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Post-season Stock Composition Analysis of Upper Cook Inlet Sockeye Salmon Harvest, 2005-2007

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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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POST-SEASON STOCK COMPOSITION ANALYSIS OF UPPER COOK INLET SOCKEYE SALMON HARVEST, 2005-2007

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ABSTRACT

Genetic data were collected from sockeye salmon *Oncorhynchus nerka* originating from all major systems in Upper Cook Inlet, Alaska, that produce sockeye salmon. All individuals in the baseline were assayed for genotypes at 45 SNP markers. These DNA-based markers revealed population structure similar to that observed in the previous analyses with allozymes. Simulations indicated that seven regional groups (Kenai River, Susitna River, Yentna River, West Cook Inlet, Kasilof River, Northeast Cook Inlet, and Knik Arm) could be identified in mixtures at high levels of precision and accuracy. Samples taken from within the rivers at fish wheels were analyzed to evaluate the precision and accuracy possible using the baseline of new markers and statistical methods. Sockeye salmon from these drainages are commercially harvested in mixed-stock aggregations in Upper Cook Inlet. Genetic Stock Identification using Bayesian methods with data from 40 to 42 loci were performed to estimate the proportion of source populations in the harvest from set and drift gillnet fisheries during selected periods in the Central District of Upper Cook Inlet from 2005 to 2007. Samples from fisheries were analyzed postseason. Samples from the offshore test fishery were also analyzed. Patterns of stock proportions through time in the fishery were similar to results from allozyme data, indicating that Kenai River fish are present in the harvest later in the season relative to Kasilof River fish. High inter-annual variation in stock composition through space and time was detected, but this high level of variation might have been due, in part, to the unusual nature of the fishery during the 3 years investigated.

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

INTRODUCTION

BACKGROUND

Since the early 1990s the Alaska Department of Fish and Game (ADF&G) has actively developed and refined genetic stock identification (GSI; see Box 1 for definition of terms) 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 *Oncorhynchus keta*, Chinook *O. tshawystcha*, and sockeye *O. nerka* salmon (e.g. Seeb et al. 2004; Templin et al. 2005; Habicht et al. 2007). ADF&G now conducts GSI projects throughout the state and maintains extensive tissue archives from spawning populations for all three species.

One of the earliest GSI projects was initiated by ADF&G in 1992 for Cook Inlet sockeye salmon following the *Exxon Valdez* oil spill (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 the population structure of sockeye salmon in Cook Inlet using allozyme (protein) analyses (Seeb et al. 2000). The data revealed a substantial amount of genetic diversity among populations of Cook Inlet 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 GSI 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 (fish were simulated based on population-specific allele frequencies) subjected to GSI, 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 local reporting group 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 Cook Inlet sockeye salmon.

Concurrent with these fishery monitoring activities, ADF&G actively focused on research to improve the techniques of GSI, 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.

Here we report on an initiative begun in July of 2005 to apply improved GSI techniques to estimate the stock composition of sockeye salmon in Upper Cook Inlet (UCI) commercial harvests for selected periods from 2005 through 2007.

Box 1.–Definition of terms commonly used in genetic stock identification of Pacific salmon.

Allele	Alternative form of a given gene or DNA sequence.
Allozyme	Allelic form of a protein enzyme encoded at a given locus. Allozymes are usually distinguished by protein electrophoresis and histochemical staining techniques.
Locus (loci, plural)	A fixed position or region on a chromosome that may contain more than one genetic marker.
Genetic marker	A known DNA sequence that can be identified by a simple assay.
GSI	Genetic Stock Identification: Method using allele frequencies from populations and genotypes from mixture samples to estimates stock compositions of mixtures
Microsatellites	DNA sequences containing short (2–5 base pairs) tandem repeats of nucleotides (e.g. GTGTGTGT)
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.
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.

Note: adapted from Seeb et al. (2007).

IMPROVEMENTS TO GSI TECHNIQUES

Development of Genetic Markers

DNA sequence polymorphisms among individuals provide the basis for GSI. The portion of a DNA sequence that is polymorphic among individuals of a species is called a “genetic marker” (see Box 1). Assays for genetic markers have been developed to allow the inference of the DNA sequence. For example, allozyme markers reflect changes in DNA that code for the formation of protein products. Forms of the marker (alleles) are detected as a result of differences in size or charge of a protein product. Over the last 15 years, allozyme markers have been replaced by markers that directly reflect differences in DNA sequence (Schlotterer 2004). The alleles at these markers reflect either the sequence of nucleic acids in the DNA or varying lengths of particular DNA fragments. These markers have an advantage over allozymes in that they typically do not require lethal sampling, can be chosen to reflect a variety of evolutionary rates and forces, and can be readily automated for high-throughput genotyping.

In the 1990s ADF&G recognized the limitations associated with the Cook Inlet allozyme data and began to evaluate other genetic markers based on DNA as part of the *Exxon Valdez* study (Seeb et al. 1997). A wide range of DNA marker types were evaluated for sockeye salmon. Allendorf and Seeb et al. (2000) compared allozymes, microsatellites (see Box 1), randomly amplified polymorphic DNA markers (RAPDs), and mitochondrial DNA (mtDNA) for Cook Inlet sockeye salmon and found concordance in population structure identified by the different marker types.

At the same time, studies utilizing microsatellites were being conducted on Bristol Bay sockeye salmon by ADF&G (Olsen et al. 2004; Habicht et al. 2004; Habicht et al. 2007). Partially driven by the early results (Habicht et al. 2007) indicating that ADF&G's microsatellite markers might be insufficient to differentiate among some Bristol Bay sockeye salmon stocks, ADF&G began to evaluate single nucleotide polymorphisms (SNPs; Box 1), which are single-base differences at a nucleotide position in a DNA sequence. The human genome project and similar projects on other species have shown that SNPs are ubiquitous throughout the genome. Since SNPs occur throughout the genome in many species, they are likely subject to a wider range of evolutionary rates than microsatellites and are thus useful for addressing a broader range of questions (Brumfield et al. 2003; Morin et al. 2004). Because some SNPs are influenced by natural selection they are particularly valuable for GSI applications where other markers show no differences between geographically close populations. For example, Miller et al. (2001) found that apparent differences in selection for SNPs in the MHC locus resulted in strong genetic distinction between nearby populations of sockeye salmon, in contrast to observations at neutral loci. Similarly, Beacham et al. (2001) demonstrated that SNPs involved in the immune system of salmon could provide as good or better resolution for genetic stock analyses than microsatellites.

SNP applications in GSI studies of Pacific salmon have become increasingly common (Smith et al. 2005b; Smith et al. *In press*; Narum et al. *In review*). 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 in-season to estimate relative stock contributions passing through the Port Moller test fishing area, and post-season to estimate the commercial-catch stock contributions in fisheries for brood-tables used to establish escapement goals. This same set of SNPs was used in this study.

Statistical Developments

The 1990s Cook Inlet study (Seeb et al. 2000) used conditional maximum likelihood methods as reviewed in Pella and Milner (1987) and implemented in the software program SPAM (Debevec et al. 2000) to estimate the composition of stocks in mixtures. This method assumes that the baseline populations were accurately and completely represented by the baseline samples.

Research by scientists at the National Marine Fisheries Service Auke Bay Laboratories focused on the uncertainties and error associated with sampling baseline (spawning) populations used in mixture analyses (Pella and Masuda 2001). Conditional maximum likelihood methods do not use the information in the stock-mixture sample to improve the estimates of the baseline allele frequencies. Pella and Masuda (2001) and Koljonen et al. (2005) implemented Bayesian methods that incorporate the information available in the mixture to augment the information in the baseline samples to better estimate the genetic composition of the various stocks in the mixture.

Along with improvements in stock composition estimation techniques, ADF&G investigated methods to detect specific populations in mixtures (Reynolds and Templin 2004a) and to compare mixture estimates (Reynolds and Templin 2004b) using Cook Inlet sockeye salmon.

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). SNP genotypes can be assayed by a variety of methods, typically with exceedingly low error rates, 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 to measure genotyping error rates. Both of these components were used and are reviewed in this study.

MANAGEMENT OF UCI SOCKEYE

Management strategy

Sockeye 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 the abundance and 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.

In recent years the drift gillnet fleet has been restricted to a smaller portion of the district to reduce the exploitation of specific sockeye salmon stocks. These restrictions to the drift fleet can vary throughout the season and across years. During the most restrictive periods, only the Kasilof River terminal area remains open. Less restrictive periods may open areas south of the northern tip of Kalgin Island or the southern tip of Kalgin Island or the Kenai or Kasilof corridors. East Side Subdistrict (Central District) set gillnet fisheries in the Kasilof Section are also sometimes restricted to within ½ mile from the beach to reduce harvests of Kenai River stocks (Figure 1). 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 2007) and in reports to the Alaska Board of Fisheries.

ADF&G uses the catch (number of fish harvested) and escapement (number of fish allowed to spawn) estimates of sockeye salmon in UCI to manage the fisheries. Escapement is estimated with hydroacoustics (sonar) and weirs. 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 drainage or area; often the synonym ‘stock mixture’ is used) of the catch is still required to develop brood tables and estimate escapement goals for specific stocks within the area.

Since 1968, a weighted age-composition allocation method has been used to estimate the stock composition of commercial gillnet sockeye salmon harvests in UCI (Tobias and Tarbox 1999). This method is based on two primary assumptions (1) that age-specific exploitation rates are equal among stocks in the gillnet fisheries (Bernard 1983), and (2) that 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 four data sources: (1) commercial harvests, (2) escapements into major UCI river systems, (3) age composition of harvests, and (4) age composition of escapements. Beginning in 1979, side-looking sonars were used to enumerate sockeye salmon, and fish wheels were used to collect scale samples on all major river systems in UCI (Westerman and Willette 2003). Prior to 1979, uplooking sonar arrays were used on the Kasilof River, and peak ground survey counts on 23 streams were used to index escapements in the Susitna drainage. 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).

Description of Fishery 2005 to 2007

From 2005 to 2007, 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, in 2005, 2006, and 2007, sockeye salmon runs were substantially atypical. The oddity of these years is described below.

In 2005, the estimated UCI commercial harvest of 5.1 million sockeye salmon was 25% above the preseason forecast, and the total run of sockeye salmon to UCI was 44% more than the preseason forecast (Tobias and Willette *In prep*). Returns to all systems in UCI, with the exception of the Susitna River and Fish Creek, were stronger than expected in 2005. 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 half of the Susitna River run bound for the Yentna River, the escapement to the Yentna River was significantly short of the escapement goal.

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 2007). 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 to 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 to 950,000 fish. The midpoint of the run in 2006 was more than 9 days late, by far the latest run timing 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 (Tobias and Willette *In prep*). 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 Kasilof River Special Harvest Area 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 two runs were larger than other systems within the inlet, the inlet-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 run projection remained within the same tier throughout the season. This meant the inriver goal for the Kenai River remained the same (750,000 to 950,000). Although the run timing seemed normal, the migration of the fish once in the district was abnormal. For the first time since 1992 the drift fleet had back-to-back periods with a sockeye salmon catch-per-unit-effort (fish per boat per period; CPUE) 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 2nd and 5th highest in the fishery. 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 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 was never experienced.

CURRENT STUDY

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 GSI methods. The primary goal of the UCI sockeye salmon genetics project is to estimate the stock composition of the sockeye salmon harvests. Coupled with escapement estimation projects, the results will ultimately provide reliable sockeye salmon estimates of total run (catch + escapement) for brood table development and escapement goal analyses.

We report on an initiative begun in July 2005 to apply the improved GSI techniques to estimate the stock composition of harvests of UCI sockeye salmon. One of the objectives of the project was to sample fisheries across at least 3 years to provide a representation of the interannual natural variability. The current study drew heavily on collection efforts from the 1990s for tissue samples from spawning populations and inriver collections, as well as a large number of individuals collected from mixed stock fisheries and fish wheels during the period from 2005 through 2007. The application differentiates among seven major reporting groups with a high degree of accuracy and precision and elucidates patterns in the stock composition of the harvest for selected openings for the different fisheries over this 3-year period.

METHODS

TISSUE SAMPLING

Baseline

Baseline samples for SNP analysis were collected from spawning populations of sockeye salmon by ADF&G using gill nets and beach seines (Table 1; Figure 2). Most collections were made in the 1990s and reported in Seeb et al. (2000). Collections selected for inclusion in the current study represent all the populations previously identified in Seeb et al. (2000). These populations represent the known genetic diversity both geographic (location) and temporal (early- and late-spawning). Additional collections were made in 2006 from underrepresented areas. Target sample size for baseline collections was 95 individuals across all years to achieve acceptable precision for the allele frequency estimates (Allendorf and Phelps 1981; Waples 1990a).

Mixtures

Fish Wheels

Genetic samples were collected from fish captured in fish wheels operating on the Yentna, Susitna, Kenai, and Kasilof rivers in the 1990s and again in 2005. These fish wheels are all located below the spawning sites in each river (Figure 2) 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 from the offshore test fish harvests of sockeye salmon taken at six fixed stations from Anchor Point to Red River delta from July 1–August 1, 2006 and July 1-August 2, 2007 (Figure 3). Genetic samples were taken from fish harvested at each station. 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. Samples from multiple stations and dates were combined to form mixtures of 400 individuals.

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 (Figures 1 and 4–8). Temporal stratification was determined post season based on catch patterns in each fishery and the number of samples collected. In 2005, harvests were sampled in proportion to the historical average fishery harvest on each date. In 2006–2007, drift gillnet harvests were sampled in proportion to expected harvest, and set gillnet harvests were over sampled 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 sampling was conducted over 7 weeks (Table 2).

Target sample size within strata was set at 400 fish to estimate stock composition with 90% confidence of being within 5% of true stock proportions (Thompson 1987). Thompson's (1987) sample size estimator only considers uncertainty from sampling error and not uncertainty from genetic assignment error. Therefore, this expected level of precision is conservative because it assumes perfect GSI. Composite samples were constructed by combining samples from all time and area substrata to achieve this sample size goal. In 2006–2007, composite samples were constructed in proportion to actual harvests within substrata. Funding for GSI analysis of UCI sockeye salmon commercial harvests allowed for laboratory analyses of 8,000 samples per year which limited the number of stratum estimates each year. Generally, samples selected for analyses were from the earlier fishing periods (mostly from late June and July) within years.

Drift Gillnet Sampling

In 2005, most of the drift gillnet fishery sampling was conducted at Inlet Salmon's two docks located on the Kenai and Kasilof rivers. From 50 to 200 samples were taken during eight regular drift gillnet fishery openings from July 4 through July 28 (Table 2). During each sample period, 10 to 20 boats were sampled and 5 to 10 samples were collected from each boat. Overall, 63 different boats were sampled from one to four times each. We analyzed samples representing harvest from July 7 to 21 (Table 2).

In 2006–2007, drift gillnet fishery sampling was conducted at three 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 processors. During an unloading event, fish were removed from the boats, sorted, 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 the period. Icicle Seafoods had at least two tenders which collected sockeye salmon from commercial drift gillnet boats in Cook Inlet 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. 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 harvest from June 26 to July 27 in 2006 and from June 25 to July 19 in 2007 (Table 2). The July 24 to 27 openings in 2006 were restricted to the Kasilof Terminal Area (Table 2).

Set Gillnet Sampling

In 2005, set gillnet harvests were sampled in proportion to the historical average fishery harvests on each date. The East Side Subdistict (Central District) set gillnet harvests were sampled from July 4 to August 4. The West Side Subdistrict (Central District) was sampled once, and the Eastern (Northern District) and Kalgin Island (Central District) Subdistricts were sampled twice. 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 harvest from July 2 to 28 in the Kasilof Section and from July 11 to 26 in the Kenai Section (Table 2).

In 2006–2007, East Side Subdistict (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. 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 two sections were further divided into two substrata each. Each substratum was composed of one or two subsections. Kenai Section was divided into the North/South Salamatof and the

North Kalifornsky (K.) Beach substrata while the Kasilof Section was divided into the South K. Beach and the Cohoe/Ninilchik substrata (Figure 1). 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 North/South Salamatof substratum was historically three times that in the North K. Beach substratum during a specific fishery period, then the sample sizes collected from the Salamatof and North K. Beach substrata would be 300 and 100, respectively. In some years, >90% of the harvest in the Kenai Section came from the North/South Salamatof substratum, so 400 samples were collected from this substratum to provide for postseason construction of composite samples in proportion to substratum 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 to 6 buying stations near each beach (substratum), and each buying station received fish from different sites within 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. Mixtures from the Kasilof and Kenai Sections set gillnet fisheries were pooled within years and then divided into substrata to produce new mixtures for which stock composition estimates were produced. For 2006, we analyzed samples representing harvest from June 26 to July 27 in the Kasilof Section and from July 10 to 17 in the Kenai Section (Table 2). The July 24 to 27 openings were restricted to the Kasilof Terminal Area (Table 2). For 2007, we analyzed samples representing harvest from June 25 to July 21 in the Kasilof Section and from July 9 to 28 in the Kenai Section (Table 2).

Harvests from the West Side and Kalgin Island subdistricts (Central District) were sampled at Pacific Star and Inlet Salmon processors where tenders that purchase fish from these areas were unloaded the morning after each fishery period. ADF&G randomly collected 130 samples from the harvest from each fishing period in 2006 and 100 per period in 2007. None of these samples have been analyzed in the laboratory at this time.

The Kasilof Terminal Area (Central District, East Side Subdistrict) was established at the mouth of the Kasilof River to target the harvest of Kasilof River sockeye salmon (Figure 4). Genetic samples were collected from the Kasilof Terminal Area harvest in 2006 and 2007. In 2006, the combined set and drift gillnet harvest was sampled from July 17 to July 23. From July 24 to July 27, set and drift gillnet harvests were sampled separately. Only the two later collections from 2006 have been analyzed in the laboratory at this time.

Tissue Handling

Tissue samples for genetic analysis were collected from sockeye salmon without regard to size, sex, or condition. An axillary process was excised from individual fish and placed in ethanol in either individually labeled 2 ml plastic vials or deep-well plates. For data continuity, tissue samples were paired with age, sex, and length information collected from each fish. These data were collated and archived by Commercial Fisheries Division staff at the ADF&G office in Soldotna.

LABORATORY ANALYSIS

Genomic DNA was extracted using a DNeasy® 96 Tissue Kit by QIAGEN® (Valencia, CA). Forty-five sockeye SNP markers were assayed, 3 mitochondrial and 42 nuclear DNA (Table 3).

For all samples except the samples collected in 2007, SNP genotyping was performed in 384-well reaction plates. Each reaction was conducted in a 5-µL volume consisting of 0.10-µL template DNA in 0.7x TaqMan Universal Buffer (Applied Biosystems), 900 nM of each polymerase chain reaction (PCR) primer, and 200 nM of each probe. Thermal cycling was performed on a Dual 384-Well GeneAmp PCR System 9700 as follows: an initial denaturation of 10 min at 95°C followed by 50 cycles of 92° for 15 s and annealing/extension temperature for 1.0 or 1.5 min. Cycling was conducted at a ramp speed of 1°C per s. The plates were read on an Applied Biosystems (AB) Prism 7900HT Sequence Detection System after amplification and scored using AB Sequence Detection software 2.2.

For the samples collected in 2007, SNP genotyping for *One_MHC2_251* and *One_STC-410* was accomplished as described above, while genotyping of the additional 43 markers was performed using the BioMark 48.48 Dynamic Array (Fluidigm http://www.fluidigm.com/biomark_genotyping.htm). The BioMark 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 48 individual fish, and on the other are 48 inlets to accept the assays for up to 48 SNP markers. Once in the wells, the components are pressurized into the chip using the NanoFlex 4-IFC Controller. The 48 samples and 48 assays are then systematically combined into 2,304 parallel reactions. In this study, 43 assays were loaded. Each reaction was conducted in a 6.75 nL volume consisting of 1xTaqMan Universal Buffer (Applied Biosystems), 1.5 U AmpliTaq Gold DNA Polymerase (Applied Biosystems), 9 mM of each polymerase chain reaction (PCR) primer, 2 mM of each probe, 1xDA Assay Loading Buffer (Fluidigm), 12.5xROX (Invitrogen), and 0.01% Tween-20. Thermal cycling was performed on a BioMark IFC Cycler as follows: an initial denaturation of 10 min at 95°C followed by 50 cycles of 92° for 15 s and 60° for 1 min. The Dynamic Arrays were read on a BioMark Real-Time PCR System after amplification and scored using BioMark Genotyping Analysis software (Fluidigm).

Genotypes collected from both instruments were entered into the Gene Conservation Laboratory Oracle database, *LOKI*. Quality control measures included reanalysis of 8% of each collection for all markers to insure that genotypes were reproducible and to identify laboratory errors and measure rates of inconsistencies during repeated analyses. Assuming that the inconsistencies are 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.

STATISTICAL ANALYSIS

Baseline Development

Genotype distributions were tested for deviation from Hardy-Weinberg expectation (H-W), and all pairs of markers were tested for linkage disequilibrium within each collection using GENEPOP (version 3.3; updated version of Raymond and Rousset 1995). Critical values (α=0.01) were adjusted for multiple tests within collections and multiple tests across markers within collection (Rice 1989). If linkage disequilibrium was significant in more than half of the collections, we produced composite haplotypes for each fish by combining the genotypes from these markers and treated them as a single locus in further analyses. Composite haplotypes were used rather than eliminating one of the loci because, for some loci, linkage associations between alleles are not consistent across populations. Eliminating a locus would result in the loss of additional information found in the differences in association between alleles. For each fish, if the genotype for either marker was missing, then the composite-haplotype locus was excluded from further analysis. All mtDNA markers were combined into a single locus.

Collections taken at the same or adjacent sites in different years were pooled following the recommendations of Waples (1990b). Collections made at nearby locations whose fish demonstrate phenotypic similarity were tested for homogeneity using pair-wise exact tests for genetic differentiation (Goudet 1995) calculated in GENEPOP with the following Markov chain parameters: 5000 as the dememorisation number, 1,000 batches, and 1,000 iterations per batch. Collections were pooled if the exact tests indicated homogeneity (collections grouped within sites or pooled collections taken at different sites are referred to as "populations.")

Nei (1978) genetic distances between all pairs of populations were computed, and 1,000 bootstrapped neighbor-joining (N-J) trees were produced by bootstrap resampling loci using PHYLIP version 3.63 (http://evolution.gs.washington.edu/phylip.html) to visualize relationships among populations and test node concordance.

Baseline Evaluation

Simulations

Populations were assigned into seven reporting groups based on geographic structure (e.g. watersheds) and management needs; four that represented the larger drainages (Kenai, Kasilof, Yentna, and Susitna rivers) and three that represented regions with many, smaller drainages (West Cook Inlet, Knik Arm, and Northeast Cook Inlet). Populations were maintained separately within these reporting groups as recommended by Wood et al. (1987). We then assessed the potential of these reporting groups for GSI applications with 100% simulations. To do these simulations, we generated 400 fish based on the population-specific allele frequencies from all the populations within each reporting group. An equal number of fish were generated from each population within each reporting group such that the total for each mixture equaled 400 fish. This process was repeated 1,000 times, and the mean and central 90% of the distribution of estimates were reported as the estimate and the 90% confidence interval. Simulated mixtures were analyzed using SPAM version 3.7b (Debevec et al. 2000; ADF&G 2001). A critical level of 90% correct allocation was used to determine if the reporting group was acceptably identifiable.

Proof Tests

Individuals from known origins, but not included in the baseline, were used as another test of baseline performance. These tests, termed "proof tests", were performed to further examine the baseline using both maximum likelihood and Bayesian analyses. Two hundred fish were randomly sampled without replacement and removed from the baseline from each reporting group. These 200 fish were used to create mixtures that were analyzed to evaluate accuracy and precision of the reporting groups. This analysis does not assume populations are in H-W equilibrium as does the simulation analysis. The proof tests are conservative because the baseline is reduced by the removal of individuals that contribute to the mixtures and, thus, the overall number of individuals in the baseline is reduced. Proof tests allow evaluation of the baseline using both the SPAM and BAYES (Pella and Masuda 2001) methods. For BAYES, the estimation was run using a single chain without thinning with a Markov Chain Monte Carlo sample size of 10,000. Three chains were run beginning with different starting conditions. Inference was based on the posterior distribution based on a combined set of the last 5,000 steps of each chain. The mean of the posterior distribution is reported as the best estimate, and the central 90% of the distribution was reported as the 90% credibility interval. Both a SPAM prior distribution and a flat prior distribution were evaluated for accuracy and precision in the BAYES analyses. For the flat prior, the Dirichlet prior distribution parameters for stock proportions were equal (1/N). For the SPAM prior, the Dirichlet prior distribution parameters for each stock were proportional to the SPAM estimation results.

Fish Wheel Samples

Finally, we analyzed fish captured in the fish wheels operating in the Kenai, Kasilof, Yentna, and Susitna rivers as a further test of the performance of the baseline (Table 4). We used BAYES with a SPAM 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 stock composition proportions from approximately weekly samples from the offshore test fishery and all mixtures outlined in Table 2. In addition, samples from the Kenai and Kasilof sections of the set gillnet fisheries were combined within years and then split out by subsection to estimate stock composition by subsection for each year. Stock compositions for all mixture samples were estimated using BAYES with the SPAM prior, the best performing GSI method identified in the proof test analyses. Once stock compositions and their 90% credibility intervals were estimated for each time/fishery stratum, the estimates were multiplied by the harvest represented by the analyzed sample to determine the best estimate and the 90% credibility interval around the estimate. Estimates and their 90% credibility intervals were tabulated and estimates were graphically represented using stacked bar graphs for ease of interpretation.

Differences in the Baseline Among Analyses

The statistical analyses on different mixtures were performed at different times during the assembly of the baseline and, as a result, the analyses deviated in the number of collections represented by the baseline and in the number of markers screened. A reduced set of baseline collections was used in the proof tests and the fish wheel analyses, whereas all other analyses used the full baseline (Table 1). This reduced set of baseline collections resulted in a two-population reduction in the baseline, both from the Susitna reporting group. In addition, the reduced set of baseline collections reduced the sample sizes for four populations; three in the Yentna reporting group and one in the Susitna reporting group. The smallest set of loci (35 loci), was also used for the fish wheel analyses, followed by the proof tests and the 2005 and 2006 fishery mixtures (40 loci), while the 2007 fishery mixtures contained the full set of loci (42 loci; Table 3).

RESULTS

BASELINE DEVELOPMENT

Within Population Diversity

Spawning populations of sockeye salmon were collected from throughout Cook Inlet (Table 1; Figure 2). The majority of collections were made during the 1990s. Collection efforts resumed in 2006, and eight collections were made in that year. Most locations were sampled in a single year; only four were collected in multiple years. A total of 5,841 fish collected over spawning areas were analyzed for the baseline. These fish represented 68 collections taken at 62 locations throughout Cook Inlet drainages.

During quality control procedures a total of 500 fish were reanalyzed for all markers for a total of 22,500 comparisons. An inconsistency rate of 0.044% was found in the baseline data. Conformance to Hardy-Weinberg (H-W) equilibrium was tested for all collections. Over all markers and locations, 2,898 H-W tests were performed of which 23 were significant ($p < 0.01$) without the multiple test adjustment. These were spread over 17 markers with no markers out of H-W equilibrium in more than three collections. No collection was out of H-W equilibrium at more than two markers. After adjusting for multiple tests, only one collection (Six Mile Creek) was significant for only one marker (*One_MHC2_190*).

Linkage disequilibrium within each collection yielded significant results within some collections at four marker pairs (# collections before adjustment for multiple tests/# of collections after adjustment for multiple tests): *One_GPDH-201* and *One_GPDH2-187* (17/11); *One_IL8r_362* and *One_KPNA_422* (4/2); *One_MHC2_190* and *One_MHC2_251* (46/45); and *One_TF_ex11-750* and *One_TF_in3-182*(13/5). Of these, only *One_MHC2_190* and *One_MHC2_251* were significantly out of linkage equilibrium in more than half of the collections after adjustment for multiple tests (45 out of 68 collections tested). These two markers were pooled and treated as a composite-haplotype locus.

Patterns of Population Structure

A total of 59 populations were identified after pooling collections taken from similar locations over multiple years and after pooling 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 1). In two areas (between Skilak and Kenai lakes and Tustumena Lake), all collections were not pooled despite the high levels of genetic similarity observed in the N-J tree (Figure 9). The decision to keep these separate was based on field observations of discontinuous spawning between Skilak and Kenai lakes and phenotypic differentiation among spawners in Tustumena Lake (Woody et al. 2000). Between Skilak and Kenai lakes, collections from sites 1 and 2 were pooled and sites 4 and 5 were pooled, but not all sites were pooled. In collections from Tustumena Lake (Glacier Flats, Moose, Bear, Nikolai, and Seepage creeks, and sites A and B from shoals), only the sites A and B from shoals were pooled. A more complete analysis of the patterns of population structure revealed by SNPs is underway.

Genetic relationships among baseline populations are shown in the N-J tree (Figure 9). The patterns of genetic similarity between populations are consistent with those revealed by earlier studies and support a model of population structure based on the nursery lake (e.g. Seeb et al. 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.

Kasilof River populations clustered as a single group with little variation among populations, including tributary and lake-shore spawners. Juveniles from these populations all rear in Tustumena Lake.

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, a relationship previously described with allozymes. Populations spawning in the mainstem between Kenai and Skilak lakes (including the Russian River below the falls) use both lakes for their early life history and clustered together in 47% of the trees. Populations rearing in Trail Lake (Johnson, Railroad, and Moose creeks) also form a separate group. 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. All the Northeastern Cook Inlet populations clustered together with good support.

The rest of the reporting groups contained some populations that clustered and others that did not, however there were no well-supported nodes that included populations from multiple reporting groups. Some of the Northeast populations clustered below well-supported nodes: the Eska, Bodenburg and Jim creek populations in one cluster and the Big Lake, Fish and Six Mile creeks in another cluster. Nancy Lake and Cottonwood Creek populations did not cluster with any other populations.

Several well-supported nodes clustered populations spawning within the Yentna and Susitna rivers. Most of these nodes clustered geographically proximate collections including Hewitt and Whiskey lakes in the Yentna River and Mama and Papa Bear lakes, Talkeetna sloughs, and Larson Creek in the Susitna River. The one exception to this relationship between geographic proximity and clustering is the well-supported cluster that includes Trinity/Movie lakes and the Hewitt/Whiskey lakes within the Yentna River which are geographically farther apart than some of the other populations.

The West Cook Inlet reporting group had only one well-supported cluster and this cluster contained the two Crescent Lake populations. The rest of the populations in this reporting group were below nodes with little support or were highly distinct (West Fork Coal Creek and Chilligan River).

BASELINE EVALUATION

Simulations

Sets of populations were combined into seven reporting groups based on geographic structure (e.g. watersheds) and management needs. Four reporting groups represented the primary drainages (Kenai, Kasilof, Yentna, and Susitna rivers), and three groups contained populations from regions with many smaller tributaries separated by saltwater (West Cook Inlet, Knik Arm and Northeast Cook Inlet). These reporting groups are similar to those used in the allozyme analyses in Seeb et al. (2000).

Evaluating the utility of the baseline for estimating stock composition began with a series of 100% simulations to ascertain the precision and accuracy of the reporting groups. These simulations indicated that these reporting groups can be identified with an average of better than 97% accuracy (Table 5). For these simulations, even the lower bound of the confidence interval was above the 90% threshold.

Proof Tests

Analyses of fish of known origin taken out of the baseline and used as mixtures (proof tests) also demonstrated high correct allocations for every reporting group (Table 6; Figure 10). In these tests, mixtures created from 200 genotypes from a single region showed correct allocations of 90% (Susitna River) or better using SPAM. When the Bayesian methods were applied accuracy and precision improved to almost complete identifiability (99% or better correct allocation).

Fish Wheel Samples

A total of 1,330 individuals from seven collections sampled from fish captured in fish wheels were assayed for genotypes at the SNPs in the baseline. During quality control procedures a total of 112 fish were reanalyzed for all markers for a total of 5,040 comparisons. No inconsistencies were found in the mixture data. Stock composition estimates for these samples showed low (generally < 2%) contribution of populations outside the drainage where the fish wheels operated (Table 7; Figure 11). The Kenai River and Kasilof River fish wheel collections allocated above 98% to those rivers for both the samples collected in 1992–1994 and samples taken in 2005. The 1992 Yentna River fish wheel sample allocated above 99% to the Yentna River, while the 2005 sample allocated 94% to the Yentna River with most of remaining identified as coming from the Susitna River. The Susitna River fish wheel allocated 98% to Susitna River, with the remaining portion identified as coming from the Yentna River.

MIXED STOCK ANALYSIS

During quality control procedures a total of 1,378 fish were reanalyzed for all markers for a total of 62,010 comparisons. An inconsistency rate of 0.098% was found in the mixture data.

Offshore Test Fishery

A total of 3,474 fish captured in the offshore test fishery in 2006 and 2007 were successfully genotyped (Table 8; Figure 12). The sets of individuals sampled each year were divided into four periods in 2006 (1,385 individuals) and five periods in 2007 (2,089 individuals). In each of the 2 years, a consistent pattern was seen in the distribution of stocks over time; the proportion of Kasilof River sockeye salmon decreased, and the proportion of Kenai River sockeye salmon increased. The percentage of West Cook Inlet populations fluctuated between 5% and 11% with an exception of the early period in 2007 when it was 17% of the sample. The Yentna River was estimated to make up a larger portion (range: 6–15%) of the samples than the Susitna River (range: 0–7%). Northeast Cook Inlet populations were not detected in any of the test fishery samples.

Commercial Fishery Sampling

A total of 39,242 fish were sampled for tissue suitable for genetic analysis from commercial catches from throughout the Cook Inlet Central District in 2005, 2006 and 2007. These fish represented 230 individual collections. Of these fish, 12,306 fish from 102 of the collections were subsampled to create 35 mixtures for which the stock composition and stock-specific harvest were estimated (Table 9; Figures 13–22). These mixtures had sample sizes ranging between 266 and 444 fish.

Drift Gillnet

We observed a general pattern of increasing proportions of Kenai River and decreasing proportions of Kasilof River sockeye salmon in drift gillnet fishery harvests within season for each of the 3 years (Table 9). However, the estimated percentage of Kenai River sockeye salmon in drift gillnet harvests varied tremendously among years from 22–72% during the first period in July to 41–90% during the last period sampled (Table 9). For each of the 3 years of the study, estimated harvests of Kenai River sockeye salmon peaked during July 11–19. The estimated percentage of Yentna River sockeye salmon varied from 2–15%, with the peak occurring during the first period in July for all years. In 2005 and 2006 the percentage of West Cook Inlet sockeye salmon in the harvest fluctuated from 0–5%, but in 2007 this reporting group accounted for 23% of the harvest at the beginning of the season (June 25–28) before falling back to near 6% two periods later (July 9–12). During all periods, the combined contribution of the Susitna, Knik, and Northeast Cook Inlet reporting groups did not exceed 6%.

Set Gillnet

Tables 9, 11 and 12 and corresponding Figures 13–20 were based on sampling fish in proportion to catch within periods. As such, these estimates are the best estimates of stock-specific catches in the selected periods of the Central District drift, Kasilof Section set, and Kenai Section set gillnet fisheries. The analyses presented in Table 13 were designed to examine differences in the stock composition of catches in the substrata within the Kasilof and Kenai Sections and were not weighed by harvest. Because these estimates are not weighted by harvest, low-harvest periods are treated as equal with periods in which the harvest was much larger. Table 13 does provide insights on spatial patterns of stock-specific harvest within the Kenai and Kasilof Section set gillnet fishery.

Kasilof River fish dominated the harvest in the Kasilof Terminal Area (93–96%) with Kenai River sockeye salmon comprising the remainder (3–7%; Table 10; Figures 15 and 16).

Within the East Side set gillnet fishery, we did not observe a consistent pattern of decreasing abundance of Kasilof River and increasing abundance of Kenai River sockeye salmon (Tables 11 and 12; Figures 17–20). The percent of harvest for Yentna River sockeye salmon in the East Side set gillnet harvests were as follows: 1) Kenai Section on July 16–19, 2005 (3%) and July 21–28, 2007 (13%), and 2) Kasilof Section on June 25–July 5, 2007 (7%) and July 16–21, 2007 (4%). The 90% credibility intervals for these estimates did not include zero.

Further examination of stock compositions in four statistical substrata within the East Side set net fishery were performed on mixtures ranging in size from 189 to 1,335 fish. These mixtures revealed that Yentna River sockeye salmon were primarily harvested in the Cohoe/Ninilchik and North/South Salamatof substrata (Table 13; Figures 21 and 22).

DISCUSSION

This report reviews an initiative to expand and improve on earlier ADF&G studies to estimate the stock composition of sockeye salmon in Upper Cook Inlet. ADF&G focused on research to improve the techniques of GSI as applied to Cook Inlet sockeye salmon. These efforts addressed three areas: 1) development and evaluation of genetic markers for improved resolution, 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.

Here we report on the development and evaluation of the baseline and the results from harvest sampling for the period from 2005 through 2007. ADF&G anticipates that this report will be the first of a series on GSI studies in Cook Inlet.

BASELINE DEVELOPMENT

The pattern of similarity between populations revealed by these SNPs is similar to the pattern revealed by other marker types (Seeb et al. 2000; Allendorf and Seeb 2000). 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 three main groups were found: 1) Skilak and Kenai lakes, 2) Hidden, Tern, and Trail lakes, and 3) Russian Lake.

Variation is 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. 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).

Temporal stability of allele frequencies, which allows the use of baseline samples collected over many years, is typical for selectively neutral genetic markers when population sizes are large (e.g. Beacham et al. 2006; Habicht et al. 2007). In this study, the majority of baseline collections were made in the early 1990’s, or three sockeye salmon generations ago. Baseline populations sampled for this study represented the primary spawning areas from throughout the Cook Inlet drainage and represented large populations (>1,000 fish/population). General temporal stability of allele frequencies was indicated by the lack of differences among years within the few populations where samples were collected over multiple years. In addition, samples taken from fish wheels over 10 years apart allocated to rivers in which the fish wheels operated. The only allocations outside of the river in which the fish wheel operated were observed from the Yentna River to the Susitna River for the 2005 collection and vice-versa for the single Susitna collection. Four hypotheses may explain this outside-river allocation: 1) “nosing-in” of fish from the other drainage, 2) similarities between the slough spawners in the two rivers as seen in the N-J tree (Figure 9), 3) incomplete baseline coverage of slough-spawning sockeye salmon, and 4) temporal changes in allele frequencies within one or both of these rivers. These data do not resolve among these alternatives.

Currently, SNPs have been screened on 59 populations in this region with an average of 99 individuals per population. This represents an initial baseline and contains more populations but fewer fish per population than the allozyme baseline which had 54 populations with an average of 188 individuals analyzed per population. This new baseline has additional representation in the Kenai, Susitna and Yentna rivers, and Knik Arm. It is the intent of ADF&G to continue to expand the baseline to achieve greater coverage. In addition, although previously reported with allozyme markers that allele frequencies within these populations were temporally stable, 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 (Aguilar and Garza 2007).

IMPROVEMENT OF THE GSI MODEL

The new SNP data and statistical methods demonstrated a significant improvement in the performance of the GSI model from the 1990s, which was based on allozymes and maximum likelihood methods (SPAM). These DNA-based markers (SNPs) and the Bayesian estimation methods (BAYES) provided unprecedentedly high levels of accuracy and precision of the stock composition estimates (Tables 5 and 6). In the 1990s GSI was unable to clearly distinguish between contributions from the Yentna and Susitna rivers and even when these reporting groups were combined 100% simulations showed average correct allocations of 91%. The updated baseline and methods can now distinguish between the Yentna and Susitna rivers with average correct allocations above 99%.

Improvement due to marker type and statistical analysis can be measured using the fish wheel samples. In the 1990s, samples were collected from sockeye salmon captured in fish wheels as a test of the method (Seeb et al. 2000). Using the information available at that time, estimated stock compositions averaged 85% to the river in which the fish wheel operated. When some of these same samples from fish wheels were reanalyzed using the new SNP baseline and the old statistical method (SPAM), the allocations improved: 1) Kenai from 82% to 99%; 2) Yentna from 82% to 86%; 3) Susitna from 77% to 95%; and 4) Kasilof from 85% to 98% (this study; data not shown). When the Bayesian estimation method was used with the SNP data, estimates further improved to 98%, 100%, 98%, 100%, respectively (Table 7). Improvement in estimation using Bayesian statistical methods have also been observed in stock composition estimates of Atlantic salmon (Koljonen et al. 2005).

DIFFERENCES IN THE BASELINE AMONG ANALYSES

Over the course of the project there were small changes in the baseline used to complete analyses (Tables 1 and 3). The fish wheel analyses used the smallest set of loci (35 loci), followed by the proof tests and the 2005 and 2006 fishery mixtures (40 loci), while the 2007 fishery mixtures contained the full set of loci (42 loci; Table 3). In addition, the baseline contained seven fewer collections (only two fewer populations) for both the proof tests and the fish wheel analyses.

The differences in the baseline information used for the different analyses are unlikely to significantly affect the results because the differences were minor. This is supported by the results of the fish wheel analyses. If anything, the effect of using fewer SNPs and fewer populations would likely lead to conservative estimates in the performance of the fish wheels, because the fish wheels used the smallest baseline with the smallest number of loci. Even with the smaller dataset, the fish wheel analyses produced very high allocations to the river in which they operated.

DIFFERENCES IN SAMPLING DESIGNS AMONG YEARS

Four sampling design changes were implemented after the 2005 season to improve the accuracy and precision of estimates of stock composition of the commercial catch. First, in the drift gillnet fishery, we sampled at three 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 East Side set gillnet fishery 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 the East Side set gillnet harvest. Finally, since we over-sampled the set gillnet fisheries, we have additional archived samples that can be analyzed 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 Upper Cook Inlet 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 Upper Cook Inlet can be exploited at rates up to 70%. The current age-composition method for estimating stock composition 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 assessment and development of escapement goals. The primary management directive is to meet those escapement goals.

With the accuracy demonstrated for GSI, the stock composition estimates available from this project will allow an improved understanding of stock productivity as more years of data become available. To date, estimates from GSI provide the highest quality information ever available for stock compositions of the commercial harvest. But, genetic analyses of currently unanalyzed commercial fishery samples will be required before these stock composition estimates can be incorporated into brood tables. These laboratory analyses are scheduled for the near future. When GSI estimates of stock composition are available for the entire catch taken during the 3 years of this study, estimates will be compared to those obtained using the weighted age-composition catch allocation method.

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 5.5 million in 2005, 2.5 million in 2006, and 3.1 million in 2007 (Tobias and Willette *In prep*); whereas, the UCI sockeye salmon run past the offshore test fishery transect was 2 to 9 days late (Shields and Willette 2007 *In prep*) during each of the 3 years of this study (mean dates past the transect: July 21, 2005, July 24, 2006, July 17, 2007). These run strength and run timing differences produced some of the patterns observed in the stock compositions. For example, 2006 showed lower proportions of Kenai River fish in all fisheries compared with 2005 and 2007.

Within the offshore test fishery, the most prominent temporal pattern is the decreasing trend in the proportion of Kasilof River fish and an increasing trend in the proportion of Kenai River fish. This pattern might be expected based on the early run timing of the Kasilof River fish relative to Kenai River fish. This is the first analysis of the stock composition of fish captured in the offshore test fishery.

Stock composition estimates from the offshore test fishery compiled in this study can not be used to estimate total run by stocks 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 inlet (Shields and Willette 2007), this sampling protocol resulted in stock composition estimates giving 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 this bias. 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%). Test fishery and genetic data could be used to estimate total run by stock in the future, but sampling would need to begin in mid June and end in mid to late August and may need to be collected at additional stations closer to shore.

Within the Central District drift gillnet fishery, many of the patterns observed in this study were also observed by Seeb et al. (2000). For example, the general pattern of increasing proportions of Kenai and decreasing proportions of Kasilof sockeye salmon in drift gillnet fishery harvests during the season is similar to that observed by Seeb et al. (2000). 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, 1995–1996. 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.

Estimated peak harvests of Susitna/Yentna sockeye salmon in the drift gillnet fishery have generally occurred between July 10–16, but the estimated numbers of this stock taken were highly variable among years. In our study, the estimated peak harvests of Susitna/Yentna sockeye salmon in drift gillnet harvests occurred on July 11–14, 2005, July 3–6, 2006, and July 2–5, 2007 (Table 9; Figure 14). However, the drift gillnet fishery was restricted to the corridor after July 6, 2006, so the early peak date that year is not representative of harvests in the broader Central District fisheries (Figures 5–8). 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/Yentna sockeye salmon comprised an average of 7% (range 0–15%) of drift gillnet harvests. Higher estimated contributions for this stock in the 1990's 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, the estimated total harvests of Susitna/Yentna sockeye salmon were 20,154 in 2005, 10,418, 2006, and 175,827 in 2007. Variation in the numbers of Susitna/Yentna River fish captured each year was likely due to several factors. A weak run in 2005 (Tobias and Willette *In prep*) and a severely restricted fishery in 2006 (Shields 2007) were consistent with the relatively low harvests of this stock in those years. The cause for the higher proportion of Susitna/Yentna stocks in 2007 is unclear, but may be related to the abnormal run entry patterns discussed in the "Distribution of Fishery – 2005 to 2007" section of the Introduction. In addition, in 2005 and 2006, analyzed samples represented only 65% and 43% of the catch, respectively, while in 2007, the samples represented 79% of the catch (Table 2; Figure 14). Due to this restricted representation of the catches, the estimated Susitna/Yentna River fish catches represent minimum estimates of the total harvests. Further analyses of samples representing all drift gillnet fishery openings each year will be required to estimate the full harvest.

Within the Kasilof Terminal Area (Central District, East Side Subdistrict) drift and set gillnet fisheries the estimated stock composition of sockeye salmon harvested was dominated by Kasilof River fish. The high proportions of Kasilof River 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 drift (7%) than set (3%) gillnet harvests in this area (Table 10). A model based upon size and age data estimated a slightly lower percentage of Kenai sockeye salmon in the drift (3%) and set (1%) gillnet harvests in this area during this same time period.

Within the East Side Subdistrict (Central District) set gillnet fishery, we did not observe a consistent pattern of decreasing abundance of Kasilof River and increasing abundance of Kenai River sockeye salmon in July as described by Bethe et al. (1980) using scale pattern analysis (SPA). Such a pattern is somewhat evident in the Kenai Section in 2006 and in the Kasilof Section in 2005 and 2007, but it is not evident in the Kasilof Section in 2006 and the Kenai Section in 2005 and 2007. There are three potential explanations for this lack of a consistent pattern in the Kasilof Section in 2006: 1) the relatively strong Kasilof River (1.6 million) and weak Kenai River (2.5 million) sockeye salmon runs that year (Tobias and Willette *In prep*); 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 (Waltemyer 1995; Waltemyer et al. 1996); and 3) changes in fishing patterns between the 1970s and 2006.

Yentna River sockeye salmon contributed to the East Side set gillnet harvests and most of these sockeye salmon were harvested in the substrata farthest from the Kenai and Kasilof river mouths (Table 13). Since these estimated harvests of Yentna River sockeye salmon in the East Side Subdistrict set gillnet fishery were highly variable over time, it is difficult to project when or under what conditions this stock may be harvested in this fishery in the future. These results are in concordance with previous allozyme-based GSI estimates that Susitna/Yentna sockeye salmon comprised 1–6% of East Side Section set gillnet harvests (Seeb et al. 2000). The SNP GSI results support the conclusions from the SPA that Susitna/Yentna sockeye salmon have contributed 0–28% of the East Side Subdistrict set gillnet harvests (Bethe et al. 1980; Cross et al. 1986).

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 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 3 years analyzed in this project provide guidance on the range of inter-annual variability in stock compositions among the fishing strata as they are prosecuted. 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 within years and over multiple years. These specific experimental designs will likely require a combination of commercial and test fishing coupled with GSI. 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 fishers 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 the new GSI methods have the potential to resolve these issues. 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.

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TABLES AND FIGURES

Table 1.–Tissue collections of sockeye salmon in the Upper Cook Inlet genetic baseline including the year sampled and the number of individuals analyzed from each collection and their assigned reporting group for genetic stock identification.

Map No.	Pop. No.	Reporting Group	Location	Sub-location	Analysis set	Sample Year	N
1	1	West	Crescent Lake	Site 1	a,b	1994	48
1	2			Site 2	a,b	1994	47
2	3		Little Jack Creek		a,b	2006	95
3	4		Wolverine Creek		a,b	1993	95
4	5		McArthur River		a,b	1993	95
5	6		Chilligan River		a,b	1992	95
6	7		West Fork Coal Creek		a,b	1993	95
7	8		Packers Lake		a,b	1992	95
8	9	Yentna	Puntilla Lake		a,b	2006	95
9	10		Red Salmon Lake		a,b	2006	95
10	11		Shell Lake		a,b	1993	94
11	12		Judd Lake		a,b	1993	95
12	13		Trinity and Movie Lakes		a,b	1992	95
12	13				a	1993	95
13	14		Hewitt Lake		a,b	1992	49
13	14				a	2006	65
14	15		Whiskey Lake Outlet		a,b	2006	58
15	16		West Fork Yentna River slough		a,b	1992	96
15	16				a	1993	100
16	17		Chelatna Lake		a,b	1993	95
17	18	Susitna	Susitna River sloughs		a,b	1995	50
17	18				a	1996	6
17	18				a	1997	95
18	19		Byers Lake		a,b	1993	95
19	20		Swan Lake		a,b	2006	95
20	21		Stephan Lake		a,b	1993	95
21	22		Larson Creek		a,b	1993	95
22	23		Mama and Papa Bear Lakes		a	1997	50
23	24		Talkeetna River sloughs		a,b	1997	79
24	25		Birch Creek		a	1993	67
25	26	Knik	Nancy Lake		a,b	1993	95
26	27		Big Lake		a,b	1992	95
27	28		Fish Creek		a,b	1993	95
28	29		Cottonwood Creek		a,b	1993	95
29	30		Eska Creek		a,b	2006	95

-continued-

Table 1.–Page 2 of 2.

Map No.	Pop. No.	Reporting Group	Location	Sub-location	Analysis set	Sample Year	N
30	31		Bodenburg Creek		a,b	2006	95
31	32		Jim Creek		a,b	1997	95
32	33		Six Mile Creek		a,b	1997	95
33	34	Northeast	Daniels Lake		a,b	1993	95
34	35		Bishop Creek		a,b	1993	95
35	36		Swanson River		a,b	1997	95
36	37	Kenai	Johnson Creek		a,b	1997	88
37	38		Railroad Creek		a,b	1997	95
38	39		Moose Creek		a,b	1994	95
39	40		Ptarmigan Creek		a,b	1993	95
40	41		Tern Lake		a,b	1993	95
41	42		Quartz Creek		a,b	1993	95
42	43		Upper Russian River Early	Lower Lake Outlet	a,b	1992	96
43	43			Goat Creek	a,b	1997	95
42	44		Upper Russian River Late	Lower Lake Outlet	a,b	1993	95
44	45			Upper Lake Bear Creek	a,b	1997	95
45	46			Upper Lake South Shore	a,b	1999	95
46	47			Upper Lake North Shore	a,b	1999	95
48	48		Lower Russian River		a,b	1993	94
49	49		Kenai River, between Skilak	site 1	a,b	1994	47
50	49		and Kenai lakes	site 2	a,b	1994	48
51	50			site 3	a,b	1994	143
52	51			site 4	a,b	1994	48
53	51			site 5	a,b	1994	95
54	52		Hidden Creek		a,b	1993	95
55	53		Skilak Lake outlet		a,b	1992	96
56	54	Kasilof	Glacier Flats Creek		a,b	1994	95
57	55		Moose Creek		a,b	1992	96
58	56		Bear Creek		a,b	1993	95
59	57		Nikolai Creek		a,b	1992	95
60	58		Seepage Creek		a,b	1994	95
61	59		Tustumena Lake	site A	a,b	1994	48
62	59			site B	a,b	1994	48

Note: Map numbers correspond to sampling sites on Figure 2, unique population numbers represent all the collections that contribute to single population, and the analysis set denotes what collections were included and are as follows: (a) simulation and mixture analyses, and (b) proof test and fish wheel analyses.

Table 2.–Tissue collections for genetic analysis from fish captured in the Upper Cook Inlet fisheries in 2005, 2006, and 2007.

Sub-strata [a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Sample Size Analyzed	Sample Size Collected
Central District Drift Gillnet							
	1	7/4/05	63,795	7/4			100
	1	7/7/05	112,174	7/7	7/7	200	200
	1	7/11/05	244,130	7/11	7/11-14	200	200
	1	7/14/05	176,127	7/14		200	400
	2,3,4,5	7/18/05	230,353	7/18	7/18-21	200	200
	2,3,4	7/21/05	142,653	7/21		200	200
	2,3,6	7/25/05	127,842	7/25			50
	7	7/28/05	262,056	7/28			50
	2,3,7	8/1/05	38,493	8/1			50
	1	6/26/06	13,352	6/26	6/26-29	135	460
	1	6/29/06	25,083	6/29		265	448
	1	7/3/06	35,007	7/3	7/3-6	192	538
	1	7/6/06	32,491	7/6		208	600
	2,3	7/10/06	1,650	7/10	7/10-13	154	400
	2,3	7/13/06	1,544	7/13		46	152
	2,3	7/17/06	26,418	7/17	7/17	300	589
	1	7/31/06	89,680	7/31			507
	1	8/2/06	56,418	8/2-5			520
	1	8/7/06	19,154	8/7			520
	1	8/10/06	13,928	8/9-11			513
	1	6/25/07	5,658	6/25	6/25-28	109	412
	1	6/28/07	15,728	6/28		291	460
	1	7/2/07	22,201	7/2	7/2-5	105	455
	1	7/5/07	61,693	7/5		295	466
	2,3,4	7/9/07	102,853	7/9	7/9-12	156	530
	2,3,4	7/12/07	190,338	7/12		244	499
	2,3,4	7/16/07	481,878	7/16	7/16	400	611
	2,3,4	7/19/07	439,023	7/19	7/19	400	526
	2,3,6	7/23/07	127,247	7/23			460
	2,3,6	7/26/07	62,192	7/26			460
	2,3,7	7/30/07	84,275	7/30			413
	2,3,8	8/2/07	35,780	8/2			404
	2,3,8	8/6/07	15,926	8/6			368
	2,3	8/9/07	26,455	8/9			419

-continued-

Table 2.–Page 2 of 7.

Sub-strata[a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Analyzed	Collected
Kasilof Terminal Area Drift Gillnet (Central District, East Side Subdistrict)							
	9	7/24/06	118,160	7/24	7/24-27	187	200
	9	7/25/06	54,078	7/25		56	200
	9	7/26/06	14,196	7/26		21	100
	9	7/27/06	16,432	7/27		36	200
Kasilof Terminal Area Drift/Set Gillnet (Central District, East Side Subdistrict)							
	9	7/17/06	21,094	7/16-17			100
	9	7/19/06	4,651	7/18-19			100
	9	7/20/06	36,275	7/20			100
	9	7/22/06	21,929	7/21-22			100
	9	7/23/06	39,415	7/23			100
	9	7/27/07	3,464	7/27			100
Kasilof Terminal Area Set Gillnet (Central District, East Side Subdistrict)							
	9	7/24/06	68,098	7/24	7/24-27	182	200
	9	7/25/06	51,187	7/25		93	200
	9	7/26/06	24,493	7/26		51	100
	9	7/27/06	21,739	7/27		74	200
Kasilof Section Set Gillnet (Central District, East Side Subdistrict)							
a	1	7/4/05	62,603	7/2-4	7/2-9	50	50
b	1	7/4/05	29,881	7/2-4		50	50
a	1	7/7/05	58,873	7/6-9		50	50
b	1	7/7/05	26,398	7/6-9		50	50
a	1	7/11/05	71,035	7/11-15	7/11-15	50	50
b	1	7/11/05	27,858	7/11-12		200	200
b	1	7/14/05	15,253	7/13-15		156	156
a	1	7/18/05	63,369	7/16-21	7/16-18	50	50
b	1	7/18/05	50,641	7/16-18		200	200
b	1	7/21/05	21,824	7/19-21	7/19-28	200	200
a	1	7/25/05	154,327	7/23-28		50	50
b	1	7/25/05	47,054	7/23-26		50	50
b	1	7/28/05	41,644	7/27-31			50
a	1	8/1/05	95,176	7/30-8/4			50
b	1	8/4/05	36,597	8/1-7			50
a	1	6/26/06	19,285	6/26	6/26-7/1	66	200
b	1	6/26/06	8,270	6/26		81	100
a	1	6/29/06	57,478	6/29-7/1		193	200
b	1	6/29/06	29,772	6/29-7/1		60	60

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Table 2.–Page 3 of 7.

Sub-strata[a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Analyzed	Collected
a	1	7/3/06	17,752	7/2-3		67	200
b	1	7/3/06	6,992	7/2-3	7/2-8	44	130
a	1	7/6/06	45,909	7/6-8		169	200
b	1	7/6/06	31,858	7/6-8		120	120
a	1	7/10/06	13,979	7/10		142	200
b	1	7/10/06	3,290	7/10	7/10-13	34	200
a	1	7/13/06	15,984	7/12-13		200	200
b	1	7/13/06	2,840	7/12-13		24	67
a	10	7/15/06	80,250	7/15		177	300
b	10	7/15/06	63,467	7/15	7/15-16	131	250
a	10	7/16/06	45,690	7/16		92	200
a	1	7/17/06	17,110	7/17		50	200
b	1	7/17/06	10,701	7/17	7/17-22	27	200
a	10	7/20/06	54,600	7/19-22		179	200
b	10	7/20/06	52,781	7/19-22		144	210
a	1	7/31/06	9,906	7/31-8/1			130
b	1	7/31/06	10,461	7/31-8/1			130
a	1	8/2/06	14,334	8/2-5			130
b	1	8/2/06	26,145	8/2-5			130
a	1	8/7/06	4,707	8/6-9			200
b	1	8/7/06	11,767	8/6-9			130
a	1	6/25/07	6,466	6/25		23	200
b	1	6/25/07	1,901	6/25		7	118
a	1	6/28/07	45,499	6/28-30		160	200
b	1	6/28/07	9,525	6/28-30	6/25-7/5	35	130
a	1	7/2/07	16,501	7/2		58	200
b	1	7/2/07	2,516	7/2		9	130
a	1	7/5/07	26,545	7/4-5		93	200
b	1	7/5/07	4,661	7/4		15	130
a	1	7/9/07	76,393	7/9		170	200
b	1	7/9/07	3,291	7/9	7/9-12	17	188
a	1	7/12/07	42,464	7/11-12		95	200
b	1	7/12/07	12,527	7/11-12		18	200
a	1	7/16/07	57,649	7/16		97	250
b	1	7/16/07	27,218	7/16	7/16-21	46	187
a	1	7/19/07	115,143	7/18-21		193	250
b	1	7/19/07	38,127	7/18-21		64	200
a	1	7/23/07	45,486	7/22-23			250
b	1	7/23/07	23,371	7/22-23			200
a	1	7/26/07	28,088	7/25-28			200

-continued-

Table 2.–Page 4 of 7.

Sub-strata[a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Analyzed	Collected
b	1	7/26/07	23,639	7/25-28			200
a	1	7/30/07	18,739	7/30-31			130
b	1	7/30/07	12,452	7/30-31			130
a	1	8/2/07	11,090	8/2-5			130
b	1	8/2/07	4,775	8/2-5			130
a	1	8/6/07	16,187	8/5-7			130
b	1	8/6/07	6,648	8/5-7			130
a	1	8/9/07	10,446	8/8-9			130
b	1	8/9/07	8,864	8/8-9			130
Kenai Section Set Gillnet (Central District, East Side Subdistrict)							
c	1	7/11/05	40,134	7/11-12	7/11-12	200	200
d	1	7/11/05	100,348	7/11-12		50	50
c	1	7/14/05	14,712	7/13-14	7/13-14	200	200
d	1	7/14/05	27,137	7/13-14		50	50
c	1	7/18/05	92,841	7/16-19	7/16-19	200	200
d	1	7/18/05	129,636	7/16-19		50	50
c	1	7/21/05	27,702	7/20-23	7/20-26	200	200
d	1	7/21/05	229,936	7/20-24		50	50
c	1	7/25/05	22,676	7/24-26		50	50
c	1	7/28/05	27,630	7/27-30			50
d	1	7/28/05	190,259	7/25-31			50
c	1	8/1/05	25,298	7/31-8/1			50
c	1	8/4/05	34,905	8/3-7			50
d	1	8/4/05	197,568	8/1-7			50
c	1	7/10/06	2,833	7/10	7/10-13	67	200
d	1	7/10/06	6,960	7/10		165	403
c	1	7/13/06	975	7/13		25	106
d	1	7/13/06	6,058	7/13		143	272
c	1	7/17/06	7,939	7/17	7/17	97	200
d	1	7/17/06	21,789	7/17		303	400
c	1	7/31/06	18,026	7/31-8/1			130
d	1	7/31/06	82,070	7/31-8/1			130
c	1	8/2/06	29,488	8/2-5			130
d	1	8/2/06	77,670	8/2-5			130
c	1	8/7/06	12,468	8/6-9			130
d	1	8/7/06	41,550	8/6-9			200

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Table 2.–Page 5 of 7.

Sub-strata[a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Analyzed	Collected
c	1	7/9/07	1,652	7/9	7/9-12	62	100
d	1	7/9/07	5,106	7/9		193	300
c	1	7/12/07	795	7/12		30	100
d	1	7/12/07	3,033	7/12		115	300
c	1	7/16/07	1,351	7/16	7/16-19	10	100
d	1	7/16/07	8,272	7/16		64	300
c	1	7/19/07	5,139	7/19		40	100
d	1	7/19/07	37,093	7/19		286	300
c	1	7/23/07	25,867	7/21-23	7/21-28	30	100
d	1	7/23/07	183,402	7/21-23		215	350
c	1	7/26/07	26,204	7/26-28		31	100
d	1	7/26/07	105,336	7/26-28		124	300
c	1	7/30/07	14,061	7/30-31			130
d	1	7/30/07	54,201	7/30-31			130
c	1	8/2/07	4,323	8/1-2			130
d	1	8/2/07	43,823	8/1-2			130
c	1	8/6/07	10,041	8/5-7			130
d	1	8/6/07	45,861	8/5-7			130
c	1	8/9/07	8,152	8/8-9			130
d	1	8/9/07	29,934	8/8-9			130
		Kalgin Island Subdistrict Set Gillnet (Central District)					
	1	8/6/05	36,467	8/4-11			100
	1	6/26/06	2,867	6/23-26			109
	1	6/29/06	1,291	6/29			117
	1	7/3/06	1,375	7/3			100
	1	7/6/06	560	7/6			77
	1	7/10/06	861	7/10			112
	1	7/13/06	471	7/13			53
	1	7/17/06	1,656	7/17			101
	1	7/20/06	1,434	7/20			112
	1	7/24/06	3,271	7/24			118
	1	7/27/06	2,690	7/27			80
	1	7/31/06	4,503	7/31-8/1			85
	1	8/3/06	4,130	8/3			93
	1	8/10/06	6,106	8/7-10			100
	1	8/16/06	3,731	8/14-17			100
	1	6/25/07	2,754	6/22-25			100
	1	6/28/07	2,364	6/28			100
	1	7/2/07	2,642	7/2			100
	1	7/5/07	2,894	7/5			100

-continued-

Table 2.–Page 6 of 7.

Sub-strata[a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Analyzed	Collected
	1	7/9/07	2,461	7/9			100
	1	7/12/07	1,395	7/12			100
	1	7/16/07	575	7/16			85
	1	7/19/07	3,148	7/19			100
	1	7/23/07	4,596	7/23			100
	1	7/26/07	5,196	7/26			100
	1	7/29/07	4,596	7/29-31			100
	1	8/2/07	3,533	8/2			100
	1	8/6/07	2,234	8/6			100
	1	8/9/07	8,809	8/9-13			100
Western Subdistrict Set Gillnet (Central District)							
	1	7/11/05 7/21/05	12,127	7/11-21			100
	1	6/26/06	810	6/19-26			132
	1	6/29/06	2,137	6/29-7/1			128
	1	7/3/06	2,682	7/3			116
	1	7/6/06	2,444	7/5-6			100
	1	7/10/06	3,280	7/8-10			102
	1	7/13/06	4,477	7/12-13			108
	1	7/17/06	3,764	7/17-18			83
	1	7/20/06	5,151	7/20-22			119
	1	7/24/06	1,492	7/23-25			105
	1	7/27/06	3,236	7/26-27			85
	1	7/31/06	1,695	7/29-31			46
	1	6/25/07	2,666	6/18-25			100
	1	6/28/07	1,926	6/28			100
	1	7/2/07	3,592	7/1-2			100
	1	7/9/07	5,709	7/7-9			100
	1	7/5/07	5,951	7/4-5			100
	1	7/12/07	6,465	7/10-13			100
	1	7/16/07	2,510	7/14-16			100
	1	7/19/07	8,639	7/18-20			100
	1	7/23/07	4,540	7/21-23			100
	1	7/26/07	6,287	7/25-26			100
	1	7/30/07	2,167	7/27-30			100
	1	8/2/07	1,704	8/2-6			100
	1	8/9/07	3,675	8/9-20			100
Eastern Subdistrict Set Gillnet (Northern District)							
	1	7/14/05 7/18/05	2,396	7/14-18			100
	1	7/3/06	463	7/3			50

-continued-

Table 2.–Page 7 of 7.

Sub-strata[a]	Restrictions[b]	Date(s) Sampled	Harvest Represented	Harvest Dates Represented	Mixture Date(s)	Analyzed	Collected
	1	7/6/06	619	7/6			40
	1	8/7/06	713	8/7			250
	1	8/10/06	696	8/10			198
	1	7/2/07	326	7/2			33
	1	7/5/07	419	7/5			40
	1	7/9/07	393	7/9			40
	1	7/12/07	222	7/12			28
	1	7/16/07	229	7/16			40
	1	7/19/07	1,466	7/19			40
	1	7/23/07	1,280	7/23			40
	1	8/9/07	2,138	8/9-20			80
General Subdistrict Set Gillnet (Northern District)							
	1	7/18/05	3,250	7/18			30

Note: Corresponding restrictions to the fisheries and substrata are provided when applicable.

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

[b] (see Figures 1 and 4–8) 1-No Restrictions; 2-Kasilof Corridor; 3-Kenai Corridor; 4-Area 1; 5-Area 2; 6-South of Blanchard line; 7-South of north end of Kalgin Island; 8-South of a line from Collier's Dock / Northwest Point on Kalgin Island / Latitude 60.5208°N to western shore; 9-Kasilof Terminal Area; 10-within 1/2 mile of shore.

Table 3.–Forty five single nucleotide polymorphism markers used for this project with subsets noted for each analysis.

Marker	Marker Set [a]	mtDNA	Linked Markers	H_s	F_{st}	Reference [b]
One_ACBP-79	1,2,3			0.429	0.139	A
One_ALDOB-135	1,2,3			0.219	0.099	A
One_CO1	1,2,3	yes		NA	NA	A
One_ctgf-301	1,2,3			0.066	0.035	A
One_Cytb_17	1,2,3	yes		NA	NA	A
One_Cytb_26	1,2,3	yes		NA	NA	A
One_E2-65	1,2,3			0.359	0.166	B
One_GHII-2165	1,2,3			0.239	0.152	A
One_GPDH-201	1,2,3			0.463	0.067	B
One_GPDH2-187	1,2,3			0.177	0.096	B
One_GPH-414	1,2,3			0.399	0.067	A
One_hsc71-220	1,2,3			0.286	0.146	A
One_HGFA-49	1,2,3			0.260	0.097	B
One_HpaI-71	1,2,3			0.352	0.103	A
One_HpaI-99	1,2,3			0.139	0.121	A
One_IL8r-362	1,2			0.097	0.206	C
One_KPNA-422	1,2,3			0.260	0.118	A
One_LEI-87	1,2,3			0.448	0.091	A
One_MARCKS-241	1,2,3			0.051	0.096	C
One_MHC2_190	1,2,3		1	NA	NA	A
One_MHC2_251	1,2,3		1	NA	NA	A
One_Ots213-181	1,2,3			0.226	0.060	A
One_p53-534	1,2,3			0.065	0.242	A
One_ins-107	1,2,3			0.429	0.108	B
One_Prl2	1,2,3			0.452	0.094	A
One_RAG1-103	1,2,3			0.085	0.131	A
One_RAG3-93	1,2,3			0.111	0.080	A
One_RFC2-102	1,2,3			0.331	0.145	B
One_RFC2-285	1,2,3			0.080	0.105	B
One_RH2op-395	2,3			0.001	0.002	A
One_serpin-75	1,2,3			0.045	0.178	B
One_STC-410	1,2,3			0.314	0.230	A
One_STR07	1,2,3			0.344	0.158	A
One_Tf_ex11-750	1,2,3			0.355	0.169	A

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Table 3.–Page 2 of 2.

Marker	Marker Set [a]	mtDNA	Linked markers	Hs	Fst (W&C)	Reference [b]
One_Tf_in3-182	1,2,3			0.046	0.101	A
One_U301_92	2,3			0.265	0.083	A
One_U401-224	1,2,3			0.457	0.082	C
One_U404-229	1,2			0.037	0.097	C
One_U502-167	2			0.049	0.065	C
One_U503-170	1,2			0.143	0.077	C
One_U504-141	1,2			0.394	0.088	C
One_U508-533	1,2			0.091	0.281	C
One_VIM-569	1,2,3			0.228	0.132	A
One_ZNF-61	1,2			0.276	0.182	C
One_Zp3b-49	1,2,3			0.144	0.392	B

Note: Expected heterozygosity (Hs) and Fst 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 GSI analyses.

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

[b] A) Elfstrom et al. (2006); B) Smith et al. (2005a); C) ADF&G unpublished data.

Table 4.–Tissue collections of sockeye salmon sampled for genetic studies taken from fish captured in fish wheels operated within four of the major drainages into Cook Inlet, Alaska.

Map No.	River	Location	Date	N
101	Kasilof	Kasilof River (fish wheel, rkm 11.3)	7/22/1992-7/23/1992	190
			7/11/2005-7/20/2005	190
102	Kenai	Kenai River (fish wheel, rkm 30.6)	7/31/1994-8/1/1994	190
			7/11/2005-7/20/2005	190
103	Yentna	Yentna River (fish wheel, rkm 6.5)	7/15/1992	190
			7/9/2005-8/12/2005	190
104	Susitna	Susitna River (Sunshine fish wheel, rkm 116)	7/26/1992	190

Note: Map numbers correspond to fish wheel sites on Figure 2.

Table 5.–Allocation proportions (90% confidence interval) for mixtures of simulated fish that originate from all populations that contribute to each reporting group (100% simulations).

Reporting Group	West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
West	**0.97**	0.01	0.01	0.00	0.00	0.01	0.00
	(0.95 - 0.99)	(0.00 - 0.03)	(0.00 - 0.02)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)
Yentna	0.00	**0.98**	0.02	0.00	0.00	0.00	0.00
	(0.00 - 0.01)	(0.95 - 0.99)	(0.00 - 0.04)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)
Susitna	0.00	0.02	**0.97**	0.00	0.00	0.00	0.00
	(0.00 - 0.01)	(0.00 - 0.04)	(0.94 - 0.99)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.01)
Knik	0.00	0.00	0.00	**0.99**	0.00	0.00	0.00
	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.98 - 1.00)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.01)
Northeast	0.00	0.00	0.00	0.00	**0.99**	0.00	0.00
	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.97 - 1.00)	(0.00 - 0.01)	(0.00 - 0.00)
Kenai	0.00	0.00	0.00	0.00	0.00	**0.98**	0.01
	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.97 - 1.00)	(0.00 - 0.03)
Kasilof	0.00	0.00	0.00	0.00	0.00	0.02	**0.98**
	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.04)	(0.96 - 1.00)

Note: Baseline frequencies from SNP loci were used to generate the simulated fish used in the mixtures. Mixed stock analyses were performed using SPAM.

Table 6.–Allocation proportions (SPAM; 90% confidence interval, BAYES; 90% credibility interval in parentheses) for mixtures of 200 known fish that were removed from the baseline populations that contribute to each reporting group (proof tests).

Reporting Group	West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
				SPAM			
West	**0.94**	0.05	0.01	0.00	0.00	0.00	0.00
	(0.87 - 1.00)	(0.04 - 0.06)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.05)	(0.00 - 0.01)
Yentna	0.00	**1.00**	0.00	0.00	0.00	0.00	0.00
	(0.00 - 0.01)	(0.94 - 1.00)	(0.00 - 0.07)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)
Susitna	0.01	0.05	**0.92**	0.00	0.00	0.02	0.00
	(0.00 - 0.02)	(0.04 - 0.06)	(0.86 - 0.98)	(0.00 - 0.00)	(0.00 - 0.01)	(0.02 - 0.02)	(0.00 - 0.01)
Knik	0.00	0.01	0.00	**0.97**	0.01	0.01	0.00
	(0.00 - 0.04)	(0.00 - 0.01)	(0.00 - 0.01)	(0.91 - 1.00)	(0.00 - 0.02)	(0.01 - 0.02)	(0.00 - 0.01)
Northeast	0.02	0.03	0.00	0.04	**0.90**	0.02	0.00
	(0.00 - 0.03)	(0.02 - 0.03)	(0.00 - 0.05)	(0.03 - 0.06)	(0.86 - 0.95)	(0.01 - 0.02)	(0.00 - 0.02)
Kenai	0.00	0.01	0.00	0.01	0.00	**0.98**	0.00
	(0.00 - 0.01)	(0.01 - 0.01)	(0.00 - 0.01)	(0.01 - 0.01)	(0.00 - 0.00)	(0.91 - 1.00)	(0.00 - 0.02)
Kasilof	0.00	0.00	0.00	0.01	0.00	0.00	**0.99**
	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.02)	(0.94 - 1.00)
				BAYES:Flat prior			
West	**0.99**	0.00	0.00	0.00	0.00	0.00	0.00
	(0.98 - 1.00)	(0.00 - 0.02)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.01)
Yentna	0.00	**0.99**	0.00	0.00	0.00	0.00	0.00
	(0.00 - 0.01)	(0.98 - 1.00)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)
Susitna	0.00	0.00	**0.99**	0.00	0.00	0.01	0.00
	(0.00 - 0.01)	(0.00 - 0.03)	(0.95 - 1.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.01)
Knik	0.00	0.00	0.00	**0.99**	0.00	0.00	0.00
	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.97 - 1.00)	(0.00 - 0.01)	(0.00 - 0.02)	(0.00 - 0.01)
Northeast	0.00	0.00	0.00	0.00	**0.99**	0.00	0.00
	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.02)	(0.97 - 1.00)	(0.00 - 0.01)	(0.00 - 0.01)
Kenai	0.00	0.00	0.00	0.01	0.00	**0.99**	0.00
	(0.00 - 0.01)	(0.00 - 0.02)	(0.00 - 0.01)	(0.00 - 0.03)	(0.00 - 0.00)	(0.96 - 1.00)	(0.00 - 0.01)
Kasilof	0.00	0.00	0.00	0.00	0.00	0.00	**0.99**
	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.02)	(0.97 - 1.00)
				BAYES:SPAM prior			
West	**1.00**	0.00	0.00	0.00	0.00	0.00	0.00
	(0.99 - 1.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)
Yentna	0.00	**1.00**	0.00	0.00	0.00	0.00	0.00
	(0.00 - 0.00)	(1.00 - 1.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)
Susitna	0.00	0.00	**1.00**	0.00	0.00	0.00	0.00
	(0.00 - 0.00)	(0.00 - 0.01)	(0.98 - 1.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)

-continued-

Table 6.–Page 2 of 2.

Reporting Group	West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
Knik	0.00	0.00	0.00	**1.00**	0.00	0.00	0.00
	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(1.00 - 1.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)
Northeast	0.00	0.00	0.00	0.00	**1.00**	0.00	0.00
	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.01)	(0.99 - 1.00)	(0.00 - 0.00)	(0.00 - 0.00)
Kenai	0.00	0.00	0.00	0.00	0.00	**1.00**	0.00
	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(1.00 - 1.00)	(0.00 - 0.00)
Kasilof	0.00	0.00	0.00	0.00	0.00	0.00	**1.00**
	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(1.00 - 1.00)

Note: New baselines, that excluded the 200 used in the mixture, were used for each mixed stock analysis. Mixed stock analyses were performed using SPAM, BAYES with a flat prior, and BAYES with a SPAM prior. Numbers in bold indicate allocation to the drainage of the fish wheel.

Table 7.–Stock composition estimate for mixtures of fish captured in fish wheels operated on the Kasilof, Kenai, Yentna, and Susitna rivers in 1992, 1994, and 2005.

Date(s)	N	West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
				Kasilof				
7/22-23/92	190	0.00	0.00	0.00	0.00	0.00	0.00	**1.00**
		(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(1.00 - 1.00)
7/11-20/05	190	0.00	0.00	0.00	0.00	0.00	0.00	**0.99**
		(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.02)	(0.97 - 1.00)
				Kenai				
7/31-8/1/94	190	0.00	0.00	0.00	0.01	0.00	**0.98**	0.00
		(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.04)	(0.00 - 0.00)	(0.95 - 1.00)	(0.00 - 0.03)
7/11-20/05	190	0.00	0.01	0.00	0.00	0.00	**0.99**	0.01
		(0.00 - 0.00)	(0.00 - 0.05)	(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.00)	(0.92 - 1.00)	(0.00 - 0.06)
				Yentna				
7/15/92	190	0.00	**1.00**	0.00	0.00	0.00	0.00	0.00
		(0.00 - 0.00)	(0.96 - 1.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)
7/9-8/12/05	190	0.00	**0.94**	0.05	0.01	0.00	0.00	0.00
		(0.00 - 0.01)	(0.77 - 1.00)	(0.00 - 0.20)	(0.00 - 0.05)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)
				Susitna				
7/26/92	190	0.00	0.02	**0.98**	0.00	0.00	0.00	0.00
		(0.00 - 0.00)	(0.00 - 0.06)	(0.94 - 1.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)

Note: Credibility intervals (90%) are included in parentheses. BAYES with a SPAM prior was used to estimate the proportions.

Table 8.–Stock composition estimate and the number of fish successfully screened for mixtures of fish captured in the Cook Inlet offshore test fishery in 2006 and 2007.

Date(s)	N	West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
				2006				
7/1-9	325	0.11	0.06	0.00	0.01	0.00	0.30	0.51
		(0.08 - 0.15)	(0.04 - 0.10)	(0.00 - 0.01)	(0.00 - 0.02)	(0.00 - 0.00)	(0.24 - 0.36)	(0.45 - 0.58)
7/10-16	266	0.08	0.13	0.07	0.05	0.00	0.34	0.33
		(0.05 - 0.12)	(0.07 - 0.19)	(0.04 - 0.11)	(0.02 - 0.08)	(0.00 - 0.00)	(0.27 - 0.40)	(0.26 - 0.39)
7/17-23	401	0.10	0.09	0.02	0.02	0.00	0.61	0.16
		(0.07 - 0.13)	(0.06 - 0.13)	(0.01 - 0.03)	(0.01 - 0.03)	(0.00 - 0.00)	(0.56 - 0.67)	(0.12 - 0.21)
7/24 - 8/1	393	0.05	0.07	0.03	0.02	0.00	0.70	0.12
		(0.03 - 0.07)	(0.03 - 0.12)	(0.00 - 0.07)	(0.01 - 0.04)	(0.00 - 0.01)	(0.65 - 0.75)	(0.08 - 0.16)
				2007				
7/1-9	374	0.17	0.12	0.01	0.06	0.00	0.41	0.24
		(0.12 - 0.22)	(0.07 - 0.16)	(0.00 - 0.02)	(0.04 - 0.09)	(0.00 - 0.01)	(0.35 - 0.47)	(0.18 - 0.29)
7/10-13	444	0.07	0.15	0.02	0.04	0.00	0.54	0.18
		(0.05 - 0.10)	(0.11 - 0.19)	(0.00 - 0.04)	(0.02 - 0.07)	(0.00 - 0.00)	(0.48 - 0.60)	(0.13 - 0.23)
7/14-18	404	0.07	0.13	0.04	0.03	0.00	0.62	0.12
		(0.04 - 0.10)	(0.08 - 0.18)	(0.01 - 0.09)	(0.01 - 0.04)	(0.00 - 0.00)	(0.57 - 0.67)	(0.08 - 0.16)
7/19-23	429	0.08	0.08	0.05	0.03	0.00	0.68	0.09
		(0.06 - 0.11)	(0.05 - 0.12)	(0.02 - 0.08)	(0.01 - 0.04)	(0.00 - 0.00)	(0.63 - 0.73)	(0.06 - 0.13)
7/24-8/2	438	0.07	0.07	0.05	0.01	0.00	0.71	0.09
		(0.05 - 0.10)	(0.04 - 0.10)	(0.03 - 0.07)	(0.00 - 0.02)	(0.00 - 0.00)	(0.66 - 0.76)	(0.06 - 0.13)

Note: Credibility intervals (90%) are included in parentheses. Proportions are estimated from BAYES using a SPAM prior.

Table 9.–Stock composition estimates (P) and extrapolated harvests (H) from mixtures of fish captured in the Central District drift gillnet fishery in 2005, 2006, and 2007.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
						2005			
7/7	200	P	0.03	0.08	0.00	0.03	0.00	0.72	0.13
			(0.01 - 0.06)	(0.05 - 0.11)	(0.00 - 0.00)	(0.01 - 0.06)	(0.00 - 0.00)	(0.65 - 0.79)	(0.08 - 0.20)
		H	3,892	8,794	11	3,634	0	81,012	14,841
			(1548 - 6921)	(5373 - 12698)	(0 - 11)	(1503 - 6428)	(0 - 0)	(72577 - 88730)	(8492 - 22166)
7/11-14	400	P	0.05	0.02	0.00	0.00	0.00	0.88	0.05
			(0.03 - 0.08)	(0.01 - 0.05)	(0.00 - 0.01)	(0.00 - 0.01)	(0.00 - 0.00)	(0.84 - 0.91)	(0.03 - 0.08)
		H	20,509	9,540	504	546	0	368,019	21,139
			(11179 - 31687)	(2437 - 21433)	(0 - 2942)	(0 - 2732)	(0 - 0)	(351209 - 383400)	(10759 - 33032)
7/18-21	400	P	0.02	0.00	0.00	0.01	0.00	0.90	0.06
			(0.01 - 0.04)	(0.00 - 0.01)	(0.00 - 0.02)	(0.00 - 0.03)	(0.00 - 0.00)	(0.86 - 0.93)	(0.04 - 0.09)
		H	8,542	261	1,044	3,767	37	335,370	23,984
			(2201 - 15480)	(0 - 1902)	(0 - 7050)	(0 - 9959)	(0 - 0)	(321382 - 348015)	(13839 - 35398)
						2006			
6/26-29	400	P	0.03	0.03	0.00	0.01	0.00	0.11	0.82
			(0.01 - 0.04)	(0.01 - 0.06)	(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.08 - 0.14)	(0.78 - 0.86)
		H	1,034	1,226	12	523	0	4,059	31,578
			(511 - 1722)	(400 - 2141)	(0 - 77)	(119 - 1088)	(0 - 0)	(2898 - 5354)	(30087 - 32977)
7/3-6	399	P	0.02	0.10	0.02	0.00	0.00	0.22	0.64
			(0.01 - 0.04)	(0.07 - 0.14)	(0.01 - 0.03)	(0.00 - 0.01)	(0.00 - 0.00)	(0.17 - 0.27)	(0.58 - 0.69)
		H	1,438	6,986	1,161	142	0	14,613	43,158
			(472 - 2639)	(4813 - 9328)	(472 - 2099)	(0 - 931)	(0 - 0)	(11353 - 18184)	(39297 - 46803)
7/10-13	200	P	0.02	0.01	0.00	0.00	0.00	0.20	0.77
			(0.00 - 0.04)	(0.00 - 0.02)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.02)	(0.14 - 0.27)	(0.70 - 0.83)
		H	52	22	5	1	15	646	2,454
			(0 - 124)	(0 - 74)	(0 - 27)	(0 - 0)	(0 - 58)	(452 - 862)	(2228 - 2650)

-continued-

Table 9.–Page 2 of 2.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
7/17	300	P	0.00	0.02	0.02	0.01	0.00	0.41	0.54
			(0.00 - 0.01)	(0.00 - 0.05)	(0.00 - 0.05)	(0.00 - 0.03)	(0.00 - 0.00)	(0.34 - 0.49)	(0.46 - 0.62)
		H	32	491	515	259	0	10,853	14,268
			(0 - 193)	(0 - 1210)	(69 - 1279)	(11 - 724)	(0 - 0)	(8853 - 12887)	(12245 - 16260)
						2007			
6/25-28	400	P	0.23	0.11	0.00	0.01	0.00	0.28	0.38
			(0.03 - 0.36)	(0.00 - 0.33)	(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.23 - 0.34)	(0.32 - 0.43)
		H	4,874	2,265	0	137	0	6,078	8,033
			(695 - 7675)	(73 - 7049)	(0 - 0)	(0 - 618)	(0 - 0)	(4908 - 7290)	(6835 - 9260)
7/2-5	400	P	0.10	0.15	0.00	0.03	0.00	0.42	0.30
			(0.07 - 0.14)	(0.11 - 0.19)	(0.00 - 0.01)	(0.01 - 0.05)	(0.00 - 0.00)	(0.35 - 0.49)	(0.24 - 0.36)
		H	8,608	12,517	302	2,206	0	35,235	25,034
			(5990 - 11401)	(9337 - 15948)	(0 - 1250)	(940 - 3935)	(0 - 0)	(29757 - 40798)	(19723 - 30294)
7/9-12	399	P	0.06	0.10	0.03	0.02	0.00	0.55	0.24
			(0.04 - 0.09)	(0.06 - 0.14)	(0.00 - 0.06)	(0.01 - 0.04)	(0.00 - 0.01)	(0.49 - 0.61)	(0.19 - 0.30)
		H	17,533	28,469	7,945	5,893	704	161,314	71,363
			(11083 - 24980)	(18002 - 41926)	(0 - 17152)	(1818 - 11024)	(0 - 4222)	(144250 - 178583)	(55941 - 87312)
7/16	400	P	0.03	0.13	0.02	0.03	0.00	0.64	0.15
			(0.01 - 0.05)	(0.10 - 0.17)	(0.01 - 0.04)	(0.01 - 0.04)	(0.00 - 0.00)	(0.58 - 0.70)	(0.11 - 0.20)
		H	14,023	62,548	11,469	12,673	0	307,968	73,197
			(5831 - 23998)	(46164 - 80715)	(4963 - 19516)	(5831 - 21058)	(0 - 0)	(280212 - 335050)	(50645 - 97580)
7/19	398	P	0.02	0.11	0.00	0.03	0.00	0.69	0.15
			(0.01 - 0.03)	(0.08 - 0.15)	(0.00 - 0.00)	(0.02 - 0.06)	(0.00 - 0.00)	(0.63 - 0.74)	(0.10 - 0.20)
		H	7,946	50,224	88	14,663	0	301,038	65,063
			(2634 - 14751)	(34771 - 66644)	(0 - 44)	(6805 - 24234)	(0 - 0)	(275706 - 325228)	(45088 - 86883)

Note: Credibility intervals (90%) are included in parentheses. The number of fish successfully screened from each stratum (N) is indicated. BAYES with a SPAM prior was used to estimate the proportions. The 90% confidence intervals of harvest estimates may not include the point estimate for very low extrapolated harvest numbers because less than 5% of iterations had values above zero.

Table 10.–Stock composition estimates (P) and extrapolated harvests (H) from mixtures of fish captured in the Kasilof Terminal Area drift and set gillnet fisheries (Central District, East Side Subdistrict) in 2006.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
						Drift Gillnet			
7/24-27	300	P	0.00	0.00	0.00	0.01	0.00	0.03	0.96
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)	(0.01 - 0.06)	(0.93 - 0.98)
		H	61	0	20	1,724	0	7,039	194,041
			(0 - 365)	(0 - 0)	(0 - 0)	(0 - 4220)	(0 - 0)	(2881 - 12395)	(188341 - 198606)
						Set Gillnet			
7/24-27	400	P	0.00	0.00	0.00	0.00	0.00	0.07	0.93
			(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.04 - 0.10)	(0.90 - 0.96)
		H	414	0	0	0	0	11,404	153,699
			(17 - 1258)	(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(7018 - 16403)	(148667 - 158118)

Note: Credibility intervals (90%) are included in parentheses. The number of fish successfully screened from each stratum (N) is indicated. BAYES with a SPAM prior was used to estimate the proportions. The 90% credibility intervals of harvest estimates may not include the point estimate for very low extrapolated harvest numbers because less than 5% of iterations had values above zero.

Table 11.–Stock composition estimates (P) and extrapolated harvests (H) from mixtures of fish captured in the Kasilof Section set gillnet fishery (Central District, East Side Subdistrict) in 2005, 2006, and 2007.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
						2005			
7/2-9	200	P	0.00	0.00	0.00	0.00	0.00	0.17	0.83
			(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.11 - 0.24)	(0.76 - 0.89)
		H	36	871	0	0	0	29,632	147,217
			(0 - 53)	(18 - 2666)	(0 - 0)	(0 - 0)	(0 - 0)	(18895 - 41915)	(134827 - 158060)
7/11-15	406	P	0.00	0.00	0.01	0.00	0.00	0.48	0.50
			(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.00)	(0.43 - 0.54)	(0.45 - 0.55)
		H	23	422	936	0	0	55,292	57,473
			(0 - 11)	(11 - 1495)	(0 - 2351)	(0 - 0)	(0 - 0)	(49528 - 61239)	(51537 - 63237)
7/16-18	250	P	0.00	0.00	0.00	0.00	0.00	0.38	0.62
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.32 - 0.44)	(0.56 - 0.68)
		H	0	0	0	0	0	43,312	70,686
			(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(36666 - 50039)	(63960 - 77322)
7/19-28	300	P	0.00	0.00	0.00	0.00	0.00	0.43	0.57
			(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.36 - 0.50)	(0.50 - 0.64)
		H	0	357	0	0	0	95,398	127,450
			(0 - 0)	(0 - 1875)	(0 - 0)	(0 - 0)	(0 - 0)	(81090 - 110531)	(112339 - 141757)
						2006			
6/26-7/1	400	P	0.00	0.00	0.00	0.00	0.00	0.13	0.87
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.10 - 0.16)	(0.84 - 0.90)
		H	23	57	0	0	0	14,867	99,846
			(0 - 80)	(0 - 482)	(0 - 0)	(0 - 0)	(0 - 0)	(11733 - 18369)	(96333 - 103003)
7/2-8	400	P	0.00	0.02	0.00	0.01	0.00	0.08	0.89
			(0.00 - 0.00)	(0.00 - 0.05)	(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.05 - 0.11)	(0.85 - 0.92)
		H	62	2,030	10	1,251	10	8,160	90,999
			(0 - 400)	(0 - 5085)	(0 - 0)	(0 - 3362)	(0 - 0)	(5167 - 11666)	(87329 - 94085)

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Table 11.–Page 2 of 2.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
7/10-13	400	P	0.00	0.00	0.00	0.00	0.00	0.14	0.86
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.1 0 - 0.18)	(0.82 - 0.89)
		H	4	0	14	4	0	5,031	31,036
			(0 - 7)	(0 - 0)	(0 - 115)	(0 - 11)	(0 - 0)	(3779 - 6425)	(29650 - 32285)
7/15-16	400	P	0.00	0.01	0.00	0.00	0.00	0.16	0.83
			(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.13 - 0.20)	(0.79 - 0.86)
		H	19	1,951	0	0	0	30,854	156,564
			(0 - 0)	(0 - 4849)	(0 - 0)	(0 - 0)	(0 - 0)	(24187 - 37995)	(149328 - 163382)
7/17-22	400	P	0.00	0.00	0.00	0.01	0.00	0.13	0.86
			(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)	(0.10 - 0.16)	(0.82 - 0.89)
		H	257	14	0	1,663	0	17,237	116,022
			(0 - 1000)	(0 - 0)	(0 - 0)	(554 - 3231)	(0 - 0)	(13005 - 21820)	(111290 - 120388)
2007									
6/25-7/5	399	P	0.01	0.07	0.00	0.02	0.00	0.13	0.78
			(0.00 - 0.02)	(0.04 - 0.09)	(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.09 - 0.17)	(0.73 - 0.83)
		H	898	7,487	11	1,761	0	14,361	89,119
			(102 - 2204)	(4635 - 10714)	(0 - 0)	(364 - 3590)	(0 - 0)	(9748 - 19644)	(83313 - 94640)
7/9-12	299	P	0.00	0.04	0.00	0.01	0.00	0.46	0.49
			(0.00 - 0.00)	(0.00 - 0.07)	(0.00 - 0.00)	(0.00 - 0.03)	(0.00 - 0.00)	(0.39 - 0.54)	(0.42 - 0.56)
		H	13	4,916	13	1,603	0	62,449	65,694
			(0 - 0)	(323 - 10087)	(0 - 0)	(0 - 4404)	(0 - 0)	(53062 - 72159)	(56213 - 74960)
7/16-21	400	P	0.00	0.04	0.02	0.04	0.00	0.58	0.32
			(0.00 - 0.01)	(0.02 - 0.07)	(0.00 - 0.03)	(0.02 - 0.06)	(0.00 - 0.01)	(0.53 - 0.64)	(0.26 - 0.37)
		H	381	9,811	4,120	9,573	476	138,572	75,227
			(0 - 2834)	(4525 - 16789)	(1143 - 8240)	(5025 - 14836)	(0 - 1738)	(125308 - 151812)	(62392 - 88230)

Note: Credibility intervals (90%) are included in parentheses. The number of fish successfully screened from each stratum (N) is indicated. BAYES with a SPAM prior was used to estimate the proportions. The 90% credibility intervals of harvest estimates may not include the point estimate for very low extrapolated harvest numbers because less than 5% of iterations had values above zero.

Table 12.–Stock composition estimates (P) and extrapolated harvests (H) from mixtures of fish captured in the Kenai Section set gillnet fishery (Central District, East Side Subdistrict) in 2005, 2006, and 2007.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
2005									
7/11-12	250	P	0.00	0.00	0.00	0.00	0.00	0.67	0.32
			(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.61 - 0.74)	(0.26 - 0.39)
		H	112	140	42	14	0	94,797	45,376
			(0 - 660)	(0 - 941)	(0 - 112)	(0 - 14)	(0 - 0)	(85708 - 103760)	(36455 - 54451)
7/13-14	250	P	0.00	0.00	0.00	0.00	0.00	0.78	0.22
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.72 - 0.84)	(0.16 - 0.28)
		H	4	0	0	0	0	32,678	9,160
			(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(30196 - 34992)	(6846 - 11642)
7/16-19	250	P	0.00	0.03	0.01	0.01	0.00	0.42	0.53
			(0.00 - 0.00)	(0.01 - 0.05)	(0.00 - 0.04)	(0.00 - 0.02)	(0.00 - 0.00)	(0.36 - 0.49)	(0.47 - 0.6)
		H	22	5,562	2,292	2,069	0	94,330	118,224
			(0 - 0)	(1646 - 11079)	(0 - 7809)	(356 - 4939)	(0 - 0)	(80336 - 108791)	(103719 - 132441)
7/20-26	300	P	0.00	0.00	0.00	0.00	0.00	0.56	0.44
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.50 - 0.61)	(0.39 - 0.5)
		H	0	0	0	0	0	156,107	124,207
			(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(139568 - 172337)	(107977 - 140746)
2006									
7/10-13	400	P	0.00	0.00	0.00	0.00	0.00	0.43	0.56
			(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.37 - 0.49)	(0.50 - 0.62)
		H	2	56	0	67	0	7,281	9,419
			(0 - 0)	(0 - 271)	(0 - 0)	(0 - 244)	(0 - 0)	(6281 - 8287)	(8425 - 10407)
7/17	400	P	0.00	0.00	0.00	0.00	0.00	0.75	0.25
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.69 - 0.80)	(0.20 - 0.30)
		H	0	0	0	83	0	22,168	7,477
			(0 - 0)	(0 - 0)	(0 - 0)	(0 - 318)	(0 - 0)	(20596 - 23666)	(5990 - 9052)

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Table 12.–Page 2 of 2.

Date	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
						2007			
7/9-12	400	P	0.00	0.02	0.01	0.01	0.00	0.86	0.09
			(0.00 - 0.01)	(0.00 - 0.05)	(0.00 - 0.02)	(0.00 - 0.03)	(0.00 - 0.00)	(0.81 - 0.91)	(0.05 - 0.14)
		H	43	162	89	149	0	9,143	999
			(3 - 122)	(21 - 476)	(0 - 227)	(0 - 311)	(0 - 0)	(8607 - 9621)	(570 - 1485)
7/16-19	399	P	0.00	0.03	0.00	0.00	0.00	0.89	0.07
			(0.00 - 0.01)	(0.01 - 0.05)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.85 - 0.93)	(0.04 - 0.12)
		H	83	1,665	0	0	0	46,307	3,806
			(0 - 399)	(674 - 2826)	(0 - 0)	(0 - 0)	(0 - 0)	(43921 - 48433)	(1872 - 5994)
7/21-28	400	P	0.00	0.13	0.00	0.04	0.00	0.72	0.11
			(0.00 - 0.00)	(0.09 - 0.17)	(0.00 - 0.01)	(0.02 - 0.06)	(0.00 - 0.00)	(0.67 - 0.77)	(0.08 - 0.15)
		H	0	43,146	579	13,496	0	245,042	38,545
			(0 - 0)	(30366 - 57426)	(0 - 3613)	(6237 - 21573)	(0 - 0)	(228376 - 261469)	(26345 - 51973)

Note: Credibility intervals (90%) are included in parentheses. The number of fish successfully screened from each stratum (N) is indicated. BAYES with a SPAM prior was used to estimate the proportions. The 90% credibility intervals of harvest estimates may not include the point estimate for very low extrapolated harvest numbers because less than 5% of iterations had values above zero.

Table 13.–Stock composition estimates (P) and extrapolated harvests (H) from mixtures of fish captured in the Kasilof and Kenai Section set gillnet fisheries (Central District, East Side Subdistrict) analyzed by subsections in 2005, 2006, and 2007.

Dates	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
					Cohoe/Ninilchik 2005				
7/2-28	250	P	0.00	0.00	0.01	0.00	0.00	0.42	0.57
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.02)	(0.00 - 0.00)	(0.00 - 0.00)	(0.36 - 0.49)	(0.50 - 0.64)
		H	0	164	3,569	0	0	173,928	232,546
			(0 - 0)	(0 - 164)	(0 - 9148)	(0 - 0)	(0 - 0)	(145829 - 202888)	(203545 - 260728)
					South K. Beach 2005				
7/2-26	906	P	0.00	0.00	0.00	0.00	0.00	0.39	0.61
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.35 - 0.42)	(0.58 - 0.64)
		H	0	175	0	0	0	84,674	134,038
			(0 - 0)	(0 - 919)	(0 - 0)	(0 - 0)	(0 - 0)	(77559 - 92095)	(126573 - 141153)
					North K. Beach 2005				
7/11-26	850	P	0.00	0.00	0.00	0.00	0.00	0.65	0.35
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.61 - 0.68)	(0.32 - 0.39)
		H	0	20	20	20	0	128,386	69,620
			(0 - 0)	(0 - 119)	(0 - 79)	(0 - 0)	(0 - 0)	(121176 - 135437)	(62589 - 76810)
					North and South Salamatof 2005				
7/11-24	200	P	0.00	0.02	0.00	0.01	0.00	0.82	0.14
			(0.00 - 0.00)	(0.01 - 0.04)	(0.00 - 0.03)	(0.00 - 0.03)	(0.00 - 0.00)	(0.75 - 0.89)	(0.08 - 0.21)
		H	0	9,741	2,046	5,406	0	400,020	69,844
			(0 - 0)	(2533 - 20164)	(0 - 13979)	(195 - 13248)	(0 - 0)	(365439 - 433578)	(37844 - 102428)
					Cohoe/Ninilchik 2006				
6/26-7/22	1335	P	0.00	0.02	0.00	0.01	0.00	0.16	0.82
			(0.00 - 0.00)	(0.01 - 0.03)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.13 - 0.18)	(0.79 - 0.84)
		H	294	8,170	0	2,319	0	57,083	300,171
			(0 - 1399)	(5079 - 11593)	(0 - 0)	(920 - 4085)	(0 - 0)	(49243 - 65437)	(291449 - 308268)
					South K. Beach 2006				
6/26-7/22	665	P	0.00	0.00	0.00	0.00	0.00	0.07	0.93
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.05 - 0.09)	(0.91 - 0.95)
		H	0	0	0	0	0	15,160	194,811
			(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(0 - 0)	(11065 - 19758)	(190213 - 198885)

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Table 13.–Page 2 of 2.

Dates	N		West	Yentna	Susitna	Knik	Northeast	Kenai	Kasilof
						North K. Beach 2006			
7/10-17	189	P	0.00	0.00	0.00	0.00	0.00	0.26	0.73
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.20 - 0.34)	(0.66 - 0.80)
		H	6	0	0	7	0	3,108	8,627
			(0 - 43)	(0 - 0)	(0 - 0)	(0 - 46)	(0 - 0)	(2300 - 3988)	(7744 - 9437)
						North and South Salamatof 2006			
7/10-17	611	P	0.00	0.00	0.00	0.00	0.00	0.68	0.31
			(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.00)	(0.00 - 0.01)	(0.00 - 0.00)	(0.64 - 0.73)	(0.27 - 0.36)
		H	0	11	0	49	0	23,817	10,929
			(0 - 0)	(0 - 25)	(0 - 0)	(0 - 222)	(0 - 0)	(22267 - 25311)	(9436 - 12467)
						Cohoe/Ninilchik 2007			
6/25-7/21	878	P	0.01	0.06	0.00	0.02	0.00	0.37	0.54
			(0.00 - 0.01)	(0.04 - 0.08)	(0.00 - 0.01)	(0.01 - 0.03)	(0.00 - 0.00)	(0.33 - 0.41)	(0.50 - 0.58)
		H	2,513	23,470	773	8,004	116	141,943	209,879
			(657 - 5027)	(16317 - 31435)	(0 - 3480)	(4369 - 12257)	(0 - 851)	(126902 - 157525)	(194103 - 225191)
						South K. Beach 2007			
6/25-7/21	205	P	0.00	0.04	0.01	0.00	0.00	0.45	0.50
			(0.00 - 0.00)	(0.00 - 0.08)	(0.00 - 0.03)	(0.00 - 0.02)	(0.00 - 0.00)	(0.37 - 0.54)	(0.42 - 0.59)
		H	0	3,661	599	389	0	44,994	50,122
			(0 - 0)	(0 - 8121)	(0 - 3312)	(0 - 2165)	(0 - 0)	(36494 - 53664)	(41652 - 58603)
						North K. Beach 2007			
7/9-28	203	P	0.01	0.01	0.01	0.00	0.00	0.61	0.36
			(0.00 - 0.02)	(0.00 - 0.04)	(0.00 - 0.04)	(0.00 - 0.00)	(0.00 - 0.00)	(0.52 - 0.69)	(0.28 - 0.45)
		H	317	811	860	0	0	37,038	21,975
			(18 - 958)	(12 - 2306)	(0 - 2355)	(0 - 0)	(0 - 0)	(31834 - 42254)	(16832 - 27234)
						North and South Salamatof 2007			
7/9-28	997	P	0.00	0.06	0.00	0.03	0.00	0.85	0.06
			(0.00 - 0.00)	(0.05 - 0.08)	(0.00 - 0.00)	(0.02 - 0.04)	(0.00 - 0.00)	(0.82 - 0.88)	(0.04 - 0.08)
		H	0	21,732	68	9,377	0	291,282	19,816
			(0 - 0)	(15948 - 28098)	(0 - 342)	(5921 - 13279)	(0 - 0)	(281186 - 300660)	(12321 - 27927)

Note: Credibility intervals (90%) are included in parentheses. The number of fish successfully screened from each stratum (N) is indicated. BAYES with a SPAM prior was used to estimate the proportions. The 90% credibility intervals of harvest estimates may not include the point estimate for very low extrapolated harvest numbers because less than 5% of iterations had values above zero.

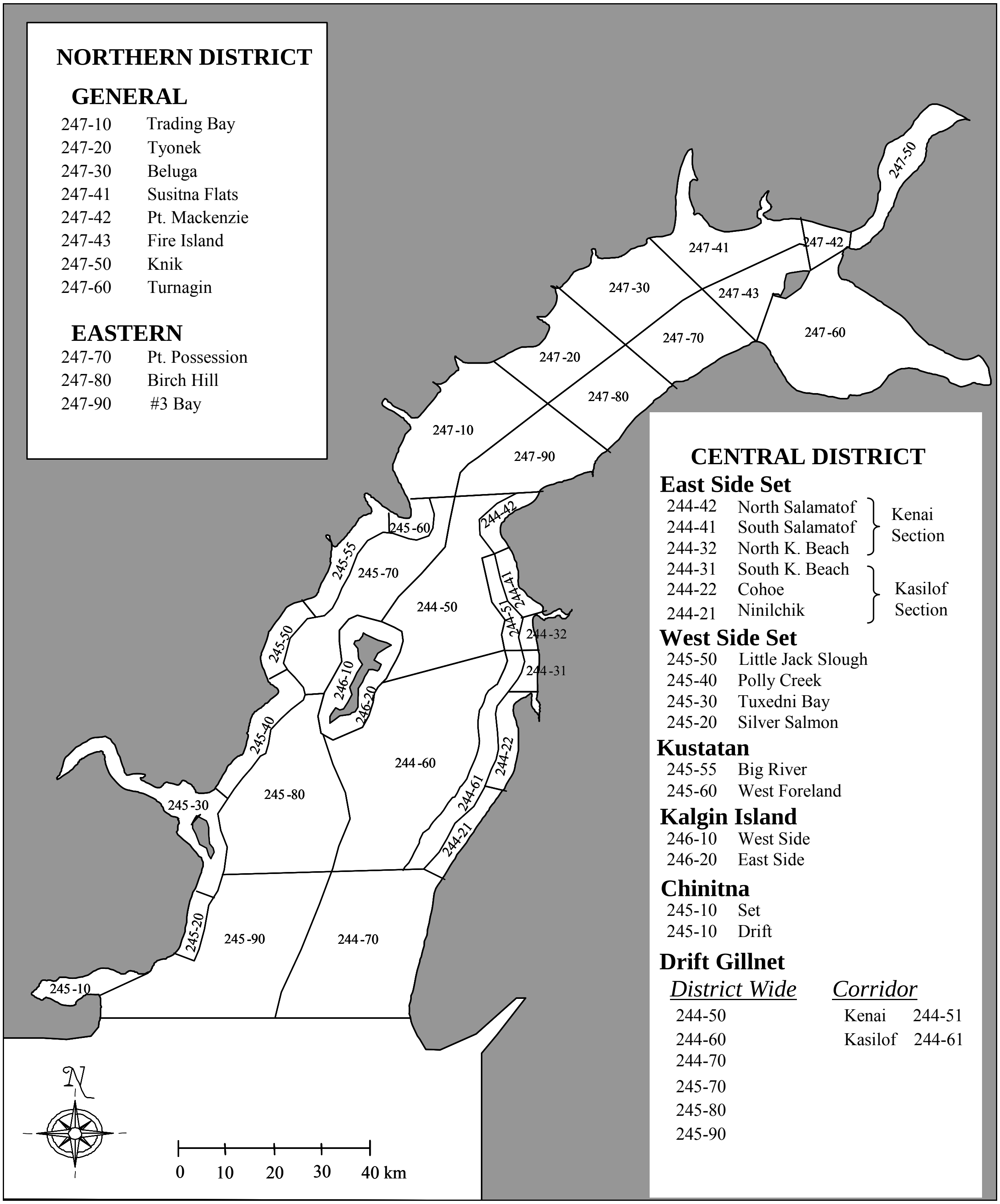

Figure 1.–Map of Upper Cook Inlet showing management fishing boundaries (statistical areas) for subdisticts, sections, and subsections within the Northern and Central Districts for both set and drift gillnet fisheries.

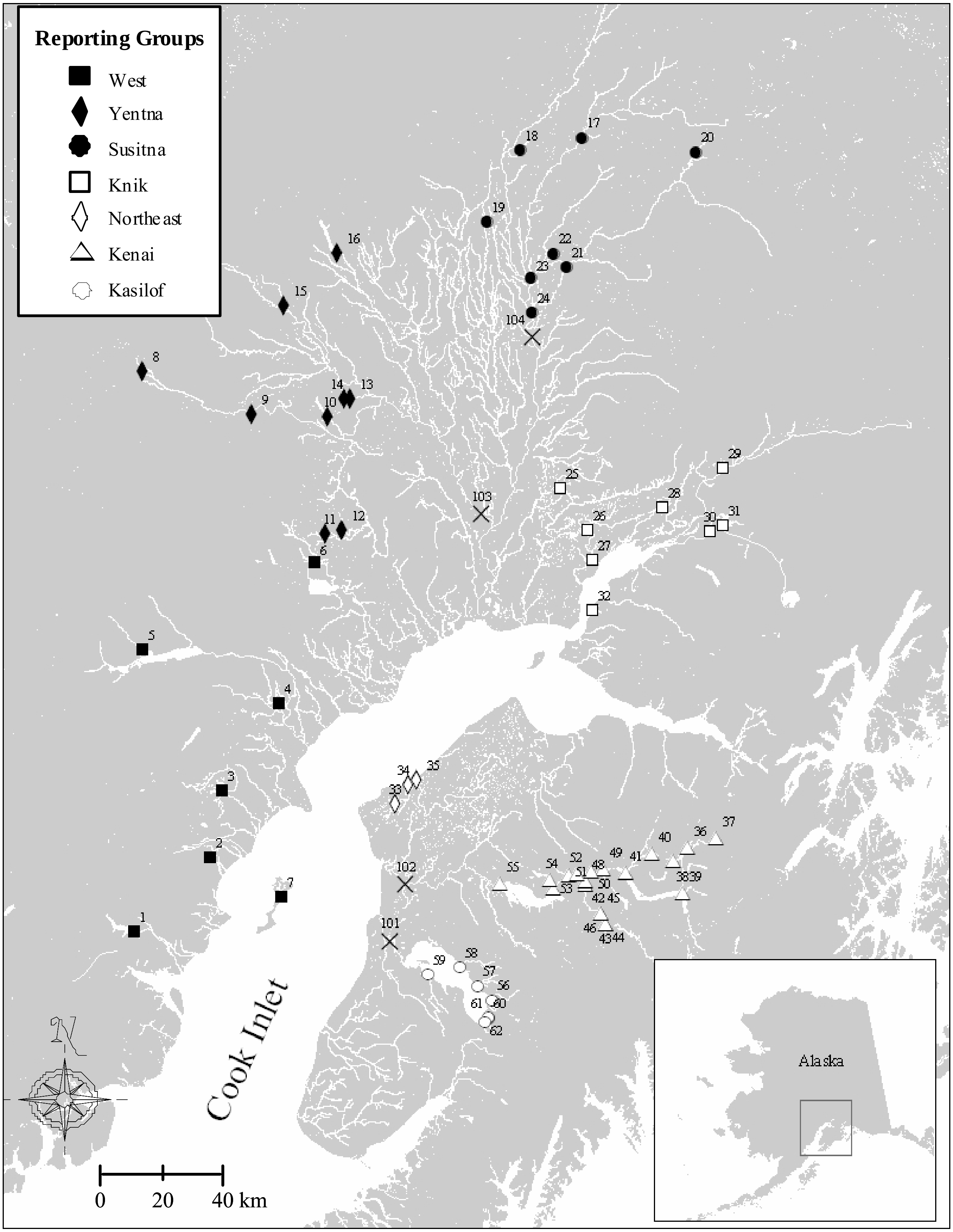

Figure 2.–Sampling locations for sockeye salmon originating from upper Cook Inlet, Alaska, 1992-2006 used to compile a genetic baseline.

Note: Fish wheels are designated by an "X". Symbols identify the seven regional reporting groups (see text).

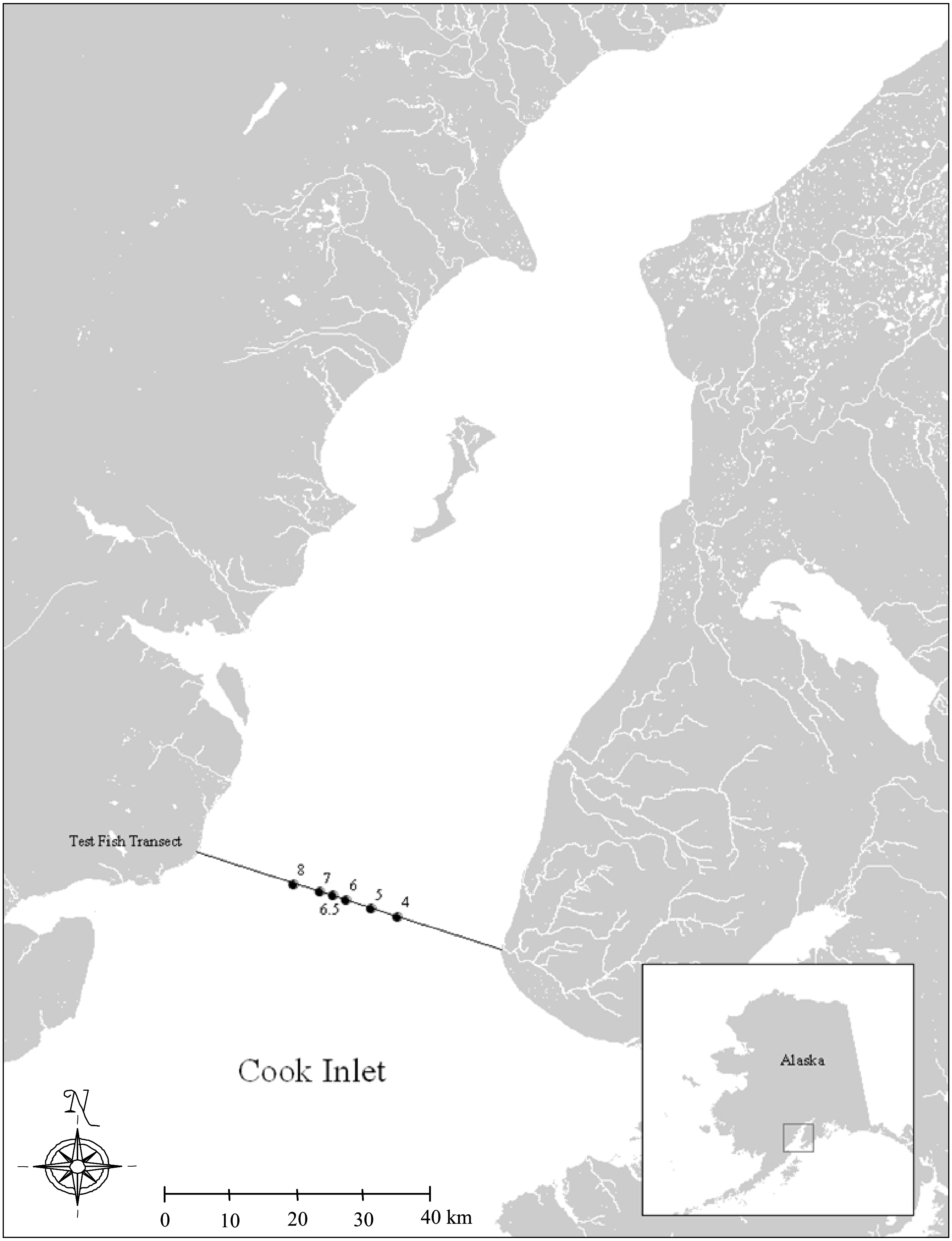

Figure 3.–Offshore test fishery stations for sockeye salmon migrating into Upper Cook Inlet, Alaska.

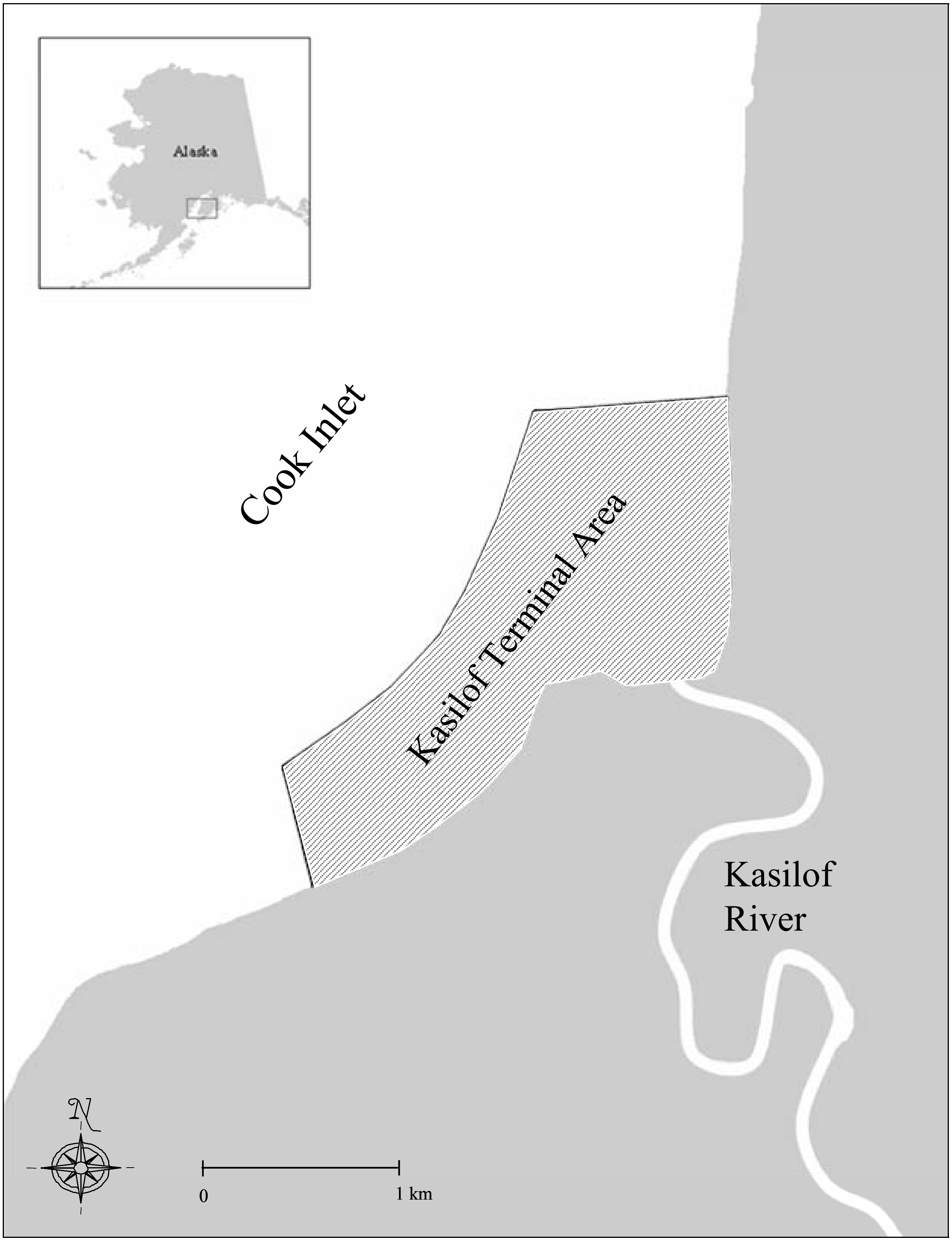

Figure 4.–Map of the mouth of the Kasilof River showing management fishing boundaries for the Kasilof Terminal Area (Central District, East Side Subdistrict).

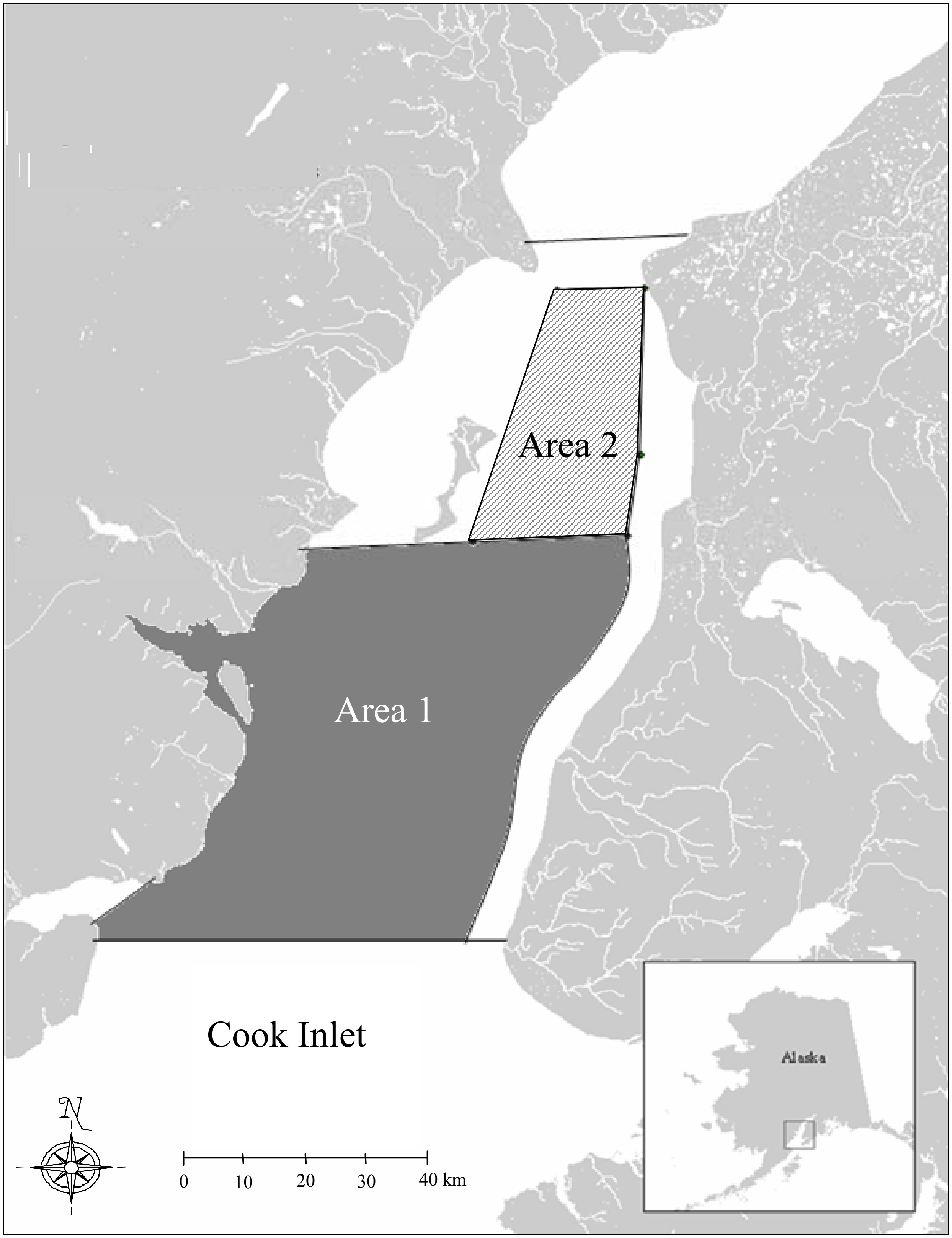

Figure 5.–Map of Central Cook Inlet showing management fishing boundaries for Area 1 and Area 2 for drift gillnet fisheries.

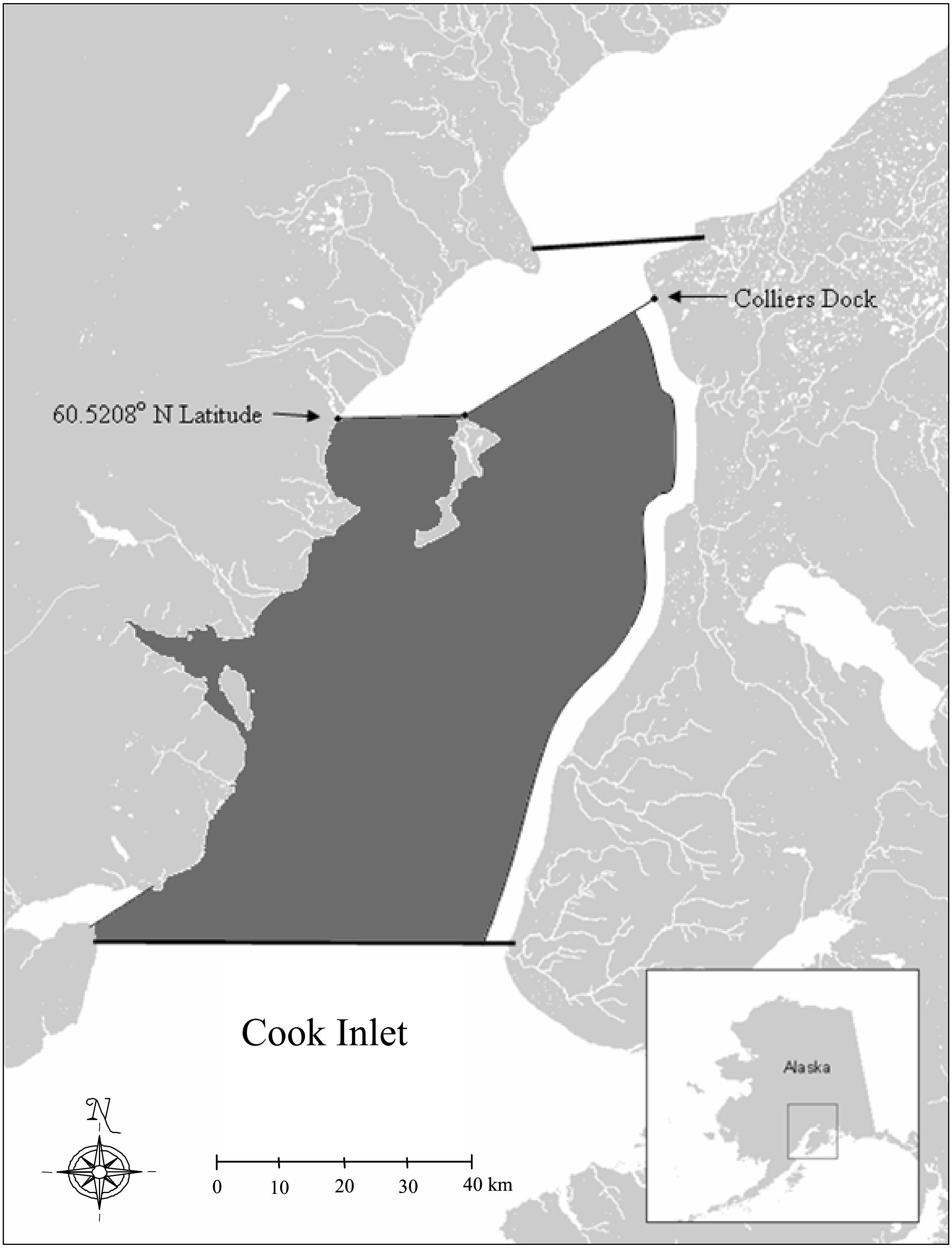

Figure 6.–Map of Central Cook Inlet showing management fishing boundaries for the area south of a line from Collier's Dock to Northwest Point on Kalgin Island to 60.5208° N on the western shore and north of the southern limit of the Central District.

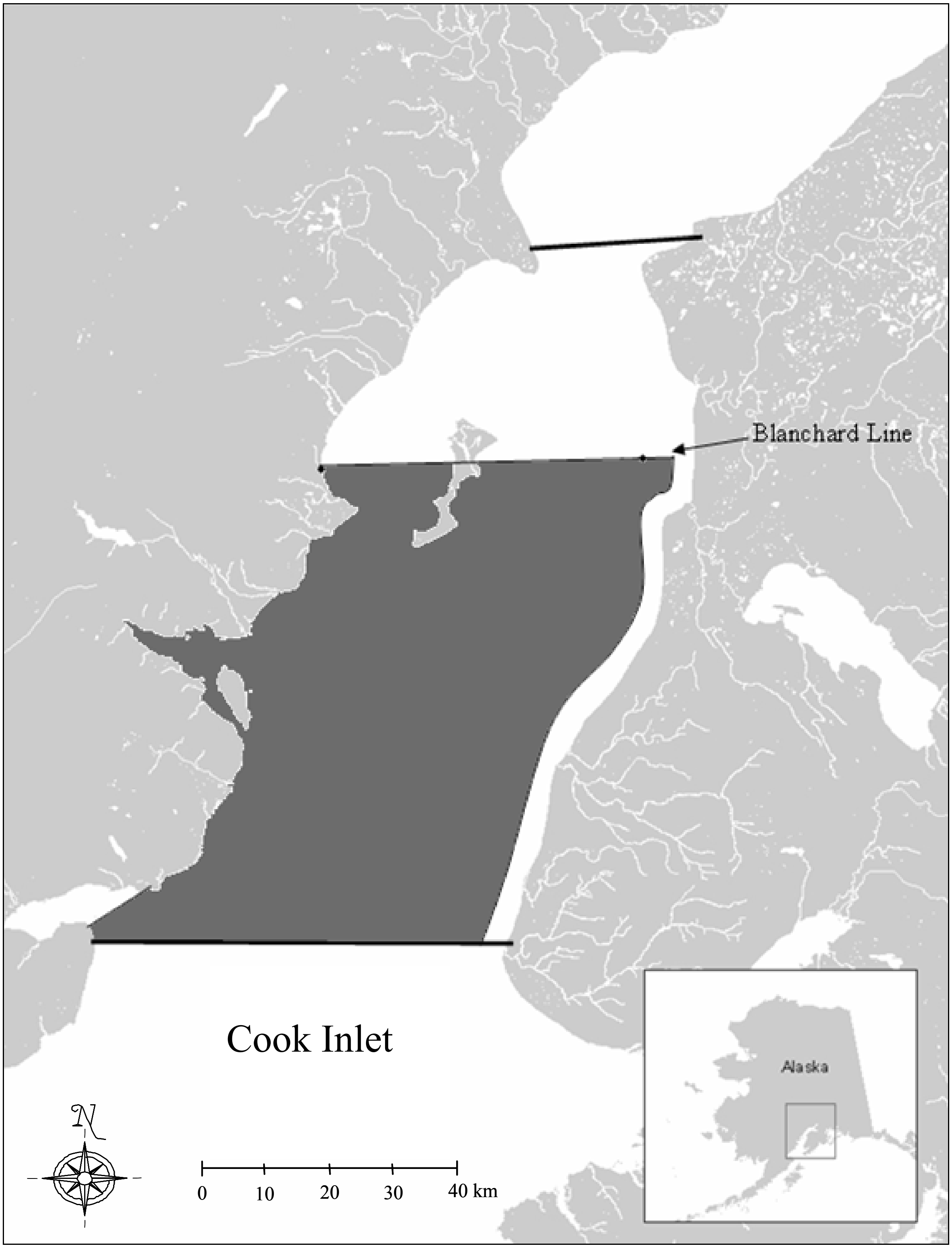

Figure 7.–Map of Central Cook Inlet showing management fishing boundaries for the area south of the Blanchard Line and north of the southern limit of the Central District.

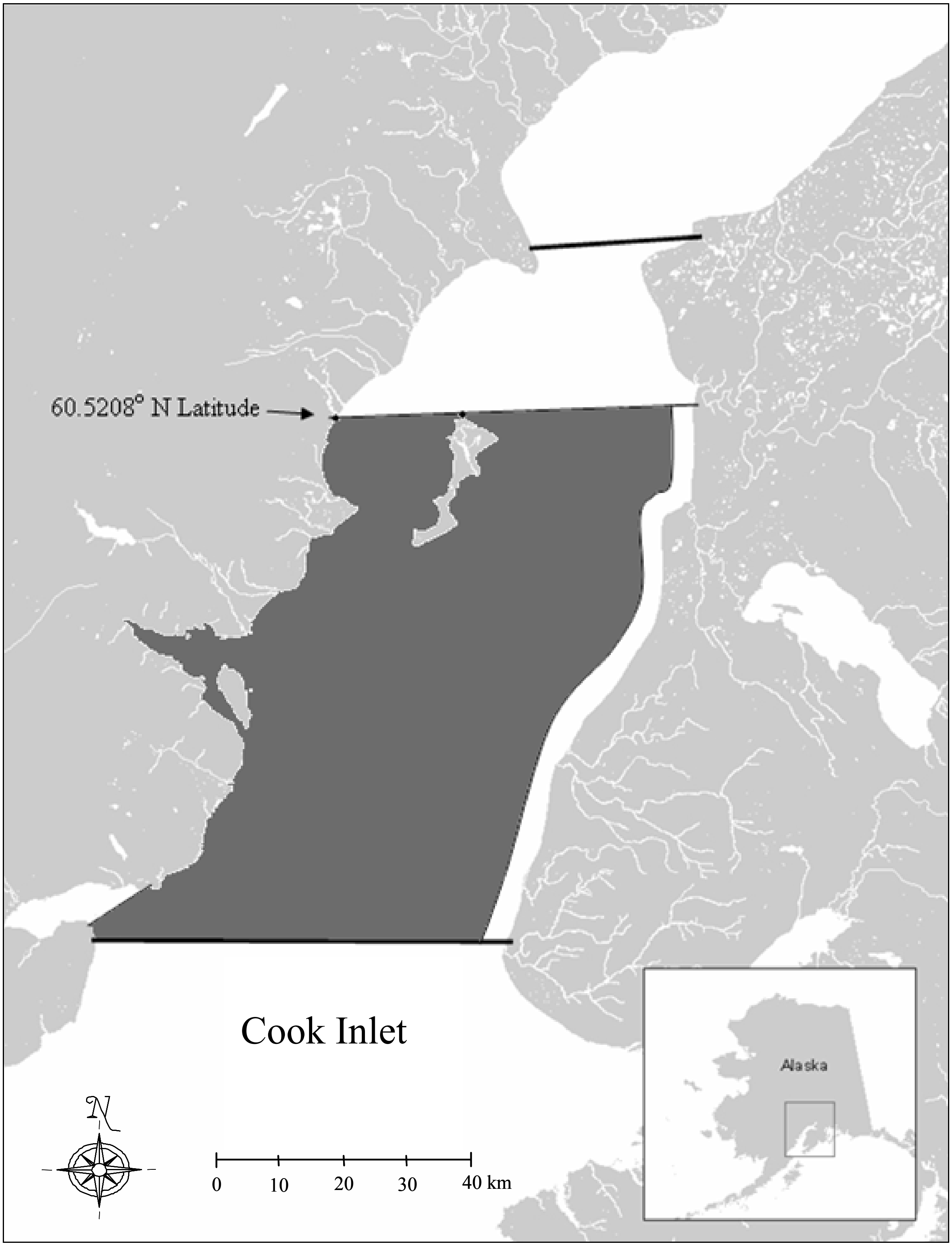

Figure 8.–Map of Central Cook Inlet showing management fishing boundaries for the area south of the longitudinal line that intersects with the north end of Kalgin Island and north of the southern limit of the Central District.

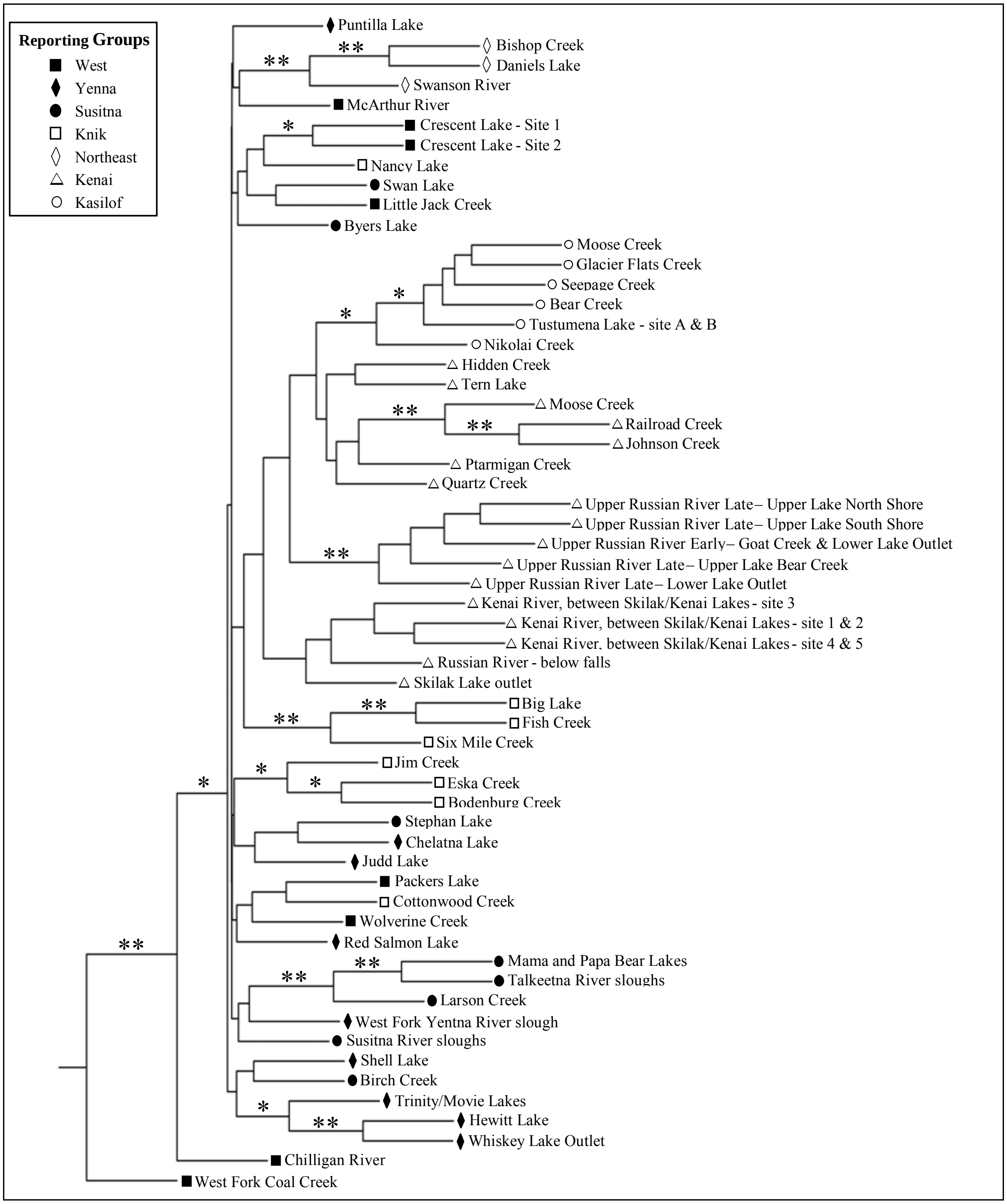

Figure 9.–Consensus N-J tree based on the Nei (1978) genetic distances between sockeye salmon populations sampled from spawning areas in drainages of Cook Inlet, Alaska (see Table 1 for collection details).

Note: ** = 70% consensus nodes; * = 50–70% consensus nodes. Reporting group symbols for each collection are included (see text and Figure 2).

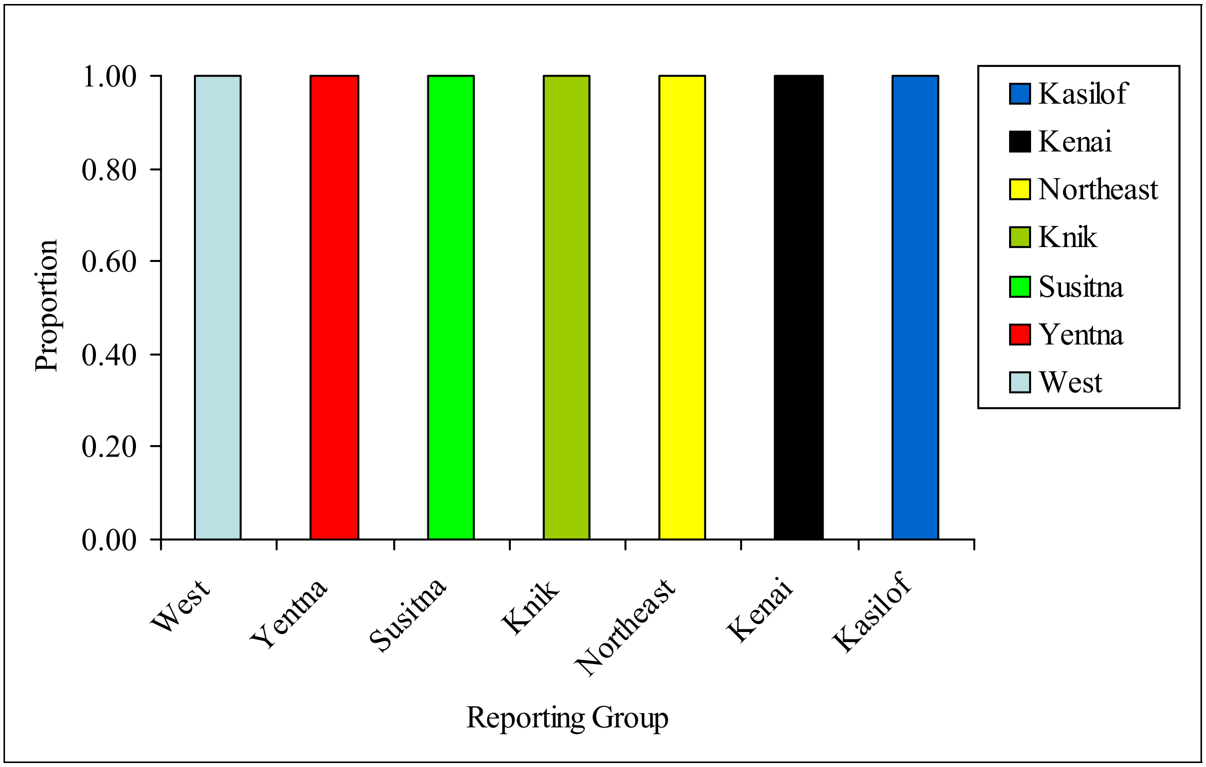

Figure 10.–Stock composition estimates from mixtures of 200 fish from each reporting group.

Note: New baselines were created to determine stock composition estimates for each reporting group, and these baselines excluded the 200 fish used in the mixtures.

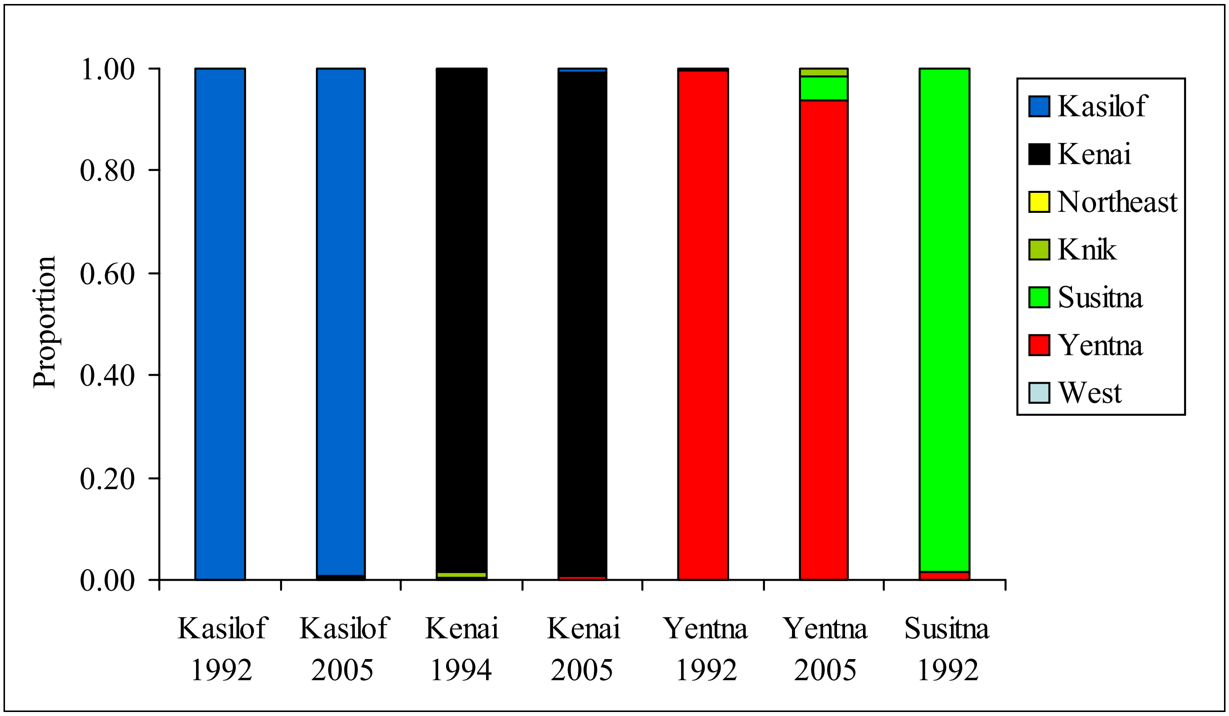

Figure 11.–Stock composition estimates from mixtures captured in fish wheels within four drainages of Cook Inlet in 1992, 1994, and 2005.

Note: BAYES with a SPAM prior was used to estimate the proportions.

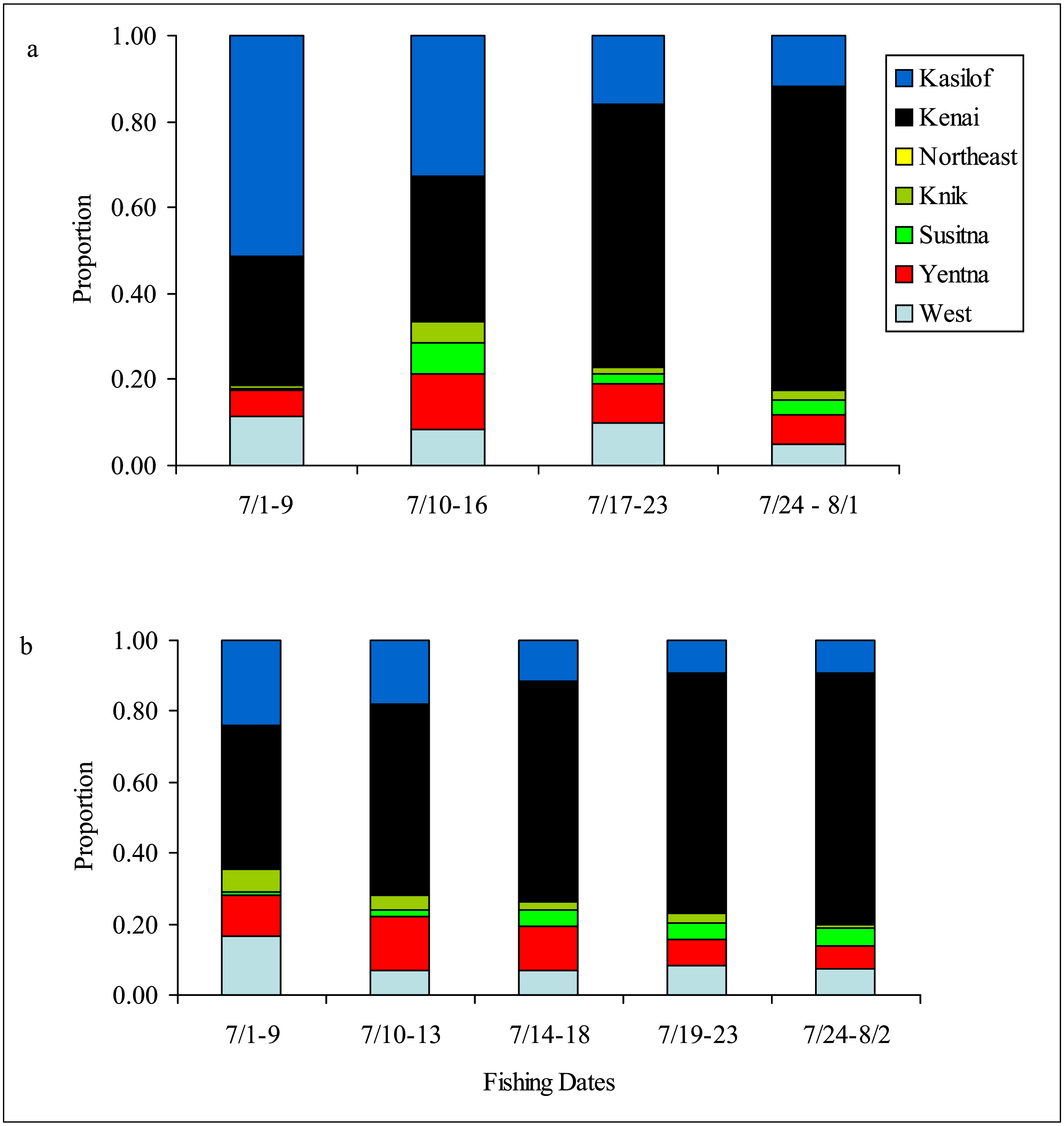

Figure 12.–Stock composition estimates for the Cook Inlet offshore test fishery taken in a) 2006, and b) 2007.

Note: BAYES with a SPAM prior was used to estimate the proportions.

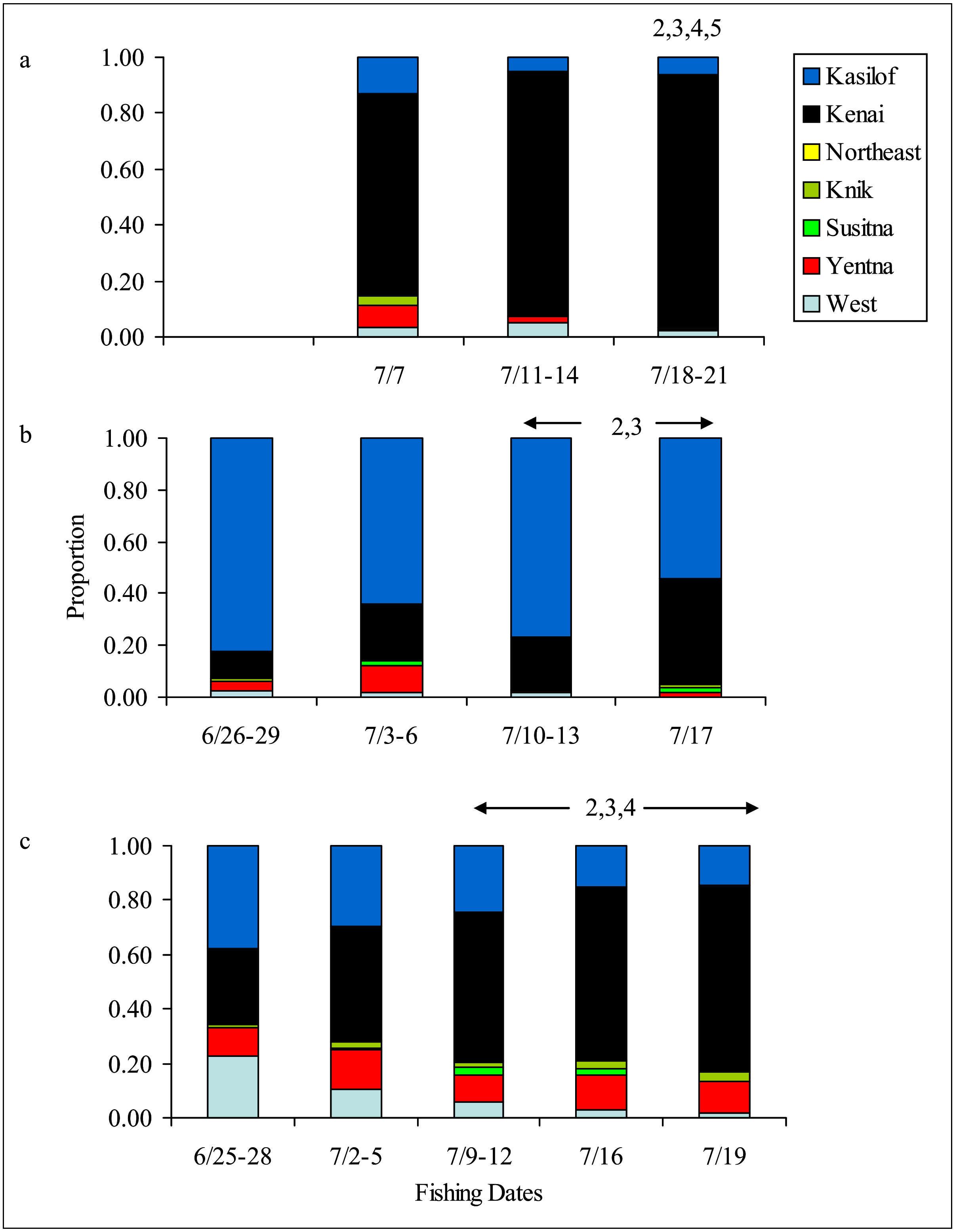

Figure 13.–Stock composition estimates for the Central District drift gillnet fishery from a) 2005, b) 2006, and c) 2007.

Note: Numbers above the bars indicate fisheries were restricted to particular areas: 2-Kasilof Corridor; 3-Kenai Corridor; 4-Area 1; 5-Area 2 (see Figures 1 and 4–8 and Table 2). BAYES with a SPAM prior was used to estimate the proportions.

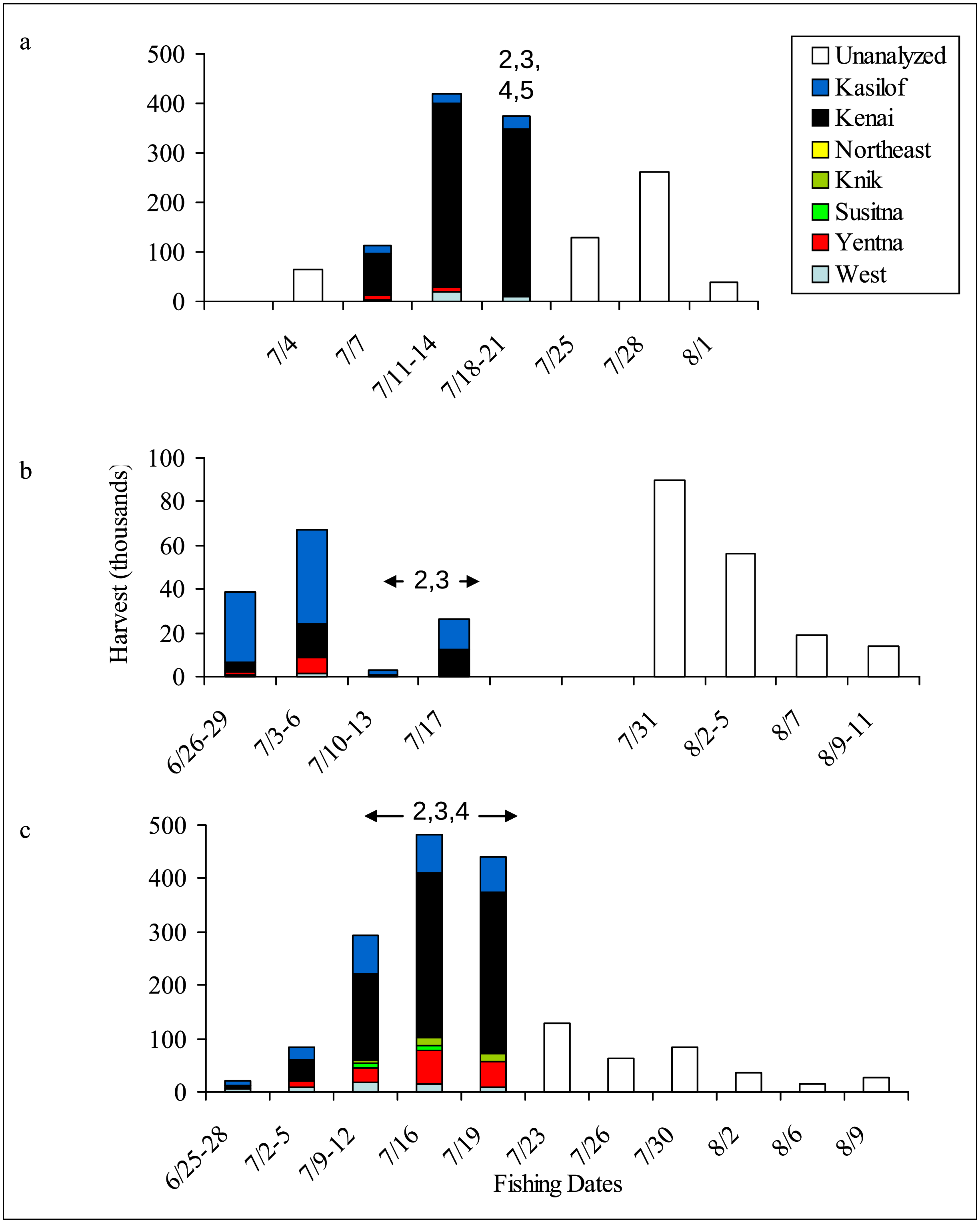

Figure 14.–Harvest by stock estimates for the Central District drift gillnet fishery from a) 2005, b) 2006, and c) 2007.

Note: Numbers above the bars indicate fisheries were restricted to particular areas: 2-Kasilof Corridor; 3-Kenai Corridor; 4-Area 1; 5-Area 2 (see Figures 1 and 4–8 and Table 2). BAYES with a SPAM prior was used to estimate the proportions.

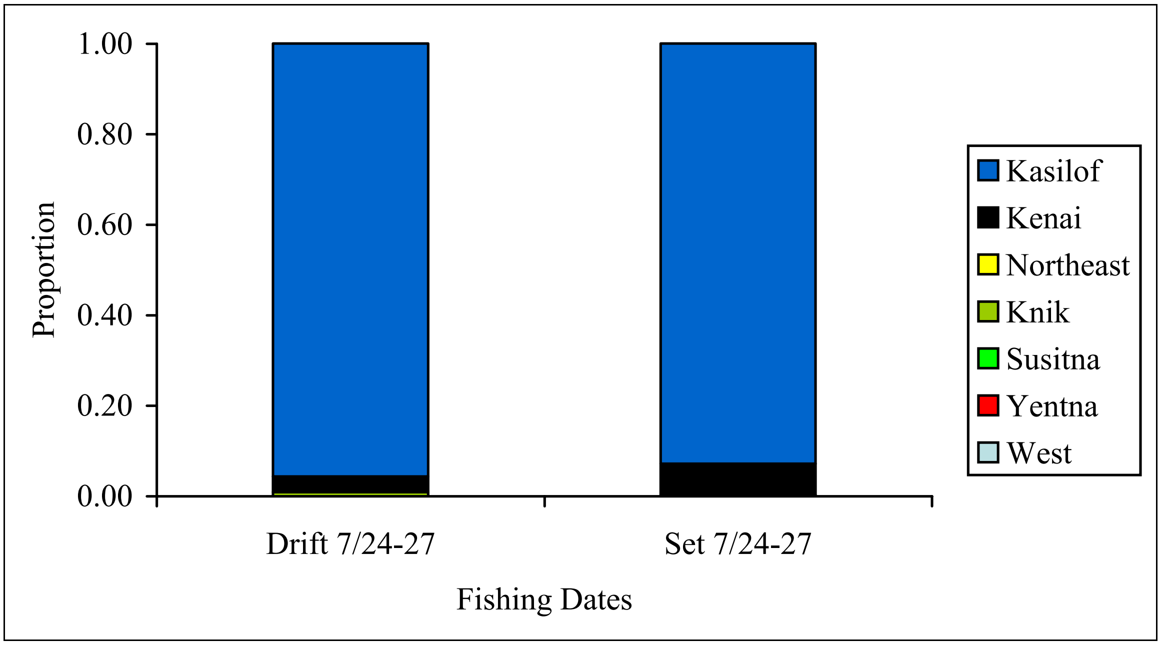

Figure 15.–Stock composition estimates for the Kasilof Terminal Area drift and set gillnet fisheries (Central District, East Side Subdistrict) in 2006.

Note: BAYES with a SPAM prior was used to estimate the proportions.

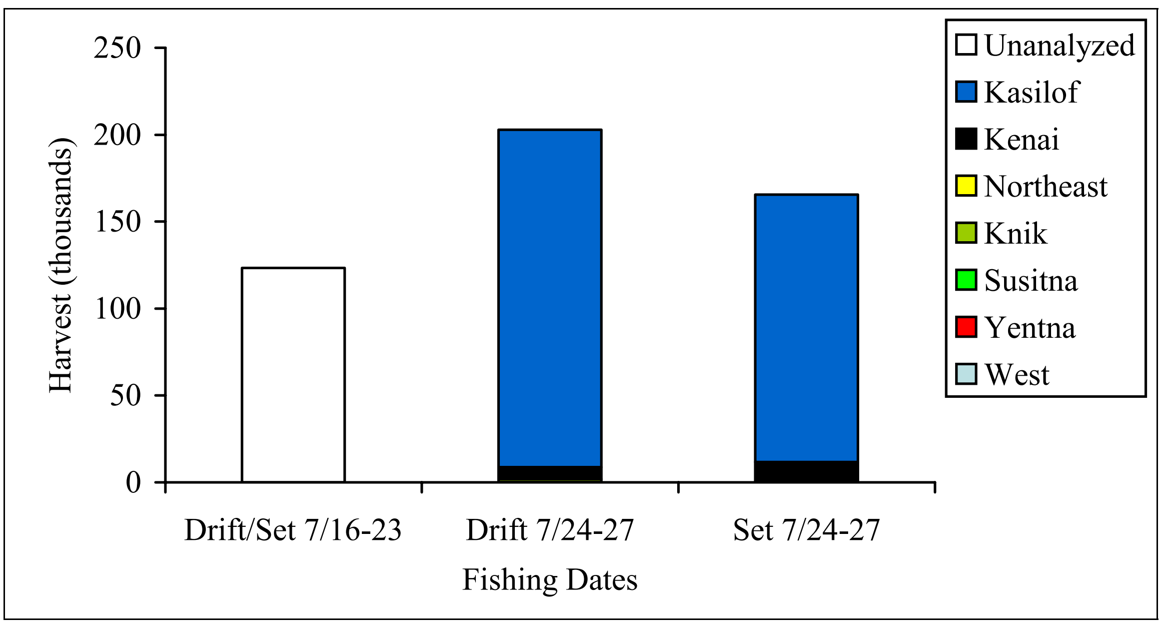

Figure 16.–Harvest by stock estimates for the Kasilof Terminal Area drift and set gillnet fisheries (Central District, East Side Subdistrict) in 2006.

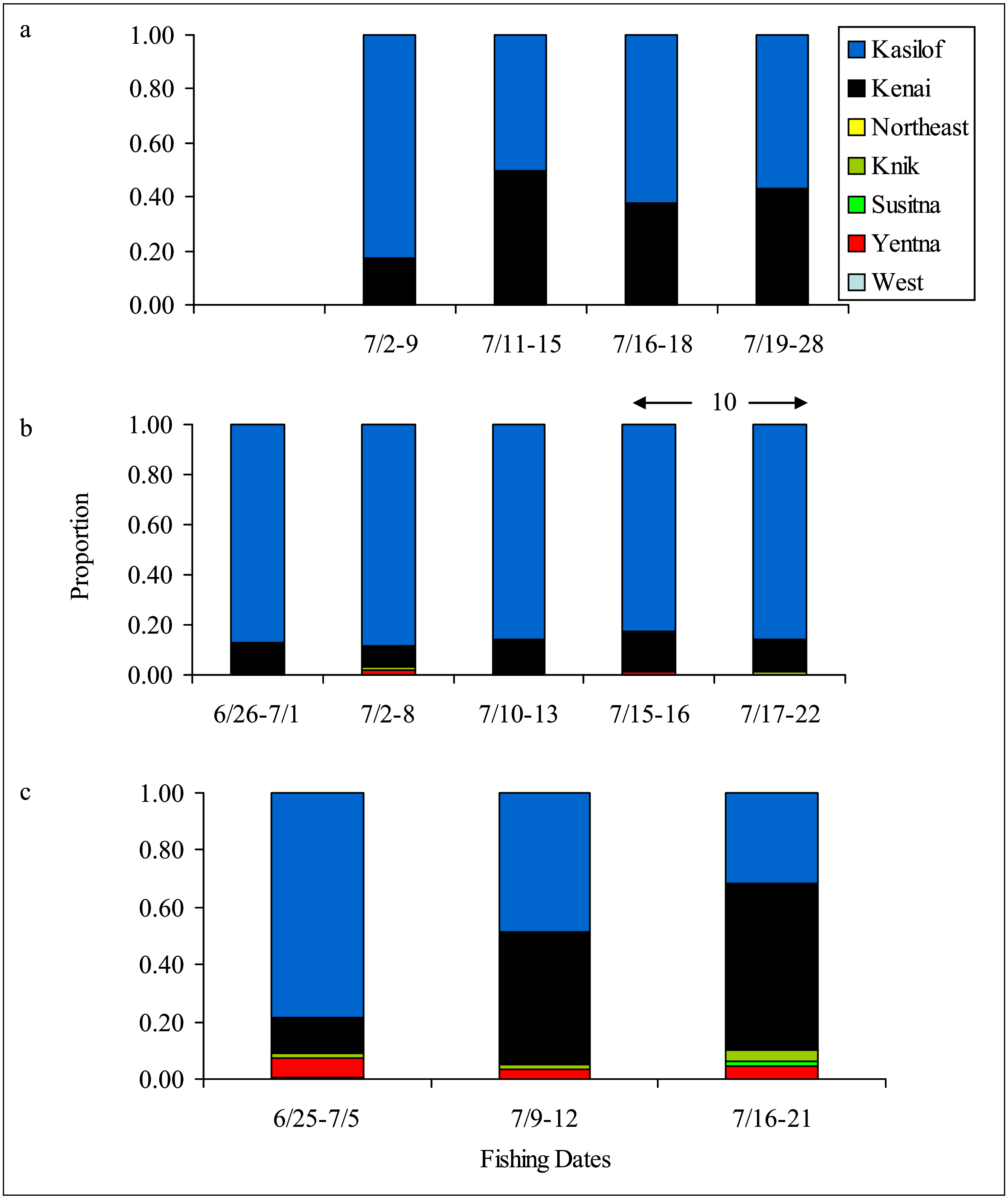

Figure 17.–Stock composition estimates for the Kasilof Section set gillnet fishery (Central District, East Side Subdistrict) from a) 2005, b) 2006, and c) 2007.

Note: Numbers above the bars indicate fishery restrictions during openings (10- Restricted to within 1/2 mile of shore: see Table 2). BAYES with a SPAM prior was used to estimate the proportions.

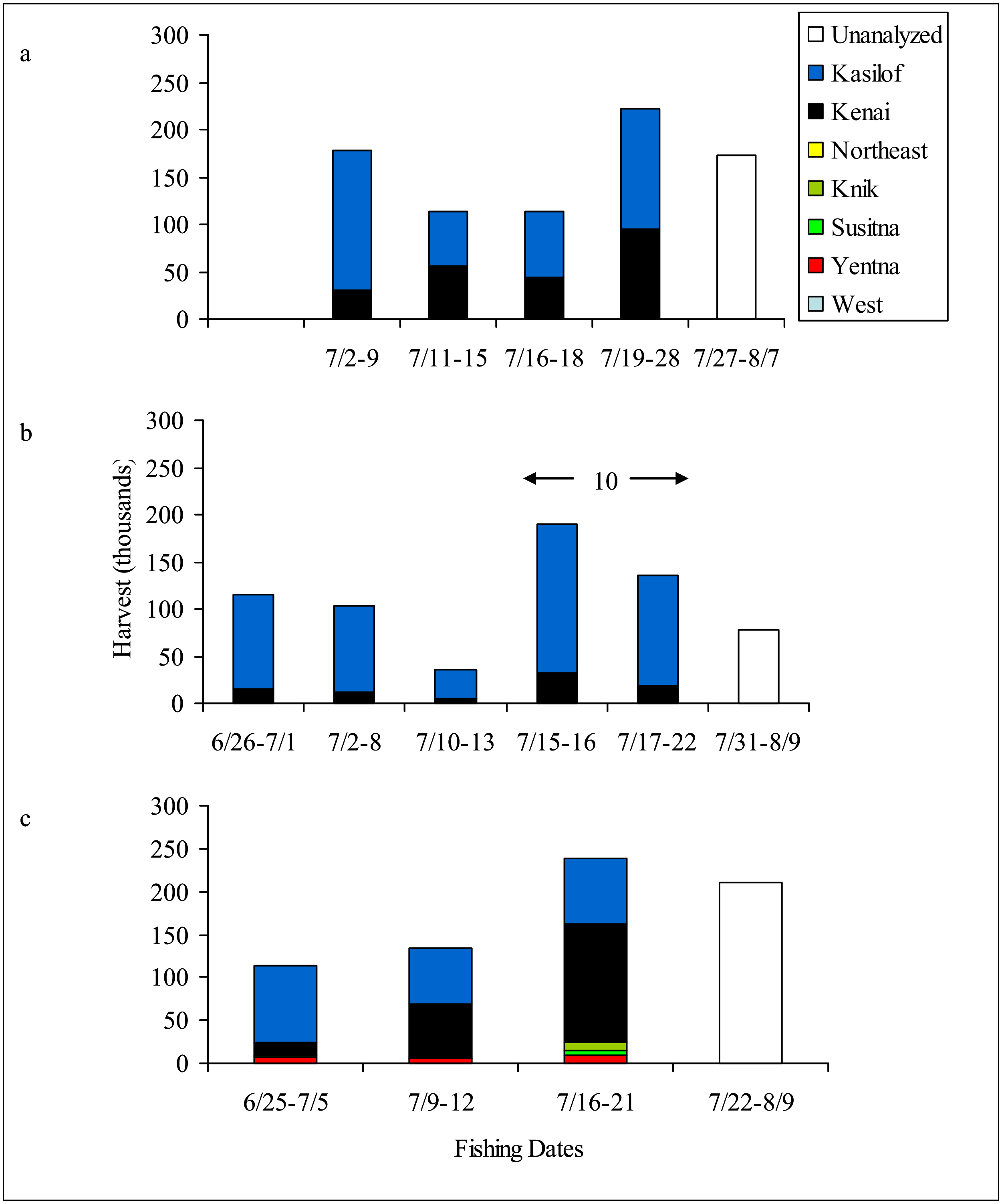

Figure 18.–Harvest by stock estimates for the Kasilof Section set gillnet fishery (Central District, East Side Subdistrict) from a) 2005, b) 2006, and c) 2007.

Note: Numbers above the bars indicate fishery restrictions during openings (10- Restricted to within 1/2 mile of shore: see Table 2). Fishing dates between subsections sometimes overlapped (see Table 2).

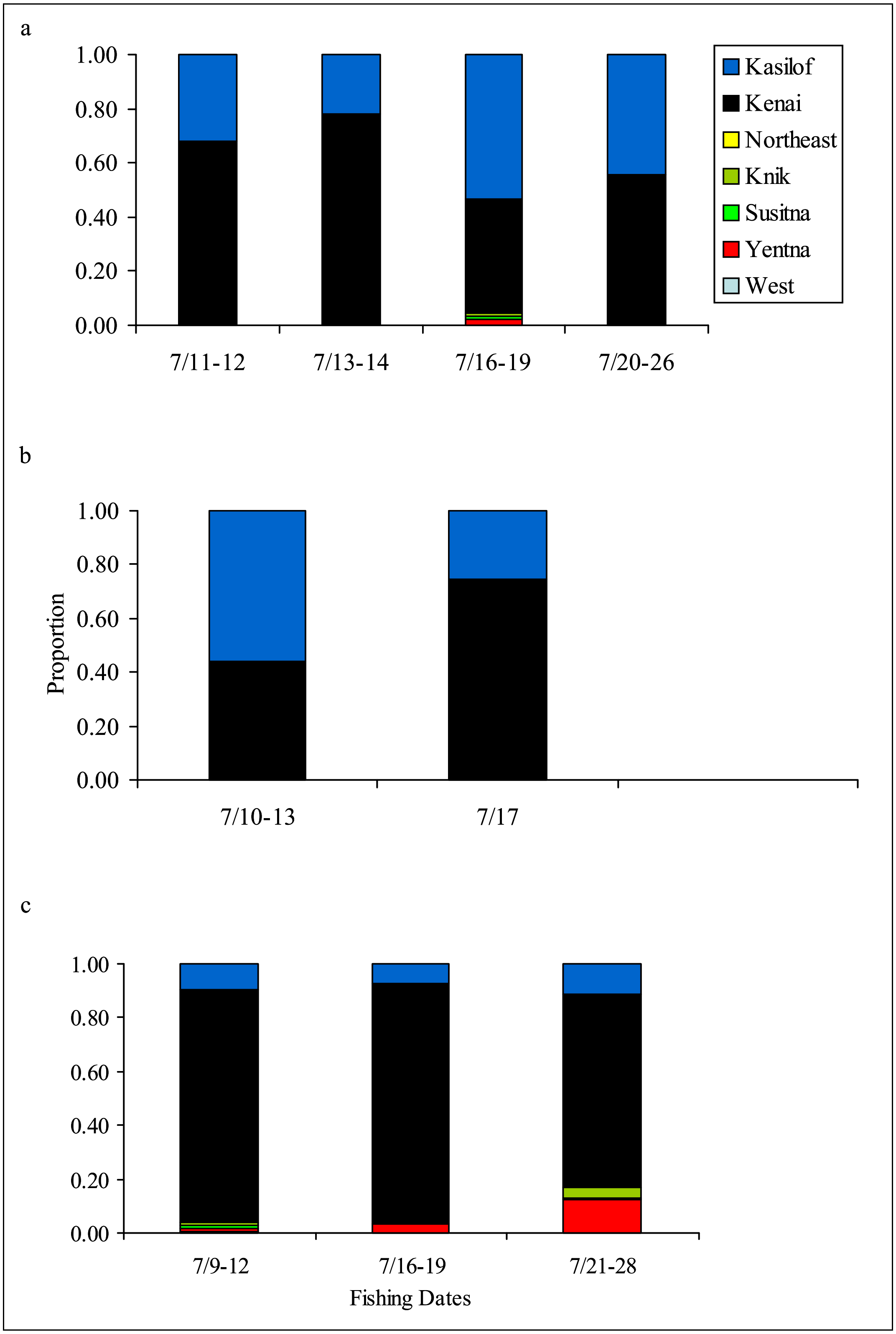

Figure 19.–Stock composition estimates for the Kenai Section set gillnet fishery (Central District, East Side Subdistrict) from a) 2005, b) 2006, and c) 2007.

Note: BAYES with a SPAM prior was used to estimate the proportions.

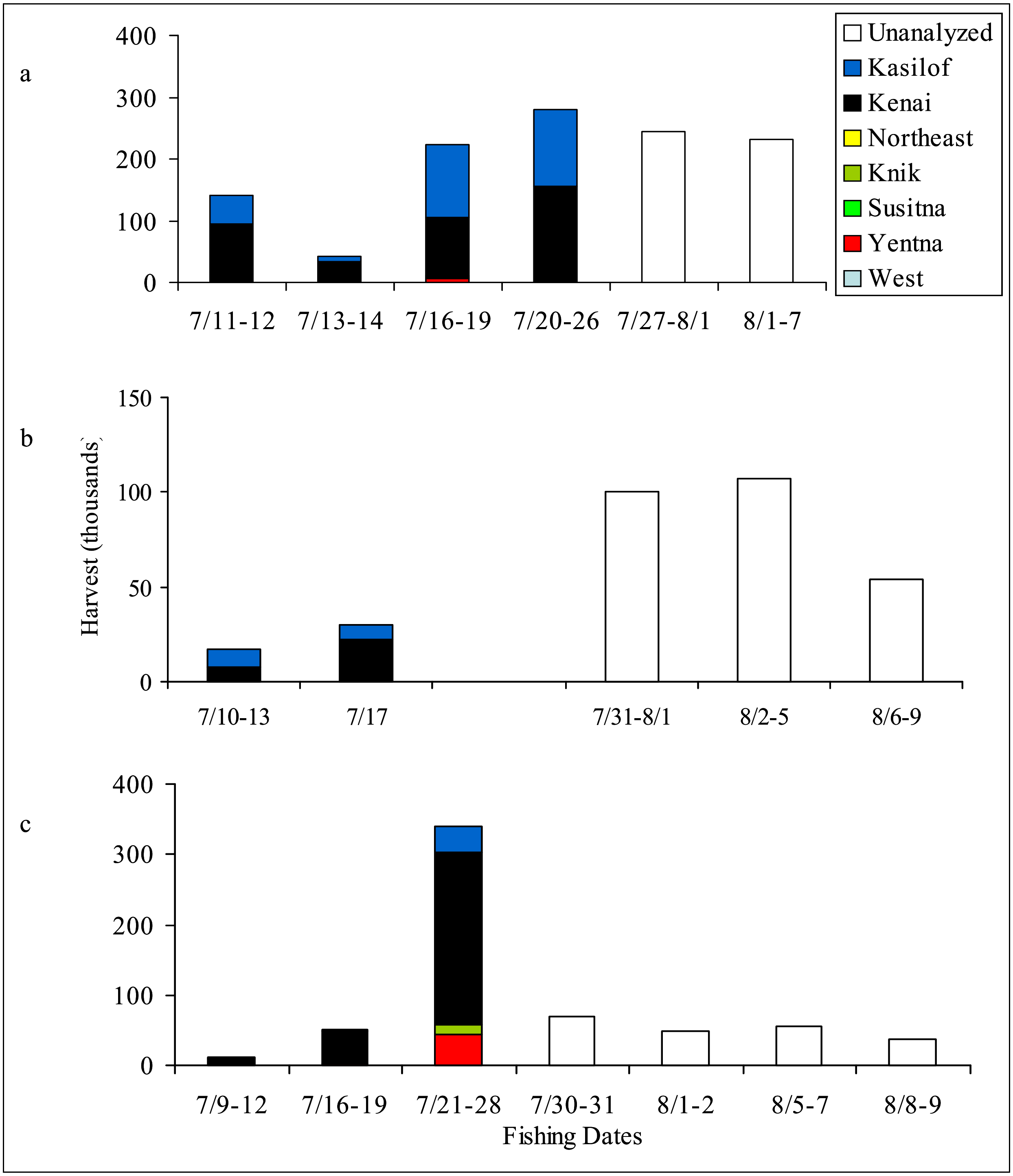

Figure 20.–Harvest by stock estimates for the Kenai Section set gillnet fishery (Central District, East Side Subdistrict) from a) 2005, b) 2006, and c) 2007.

Note: The 2006 graph has different scale from 2005 and 2007. Fishing dates between subsections sometimes overlapped (see Table 2).

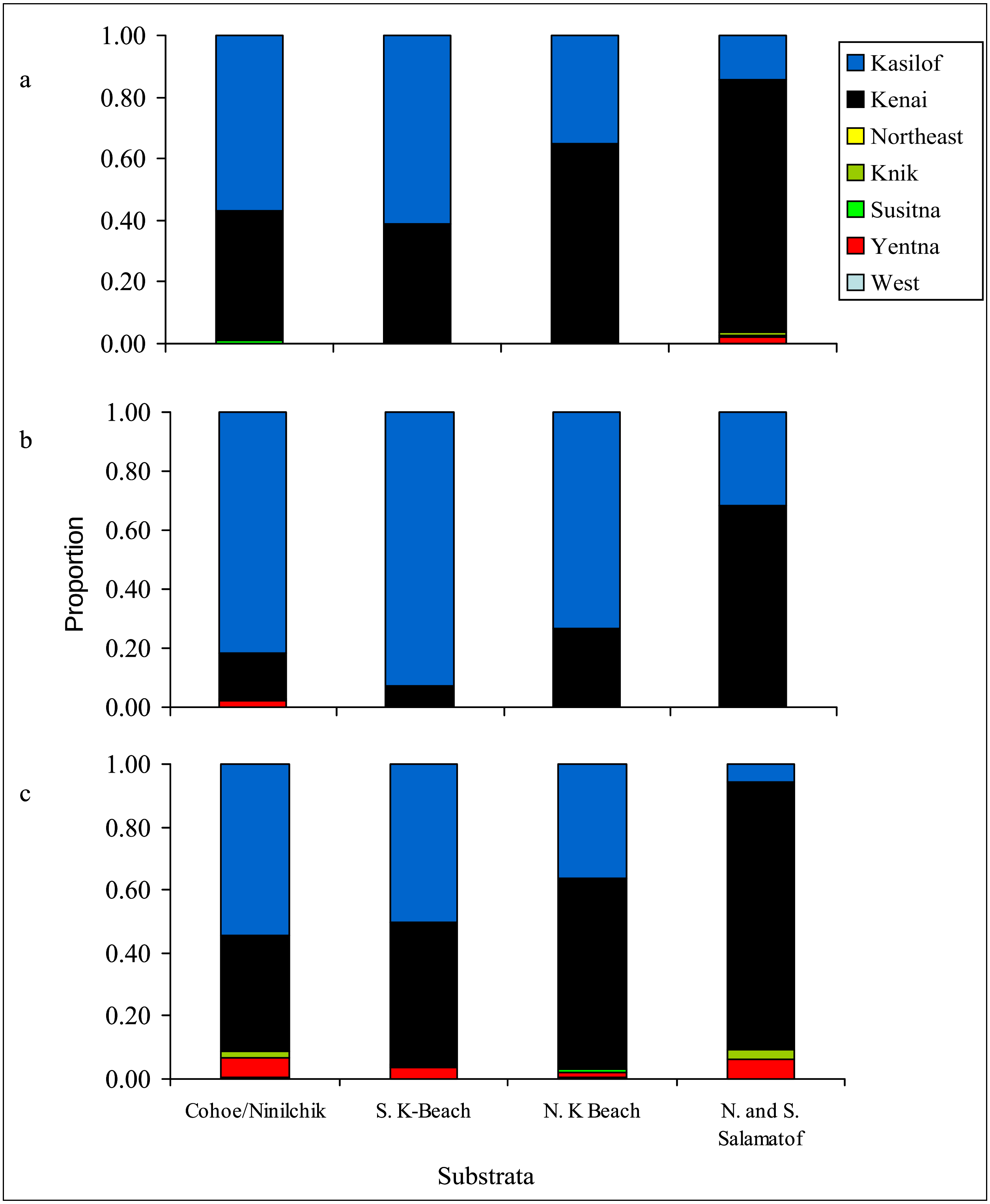

Figure 21.–Stock composition estimates for the Kasilof and Kenai Section set gillnet fisheries (Central District, East Side Subdistrict) divided into substrata from a) 2005, b) 2006, and c) 2007.

Note: There are two substrata for each section and they are displayed from south to north. BAYES with a SPAM prior was used to estimate the proportions.

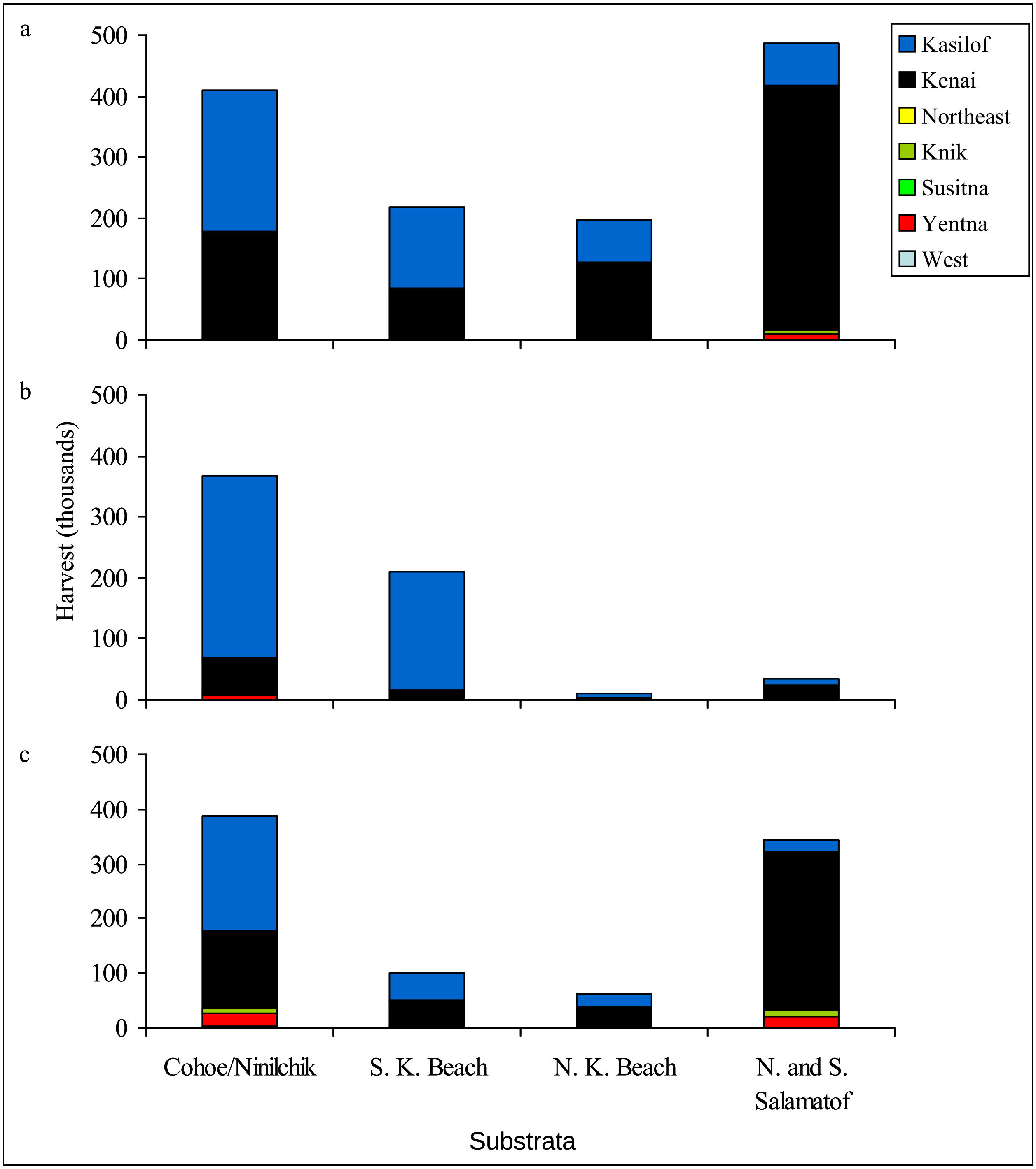

Figure 22.–Harvest by stock estimates for the Kasilof and Kenai Section set gillnet fisheries (Central District, East Side Subdistrict) divided into substrata from a) 2005, b) 2006, and c) 2007.

Note: There are two substrata for each section and they are displayed from south to north.