Fishery Data Series No. 07-79

Assessment of Coho Salmon from the Kenai River, Alaska, 2004

by

Rob Massengill

December 2007

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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by

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December 2007

This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-20 Job S-2-14b.

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This document should be cited as:
Massengill, R. 2007. Assessment of coho salmon from the Kenai River, Alaska, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-79, Anchorage.

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ABSTRACT

Wild coho salmon *Oncorhynchus kisutch* smolt were captured in the Kenai River drainage in spring 2003, marked with an adipose finclip and injected with a coded wire tag (CWT). Marked adults were recovered in 2004 from selected commercial fisheries in Upper Cook Inlet (UCI), Alaska, and from the Kenai River drainage. Mark-recapture data were used to estimate the UCI commercial harvest of Kenai River coho salmon in 2004 and smolt abundance in 2003.

There were 309,548 coho salmon harvested among all UCI commercial fisheries and 97,043 (31%) were examined for marks. There were 28,461 coho salmon (64% of the harvest) examined from Northern District harvests, 53,139 (27%) examined from Central District drift gillnet harvests, and 4,991 (17%) examined from Central District eastside set gillnet harvests. Among these, 1,055 adipose-clipped fish were observed: 1,044 were recovered, 941 bore a readable CWT, and 181 were identified as being of Kenai River origin.

Significant temporal variation in the tag-bearing proportion of Kenai River coho salmon sampled inriver precluded an accurate estimate of the tag-bearing proportion passing through the commercial fisheries and those commercially harvested. However, an overall tagged proportion estimate ($\hat{\theta}$) of the return ($\hat{\theta}$=0.100, SE=0.003); was generated from inriver sampling. Estimates were also generated for potential minimum ($\hat{\theta}$=0.068, SE=0.005) and maximum ($\hat{\theta}$=0.137, SE=0.009; $\hat{\theta}^{-1}$=7.3, SE=0.486) tagged proportion. These harvest estimates were compared to evaluate the practical impact of the temporal variation on commercial harvest estimates. The evaluation indicated that harvest estimates based on the overall tagged proportion are practical for assessment and planning purposes, but must be qualified for addressing allocation issues.

An estimated 5,921 (SE=1,092) Kenai River coho salmon were harvested by the Central District eastside set gillnet fishery, 4,251 (SE=531) by the Central District drift gillnet fishery, and 977 (SE=218) by all Northern District set gillnet fisheries for a total of 11,149 (SE=1,234). These estimates represented 19.7% of the total eastside set gillnet harvest of coho salmon, 2.1% of the drift gillnet harvest, and 2.2% of the Northern District set gillnet harvest.

Based on the number of live smolt released with an adipose-clip at the Moose River in 2003 (120,305), and the proportion of adult coho salmon examined with an adipose-clip in Kenai River fish wheel samples in 2004, an estimated 1,196,310 (SE=37,100) smolt emigrated from the Kenai River in 2003.

Key words: coho salmon, *Oncorhynchus kisutch*, population assessment, sustained yield, contribution, commercial harvest, coded wire tag, Kenai River, smolt abundance, wild.

INTRODUCTION

BACKGROUND

Wild coho salmon *Oncorhynchus kisutch* spawn and rear in freshwater drainages of Upper Cook Inlet (UCI), Alaska (Figure 1). As they return to spawn, adults are harvested in mixed-stock commercial and sport marine fisheries. Sport and personal use harvests also occur in fresh water. Cook Inlet ranks first in average (1993-2003) sport harvest of coho salmon among all regions of the state, sixth in commercial harvest, and third in overall harvest (Figure 2).

The Alaska Department of Fish and Game (ADF&G) initiated a program to assess the status of UCI coho salmon stocks in 1991 (Meyer et al. *Unpublished*). A primary component of the program is the wild coho salmon population from the Kenai River. This population was selected because of its history of large inriver harvests and unknown exploitation rates. These coho salmon support the largest freshwater sport harvest in the state (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995-1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004; Jennings et al. 2006a-b) and account for about 1 of every 11 coho salmon sport-harvested from Alaskan waters. The population also contributes to commercial marine fisheries in UCI and to marine sport and inriver personal use fisheries.

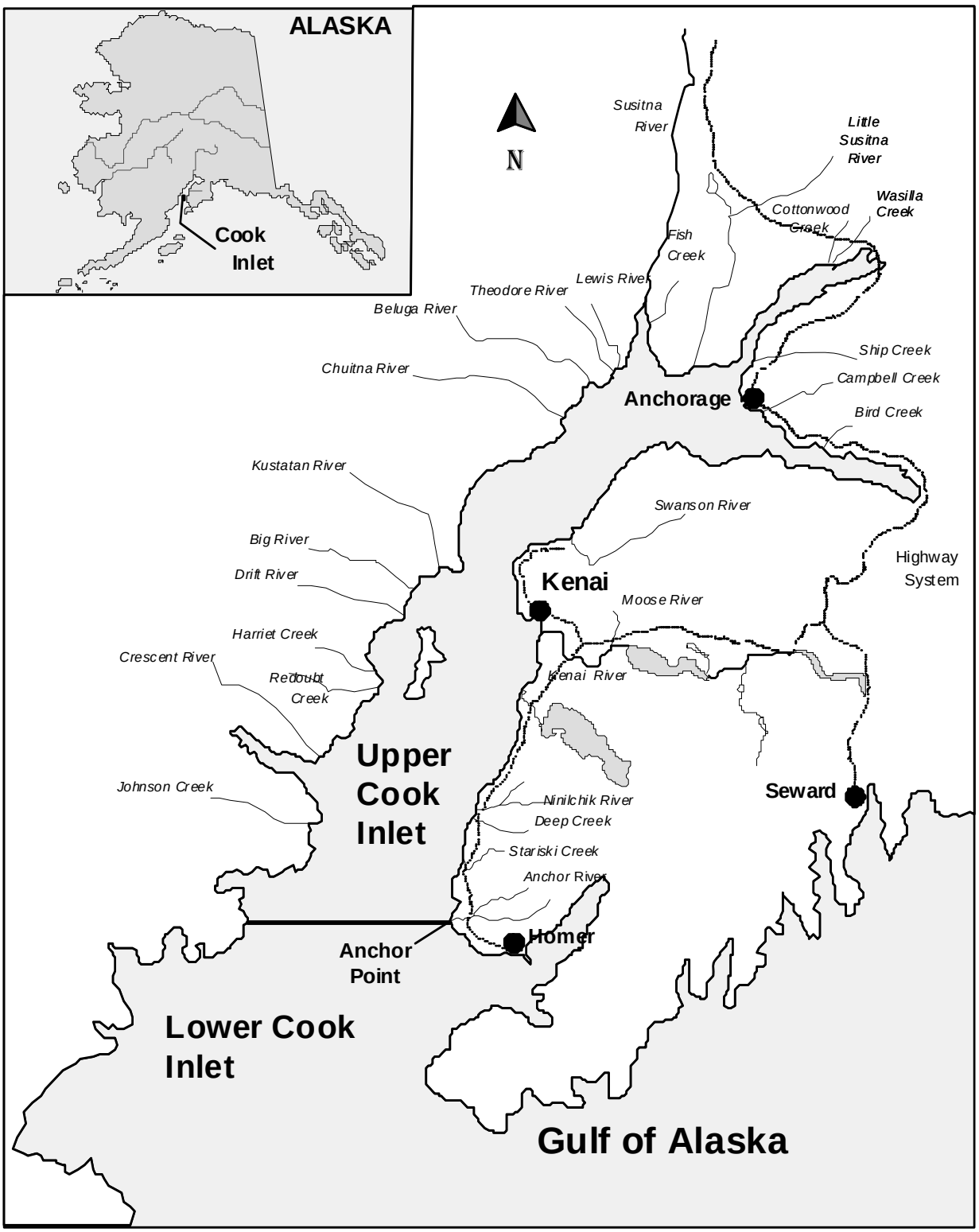

Figure 1.–The Cook Inlet Basin with selected tributaries known to support coho salmon.

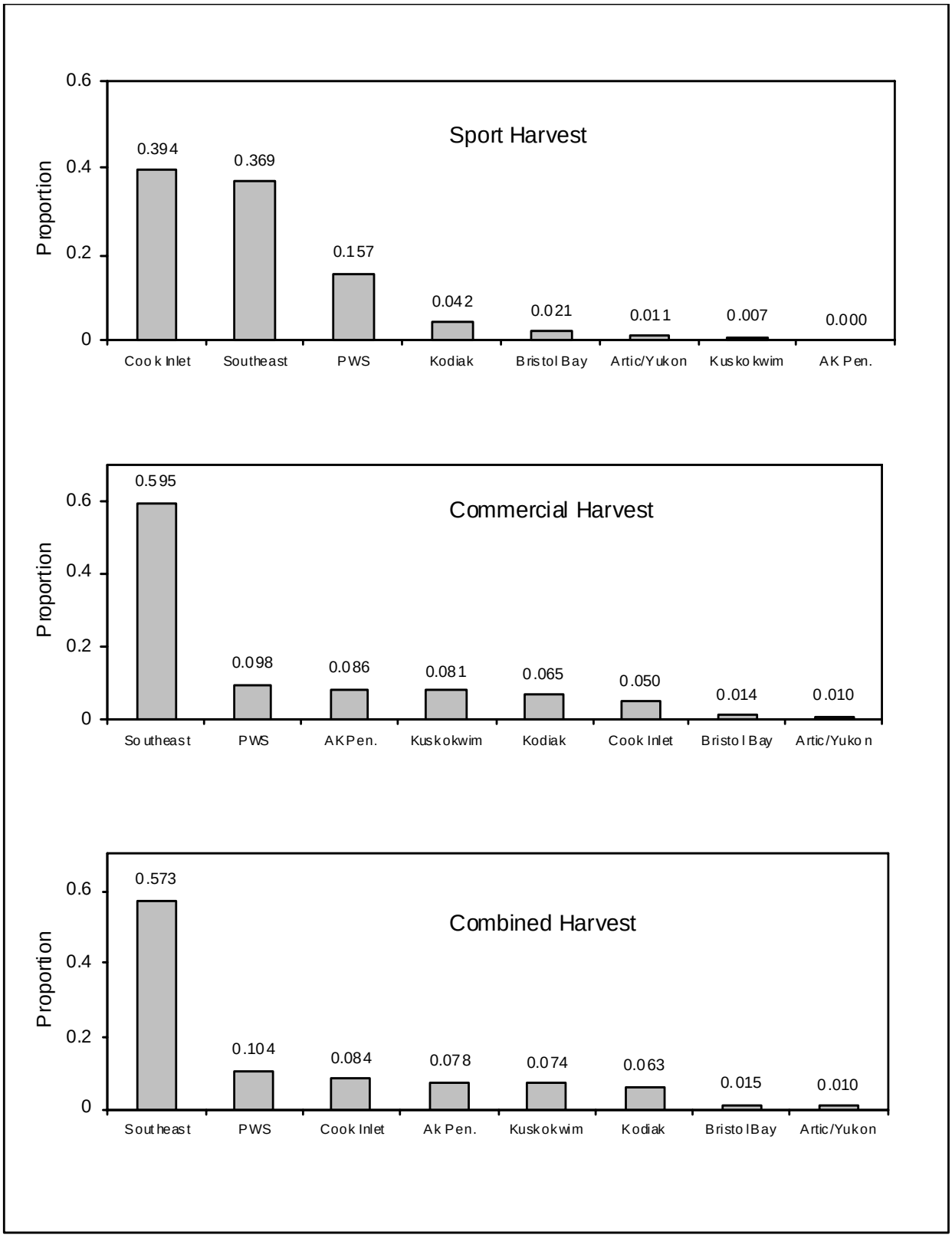

Figure 2.–Average proportions by region of the statewide commercial and sport harvests of coho salmon, 1993-2003.

The initial goal of the Kenai River population assessment program was to determine if exploitation by existing fisheries was threatening sustained yield and to develop a sustained-yield management objective (Meyer et al. *Unpublished*). To achieve this goal, annual exploitation rates and adult production were needed. A decline in production associated with increasing exploitation would signal the need for conservation actions and a long-term record would provide a quantitative way to develop a sustained-yield objective.

The initial research was to estimate the annual:

(A) Population-specific harvest in commercial marine fisheries,

(B) Inriver harvest by sport and personal use fisheries, and

(C) Spawning escapement.

The sum of these components (A + B + C) would provide the desired estimate of annual adult production. The sum of the two harvest components (A + B) divided by the estimated adult production would provide an estimate of exploitation rate.

Commercial harvest (component A) has been estimated annually since 1993 through a coded wire tag (CWT) release and recovery program (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004a-b; Massengill and Evans *in prep;* Massengill and Carlon 2007a-b). Inriver harvest by sport and personal use fisheries (component B) are estimated annually from angler surveys (Hammarstrom 1977, 1978, 1988-1992; King 1993; Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995-1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004; Reimer and Sigurdsson 2004; Jennings et al. 2006a-b). Mark-recapture studies have been used to estimate inriver adult abundance since 1999, when stress-related handling concerns were addressed (Vincent-Lang et al. 1993). Attempts to estimate abundance using sonar have been unsuccessful (Bendock and Vaught 1994).

Because adult exploitation rates and total adult production have only been estimated since 1999, an adequate series of these estimates is not available. Coho produced from the 2000 escapement returned as adults in 2004 and provided only the second total return estimate from a known parent escapement. Meanwhile, two interim indicators of sustainability are being monitored annually: total harvest and drainage-wide smolt abundance.

The Kenai River assessment program revealed an overall decline in smolt abundance between 1992 and 1995 (Carlon and Clark *Unpublished*). Although the cause of the decline remains unknown, it heightened concerns about the sustainability of historic harvest levels. The Alaska Board of Fisheries (BOF) responded by developing and adopting a management plan for Kenai River coho salmon. The first Kenai River Coho Salmon Management Plan (Alaska Fish and Game Laws and Regulations Annotated 1997-1998; 5 AAC 21.357) was adopted and took effect in 1997.

A review in 2000 suggested that adult Kenai River coho salmon abundance was declining and that additional precautionary restrictions were needed to protect the stock (Clark et al. *Unpublished*). Concurrently, other UCI coho salmon stocks were declining and, in 2000, the BOF responded by adopting the Kenai River Coho Salmon Conservation Management Plan (Alaska Fish and Game Laws and Regulations Annotated 2000-2001; 5 AAC 21.357). This plan modified the 1997 version and included additional restrictions to both commercial and sport fisheries.

This report documents the 2004 commercial harvest of Kenai River coho salmon and the 2003 smolt abundance estimates. Adult coho salmon exploitation rate and production are estimated in a companion mark-recapture study (Carlon *In prep*). The commercial harvest of Kenai River coho salmon has been documented since 1993 and smolt abundance since 1992 (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004ba-b*;* Massengill *In prep a;* Massengill and Carlon 2007a-b).

OBJECTIVES

The primary objectives of this study were to estimate:

1. the harvest of coho salmon of Kenai River origin in the eastside set gillnet and drift gillnet fisheries of the Central District and in the set gillnet fisheries of the Northern District of UCI in 2004, and
2. the number of coho salmon smolt that emigrated from the Kenai River in 2003.

METHODS

EXPERIMENTAL DESIGN

Commercial Harvest Objective

To estimate the commercial harvest of Kenai River coho salmon, smolt were captured in the Kenai River in 2003, marked with a CWT, and released. These fish were then recovered as adults in 2004 from commercial mixed stock fisheries which take place in defined statistical areas (Figure 3). The number of Kenai River tags recovered in the commercial harvest was expanded by the reciprocal of the tagged proportion initially tagged to provide an estimate of the Kenai River-specific harvest. Total harvest of coho salmon in 2004 commercial fisheries was obtained from the ADF&G commercial fishery fish ticket database system. Sampling the commercial harvest for marked fish was accomplished by the Division of Commercial Fisheries (CFD). The tagged fraction of the adult return to the Kenai River was estimated by examining adults from inriver fish wheel samples in 2004.

Smolt Abundance Objective

Smolt abundance was estimated via a two-event mark-recapture study. During the first event, smolt were captured, injected with CWTs, and released with an adipose fin clip in 2003. In the second event, the 2004 inriver return was sampled for marked fish. The smolt abundance estimate was considered accurate if there was statistically no temporal variation in the fraction of adults marked with adipose-clips in the inriver samples. A constant marked fraction over time indicates that marked smolt were representative of, or mixed with, the drainage-wide smolt population. Either condition allows an unbiased estimate of the drainage-wide smolt production.

In contrast to the commercial harvest model, temporal variation in the marked fraction does not necessarily result in biased smolt abundance estimates. Mark-recapture models are inherently robust because bias in selecting individuals during the marking phase can be overcome by randomly selecting individuals during the recovery phase. While bias in selecting individuals for marking is unknown, bias during adult sampling is considered minimal.

Cook Inlet Commercial Salmon Statistical Areas

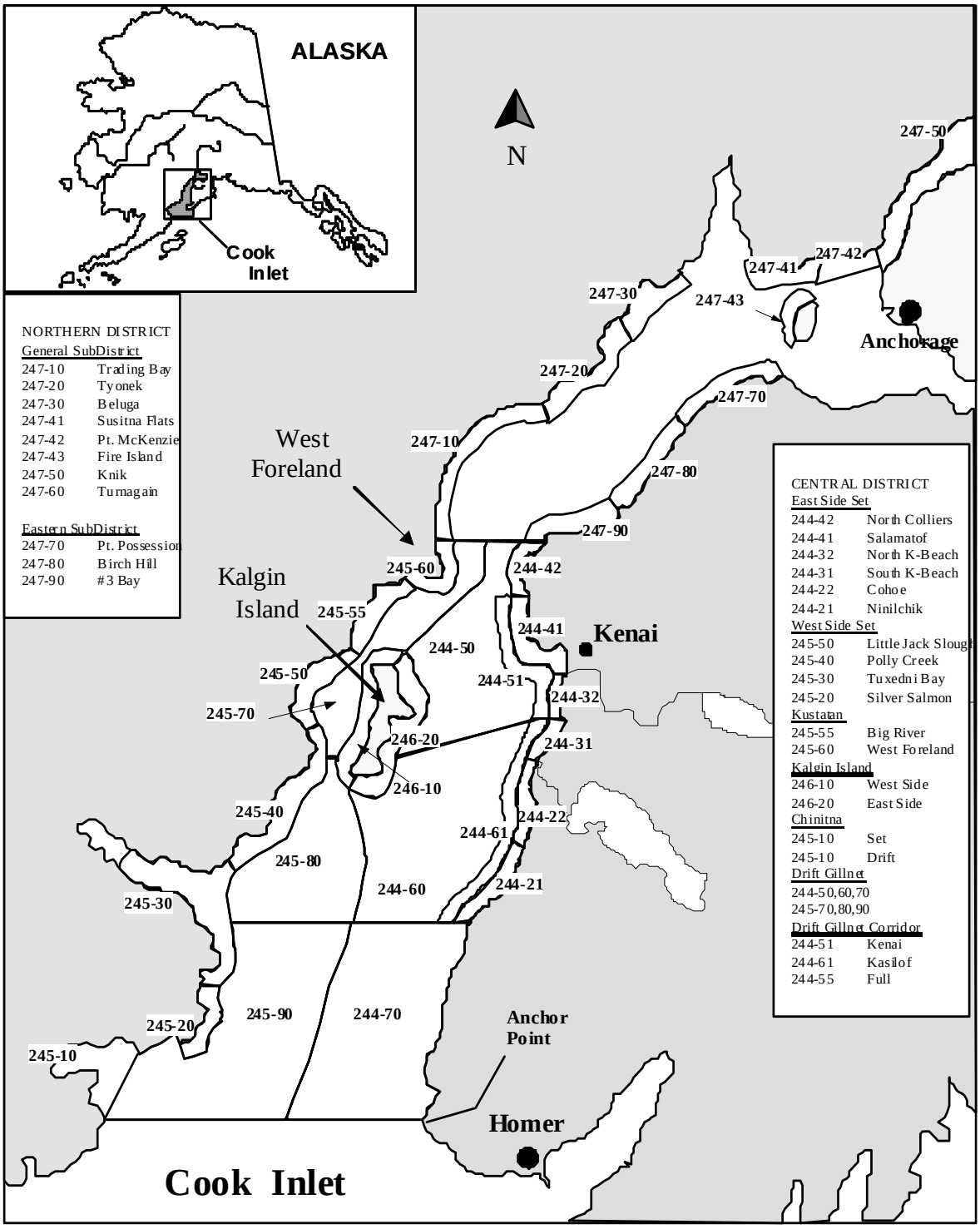

Figure 3.–Upper Cook Inlet commercial fisheries statistical areas.

DATA COLLECTION

Smolt Marking in 2003

Smolt were captured and marked at the Moose River in 2003, 7.5 river kilometers (rkm) upstream of its confluence with the Kenai River (Figure 4). Before 1994, smolt were captured and tagged at a variety of locations (Carlon 1992, Carlon and Hasbrouck 1993). However, recovery of marked adults indicated that the Moose River was the only suitable location for marking smolt (Carlon and Hasbrouck 1994). In addition to providing a sufficient number of smolt, the Moose River provided smolt that were representative of the entire Kenai River population (Carlon and Hasbrouck 1994). Smolt have been marked only at the Moose River since 1994.

A weir with a trap was installed in the mainstem of the Moose River on May 19, 2003, to capture smolt as they emigrated downstream from wintering habitats higher in the drainage. The weir was a total barrier to fish migration from May 20 to June 22, 2003. Marking smolt with both CWTs and adipose finclips began on May 20 and ended on June 13.

Smolt were the primary lifestage captured and tagged at the Moose River. Although some coho salmon shorter than 100 mm FL were present, they were not marked because they were different in appearance (parr marks highly visible and substantially less silver skin pigmentation). In addition, scale samples from fish shorter than 100 mm all exhibited only one annulus. Most Kenai River coho salmon smolt after 2 years in fresh water and exhibit two scale annuli (Hammarstrom 1988-1992).

The marked proportion of the adult return in recent years has exhibited significant inriver temporal variation. To reduce any temporal variation caused by “front-loading” tags during emigration, we discarded the strategy of marking the minimum goal of 95,000 smolt as quickly as possible in favor of protracting the tagging. Hence, a maximum tagging rate of about 5,000 tags per day was implemented in 2003. After tagging was discontinued, the weir remained in place until June 23 to census the smolt emigration.

Fish captured in the weir throughout each day were partially immobilized by sedating with MS-222 to a level-two anesthesia (Yoshikawa et al. 1988), hand-sorted into two length groups, and transferred to instream holding pens. An inriver tagging facility allowed fish to be netted directly into a holding tank for tagging. Fish were handled and marked following standard CWT procedures (Moberly et al. 1977). Fish were re-sedated to a level-three anesthesia (Yoshikawa et al. 1988) and the adipose fin was excised with surgical scissors. All fish were then tagged using a Northwest Marine Technologies® Mark IV tag injector fitted with the optimal head mold. Head molds were chosen to result in proper and precise tag placement in fish of each length group (Northwest Marine Technologies Inc 1990; Peltz and Hansen 1994). Fish ≤125 mm were tagged using a 30-per-pound head mold, those >125 mm and ≤150 mm were tagged with a 20-per-pound head mold. Smolt >150 mm were rarely captured and were released untagged because of the additional time required to sedate them; because this was rare, there was no expected impact on the marked proportion in the subsequent year’s return of adults. Marked fish were released to continue their downstream migration after recovering from anesthesia in an inriver holding pen.

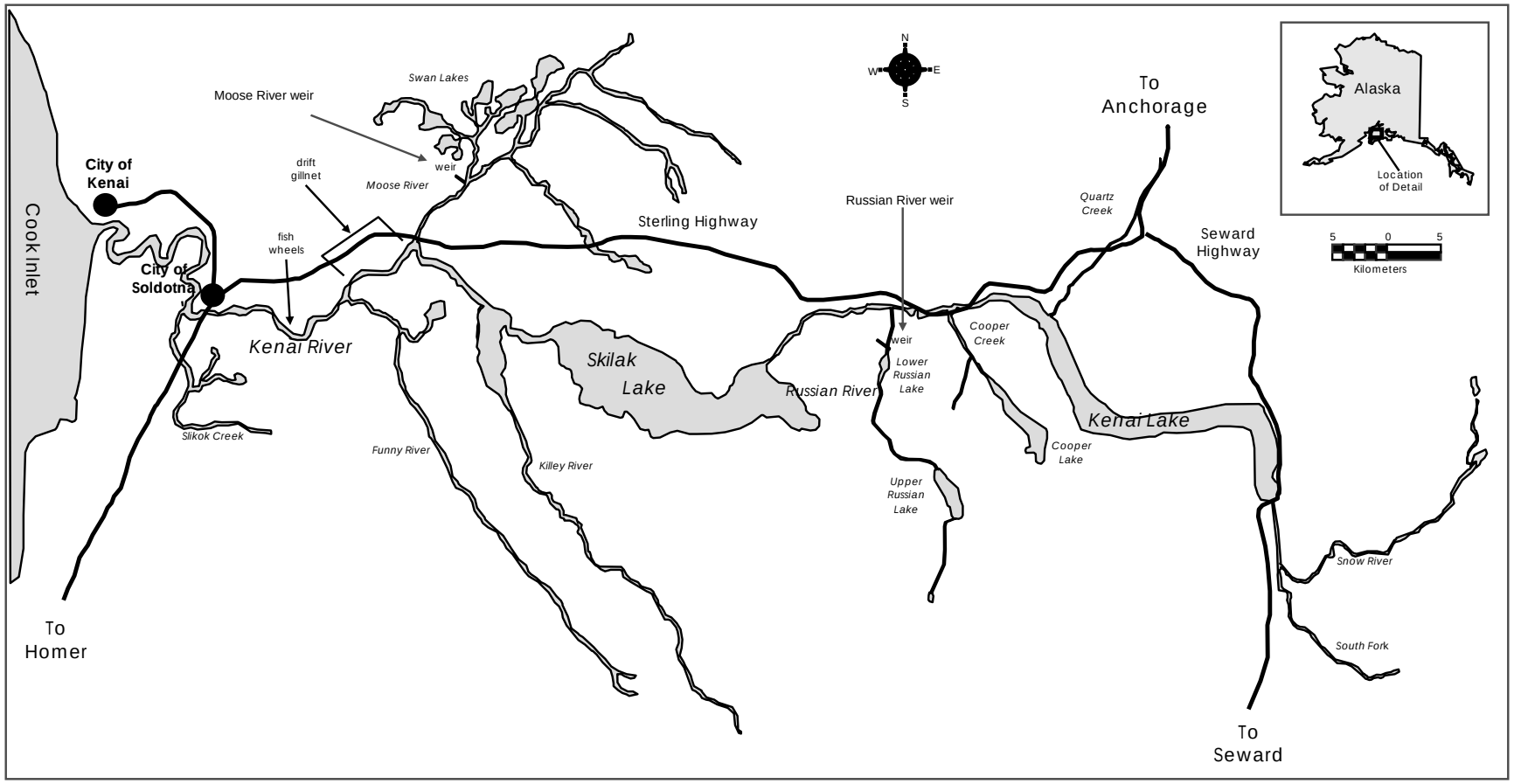

Figure 4.–The Kenai River drainage showing the Moose River weir location where coho salmon smolt were marked and released in 2003, and Kenai River fish wheel and Russian River weir locations in 2004.

Tag codes released in 2003 were verified visually with a binocular microscope on site and the number of smolt marked each day was recorded. Smolt were batch marked and a single tag code was applied to all individuals in a group. The number marked per group ranged from 11,834 to 23,321 depending on the number of tags per tag code. Nine tag codes were released during the emigration.

Short-term survival and tag retention rates were estimated for smolt marked during each tagging shift by detaining about 200 marked fish in holding pens overnight. These rates were monitored as a quality control measure. Substantial decreases in survival or tag retention would identify a need to adjust the capture, handling, or marking procedures. Estimated short-term survival rates were used to estimate the total number of marked smolt that survived the marking procedure. The number of marked fish that survived marking and were released is a requirement of the model used to estimate smolt abundance.

Recovery of Marked Adults in the 2004 Return

Fish Wheels

As part of the companion mark-recapture study, two fish wheels were operated in the mainstem of the Kenai River to capture adults for marking. This also provided a sample source for examining fish for a missing adipose fin.

Coho salmon were captured in fish wheels and examined for a missing adipose fin from August 1 to September 30 (the last day coho salmon were caught). Most fish with a missing adipose fin were checked with an electronic tag detection wand for the presence of an embedded CWT. A sample of marked fish with no tag detected was sacrificed to determine the rate of false-negative wand results. This was used to adjust the tagged fraction estimate. The false-positive rate was assumed to be zero.

Drift Gillnetting

Drift gillnets were the primary gear used in the recapture event of the companion mark-recapture study in 2004. The drift gillnet samples were used to evaluate the recapture event as a source for estimating the tagged proportion of the 2004 return. This constituted the recapture event and provided another source of adult coho salmon to examine for a missing adipose fin.

Two to four (two-person) crews' deployed drift gillnets in the mainstem Kenai River each day during all daylight hours from August 1 to October 5. Crews operated from riverboats between rkm 48.9 and 58.4 to distribute sampling effort over the entire recapture reach and throughout the day.

All coho salmon captured were marked with a dorsal fin punch (to avoid duplicate sampling), and examined for external tags and an adipose fin. The number of coho with and without an adipose fin was recorded daily.

Russian River

Supplemental samples were also collected at the Russian River weir. The weir is used to census sockeye salmon *O. nerka* returns and is managed for an escapement goal. Until 2001, the weir had also been used to census coho salmon escapement, but now is only operational through early September. The weir is used to enumerate early returning coho salmon and to

examine the Russian River population for missing adipose fins. Fish were not sacrificed to retrieve CWTs nor were they detained, but were simply counted and visually examined for an adipose fin as they passed through the weir.

Russian River coho salmon escapements have been fully enumerated previously (Carlon 2000, 2003; Marsh 1995; Nelson 1983; Massengill and Carlon 2004ba-b; Massengill *In prep a;* Massengill and Carlon 2007a-b). A census of annual escapements at the Russian River was done most recently from 1997 to 2001 by extending weir operation into early October to enhance the overall assessment program and to provide another source of adults to examine for missing adipose fins. In 2004, the weir operated June 8 through September 3.

Upper Cook Inlet Commercial Harvest in 2004

Commercial fisheries sampled in 2004 included the drift gillnet and the eastside set gillnet fisheries of the Central District and the set gillnet fisheries of the Northern District. These areas historically account for most of the UCI coho salmon harvest (Ruesch and Fox 1995). Northern District fisheries typically harvest less than a few hundred coho salmon of Kenai River origin, but were sampled to estimate the harvest of hatchery-produced coho salmon stocked in Northern District streams (Bosch and Evans 2006; Bosch and Evans *In prep*; Namtvedt. *In prep*). Harvests in other UCI commercial fisheries have previously been sampled incidental to this effort (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004ba-b; Massengill *In prep a;* Massengill and Carlon 2007a-b).

In 2004, both the Central District drift gillnet and eastside set gillnet fishing seasons opened on June 25 (Fox and Shields 2004). The harvests in both fisheries were examined during most open periods through the fishing season from late June to early August. Northern District set gillnet harvests were likewise examined through the last fishing period.

Coho salmon were examined at shorebased processing locations (main plants and buying stations) throughout UCI to recover CWTs from adipose-clipped fish. Daily totals of coho salmon examined and the number missing an adipose fin were recorded. Heads were collected from adipose-clipped fish, frozen, and shipped to the ADF&G Mark, Tag, and Age Laboratory (Tag Lab) for retrieval of the CWT. The date sold (date harvested), statistical area of harvest when available, and processor was also recorded. In general, the statistical area of each set gillnet harvest sample was known. Drift gillnet harvests were typically a mix of fish from multiple statistical areas. All tag recovery data were recorded and archived by the Tag Lab. The raw data are accessible via the World Wide Web at URL http://tagotoweb.adfg.state.ak.us.

DATA ANALYSIS

Several steps were required to estimate smolt production in 2003 and commercial harvest of Kenai River coho salmon in 2004. For the smolt production estimate, the essential steps were: (1) estimate the number of smolt marked in 2003 that survived the marking process and (2) detect adipose-clipped fish in the 2004 adult inriver return from known sample sizes. For the commercial harvest estimate of Kenai River coho salmon, the essential steps were: 1) test the hypothesis that the proportion of adults with CWTs observed inriver in 2004 did not change over time, (2) estimate the proportion of the adult return in 2004 with CWTs, and 3) recover CWTs from known sample sizes in the commercial fishery.

Smolt Marking in 2003

To determine the number of marked smolt released in 2003, short-term survival and tag retention rates were estimated from a representative sample of about 200 smolt detained in holding pens for 18 to 24 hours after marking.

Short-term survival rate (s_k) for smolt marked and released during marking shift *k* was estimated as the fraction of smolt that survived the detainment period. Short-term tag retention rate (b_k) for smolt marked during a shift that survived was estimated as the fraction of surviving smolt that retained their tags. The number of smolt marked with a tag during each shift *k* (m'_k) was adjusted to account for short-term survival and tag retention to yield an estimate of the total number of tagged smolt that survived and retained a tag in shift *k*, m_k:

$$\hat{m}_k = m'_k \hat{s}_k \hat{b}_k \quad (1)$$

The number of smolt that were marked, survived, and retained a tag at the Moose River in 2003 was estimated by summing $\hat{m}_k$ over all marking shifts. This was required to determine when the goal of releasing 95,000 tagged live fish was achieved. The quantities $\hat{s}_k$ and $\hat{b}_k$ also served as real-time quality control measures. The number of smolt marked with an adipose-clip was estimated by summing the individual estimates of the number of marked fish that survived the marking process. This represented the number of fish marked and released in the mark-recapture study to estimate smolt abundance.

Recovery of Marked Adults in the 2004 Return

Estimating the commercial harvest of Kenai River coho salmon in 2004 required estimating the tagged proportion (θ) of the return (i.e., the proportion physically bearing CWTs). The tagged proportion was unknown at the time of smolt marking in 2003, but was estimated when adults returned in 2004 by examining fish from the inriver sampling.

Estimating the tagged proportion (θ) from a specific bank at the fish wheel site was a three-step process. The first step was to estimate the adipose-clip rate (y_i) in the returning population sampled at each fish wheel during weekly interval *i*. The rate was estimated as the proportion of fish examined that had a missing adipose fin. The second was to estimate the smolt-to-adult tag retention rate (c_i) in the returning population of adipose-clipped fish sampled at each fish wheel during weekly interval i:

$$\hat{c}_i = v'_i / h_i, \quad (2)$$

where:

h_i = the number of adipose-clipped fish that were wand-tested in each fish wheel sample in week *i*,

$$v'_i = v_i + (h_i - v_i)(\sum_i f_i / \sum_i s_i), \quad (3)$$

where:

v_i = the number of positive wand results (tag detected) from sample h_i,

s_i = the number of fish with negative wand results (no tag detected) in h_i that were sacrificed to verify the negative result, and

f_i = the number, of false negatives in s_i (number of adipose-clipped fish that tested negatively with the wand, were sacrificed, and found to carry a tag).

An overall false-negative correction factor $(\sum_i f_i / \sum_i s_i)$ is estimated using equation (3) by summing false-negative data (s_i and f_i) over all weekly intervals *i*. By including this correction, it is assumed that the probability of a false negative reading remains constant through weeks. The pooling was required because only a small sample of fish with negative wand results were sacrificed in 2004. Combining all data was necessary to obtain a reasonably precise estimate of the false-negative rate.

The third step was to estimate the tagged proportion (θ_i) of the population sampled at each fish wheel during weekly interval *i* that carried a tag implanted at the Moose River in 2003:

$$\hat{\theta}_i = \hat{y}_i \hat{c}_i \tag{4}$$

Estimating the tagged proportion (θ) from each drift gillnetting bank and from the Russian River weir was calculated similarly, except that no estimate of tag retention was made. An overall tag retention estimate, calculated from the fish wheel data, was used in place of c_i to adjust the adipose-clip rate. To minimize physically detaining the spawning migration fish were not checked with an electronic tag detection wand, and it was assumed that tag retention rates were similar among all inriver sample sources within the Kenai River.

For each sample source, a chi-square statistic was used to test the hypothesis that the proportion of fish carrying a Moose River tag did not change weekly ($\alpha = 0.05$). Failure to reject the hypothesis would indicate that the proportion of adults bearing a tag was constant over weeks, allowing calculation of an overall estimate of the tagged proportion (θ) for the sample source by combining weekly data. A chi-square statistic ($\alpha = 0.05$) was also used to compare pooled data among sampling sources. These calculations were used to determine if samples could be combined among weeks and sources to provide a more precise estimate of the overall tagged proportion in the 2004 return.

Smolt abundance was estimated using the adipose-clip recoveries as opposed to the presence of a CWT. The number of adipose-clipped adult fish recovered in the 2004 inriver samples was recorded as a requirement for estimating smolt abundance in 2003.

Smolt Abundance in 2003

The model used to estimate smolt abundance was the Chapman modified Lincoln-Petersen model (Seber 1982):

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1, \tag{5}$$

where:

M = the number of smolt marked with an adipose-clip that survived to emigrate in 2003,

C = the number of adult coho salmon examined for an adipose-clip in the 2004 return sample, and

R = the number of adult coho salmon in the 2004 sample that had an adipose-clip.

The variance of the smolt abundance estimate was estimated by:

$$\hat{V}(\hat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}, \quad (6)$$

This model produces unbiased estimates of abundance when all of the following assumptions are met:

1. adult coho salmon examined were a random sample of the inriver return or the marked smolt were representative of the drainage-wide smolt emigration in 2003 or there is complete mixing of individuals between the mark and recapture events,
2. all juveniles marked at the Moose River in 2003 were actually smolt,
3. survival and catchability were the same for marked and unmarked individuals,
4. adipose fins were not regenerated between the mark and recovery events,
5. there was no natural loss of adipose fins at any time during the life of the population, and
6. fish were correctly categorized for the presence or absence of an adipose fin during inriver sampling.

Independence between the timing of smolt tagging and adult return timing has been observed (1993-1997) in both inriver and commercial recoveries (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000). The independence observed is indicative of mixing of marked and unmarked fish after tagging. Observations also indicate that smolt emigrating from the Moose River contain representatives of the entire Kenai River population. While independence between release and return timing and the cosmopolitan nature of the Moose River smolt migration does not guarantee representative tagging of the entire Kenai River smolt population, or complete mixing of fish between tagging and recapture, they are consistent with the latter two conditions of assumption 1. Also, the inriver fish wheel and drift gillnet samples are assumed to be random because of the wide (4.2 to 13.9 rkm) spatial and temporal distribution of the fishing effort. Therefore, there is a good chance that at least one of the three conditions of assumption 1 is fulfilled.

The other five assumptions are also likely valid. Experience and observations indicate that most juveniles marked at the Moose River each year are smolt (assumption 2). Although long-term survival and catchability assumptions are untested for this population, short-term survival of marked smolt has been nearly 100% during all smolt-marking events at the Moose River (assumption 3) (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004ba-b; Massengill *In prep a;* Massengill and Carlon 2007a-b),. Hatchery-produced coho salmon marked with adipose-clips and CWTs and released in a western Kenai Peninsula drainage experienced similar smolt-to-adult survival as unmarked coho salmon (Vincent-Lang 1993). Thompson and Blankenship (1997) found no regeneration of coho salmon adipose fins after excision if the fin was completely removed at the outset (assumption 4). There has been no quantitative study to estimate the occurrence of naturally

missing adipose fins in the Kenai River drainage (assumption 5). However, of more than 1,400,000 coho salmon juveniles handled since 1991, only a few have been found to be naturally missing the adipose fin. Also, the short-term and long-term tag retention rates have been nearly identical (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004ba-b; Massengill *In prep a;* Massengill and Carlon 2007a-b). This supports the supposition that naturally missing adipose fins are rare with coho salmon in the Kenai River drainage.

Commercial Harvest in 2004

All commercial harvest estimates of Kenai River coho salmon were stratified by date (fishing period). The eastside set gillnet harvest was additionally stratified by statistical area. Likewise, the Northern District set gillnet harvest was stratified by statistical area or a combination of areas representing a discrete fishery. The drift gillnet harvest was not stratified by statistical area because sampled fish were often a mixture of the harvest from more than one area. The total harvest of Kenai River coho salmon in each fishery was estimated by summing estimates for each stratum. Because sampling among strata was considered independent, the variance of total harvest was calculated by summing stratum variances. The Commercial Fish Ticketing System managed by ADF&G, Commercial Fisheries and Management Development Division, provided the commercial harvest data by fishery, date, and statistical area. The Central District commercial harvest data used in this report was provided in November 2004 and may differ slightly (<1%) from the total harvest reported elsewhere because fish tickets were reported after the deadline.

Commercial harvest of Kenai River coho salmon was estimated by total harvest and number examined for marks; the number of CWTs recovered was considered known. The tagged proportion of the return was estimated by examining the inriver fish wheel catch, the inriver drift gillnetting catch, and the return of adults to the Russian River weir. The harvest of coho salmon of Kenai River origin in each commercial fishery stratum *i* was estimated by (Bernard and Clark 1996):

$$\hat{r}_i = N_i \hat{\theta}^{-1} \left(\frac{m_i}{\lambda_i n_i} \right) = N_i \hat{\theta}^{-1} \hat{p}_i \qquad (7)$$

where:

N_i = the total number of coho salmon harvested in stratum *i*,

θ = the proportion of the 2004 Kenai River return marked with CWTs,

m_i = the number of CWTs recovered from commercial fishery stratum *i* and subsequently decoded as a tag from the Moose River 2003 tagging event,

n_i = the number of fish harvested during stratum *i* and examined for a missing adipose fin, and

$\lambda_i = \frac{a_i' t_i'}{a_i t_i}$ = the decoding rate of CWTs for marked fish recovered from stratum *i*,

where:

a_i = the number of heads collected in stratum *i* from fish with a missing adipose fin,

a_i' = the number of heads collected in stratum *i* that arrived at the Tag Lab,

t_i = the number of heads collected in stratum *i* with CWTs detected, and

t_i' = the number of CWTs found that were readable from any coho salmon marking event (not just the Moose River 2003 event).

This estimator is statistically unbiased when sampled from a simple random or pseudo-random process (Clark and Bernard 1987). When the proportion marked is estimated, the large-sample approximation of the variance (Bernard and Clark 1996) of commercial harvest is:

$$\hat{V}(\hat{r}_i) = \hat{r}_i^2 \left[G(\hat{p}_i) + G(\hat{\theta}^{-1}) - G(\hat{p}_i) G(\hat{\theta}^{-1}) \right] \quad (8)$$

where:

$$G(\hat{p}_i) = \frac{1 - \lambda_i \phi_i \hat{\theta}}{m_i},$$

$$\phi_i = \frac{n_i}{N_i}, \text{ and}$$

$$G\left(\hat{\theta}^{-1}\right) = \frac{\hat{V}(\hat{\theta}^{-1})}{\hat{\theta}^{-2}},$$

where $\hat{V}(\hat{\theta}^{-1})$ is estimated by Monte Carlo simulation.

Although the number of fish harvested is estimated as a product of pounds purchased and average weight per fish, the overall variance of the number harvested is considered small because the entire harvest is weighed. Therefore, the number of coho salmon harvested by fishery was considered a known constant, not an estimate (Fox and Shields 2004). The variance component associated with estimated average weight is not known and not included in the 2004 harvest estimates.

Harvest estimates were based on pooled samples among processors receiving fish from harvests within the estimation stratum (area and/or time). Pooling bias is assumed insignificant because of the similarity of the marked proportion among intensively sampled processors in previous years (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004b *a-b*; Carlon and Evans *in prep;* Massengill and Carlon 2007a-b). Pooling data among processors in 2004 should improve precision of harvest estimates without introducing significant bias. The tagged proportion (and harvest contribution) for dates not sampled was accounted for by pooling the harvest on those dates with those from the nearest harvest date sampled from the same statistical area.

RESULTS

SMOLT MARKING IN 2003

There were 120,351 coho salmon smolt marked (and released) with CWTs and adipose finclips as they emigrated from the Moose River May 20 through June 13, 2003; and the last release of marked smolt occurred on June 14, 2003 (Appendix A1). An estimated 120,305 survived tagging based on an estimated average short-term survival rate of 99.9%. More than 99% of the surviving marked smolt retained tags resulting in an estimated 119,640 tagged smolt released alive. Although marking was discontinued after exceeding the marking goal of 95,000 (120,351) on June 13, 2003, the weir remained in place until June 23 to census the smolt emigration. There were 305,326 smolt captured at the weir between May 20 and June 23, 2003.

TAGGED PROPORTION OF THE 2004 RETURN

Fish Wheel Sampling

The two fish wheels (one adjacent to each riverbank) were operated daily during most daylight hours from August 1 to September 30 to minimize seasonal sampling bias. Fish wheel operation in 2004 was reduced an hour each week beginning September 15 to avoid boating during nighttime conditions. Daily hours of operation varied based on fish wheel maintenance and available daylight, but averaged 8.6 hours per day for the north bank fish wheel and 9.0 hours per day for the south bank fish wheel (Massengill *In prep* b). There were 9,217 coho salmon captured in fish wheels and examined for marks (Appendix A2; Table 1).

There were 5,136 coho salmon captured in the south bank fish wheel. The weekly tagged proportion in the south bank fish wheel catch ranged from 0.047 to 0.146 and varied over all weeks ($P < 0.001$). The overall tagged proportion estimated for the season at the south bank fish wheel was 0.094.

There were 4,081 coho salmon captured in the north bank fish wheel. The weekly tagged proportion ranged from 0.051 to 0.143 and varied over all weeks ($P < 0.001$). The tagged proportion estimated for the season at the north bank fish wheel was 0.107. This proportion was different from the south bank fish wheel estimate ($P = 0.04$).

Of the 9,217 coho salmon captured in the fish wheels, 926 (0.100) were missing an adipose fin. The overall tag retention rate for fish sampled at the fish wheels (c) was 0.996 (891/895). Three of the four fish with no tags detected were sacrificed and sent to the Tag Lab for verification, and no tags were found. Therefore, no false-negative adjustment was needed. Adjusting the overall adipose-clip rate (y) by the 0.996 tag retention rate produced an overall tagged proportion estimate ($\hat{\theta}$) of 0.100. The weekly tagged proportion ranged from 0.049 to 0.144 and varied over weekly intervals ($P < 0.001$). However, there was no difference among the August 1 through August 21 weekly intervals ($P > 0.05$) or the September 19 through September 30 weekly intervals ($P = 0.295$).

Table 1.-Coho salmon recoveries from the Kenai River drainage, August 1 - October 5, 2004, with estimates of weekly and seasonal marked and tagged proportions by source and overall estimates based on combined representative sources.

Weekly Period	Number Examined	Marked Fish Observed	y_i [a]	Marked Fish Checked for a CWT[b]	Number of CWTs Detected	c_i [c]	$Theta_i$[d]	Estimated CWTs Missing [e]
North Bank Fish Wheel								
08/01-08/07	35	3	0.086	2	2	1.000	0.086	0
08/08-08/14	216	11	0.051	11	11	1.000	0.051	0
08/15-08/21	424	27	0.064	27	27	1.000	0.064	0
08/22-08/28	551	47	0.085	35	35	1.000	0.085	0
08/29-09/04	429	47	0.110	46	46	1.000	0.110	0
09/05-09/11	574	71	0.124	70	70	1.000	0.124	0
09/12-09/18	625	61	0.098	60	60	1.000	0.098	0
09/19-09/25	790	113	0.143	112	112	1.000	0.143	0
09/26-09/30	437	58	0.133	58	58	1.000	0.133	0
Total	4,081	438	0.11	421	421	1.000	0.107	0
South Bank Fish Wheel								
08/01-08/07	64	3	0.047	3	3	1.000	0.047	0
08/08-08/14	515	26	0.050	26	25	0.962	0.049	1
08/15-08/21	1201	98	0.082	98	97	0.990	0.081	1
08/22-08/28	1234	128	0.104	118	117	0.992	0.103	1
08/29-09/04	954	107	0.112	106	105	0.991	0.111	1
09/05-09/11	553	65	0.118	62	62	1.000	0.118	0
09/12-09/18	301	21	0.070	21	21	1.000	0.070	0
09/19-09/25	205	30	0.146	30	30	1.000	0.146	0
09/26-09/30	109	10	0.092	10	10	1.000	0.092	0
Total	5,136	488	0.095	474	470	0.992	0.094	4
North Bank Recapture Effort								
08/01 - 08/07	12	2	0.167			0.996	0.166	0
08/08 - 08/14	100	10	0.100			0.996	0.100	0
08/15 - 08/21	272	33	0.121			0.996	0.121	0
08/22 - 08/28	313	53	0.169			0.996	0.169	0
08/29 - 09/04	426	60	0.141			0.996	0.140	0
09/05 - 09/11	301	42	0.140			0.996	0.139	0
09/12 - 09/18	198	18	0.091			0.996	0.091	0
09/19 - 09/25	213	23	0.108			0.996	0.107	0
09/26 - 10/02	83	10	0.120			0.996	0.120	0
10/03 - 10/05	23	2	0.087			0.996	0.087	0
Total	1,941	253	0.130			0.996	0.130	1
South Bank Recapture Effort								
08/01 - 08/07	17	2	0.118			0.996	0.117	0
08/08 - 08/14	80	9	0.113			0.996	0.112	0
08/15 - 08/21	275	32	0.116			0.996	0.116	0
08/22 - 08/28	291	28	0.096			0.996	0.096	0
08/29 - 09/04	293	38	0.130			0.996	0.129	0
09/05 - 09/11	302	29	0.096			0.996	0.096	0
09/12 - 09/18	392	49	0.125			0.996	0.124	0
09/19 - 09/25	476	58	0.122			0.996	0.121	0
09/26 - 10/02	259	24	0.093			0.996	0.092	0
10/03 - 10/05	38	4	0.105			0.996	0.105	0
Total	2,423	273	0.113			0.993	0.112	2

-continued-

Table 1.–Page 2 of 2.

Weekly Period	Number Examined	Marked Fish Observed	y_i [a]	Marked Fish Checked for a CWT[b]	Number of CWTs Detected	c_i [c]	$Theta_i$[d]	Estimated CWTs Missing [e]
Russian River Weir								
07/25 - 07/31	1	0	0.000			0.996	0.000	0
08/01 - 08/07	16	0	0.000			0.996	0.000	0
08/08 - 08/14	87	2	0.023			0.996	0.023	0
08/15 - 08/21	139	5	0.036			0.996	0.036	0
08/22 - 08/28	114	10	0.088			0.996	0.087	0
08/29 - 09/03	83	5	0.060			0.996	0.060	0
Total	440	22	0.050			0.996	0.050	0
Combined North and South Banks Fish Wheels								
08/01 - 08/07	99	6	0.061	5	5	1.000	0.061	0
08/08 - 08/14	731	37	0.051	37	36	0.973	0.049	1
08/15 - 08/21	1625	125	0.077	125	124	0.992	0.076	1
08/22 - 08/28	1785	175	0.098	153	152	0.993	0.097	1
08/29 - 09/04	1383	154	0.111	152	151	0.993	0.111	1
09/05 - 09/11	1127	136	0.121	132	132	1.000	0.121	0
09/12 - 09/18	926	82	0.089	81	81	1.000	0.089	0
09/19 - 09/25	995	143	0.144	142	142	1.000	0.144	0
09/26 - 09/30	546	68	0.125	68	68	1.000	0.125	0
Total	9,217	926	0.100	895	891	0.996	0.100	4

a Proportion of fish examined that were missing the adipose fin.

b Number of marked fish checked for the presence of an embedded coded wire tag using an electronic tag detection wand. Marked fish observed in samples from both riverbanks in the recapture efforts and at the Russian River weir were not checked; the proportion bearing a coded wire tag was assumed to be the same as that verified in the sample of fish wheel-caught fish.

c Estimated proportion of adipose-clipped fish bearing a coded wire tag implanted at the Moose River in 2003 based on tag detection results.

d Estimated proportion of the number examined bearing a coded wire tag originally implanted at the Moose River in 2003.

e Estimated number of coded wire tags that are missing from the marked fish observed ((Marked Fish Observed)-[($Theta_i$) x (Number Examined)]). This field is required to develop contingency tables for comparing marked proportions over weekly period and among sample sources. Weekly estimates are rounded to the nearest whole fish; weekly estimates may not sum to total because of rounding.

Drift Gillnet Sampling

From August 1 to October 5, there were 4,364 coho salmon captured, examined, and assigned to a bank of capture (Appendix A3, Table 1). A tag detection wand was not used to check for tags in the drift gillnetting catch. Instead, the tagged proportion ($\hat{\theta}$) for each drift gillnet sample was estimated by multiplying the adipose-clip rate (y_i) (0.121) by the overall tag retention rate (c) measured in the fish wheel capture event (0.996).

There were 2,423 coho salmon captured in drift gillnets along the south bank. After adjusting for tag retention (using the 0.996 fish wheel catch tag retention rate), the weekly tagged proportion in the south bank catch ranged from 0.092 to 0.129 and did not vary over all weeks ($P = 0.87$). The seasonal tagged proportion estimated for all south bank drift gillnet samples was 0.112. This proportion also did not differ from the seasonal fish wheel samples ($P = 0.078$).

There were 1,941 coho salmon captured in the drift gillnets along the north bank. The weekly tagged proportion ranged from 0.087 to 0.169 and did not vary over all weeks ($P = 0.343$). The seasonal tagged proportion estimated for all north bank drift gillnetting samples was 0.130. This proportion did not differ from the south bank drift gillnet samples ($P = 0.076$), but did differ from the seasonal fish wheel samples ($P < 0.001$).

Of the 4,364 coho salmon sampled in drift gillnets, 526 (0.121) were missing an adipose fin. The overall tagged proportion ($\hat{\theta}$) for the drift gillnet estimate was 0.120. This proportion differed from the overall fish wheel proportion of 0.100 ($P < 0.001$). The weekly tagged proportion ranged from 0.098 to 0.137 and did not differ over all weeks ($P < 0.807$).

Russian River Weir Sampling

The first coho salmon arrived at the Russian River weir on July 31 (Appendix A4). However, because weir operation was discontinued before the completion of the coho salmon return, a census of the return was not achieved in 2004, and the fish examined represent an unknown portion of the return.

Between July 31 and September 3, 440 coho salmon passed through the weir, 426 were examined and 22 (5.2%) were missing an adipose fin. The estimated weekly proportion of fish bearing a CWT, adjusted for estimated tag loss, ranged from 0 to 0.088 and did not vary among weeks ($P = 0.312$). The seasonal tagged proportion (0.051) estimate from the Russian River weir samples, was different from the seasonal fish wheel samples ($P = 0.001$) and the seasonal drift gillnet recapture samples ($P < 0.001$).

Tagged Proportion Estimate

Because temporal variations in the tagged proportion existed among and between inriver samples, the tagged proportion of coho salmon that passed through commercial fishery areas was unknown. The changes in the tagged proportion over time in the inriver samples suggest that representative tagging of smolt did not occur drainage-wide. Therefore, commercial harvest estimates may be biased, depending on the actual (but unknown) tagged proportion existing in the 2004 UCI commercial fisheries. However, an estimate of the tagged proportion was made using the pooled fish wheel data to generate the primary harvest estimates because of the relative consistency of the tagged proportion over the majority of the return and similarity between overall tagged proportions. Sensitivity tests were conducted to compare the effect of using subsets of fish wheel data (minimum and maximum tagged proportions) on the harvest estimates.

Recovery data from the Russian River, a tributary located high in the drainage, was therefore not used. Likewise, the upstream location of the drift gillnet (recapture) reach and its close proximity to the tagging site and the lower chance of representative sampling in the recapture effort (versus the fish wheel effort) made this a less attractive source for estimating the tagged proportion.

The overall estimated tagged proportion ($\hat{\theta}$) of the 2004 return was 0.100 (SE=0.003); $\hat{\theta}^{-1}$=10.0 (SE=0.32). Because of the temporal trend in the pooled fish wheel samples, this is considered a "qualified" estimate of the tagged proportion passing through the commercial fishing areas. The minimum tagged proportion of 0.068 (SE=0.005); $\hat{\theta}^{-1}$=14.9 (SE=0.1.163) was estimated from samples collected during the first three weeks of sampling (August 1-21) because no difference was detected in the tagged proportion among those weeks. The maximum tagged proportion estimate from samples taken during the last two weeks (September 19-30) was 0.137 (SE=0.009); $\hat{\theta}^{-1}$=7.3, (SE=4.75).

SMOLT ESTIMATE IN 2003

An estimated 1,196,310 (SE = 37,100) smolt emigrated from the Kenai River in 2003. This estimate was generated using the number of live smolt released with an adipose-clip at the Moose River in 2003 (120,305), the number of adult coho salmon examined for an adipose fin in the Kenai River fish wheel samples in 2004 (9,217), and the number of adults in the sample that were missing an adipose fin (926).

COMMERCIAL HARVEST IN 2004

General inlet-wide sampling is summarized below to add perspective and to document the recovery of marked Kenai River coho salmon in other areas of Cook Inlet. Commercial fishery sampling is also summarized for the target fisheries of the Central District (drift and eastside set) and all Northern District fisheries. Additional details of the 2004 Northern District sampling efforts and recoveries of hatchery-produced coho salmon are documented in Namtvedt (*In prep*).

Inlet-Wide Fisheries

In 2004, 309,548 coho salmon were harvested in UCI commercial fisheries (Table 2). This harvest was 24% higher than the 1994-2003 average harvest (Fox and Shields 2004). About 86% of the 2004 UCI commercial harvest was taken in Central District fisheries. The greatest harvest occurred in the drift gillnet fishery (75% of the Central District harvest); other fisheries comprised 0.5-8.4% of the Central District harvest (Figure 5). The Northern District set gillnet fisheries comprised 14% of the total UCI commercial harvest.

There were 97,043 fish (31%) examined for adipose-clips in the inlet-wide commercial harvest. Adipose-clipped fish were found in all sampled fisheries. The statistical area could not be identified for 5,097 fish (Table 2, Appendix A5); these fish were sampled from processor deliveries consisting of harvests from multiple statistical areas. They were not used to calculate harvest estimates because of the ambiguity of their origin. In the mixed area samples, 33 coho were found with an adipose-clip (0.6%), heads were recovered from all of them, and a decodable tag was found in 26. There were 10 decodable tags recovered from smolt implanted at the Moose River in 2003.

Table 2.–Sampling performance and recovery of coded wire tags (CWT) from coho salmon harvested in Upper Cook Inlet commercial fisheries in 2004.

Gillnet Fishery	Harvest	Number Examined	Percent of Harvest Examined	Marked Fish Found[a]	Percent Marked	Heads Recovered	Missing, Lost, or Unreadable	Percent Not Decoded	Heads with Decodable CWT[b]	Number from Cohort Marked at Moose R. in 2003
CENTRAL DISTRICT										
Central District Drift	198,465	53,139	0.27	438	0.01	438	57	0.13	381	88
244-25 Drift (Kasilof R. Mouth)	32	0	0.00	0						
Drift Total	198,497	53,139	0.27	438	0.01	438	57	0.13	381	88
East Side Set (by Statistical Area)										
244-21	1,454	229	0.16	8	0.03	8	1	0.13	7	7
244-22	2,349	344	0.15	6	0.02	6	2	0.33	4	4
244-31/32	4,187	367	0.09	9	0.02	9	1	0.11	8	8
244-41/42	22,127	4,051	0.18	52	0.01	52	6	0.12	46	32
East Side Set Total	30,117	4,991	0.17	75	0.02	75	10	0.13	65	51
Kalgin Is. Set	21,096	1,104	0.05	8		8	2		6	1
West Side Set	15,161	4,251	0.28	6	0.00	6	5	0.83	1	1
Mixed East Side Set[c]		194		5	0.03	5	1	0.20	4	3
Mixed West Side Set/Kalgin Island Set[c]		4,161		28	0.01	28	6	0.21	22	7
Mixed East Side and Central District Drift		28		0						
Central District Total	264,871	63,485	0.24	527	0.01	527	74	0.14	453	141
NORTHERN DISTRICT										
East Side Set	12,308	6,252	0.51	49	0.01	48	0	0.17	40	23
Fire Island Set	6,141	4,438	0.72	98	0.02	96	31	0.05	91	12
Pt. MacKenzie/Susitna Flats	19,090	15,084	0.79	388	0.03	380	23	0.04	363	7
West Side Set	7,138	2,687	0.38	7	0.00	7	8	0.86	1	0
Northern District Set Total	44,677	28,461	0.64	542	0.02	531	62	0.07	495	42
Mixed West Side and Fire Island Set		714		0						
Northern District Total	44,677	29,175	0.65	542	0.02	531	62	0.07	495	42
Mixed Fishery Total		5,097		33	0.01	33	7	0.21	26	10
Unmixed Fishery Total[d]	309,548	91,946	0.30	1,069	0.01	1,058	136	0.13	948	183
Grand Total[e]	309,548	97,043	0.31	1,102	0.01	1,091	143	0.13	948	193

[a] Marked fish are those missing an adipose fin.

[b] Includes marked wild fish released in the Kenai River and hatchery-produced, marked fish released at other Cook Inlet locations.

[c] Examined fish were from an unknown mixture harvested from among multiple Upper Cook Inlet commercial fisheries.

[d] Sampling result total for all samples positively assigned to known fisheries throughout Upper Cook Inlet.

[e] Sampling result total for all samples positively assigned to known fisheries and also samples not assigned to known fisheries throughout Upper Cook Inlet.

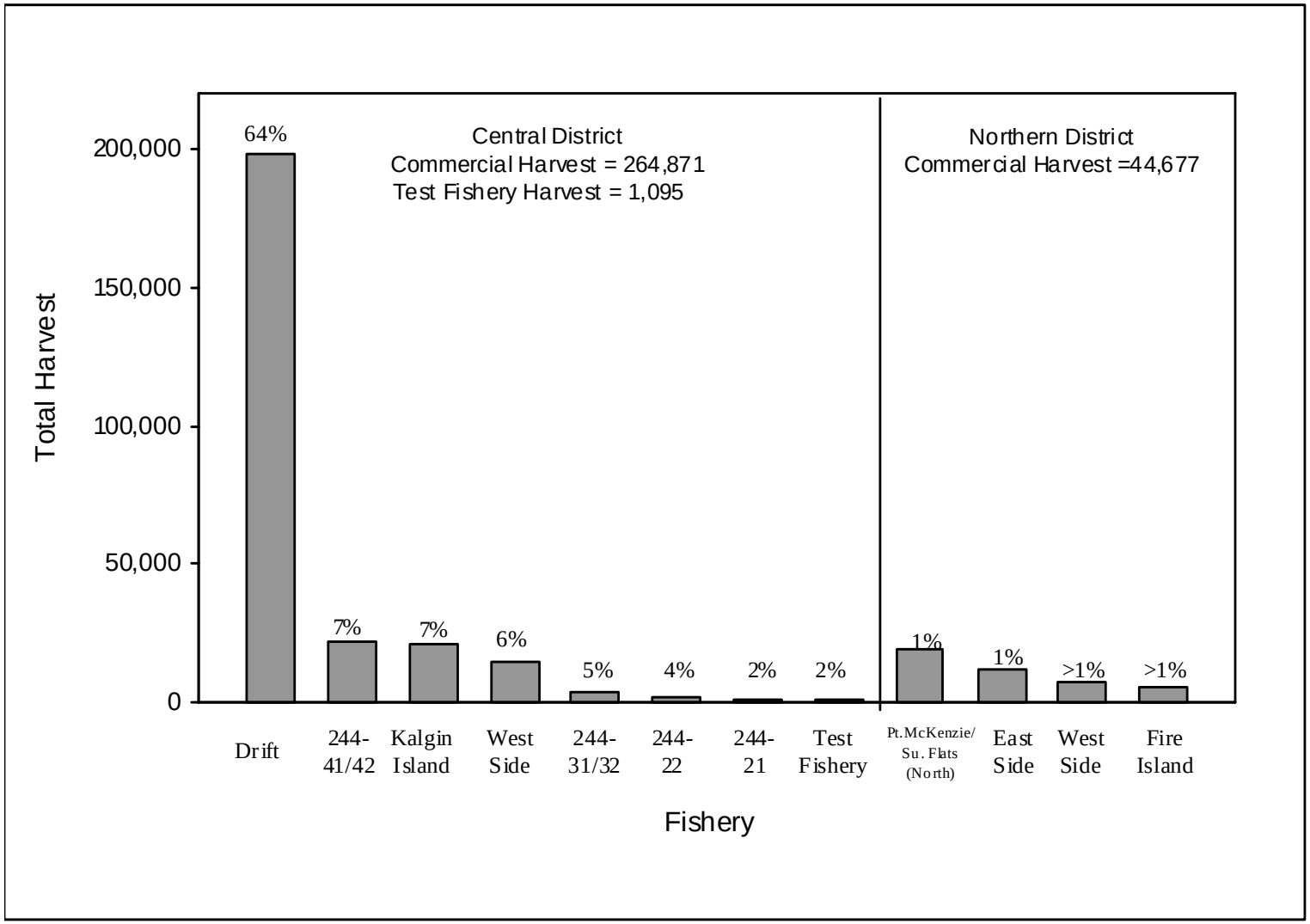

Figure 5.–Coho salmon harvest in 11 Upper Cook Inlet (UCI) commercial fishery areas (and the Alaska Department of Fish and Game UCI test fisheries) with percentage of total harvest represented in 2004.

The remaining 91,946 examined fish were assigned to fishery strata (Appendix A6) and 1,069 (1.2%) were missing the adipose fin. There were 1,058 heads recovered, 948 had decodable tags (89.6%). All but 10 originated from UCI release locations in 2003; these were released into Northern District streams in 2002.

Of the 948 decodable tags recovered from adults commercially harvested in known fishery strata, 183 (19.3%) were released as smolt emigrating from the Moose River in 2003. Most CWTs (141) were recovered from Central District fisheries and 42 were recovered from known Northern District fisheries.

Among the commercial processors receiving at least 500 coho salmon harvested in the Central District eastside set gillnet fisheries in 2004, the proportion examined that carried CWTs from the Moose River in 2003 did not exceed 2.1% (Figure 6). Among all plants processing coho salmon in the Central District drift gillnet fishery, the tagged proportion did not exceed 0.51%. The proportions were similar among processors and sampling summaries (and harvest estimates) that follow are based on samples pooled among processors.

Central District Drift Gillnet Fishery

In 2004, 198,465 coho salmon were harvested in the Central District drift gillnet fishery (Table 3). The 2004 harvest was 154% of the 1994-2003 average harvest (Fox and Shields 2004).

The Central District drift gillnet fishery harvest was sampled during most fishing openers between June 25 and August 9. Overall, 27% of the harvest was examined. The harvest on days not sampled accounted for 11% of the total harvest.

There were 53,139 fish examined (Table 2); 438 (0.8%) were missing the adipose fin and 381 (0.7%) had decodable tags. There were 88 tags originally implanted in wild smolt emigrating from the Moose River (Kenai River drainage) in 2003. There were 293 decodable tags from Northern District wild and hatchery releases, all released in 2003 except for 6 released in 2002. Therefore, less than 0.02% of the fish examined had tags from smolt implanted at the Moose River in 2003.

The first recovery of Moose River CWTs in the Central District drift gillnet fishery occurred on July 21. Coho salmon marked at the Moose River were recovered on 12 of the 14 sampled days between July 21 and August 9.

Central District Eastside Set Gillnet Fishery

In 2004, 30,117 coho salmon were harvested in the Central District eastside set gillnet fishery. The 2004 harvest was 114% of the 1994-2003 average harvest (Fox and Shields 2004).

The Central District eastside set gillnet fishery harvest was sampled during most openers between June 25 and August 7. Overall, 17% of the harvest (4,991 fish) was examined and assigned to spatial-temporal strata (Table 2). The combined eastside harvest on days not sampled accounted for 25% of the total harvest. Adipose-clipped fish were found on all but 6 of the 21 days fish were examined.

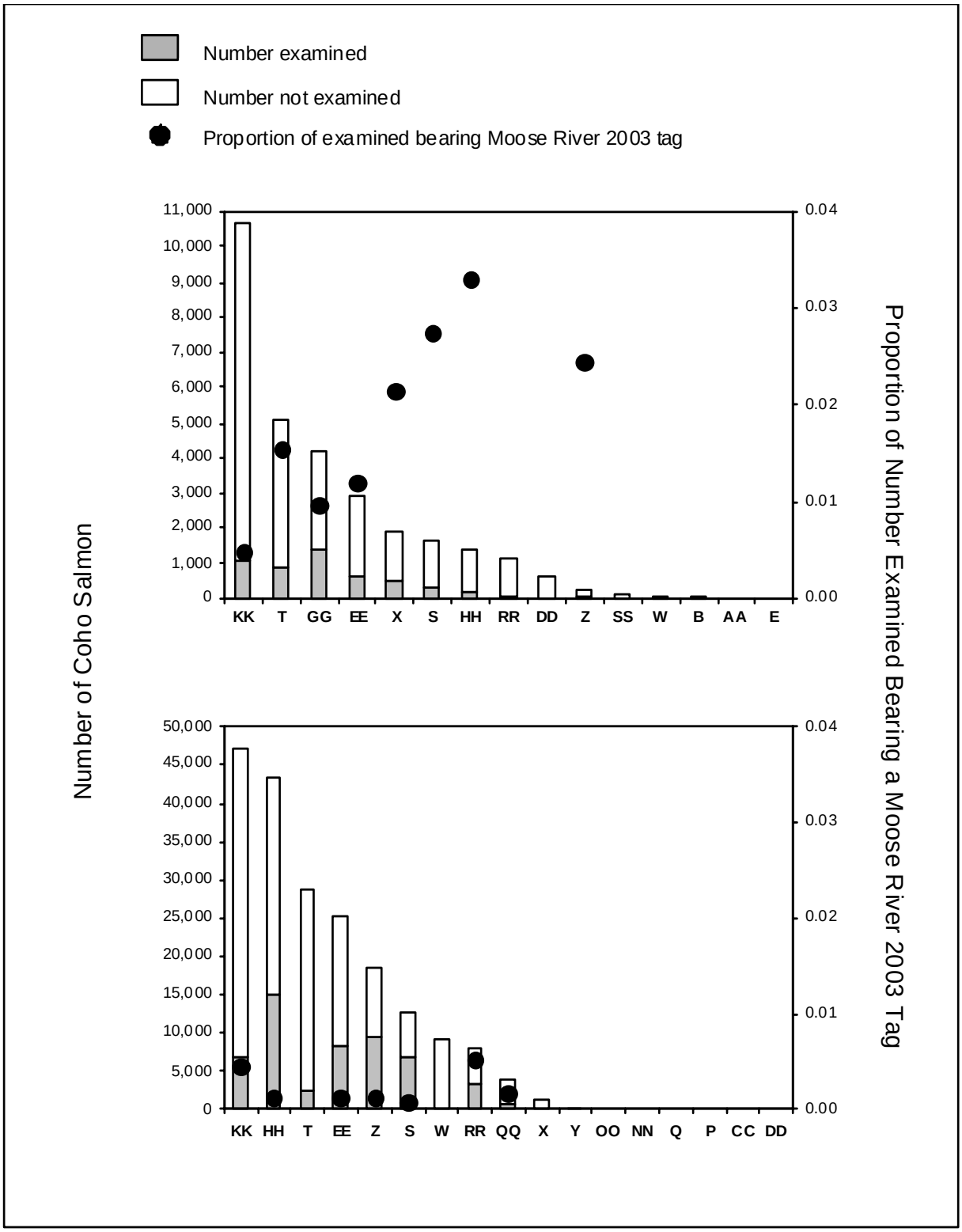

Figure 6.–Number of coho salmon commercially harvested and processed in 2004 in the eastside set net fishery (top) and Central District drift fishery of Upper Cook Inlet by commercial processor (alias name), and proportion of examined fish that were originally marked at the Moose River in 2003.

Table 3.–Harvest of all coho salmon and coho salmon of Kenai River origin in selected Upper Cook Inlet marine commercial fisheries, 1993-2004.

	Central District				Northern District			
	Drift[b]		Eastside Set		Set		Total	
Year	All	Kenai River	All	Kenai River	All	Kenai River	All	Kenai River
1993	121,829	930	43,098	6,806	106,294	148	271,221	7,884
1994	310,114	11,732	68,449	14,673	144,064	477	522,627	26,882
1995	241,473	6,956	44,750	13,152	89,300	582	375,523	20,690
1996	171,434	2,671	40,724	11,856	78,105	29	290,263	14,556
1997	78,662	1,236	19,668	2,093	37,369	36	135,699	3,365
1998	83,338	1,974	18,677	8,096	34,359	175	136,374	10,245
1999	64,814	818	11,923	2,905	31,446	171	108,183	3,894
2000	131,478	531	11,078	2,351	71,475	83	214,031	2,965
2001	39,418	282	4,246	349	45,928	1,303	89,592	1,934
2002	125,831	1,370	35,153	4,688	50,292	57	211,276	6,115
2003	52,421	330	10,171	2,122	24,015	126	86,607	2,578
Average	129,165	2,621	27,994	6,281	64,786	290	221,945	9,192
2004	198,465	4,251	30,117	5,921	44,677	977	273,259	11,149

[a] Sources of harvest of Kenai River-specific coho salmon are: Carlon and Hasbrouck (1996-1998); Carlon (2000, 2003); Massengill and Carlon (2004 a-b); Massengill (*In prep* a); Massengill and Carlon (2007a-b). Source of all coho salmon harvest is ADF&G CFD Fish Ticket Database.

[b] Does not include 32 coho salmon harvested from the special drift area 244-25 (Kasilof River mouth).

There were 75 (1.5%) fish missing the adipose fin. All 75 heads were recovered, 10 (13%) had no tag and 65 had readable tags. There were 51 tags originally implanted in wild smolt emigrating from the Moose River in 2003 and the other 14 were from 2003 tag releases in the Northern District. Therefore, 1.0% of the fish examined had tags from smolt implanted at the Moose River in 2003.

The portion of the harvest on days not sampled or days when no harvest was observed ranged from 39 to 42% among the statistical areas of 24421, 24422, 24431/32, and 24441/24. Coho salmon marked at the Moose River in 2003 were recovered from all statistical areas in 2004. The first recovery of Moose River tags occurred on July 1 in statistical area 24422 and July 8 in statistical areas 244422, 24431/32, and 24441/42. The portion of fish examined in 2004 that were marked at the Moose River in 2003 were 3.1%, 1.2%, 2.2%, and 0.8% for statistical areas 24421, 24422, 24431/32, and 24441/42, respectively.

Northern District Gillnet Fisheries

In 2004, 44,677 coho salmon were harvested among all Northern District set net fisheries. Table 2). The 2004 harvest was 74% of the 1994-2003 average harvest (Table 3) (Fox and Shields 2004).

The Northern District harvest was sampled during most fishery openings after the first open period on June 28. Although specific fisheries were not sampled near the beginning and end of the fishing season, the harvest among all Northern District fisheries was the most intensively sampled of all UCI fisheries (65% of the harvest).

Of the 29,175 fish examined, 28,461 were from unmixed district samples and could be assigned to a statistical area. The harvest on days not sampled accounted for 1.6% of the total harvest. Adipose-clipped fish were found on all but one of the days coho salmon were examined.

There were 542 (1.9%) fish missing the adipose fin and heads were collected from all but 11. Of the 531 heads recovered, 35 (6.6%) had no tag, 495 had decodable tags, and 1 tag was unreadable. There were 42 tags implanted in wild smolt emigrating from the Moose River in 2003 and the other 453 were from 2003 tag releases in Northern District area streams (except for 4 released in the Northern District in 2002 and 1 from a 2002 release in the Chickamin River in Southeast Alaska). Therefore, among known Northern District fisheries, 0.15% of the fish examined had tags from smolt implanted at the Moose River in 2003.

Commercial Harvest Estimates

Based on the commercial catch and the tagged proportion estimate of the 2004 adult return to the Kenai River, a set of harvest estimates were generated for UCI commercial fisheries in 2004. There were 11,149 (SE=1,233) Kenai River coho salmon commercially harvested in 2004. An estimated 5,921 (SE=1,092) by the Central District eastside set gillnet fishery (Table 4) and 4,251 (SE=531) were harvested by the Central District drift gillnet fishery (Table 5), and 977 (SE= 218) by all Northern District set gillnet fisheries (Appendix A6). These estimates comprised 2.1% of the total drift gillnet harvest, 19.7% of the total eastside set gillnet harvest, and 2.2% of the total Northern District set gillnet harvest in 2004.

The contribution of Kenai River origin fish to the harvest was minimal throughout the commercial drift gillnet season with the greatest proportional and absolute harvest (10%) occurring after August 8 (Table 3; Figure 7).

The first Kenai River coho salmon were detected in the Central District eastside set gillnet harvest on July 15. The harvest of 2,920 coho salmon before July 15 represents 3% of the total harvest in this fishery. Total coho salmon harvest increased as the season progressed in all statistical areas and the proportional contribution of Kenai River coho salmon increased most noticeably in statistical areas 24431/32 and 24441/42 peaking in early August at 44.4% and 39.7%, respectively (Figure 8). The total coho salmon harvest in the Central District eastside set gillnet fishery ranged from 1,454 in statistical area 244-21 to 22,127 in statistical area 244-41/42 (Figure 9). The portion of the seasonal harvest comprised of Kenai River coho salmon ranged from 14.1 to 30.6%.

Table 4.–Total harvest and estimated contribution of Kenai River coho salmon to the eastside set gillnet fishery of Upper Cook Inlet by statistical area and selected time intervals, 2004.

Interval	Total harvest	Estimated contribution	Standard Error	Portion of total harvest
		Statistical Area 244-21		
<20 July	188	106	105	0.564
20-26 July	228	41	28	0.180
27 July-1 August	301	145	144	0.482
>2 August	737	115	66	0.156
Total	1,454	407	193	0.280
		Statistical Area 244-22		
<20 July	154	0	0	0.000
20-26 July	357	102	71	0.286
27-31 July	431	28	27	0.065
>31 July	1,407	201	200	0.143
Total	2,349	331	215	0.141
		Statistical Area 244-31/32		
<20 July	197	0	0	0.000
20-26 July	512	0	0	0.000
27-31 July	677	36	35	0.053
>31 July	2,801	1,245	475	0.444
Total	4,187	1,281	477	0.306
		Statistical Area 244-41/42		
<20 July	1,403	60	0	0.000
20-26 July	5,588	139	113	0.025
27-31 July	7,113	517	132	0.073
>31 July	8,023	3,186	921	0.397
Total	22,127	3,902	940	0.176
		Combined Statistical Areas		
<20 July	1,942	166	105	0.085
20-26 July	6,685	282	213	0.042
27-31 July [a]	8,522	726	340	0.085
>31 July	12,968	4,747	1,663	0.366
Total	30,117	5,921	1,092	0.197

[a] Includes the August 1 harvest data from statistical area 244-21.

Table 5.–Estimated harvest, and associated standard errors, of Kenai River coho salmon in the commercial drift gillnet fishery of the Central District of Upper Cook Inlet during selected time intervals, 2004.

Interval	Total Harvest	Estimated Harvest of Coho Salmon of Kenai River Origin	Standard Error	Portion of Total Harvest
< 25 July	118,376	207	92	0.002
25-31 July	47,719	987	227	0.021
1-8 August	11,263	892	355	0.079
>8 August	21,107	2,165	309	0.103
Total	198,465	4,251	531	0.021

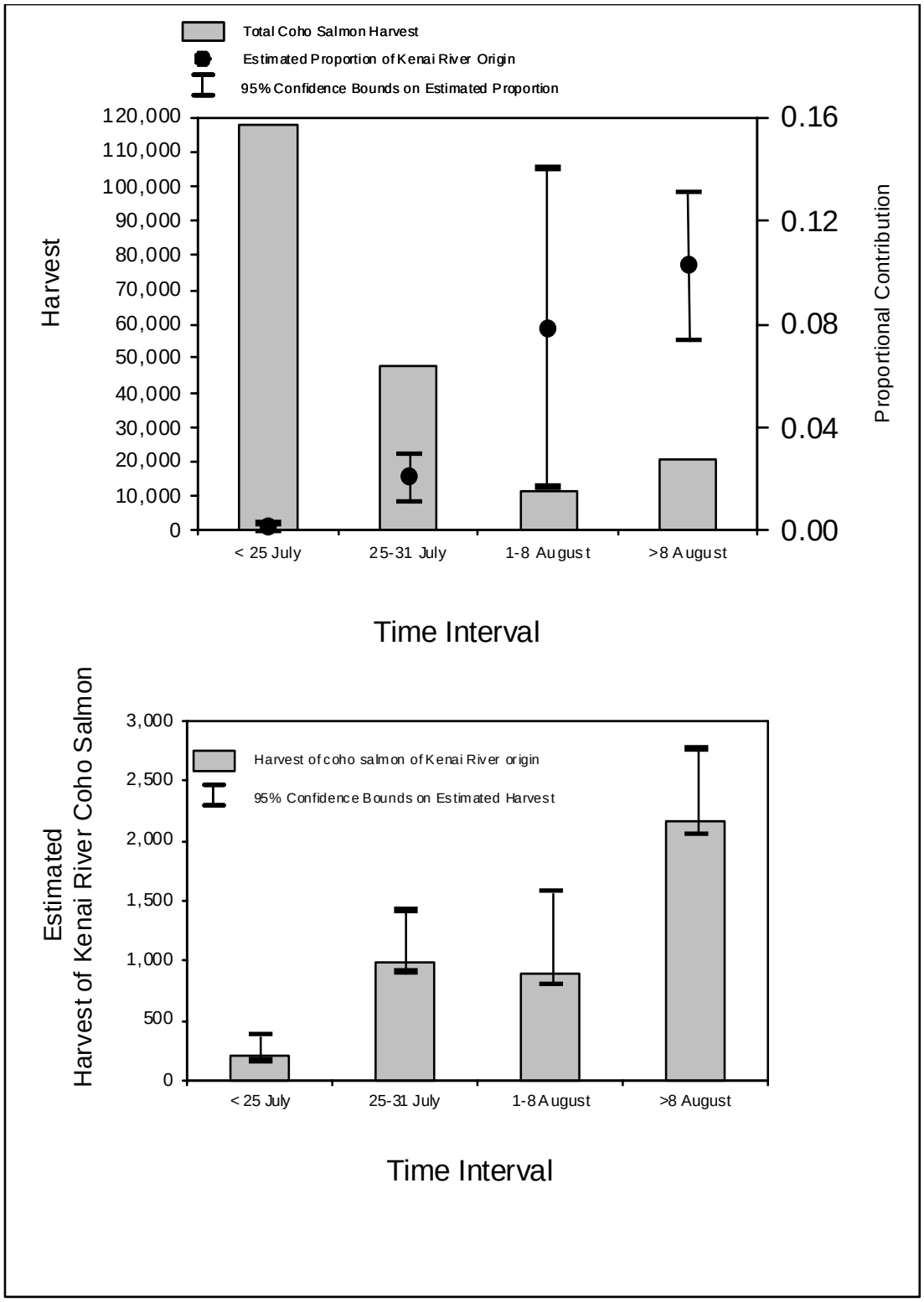

Figure 7.–Temporal trend in proportional contribution of Kenai River coho salmon to the total harvest (top) and trend in absolute contribution (bottom) occurring in the drift gillnet fishery of the Upper Cook Inlet Central District, 2004.

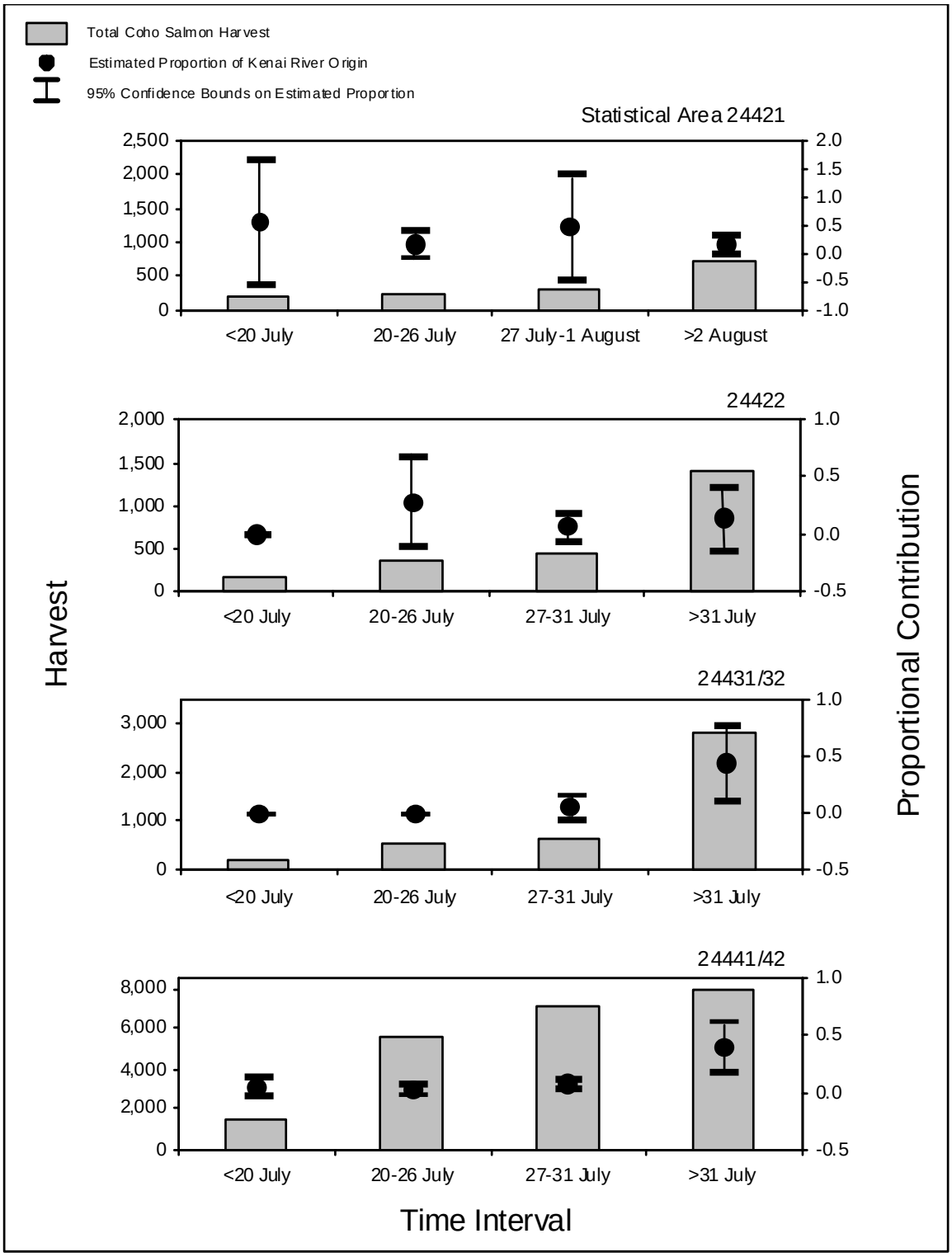

Figure 8.–Temporal trends in total harvest of coho salmon and proportional contribution of coho salmon from the Kenai River to the total harvest occurring in four statistical areas of the Upper Cook Inlet Central District eastside set gillnet fishery during four similar time periods in 2004.

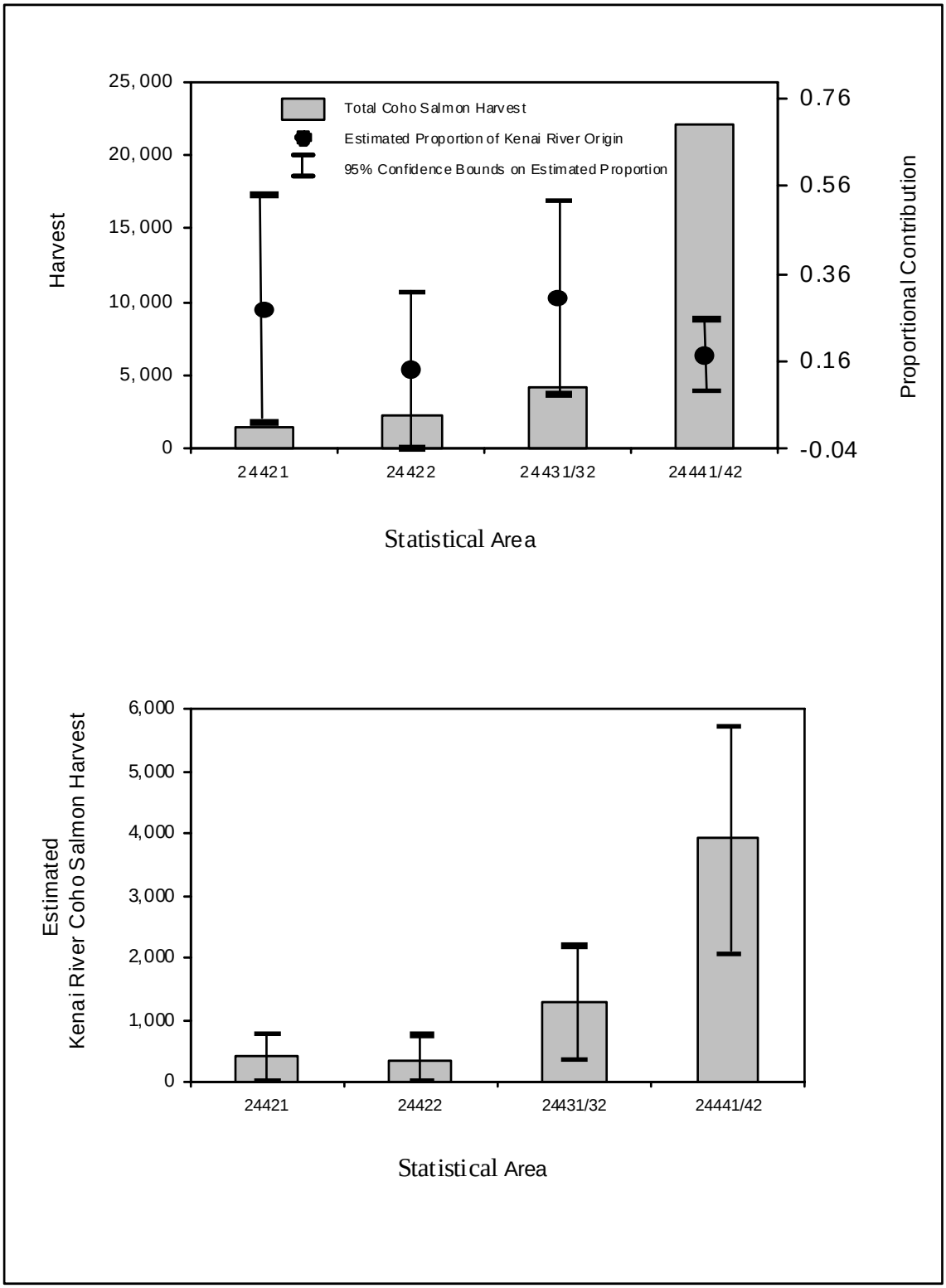

Figure 9.–Geographic trends in total coho salmon harvest and proportional contribution of coho salmon of Kenai River origin (top) and in estimated number of coho salmon of Kenai River origin (bottom) harvested among statistical areas in the eastside set gillnet fishery of the Central District of Upper Cook Inlet, 2004.

There were 42 fish with CWTs from the Kenai River drainage detected in the combined Northern District set gillnet fishery and 23 came from the eastside set area. The first CWT recovered from an adult tagged as a smolt in 2003 at the Moose River occurred on July 29, 2004.

Effect of Variations of the Tagged Proportion on Commercial Harvest Estimates

To determine the sensitivity of commercial harvest estimates to the observed temporal variation in the estimated tagged proportion three sets of commercial harvest estimates were calculated for the sampled fisheries and examined for differences. The estimated pooled seasonal tagged proportion was 0.100, the minimum proportion from the first three weeks was 0.068, and the maximum proportion from the last two weeks was 0.137 (Table 6). Minimum and maximum harvest estimates represent the most-extreme plausible scenarios. The lower and upper bound harvest estimates differed from the pooled seasonal estimate by +48% and -27%, respectively.

DISCUSSION

COMMERCIAL HARVEST

There is potential for bias in the estimates for the Kenai River's contribution to the commercial harvest of coho salmon because of temporal variability in the tagged proportion from the inriver samples. However, minimally biased estimates are still of value for current management and research needs.

The similarity between the maximum commercial harvest estimate (16,491) and the pooled commercial harvest estimate (11,149), relative to harvest magnitudes and total return, illustrates the intrinsic value of the estimates regardless of the potential bias. The maximum estimate represents 6.0% of the total UCI commercial harvest (excluding the Central District areas of Kalgin Island set and the westside set where interception of Kenai River coho salmon is negligible) and 4.1% under the pooled seasonal scenario. The similarity reveals the small part that the Kenai River population plays in the overall UCI coho salmon commercial harvest.

Managers can reliably state that less than about 6.5% (upper 95% C.I. associated with the minimum tagged proportion) of the 2004 UCI commercial harvest is of Kenai River origin. The largest estimate also represents 31.7% of the 1993-2003 average combined sport and personal use harvest of Kenai River coho salmon and 21.0% under the pooled scenario. Thus, within Kenai River specific harvests, the commercial harvest was relatively small, even though it was the largest harvest since 1996.

Comparing estimates derived from pooled seasonal tagged proportions from those derived from minimum and maximum tagged proportions are an objective way to evaluate the impact of potential bias when using the pooled estimates for making decisions. The three estimates demonstrate that the potential range in contribution to the commercial harvest is relatively small, and under current management, commercial fishing intercepts a small percentage of the total Kenai River coho salmon return.

Table 6.–Sensitivity of 2004 commercial harvest estimates to variations in the tagged proportion.

Fishery	Total harvest	Pooled marked proportion (0.100) Estimated contribution [c]	Marked proportion: minimum [a] (0.068) Estimated contribution [c]	Difference from pooled	% Difference from pooled	Difference from Pooled as % of Total harvest	Marked proportion: maximim [b] (0.137) Estimated contribution [c]	Difference from pooled	% Difference from pooled	Difference from pooled as % of total harvest
Central District Drift Gillnet	198,465	4,251	6,292	2,041	48%	1.0%	3,108	-1,143	-27%	0.6%
Central District East Side Set Gillnet [d]										
244-21	1,454	407	601	194	48%	13.3%	296	-111	-27%	7.6%
244-22	2,349	331	489	158	48%	6.7%	242	-89	-27%	3.8%
244-31/32	4,187	1,281	1,895	614	48%	14.7%	937	-344	-27%	8.2%
244-41/42	22,127	3,902	5,770	1,868	48%	8.4%	2,850	-1,052	-27%	4.8%
Combined	30,117	5,921	8,755	2,834	48%	9.4%	4,325	-1,596	-27%	5.3%
Northern District Set Gillnet	44,677	977	1,444	467	48%	1.0%	713	-264	-27%	0.6%
Total [e]	273,259	11,149	16,491	5,342	48%	2.0%	8,146	-3,003	-27%	1.1%

[a] The minimum marked proportion determined from the the pooled fish wheel data collected from August 1 to August 21.

[b] The maximum marked proportion determined from the the pooled fish wheel data collected from September 19 to September 30.

[c] Kenai River population-specific harvest estimate.

[d] By statistical area and combined areas.

[e] Sum of estimates for Central District drift gillnet, Central District eastside set gillnet, and Northern District set gillnet fisheries. Does not include Central District west side set or Kalgin Island set (areas that were incidentally sampled because of a history of insignificant harvest of Kenai River origin coho salmon) or the statistical area 244-25 (Kasilof River mouth).

There has been no evaluation of migration rates for Kenai River-bound coho salmon in the marine waters of UCI or the lower 44 km of the Kenai River. A thorough evaluation may allow selection of a subset of the inriver samples on which to base the tagged proportion appropriate for UCI commercial fisheries. Using a subset of the inriver samples for estimating commercial harvest can be beneficial during years when the inriver marked proportion varies significantly over time, as in 2004. Accurate harvest estimates currently rely on a constant tagged proportion within the inriver samples over a 2-month period. If variation is detected, the only objective alternative developed to date has been to qualify the estimates with a sensitivity analysis. An evaluation of lower Kenai River and UCI marine migratory rates should be considered because temporal variation has been detected most years since 1998 (Carlon 2003; Massengill and Carlon 2004ba-b; Massengill and Carlon 2007a-b).

The commercial harvest estimate of Kenai River-bound coho salmon in the two primary Central District fisheries in 2004 was 10,172 and represents 114% of the 1993-2003 average. The 2004 total return of Kenai coho salmon could be the second largest (Massengill *In prep* b) since 1999 when total return estimates were first generated. Significant commercial fishing restrictions included a closure after August 7, but did allow for four "extra" non-regular fishing periods between August 1 and August 7. The above average harvest in 2004 likely resulted from both a strong adult coho salmon run and 41 additional fishing openings (emergency openings) designed to reduce sockeye salmon escapement in Cook Inlet drainages (Fox and Shields 2004).

A substantial portion of the harvest of Kenai River-bound coho salmon typically occurs during the last week of July and the first week of August in the Central District drift gillnet fishery and the first week of August in the Central District eastside set gillnet fishery (Carlon 2003; Massengill and Carlon 2004ba-b; Massengill and Carlon 2007a-b). The restrictions imposed by the management plan likely had their intended conservation effect of reducing the Kenai River population-specific harvest in commercial fisheries in 2004. The Kenai River population has comprised a minority of the total harvest in Central District commercial fisheries since 1993 (Figure 10). Since additional restrictions were imposed in 2000, the commercial harvest of Kenai River-bound coho salmon has been lower than average every year except this year. The estimated harvest of 977 Kenai River coho salmon in Northern District fisheries was the second highest since monitoring began in 1993 (Carlon 2003; Massengill and Carlon 2004ba-b; Massengill and Carlon 2007a-b).

SMOLT ABUNDANCE

History

The smolt abundance estimate has become an important element of the stock assessment program. The complete record (since 1992) has been cited by ADF&G as a basis for recommending conservation actions. Although declining smolt abundance was the impetus for developing the Kenai River Coho Salmon Management Plan in 1997, the original intent was to monitor smolt abundance and parent-year harvest to determine a link between total harvest and smolt production. Therefore, the management plan is a precautionary measure because it is still not known if the decline was harvest-induced, natural, or both.

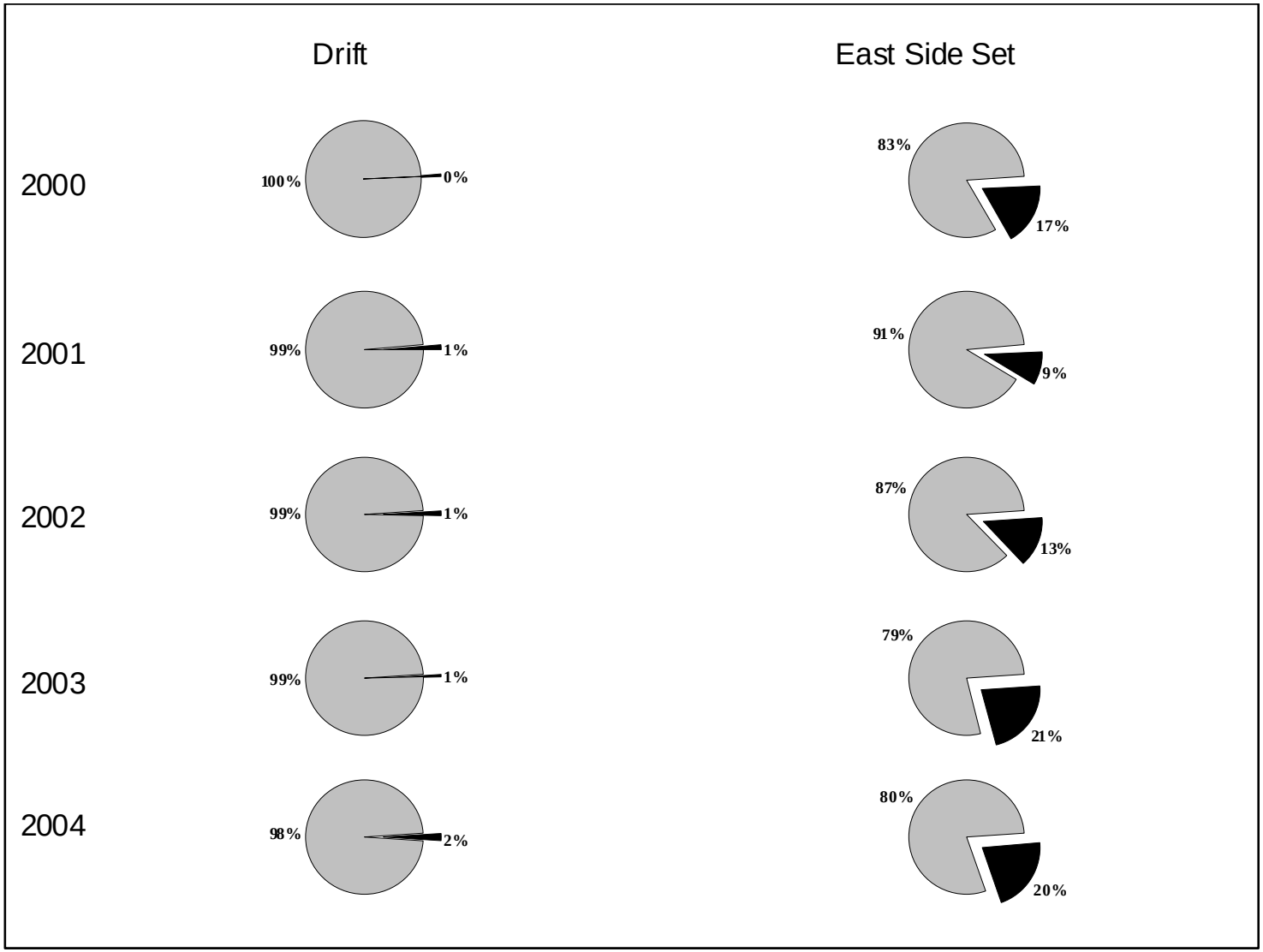

Figure 10.–Contribution of coho salmon from the Kenai River to the drift and eastside set gillnet commercial fisheries of Upper Cook Inlet, 2000-2004.

Smolt abundance estimates were the sole stock assessment "barometer" from 1995 to 1998, after smolt abundance was identified as an alternative to an adult-based stock assessment. Developing annual harvest and smolt abundance estimates is a long-term endeavor, but has been favored because of the lack of success and the potential high cost of estimating adult abundance. However, the weak 1997 return and the resultant fishery restrictions renewed interest in estimates of inriver adult abundance. Since 1999, a full-scale mark-recapture study has been conducted annually to estimate the adult population size. Smolt abundance, total harvest, and adult return and escapement estimates will enhance ADF&Gs ability to assess the population and the sustainability of the fisheries.

The 2003 smolt abundance estimate is the twelfth annual estimate since 1992 (Figure 11). It also represents the second smolt production estimate that can be associated with a parent-year escapement estimate for Kenai River coho salmon. Because most Kenai River coho salmon develop into smolt at age-2, the primary parent year for the 2003 smolt emigration was 2000. The escapement estimate for 2003 is preliminary (Carlon *In prep*), but will be about 74,000 adults. This escapement is associated with the largest recorded smolt production estimate of 1,196,310 in 2000. It is too early to determine if a relationship between escapement and smolt production exists for developing management objectives (e.g., an escapement goal), but it will be monitored as additional estimates become available. Note that the 1999 adult escapement estimate of 20,422 was unusually low, yet was the primary parent-year class that produced a near average estimate of 627,347 smolt in 2002.

Relationship Between Total Harvest and Smolt Abundance

In addition to 12 smolt abundance estimates, there are 11 annual total adult harvest estimates since 1993 (Appendix A7, Figure 12). The coupling of these records has produced eight pairs of harvest and smolt abundance estimates (Figure 13). While the relationship does not identify a threshold harvest beyond which smolt abundance is negatively, and consistently impacted, it suggests that the record adult harvest in 1994 may have been excessive. It is associated with the 1997 smolt production (Carlon 2003) which is the lowest on record. This also suggests that the precautionary measures adopted under the Kenai River Coho Salmon Conservation Management Plan should be retained until additional information demonstrates that surplus yield is available. Additional monitoring of the adult harvest-smolt abundance relationship is necessary to determine if a practical harvest guideline management objective can be developed. This relationship, and others developed from the ongoing assessment program, will eventually provide information to modify the management plan or formulate quantitative management objectives.

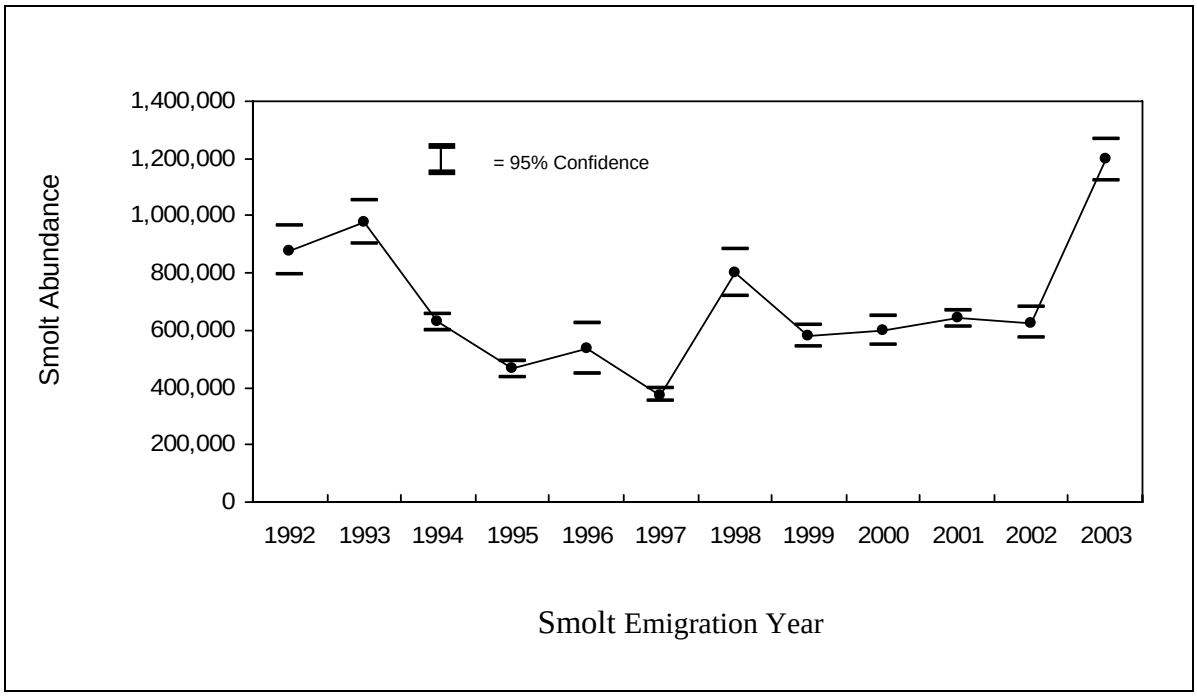

Figure 11.–Estimates of coho salmon smolt abundance in the Kenai River, 1992-2003.

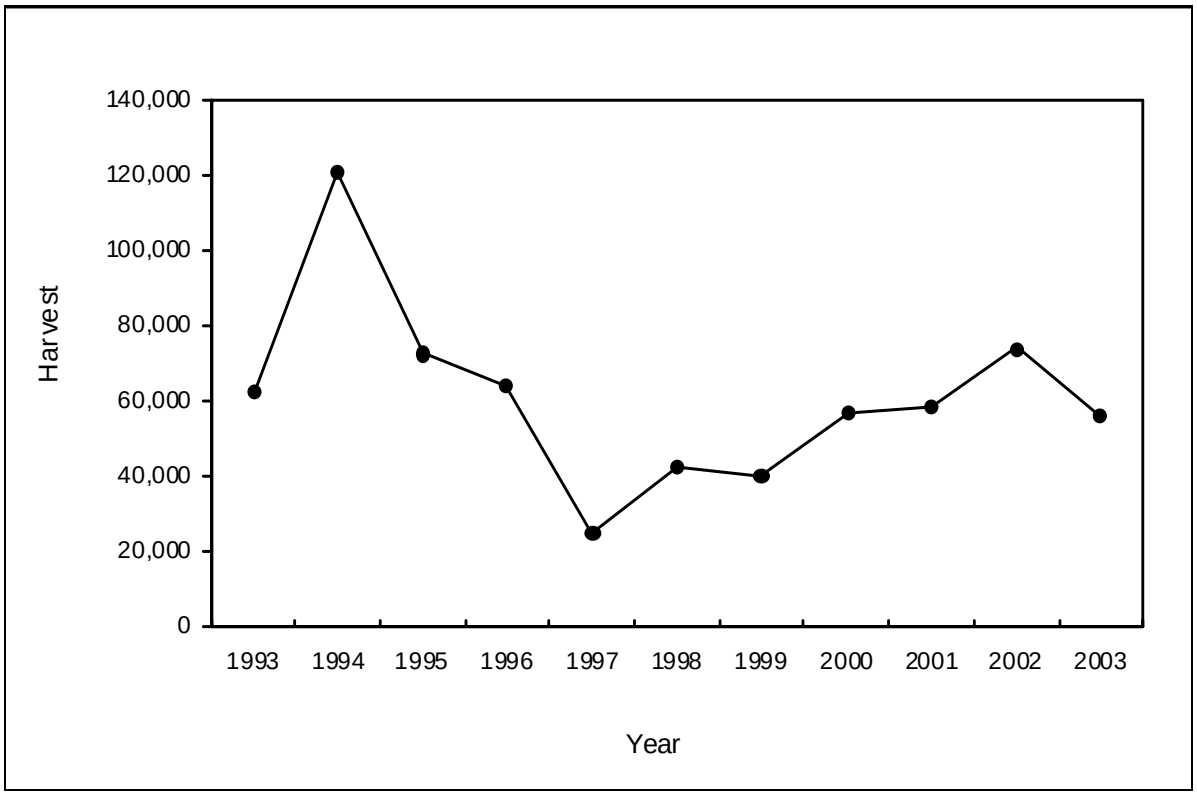

Figure 12.-Estimates of total harvest of coho salmon of Kenai River origin by combining estimates of commercial marine harvest with inriver estimates of personal-use, mainstem sport, and Russian River sport harvest, 1993-2003.

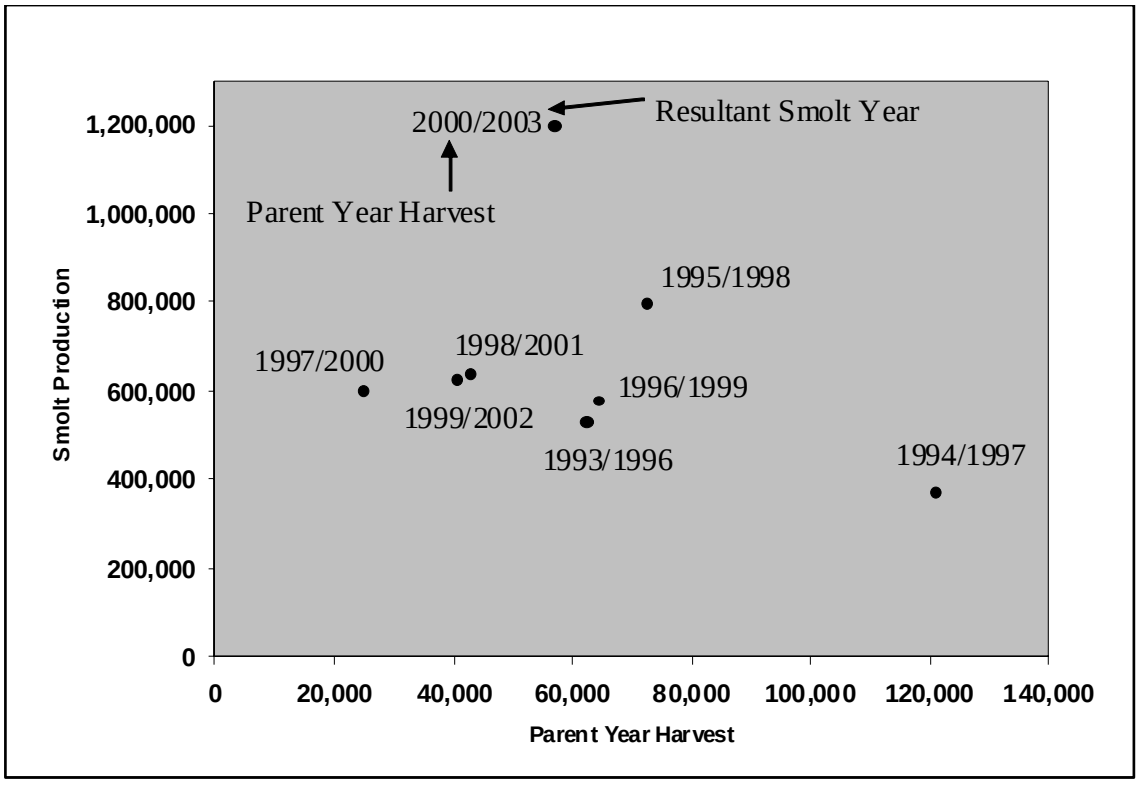

Figure 13.–Available points in the long-term assessment approach relating annual smolt production to parent-year harvest for coho salmon from the Kenai River, Alaska.

RECOMMENDATIONS

Continue estimating total harvest and smolt abundance of Kenai River coho salmon.

The relationship between annual fishing mortality and smolt abundance should continue to be monitored long-term to determine if harvest levels are influencing smolt production. With only eight pairs of estimates currently available, it is not possible to establish a link between harvest and smolt production, however the record low smolt abundance of 1994 is associated with the highest harvest on record (1997) which suggests this approach may be sensitive enough to have management implications if continued. Estimating annual smolt production will at least provide continued monitoring of coho salmon productivity in the Kenai River drainage and help identify the source (freshwater or marine) of major population changes.

Continue companion project to estimate spawning escapement.

The companion project to estimate adult abundance, exploitation rate, and escapement provides more immediate assessment information than can be provided by the long-term approach of relating smolt production to harvest. The record harvest in 1994 demonstrates the substantial harvest potential of sport and commercial fisheries in UCI. More immediate assessment information is desired to supplement the long-term approach. The annual mark-recapture study initiated in 1998 should be continued to enhance the assessment of the population of Kenai River coho salmon.

Distribute coded wire tags evenly throughout the smolt emigration.

Inriver temporal variations in the adult marked proportion have been observed since 2000. To reduce temporal variation in the inriver adult return, smolt have been tagged evenly throughout the emigration since 2002 In 2003, a daily coded wire tagging goal limit was set at around 5,000 smolt to provide better tagging coverage throughout the emigration. In 2004, the adult inriver tagged proportion (marked in 2003) varied temporally, but to a lesser degree than the two previous returns. The total number of smolt tagged in 2004 was reduced by about 30% as a cost–savings measure. Therefore, to protract tagging through most of the emigration the daily tagging goal was reduced to about 3,500 smolt. Until the results of tagging more evenly throughout the emigration can be evaluated from the 2005 adult return, it is recommended that tagging 3,500 a day continue.

ACKNOWLEDGMENTS

The following people comprised the team that marked smolt at the Moose River in 2003. Kurt Strausbaugh was the field project leader and participated in all phases of field investigation. Sandee Simons, Jake Glotfelty, Jerry Strait, Stan Walker, T.D. Hacklin and Ramona Baker (American Fisheries Society: E.F. Hutton Student) assisted with all phases of the field investigation including logistical support, weir operation and maintenance, and smolt tagging and enumeration. “Cotton” and Lorraine Moore granted convenient access to the Moose River.The commercial harvest was examined in 2004 by technicians of CFD. Kim Rudge-Karic supervised commercial harvest sampling in the Central District, provided logistical support, and collated commercial sampling data. Likewise, Dan Bosch supervised commercial harvest sampling in the Northern District. Personnel of the CFD Mark, Tag, and Aging Laboratory in Juneau processed all coded wire tag data collected in 2003 and 2004. All CFD personnel contributed to the successful achievement of study objectives.

David Evans provided in-depth, biometric and editorial reviews of the operational plan and this report. Mike Buntjer provided the final technical and formatting reviews.

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APPENDIX A

Appendix A1.–Number of wild coho salmon smolt captured from the Moose River, marked with an adipose finclip and coded wire tags, and released in 2003, and tag codes identified in the sample of 187 Moose River tagged fish recovered from known, unmixed UCI commercial fishery strata in 2004.

Tag Code	First day released	Last day released	Number marked [a]	Short-term survival rate	Number Marked at Release [b]	Short-Term Tag Retention	Number Tagged at Release [c]	Number identified in UCI commercial harvest sample in 2004 [d]
310294	05/20	05/24	12,074	100.00%	12,074	99.6%	12,026	20
310295	05/23	05/26	12,170	100.00%	12,170	99.2%	12,073	10
310296	05/26	05/29	12,190	100.00%	12,190	99.5%	12,129	9
310297	05/28	05/31	12,244	99.84%	12,223	99.7%	12,186	19
310298	05/30	06/03	11,834	100.00%	11,834	99.4%	11,763	19
310299	06/02	06/05	12,071	100.00%	12,071	99.5%	12,011	15
310301	06/04	06/08	12,221	100.00%	12,221	99.4%	12,148	16
310128	06/07	06/12	23,321	99.92%	23,296	99.8%	23,249	50
310302	06/11	06/14	12,226	100.00%	12,226	98.6%	12,055	25
Total			120,351	99.96%	120,305	99.4%	119,640	183

[a] Total number of adipose-clipped smolt injected with a coded wire tag.

[b] Estimated number of marked smolt that survived after release.

[c] Estimated number of marked smolt that survived and retained a tag after release.

[d] Number of tags physically recovered from known fishery areas of UCI by commercial fishing in 2004, and identified as Moose River coho salmon released in 2003.

Appendix A2.–Daily summary of coho salmon adults captured by two fish wheels located along the north and south banks of the Kenai River near river kilometer 44.5 between August 1 and September 30, 2004.

Date	August: Number Captured and Examined	August: Marked Fish Observed[a]	August: Marked Fish Checked with Tag Detector[b]	August: Coded Wire Tag Detected	Date	September: Number Captured and Examined	September: Marked Fish Observed[a]	September: Marked Fish Checked with Tag Detector[b]	September: Coded Wire Tag Detected
					North Bank				
08/01					09/01	67	3	3	3
08/02	1				09/02	67	8	8	8
08/03	12	2	1	1	09/03	70	12	11	11
08/04	4				09/04	73	7	7	7
08/05	2				09/05	45	9	9	9
08/06	5				09/06	67	4	4	4
08/07	11	1	1	1	09/07	79	4	4	4
08/08	12	1	1	1	09/08	52	10	9	9
08/09	29	2	2	2	09/09	104	16	16	16
08/10	28	1	1	1	09/10	112	17	17	17
08/11	20	2	2	2	09/11	115	11	11	11
08/12	31	1	1	1	09/12	88	9	9	9
08/13	50	1	1	1	09/13	86	11	11	11
08/14	46	3	3	3	09/14	71	11	11	11
08/15	64	6	6	6	09/15	97	6	5	5
08/16	68	3	3	3	09/16	79	5	5	5
08/17	64	3	3	3	09/17	109	11	11	11
08/18	47	3	3	3	09/18	95	8	8	8
08/19	32	3	3	3	09/19	91	12	12	12
08/20	85	6	6	6	09/20	165	21	21	21
08/21	64	3	3	3	09/21	86	14	14	14
08/22	47	4	4	4	09/22	130	19	18	18
08/23	88	8	1	1	09/23	143	25	25	25
08/24	86	6	6	6	09/24	92	15	15	15
08/25	114	9	4	4	09/25	83	7	7	7
08/26	72	6	6	6	09/26	94	11	11	11
08/27	73	6	6	6	09/27	77	8	8	8
08/28	71	8	8	8	09/28	68	6	6	6
08/29	39	3	3	3	09/29	81	11	11	11
08/30	84	10	10	10	09/30	117	22	22	22
08/31	29	4	4	4					
Subtotal	1,378	105	92	92		2,703	333	329	329
North Bank Subtotal						4,081	438	421	421

-continued-

Appendix A2.–Page 2 of 2.

August					September				
Date	Number Captured and Examined	Marked Fish Observed[a]	Marked Fish Checked with Tag Detector[b]	Coded Wire Tag Detected	Date	Number Captured and Examined	Marked Fish Observed[a]	Marked Fish Checked with Tag Detector[b]	Coded Wire Tag Detected
					South Bank				
08/01	3				09/01	158	24	24	24
08/02	1				09/02	172	19	18	18
08/03	6				09/03	114	12	12	12
08/04	5				09/04	134	15	15	15
08/05	14	2	2	2	09/05	117	12	12	12
08/06	10				09/06	128	17	15	15
08/07	25	1	1	1	09/07	55	2	2	2
08/08	14	1	1	1	09/08	61	9	9	9
08/09	43				09/09	50	5	4	4
08/10	53	4	4	3	09/10	95	13	13	13
08/11	106	6	6	6	09/11	47	7	7	7
08/12	109	4	4	4	09/12	132	9	9	9
08/13	99	5	5	5	09/13	88	6	6	6
08/14	91	6	6	6	09/14	37			
08/15	132	7	7	7	09/15	21	3	3	3
08/16	113	11	11	11	09/16				
08/17	132	11	11	10	09/17	6	1	1	1
08/18	206	19	19	19	09/18	17	2	2	2
08/19	174	12	12	12	09/19	16	4	4	4
08/20	239	19	19	19	09/20	46	6	6	6
08/21	205	19	19	19	09/21	20	5	5	5
08/22	212	19	19	18	09/22	44	5	5	5
08/23	220	33	33	33	09/23	47	5	5	5
08/24	204	20	13	13	09/24	15	1	1	1
08/25	241	24	21	21	09/25	17	4	4	4
08/26	117	14	14	14	09/26	11	1	1	1
08/27	124	8	8	8	09/27	77	4	4	4
08/28	116	10	10	10	09/28	6	1	1	1
08/29	157	17	17	17	09/29	5	1	1	1
08/30	132	15	15	14	09/30	10	3	3	3
08/31	87	5	5	5					
Subtotal	3,390	292	282	278		1,746	196	192	192
South Bank Subtotal						5,136	488	474	470
Grand Total (both banks)						9,217	926	895	891

[a] Number of coho salmon missing an adipose fin.

[b] Captured coho salmon that were missing an adipose fin and were checked for a coded wire tag using a Northwest Marine Technologies tag detection wand before releasing the fish.

Appendix A3.–Daily summary of coho salmon adults captured by all recapture gear (primarily drift gillnetting) and examined for a missing adipose fin on the Kenai River between river kilometer 58.4 and 48.9 from August 1 to October 5, 2004.

	August					September-October				
Date[a]	Number Captured and Examined	Marked Fish Observed[b]	Number Captured and Examined	Marked Fish Observed[b]		Date[a]	Number Captured and Examined	Marked Fish Observed[b]	Number Captured and Examined	Marked Fish Observed[b]
	North Bank		**South Bank**				**North Bank**		**South Bank**	
08/01						09/01	51	12	41	4
08/02			2			09/02	124	14	51	7
08/03			2	1		09/03	66	7	54	7
08/04	1					09/04	71	5	40	3
08/05			3			09/05	24	3	18	2
08/06	4	1	5			09/06	37	2	20	2
08/07	7	1	5	1		09/07	48	10	39	6
08/08	7		3	1		09/08	65	10	43	1
08/09	2		4	1		09/09	40	4	54	9
08/10	9	1	7			09/10	45	6	57	5
08/11	4		13	2		09/11	42	7	71	4
08/12	23	2	17			09/12	27	3	23	5
08/13	31	4	9			09/13	25	4	27	5
08/14	24	3	27	5		09/14	17	4	55	7
08/15	23	2	21	1		09/15	35		51	9
08/16	29	4	20	3		09/16	24	3	97	10
08/17	36	4	26	3		09/17	35	3	76	7
08/18	44	4	55	6		09/18	35	1	63	6
08/19	46	8	52	3		09/19	44	5	35	1
08/20	53	7	38	9		09/20	41	3	44	6
08/21	41	4	63	7		09/21	54	7	99	14
08/22	18	3	27	2		09/22	22	1	80	8
08/23	26	3	25	1		09/23	19	4	85	9
08/24	51	10	37	4		09/24	25	2	80	12
08/25	42	8	43	3		09/25	8	1	53	8
08/26	63	9	56	6		09/26	6		26	2
08/27	50	8	41	4		09/27	7		41	2
08/28	63	12	62	8		09/28	10	1	43	5
08/29	23	4	31	1		09/29	7		38	3
08/30	23	3	31	7		09/30	36	5	39	1
08/31	68	15	45	9		10/01	11	3	28	3
						10/02	6	1	44	8
						10/03	5		12	1
						10/04	13	1	16	2
						10/05	5	1	10	1
Subtotal	811	120	770	88			1,130	133	1,653	185
							North Bank Total		South Bank Total	
							1,941	253	2,423	273
					Grand total		4,364	526		

Appendix A4.–Daily summary of coho salmon adults examined at the Russian River weir, June 7 through September 3, 2004.

Date	Weir Count	Examined	Marked Fish Observed [b]	Date	Weir Count	Examined	Marked Fish Observed [b]
7/31	1	1	0	8/21	15	15	0
8/1	0	0	0	8/22	16	16	0
8/2	0	0	0	8/23	10	9	0
8/3	1	1	0	8/24	7	7	0
8/4	2	2	0	8/25	11	11	3
8/5	2	2	0	8/26	15	15	2
8/6	5	5	0	8/27	21	21	2
8/7	6	6	0	8/28	34	34	3
8/8	2	2	0	8/29	12	12	1
8/9	7	7	0	8/30	19	18	0
8/10	14	14	0	8/31	23	23	2
8/11	15	15	1	9/1	29	29	2
8/12	16	15	1	9/2	0	0	0
8/13	17	14	0	9/3	0	0	0
8/14	16	14	0				
8/15	10	9	0				
8/16	15	12	1				
8/17	24	22	2				
8/18	21	21	0				
8/19	38	38	0				
8/20	16	16	2				
Subtotal	228	216	7	Subtotal	212	210	15
				Grand Total	440	426	22

[a] Weir was operated between June 9 and September 3, 2004, but the first coho salmon did not arrive at the weir until July 31, 2004.

[b] Number of coho salmon missing an adipose fin.

Appendix A5.–Coho salmon examined, including coded wire tag recoveries, and recovery of marked Kenai River coho salmon in commercial harvest samples from mixed Cook Inlet statistical areas in 2004.

Date	Statistical areas	(n_i) Number examined	(a_i) Adipose-clips observed	(a'_i) Heads recovered	(t_i) Heads with tags	(t'_i) Decodable tags	(m_i) Source= Moose R 2001
	Mixed Central District Statistical Areas						
East Side Set							
7/15/2004	Mixed(ESS)-24421/22	14	0	0	0	0	
7/15/2004	Mixed(ESS)-24422/31/32	9	0	0	0	0	
7/21/2004	Mixed(ESS)-24421/22	18	1	1	1	1	
7/23/2004	Mixed(ESS)-24421/22	12	1	1	1	1	1
7/23/2004	Mixed(ESS)-24421/31	2	0	0	0	0	
7/24/2004	Mixed(ESS)-24421/31	5	0	0	0	0	
7/27/2004	Mixed(ESS)-24421/22	29	0	0	0	0	
7/28/2004	Mixed(ESS)-24421/22/31	13	1	1	1	1	1
7/29/2004	Mixed(ESS)-24421/31/41	4	0	0	0	0	
7/29/2004	Mixed(ESS)-24422/31	7	0	0	0	0	
7/30/2004	Mixed(ESS)-24422/31	6	0	0	0	0	
8/2/2004	Mixed(ESS)-24421/22/31/32	51	1	1	1	1	1
8/5/2004	Mixed(ESS)-24422/31	24	1	1	0	0	
Total		194	5	5	4	4	3
West Side and Kalgin Island Set							
7/26/2004	Mixed(WSS/KIS)-24530-24620	257	2	2	2	2	
8/2/2004	Mixed(WSS/KIS)-245/30-24610/20	1952	13	13	9	9	2
8/9/2004	Mixed(WSS/KIS)-245/30-24610/20	720	3	3	2	2	
8/12/2004	Mixed(WSS/KIS)-245/30-24610/20	753	2	2	1	1	1
8/16/2004	Mixed(WSS/KIS)-24530-24610	479	8	8	8	8	4
Total		4,161	28	28	22	22	7
Central District Drift and East Side Set							
7/15/2004	Mixed(CDD/ESS)-244CDD-24431	28	0	0	0	0	
Mixed Central District Total		4,383	33	33	26	26	10
	Mixed Northern District Statistical Areas						
Northern District East Side and Fire Island Set							
7/26/2004	Mixed(NDW/NDN)-24730/41	714	0	0	0	0	0
Grand Total		5,097	33	33	26	26	10

[a] These data were excluded from analyses and harvest contribution estimates because of geographic ambiguity in the sample source.

Appendix A6.–Upper Cook Inlet commercial and test fishery coho salmon harvest in 2004, coded wire tag sampling information, and population-specific harvest estimates of Kenai River coho salmon based on recoveries of fish marked at the Moose River in 2003.

Date (2004)[b]	(H) Total Harvest	(ni) Number Examined [c]	(ai) Adipose-clips Observed	(a'i) Heads Recovered	(ti) Heads with Tags[d]	(t'i) Decodable Tags[e]	(mi) Source= Moose R 2002	(ri) Harvest Estimate	V(ri) Variance
Commercial Harvest									
Central District									
Drift Gillnet									
Central									
06/28 - 06/29	445	44	0	0	0	0	0	0	0
07/01 - 07/02	1299	339	0	0	0	0	0	0	0
07/05	2,563	830	0	0	0	0	0	0	0
07/07 - 07/09	8713	2580	6	6	3	3	0	0	0
07/10 - 07/12	13063	4879	15	15	9	9	0	0	0
07/14 - 07/16	10768	4578	18	18	10	10	0	0	0
07/17 - 07/19	28040	7081	40	40	31	31	0	0	0
07/21	18,738	5,394	24	24	19	19	2	69	2314
07/22	227	156	1	1	1	1	0	0	0
07/23 - 07/24	34520	7497	54	54	49	49	3	138	6223
07/25 - 07/26	7455	2042	17	17	16	16	0	0	0
07/27	5,164	1,391	10	10	10	10	2	74	2667
07/28	12,960	3,815	51	51	46	46	6	204	6768
07/29	20,107	3,159	52	52	47	47	10	636	40188
07/30 - 07/31	2033	831	11	11	10	10	3	73	1707
08/01 - 08/02	8,600	3,071	20	20	17	17	7	196	5326
08/06 - 08/08	2,663	153	5	5	4	4	4	696	120781
08/09 - 08/16	4,471	1,009	25	25	25	25	21	930	41101
08/03	2,117	782	12	12	12	12	7	189	4946
08/04	12,682	3,215	66	66	62	62	17	670	26170
08/05	1,837	293	11	11	10	10	6	376	23308
Total	198,465	53,139	438	438	381	381	88	4,251	281,500
East Side Set									
Statistical Area 24421									
06/25 - 07/08	48	2	0	0	0	0	0	0	0
07/10 - 07/12	13	1	0	0	0	0	0	0	0
07/14 - 07/19	127	12	1	1	1	1	1	106	11,130
07/21	55	17	0	0	0	0	0	0	0
07/22	18	7	0	0	0	0	0	0	0
07/23	19	22	0	0	0	0	0	0	0
07/24	53	27	1	1	1	1	1	20	380
07/25 - 07/26	83	40	1	1	1	1	1	21	420
07/27	48	9	0	0	0	0	0	0	0
07/28	56	30	0	0	0	0	0	0	0
07/29	23	5	0	0	0	0	0	0	0
07/30 - 08/01	174	12	1	1	1	1	1	145	20,880
08/02 - 08/04	153	40	4	4	3	3	3	115	4,302
08/05 - 08/07	584	5	0	0	0	0	0	0	0
Total	1,454	229	8	8	7	7	7	407	37,112
Statistical Area 24422									
06/25 - 07/05	16	1	0	0	0	0	0	0	0
07/08 - 07/12	23	4	0	0	0	0	0	0	0
07/14 - 07/15	50	11	1	1	0	0	0	0	0
07/16	12	4	0	0	0	0	0	0	0
07/17	20	9	0	0	0	0	0	0	0
07/18 - 07/19	33	8	0	0	0	0	0	0	0
07/21	42	11	0	0	0	0	0	0	0
07/22	20	12	0	0	0	0	0	0	0
7/23 - 07/26	295	58	2	2	2	2	2	102	5,105
07/27	105	31	0	0	0	0	0	0	0
07/28	139	49	2	2	1	1	1	28	756

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Date (2004)[b]	(H) Total Harvest	(ni) Number Examined[c]	(ai) Adipose-clips Observed	(a'i) Heads Recovered	(ti) Heads with Tags[d]	(t'i) Decodable Tags[e]	(mi) Source= Moose R 2002	(ri) Harvest Estimate	V(ri) Variance
07/29	52	21	0	0	0	0	0	0	0
7/30 - 7/31	135	25	0	0	0	0	0	0	0
08/01 - 08/02	261	13	1	1	1	1	1	201	40,200
08/04	102	51	0	0	0	0	0	0	0
08/05 - 08/07	1,044	36	0	0	0	0	0	0	0
Total	2,349	344	6	6	4	4	4	331	46,061
Statistical Area 24431/32									
06/28 - 07/09	26	3	0	0	0	0	0	0	0
07/10 - 07/15	108	2	0	0	0	0	0	0	0
07/16 - 07/19	63	15	0	0	0	0	0	0	0
07/21	74	18	0	0	0	0	0	0	0
07/22	18	9	0	0	0	0	0	0	0
07/23 - 07/24	244	32	0	0	0	0	0	0	0
07/25 - 07/26	176	29	0	0	0	0	0	0	0
07/27	164	45	1	1	1	1	1	36	1,260
07/28	137	45	0	0	0	0	0	0	0
07/29 - 07/31	376	8	0	0	0	0	0	0	0
08/01 - 08/02	497	21	1	1	1	1	1	237	55,932
08/04	297	20	2	2	2	2	2	297	43,853
08/05	513	36	0	0	0	0	0	0	0
08/06 - 08/07	1,494	84	5	5	4	4	4	711	126,059
Total	4,187	367	9	9	8	8	8	1,281	227,104
Statistical Area 24441/42									
07/08	91	50	0	0	0	0	0	0	0
07/12	128	51	0	0	0	0	0	0	0
07/14 - 07/16	582	89	1	1	1	1	0	0	0
07/17 - 07/19	602	101	1	1	1	1	1	60	3,540
07/21	1,126	147	0	0	0	0	0	0	0
07/22	354	122	1	1	1	1	1	29	812
07/23 - 07/24	2,088	189	3	3	3	3	1	110	11,991
07/25 - 07/26	2,020	666	5	5	4	4	0	0	0
07/27	1,990	502	5	5	4	4	3	119	4,611
07/28	2,899	1,223	15	15	13	13	8	190	4,355
07/29 - 07/31	2,224	534	6	6	5	5	5	208	8,481
08/01 - 08/02	2,132	135	3	3	2	2	2	316	49,663
08/04	843	69	2	2	2	2	2	244	29,555
08/05 - 08/07	5,048	173	10	10	10	10	9	2,626	769,868
Total	22,127	4,051	52	52	46	46	32	3,902	882,875
Eastside Set Gillnet									
Total	30,117	4,991	75	75	65	65	51	5,921	1,193,152
Statistical Area 24425[f]									
07/14 - 08/07	32	0	0	0	0	0	0	0	0
Kalgin Island Set Area 24610/20									
06/28 - 07/29	10,386	908	6	6	5	5	0	0	0
07/31 - 8/23	10,710	196	2	2	1	1	1	546	297,571
Total	21,096	1,104	8	8	6	6	1	546	297,571
West Side Set Areas 24520/30/40/50/55/60									
06/25 - 07/17	1,098	19	0	0	0	0	0	0	0
07/18 - 07/24	2,228	68	0	0	0	0	0	0	0
07/25 - 07/26	413	61	0	0	0	0	0	0	0
07/28 - 07/30	2,431	264	0	0	0	0	0	0	0
08/02	943	641	0	0	0	0	0	0	0
08/04 - 08/05	2,136	683	2	2	0	0	0	0	NA
08/09 - 08/12	3,429	743	2	2	0	0	0	0	NA
08/23 - 08/26	1,116	651	1	1	0	0	0	0	NA
08/16	741	510	1	1	1	1	1	15	210
08/19	626	611	0	0	0	0	0	0	0
Total	15,161	4,251	6	6	1	1	1	15	210

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Date (2004)[b]	(H) Total Harvest	(ni) Number Examined[c]	(ai) Adipose-clips Observed	(a'i) Heads Recovered	(ti) Heads with Tags[d]	(t'i) Decodable Tags[e]	(mi) Source= Moose R 2002	(ri) Harvest Estimate	V(ri) Variance
Central District East Side Set Net and Drift Gill Net Fishery									
Total	228,614	58,130	513	513	446	446	139	10,172	1,474,652
Entire Central District Total									
	264,871	63,485	527	527	453	453	141	10,733	1,772,433
Northern District									
East Side Set Areas 24770/80/90									
06/28 - 07/05	210	4	0	0	0	0	0	0	0
07/08	81	30	0	0	0	0	0	0	0
07/12	43	33	1	1	1	1	0	0	0
07/15	369	255	1	0	0	0	0	0	NA
07/19 - 07/22	1,027	154	0	0	0	0	0	0	0
07/26	521	525	3	3	3	3	0	0	0
07/29	698	503	5	5	4	4	1	14	182
08/05	429	272	2	2	2	2	1	16	240
08/09	535	572	2	2	2	2	0	0	0
08/12	987	845	4	4	3	3	2	23	242
08/16	1,673	162	4	4	3	3	3	310	31,789
08/19	1,292	258	3	3	3	3	3	150	7,366
08/23	2,050	998	10	10	8	8	5	103	2,027
08/26	1,848	1,508	13	13	10	10	8	98	1,111
08/30 - 09/13	545	133	1	1	1	1	0	0	0
Total	12,308	6,252	49	48	40	40	23	714	42,957
Fire Island Set Area 247/43									
06/28 - 07/08	21	45	1	1	1	1	0	0	0
07/12	144	143	2	2	2	2	0	0	0
07/15	616	558	6	6	5	5	0	0	0
07/19 - 07/22	247	106	0	0	0	0	0	0	0
07/26	59	59	0	0	0	0	0	0	0
07/29	549	195	8	6	6	6	1	38	1,406
08/05	858	418	6	6	6	6	0	0	0
08/09	989	974	18	18	16	16	1	10	90
08/12	726	740	15	15	14	14	6	59	525
08/16	818	800	21	21	21	21	2	20	181
08/19 - 8/30	1,114	400	21	21	20	20	2	56	1,513
Total	6,141	4,438	98	96	91	91	12	183	3,715
Pt. MacKenzie/Su Flats Set Area 24741/42									
06/14 - 07/08	155	83	0	0	0	0	0	0	0
07/12	489	234	0	0	0	0	0	0	0
07/14 - 07/15	1,985	925	8	8	8	8	0	0	0
07/19	1,989	1,636	16	16	15	15	0	0	0
07/22	1,205	943	15	8	7	7	0	0	0
07/26	2,529	1,763	42	42	37	37	0	0	0
07/29	2,028	1,806	32	32	31	31	0	0	0
08/05	2,038	1,770	47	46	45	45	0	0	0
08/09	1,943	1,367	45	45	42	42	1	14	182
08/12	1,978	2,014	87	87	84	84	1	10	90
08/16	1,451	1,207	50	50	50	50	3	36	397
08/19	863	866	31	31	31	31	2	20	180
08/23 - 08/26	422	455	14	14	13	12	0	0	0
09/02	15	15	1	1	1	1	0	0	0
Total	19,090	15,084	388	380	364	363	7	80	849
West Side Set Area 24710/20/30									
06/28 - 07/08	188	11	0	0	0	0	0	0	0
07/12	1,271	1,482	4	4	1	1	0	0	0
07/15	1,199	200	0	0	0	0	0	0	0
07/19	831	90							
07/22 - 07/26	982	375	1	1	0	0	0	0	NA
07/29	1,226	167	2	2	0	0	0	0	NA

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Date (2004)[b]	(H) Total Harvest	(ni) Number Examined[c]	(ai) Adipose-clips Observed	(a'i) Heads Recovered	(ti) Heads with Tags[d]	(t'i) Decodable Tags[e]	(mi) Source= Moose R 2002	(ri) Harvest Estimate	V(ri) Variance
08/05	1,054	87	0	0	0	0	0	0	0
08/09 - 08/23	387	275	0	0	0	0	0	0	0
Total	7,138	2,687	7	7	1	1	0	0	0
Northern District									
Total	44,677	28,461	542	531	496	495	42	977	47,522
Northern District Total and Central District Drift/East Side Set Total[g]									
	273,291	86,591	1,055	1,044	942	941	181	11,149	1,522,174
Commercial Harvest									
Grand Total	309,548	91,946	1,069	1,058	949	948	183	11,710	1,819,954
				Test Fishery					
Central District									
Drift Gill Net Test Fishery[g]									
07/02 - 07/22	630	149	1	1	1	1	0	0	0
07/23 - 07/25	332	109	1	1	1	1	0	0	0
07/28 - 07/29	133	68	1	1	1	1	0	0	0
Test Fishery									
Total	1095	326	3	3	3	3	0	0	0
				Commercial and Test Fishery					
Grand Total	310,643	92,272	1,072	1,061	952	951	183	11,710	1,819,954

[a] The Central District set gillnet fisheries of Kalgin Island and the Westside were not sampled or were sampled incidentally, but are included here to add perspective to information from sampled fisheries.

[b] Multiple date entries represent strata when unsampled harvests were combined with a temporally adjacent sampled harvest to account for contributions to unsampled harvests.

[c] Estimates with blank entries indicate that a harvest was reported, but the fishery was not sampled.

[d] Denotes heads with tags magnetically detected.

[e] Denotes the number of heads with tags that were decoded and assigned to a known release event.

[f] Denotes an ADF&G drift gillnet fishery located within the mouth of the Kasilof River and opened by emergency order only. Harvest recorded is biased low because of improper reporting on fish tickets .

[g] Does not include the special drift area of 244-25 (Kasilof River mouth).

[h] Denotes an ADF&G offshore drift gillnet test fishery (OTF) occurring in statistical areas 24590 and 24470.

Appendix A7.–Total harvest of coho salmon of Kenai River origin in Upper Cook Inlet inriver and marine commercial fisheries, 1993-2003.

	Inriver											
	Sport[a]					Personal use/Subsistence		UCI Marine Commercial[b]				
Year	Unguided[a]	Guided	Total	Russian River	Total	Kenai River	Inriver Total	Eastside Set Gillnet	Drift Gillnet	Northern District	Commercial Total	Grand Total
1993	26,805	23,743	50,548	2,290	52,838	1,597 [c]	54,435	6,806	930	148	7,884	62,319
1994	45,623	41,170	86,793	4,607	91,400	2,535 [d]	93,935	14,673	11,732	477	26,882	120,817
1995	22,663	23,587	46,250	4,077	50,327	1,261 [e]	51,588	13,152	6,956	582	20,690	72,278
1996	28,764	13,728	42,492	4,599	47,091	1,932 [f]	49,023	11,856	2,671	29	14,556	63,579
1997	13,063	3,101	16,164	4,586	20,750	559 [f]	21,309	2,093	1,236	36	3,365	24,674
1998	21,750	5,217	26,967	4,612	31,579	1,011 [f]	32,590	8,096	1,974	175	10,245	42,835
1999	23,550	8,087	31,637	3,910	35,547	1,009 [f]	36,556	2,905	818	171	3,894	40,450
2000	39,170	9,349	48,519	3,938	52,457	1,449 [f]	53,906	2,351	531	83	2,965	56,871
2001	36,264	13,563	49,827	5,222	55,049	1,555 [f]	56,604	349	282	1,303	1,934	58,538
2002	45,243	14,444	59,687	6,093	65,780	1,721 [f]	67,501	4,688	1,370	57	6,115	73,616
2003	34,783	11,964	46,747	5,197	51,944	1,332 [f]	53,276	2,122	330	126	2,578	55,854
Average	30,698	15,268	45,966	4,466	50,433	1,451	51,884	6,281	2,621	290	9,192	61,076

[a] Source is Statewide Harvest Survey (Mills 1994; Howe et al. (1995, 1996); Howe et al. (2001a-b); Walker et al. (2003); Jennings et al. (2004); Jennings et al. (2006a-b); 1996-2000 are revised estimates. Mainstem unguided includes Skilak Lake.

[b] Carlon and Hasbrouck (1996-1998); Carlon (2000, 2003); Massengill and Carlon (2004a-b); Massengill (*In prep* a); Massengill and Carlon (2007a-b).

[c] Kenai River personal use dipnet fishery harvest (Mills 1994).

[d] Kenai River subsistence dipnet fishery harvest (Brannian and Fox 1996).

[e] Kenai River personal use dipnet fishery harvest (Reusch and Fox 1996).

[f] Reimer and Sigurdsson (2004).