	7/5	2,894		80	100
1	7/9	2,461	7/9	2,461		68	100
1	7/12	1,395	7/12	1,395		38	100
1	7/16	575	7/16	575	7/16-8/18	7	85
1	7/19	3,148	7/19	3,148		40	100
1	7/23	4,596	7/23	4,596		58	100
1	7/26	5,196	7/26	5,196		65	100
1	7/29	2,556	7/29-31	4,596		58	100
1	8/2	3,533	8/2	3,533		44	100
1	8/6	3,285	8/6	3,285		28	100
1	8/9	3,285	8/9-18	10,429		99	100
2008							
1	6/2	1,208	6/2-6	6,544	6/2-26	39	40
1	6/9	1,950	6/9-13	5,599		34	40
1	6/18	606	6/16-23	2,415		15	40
1	6/26	611	6/23-26	1,827		12	40

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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
1	6/30	1,201	6/30	1,201	6/30-8/16	18	50
1	7/3	2,204	7/3	2,204		44	99
1	7/7	1,676	7/7	1,676		25	100
1	7/10	746	7/10	746		11	100
1	7/14	3,150	7/14	3,150		47	100
1	7/17	4,455	7/17	4,455		67	100
1	7/21	1,946	7/21	1,946		29	100
1	7/24	1,167	7/24	1,167		17	100
1	7/28	2,264	7/28	2,264		34	100
1	7/31	2,222	7/31	2,222		33	100
1	8/2	885	8/2	885		13	100
1	8/4	1,022	8/4	1,022		15	100
1	8/7	789	8/7	789		12	100
1	8/11	702	8/9-11	1,571		24	100
1	8/14	412	8/14-16	690		11	50
West Side Subdistrict set gillnet (Central District)							
2005							
1	7/21	1,906	6/16-8/25	49,753		-	100
2006							
1	6/26	460	6/19-26	810	6/19-7/10	30	132
1	6/29	285	6/29-7/1	2,137		78	128
1	7/3	2,682	7/3	2,682		99	116
1	7/6	1,636	7/5-6	2,444		90	100
1	7/10	2,026	7/8-10	3,280		102	102
1	7/13	1,663	7/12-15	4,477	7/12-7/31	91	108
1	7/17	2,796	7/17-18	3,764		76	83
1	7/20	2,681	7/20-22	5,151		104	119
1	7/24	888	7/24-25	1,492		30	105
1	7/27	2,684	7/26-27	3,236		65	85
1	7/31	1,453	7/29-31	1,695		34	46
1			8/2-28	8,502		-	-
2007							
1	6/25	2,107	6/18-25	3,553	6/18-8/27	19	100
1	6/28	1,950	6/28	1,950		14	100
1	7/2	2,449	7/1-2	3,592		26	100
1	7/5	3,265	7/4-5	5,951		41	100
1	7/9	1,537	7/7-9	5,762		43	100
1	7/12	1,679	7/10-13	6,466		46	100

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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
1	7/16	1,508	7/14-16	2,510	6/18-8/27	18	100
1	7/19	2,974	7/18-20	8,644		62	100
1	7/23	1,546	7/21-23	4,542		33	100
1	7/26	3,448	7/25-28	5,875		45	100
1	7/30	1,871	7/30-31	2,379		16	100
1	8/2	627	8/2-8	1,804		12	100
1	8/9	2,840	8/9-27	3,826		25	100
			2008				
1	6/26	463	6/16-26	1,407	6/16-8/11	29	40
1	6/30	684	6/30	684		13	40
1	7/3	810	6/3-5	1,684		35	100
1	7/7	892	6/6-7	1,544		31	100
1	7/10	544	6/10-13	4,252		83	100
1	7/15	777	7/15-17	4,887		80	99
1	7/17	1,112	7/17-18	2,819		34	100
1	7/25	591	7/20-26	2,653		30	100
1	7/28	2,186	7/28-31	2,861		50	50
1	8/7	186	8/1-7	611		12	50
1	8/11	151	8/11	151		3	50
			Eastern Subdistrict set gillnet (Northern District)				
			2005				
1	7/14-18	2,396	5/30-9/15	15,802		-	100
			2006				
1			5/27-6/29	2,780		-	-
1	7/3	481	7/3	481		-	50
1	7/6	629	7/6	629		-	40
1	8/7	723	8/7	723	8/7-9/14	202	280
1	8/10	720	8/10-9/14	4,804		195	198
			2007				
1			5/28-6/28	1,253		-	-
1	7/2	326	5/28-7/2	326	7/2-8/20	10	33
1	7/5	419	7/5	419		14	40
1	7/9	492	7/9	492		13	40
1	7/12	222	7/12	222		7	28
1	7/16	259	7/16	259		8	40
1	7/19	1,466	7/19	1,466		40	40
13	7/23	1,280	7/23	1,280		40	40
1	8/9	760	8/9-8/20	2,502		68	80
1			8/23-9/10	1,003		-	-

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Table 3.–Page 11 of 11.

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
			2008				
1			5/26-6/30	4,275		-	-
1	7/7	193	7/7	193	7/7-8/18	6	76
1	7/10	358	7/10	358		59	62
1	7/14	4,522	7/14	4,522		80	80
1	7/17	3,739	7/17	3,739		70	70
13	7/21	1,065	7/21-24	1,105		60	60
13	7/28	771	7/28	771		81	160
13	7/31	572	7/31	572		15	140
13	8/4	322	8/4	322		10	129
13	8/7	206	8/7	206		6	50
13	8/11	246	8/11-18	433		13	49
13			8/21-9/4	156		-	-
			General Subdistrict set gillnet (Northern District)				
			2005				
1	7/18	3,250	5/30-8/29	10,613		-	30
			2006				
1			5/29-8/28	3,036		-	-
			2007				
1			5/28-9/13	8,245		-	-
			2008				
1			5/26-6/30	711		-	-
1	7/3	65	7/3	65	7/3-8/25	4	19
1	7/10	263	7/7-10	305		48	92
1	7/14	2,151	7/14	2,151		45	146
1	7/17	2,420	7/17	2,420		130	130
13	7/21	1,381	7/21	1,381		48	48
13	7/24	728	7/24	728		33	77
13	7/29	516	7/28-31	812		40	81
13	8/4	415	8/4	415		23	77
13	8/7	260	8/7	260		14	42
13	8/11	263	8/11-25	330		15	18

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

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

[b] Expansion of the of the corridor boundary 2 miles to the west. For description of restrictions see Table 1 and Figures 1–3).

Table 4.–Forty-five single nucleotide polymorphism markers used for this project with subsets noted for each analysis.

Marker[a]	Marker Set [a]	mtDNA	Linked loci	H_E	H_O	F_{ST}	Reference[b]
One_ACBP-79	1,2,3			0.500	0.440	0.110	A
One_ALDOB-135	1,2,3			0.260	0.234	0.088	A
One_CO1	1,2,3	yes	1	NA	NA	0.323	A
One_ctgf-301	1,2,3			0.069	0.067	0.032	A
One_Cytb_17	1,2,3	yes	1	NA	NA	0.677	A
One_Cytb_26	1,2,3	yes	1	NA	NA	0.288	A
One_E2-65	1,2,3			0.415	0.338	0.174	B
One_GHII-2165	1,2,3			0.265	0.219	0.158	A
One_GPDH-201				0.497	0.468	0.061	B
One_GPDH2-187	1,2,3			0.188	0.170	0.092	B
One_GPH-414	1,2,3			0.433	0.409	0.059	A
One_hsc71-220	1,2,3			0.371	0.314	0.152	A
One_HGFA-49	1,2,3			0.279	0.250	0.087	B
One_HpaI-71	1,2,3			0.415	0.362	0.113	A
One_HpaI-99	1,2,3			0.139	0.124	0.103	A
One_IL8r-362	1,2			0.104	0.089	0.157	C
One_KPNA-422	1,2,3			0.307	0.272	0.106	A
One_LEI-87	1,2,3			0.492	0.437	0.094	A
One_MARCKS-241	1,2,3			0.062	0.054	0.097	C
One_MHC2_190	1,2,3		2	0.469	0.304	0.324	A
One_MHC2_251	1,2,3		2	0.492	0.324	0.319	A
One_Ots213-181	1,2,3			0.244	0.235	0.049	A
One_p53-534	1,2,3			0.063	0.049	0.213	A
One_ins-107	1,2,3			0.489	0.433	0.104	B
One_Prl2	1,2,3			0.499	0.440	0.095	A
One_RAG1-103	1,2,3			0.102	0.095	0.108	A
One_RAG3-93	1,2,3			0.107	0.102	0.073	A
One_RFC2-102	1,2,3			0.369	0.313	0.133	B
One_RFC2-285	1,2,3			0.098	0.085	0.087	B
One_RH2op-395	2,3			0.001	0.001	0.001	A
One_serpin-75	1,2,3			0.053	0.044	0.164	B
One_STC-410	1,2,3			0.400	0.338	0.170	A
One_STR07	1,2,3			0.426	0.371	0.131	A
One_Tf_ex11-750	1,2,3			0.429	0.369	0.150	A
One_Tf_in3-182	1,2,3			0.045	0.040	0.110	A

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Table 4.–Page 2 of 2.

Marker	Marker Set [a]	mtDNA	Linked loci	H_E	H_O	F_{ST}	Reference[b]
One_U301-92	2,3			0.297	0.273	0.079	A
One_U401-224	1,2,3			0.500	0.469	0.072	C
One_U404-229	1,2			0.048	0.043	0.085	C
One_U502-167	2			0.053	0.050	0.060	C
One_U503-170	1,2			0.172	0.162	0.084	C
One_U504-141	1,2			0.419	0.380	0.088	C
One_U508-533	1,2			0.119	0.091	0.207	C
One_VIM-569	1,2,3			0.247	0.216	0.122	A
One_ZNF-61	1,2			0.339	0.291	0.149	C
One_Zp3b-49	1,2,3			0.188	0.128	0.332	B
mtDNAall*	1,2,3			NA	NA	0.358	
MHC2190251*	1,2,3			NA	NA	0.253	

Note: Expected heterozygosity (H_E), observed heterozygosity (H_O), and F_{ST} for baseline samples and reference are listed for each marker. MtDNA markers are noted, and linked markers are numerically coded by linkage group. Composite haplotype loci (*) were assembled for both of these marker classes for use in genetic stock identification analyses.

[a] 1) 2005 and 2006 mixtures; 2) 2007 and 2008 mixtures, proof tests; 3) fish wheel.

[b] A) Elfstrom et al. (2006); B) Smith et al. (2005a); C) Habicht et al. (2007a).

Table 5.–Location, date(s) sampled, and sample size (*N*) for tissue collections of sockeye salmon sampled for genetic studies taken from fish captured in fish wheels operated within 4 of the major drainages into Upper Cook Inlet, Alaska.

Map No.	Location	Date(s)	*N*
81	Kasilof River (fish wheel, river km 11.3)	7/22-23/1992	190
		7/11-20/2005	190
82	Kenai River (fish wheel, river km 30.6)	7/31-8/1/1994	190
		7/11-20/2005	190
83	Yentna River (fish wheel, river km 6.5)	7/15/1992	190
84	Susitna River (Sunshine fish wheel, river km 116)	7/26/1992	190

Note: Map numbers correspond to the fish wheel sites on Figure 5.

Table 6.–Predetermined priors based on the best available information for the first strata within each Upper Cook Inlet (UCI) district, subdistrict, section, subsection, and test fishery.

		Reporting Group							
Gillnet fishery	Date	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Central District drift	June 27 - July 7, 2005	0.08	0.05	0.05	0.05	0.01	0.01	0.17	0.59
KRSHA drift	July 24 - 29, 2006	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.89
KRSHA drift/set	July 11 - July 23, 2006	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.89
KRSHA set	July 24 - 29, 2006	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.89
Kasilof Section set	June 20 - July 9, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.14	0.80
Kenai Section set	July 11 - 12, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.47	0.47
Cohoe/Ninilchik Subsection set	July 4 - July 11, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.14	0.80
Cohoe/Ninilchik Subsection set	July 4 - August 7, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.73	0.21
South K. Beach Subsection set	July 4 - July 14, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.14	0.80
South K. Beach Subsection set	July 4 - August 7, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.73	0.21
North K. Beach Subsection set	July 11 - 14, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.47	0.47
North K. Beach Subsection set	July 11 - August 4, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.73	0.21
Salamatof Subsection set	July 11 - August 4, 2005	0.01	0.01	0.01	0.01	0.01	0.01	0.73	0.21
Kalgin Island Subdistrict set	June 23 - August 17, 2006	0.04	0.03	0.04	0.04	0.01	0.01	0.49	0.34
Western Subdistrict set	June 19 - July 10, 2006	0.58	0.29	0.05	0.05	0.01	0.01	0.01	0.01
Eastern Subdistrict set	August 7 - September 14, 2006	0.01	0.10	0.10	0.10	0.01	0.10	0.49	0.10
General Subdistrict set	July 3 - August 25, 2008	0.01	0.07	0.01	0.77	0.07	0.06	0.01	0.01
UCI offshore test fishery	July 1 - 9, 2006	0.04	0.03	0.05	0.05	0.01	0.02	0.28	0.52

Note: Strata composed of the Kasilof River Special Harvest Area (KRSHA) are included. All priors for subsequent strata (including subsequent strata within the same year and all strata in following years) 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 7.–Stock composition estimates, standard deviation (SD), 90% credibility interval (CI), sample size (n), and effective sample size (n_{eff}) for mixtures of sockeye salmon captured in fish wheels operated on the Kasilof, Kenai, Yentna, and Susitna rivers in 1992, 1994, and 2005.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
						Kasilof				
Year	1992	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99
		SD	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
n	190	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97
n_{eff}	189	Upper 90% CI	0.00	0.01	0.00	0.01	0.01	0.00	0.01	1.00
Year	2005	Proportion	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.98
		SD	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01
n	190	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96
n_{eff}	190	Upper 90% CI	0.02	0.01	0.01	0.01	0.02	0.01	0.01	1.00
						Kenai				
Year	1994	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00
		SD	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01
n	190	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00
n_{eff}	188	Upper 90% CI	0.01	0.02	0.00	0.01	0.00	0.01	1.00	0.02
Year	2005	Proportion	0.00	0.00	0.00	0.01	0.00	0.00	0.95	0.03
		SD	0.00	0.01	0.00	0.02	0.01	0.00	0.03	0.03
n	190	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.00
n_{eff}	189	Upper 90% CI	0.00	0.01	0.01	0.05	0.01	0.00	1.00	0.09
						Yentna/Susitna				
Year	1992	Proportion	0.00	0.00	0.09	0.90	0.00	0.00	0.00	0.00
		SD	0.00	0.00	0.04	0.05	0.00	0.01	0.00	0.00
n	380	Lower 90% CI	0.00	0.00	0.04	0.81	0.00	0.00	0.00	0.00
n_{eff}	377	Upper 90% CI	0.01	0.01	0.19	0.95	0.01	0.01	0.00	0.00

Note: Effective sample size (n_{eff}) is 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 8.–Stock composition estimates, standard deviation (SD), 90% credibility interval (CI), sample size (*n*), and effective sample size (n_{eff}) for mixtures of sockeye salmon captured in the Upper Cook Inlet offshore test fishery in 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
					2006					
Start Date	07/01	Proportion	0.04	0.06	0.01	0.05	0.00	0.03	0.30	0.51
End Date	07/09	SD	0.01	0.02	0.01	0.02	0.00	0.01	0.04	0.04
n	325	Lower 90% CI	0.02	0.03	0.00	0.02	0.00	0.01	0.24	0.45
n_{eff}	325	Upper 90% CI	0.06	0.09	0.02	0.08	0.00	0.06	0.36	0.57
Start Date	07/10	Proportion	0.00	0.11	0.06	0.11	0.00	0.05	0.33	0.33
End Date	07/16	SD	0.00	0.04	0.02	0.04	0.00	0.02	0.04	0.04
n	266	Lower 90% CI	0.00	0.06	0.03	0.04	0.00	0.02	0.27	0.27
n_{eff}	263	Upper 90% CI	0.01	0.18	0.09	0.18	0.01	0.09	0.39	0.39
Start Date	07/17	Proportion	0.02	0.07	0.05	0.07	0.00	0.02	0.60	0.17
End Date	07/23	SD	0.01	0.02	0.02	0.02	0.00	0.01	0.03	0.03
n	401	Lower 90% CI	0.00	0.05	0.03	0.04	0.00	0.01	0.55	0.13
n_{eff}	397	Upper 90% CI	0.04	0.10	0.08	0.11	0.00	0.03	0.66	0.21
Start Date	07/24	Proportion	0.00	0.07	0.05	0.02	0.00	0.03	0.70	0.12
End Date	08/01	SD	0.00	0.02	0.01	0.02	0.00	0.02	0.03	0.02
n	393	Lower 90% CI	0.00	0.04	0.03	0.00	0.00	0.01	0.65	0.09
n_{eff}	391	Upper 90% CI	0.01	0.11	0.08	0.05	0.00	0.06	0.75	0.16
					2007					
Start Date	07/01	Proportion	0.08	0.16	0.03	0.03	0.02	0.05	0.39	0.23
End Date	07/09	SD	0.02	0.03	0.01	0.01	0.01	0.02	0.03	0.03
n	374	Lower 90% CI	0.05	0.11	0.02	0.01	0.00	0.02	0.34	0.19
n_{eff}	372	Upper 90% CI	0.12	0.22	0.05	0.05	0.03	0.09	0.45	0.28

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Table 8.–Page 2 of 3.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Start Date	07/10	Proportion	0.03	0.08	0.05	0.10	0.01	0.03	0.53	0.17
End Date	07/13	SD	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.03
n	444	Lower 90% CI	0.02	0.04	0.03	0.07	0.00	0.01	0.47	0.13
n_{eff}	437	Upper 90% CI	0.06	0.11	0.07	0.14	0.02	0.05	0.59	0.22
Start Date	07/14	Proportion	0.04	0.02	0.07	0.11	0.00	0.03	0.61	0.12
End Date	07/18	SD	0.01	0.01	0.02	0.03	0.00	0.01	0.03	0.02
n	404	Lower 90% CI	0.02	0.01	0.05	0.06	0.00	0.01	0.56	0.08
n_{eff}	399	Upper 90% CI	0.06	0.05	0.10	0.15	0.00	0.05	0.66	0.16
Start Date	07/19	Proportion	0.05	0.02	0.04	0.08	0.00	0.03	0.67	0.10
End Date	07/23	SD	0.01	0.01	0.01	0.02	0.00	0.01	0.03	0.02
n	429	Lower 90% CI	0.04	0.01	0.03	0.05	0.00	0.02	0.62	0.06
n_{eff}	427	Upper 90% CI	0.08	0.04	0.07	0.11	0.00	0.05	0.72	0.13
Start Date	07/24	Proportion	0.05	0.04	0.05	0.06	0.00	0.02	0.69	0.09
End Date	08/02	SD	0.02	0.01	0.01	0.02	0.00	0.01	0.03	0.02
n	438	Lower 90% CI	0.03	0.02	0.03	0.03	0.00	0.00	0.64	0.06
n_{eff}	434	Upper 90% CI	0.08	0.06	0.08	0.09	0.00	0.04	0.74	0.13
					2008					
Start Date	07/01	Proportion	0.03	0.11	0.05	0.04	0.01	0.03	0.27	0.45
End Date	07/07	SD	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.03
n	422	Lower 90% CI	0.02	0.07	0.04	0.02	0.00	0.02	0.22	0.40
n_{eff}	418	Upper 90% CI	0.05	0.15	0.08	0.08	0.03	0.05	0.32	0.50
Start Date	07/08	Proportion	0.04	0.12	0.07	0.10	0.00	0.01	0.43	0.22
End Date	07/12	SD	0.01	0.02	0.01	0.02	0.00	0.01	0.03	0.02
n	465	Lower 90% CI	0.02	0.09	0.05	0.07	0.00	0.00	0.39	0.18
n_{eff}	457	Upper 90% CI	0.06	0.16	0.10	0.14	0.00	0.02	0.48	0.26

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Table 8.–Page 3 of 3.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Start Date	07/13	Proportion	0.05	0.13	0.10	0.05	0.00	0.03	0.49	0.15
End Date	07/17	SD	0.01	0.02	0.02	0.02	0.00	0.01	0.03	0.02
n	436	Lower 90% CI	0.03	0.09	0.07	0.01	0.00	0.01	0.44	0.11
n_{eff}	429	Upper 90% CI	0.07	0.16	0.14	0.09	0.00	0.05	0.54	0.19
Start Date	07/18	Proportion	0.03	0.13	0.06	0.04	0.00	0.02	0.58	0.14
End Date	07/31	SD	0.01	0.02	0.01	0.01	0.00	0.01	0.03	0.02
n	438	Lower 90% CI	0.01	0.10	0.04	0.02	0.00	0.01	0.54	0.11
n_{eff}	426	Upper 90% CI	0.05	0.16	0.08	0.06	0.00	0.03	0.63	0.18

Note: Effective sample size (n_{eff}) is 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 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 Central District drift gillnet fishery (excluding corridor-only periods) in 2005, 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2005	Proportion	0.00	0.04	0.04	0.06	0.00	0.02	0.71	0.12
Start Date	06/27	SD	0.00	0.01	0.01	0.02	0.00	0.01	0.04	0.03
End Date	07/07	Lower 90% CI	0.00	0.02	0.02	0.03	0.00	0.01	0.65	0.08
		Upper 90% CI	0.01	0.06	0.07	0.09	0.00	0.04	0.77	0.17
Harvest	227,076	Harvest	237	8,898	10,093	12,889	9	5,597	161,421	27,931
n	300	Lower 90% CI	0	4,711	5,540	6,706	0	2,396	147,773	17,306
n_{eff}	300	Upper 90% CI	1,510	14,002	15,474	20,351	2	9,714	174,478	39,361
Year	2005	Proportion	0.00	0.04	0.01	0.02	0.00	0.01	0.88	0.05
Start Date	07/11	SD	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.02
End Date	07/14	Lower 90% CI	0.00	0.02	0.00	0.00	0.00	0.00	0.84	0.02
		Upper 90% CI	0.01	0.06	0.02	0.03	0.00	0.02	0.91	0.07
Harvest	420,257	Harvest	659	16,217	4,752	6,332	29	2,408	370,007	19,853
n	400	Lower 90% CI	0	8,297	1,580	1,525	0	0	354,461	10,098
n_{eff}	399	Upper 90% CI	5,154	25,455	9,251	13,394	13	8,292	384,283	31,021
Year	2005	Proportion	0.00	0.01	0.01	0.01	0.02	0.00	0.94	0.02
Start Date	07/18	SD	0.00	0.01	0.01	0.01	0.01	0.00	0.03	0.02
End Date	07/18	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.00
		Upper 90% CI	0.00	0.04	0.03	0.03	0.04	0.00	0.98	0.06
Harvest	230,353	Harvest	21	3,132	1,832	1,346	3,456	29	216,409	4,129
n	200	Lower 90% CI	0	0	0	0	0	0	205,157	0
n_{eff}	200	Upper 90% CI	6	9,354	6,090	8,016	8,438	10	225,726	13,184
Year	2005	Proportion	0.02	0.01	0.00	0.00	0.00	0.00	0.88	0.09
Start Date	07/21	SD	0.01	0.01	0.00	0.01	0.00	0.00	0.02	0.02
End Date	08/08	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.06
		Upper 90% CI	0.04	0.02	0.01	0.01	0.00	0.01	0.92	0.12
Harvest	744,404	Harvest	13,299	3,990	2,304	2,725	104	1,409	656,217	64,356
n	350	Lower 90% CI	0	124	0	0	0	0	627,698	41,975
n_{eff}	347	Upper 90% CI	28,110	14,236	8,207	10,806	185	8,362	682,349	89,222

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Table 9.–Page 2 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.00	0.03	0.01	0.00	0.00	0.02	0.11	0.81
Start Date	06/19	SD	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.02
End Date	06/29	Lower 90% CI	0.00	0.02	0.00	0.00	0.00	0.00	0.08	0.77
		Upper 90% CI	0.01	0.06	0.02	0.03	0.01	0.05	0.15	0.85
Harvest	44,857	Harvest	73	1,561	365	198	53	1,095	5,154	36,358
n	400	Lower 90% CI	0	811	0	0	0	167	3,687	34,555
n_{eff}	399	Upper 90% CI	563	2,697	927	1,263	347	2,071	6,765	38,054
Year	2006	Proportion	0.00	0.08	0.00	0.04	0.00	0.03	0.21	0.64
Start Date	07/03	SD	0.00	0.02	0.00	0.02	0.00	0.01	0.03	0.03
End Date	07/06	Lower 90% CI	0.00	0.04	0.00	0.01	0.00	0.01	0.16	0.59
		Upper 90% CI	0.00	0.12	0.01	0.08	0.00	0.05	0.26	0.70
Harvest	67,498	Harvest	34	5,466	83	2,836	35	1,705	14,040	43,301
n	400	Lower 90% CI	0	2,940	0	798	0	559	10,753	39,591
n_{eff}	399	Upper 90% CI	245	8,292	573	5,433	173	3,087	17,462	47,002
Year	2006	Proportion	0.00	0.06	0.05	0.09	0.00	0.02	0.65	0.12
Start Date	07/31	SD	0.00	0.01	0.01	0.02	0.00	0.01	0.03	0.02
End Date	07/31	Lower 90% CI	0.00	0.04	0.03	0.05	0.00	0.01	0.60	0.08
		Upper 90% CI	0.00	0.09	0.08	0.13	0.00	0.04	0.70	0.16
Harvest	89,680	Harvest	22	5,696	4,820	8,035	6	2,214	58,418	10,469
n	399	Lower 90% CI	0	3,690	2,825	4,926	0	986	53,698	7,007
n_{eff}	398	Upper 90% CI	32	8,056	7,057	11,502	3	3,858	63,055	14,079
Year	2006	Proportion	0.00	0.07	0.05	0.03	0.00	0.01	0.73	0.10
Start Date	08/02	SD	0.00	0.02	0.02	0.02	0.00	0.01	0.03	0.02
End Date	08/02	Lower 90% CI	0.00	0.03	0.03	0.00	0.00	0.00	0.69	0.07
		Upper 90% CI	0.00	0.11	0.08	0.07	0.00	0.03	0.78	0.14
Harvest	56,418	Harvest	13	3,882	2,970	1,897	3	593	41,284	5,774
n	399	Lower 90% CI	0	1,775	1,698	274	0	0	38,653	3,998
n_{eff}	397	Upper 90% CI	14	6,083	4,626	3,868	1	1,587	43,871	7,683

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Table 9.–Page 3 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.00	0.09	0.05	0.10	0.00	0.01	0.68	0.06
Start Date	08/05	SD	0.00	0.02	0.01	0.02	0.00	0.01	0.03	0.02
End Date	08/11	Lower 90% CI	0.00	0.07	0.03	0.07	0.00	0.00	0.64	0.03
		Upper 90% CI	0.00	0.12	0.08	0.14	0.00	0.03	0.73	0.09
Harvest	105,613	Harvest	4	9,625	5,378	10,724	6	1,263	72,293	6,320
n	400	Lower 90% CI	0	6,914	3,145	7,388	0	170	67,101	3,324
n_{eff}	399	Upper 90% CI	1	12,734	7,956	14,423	2	2,697	77,247	9,737
Year	2007	Proportion	0.01	0.34	0.00	0.01	0.00	0.00	0.26	0.38
Start Date	06/21	SD	0.01	0.03	0.00	0.01	0.00	0.01	0.03	0.03
End Date	06/28	Lower 90% CI	0.00	0.29	0.00	0.00	0.00	0.00	0.22	0.33
		Upper 90% CI	0.03	0.39	0.01	0.02	0.00	0.03	0.32	0.43
Harvest	26,005	Harvest	168	8,829	16	186	4	130	6,888	9,785
n	400	Lower 90% CI	0	7,547	0	0	0	0	5,616	8,454
n_{eff}	398	Upper 90% CI	736	10,082	132	448	3	786	8,240	11,122
Year	2007	Proportion	0.05	0.14	0.04	0.03	0.02	0.01	0.44	0.28
Start Date	07/02	SD	0.01	0.02	0.01	0.02	0.01	0.01	0.04	0.04
End Date	07/05	Lower 90% CI	0.03	0.10	0.02	0.01	0.01	0.00	0.37	0.22
		Upper 90% CI	0.07	0.18	0.07	0.06	0.03	0.02	0.50	0.34
Harvest	85,295	Harvest	4,132	11,556	3,506	2,623	1,358	802	37,225	24,093
n	400	Lower 90% CI	2,404	8,237	1,674	948	480	155	31,860	19,186
n_{eff}	396	Upper 90% CI	6,160	15,123	5,628	5,120	2,563	1,878	42,657	29,184
Year	2007	Proportion	0.02	0.06	0.07	0.04	0.00	0.02	0.55	0.24
Start Date	07/09	SD	0.01	0.02	0.02	0.02	0.00	0.01	0.03	0.03
End Date	07/12	Lower 90% CI	0.01	0.03	0.05	0.01	0.00	0.01	0.50	0.19
		Upper 90% CI	0.03	0.09	0.10	0.08	0.00	0.04	0.61	0.29
Harvest	295,214	Harvest	5,655	17,238	21,085	11,761	20	6,222	163,365	69,868
n	400	Lower 90% CI	2,262	8,362	13,464	4,148	0	2,347	146,344	55,110
n_{eff}	394	Upper 90% CI	10,153	26,947	29,241	23,096	31	11,220	180,212	85,179

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			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2007	Proportion	0.00	0.02	0.06	0.08	0.00	0.04	0.64	0.16
Start Date	07/16	SD	0.01	0.01	0.02	0.02	0.00	0.01	0.03	0.03
End Date	07/16	Lower 90% CI	0.00	0.00	0.03	0.04	0.00	0.02	0.59	0.11
		Upper 90% CI	0.01	0.04	0.09	0.12	0.00	0.06	0.70	0.21
Harvest	481,204	Harvest	1,502	9,077	27,038	37,920	25	19,642	310,165	75,835
n	400	Lower 90% CI	0	2,151	13,981	20,546	0	10,426	283,427	54,455
n_{eff}	382	Upper 90% CI	6,955	18,350	42,108	57,501	9	31,175	335,826	98,868
Year	2007	Proportion	0.00	0.01	0.07	0.05	0.00	0.04	0.69	0.14
Start Date	07/19	SD	0.00	0.01	0.01	0.02	0.00	0.01	0.03	0.03
End Date	07/19	Lower 90% CI	0.00	0.00	0.05	0.01	0.00	0.02	0.63	0.10
		Upper 90% CI	0.00	0.03	0.09	0.09	0.01	0.06	0.74	0.19
Harvest	451,216	Harvest	38	6,265	30,741	22,304	1,289	15,798	311,011	63,770
n	400	Lower 90% CI	0	821	20,587	6,729	0	7,622	285,860	44,293
n_{eff}	391	Upper 90% CI	18	14,425	42,178	38,422	5,658	25,661	335,553	84,294
Year	2007	Proportion	0.01	0.01	0.05	0.01	0.02	0.01	0.80	0.10
Start Date	07/23	SD	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.02
End Date	07/26	Lower 90% CI	0.00	0.00	0.03	0.00	0.01	0.00	0.76	0.07
		Upper 90% CI	0.03	0.02	0.07	0.03	0.03	0.03	0.84	0.14
Harvest	189,009	Harvest	1,152	1,183	8,984	1,711	3,400	2,104	151,012	19,464
n	400	Lower 90% CI	0	0	5,596	0	1,101	311	142,780	13,526
n_{eff}	395	Upper 90% CI	4,834	4,139	12,811	5,793	6,551	4,763	158,838	25,971
Year	2007	Proportion	0.00	0.12	0.07	0.03	0.00	0.01	0.71	0.06
Start Date	07/30	SD	0.00	0.03	0.02	0.02	0.00	0.01	0.03	0.02
End Date	08/09	Lower 90% CI	0.00	0.08	0.04	0.00	0.00	0.00	0.65	0.03
		Upper 90% CI	0.00	0.17	0.11	0.06	0.00	0.04	0.76	0.10
Harvest	156,803	Harvest	76	19,400	11,307	4,222	17	2,003	110,603	9,174
n	378	Lower 90% CI	0	12,529	6,787	0	0	0	102,097	3,991
n_{eff}	343	Upper 90% CI	278	26,557	16,907	9,592	32	5,900	118,790	14,907

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Table 9.–Page 5 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2008	Proportion	0.02	0.04	0.05	0.05	0.00	0.04	0.18	0.63
Start Date	06/19	SD	0.01	0.02	0.01	0.02	0.00	0.01	0.03	0.03
End Date	07/03	Lower 90% CI	0.00	0.01	0.03	0.02	0.00	0.02	0.14	0.58
		Upper 90% CI	0.03	0.07	0.07	0.09	0.00	0.06	0.23	0.69
Harvest	165,719	Harvest	2,543	6,177	7,673	8,121	11	6,178	30,215	104,802
n	400	Lower 90% CI	0	1,579	4,848	3,353	0	2,839	22,584	95,677
n_{eff}	393	Upper 90% CI	5,536	11,933	10,960	14,309	4	10,103	38,743	113,542
Year	2008	Proportion	0.01	0.04	0.06	0.03	0.01	0.03	0.32	0.50
Start Date	07/07	SD	0.01	0.01	0.01	0.02	0.01	0.01	0.03	0.04
End Date	07/10	Lower 90% CI	0.00	0.02	0.04	0.00	0.00	0.01	0.26	0.45
		Upper 90% CI	0.03	0.06	0.09	0.06	0.03	0.06	0.37	0.56
Harvest	140,487	Harvest	1,643	4,937	8,422	3,869	1,732	4,854	44,295	70,736
n	400	Lower 90% CI	0	2,647	5,239	511	0	1,932	36,427	62,623
n_{eff}	390	Upper 90% CI	3,584	7,796	12,082	8,146	4,285	8,270	52,479	78,969
Year	2008	Proportion	0.00	0.02	0.07	0.06	0.00	0.03	0.60	0.22
Start Date	07/14	SD	0.00	0.01	0.01	0.02	0.00	0.01	0.03	0.03
End Date	07/17	Lower 90% CI	0.00	0.01	0.05	0.04	0.00	0.01	0.54	0.17
		Upper 90% CI	0.00	0.04	0.09	0.10	0.00	0.05	0.65	0.27
Harvest	348,709	Harvest	20	7,105	24,217	22,656	21	10,277	208,034	76,379
n	400	Lower 90% CI	0	2,334	16,252	13,201	0	5,226	188,804	59,547
n_{eff}	392	Upper 90% CI	12	12,924	33,070	33,718	17	16,597	227,079	93,741
Year	2008	Proportion	0.00	0.04	0.08	0.05	0.00	0.01	0.62	0.19
Start Date	07/21	SD	0.00	0.01	0.02	0.02	0.00	0.01	0.03	0.03
End Date	07/24	Lower 90% CI	0.00	0.03	0.05	0.03	0.00	0.00	0.57	0.15
		Upper 90% CI	0.00	0.06	0.10	0.08	0.00	0.02	0.67	0.24
Harvest	173,778	Harvest	7	7,679	13,111	9,165	7	1,675	108,494	33,639
n	400	Lower 90% CI	0	4,639	8,771	4,737	0	285	99,801	26,522
n_{eff}	388	Upper 90% CI	2	11,264	17,966	14,339	2	3,989	117,102	41,062

Note: Effective sample size (n_{eff}) is 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 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 mixtures of sockeye salmon harvested in the Central District drift gillnet fishery (corridor-only periods) in 2006.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.00	0.03	0.00	0.00	0.00	0.01	0.20	0.75
Start Date	07/10	SD	0.00	0.02	0.01	0.00	0.00	0.01	0.04	0.04
End Date	07/13	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.67
		Upper 90% CI	0.00	0.07	0.01	0.01	0.00	0.04	0.27	0.81
Harvest	3,313	Harvest	1	110	16	3	0	45	666	2,472
n	200	Lower 90% CI	0	0	0	0	0	0	458	2,233
n_{eff}	199	Upper 90% CI	3	240	49	17	0	134	900	2,686
Year	2006	Proportion	0.00	0.00	0.01	0.03	0.00	0.01	0.40	0.55
Start Date	07/17	SD	0.00	0.01	0.01	0.01	0.00	0.01	0.04	0.04
End Date	07/17	Lower 90% CI	0.00	0.00	0.00	0.01	0.00	0.00	0.33	0.48
		Upper 90% CI	0.00	0.01	0.02	0.05	0.00	0.03	0.47	0.62
Harvest	15,370	Harvest	3	42	144	410	1	188	6,129	8,453
n	300	Lower 90% CI	0	0	0	87	0	9	5,050	7,347
n_{eff}	300	Upper 90% CI	2	206	373	830	1	460	7,253	9,527

Note: Effective sample size (n_{eff}) is 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 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, extrapolated harvest, standard deviation (SD), 90% credibility interval (CI), sample size (*n*), and effective sample size (n_{eff}) for mixtures of sockeye salmon in the Kasilof River Special Harvest Area drift and set gillnet fisheries (Central District, East Side Subdistrict) in 2006 and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
			drift gillnet							
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.95
Start Date	07/24	SD	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
End Date	07/29	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.92
		Upper 90% CI	0.01	0.00	0.00	0.00	0.00	0.02	0.07	0.98
Harvest	210,099	Harvest	318	16	16	28	19	1,650	7,573	200,480
n	300	Lower 90% CI	0	0	0	0	0	0	2,904	193,580
n_{eff}	300	Upper 90% CI	2,129	80	105	244	130	4,965	14,058	205,712
			set gillnet							
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.93
Start Date	07/24	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
End Date	07/29	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.90
		Upper 90% CI	0.00	0.01	0.01	0.00	0.00	0.01	0.09	0.96
Harvest	182,426	Harvest	39	488	265	9	10	129	11,556	169,931
n	400	Lower 90% CI	0	20	0	0	0	0	7,260	164,909
n_{eff}	398	Upper 90% CI	184	1,502	1,181	2	3	1,035	16,494	174,378
			drift/set gillnet							
Year	2006	Proportion	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.94
Start Date	07/11	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
End Date	07/23	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.92
		Upper 90% CI	0.00	0.02	0.00	0.00	0.00	0.00	0.07	0.97
Harvest	234,916	Harvest	137	2,648	26	18	12	9	10,104	221,962
n	380	Lower 90% CI	0	0	0	0	0	0	5,825	216,244
n_{eff}	377	Upper 90% CI	1,140	5,832	18	5	4	3	15,333	226,803

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Table 11.–Page 2 of 2.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2008	Proportion	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.96
Start Date	07/27	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
End Date	07/29	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.94
		Upper 90% CI	0.00	0.03	0.00	0.00	0.00	0.00	0.05	0.98
Harvest	22,081	Harvest	1	315	1	8	1	2	575	21,177
n	400	Lower 90% CI	0	64	0	0	0	0	237	20,676
n_{eff}	395	Upper 90% CI	0	626	0	19	0	2	1,031	21,581
Year	2008	Proportion	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.97
Start Date	07/30	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
End Date	08/01	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.95
		Upper 90% CI	0.01	0.02	0.00	0.00	0.00	0.00	0.04	0.99
Harvest	29,394	Harvest	40	180	1	11	2	2	535	28,623
n	399	Lower 90% CI	0	3	0	0	0	0	181	28,028
n_{eff}	397	Upper 90% CI	179	515	0	62	1	1	1,096	29,065
Year	2008	Proportion	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.89
Start Date	08/02	SD	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02
End Date	08/07	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.86
		Upper 90% CI	0.01	0.01	0.00	0.00	0.00	0.05	0.10	0.92
Harvest	25,349	Harvest	32	78	1	2	1	811	1,794	22,632
n	400	Lower 90% CI	0	0	0	0	0	399	1,165	21,816
n_{eff}	386	Upper 90% CI	222	274	0	1	0	1,312	2,518	23,359

Note: Effective sample size (n_{eff}) is 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 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 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 Kasilof Section set gillnet fishery (Central District, East Side Subdistrict) in 2005, 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2005	Proportion	0.00	0.00	0.01	0.00	0.00	0.00	0.19	0.81
Start Date	06/20	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
End Date	07/09	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.74
		Upper 90% CI	0.00	0.00	0.01	0.00	0.00	0.00	0.25	0.87
Harvest	480,047	Harvest	225	73	2,416	72	28	175	88,870	388,187
n	200	Lower 90% CI	0	0	123	0	0	0	60,825	356,321
n_{eff}	200	Upper 90% CI	1,108	31	7,145	55	12	226	120,630	416,474
Year	2005	Proportion	0.00	0.01	0.00	0.01	0.00	0.00	0.49	0.50
Start Date	07/10	SD	0.00	0.01	0.00	0.01	0.00	0.00	0.03	0.03
End Date	07/15	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.45
		Upper 90% CI	0.00	0.02	0.00	0.02	0.00	0.00	0.54	0.55
Harvest	114,146	Harvest	5	730	55	808	4	20	55,447	57,077
n	406	Lower 90% CI	0	0	0	0	0	0	49,712	51,142
n_{eff}	405	Upper 90% CI	1	2,844	443	2,750	2	84	61,392	62,862
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.62
Start Date	07/16	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
End Date	07/21	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.56
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.67
Harvest	124,382	Harvest	7	8	6	7	7	19	47,526	76,802
n	250	Lower 90% CI	0	0	0	0	0	0	40,441	69,529
n_{eff}	250	Upper 90% CI	2	3	2	2	2	5	54,810	83,868
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.66
Start Date	07/20	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
End Date	07/23	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.59
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.72
Harvest	26,392	Harvest	1	3	1	2	2	2	9,090	17,290
n	200	Lower 90% CI	0	0	0	0	0	0	7,426	15,538
n_{eff}	198	Upper 90% CI	0	1	0	1	0	1	10,841	18,957

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Table 12.–Page 2 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.23
Start Date	07/23	SD	0.00	0.00	0.01	0.01	0.00	0.00	0.04	0.03
End Date	08/10	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.18
		Upper 90% CI	0.00	0.00	0.02	0.02	0.00	0.00	0.82	0.29
Harvest	394,168	Harvest	29	185	1,641	1,535	146	207	299,213	91,212
n	250	Lower 90% CI	0	0	0	0	0	0	276,030	69,401
n_{eff}	245	Upper 90% CI	11	1,223	6,239	7,510	305	1,254	321,440	113,970
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.86
Start Date	06/26	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
End Date	07/01	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.83
		Upper 90% CI	0.00	0.00	0.01	0.00	0.00	0.00	0.16	0.89
Harvest	114,767	Harvest	4	74	189	87	20	18	15,286	99,090
n	400	Lower 90% CI	0	0	0	0	0	0	12,089	95,471
n_{eff}	397	Upper 90% CI	1	497	918	569	21	22	18,843	102,339
Year	2006	Proportion	0.00	0.01	0.00	0.01	0.00	0.01	0.09	0.88
Start Date	07/02	SD	0.00	0.02	0.01	0.01	0.00	0.01	0.02	0.02
End Date	07/08	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.84
		Upper 90% CI	0.01	0.05	0.02	0.03	0.00	0.04	0.12	0.91
Harvest	102,511	Harvest	97	1,092	431	521	5	1,522	8,871	89,973
n	400	Lower 90% CI	0	0	0	0	0	0	5,606	85,884
n_{eff}	399	Upper 90% CI	609	5,023	1,674	3,537	2	3,738	12,767	93,533
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.85
Start Date	07/10	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
End Date	07/13	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.82
		Upper 90% CI	0.00	0.00	0.00	0.01	0.00	0.01	0.18	0.89
Harvest	36,093	Harvest	5	8	19	40	3	34	5,178	30,807
n	400	Lower 90% CI	0	0	0	0	0	0	3,918	29,433
n_{eff}	396	Upper 90% CI	15	40	132	261	1	235	6,552	32,072

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Table 12.–Page 3 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.00	0.02	0.00	0.00	0.00	0.00	0.16	0.82
Start Date	07/15	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.02
End Date	07/16	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.78
		Upper 90% CI	0.00	0.03	0.01	0.01	0.00	0.00	0.20	0.85
Harvest	189,407	Harvest	17	3,074	229	244	23	30	30,856	154,933
n	400	Lower 90% CI	0	0	0	0	0	0	24,171	147,610
n_{eff}	400	Upper 90% CI	8	6,617	1,520	2,210	15	8	37,973	161,774
Year	2006	Proportion	0.00	0.01	0.00	0.00	0.00	0.01	0.13	0.85
Start Date	07/17	SD	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.02
End Date	07/22	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.81
		Upper 90% CI	0.00	0.04	0.00	0.00	0.00	0.02	0.16	0.88
Harvest	135,192	Harvest	54	1,499	5	22	5	1,244	17,494	114,870
n	400	Lower 90% CI	0	0	0	0	0	0	13,039	110,059
n_{eff}	400	Upper 90% CI	316	5,749	1	5	1	3,078	22,240	119,304
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.03	0.28	0.69
Start Date	07/30	SD	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03
End Date	08/09	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.23	0.65
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.05	0.32	0.74
Harvest	77,320	Harvest	3	79	3	30	7	2,067	21,449	53,682
n	400	Lower 90% CI	0	0	0	0	0	878	18,054	50,137
n_{eff}	397	Upper 90% CI	1	323	1	64	3	3,508	24,958	57,127
Year	2007	Proportion	0.01	0.09	0.00	0.00	0.00	0.00	0.14	0.77
Start Date	06/25	SD	0.01	0.02	0.00	0.00	0.00	0.00	0.03	0.03
End Date	07/05	Lower 90% CI	0.00	0.06	0.00	0.00	0.00	0.00	0.10	0.71
		Upper 90% CI	0.02	0.12	0.00	0.00	0.00	0.00	0.18	0.81
Harvest	115,315	Harvest	959	10,003	11	86	80	33	15,808	88,336
n	400	Lower 90% CI	143	6,752	0	0	0	0	10,998	82,397
n_{eff}	374	Upper 90% CI	2,292	13,544	4	171	569	10	21,170	93,822

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Table 12.–Page 4 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2007	Proportion	0.00	0.04	0.00	0.01	0.00	0.00	0.45	0.50
Start Date	07/09	SD	0.00	0.02	0.01	0.01	0.01	0.01	0.04	0.04
End Date	07/14	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.43
		Upper 90% CI	0.00	0.07	0.01	0.04	0.02	0.01	0.51	0.56
Harvest	137,641	Harvest	27	5,445	496	1,075	565	324	61,367	68,342
n	300	Lower 90% CI	0	3	0	0	0	0	52,207	59,191
n_{eff}	297	Upper 90% CI	16	10,151	1,945	5,126	2,820	1,863	70,853	77,402
Year	2007	Proportion	0.00	0.02	0.03	0.00	0.00	0.04	0.59	0.31
Start Date	07/16	SD	0.00	0.02	0.01	0.01	0.00	0.02	0.04	0.03
End Date	07/21	Lower 90% CI	0.00	0.00	0.02	0.00	0.00	0.01	0.53	0.26
		Upper 90% CI	0.01	0.07	0.06	0.03	0.00	0.07	0.65	0.37
Harvest	245,816	Harvest	331	4,986	8,579	1,162	8	9,124	144,988	76,640
n	400	Lower 90% CI	0	0	4,063	0	0	1,904	130,436	62,995
n_{eff}	361	Upper 90% CI	2,140	16,217	14,073	8,125	2	17,313	159,348	90,656
Year	2007	Proportion	0.01	0.01	0.01	0.00	0.00	0.01	0.43	0.53
Start Date	07/22	SD	0.01	0.02	0.01	0.00	0.00	0.01	0.03	0.03
End Date	07/28	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.48
		Upper 90% CI	0.03	0.05	0.02	0.01	0.00	0.03	0.48	0.58
Harvest	122,454	Harvest	744	1,001	1,150	142	7	1,453	52,805	65,152
n	400	Lower 90% CI	0	0	122	0	0	0	46,526	58,925
n_{eff}	388	Upper 90% CI	3,279	6,175	2,502	1,077	2	3,924	59,182	71,275
Year	2007	Proportion	0.00	0.07	0.01	0.03	0.01	0.00	0.45	0.43
Start Date	07/30	SD	0.00	0.02	0.01	0.02	0.01	0.00	0.03	0.03
End Date	08/09	Lower 90% CI	0.00	0.04	0.00	0.00	0.00	0.00	0.40	0.38
		Upper 90% CI	0.00	0.10	0.03	0.06	0.02	0.00	0.51	0.49
Harvest	97,646	Harvest	7	6,496	1,038	2,590	999	29	44,139	42,349
n	400	Lower 90% CI	0	3,749	0	0	0	0	38,820	37,148
n_{eff}	395	Upper 90% CI	2	9,505	3,061	5,689	2,353	44	49,582	47,561

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Table 12.–Page 5 of 5.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2008	Proportion	0.00	0.02	0.01	0.01	0.00	0.02	0.05	0.89
Start Date	06/26	SD	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.02
End Date	07/05	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.85
		Upper 90% CI	0.02	0.04	0.02	0.03	0.00	0.04	0.08	0.92
Harvest	286,708	Harvest	1,188	4,691	2,959	2,464	158	6,466	14,071	254,710
n	400	Lower 90% CI	0	868	111	0	0	2,878	7,155	243,479
n_{eff}	394	Upper 90% CI	5,530	11,641	6,289	9,240	1,120	11,177	23,656	263,792
Year	2008	Proportion	0.02	0.03	0.02	0.00	0.01	0.02	0.18	0.71
Start Date	07/07	SD	0.01	0.02	0.01	0.01	0.01	0.01	0.03	0.03
End Date	07/12	Lower 90% CI	0.00	0.01	0.01	0.00	0.00	0.00	0.14	0.66
		Upper 90% CI	0.04	0.06	0.04	0.02	0.02	0.05	0.23	0.76
Harvest	114,052	Harvest	2,349	3,061	2,710	555	981	2,675	21,067	80,653
n	400	Lower 90% CI	0	1,145	1,298	0	0	211	15,793	74,727
n_{eff}	397	Upper 90% CI	4,602	7,084	4,462	2,738	2,507	5,749	26,572	86,361
Year	2008	Proportion	0.01	0.00	0.04	0.00	0.00	0.03	0.16	0.76
Start Date	07/13	SD	0.01	0.01	0.01	0.00	0.00	0.01	0.03	0.03
End Date	07/19	Lower 90% CI	0.00	0.00	0.02	0.00	0.00	0.01	0.12	0.71
		Upper 90% CI	0.03	0.02	0.06	0.00	0.01	0.05	0.21	0.81
Harvest	331,947	Harvest	3,388	1,451	11,864	271	282	8,797	53,741	252,153
n	400	Lower 90% CI	0	0	6,406	0	0	2,596	39,484	235,864
n_{eff}	384	Upper 90% CI	9,147	8,097	18,371	1,056	1,954	16,303	68,847	267,846
Year	2008	Proportion	0.00	0.00	0.01	0.00	0.00	0.01	0.25	0.73
Start Date	07/20	SD	0.00	0.00	0.01	0.00	0.00	0.01	0.03	0.03
End Date	07/27	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.67
		Upper 90% CI	0.00	0.01	0.02	0.00	0.00	0.02	0.31	0.78
Harvest	149,072	Harvest	6	322	1,513	45	6	887	37,723	108,569
n	400	Lower 90% CI	0	0	394	0	0	0	29,895	99,733
n_{eff}	390	Upper 90% CI	2	1,164	3,160	129	2	3,412	46,616	116,409

Note: Effective sample size (n_{eff}) is 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 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 Kenai Section set gillnet fishery in (Central District, East Side Subdistrict) 2005, 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.32
Start Date	07/11	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
End Date	07/12	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.26
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.38
Harvest	140,482	Harvest	9	10	6	28	67	8	95,316	45,039
n	250	Lower 90% CI	0	0	0	0	0	0	86,462	36,389
n_{eff}	249	Upper 90% CI	2	3	2	26	383	2	103,973	53,871
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.22
Start Date	07/13	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
End Date	07/15	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.16
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.28
Harvest	41,849	Harvest	13	24	2	5	10	8	32,678	9,109
n	250	Lower 90% CI	0	0	0	0	0	0	30,247	6,802
n_{eff}	248	Upper 90% CI	14	148	1	3	9	13	34,995	11,522
Year	2005	Proportion	0.00	0.00	0.02	0.01	0.00	0.02	0.71	0.25
Start Date	07/16	SD	0.00	0.00	0.01	0.02	0.00	0.01	0.04	0.04
End Date	07/19	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.19
		Upper 90% CI	0.00	0.00	0.04	0.04	0.00	0.03	0.77	0.31
Harvest	222,477	Harvest	12	19	3,983	1,942	19	3,699	157,900	54,902
n	250	Lower 90% CI	0	0	1,056	0	0	896	143,878	41,998
n_{eff}	247	Upper 90% CI	4	6	7,990	9,269	7	7,698	171,614	68,188
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.43
Start Date	07/21	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
End Date	07/26	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.37
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.48
Harvest	219,866	Harvest	10	10	15	17	19	22	126,051	93,722
n	300	Lower 90% CI	0	0	0	0	0	0	113,421	81,289
n_{eff}	294	Upper 90% CI	3	3	27	5	7	31	138,500	106,367

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			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2005	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.10
Start Date	07/27	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
End Date	08/10	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.06
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.94	0.14
Harvest	692,125	Harvest	41	53	72	41	33	1,217	620,343	70,326
n	250	Lower 90% CI	0	0	0	0	0	0	590,833	43,776
n_{eff}	247	Upper 90% CI	15	16	31	10	10	6,532	647,148	99,376
Year	2006	Proportion	0.00	0.00	0.00	0.01	0.00	0.01	0.43	0.55
Start Date	07/10	SD	0.00	0.00	0.00	0.01	0.00	0.01	0.03	0.03
End Date	07/13	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.50
		Upper 90% CI	0.00	0.00	0.00	0.02	0.01	0.03	0.49	0.61
Harvest	16,826	Harvest	6	7	1	129	16	134	7,235	9,298
n	400	Lower 90% CI	0	0	0	0	0	0	6,300	8,356
n_{eff}	398	Upper 90% CI	40	52	0	408	105	422	8,196	10,226
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.25
Start Date	07/17	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
End Date	07/17	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.20
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.80	0.30
Harvest	29,728	Harvest	4	3	1	4	2	122	22,294	7,299
n	400	Lower 90% CI	0	0	0	0	0	0	20,787	5,863
n_{eff}	397	Upper 90% CI	7	2	0	1	1	368	23,748	8,795
Year	2006	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.19
Start Date	07/31	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
End Date	08/09	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.15
		Upper 90% CI	0.01	0.01	0.00	0.01	0.00	0.00	0.84	0.24
Harvest	261,276	Harvest	460	374	10	318	41	207	209,301	50,565
n	399	Lower 90% CI	0	0	0	0	0	0	197,305	39,477
n_{eff}	397	Upper 90% CI	3,224	3,212	3	2,516	36	1,287	220,649	62,205

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Table 13.–Page 3 of 4.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2007	Proportion	0.00	0.00	0.01	0.01	0.00	0.03	0.84	0.10
Start Date	07/09	SD	0.00	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	0.00	0.00	0.80	0.06
		Upper 90% CI	0.00	0.02	0.02	0.03	0.01	0.05	0.89	0.15
Harvest	10,625	Harvest	1	51	99	76	39	297	8,971	1,092
n	400	Lower 90% CI	0	0	6	0	0	45	8,474	674
n_{eff}	389	Upper 90% CI	1	256	236	366	155	533	9,441	1,548
Year	2007	Proportion	0.00	0.00	0.00	0.02	0.00	0.00	0.90	0.08
Start Date	07/16	SD	0.01	0.01	0.00	0.01	0.00	0.00	0.03	0.03
End Date	07/19	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.04
		Upper 90% CI	0.01	0.02	0.00	0.04	0.00	0.00	0.94	0.12
Harvest	51,623	Harvest	204	101	9	1,054	3	18	46,253	3,981
n	400	Lower 90% CI	0	0	0	0	0	0	43,849	1,942
n_{eff}	387	Upper 90% CI	735	897	18	2,261	1	99	48,539	6,228
Year	2007	Proportion	0.00	0.04	0.05	0.04	0.00	0.04	0.70	0.12
Start Date	07/21	SD	0.00	0.02	0.01	0.03	0.00	0.01	0.03	0.02
End Date	07/28	Lower 90% CI	0.00	0.01	0.03	0.00	0.00	0.02	0.65	0.09
		Upper 90% CI	0.00	0.08	0.07	0.09	0.00	0.06	0.75	0.16
Harvest	338,985	Harvest	30	14,993	17,302	13,244	160	12,838	238,465	41,952
n	400	Lower 90% CI	0	3,152	10,883	1,413	0	5,800	221,298	29,353
n_{eff}	394	Upper 90% CI	13	27,652	24,622	30,006	839	21,630	255,004	55,208
Year	2007	Proportion	0.00	0.00	0.00	0.01	0.00	0.01	0.89	0.08
Start Date	07/30	SD	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.02
End Date	08/09	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.05
		Upper 90% CI	0.00	0.00	0.01	0.03	0.00	0.01	0.93	0.12
Harvest	217,671	Harvest	11	138	796	2,962	19	1,210	194,473	18,061
n	387	Lower 90% CI	0	0	0	0	0	96	185,853	10,991
n_{eff}	371	Upper 90% CI	4	825	2,591	7,235	8	3,239	202,318	25,809

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Table 13.–Page 4 of 4.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2008	Proportion	0.00	0.00	0.03	0.01	0.00	0.02	0.77	0.17
Start Date	07/10	SD	0.00	0.00	0.01	0.01	0.00	0.01	0.03	0.03
End Date	07/17	Lower 90% CI	0.00	0.00	0.02	0.00	0.00	0.01	0.72	0.13
		Upper 90% CI	0.00	0.01	0.05	0.03	0.00	0.04	0.81	0.22
Harvest	252,012	Harvest	36	235	8,413	1,333	24	5,194	193,020	43,756
n	400	Lower 90% CI	0	0	4,144	0	0	2,356	180,761	32,856
n_{eff}	379	Upper 90% CI	33	1,700	13,421	6,533	13	8,844	204,866	55,190
Year	2008	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.13
Start Date	07/21	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
End Date	07/24	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.09
		Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.17
Harvest	108,946	Harvest	4	4	10	5	5	7	94,821	14,089
n	400	Lower 90% CI	0	0	0	0	0	0	90,400	9,952
n_{eff}	392	Upper 90% CI	2	2	44	2	2	16	98,970	18,521

Note: Effective sample size (n_{eff}) is 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 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 Kenai and Kasilof Section set gillnet fisheries (Central District, East Side Subdistrict) analyzed by subsection in 2005.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
					Cohoe\Ninilchik					
Start Date	07/04	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.63
End Date	07/11	SD	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.05
n	150	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.55
n_{eff}	149	Upper 90% CI	0.00	0.01	0.01	0.02	0.00	0.00	0.45	0.71
Start Date	07/18	Proportion	0.00	0.00	0.00	0.01	0.00	0.00	0.61	0.37
End Date	08/01	SD	0.00	0.01	0.01	0.01	0.00	0.01	0.05	0.05
n	150	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.29
n_{eff}	147	Upper 90% CI	0.00	0.01	0.02	0.03	0.00	0.01	0.69	0.45
					South K. Beach					
Start Date	07/04	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.59
End Date	07/14	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
n	456	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.54
n_{eff}	456	Upper 90% CI	0.00	0.00	0.01	0.01	0.00	0.00	0.45	0.64
Start Date	07/18	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.52
End Date	08/04	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
n	550	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.48
n_{eff}	546	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.56
					North K. Beach					
Start Date	07/11	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.30
End Date	07/14	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
n	400	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.26
n_{eff}	397	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.35
Start Date	07/18	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.43
End Date	07/21	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
n	400	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.38
n_{eff}	394	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.48
Start Date	07/25	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.12
End Date	08/04	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
n	200	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.07
n_{eff}	196	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.17
					Salamatof					
Start Date	07/11	Proportion	0.00	0.00	0.02	0.00	0.00	0.01	0.87	0.10
End Date	08/04	SD	0.00	0.00	0.01	0.01	0.00	0.01	0.03	0.02
n	300	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.07
n_{eff}	298	Upper 90% CI	0.00	0.00	0.03	0.01	0.00	0.02	0.91	0.15

Note: Effective sample size (n_{eff}) is 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 15.–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 and Kasilof Section set gillnet fisheries (Central District, East Side Subdistrict) analyzed by subsection in 2005, 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
			Cohoe\Ninilchik 2005							
Start Date	07/04	Proportion	0.00	0.00	0.00	0.01	0.00	0.00	0.50	0.49
End Date	08/07	SD	0.00	0.01	0.00	0.01	0.00	0.00	0.04	0.04
n	300	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.43
n_{eff}	296	Upper 90% CI	0.00	0.01	0.00	0.03	0.00	0.00	0.56	0.55
			South K. Beach 2005							
Start Date	07/04	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.55
End Date	08/07	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
n	1006	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.51
n_{eff}	1002	Upper 90% CI	0.00	0.00	0.01	0.00	0.00	0.00	0.48	0.58
			North K. Beach 2005							
Start Date	07/11	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.32
End Date	08/04	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
n	1000	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.28
n_{eff}	987	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.35
			Salamatof 2005							
Start Date	07/11	Proportion	0.00	0.00	0.02	0.00	0.00	0.01	0.87	0.10
End Date	08/04	SD	0.00	0.00	0.01	0.01	0.00	0.01	0.03	0.02
n	300	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.07
n_{eff}	298	Upper 90% CI	0.00	0.00	0.03	0.01	0.00	0.02	0.91	0.15
			Cohoe\Ninilchik 2006[a]							
Start Date	06/26	Proportion	0.00	0.02	0.00	0.01	0.00	0.00	0.16	0.81
End Date	08/07	SD	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.01
n	1503	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.78
n_{eff}	1497	Upper 90% CI	0.00	0.04	0.00	0.03	0.00	0.01	0.18	0.83
			South K. Beach 2006							
Start Date	06/26	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.83
End Date	08/07	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
n	837	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.81
n_{eff}	886	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.86
			North K. Beach 2006							
Start Date	07/10	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.67
End Date	08/07	SD	0.00	0.01	0.00	0.01	0.00	0.00	0.04	0.04
n	277	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.60
n_{eff}	275	Upper 90% CI	0.00	0.02	0.00	0.02	0.00	0.00	0.39	0.73
			Salamatof 2006							
Start Date	07/10	Proportion	0.00	0.00	0.00	0.00	0.00	0.01	0.76	0.23
End Date	08/07	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
n	922	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.20
n_{eff}	917	Upper 90% CI	0.01	0.00	0.00	0.01	0.00	0.01	0.79	0.26

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			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
					Cohoe\Ninilchik 2007					
Start Date	06/25	Proportion	0.00	0.07	0.01	0.02	0.00	0.00	0.41	0.48
End Date	08/09	SD	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.02
n	1386	Lower 90% CI	0.00	0.06	0.00	0.00	0.00	0.00	0.38	0.45
n_{eff}	1324	Upper 90% CI	0.01	0.09	0.02	0.03	0.01	0.01	0.44	0.51
					South K. Beach 2007					
Start Date	06/25	Proportion	0.00	0.04	0.00	0.00	0.00	0.00	0.40	0.56
End Date	08/09	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.03
n	514	Lower 90% CI	0.00	0.02	0.00	0.00	0.00	0.00	0.35	0.51
n_{eff}	491	Upper 90% CI	0.00	0.06	0.00	0.00	0.01	0.01	0.45	0.61
					North K. Beach 2007					
Start Date	07/09	Proportion	0.00	0.00	0.01	0.02	0.00	0.00	0.64	0.33
End Date	08/09	SD	0.00	0.01	0.01	0.01	0.00	0.00	0.04	0.04
n	268	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.26
n_{eff}	261	Upper 90% CI	0.00	0.01	0.02	0.04	0.00	0.00	0.71	0.40
					Salamatof 2007					
Start Date	07/09	Proportion	0.00	0.02	0.03	0.03	0.00	0.02	0.84	0.05
End Date	08/09	SD	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01
n	1319	Lower 90% CI	0.00	0.01	0.02	0.02	0.00	0.02	0.82	0.03
n_{eff}	1280	Upper 90% CI	0.00	0.03	0.04	0.05	0.01	0.03	0.86	0.07
					Cohoe\Ninilchik 2008					
Start Date	06/26	Proportion	0.00	0.04	0.03	0.01	0.01	0.02	0.23	0.66
End Date	07/24	SD	0.00	0.01	0.01	0.01	0.00	0.01	0.02	0.02
n	1028	Lower 90% CI	0.00	0.03	0.02	0.00	0.00	0.01	0.20	0.62
n_{eff}	1028	Upper 90% CI	0.01	0.06	0.04	0.02	0.01	0.03	0.27	0.69
					South K. Beach 2008					
Start Date	06/26	Proportion	0.00	0.02	0.01	0.00	0.00	0.00	0.04	0.93
End Date	07/24	SD	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
n	572	Lower 90% CI	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.90
n_{eff}	572	Upper 90% CI	0.00	0.03	0.02	0.00	0.00	0.00	0.06	0.95
					North K. Beach 2008					
Start Date	07/10	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.52
End Date	07/24	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
n	225	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.45
n_{eff}	225	Upper 90% CI	0.00	0.00	0.01	0.00	0.00	0.00	0.55	0.59
					Salamatof 2008					
Start Date	07/10	Proportion	0.00	0.00	0.02	0.01	0.00	0.01	0.96	0.00
End Date	07/24	SD	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
n	575	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.01	0.94	0.00
n_{eff}	575	Upper 90% CI	0.00	0.01	0.03	0.03	0.00	0.02	0.97	0.01

Note: Effective sample size (n_{eff}) is 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.

[a] Case where 3 chains did not converge – reported estimates based on 3 chains.

Table 16.–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 Kalgin Island Subdistrict Set gillnet fishery (Central District) in 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.00	0.41	0.02	0.06	0.00	0.05	0.28	0.18
Start Date	06/02	SD	0.00	0.03	0.01	0.02	0.00	0.02	0.03	0.02
End Date	09/11	Lower 90% CI	0.00	0.36	0.01	0.03	0.00	0.01	0.24	0.14
		Upper 90% CI	0.00	0.45	0.03	0.09	0.00	0.08	0.33	0.22
Harvest	34,946	Harvest	16	14,269	657	2,124	2	1,630	9,920	6,326
n	400	Lower 90% CI	0	12,752	242	1,098	0	400	8,335	5,038
n_{eff}	391	Upper 90% CI	93	15,847	1,199	3,254	1	2,733	11,571	7,661
Year	2007	Proportion	0.12	0.39	0.02	0.00	0.00	0.03	0.25	0.19
Start Date	06/22	SD	0.02	0.03	0.01	0.00	0.01	0.01	0.03	0.03
End Date	07/12	Lower 90% CI	0.08	0.34	0.00	0.00	0.00	0.01	0.21	0.14
		Upper 90% CI	0.15	0.44	0.03	0.01	0.02	0.06	0.30	0.23
Harvest	14,960	Harvest	1,736	5,846	224	21	62	452	3,812	2,807
n	400	Lower 90% CI	1,248	5,047	70	0	0	155	3,114	2,168
n_{eff}	397	Upper 90% CI	2,252	6,651	427	109	306	861	4,544	3,468
Year	2007	Proportion	0.05	0.41	0.02	0.03	0.00	0.01	0.42	0.06
Start Date	07/16	SD	0.01	0.03	0.01	0.01	0.00	0.01	0.03	0.02
End Date	08/18	Lower 90% CI	0.03	0.36	0.01	0.01	0.00	0.00	0.37	0.04
		Upper 90% CI	0.07	0.46	0.04	0.06	0.01	0.03	0.46	0.09
Harvest	35,358	Harvest	1,727	14,425	784	1,065	90	239	14,736	2,293
n	399	Lower 90% CI	930	12,569	332	273	0	0	13,071	1,404
n_{eff}	398	Upper 90% CI	2,645	16,299	1,380	1,983	407	923	16,396	3,289

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			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2008	Proportion	0.04	0.57	0.00	0.00	0.00	0.00	0.24	0.15
Start Date	06/02	SD	0.02	0.05	0.00	0.00	0.00	0.01	0.06	0.05
End Date	06/26	Lower 90% CI	0.01	0.49	0.00	0.00	0.00	0.00	0.15	0.07
		Upper 90% CI	0.08	0.66	0.00	0.00	0.00	0.01	0.33	0.24
Harvest	16,385	Harvest	655	9,392	3	3	2	21	3,921	2,388
n	100	Lower 90% CI	173	7,968	0	0	0	0	2,396	1,125
n_{eff}	99	Upper 90% CI	1,339	10,774	3	1	1	137	5,478	3,934
Year	2008	Proportion	0.07	0.68	0.01	0.01	0.00	0.01	0.07	0.15
Start Date	06/30	SD	0.02	0.03	0.01	0.01	0.00	0.01	0.02	0.02
End Date	08/16	Lower 90% CI	0.04	0.63	0.00	0.00	0.00	0.00	0.04	0.12
		Upper 90% CI	0.10	0.73	0.03	0.03	0.00	0.03	0.09	0.18
Harvest	25,988	Harvest	1,815	17,707	379	164	4	333	1,723	3,863
n	400	Lower 90% CI	1,153	16,491	65	0	0	83	1,130	3,066
n_{eff}	399	Upper 90% CI	2,569	18,879	768	741	3	694	2,415	4,700

Note: Effective sample size (n_{eff}) is 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 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 17.–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 West Side Subdistrict set gillnet fishery (Central District) in 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.81	0.08	0.00	0.00	0.00	0.04	0.00	0.07
Start Date	06/19	SD	0.02	0.02	0.00	0.00	0.00	0.01	0.00	0.01
End Date	07/10	Lower 90% CI	0.77	0.05	0.00	0.00	0.00	0.02	0.00	0.05
		Upper 90% CI	0.85	0.12	0.00	0.00	0.00	0.06	0.00	0.09
Harvest	11,353	Harvest	9,230	952	3	6	0	403	0	758
n	399	Lower 90% CI	8,761	604	0	0	0	181	0	531
n_{eff}	396	Upper 90% CI	9,667	1,398	17	38	0	666	0	1,015
Year	2006	Proportion	0.84	0.12	0.00	0.01	0.00	0.00	0.01	0.03
Start Date	07/12	SD	0.02	0.02	0.00	0.01	0.00	0.00	0.01	0.01
End Date	07/31	Lower 90% CI	0.80	0.08	0.00	0.00	0.00	0.00	0.00	0.01
		Upper 90% CI	0.87	0.16	0.00	0.03	0.00	0.00	0.03	0.05
Harvest	19,815	Harvest	16,566	2,301	7	124	1	11	262	542
n	400	Lower 90% CI	15,753	1,543	0	0	0	0	55	254
n_{eff}	395	Upper 90% CI	17,324	3,115	32	634	1	59	597	896
Year	2007	Proportion	0.62	0.28	0.01	0.00	0.00	0.00	0.02	0.07
Start Date	06/18	SD	0.03	0.03	0.01	0.00	0.00	0.01	0.01	0.01
End Date	08/27	Lower 90% CI	0.58	0.24	0.00	0.00	0.00	0.00	0.00	0.04
Non-convergence[a]		Upper 90% CI	0.67	0.33	0.02	0.01	0.00	0.02	0.03	0.09
Harvest	56,854	Harvest	35,317	16,092	575	57	7	206	863	3,736
n	400	Lower 90% CI	32,751	13,495	0	0	0	0	0	2,422
n_{eff}	397	Upper 90% CI	37,867	18,718	1,321	416	5	1,343	1,859	5,166
Year	2008	Proportion	0.51	0.12	0.01	0.00	0.00	0.28	0.03	0.05
Start Date	06/16	SD	0.03	0.02	0.01	0.00	0.00	0.03	0.01	0.01
End Date	08/11	Lower 90% CI	0.46	0.08	0.00	0.00	0.00	0.24	0.01	0.04
		Upper 90% CI	0.55	0.15	0.03	0.00	0.00	0.32	0.05	0.08
Harvest	23,553	Harvest	11,939	2,711	330	12	2	6,593	676	1,290
n	400	Lower 90% CI	10,801	1,949	114	0	0	5,620	348	837
n_{eff}	396	Upper 90% CI	13,067	3,586	624	60	1	7,641	1,085	1,809

Note: Effective sample size (n_{eff}) is 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 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.

[a] Case where 1 of 3 chains produced highly divergent results – reported estimate based on 2 convergent chains.

Table 18.–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 Eastern Subdistrict Set gillnet fishery (Northern District) in 2006, 2007, and 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Year	2006	Proportion	0.00	0.06	0.11	0.08	0.01	0.19	0.39	0.17
Start Date	08/07	SD	0.00	0.03	0.02	0.03	0.01	0.03	0.03	0.03
End Date	09/14	Lower 90% CI	0.00	0.01	0.08	0.03	0.00	0.15	0.33	0.13
		Upper 90% CI	0.00	0.10	0.14	0.13	0.03	0.23	0.44	0.22
Harvest	5,527	Harvest	2	309	593	426	62	1,035	2,149	950
n	397	Lower 90% CI	0	58	430	141	0	811	1,845	716
n_{eff}	388	Upper 90% CI	12	575	773	716	160	1,278	2,457	1,197
Year	2007	Proportion	0.03	0.02	0.05	0.08	0.01	0.18	0.58	0.05
Start Date	07/02	SD	0.02	0.03	0.02	0.03	0.02	0.04	0.04	0.02
End Date	08/20	Lower 90% CI	0.00	0.00	0.02	0.04	0.00	0.12	0.51	0.02
		Upper 90% CI	0.06	0.08	0.10	0.14	0.05	0.25	0.65	0.10
Harvest	6,966	Harvest	186	111	371	581	47	1,279	4,027	363
n	200	Lower 90% CI	0	0	149	246	0	823	3,535	109
n_{eff}	198	Upper 90% CI	441	553	682	947	336	1,732	4,511	662
Year	2008	Proportion	0.00	0.13	0.15	0.06	0.04	0.30	0.20	0.11
Start Date	07/07	SD	0.01	0.04	0.02	0.03	0.01	0.03	0.03	0.02
End Date	08/18	Lower 90% CI	0.00	0.06	0.12	0.02	0.02	0.25	0.16	0.07
		Upper 90% CI	0.02	0.19	0.19	0.11	0.07	0.36	0.24	0.14
Harvest	12,221	Harvest	41	1,564	1,889	762	541	3,674	2,457	1,292
n	400	Lower 90% CI	0	788	1,496	242	273	3,000	1,959	909
n_{eff}	393	Upper 90% CI	256	2,287	2,307	1,356	865	4,357	2,979	1,714

Note: Effective sample size (n_{eff}) is 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 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 19.–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 General Subdistrict set gillnet fishery (Northern District) in 2008.

			Reporting Group							
			Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
		Proportion	0.00	0.05	0.19	0.13	0.09	0.54	0.00	0.00
Start Date	07/03	SD	0.00	0.01	0.03	0.03	0.02	0.03	0.00	0.00
End Date	08/25	Lower 90% CI	0.00	0.03	0.14	0.08	0.07	0.49	0.00	0.00
		Upper 90% CI	0.00	0.07	0.24	0.18	0.13	0.59	0.00	0.00
Harvest	8,867	Harvest	1	440	1,696	1,122	840	4,768	0	0
n	400	Lower 90% CI	0	268	1,263	725	585	4,319	0	0
n_{eff}	396	Upper 90% CI	0	640	2,115	1,589	1,120	5,211	0	0

Note: Effective sample size (n_{eff}) is 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 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 20.–Allocation proportions, standard deviation (SD), and Bayes; 90% credibility interval (CI) for mixtures of known fish removed from the baseline populations that contribute to each reporting group (proof tests).

		Reporting Group							
		Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof
Crescent	Proportion	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
n 196	SD	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Lower 90% CI	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Upper 90% CI	1.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00
West	Proportion	0.00	0.99	0.00	0.01	0.00	0.00	0.00	0.00
n 199	SD	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
	Lower 90% CI	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00
	Upper 90% CI	0.01	1.00	0.00	0.03	0.01	0.01	0.01	0.00
JCL	Proportion	0.00	0.00	0.94	0.06	0.00	0.00	0.00	0.00
n 200	SD	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00
	Lower 90% CI	0.00	0.00	0.84	0.00	0.00	0.00	0.00	0.00
	Upper 90% CI	0.00	0.00	1.00	0.15	0.00	0.00	0.00	0.00
SusYen	Proportion	0.00	0.01	0.04	0.95	0.00	0.00	0.00	0.00
n 198	SD	0.00	0.01	0.04	0.04	0.00	0.00	0.00	0.00
	Lower 90% CI	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00
	Upper 90% CI	0.00	0.04	0.11	1.00	0.00	0.01	0.00	0.00
Fish	Proportion	0.00	0.00	0.00	0.00	0.96	0.03	0.00	0.00
n 197	SD	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00
	Lower 90% CI	0.00	0.00	0.00	0.00	0.91	0.00	0.00	0.00
	Upper 90% CI	0.01	0.01	0.00	0.01	1.00	0.09	0.01	0.01
KTNE	Proportion	0.00	0.00	0.00	0.00	0.01	0.98	0.00	0.00
n 201	SD	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00
	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
	Upper 90% CI	0.00	0.00	0.01	0.01	0.04	1.00	0.00	0.00
Kenai	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.01
n 200	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00
	Upper 90% CI	0.00	0.01	0.01	0.01	0.00	0.00	1.00	0.04
Kasilof	Proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99
n 199	SD	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Lower 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98
	Upper 90% CI	0.00	0.00	0.00	0.00	0.00	0.00	0.01	1.00

Note: Proportions for a given mixture may not sum to 1 due to rounding error.

Table 21.–Stock-specific harvest, standard deviation (SD), and 90% credibility intervals calculated using a stratified estimator 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 2005, 2006, 2007, and 2008.

	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
Central District drift gillnet (excluding corridor-only periods)									
2005									
Harvest	14,216	32,236	18,981	23,291	3,599	9,443	1,404,054	116,269	19,573
SD	8,777	8,363	5,265	7,641	2,729	4,745	21,488	17,776	
Lower 90% CI	3	20,223	11,300	12,863	0	3,580	1,367,857	87,888	
Upper 90% CI	29,432	47,197	28,426	37,208	8,742	18,628	1,438,688	146,376	
Relative Error	104%	42%	45%	52%	121%	80%	3%	25%	
2006									
Harvest	146	26,229	13,616	23,690	103	6,870	191,189	102,223	6,320
SD	304	3,101	2,188	3,500	242	1,615	5,004	3,997	
Lower 90% CI	0	21,284	10,198	18,125	0	4,396	182,915	95,730	
Upper 90% CI	804	31,508	17,357	29,616	572	9,692	199,381	108,861	
Relative Error	275%	19%	26%	24%	277%	39%	4%	6%	
2007									
Harvest	12,722	73,548	102,678	80,726	6,113	46,702	1,090,269	271,988	2,184
SD	4,141	10,086	12,633	16,367	2,802	9,187	25,377	21,030	
Lower 90% CI	7,039	57,638	82,764	54,671	2,579	32,553	1,048,518	237,943	
Upper 90% CI	20,392	90,682	124,239	108,530	11,443	62,765	1,131,744	307,190	
Relative Error	52%	22%	20%	33%	72%	32%	4%	13%	

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	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
				2008					
Harvest	4,213	25,898	53,422	43,812	1,772	22,983	391,037	285,556	1,802
SD	2,004	5,291	6,478	8,044	1,443	4,724	14,493	13,509	
Lower 90% CI	1,164	17,703	43,206	31,268	0	15,669	367,041	263,527	
Upper 90% CI	7,736	35,049	64,464	57,630	4,375	31,134	414,916	308,022	
Relative Error	78%	33%	20%	30%	123%	34%	6%	8%	
				Central District drift gillnet (corridor-only periods)					
				2005					
-	-	-	-	-	-	-	-	-	859,345
				2006					
Harvest	4	152	160	412	2	233	6,795	10,925	46,228
SD	22	115	118	229	13	151	682	679	
Lower 90% CI	0	9	12	89	0	29	5,686	9,798	
Upper 90% CI	16	352	389	833	4	512	7,939	12,029	
Relative Error	212%	113%	118%	90%	114%	104%	17%	10%	
				2007					
-	-	-	-	-	-	-	-	-	131,888
				2008					
-	-	-	-	-	-	-	-	-	135,434

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	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
Central District, East Side Subdistrict set gillnet (including KRSHA set and drift gillnet)									
2005									
Harvest	352	1,116	8,197	4,456	336	5,377	1,532,433	903,666	97,199
SD	1,285	1,583	4,009	4,518	1,075	3,631	31,650	31,380	
Lower 90% CI	0	0	2,857	18	0	1,219	1,480,569	851,612	
Upper 90% CI	2,031	3,933	15,647	13,472	1,899	12,320	1,584,899	955,123	
Relative Error	288%	176%	78%	151%	283%	103%	3%	6%	
2006									
Harvest	1,145	9,362	1,194	1,448	162	7,167	367,196	1,202,888	60,131
SD	1,517	4,070	1,034	1,946	438	2,428	10,706	10,846	
Lower 90% CI	0	3,335	1	0	0	3,491	349,588	1,185,059	
Upper 90% CI	4,319	16,625	3,183	5,491	862	11,448	384,807	1,220,668	
Relative Error	189%	71%	133%	190%	266%	56%	5%	1%	
2007									
Harvest	2,314	43,214	29,481	22,389	1,880	25,326	807,268	405,904	20,290
SD	1,672	10,530	5,468	10,304	1,525	7,103	16,629	14,874	
Lower 90% CI	387	26,996	20,953	7,909	196	14,138	779,856	381,519	
Upper 90% CI	5,566	61,466	38,863	40,765	4,823	37,526	834,462	430,491	
Relative Error	112%	40%	30%	73%	123%	46%	3%	6%	

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	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
				2008					
Harvest	1,480	6,006	8,597	1,218	356	9,453	475,615	816,837	0
SD	842	2,201	2,156	1,369	353	2,874	13,564	13,597	
Lower 90% CI	409	2,924	5,450	0	1	5,652	453,684	794,088	
Upper 90% CI	3,076	10,019	12,484	4,019	898	14,919	498,277	838,931	
Relative Error	90%	59%	41%	165%	126%	49%	5%	3%	
				Central District, West Side and Kalgin Island subdistricts set gillnet					
				2005					
-	-	-	-	-	-	-	-	-	154,933
				2006					
Harvest	25,812	17,523	667	2,254	4	2,045	10,183	7,626	23,647
SD	559	1,086	302	697	28	703	991	830	
Lower 90% CI	24,871	15,769	247	1,173	0	800	8,579	6,284	
Upper 90% CI	26,705	19,345	1,216	3,461	12	3,173	11,846	9,021	
Relative Error	4%	10%	73%	51%	154%	58%	16%	18%	
				2007					
Harvest	38,778	36,331	1,571	1,147	159	929	19,422	8,835	12,799
SD	1,674	2,032	545	582	193	660	1,225	1,085	
Lower 90% CI	36,013	32,999	741	311	0	223	17,432	7,103	
Upper 90% CI	41,515	39,670	2,524	2,199	542	2,271	21,455	10,666	
Relative Error	7%	9%	57%	82%	171%	110%	10%	20%	

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	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
				2008					
Harvest	14,410	29,810	712	178	7	6,947	6,320	7,541	0
SD	896	1,220	267	272	36	656	1,046	1,036	
Lower 90% CI	12,968	27,791	316	0	0	5,910	4,629	5,943	
Upper 90% CI	15,910	31,800	1,185	764	37	8,064	8,074	9,342	
Relative Error	10%	7%	61%	214%	251%	15%	27%	23%	
				Northern District, Eastern and General subdistricts set gillnet					
				2005					
-	-	-	-	-	-	-	-	-	26,415
				2006					
Harvest	2	309	593	426	62	1,035	2,149	950	6,926
SD	12	157	104	173	53	143	186	147	
Lower 90% CI	0	58	430	141	0	811	1,845	716	
Upper 90% CI	12	575	773	716	160	1,278	2,457	1,197	
Relative Error	245%	84%	29%	67%	129%	23%	14%	25%	
				2007					
Harvest	186	111	371	581	47	1,279	4,027	363	10,501
SD	145	197	164	215	115	274	297	168	
Lower 90% CI	0	0	149	246	0	823	3,535	109	
Upper 90% CI	441	553	682	947	336	1,732	4,511	662	
Relative Error	119%	249%	72%	60%	358%	36%	12%	76%	

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	Reporting Group								
	Crescent	West	JCL	SusYen	Fish	KTNE	Kenai	Kasilof	Unanalyzed
				2008					
Harvest	42	2,004	3,585	1,884	1,381	8,442	2,458	1,292	5,142
SD	95	463	360	431	242	492	310	245	
Lower 90% CI	0	1,207	2,999	1,206	1,007	7,644	1,957	909	
Upper 90% CI	256	2,746	4,180	2,622	1,798	9,259	2,980	1,714	
Relative Error	305%	38%	16%	38%	29%	10%	21%	31%	

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

Table 22.–Stock-specific harvest, standard deviation (SD), and 90% credibility intervals calculated using a stratified estimator for all strata within years and based on genetic analysis of mixtures of sockeye salmon harvested in the Upper Cook Inlet in 2005, 2006, 2007, and 2008.

	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 22.–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%	

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 Chinitna (2005, 13 fish; 2006, 108 fish; 2007, 4 fish; 2008, 4 fish) subdistricts.

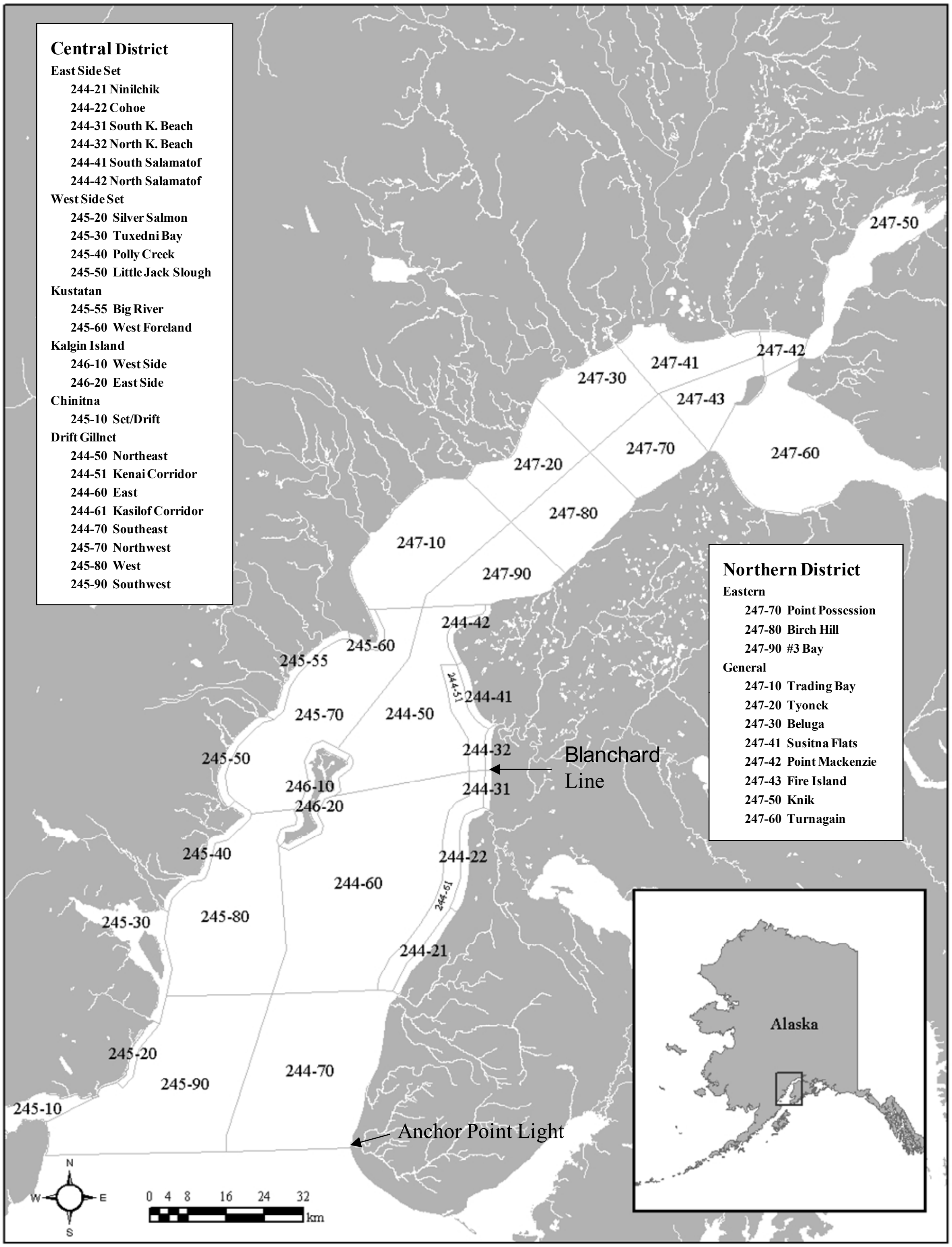


Figure 1.–Map of Upper Cook Inlet showing management fishing boundaries (statistical areas) for subdistricts, sections, and subsections within the Northern and Central Districts for both set and drift gillnet fisheries.

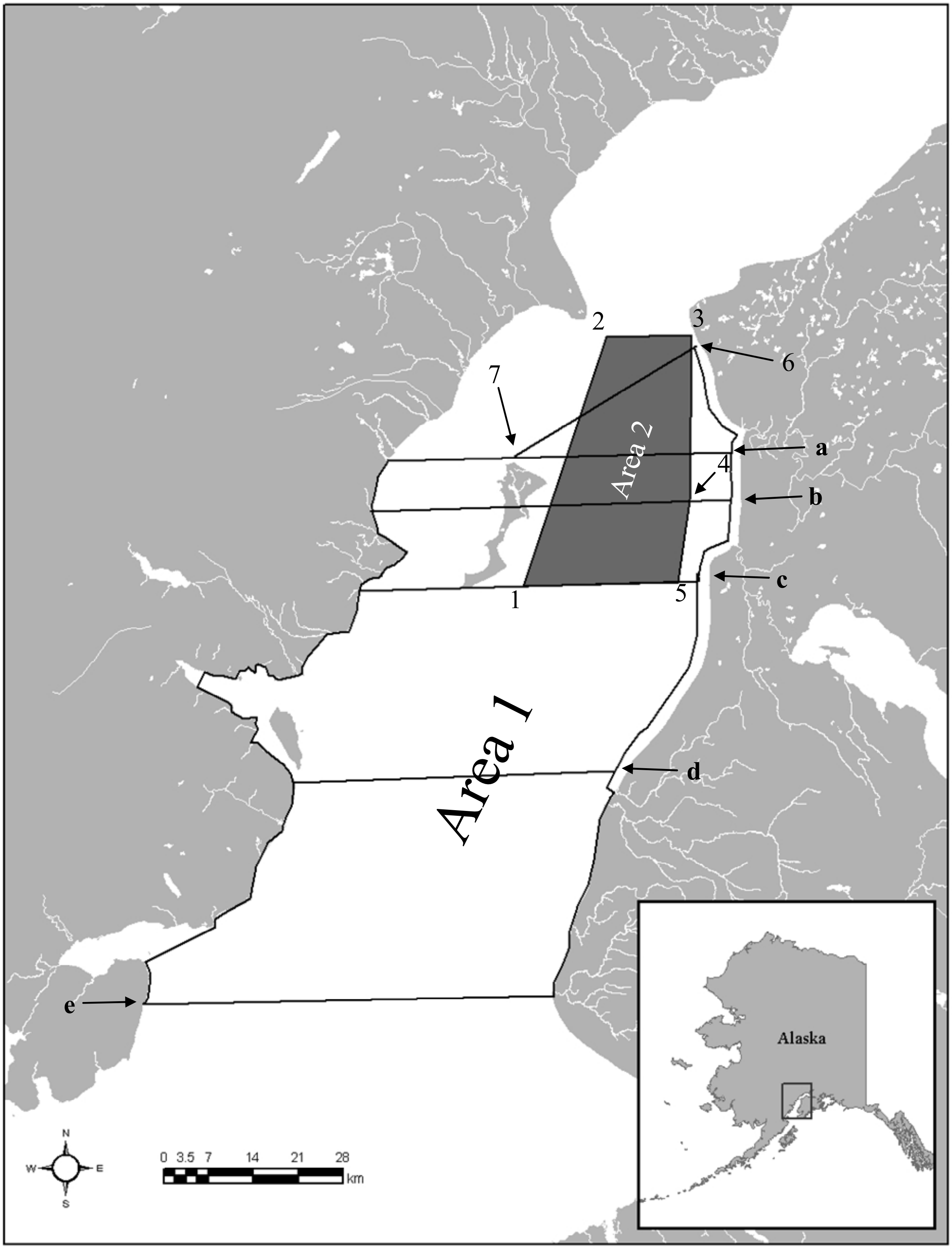


Figure 2.–Map of Upper Cook Inlet showing management fishing boundaries for the Central District drift gillnet fishery (see Table 1 for description of points [numbers] and lines [letters]).

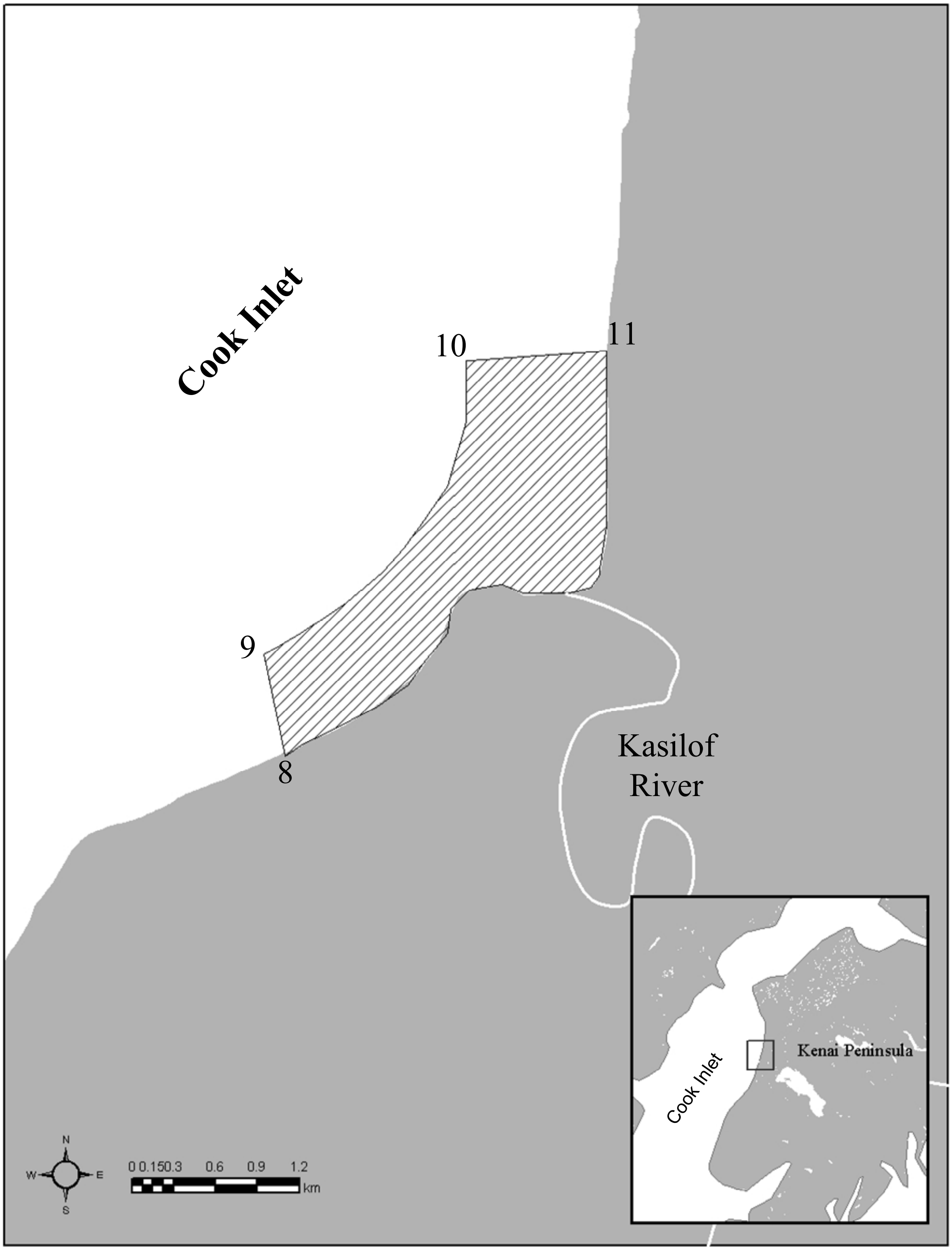


Figure 3.–Map of the mouth of the Kasilof River showing management fishing boundaries for the Kasilof River Special Harvest Area (Central District, East Side Subdistrict) (see Table 1 for description of points).

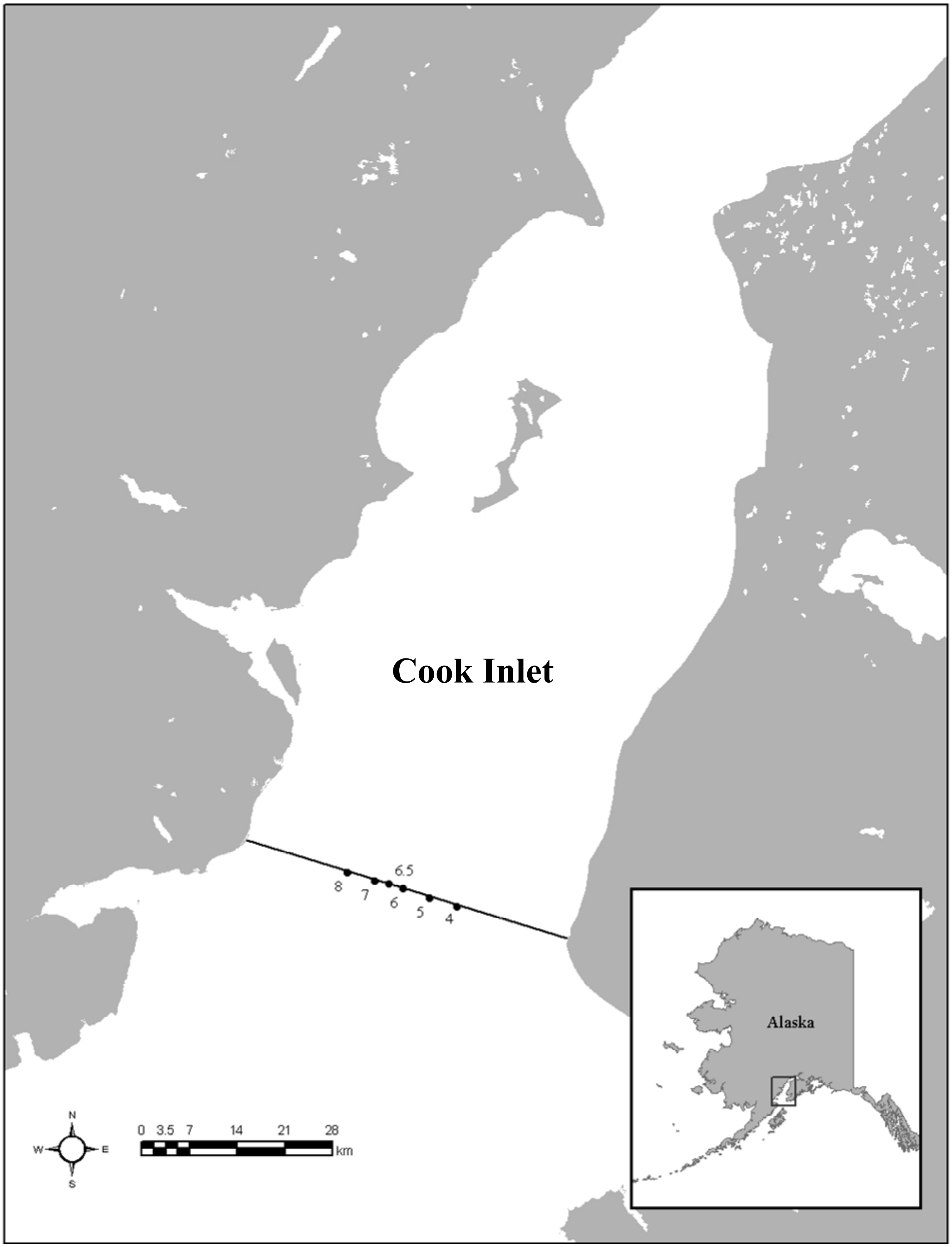


Figure 4.–Offshore test fishery stations for sockeye salmon migrating into Upper Cook Inlet, Alaska.

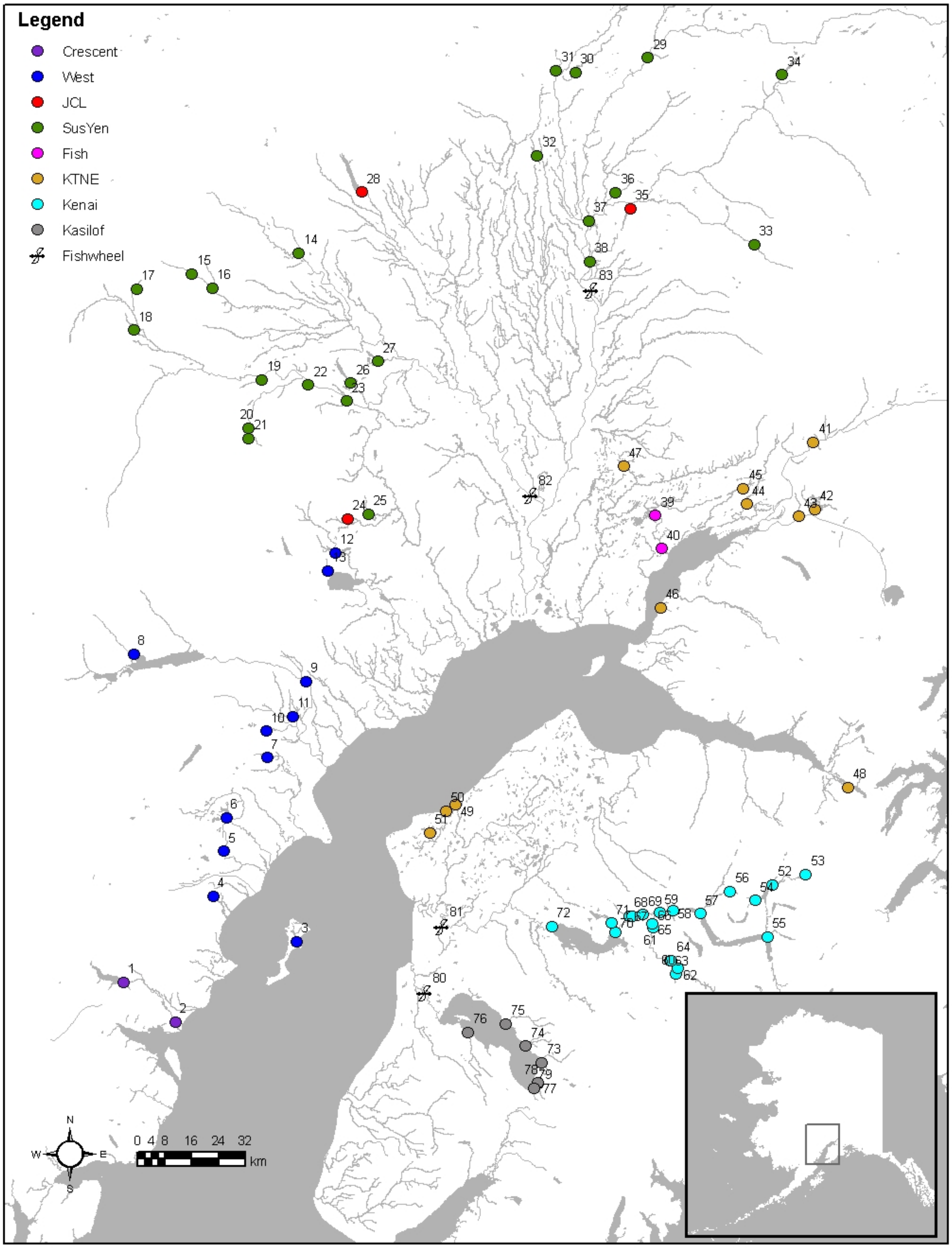
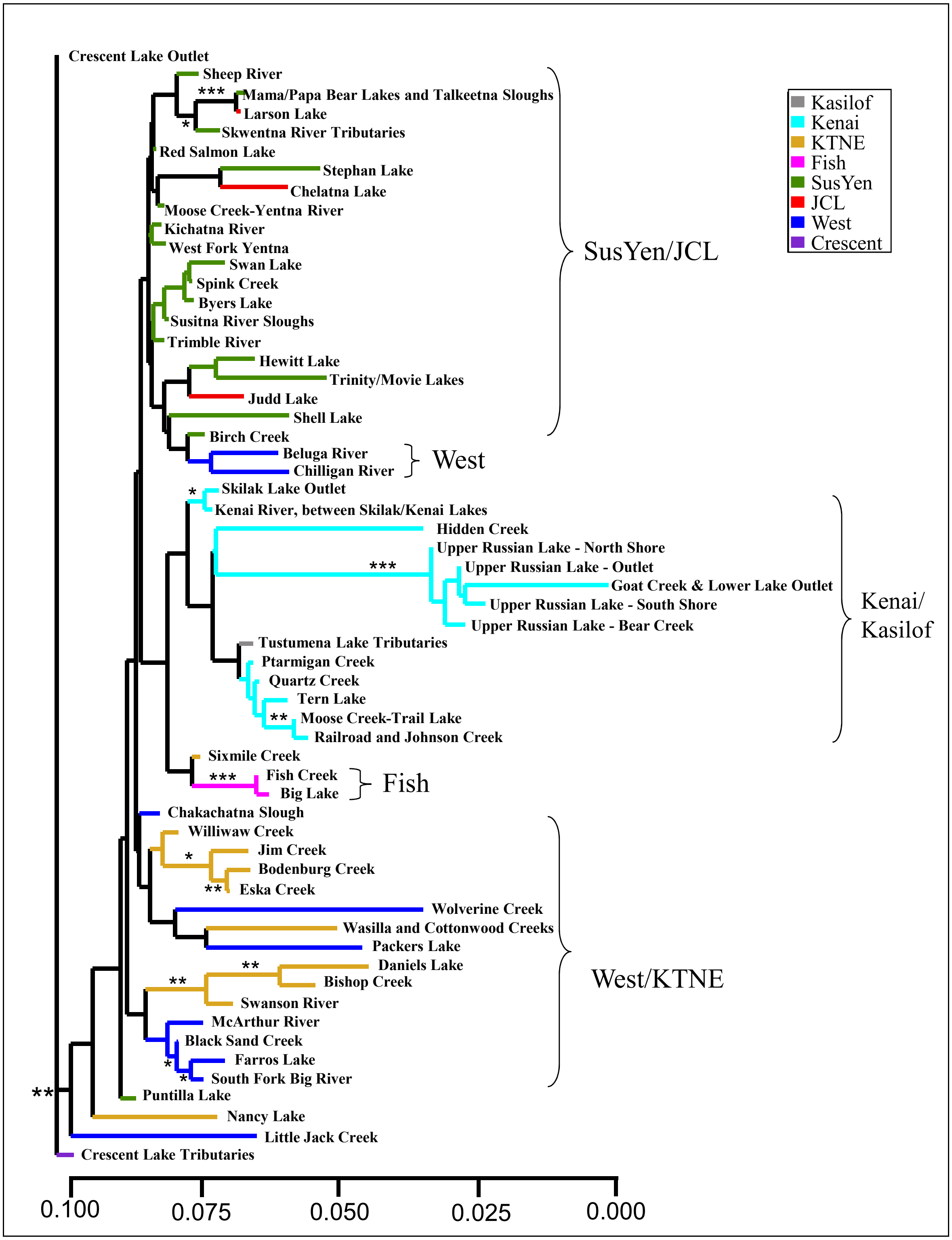


Figure 5.–Sampling locations for sockeye salmon originating for Upper Cook Inlet, Alaska, 1992-2008 used to compile a genetic baseline. Numbers correspond to map numbers on Table 2. Colors for each reporting group and symbols for fish wheels are indicated in the legend.



Note: Colors denote reporting groups as in Figure 5. Bootstrap consensus nodes: ***=95-100%; **=70-95%; *=50-70% (see text and Figure 5).

Figure 6.–Consensus N-J tree based on the Nei (1987) genetic distances between sockeye salmon populations sampled from spawning areas in drainages of Upper Cook Inlet, Alaska (see Table 2 for collection details). Population clusters within reporting groups are noted.

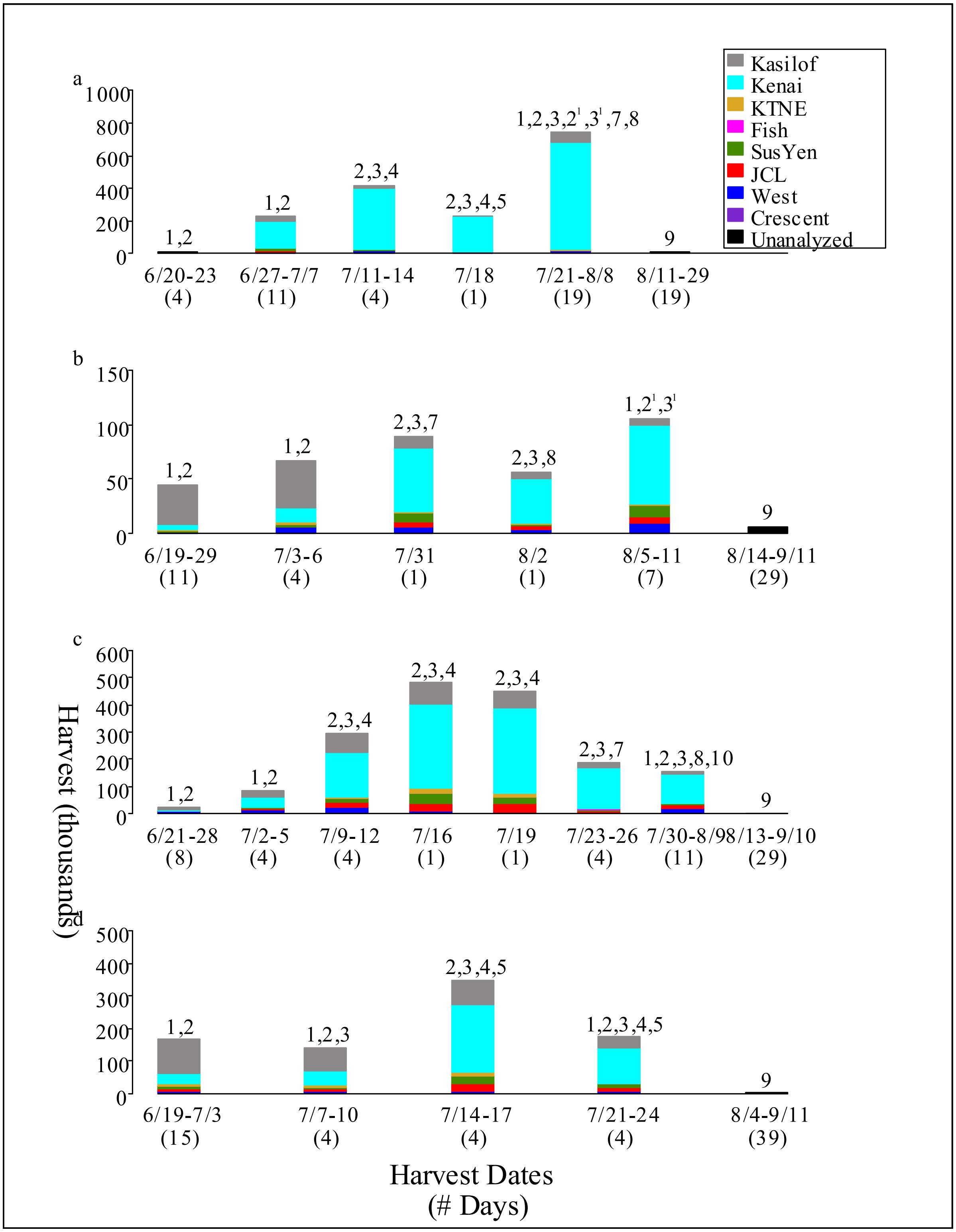


Figure 7.–Estimates of harvest by stock for the Central District drift gillnet fishery (excluding corridor-only periods) from a) 2005, b) 2006, c) 2007, and d) 2008. Numbers above the bars indicate that fisheries were restricted to particular areas (see Tables 1 and 3).

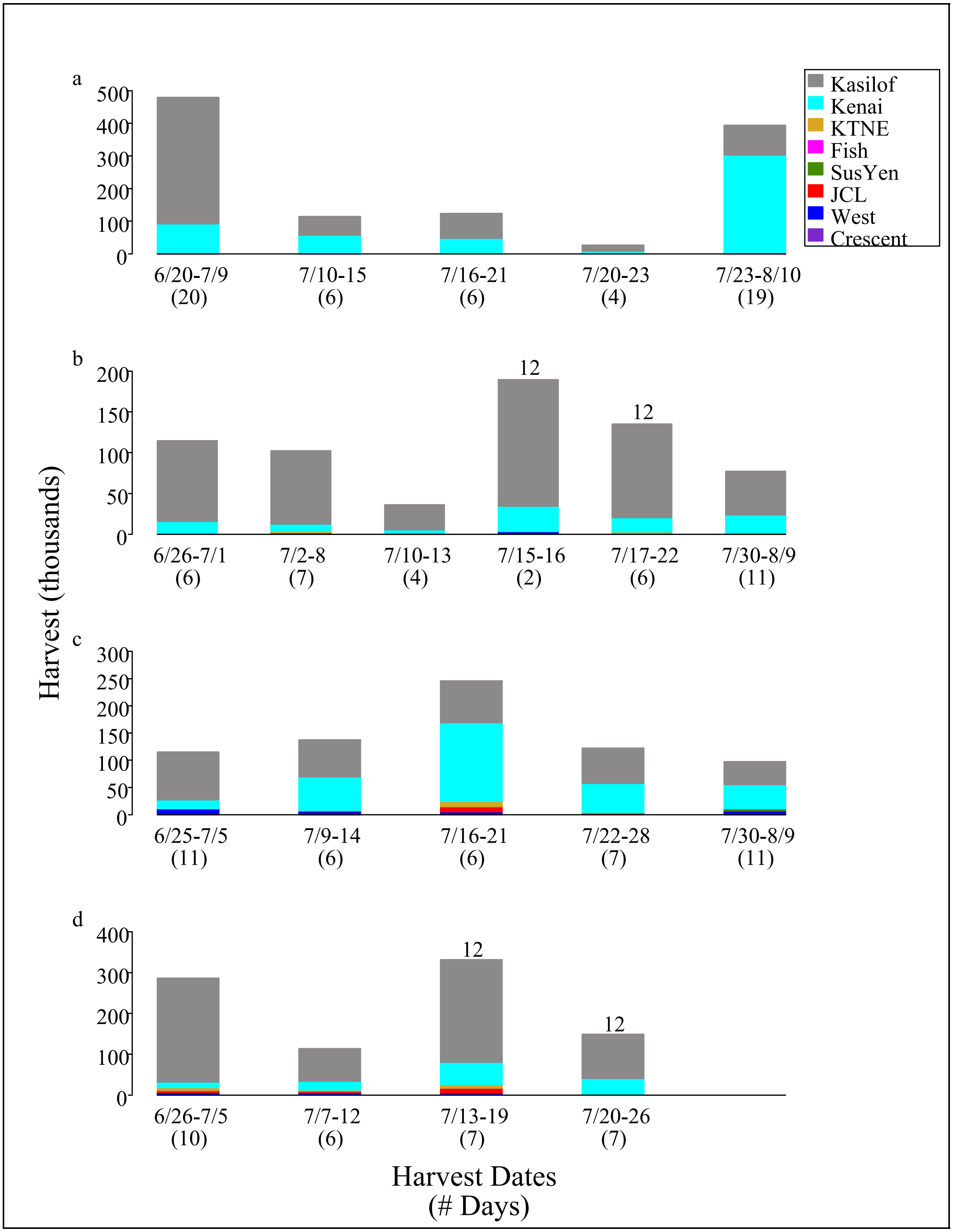


Figure 8.–Estimates of harvest by stock for the Kasilof Section set gillnet fishery (Central District, East Side Subdistrict) from a) 2005, b) 2006, c) 2007, and d) 2008. Numbers above the bars indicate that fishery restrictions during openings (see Table 1).

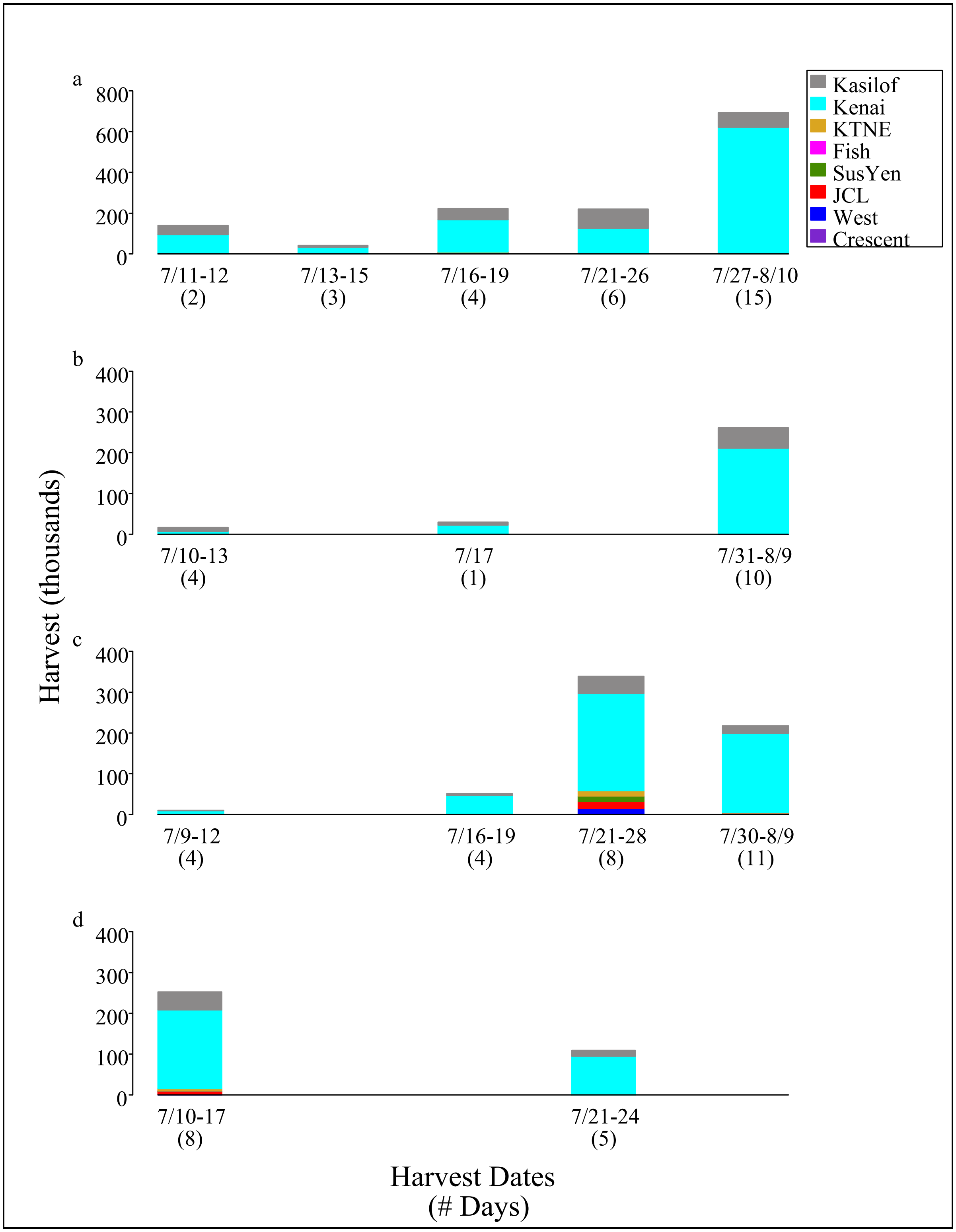
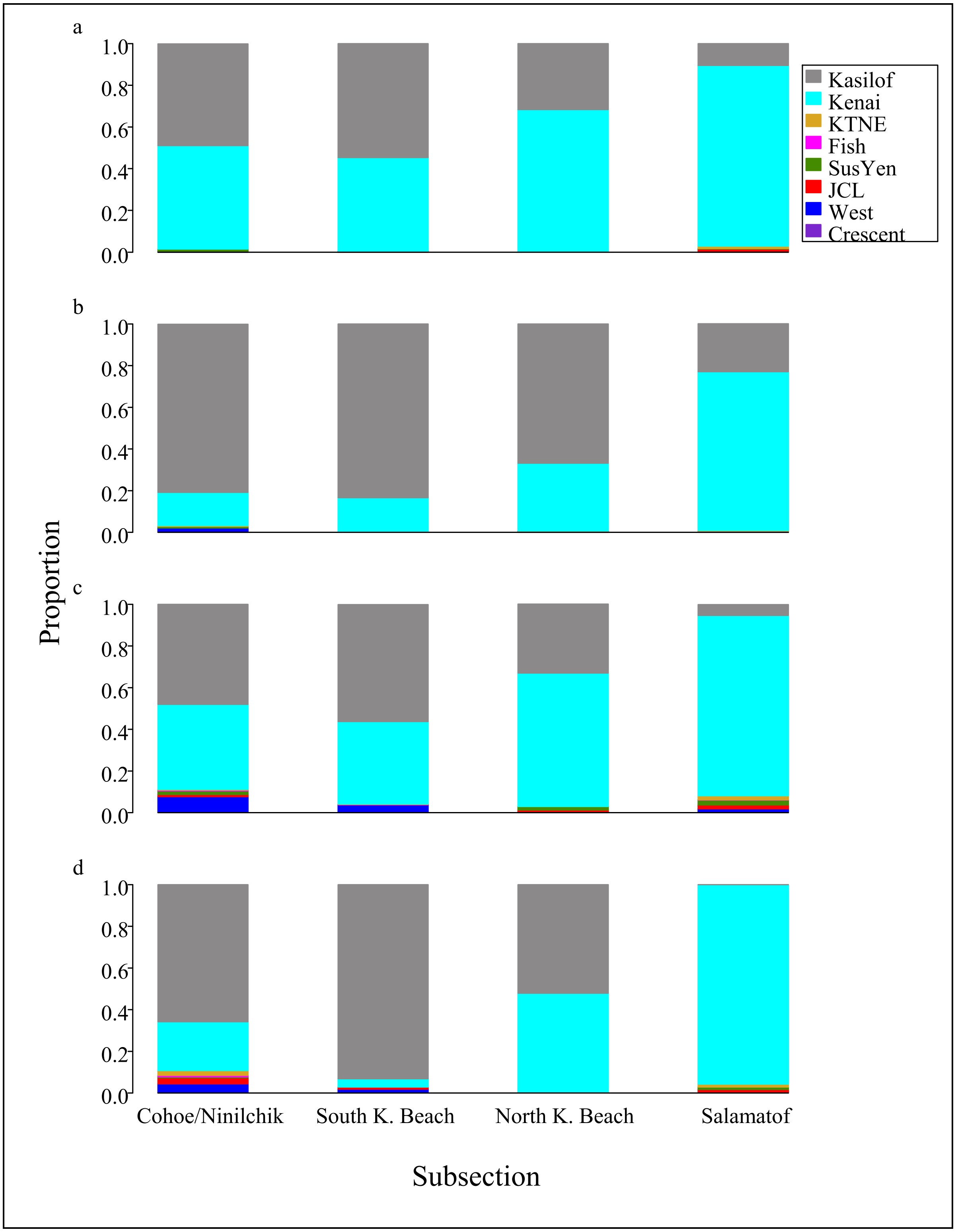


Figure 9.–Estimates of harvest by stock for the Kenai Section set gillnet fishery (Central District, East Side Subdistrict) from a) 2005, b) 2006, c) 2007, and d) 2008.



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

Figure 10.–Stock composition estimates for the Kasilof and Kenai Section set gillnet fisheries (Central District, East Side Subdistrict) divided into subsection from a) 2005, b) 2006, c) 2007, and d) 2008.