Fishery Data Series No. 07-91

Assessment of Coho Salmon from the Kenai River, Alaska, 2005

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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ABSTRACT

Wild coho salmon *Oncorhynchus kisutch* smolt were captured in the Kenai River drainage in spring 2004, marked with an adipose finclip and injected with a coded wire tag (CWT). These were recovered as adults in 2005 from selected commercial fisheries in Upper Cook Inlet (UCI), Alaska, and from within the Kenai River drainage.

There were 224,657 coho salmon harvested among all UCI commercial fisheries and 47,132 (21%) were examined for marks. There were 7,548 fish examined that could not be assigned to a fishery strata and were excluded from commercial harvest calculations. There were 269 adipose finclipped fish observed, 268 were recovered, 216 had a readable CWT, and 65 were from the Kenai River drainage.

Temporal variation in the tagged proportion of returning adults sampled inriver precluded an accurate estimate of the commercial harvest of Kenai River-bound coho salmon. However, minimum, maximum, and overall 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.

In 2005, 432 of 5,517 adult coho salmon captured in the Kenai River by fish wheels and examined were missing an adipose fin. Kenai River CWTs were found in 431 of these, resulting in an overall tagged proportion estimate of 0.078. Based on this proportion, a qualified estimate of 3,310 (SE = 681) coho salmon of Kenai River origin were harvested by the Central District eastside set gillnet fishery; 1,533 (SE = 617) by the Central District drift gillnet fishery; and 176 (SE = 51) by the Northern District eastside set gillnet fishery for a total of 5,019 (SE = 921). Qualified harvest estimates represented 17.0% of the total eastside set gillnet coho salmon harvest, 1.1% of the drift gillnet harvest, and 1.6% of the Northern District eastside set gillnet harvest.

There were 83,674 live coho salmon smolt released with an adipose finclip at the Moose River in 2004. Based on the number of returning adults (5,517) from this cohort examined from the Kenai River in 2005 and the number missing an adipose fin (432), there were an estimated 1,066,324 (SE = 49,009) coho salmon smolt that emigrated from the Kenai River in 2004.

An index of inriver adult Kenai River coho salmon abundance was developed using natural-log transformed fish wheel CPUE to periodically predict end-of-season abundance arriving at river kilometer 45. The index was classified into one of three levels (<50,000 [low], >50,000 and <120,000 [medium], >120,000 [high]). The final end-of-season log-transformed cumulative CPUE value for the period from August 1 through September 30, 2005, was 5.46 and classified as "medium" which was consistent with the inseason predictions.

Key words: coho salmon, *Oncorhynchus kisutch*, population assessment, sustained yield, fish wheel, adult abundance, index, 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, Alaska (UCI, 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 second in average (1994-2004) sport harvest of coho salmon among all regions of the state, sixth in commercial harvest, and third in overall harvest (Figure 2). UCI coho salmon support the largest freshwater sport harvest in the state (Howe et al. 1995-1996, 2001 a-d; Jennings et al. 2004; Jennings et al. 2006a-b; Jennings et al. 2007; Mills 1979-1980, 1981a-b, 1982-1994; Walker et al. 2003;) contributing about 1 of every 5 coho salmon sport-harvested from all Alaskan waters.

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*). The initial approach was to estimate the annual: (A) population specific harvest in marine commercial fisheries, (B) sport and personal use inriver harvest, and (C) spawning escapement. The sum of these three

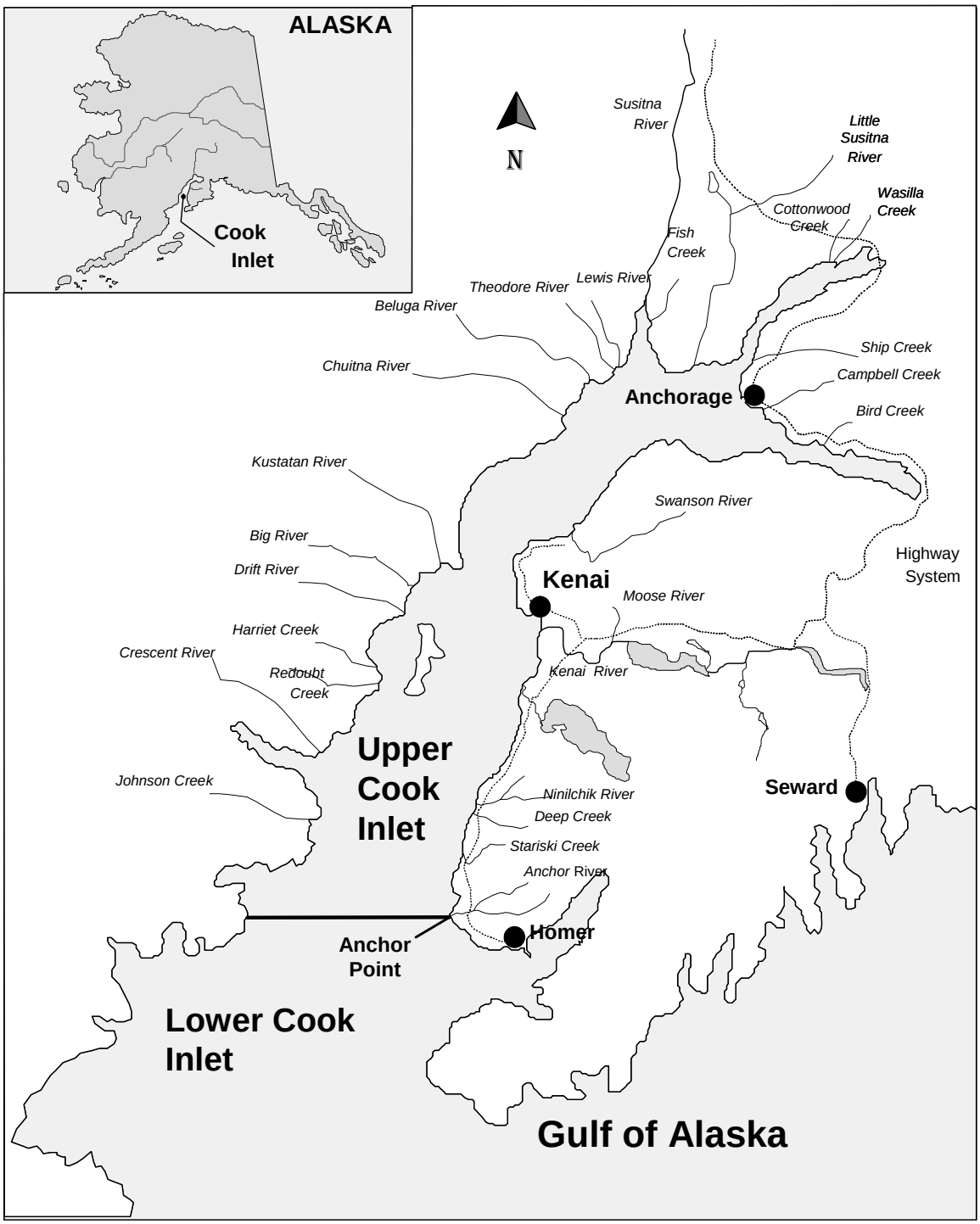

Figure 1.-The Cook Inlet Basin with tributaries known to support coho salmon.

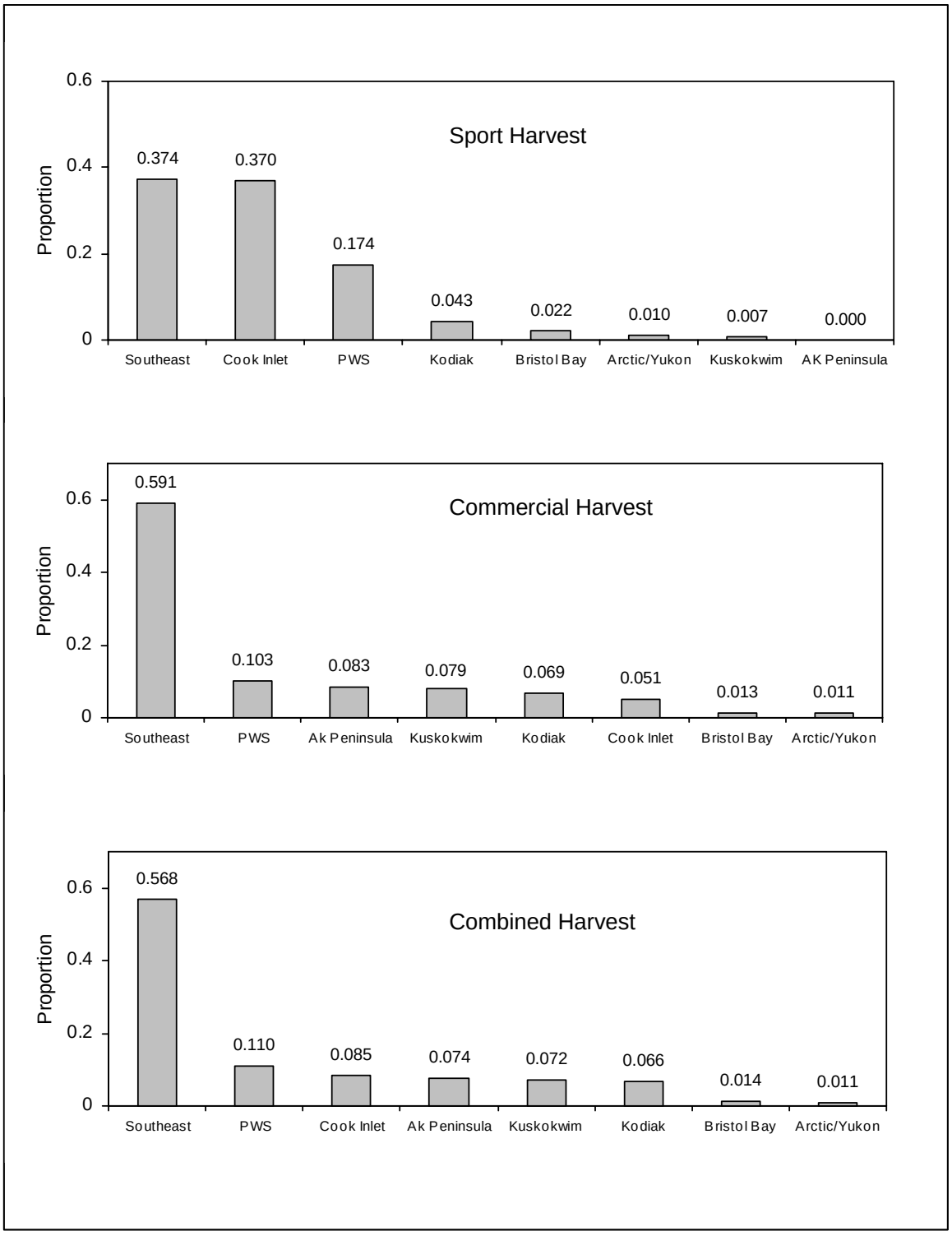

Figure 2.-Average proportions by region of the statewide commercial and sport harvests of coho salmon, 1994-2004.

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 production would provide an estimate of exploitation rate. Smolt abundance estimates were originally produced ancillary to commercial harvest estimate efforts but have become integral to the current assessment program.

Commercial harvest estimates (A) have been generated annually since 1993 through a coded wire tag release and recovery program (Carlon 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill *In prep a-b*; Massengill and Carlon 2004a-b, 2007a-b). Inriver sport and personal use fishery harvests (B) are estimated annually by angler surveys (Hammarstrom 1977, 1978, 1988-1992; Howe et al. 1995-1996, 2001 a-d; Jennings et al. 2004, 2006a-b; 2006b, 2007; King 1993; Mills 1979-1980, 1981a-b, 1982-1994; Reimer and Sigurdsson 2004; Walker et al. 2003). 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).

The Kenai River assessment program revealed an overall decline in smolt abundance between 1992 and 1995 (Carlon and Clark *Unpublished*). The Alaska Board of Fisheries (BOF) responded by developing and adopting the first management plan for Kenai River coho salmon in 1997. A review in 2000 suggested that adult abundance was declining and 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.

Kenai River coho salmon assessments since 2000 indicate that exploitation rates are sustainable, and adult returns appear to have increased since the late 1990s. The 2005 BOF therefore repealed some measures of the Kenai River Coho Salmon Conservation Management Plan by liberalizing opportunity, to some degree, for both the commercial and sport fisheries. ADF&G eliminated the commercial harvest component of the assessment program after 2005 because recent assessments indicated the harvest is sustainable under current regulations.

The inriver assessment of adult coho salmon changed in 2005 from an inriver abundance estimate to an index of abundance by class (low, medium or high). The index provides managers a tool to classify general abundance that is less costly than mark-recapture abundance estimates and produces inseason predictions of abundance and a postseason estimate.

OBJECTIVES

The primary objectives of this study were to:

1. Estimate the harvest of adult Kenai River coho salmon in the Central District drift gillnet and eastside set gillnet fisheries of the Central District of Upper Cook Inlet between late June and mid-August of 2005.
2. Estimate the number of coho salmon smolt that emigrated from the Kenai River in 2004.
3. Census the coho salmon smolt emigration from the Moose River from May 15 through June 30, 2004.
4. Index the inriver abundance of adult coho salmon into one of three ordinal levels (low, medium or high).

TASKS

1. To collect smolt scales during the smolt emigration in 2004 and from the adult inriver return in 2005 for archiving and qualitative age analysis.
2. To sample the 2005 Northern District eastside set gillnet commercial harvest for CWTs to determine if the harvest of Kenai River coho salmon is similar to previous years.

METHODS

EXPERIMENTAL DESIGN

Commercial Harvest Objective

To estimate the commercial harvest of Kenai River coho salmon, smolt were captured in the Kenai River drainage in 2004, marked with a CWT, and released (Table 1). These fish were recovered as adults in mixed-stock commercial fisheries in 2005. The number of Kenai River tags recovered in the commercial harvest was expanded by the fraction initially tagged to provide an estimate of the Kenai River-specific harvest. Total harvest of coho salmon in 2005 commercial fisheries was available from the ADF&G commercial fishery database system. Personnel of the ADF&G Commercial Fisheries (CFD) Division accomplished sampling of the commercial harvest for marked fish. The tagged fraction of the adult return to the Kenai River was estimated by inriver sampling of adults between August 1 and September 30 using two fish wheels. Expanding the number of tags recovered from the mixed-stock fisheries by the harvest sampling and inriver tagged fractions enabled the Kenai River-specific commercial harvest to be estimated.

Smolt Abundance and Census Objectives

Smolt abundance was estimated via a two-event mark-recapture study. Smolt were marked and released with an adipose finclip in 2004 and recaptured as adults from inriver sampling in 2005.

The smolt marking site is located at the Moose River, a tributary of the Kenai River (Figure3). To census the 2004 Moose River coho salmon smolt emigration a weir was used to trap and count smolt from May 20 to June 23, 2004.

2005 Adult Inriver Index Objective

To index inriver abundance of adult Kenai River coho salmon into one of three ordinal levels (low, medium, or high) two fish wheels were operated from August 1 through September 30, 2005. Fish wheel effort and coho salmon catch provided a daily cumulative catch per unit of effort (CCPUE). The CCPUE for 2005 was used inseason to periodically predict an end-of-season abundance classification. A postseason classification was determined using a fitted regression of historic (1999-2004) inriver abundance estimates on log-transformed CCPUE (LnCCPUE).

DATA COLLECTION

Smolt Marking in 2004

The Moose River weir was the site of smolt capture and marking in 2004 and is located 7.5 river kilometers (rkm) upstream of its confluence with the Kenai River (Figure 3). 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. In addition to providing enough smolt, the adult return timing

Table 1.-Assessment components of Kenai River coho salmon cohort that returned as adults in 2005.

Time period	Location	
2004 (May-Jun)	Moose River	
	Objective:	Smolt abundance estimate
	Task/data collected:	Finclip and coded wire tag a subsample of the Moose River smolt emigration
	Objective:	Census Moose River coho salmon smolt emigration
	Task/data collected:	Enumerate emigration passing the Moose River weir from mid-May through late June
2005 (Jul-Sep)	Upper Cook Inlet Kenai Peninsula (coho salmon processors)	
	Objective:	Commercial harvest estimate of Kenai River coho salmon in Upper Cook Inlet.
	Task/data collected:	Sample for coded wire tag recoveries at local fish processors and buying stations
2005 (Aug-Sep)	Kenai River fish wheels (river kilometer (rkm) 45)	
	Objective:	Estimate the marked proportion of inriver adults (required for commercial harvest and smolt abundance) and test for temporal variation of marking rate
	Task/data collected:	Collect weekly tallies of the marked and unmarked fish wheel catch of coho salmon, test for temporal variation in marking rate
	Objective:	Index the abundance of adult coho salmon arriving at rkm 45
	Task/data collected:	Collect coho salmon catch and effort (CPUE) to predict end-of-season abundance range

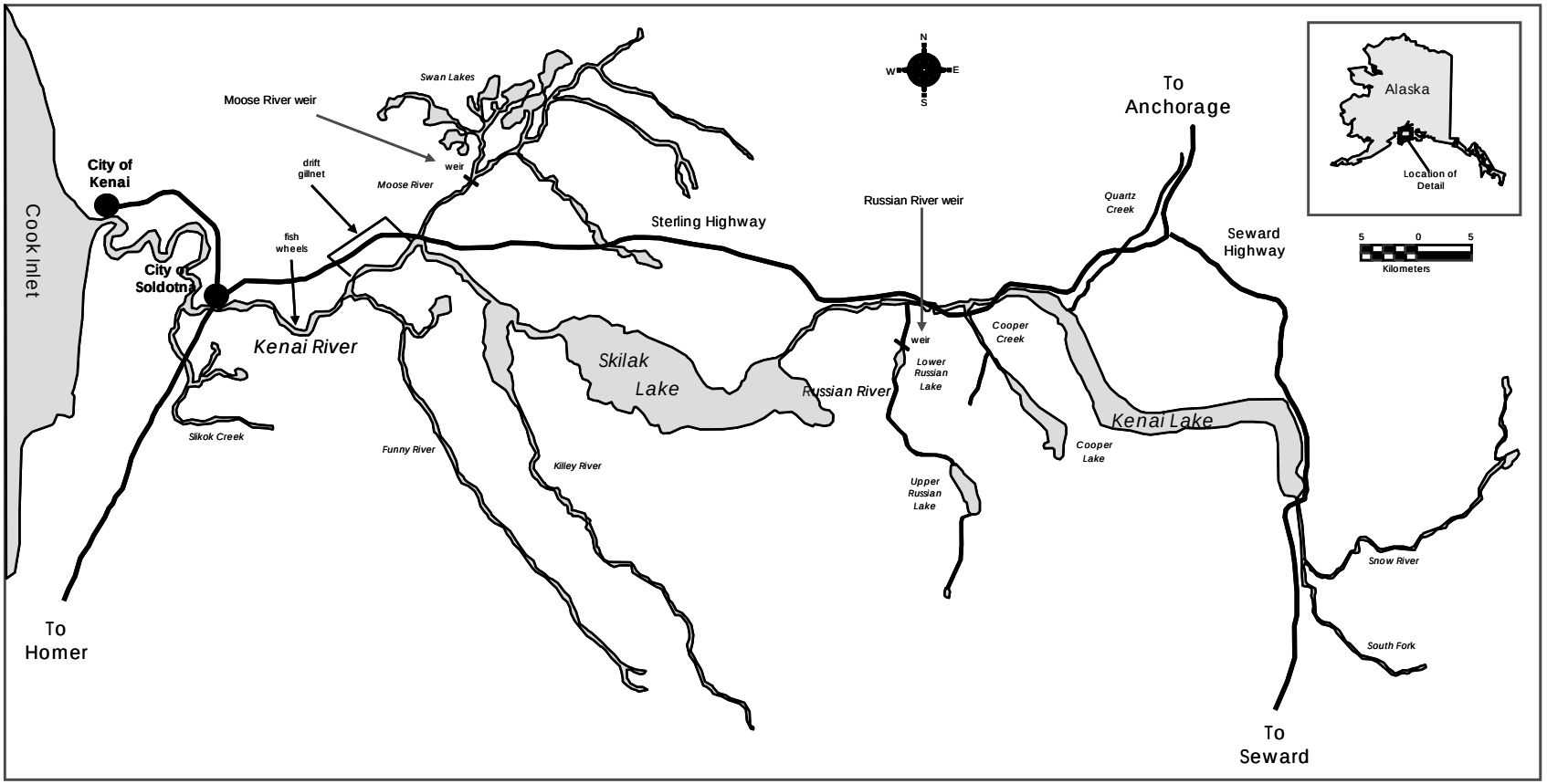

Figure 3.-The Kenai River drainage showing the Moose River weir site where coho salmon smolt were marked and released in 2004, and the Kenai River fish wheel location in 2005.

indicated that smolt marked at the Moose River were also representative of the Kenai River population (Carlon and Hasbrouck 1994).

A weir with a trap was installed in the mainstem of the Moose River on May 20, 2004, to capture smolt as they emigrated downstream from wintering habitats. The weir was a total barrier to fish migration until June 23, 2004. Marking smolt with both CWTs and adipose finclips began on May 21 and ended on June 18, 2004.

Smolt was 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, most scale samples from fish shorter than 100 mm exhibit only one annulus. Most Kenai River coho salmon smolt after 2 years in fresh water and exhibit two scale annuli (Hammarstrom 1988-1992). Further evidence that smolt are correctly identified is that most (>99.9%) CWTs recovered from adults returning to spawn from 1993 through 2004 were implanted in fish emigrating from the Moose River the previous year (Carlon 2000, 2003; Carlon and Hasbrouck 1998; Massengill and Carlon 2004a-b, 2007a-b). The recovery of an adult coho salmon tagged 2 years prior has never been documented.

Recently observed temporal variation in the marked proportion of the inriver adult return has led to changes in the marking strategy so that tagging is now more evenly distributed throughout the emigration, instead of tagging during the first half of the emigration. Although there is evidence that the return timing of marked adults is independent of the marking date, the evenly distributed tagging strategy removes most doubt that it is the cause of temporal variation observed in the inriver adult samples. Hence, the 2004 tagging goal was 3,500 tags per day for 3 weeks (75,000 total).

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 with 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, it likely had no 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.

Tag codes released in 2004 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.

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. Survival rates were used to estimate

the total number of marked smolt that survived the marking procedure. Estimating the number of marked fish that survived marking and were released is a requirement of the model used to estimate smolt abundance.

Smolt Age and Length Sampling

Smolt scales were collected and archived in 2004. Sample size calculations (Thompson 1987) were used to guide the number of scales collected. Assuming a readability rate of 85%, 150 scales were needed such that, with 95% confidence, the estimates by age group were within 10 percentage points of their true values.

To minimize age and length bias during sampling, samples were collected systematically throughout the smolt emigration by randomly sampling 50 smolt midway through each increment of 10,000 smolt passing the weir. This strategy provided a larger sample size than needed.

RECOVERY OF MARKED ADULTS IN THE 2005 RETURN

Inriver Recoveries: Fish Wheels

Two fish wheels were operated in the mainstem of the Kenai River to capture and examine adult coho salmon for missing adipose fins. Each fish wheel (one operated adjacent to each riverbank) was operated daily during most daylight hours from August 1 through September 30 to minimize seasonal sampling bias. From August 1 through September 14, the target effort was to operate each fish wheel 12.5 hours per day. Fish wheel operation was reduced 1 hour each week beginning September 15 to avoid boating at night.

Coho salmon were captured in fish wheels and examined for a missing adipose fin from August 1 through September 30, 2005 (the last day coho salmon were caught). All fish missing an 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. Daily fish wheel catches for all species, by bank, were recorded in 2005.

Commercial Sampling

Commercial fisheries sampled in 2005 included the drift gillnet and the eastside set gillnet fisheries of the Central District and the eastside set gillnet fishery of the Northern District (Figure 4). The Central District historically accounts for most of the UCI coho salmon harvest (Shields 2006). Northern District fisheries typically harvest less than a few hundred Kenai River coho salmon, and the eastside set gillnet fishery typically harvests most of these (Massengill *In prep* b). The eastside set gillnet fishery was the only Northern District fishery intentionally sampled as a "task" during 2005 to monitor whether the harvest of Kenai River coho salmon in that district was significant.

In 2005, both the Central District drift gillnet and eastside set gillnet fishing seasons opened on June 20 and ended August 10 (Shields 2006). The harvests in both fisheries were sampled for CWTs during most open periods throughout the fishing season. Northern District set gillnet harvests began on May 30 and were sampled for CWTs in most periods beginning July 7 until September 15 when the majority of coho salmon were harvested.

Coho salmon were examined at shorebased processing locations (main plants and buying stations) throughout UCI to recover CWTs. Daily totals of coho salmon examined and the

Cook Inlet Commercial Salmon Statistical Areas

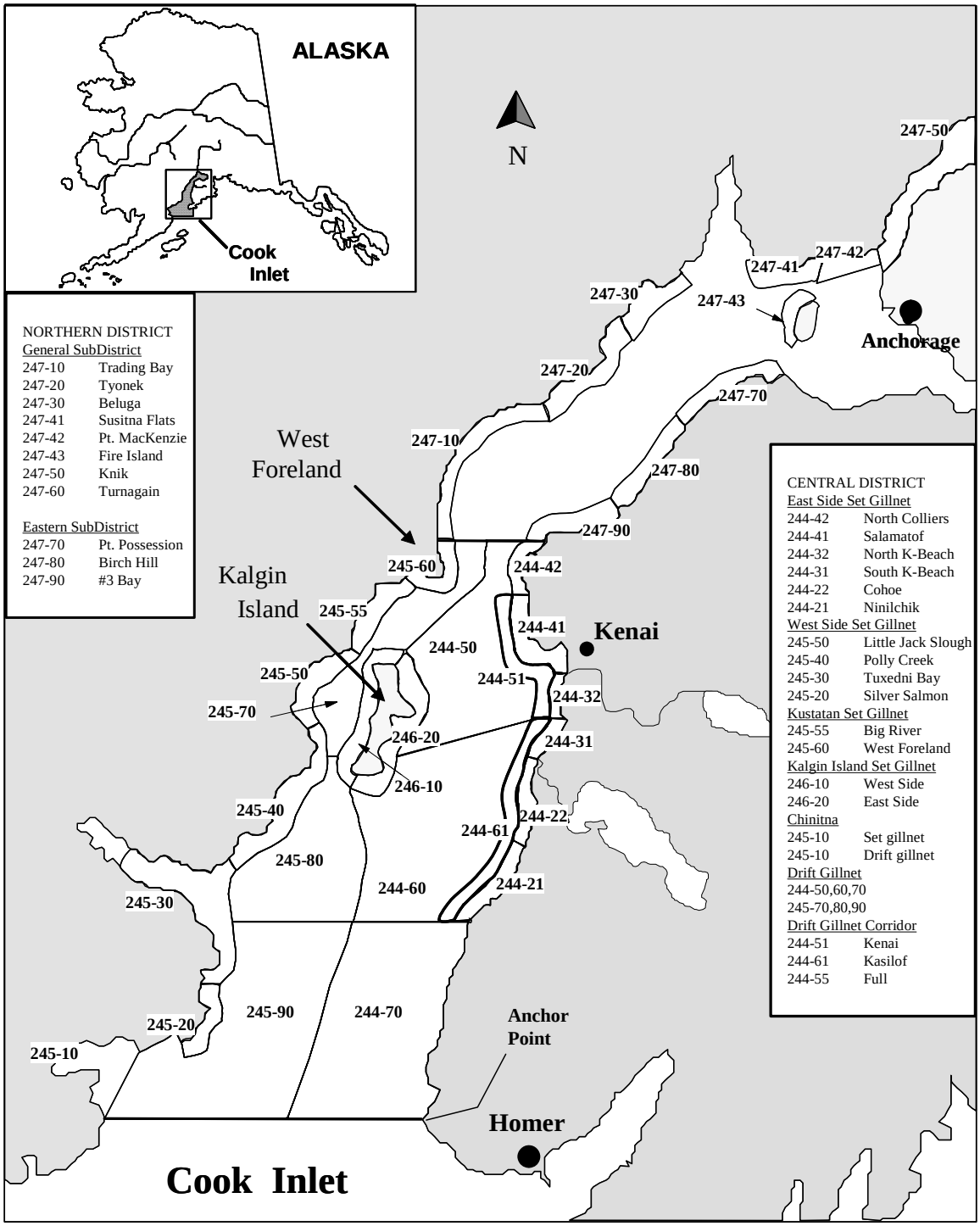

Figure 4.-Upper Cook Inlet statistical areas.

number missing an adipose fin were recorded. Heads were collected from adipose finclipped fish, frozen, and later 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 were 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 commercial harvest tag recoveries 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.

2005 Adult Inriver Index

To collect coho salmon CPUE data two fish wheels were operated at rkm 45. Because coho salmon migrate along both banks, one fish wheel was located on each riverbank. The fish wheels were operated only during daylight hours when most coho salmon move in the Kenai River. Telemetry data indicate that nearly 90% of coho salmon migrate upriver during daylight hours (Carlon and Evans *In prep*). To maintain similar operational fish wheel effort among years, a relatively constant fish wheel spin rate was maintained by either applying braking methods (to decrease the spin rate), or increasing the paddle surface (to increase the spin rate), or by relocating fish wheels short distances as water levels and velocities changed.

Fish wheel operation was standardized so that stoppage for crew meal breaks and shift changes occurred only during set times, as first implemented in 2004 (Appendix A1) (Massengill *In prep* b). The historic (1999-2004) fish wheel effort and catch data used in the regression of abundance on log cumulative CPUE was truncated to include only CPUE data collected during standardized daylight-only operational times.

To minimize handling stress and increase crew safety a two-person crew was used to process coho salmon. Quickly removing other species from the fish wheel livebox also minimized any effects of confinement-induced stress on coho salmon. All coho salmon were inspected in a dip net to check for an adipose fin and a dorsal punch mark. If a fish was missing an adipose fin, or if a fish was selected for age and length sampling, it was placed in a holding tote onboard a riverboat. A bucket was used to add fresh water to the tote. A padded, aluminum cradle device was slipped around the fish to restrain it during marking and age-length sampling. Every adipose finclipped fish received a dorsal fin punch to avoid duplicate sampling. Additionally, every 10th fish (not previously dorsal punched) was sampled for age (scales) and length (FL) and given a dorsal fin punch. An overall coho salmon recapture rate was estimated using the recapture of dorsal fin punched fish.

DATA ANALYSIS

To estimate smolt production, the essential steps were to: (1) estimate the number of smolt marked in 2004 that survived marking, and (2) detect adipose finclipped fish in the 2005 adult inriver return from known sample sizes. For the commercial harvest estimate of Kenai River coho salmon, the essential steps were to: (1) test the hypothesis that the proportion of adults with CWTs observed inriver in 2005 did not change over time, (2) estimate the proportion of the adult return in 2005 with CWTs, and (3) recover CWTs from known sample sizes in the commercial fishery.

Smolt Marking in 2004

To determine the number of marked smolt released in 2004, short-term survival and tag retention rates were estimated daily from a representative sample of about 200 smolt detained in holding

pens for 18 to 24 hours after marking. The 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. The 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:

$$\hat{m}_k = m'_k \hat{s}_k \hat{b}_k \,. \tag{1}$$

The number of smolt that were marked, survived, and retained a tag at the Moose River in 2004 was estimated by summing $\hat{m}_k$ over all marking shifts. This was required to determine when the goal of releasing 75,000 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 finclip 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.

ESTIMATION OF TAGGED FRACTION IN THE 2005 RETURN

The commercial harvest estimate of Kenai River coho salmon in 2005 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 2004, but was estimated when adults returned in 2005 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 finclip 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 were missing an adipose fin. The second step was to estimate the smolt-to-adult tag retention rate (c_i) in the returning population of adipose finclipped fish sampled at each fish wheel during weekly interval i:

$$\hat{c}_i = v'_i / h_i \,, \tag{2}$$

where:

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

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

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 finclipped fish that tested negatively with the wand, were sacrificed, and were 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 one fish with a negative wand result was sacrificed in 2005. 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 2004:

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

For each fish wheel sample, 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 sample data could be combined among weeks and sources to provide a more precise estimate of the overall tagged proportion in the 2005 return.

Smolt abundance was estimated using the adipose finclip and not the presence of a CWT. The number of adipose finclipped fish recovered in the 2005 inriver samples was recorded as a requirement for estimating smolt abundance in 2004.

SMOLT ABUNDANCE IN 2004

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 finclip that survived to emigrate in 2004,

C = the number of adult coho salmon examined for an adipose finclip in the 2005 return sample, and

R = the number of adult coho salmon in the 2005 sample that had an adipose finclip.

The variance of the smolt abundance estimate was estimated by:

$$\hat{Var}(\hat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} . \tag{6}$$

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 2004 or there is complete mixing of individuals between the mark and recapture events,
2. All juveniles marked at the Moose River in 2004 were 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,
6. Fish were correctly categorized for the presence or absence of an adipose fin during inriver sampling, and
7. Inriver adult coho salmon missing an adipose fin originated from the Moose River in 2004.

Independence between the timing of smolt tagging and adult return timing has been observed in both inriver and commercial recoveries (Carlon 2000; Carlon and Hasbrouck 1994, 1996-1998). The independence observed indicates that marked and unmarked fish mixed after tagging. Observations also indicate that emigrating smolt from the Moose River are representative of the entire Kenai River population. While independence between release and return timing 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 samples are assumed to be random because both banks were fished with similar effort throughout the season. Therefore, there is a good chance that at least one of the three conditions of assumption 1 is fulfilled.

The other six 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 remain 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 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill and Carlon 2004a-b; 2007a-b). Hatchery-produced coho salmon marked with adipose finclips 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 ~1,500,000 coho salmon juveniles handled since 1991, only occasionally have any been found to be naturally missing the adipose fin. Also, the short-term and long-term tag retention rates have been nearly identical (Carlon 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill *In prep* a-b; Massengill and Carlon 2004a-b; 2007a-b). This supports the supposition that naturally missing adipose fins are rare in Kenai River coho salmon. Only 1 of 1,020 (<0.1%) coho salmon heads recovered from the inriver sport fishery (1996-1998) did not originate from the Moose River, and only 2 Moose River tags were recovered in the same year they were released (Carlon 2000, 2003; Carlon and Hasbrouck 1998). Finally, just over 1% of the heads recovered during 1996-1998 had no tag, indicating that tag loss is low (and though rare, presumably results from tag shedding and naturally missing adipose fins). This supports

both assumption 6 and 7 that adipose finclipped fish are correctly identified and originate from Moose River releases the previous year.

COMMERCIAL HARVEST IN 2005

All commercial harvest estimates of Kenai River coho salmon were stratified by date (fishing period). The Central District eastside set gillnet harvest was also stratified by statistical area (Figure 4). The drift gillnet harvest was not stratified by statistical area because sampled fish were often a mixture 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 strata variances. The Commercial Fish Ticketing System managed by the ADF&G Commercial Fisheries Division provided the commercial harvest by fishery, date, and statistical area. The Central District commercial harvest data used in this report was provided in February 2006 and may differ slightly (<1%) from the total harvest reported elsewhere because some fish tickets were reported after this date.

The commercial harvest of Kenai River coho salmon was estimated; total harvest sampled for marks, and number of CWTs recovered was known. The tagged proportion of the return was estimated by examining the inriver fish wheel catch. 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 number of coho salmon harvested in stratum *i*,

θ = the proportion of the 2005 Kenai River return marked with CWTs,

m_i = the number of 2004 Moose River CWTs recovered from commercial fishery stratum *i*,

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 from fish in stratum *i* 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 readable CWTs found from any coho salmon marking event (not just the Moose River 2004 event).

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

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

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 by commercial processors 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 (Shields 2006). The variance associated with estimated average weight is not known and not included in the 2005 harvest estimates.

Harvest estimates were based on pooled samples of fish harvested within the desired 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 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill *In prep a-b*; Massengill and Carlon 2004a-b; 2007a-b). Pooling data among processors in 2005 likely improved the precision of harvest estimates without introducing significant bias. The harvest estimate 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.

2005 ADULT INRIVER INDEX

From August 1 to September 30, 2005 (61 days), two fish wheels near rkm 45 in the Kenai River captured adult coho salmon as they migrated upstream to spawn. The cumulative catch per unit of effort (CCPUE) at the fish wheels was calculated as:

$$CCPUE = \sum_{i=1}^{61} CPUE_i = \sum_{i=1}^{61} \frac{c_i}{h_i}, \quad (9)$$

where:

c_i = the catch of coho salmon on day i (estimated as total daily catch multiplied by the complement of the average seasonal recapture rate of the caudal punched subsample of fish), and

h_i = the hours of fish wheel operation on day i.

The adult coho salmon inriver index uses CCPUE to make three inseason predictions of expected end-of-season abundance. There is also a postseason index of abundance. The index was

developed to assess inriver coho abundance inseason and to classify postseason abundance. The index classifies abundance into one of three ordinal levels and is less costly than mark-recapture abundance studies.

The index plotted the 2005 natural-log transformed fish wheel CCPUE (LnCCPUE) data onto a fitted weighted regression of historic LnCCPUE abundance estimates (weighted regression fits are provided in Table 2). The 2005 LnCCPUE values were assigned to one of three ordinal abundance levels. The three levels were within, above, or below 50% of the average 1999-2004 estimates, but do not represent any known biological significance or management objective: low = abundance <50,000; medium = abundance >50,000 and <120,000; high = abundance >120,000.

Table 2.-Fit of weighted regression of estimated abundance on LnCCPUE by temporal interval.

Time period	Equation[a]	R^2	*P* -value (Ho:Slope=0)
Aug 1-28	*N^* = -90,722 + 39,456 *Ln (CCPUE)*	0.70	0.038
Aug 1-Sep 11	*N^* = -105,248 + 39,574 *Ln (CCPUE)*	0.87	0.007
Aug1-Sep 25	*N^* = -114,169 + 39,475 *Ln (CCPUE)*	0.91	0.003
Aug 1-Sep 30	*N^* = -115,531 + 39,410 *Ln (CCPUE)*	0.91	0.003

[a] N^ is the predicted abundance of adult coho salmon arriving at river kilometer 45 of the Kenai River in 2005.

A total of four index regressions was developed as follows: one at 4 weeks (August 1–28), 6 weeks (August 1–September 11), 8 weeks (August 1–September 25), and the end of the season (August 1–September 30). Developing an abundance index before August 28 was thought to have too much potential for error and therefore was not done.

The regression model was developed using data collected from August 1 through September 30 during all years. In some instances, historic fish wheel data used in the regressions were truncated so that CCPUE was based only on identical dates and fish wheel operating times among years. Some interpolation of CPUE data was needed because the fish wheels were not operated some days between August 1 and September 30, 1999. The interpolated CPUE for day *j* in 1999 was calculated as described in Appendix A2. A summary containing both the actual and adjusted fish wheel data for 1999-2004 is found in Appendix A3.

Model Details

The fitted regression model used to predict coho salmon abundance is relatively sensitive to changes in CCPUE, particularly when late-season CCPUE is small (<200). Conversely, the response of abundance to changes in CCPUE at higher levels (>200) is not as sensitive. Therefore, changes in CCPUE at lower levels will likely change the abundance index more than similar changes at higher levels.

A theoretical problem with regressing abundance estimates on LnCCPUE is heterogeneity in the variance of abundance estimates. In fact, variability increased markedly for estimates that were partially stratified. Another likely problem is measurement error in the CCPUE observations; the

ability to duplicate CCPUE results exactly in a given year. The first problem was overcome by using a weighted regression, with weights proportional to the inverse of the variance of the abundance estimates. The weighted analysis explains the difference of the fitted line (when displayed on a graph) from one that would be fitted by eye. The 2000-2002 abundance estimates are not within the 90% confidence interval because abundance estimates with higher variability receive less weight in the fitting process. Nothing was done to mitigate the measurement error in the CCPUE. It is assumed that the effect of this error is small, given the comprehensive schedule of fish wheel operations each year, and that measurement error is likely small compared to the 16-fold range in variation of the 1999-2004 CCPUE. Because the index classifies abundance in one of the three ordinal levels (low, medium or high), the likelihood of misclassification from measurement error is small.

RESULTS

SMOLT MARKING IN 2004

There were 83,735 smolt marked (and released) with CWTs and adipose finclips as they emigrated from the Moose River May 21 through June 17, 2004; the last release of marked smolt occurred on June 18, 2004 (Appendix A4). The number of smolt marked and released per tag code group ranged from 11,739 to 12,159 depending on the number of available tags.

An estimated 83,674 smolt survived tagging based on an estimated short-term survival rate of 99.9%. Although marking was discontinued after the marking goal was achieved on June 17, 2004, the weir remained in place until June 23 to census the smolt emigration. There were 252,348 smolt captured at the weir between May 20 and June 23, 2004. Scale and length samples from 1,250 smolt were collected and archived.

TAGGED PROPORTION OF THE 2005 RETURN

Returning adults captured in the fish wheels were examined weekly to produce an estimate of the proportion ($\hat{\theta}$) of the adult return bearing tags**.** From August 1 through September 30, there were 5,517 coho salmon captured in fish wheels and examined for marks (Appendix A5). The bycatch of other species was substantial, in particular, the 63,976 sockeye salmon captured was nearly 12 times more than the coho salmon catch (Appendix A6).

There were 2,494 coho salmon captured in the south bank fish wheel (Table 3). The weekly tagged proportion in the south bank fish wheel catch ranged from 0.000 to 0.195 and varied over all weeks ($P < 0.001$). The overall tagged proportion estimate for the season at the south bank fish wheel was 0.076.

There were 3,023 coho salmon captured in the north bank fish wheel (Table 3). The weekly tagged proportion ranged from 0.053 to 0.267 and varied over all weeks ($P < 0.001$). The tagged proportion estimate for the season at the north bank fish wheel was 0.080. This proportion was not different from the south bank fish wheel ($P = 0.66$), so all fish wheel samples were pooled.

The weekly tagged proportion for the pooled fish wheel samples ranged from 0.040 to 0.226 and varied over all weeks ($P < 0.001$). There was no difference among the August 1 through September 18 weekly intervals ($P < 0.069$). However, there was a difference between the September 19 through September 30 weekly intervals ($P = 0.040$).

Table 3.-Coho salmon recoveries from the Kenai River drainage from August 1 through September 30, 2005, with weekly and seasonal marked and tagged proportion estimates by source.

Weekly period	Number examined	Marked fish observed	y_i [a]	Marked fish checked for a CWT[b]	Number of CWTs detected	Negative wand results: Negatives sacrificed	Negative wand results: False negatives	$f_{i\,a}$	c_i [a]	Theta[c]	Estimated CWTs missing[d]
North Bank Fish Wheel											
08/01-08/07	19	1	0.053	1	1	0	0	0.000	1.000	0.053	0
08/08-08/14	88	5	0.057	5	5	0	0	0.000	1.000	0.057	0
08/15-08/21	597	34	0.057	34	34	0	0	0.000	1.000	0.057	0
08/22-08/28	1,184	79	0.067	79	79	0	0	0.000	1.000	0.067	0
08/29-09/04	574	44	0.077	44	44	0	0	0.000	1.000	0.077	0
09/05-09/11	221	21	0.095	21	20	1	0	0.000	0.952	0.090	1
09/12-09/18	139	16	0.115	16	16	0	0	0.000	1.000	0.115	0
09/19-09/25	141	26	0.184	26	26	0	0	0.000	1.000	0.184	0
09/26-09/30	60	16	0.267	16	16	0	0	0.000	1.000	0.267	0
Total	3,023	242	0.080	242	241			0.000	0.996	0.080	1
South Bank Fish Wheel											
08/01-08/07	6		0.000		0	0	0	0.000	0.998	0.000	0
08/08-08/14	33	1	0.030	1	1	0	0	0.000	1.000	0.030	0
08/15-08/21	214	7	0.033	7	7	0	0	0.000	1.000	0.033	0
08/22-08/28	701	59	0.084	59	59	0	0	0.000	1.000	0.084	0
08/29-09/04	823	55	0.067	55	55	0	0	0.000	1.000	0.067	0
09/05-09/11	285	19	0.067	19	19	0	0	0.000	1.000	0.067	0
09/12-09/18	206	19	0.092	19	19	0	0	0.000	1.000	0.092	0
09/19-09/25	149	15	0.101	15	15	0	0	0.000	1.000	0.101	0
09/26-09/30	77	15	0.195	15	15	0	0	0.000	1.000	0.195	0
Total	2,494	190	0.076	190	190	0	0	0.000	1.000	0.076	0
Combined North and South Banks Fish Wheels											
08/01 - 08/07	25	1	0.040	1	1	0	0	0.000	1.000	0.040	0
08/08 - 08/14	121	6	0.050	6	6	0	0	0.000	1.000	0.050	0
08/15 - 08/21	811	41	0.051	41	41	0	0	0.000	1.000	0.051	0
08/22 - 08/28	1,885	138	0.073	138	138	0	0	0.000	1.000	0.073	0
08/29 - 09/04	1,397	99	0.071	99	99	0	0	0.000	1.000	0.071	0
09/05 - 09/11	506	40	0.079	40	39	1	0	0.000	0.975	0.077	1
09/12 - 09/18	345	35	0.101	35	35	0	0	0.000	1.000	0.101	0
09/19 - 09/25	290	41	0.141	41	41	0	0	0.000	1.000	0.141	0
09/26 - 09/30	137	31	0.226	31	31	0	0	0.000	1.000	0.226	0
Total	5,517 [e]	432	0.078	432	431	1	0	0.000	0.998	0.078	1

[a] For definitions of variables see equations in "Estimation of Tagged Fraction in the 2005 Return" of the Data Analysis section of this report.

[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 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 the number examined bearing a coded wire tag originally implanted at the Moose River in 2004.

[d] Estimated number of coded wire tags that are missing from the marked fish observed ((Marked Fish Observed)-[(Thetai) 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 number; weekly estimates may not sum to total due to rounding.

[e] After accounting for recaptures, the estimated number of fish examined is 5,117. However, 5,517 has been used in other reports and we continue to report 5,517 for consistency, with the understanding it makes no practical difference to the tagged proportion estimates, commercial harvest estimates, smolt abundance, or the inriver abundance index.

There were 432 (0.078) coho salmon captured in the fish wheels that were missing an adipose fin and 431 had CWTs. There were no false-negative wand results. Therefore, the overall tag retention rate (c) was 0.998 (431/432).

Qualified Estimate of the Tagged Proportion

Because there were temporal variations in the tagged proportion among and between the inriver fish wheel samples, the tagged proportion of the coho salmon population that passed through the commercial fishing areas was unknown. The changes in the tagged proportion over time in the inriver samples suggest that representative drainage-wide tagging of smolt did not occur. Therefore, commercial harvest estimates could be biased, depending on the actual (but unknown) tagged proportion present in the UCI commercial fisheries. However, an estimate of the overall tagged proportion using the pooled fish wheel data was made 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 a subset of the fish wheel data (minimum and maximum tagged proportions) on the harvest estimates.

The overall tagged proportion from the fish wheel effort was used to generate qualified point estimates (and variances) of harvest in commercial fisheries of interest while the two extremes (minimum and maximum) in the tagged proportion in the fish wheel data were used to calculate extreme bounds for point estimates of commercial harvest methods.

The overall estimated tagged proportion ($\hat{\theta}$) of the 2005 return was 0.078 (SE = 0.004); $\hat{\theta}^{-1}$ = 12.8 (SE = 0.594). Because of the temporal trend in the pooled fish wheel data, this estimate is considered a "qualified" estimate of the tagged proportion passing through commercial fishing areas. The minimum tagged proportion of 0.071 (SE = 0.004); $\hat{\theta}^{-1}$ = 14.2 (SE = 0.724) was estimated from samples during the first 7 weeks (August 1–September 18) because no difference was detected in the tagged proportion among those weeks. The maximum tagged proportion estimate from samples taken during the last 5 days (September 26-30) was 0.226 (SE = 0.036); $\hat{\theta}^{-1}$ = 4.5 (SE = 0.773).

SMOLT ESTIMATE IN 2004

An estimated 1,066,324 (SE = 49,009) smolt emigrated from the Kenai River in 2004. This is the second highest smolt abundance estimate since tracking began in 1992 (Figure 5).

COMMERCIAL HARVEST AND SAMPLING IN 2005

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 in detail for the target fisheries of the Central District (drift and eastside set gillnet) and the Northern District eastside set gillnet fishery.

Inlet-Wide Fisheries

In 2005, 224,657 coho salmon were harvested in UCI commercial fisheries (Table 4). This harvest was 12% below the 1995-2004 average harvest (Shields 2006). About 86% of the 2005 UCI commercial harvest was taken in Central District fisheries. The greatest harvest occurred in the drift gillnet fishery (64%), other Central District fisheries comprised from <1% to 9% of the harvest (Figure 6). The Northern District set gillnet fisheries comprised 14% of the total UCI commercial harvest.

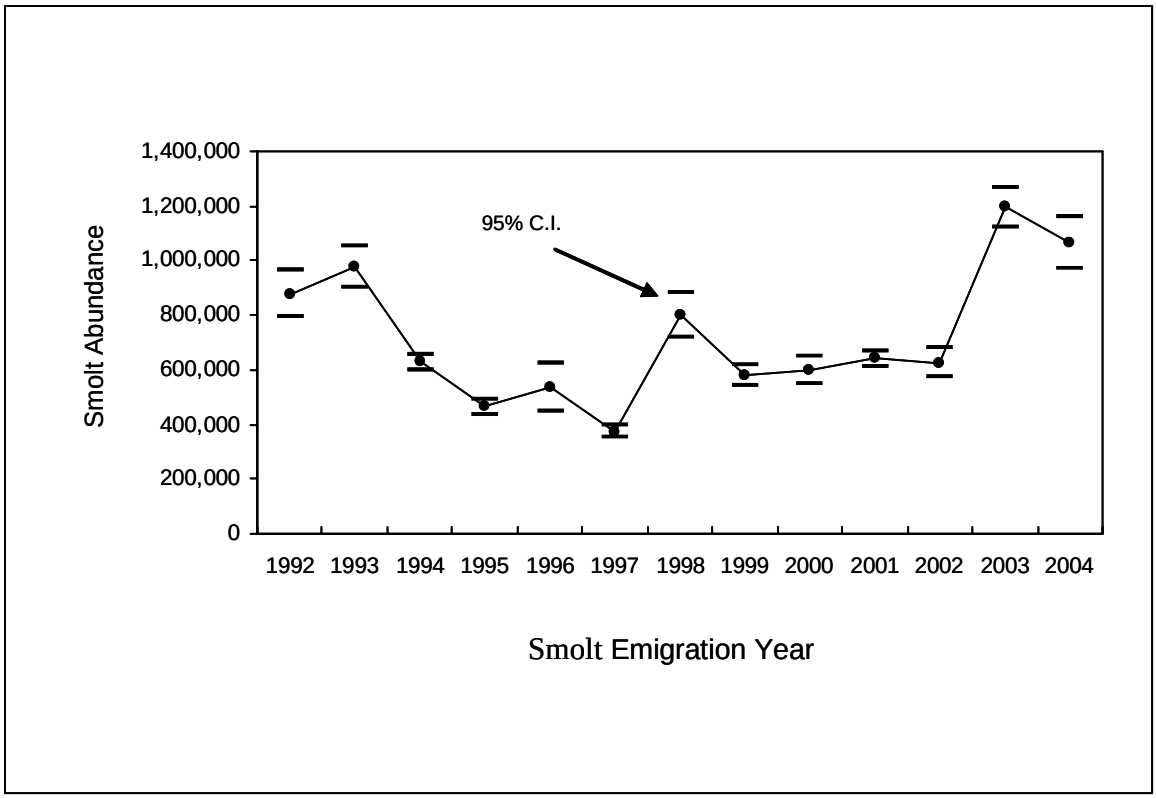

Figure 5.-Coho salmon smolt abundance estimates in the Kenai River, 1992-2004.

There were 47,132 fish (21%) examined for adipose finclips in the inlet-wide commercial harvest. Adipose finclipped fish were found in all sampled fisheries. The statistical area of harvest could not be identified for 7,548 fish (Table 4, Appendix A7); 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 these mixed area samples, 34 coho were found with an adipose finclip (0.5%), heads were recovered from all of them, and 21 had decodable tags. There were 3 decodable tags recovered from smolt implanted at the Moose River in 2004.

The remaining 39,584 examined fish were assigned to fishery strata (Table 4, Appendix A8) and 269 (0.9%) were missing the adipose fin. There were 268 heads recovered and 216 had decodable tags (81%). All originated from UCI release locations in 2004 including 65 (30%) released as wild smolt emigrating from the Moose River and 151 released as hatchery-produced smolt in Ship Creek. Most (89%) were recovered from Central District fisheries and 11% were recovered from Northern District fisheries.

Among the commercial processors receiving at least 200 coho salmon harvested in the Central District eastside set gillnet fisheries in 2005, the proportion examined that carried CWTs from the Moose River in 2004 did not exceed 1.9% (Figure 7). Among all plants processing coho salmon in the Central District drift gillnet fishery, the tagged proportion did not exceed 0.17%. The proportions were similar among processors and sampling summaries (and harvest estimates) that follow are based on samples pooled among processors.

Table 4.-Sampling performance and recovery of coded wire tags (CWTs) from coho salmon harvested in Upper Cook Inlet commercial fisheries in 2005.

Gillnet fishery	Harvest	Number examined	Proportion of harvest examined	Marked fish found[a]	Proportion marked	Heads recovered	Missing, lost, or unreadable	Proportion not decoded	Heads with decodable CWT[b]	Number from cohort marked at Moose R. in 2004
CENTRAL DISTRICT										
Central District Drift	144,742	26,083	0.18	182	0.01	181	35	0.19	146	14
244-25 Drift (Kasilof River mouth)	69	0								
Drift gillnet total	144,811	26,083	0.18	182	0.01	181	35	0.19	146	14
Eastside Set (by Statistical Area)										
244-21	1,964	265	0.13	5	0.02	5	0	0.00	5	5
244-22	3,379	802	0.24	8	0.01	8	0	0.00	8	6
244-31/32	2,352	220	0.09	5	0.02	5	2	0.40	3	3
244-41/42	11,790	1,647	0.14	28	0.02	28	3	0.11	25	23
Eastside Set gillnet total	19,485	2,934	0.15	46	0.02	46	5	0.11	41	37
Kalgin Island Set	21,043	508	0.02	6	0.01	6	1	0.17	5	1
Westside Set	8,459	2,003	0.24	6	0.00	6	5	0.83	1	0
Mixed statistical areas[c]										
Mixed Eastside Set		139		4	0.03	4	1	0.25	3	3
Mixed Eastside/Central District Drift		165		0	0.00					
Mixed Westside Set/Central District Drift		292		2	0.01	2	2	1.00	0	0
Mixed Central District Drift/Westside Set/Kalgin Island Set		641		5	0.01	5	0	0.00	5	0
Mixed Westside Set/Kalgin Island Set		6,311		23	0.004	23	10	0.43	13	0
Mixed fishery total		7,548		34	0.005	34	3	0.38	21	3
Central District total	193,798	31,528	0.16	240	0.01	239	46	0.19	193	52
NORTHERN DISTRICT										
Eastside Set	10,770	7,811	0.73	29	0.00	29	0	0.21	23	13
Fire Island Set	4,028	0								
Pt. MacKenzie/Susitna Flats	7,729	0		0						
Westside Set	8,332	245								
Northern District Set total	30,859	8,056	0.26	29	0.00	29	0	0.21	23	13
Unmixed fishery total	224,657	39,584[d]	0.18	269	0.01	268	46	0.17	216	65
Grand total[e]	224,657	47,132[e]	0.21	303	0.01	302	49	0.16	237	68

[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 harvest mixture among multiple Upper Cook Inlet commercial fisheries.

[d] Total for all samples assigned to known fisheries throughout Upper Cook Inlet.

[e] Total for all samples assigned and not assigned to known fisheries throughout Upper Cook Inlet.

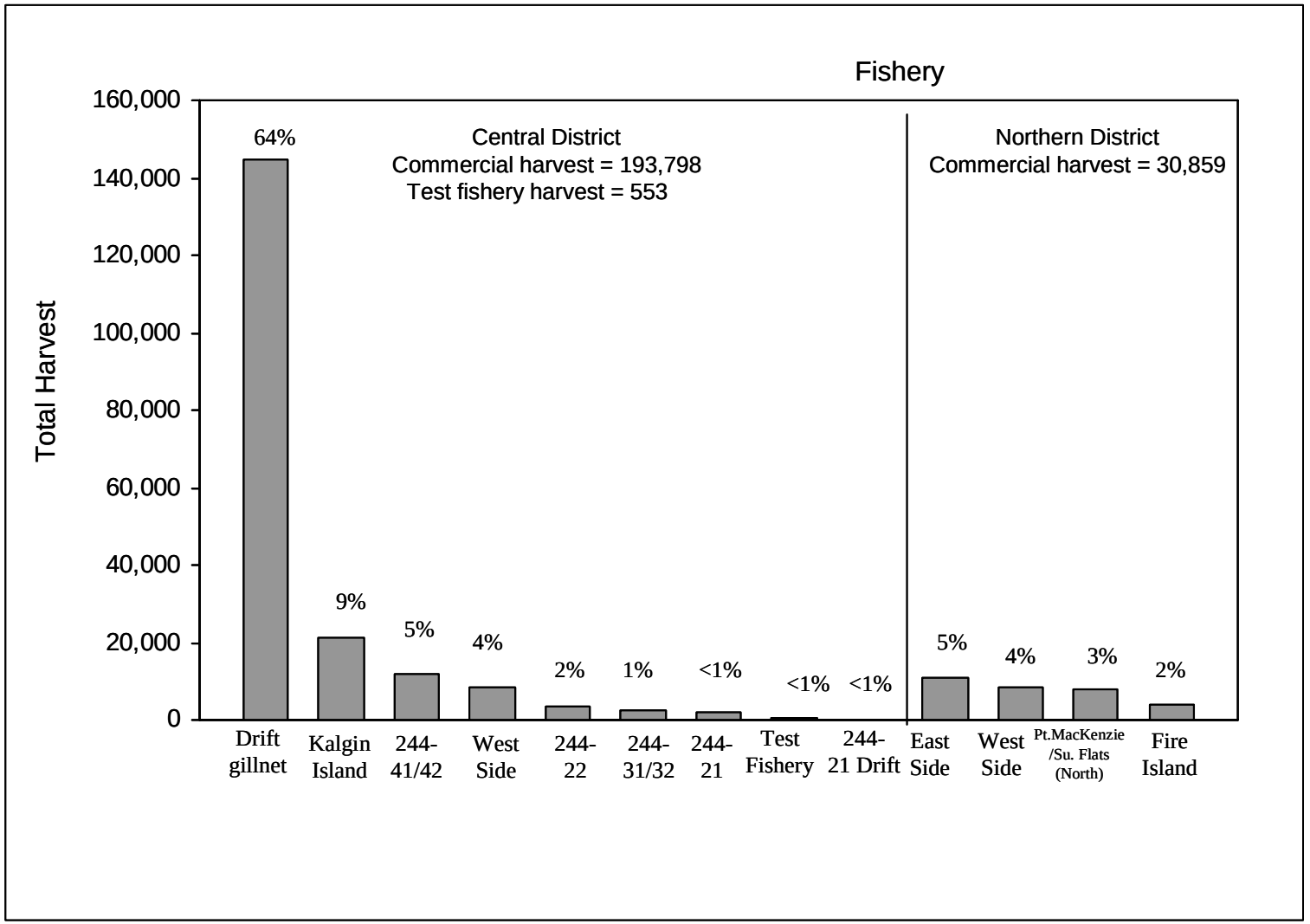

Figure 6.-Coho salmon harvest in 12 Upper Cook Inlet (UCI) commercial fishery areas (and the Alaska Department of Fish and Game UCI test fisheries) with percentage of total harvest represented in 2005.

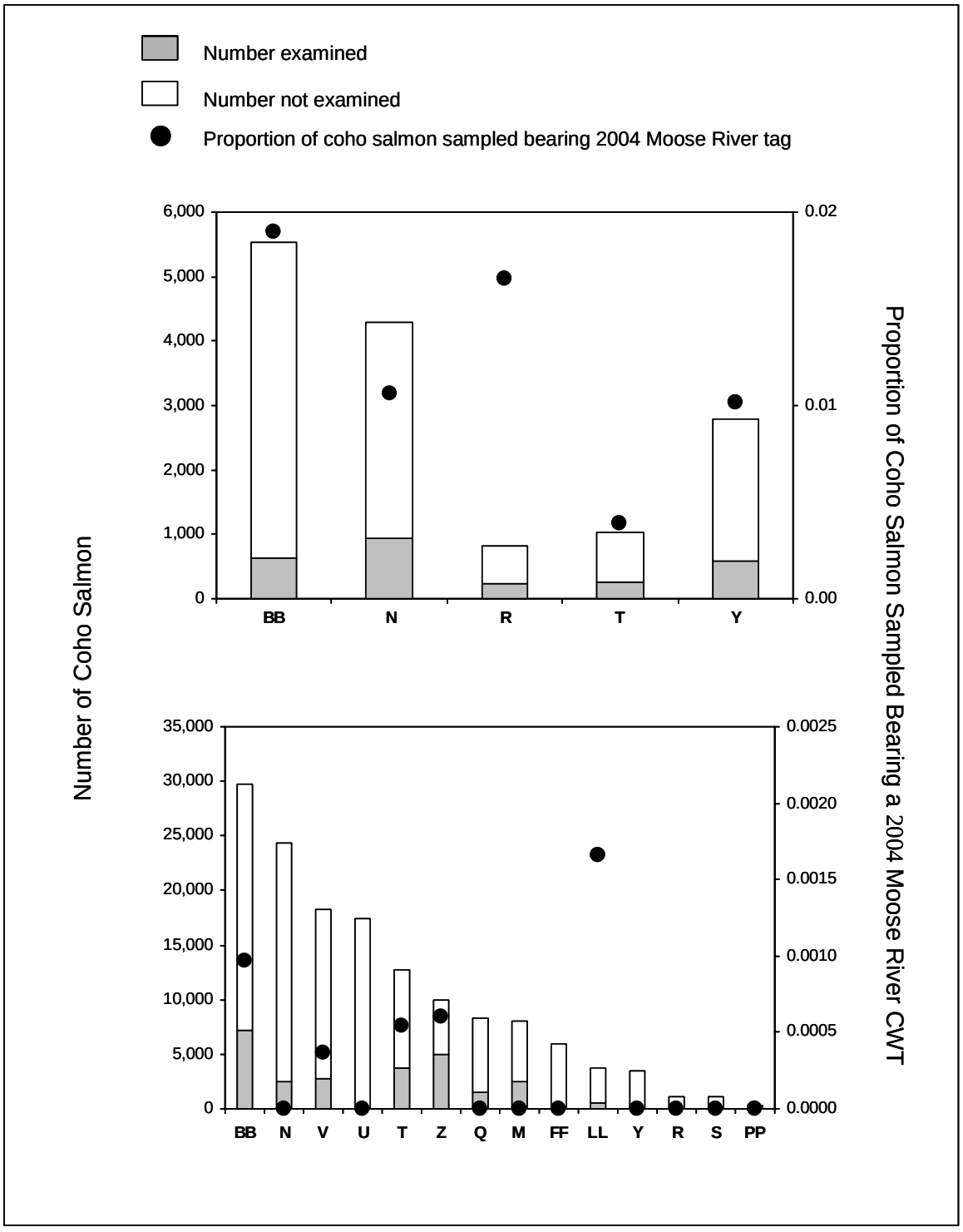

Figure 7.-Number of coho salmon commercially harvested and processed in 2005 in the eastside set gillnet fishery (top) and Central District drift gillnet fishery (bottom) of Upper Cook Inlet by commercial processor (alias name) and proportion of examined fish that were originally marked at the Moose River in 2004.

Central District Drift Gillnet Fishery

In 2005, 144,742 coho salmon were harvested in the Central District drift gillnet fishery. The 2005 harvest was 6% above the1995-2004 average harvest (Shields 2006).

The Central District drift gillnet fishery harvest was sampled on 23 of the 49 days during open fishing periods between June 20 and August 10. Some areas along the west side of Cook Inlet allowed drift gillnet fishing after August 10 (a region where historically few Kenai River coho salmon are caught relative to other Central District fisheries). The harvest sampling in these areas was incidental. Overall, 18% of the harvest was examined. The harvest on days not sampled accounted for 14% of the total harvest.

There were 26,083 fish examined in the Central District drift gillnet fishery and 182 (0.7%) were missing the adipose fin (Table 4). Heads were collected from 181 and 146 had decodable tags. There were 132 tags from hatchery-reared smolt released in Ship Creek in 2004 and 14 in wild smolt emigrating from the Moose River in 2004. Therefore, 0.05% of the 26,083 fish examined in this fishery had tags implanted at the Moose River in 2004.

The first recovery of Moose River CWTs in the Central District drift gillnet fishery occurred on July 28. Coho salmon marked at the Moose River were recovered on 10 of the 23 sampled days between June 30 and August 18.

Central District Eastside Set Gillnet Fishery

In 2005, there were 19,485 coho salmon harvested in the Central District eastside set gillnet fishery. The 2005 harvest was 27% below the 1995-2004 average harvest (Shields 2006).

The Central District eastside set gillnet fishery harvest was sampled during 17 of the 38 days fishing occurred between June 20 and September 10. Overall, 15% of the harvest (19,485) was examined and assigned to spatial-temporal strata. The combined eastside harvest on days not sampled accounted for 34% of the total harvest. Adipose finclipped fish were found on 7 of the days fish were examined.

There were 46 (1.6%) fish missing the adipose fin. Heads were collected from all 46: 5 (11%) had no tag and 41 (89%) had decodable tags. There were 4 tags from hatchery-produced smolt released in Ship Creek in 2004, and 37 tags from wild smolt implanted while emigrating from the Moose River in 2004. Therefore, 1.3% of the 2,934 fish examined in this fishery had tags implanted at the Moose River in 2004.

Portions of the harvest were not examined, particularly early in the season when coho salmon harvest was low. The portion of the harvest on days not sampled or days when no harvest was observed ranged from 26 to 42% among the statistical areas of 24421, 24422, 24431/32, and 24441/24. Coho salmon marked at the Moose River in 2004 were recovered from all statistical areas in 2005. The first recovery of Moose River tags occurred on July 28 in statistical area 24441/42, August 1 in statistical area 24421, August 3 in statistical area 24422, and August 4 in statistical area 24431/32. The proportion of fish examined in 2005 that were marked as smolt at the Moose River in 2004 was 1.9%, 0.7%, 1.4%, and 1.4% for statistical areas 24421, 24422, 24431/32, and 24441/42, respectively.

Northern District Gillnet Fisheries

There were 30,859 coho salmon harvested among all Northern District set gillnet fisheries in 2005. The 2005 Northern District coho salmon harvest was 52% of the 1995-2004 average harvest (Shields 2006).

The Northern District harvest sampling in 2005 targeted only the eastside set gillnet fishery. This differed from historic sampling efforts that targeted all four fisheries within the Northern District. Sampling was reduced because the ADF&G CWT-recovery program in Anchorage was eliminated. Historically, that program sampled all Northern District fisheries to recover tags from both wild and hatchery smolt releases. The only expected return of tagged Northern District origin coho salmon in 2005 were hatchery-raised smolt released in Ship Creek in 2004. All other releases of tagged coho salmon smolt within the District were discontinued by 2004.

Sampling the eastside fishery was a surrogate for the entire Northern District to determine if harvest of Kenai River coho salmon was significant. From 1994 through 2004, the average eastside set gillnet fishery harvest of Kenai River coho salmon was 223, representing (61.2%) of the average Kenai River coho salmon harvested from all Northern District fisheries during that period (Table 5). In 2005, eastside fishery sampling began on July 7 and continued through September 12. Sampling occurred on 15 of the 17 days when coho salmon were harvested. The first day of fishing was May 28, but few coho were harvested until early July which coincides with the start of sampling.

The eastside set gillnet fishery harvest was the most intensively sampled of all UCI fisheries, with 7,811 fish examined and assigned to a statistical area (73% of the harvest; Table 4). The harvest on the 2 days when coho salmon were harvested, but not sampled, accounted for only 1.9% of the total coho salmon harvest. Adipose finclipped coho salmon were found on 10 of the 15 days sampled, and 29 (0.4%) were missing the adipose fin. Heads were collected from all 29, and 23 (79%) had a decodable tag and 6 (21%) had no tag. There were 10 tags from the 2004 release of hatchery-produced smolt in Ship Creek, and 13 tags from wild smolt emigrating from the Moose River in 2004. Therefore, within the eastside set gillnet fishery, 0.17% of the fish examined had tags from smolt implanted at the Moose River in 2004. Because the eastside set gillnet fishery historically harvests the most Kenai River coho salmon within the District, this suggests that the overall contribution of Kenai River coho salmon to the Northern District commercial harvest is low.

Commercial Harvest Estimates

Commercial harvest estimates were generated for UCI commercial fisheries using commercial catch sampling data and the pooled coded wire tagged proportion estimate of the 2005 Kenai River adult return. The commercial harvest estimates are qualified because the tagged proportion estimate is for the population as a whole and not necessarily the population that passed through commercial fisheries.

There were 5,019 (SE = 921) Kenai River coho salmon harvested in 2005 including, 1,533 (SE = 617) harvested by the Central District drift gillnet fishery (Table 6); 3,310 (SE = 681) by the Central District eastside set gillnet fishery (Table 7); and 176 (SE = 51) by the Northern District eastside set gillnet fishery (Appendix A8). These estimates comprised 1.1% of the total drift gillnet harvest, 17.0% of the total eastside set gillnet harvest, and 1.6% of the total Northern District eastside set gillnet harvest in 2005.

The contribution of Kenai River origin fish to the harvest was low throughout the commercial drift gillnet season with the greatest proportion (6.5%) and absolute harvest occurring August 2-10 (Table 6, Figure 8). Note that this study was not designed to provide precise Kenai River coho salmon harvest estimates to time/area strata and the variability of these estimates should be considered when assessing time/area harvest trends.

Table 5.-Total estimated harvest of Kenai River coho salmon within four Northern District fisheries and the proportion each estimate represents to the total harvest in each fishery.

	Total harvest of all coho salmon					Harvest of Kenai River coho salmon					Proportion of Northern Di	
Year	East Side Set	Fire Island Set	Pt. Possession/ Susitna Set	West Side Set	Combined Total	East Side Set	Fire Island Set	Pt. Possession/ Susitna Set	West Side Set	Combined Total	East Side Set	Moose R. in 2004 Set
1994	29,035	10,354	15,228	94,401	149,018	165	20	0	292	477	0.006	0.002
1995	11,988	6,012	4,246	65,055	87,301	177	94	36	272	579	0.015	0.016
1996	16,444	8,375	6,463	45,013	76,295	29	0	0	0	29	0.002	0.000
1997	2,219	3,748	4,983	26,302	37,252	13	0	7	16	36	0.006	0.000
1998	11,200	4,767	4,870	12,974	33,811	93	52	13	17	175	0.008	0.011
1999	7,736	2,603	2,259	18,838	31,436	132	0	0	39	171	0.017	0.000
2000	18,409	7,238	11,949	33,652	71,248	26	8	0	49	83	0.001	0.001
2001	11,472	5,311	14,382	14,763	45,928	961	108	95	139	1,303	0.084	0.020
2002	13,798	6,986	15,279	14,229	50,292	45	12	0	0	57	0.003	0.002
2003	9,372	1,746	8,226	4,671	24,015	99	21	6	0	126	0.011	0.012
2004	12,308	6,141	19,090	7,138	44,677	714	183	80	0	977	0.058	0.030
Total	143,981	63,281	106,975	337,036	651,273	2,454	498	237	824	4,013		
Average	13,089	5,753	9,725	30,640	59,207	223	45	22	75	365	0.019	0.008
1994-2004 Average Contribution to All Four N.D. Fisheries	0.221	0.097	0.164	0.518	1.000	0.612	0.124	0.059	0.205	1.000		

[a] Source of data: Carlon 2000 and 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill *In prep*; Massengill and Carlon 2004 a, b, 2007a, b.

Table 6.-Estimated harvest, and associated standard errors, of Kenai River coho salmon in the Upper Cook Inlet Central District commercial drift gillnet fishery during selected time intervals, 2005.

Interval	Total harvest	Kenai River coho salmon	Standard error	Proportion of total harvest
< 26 July	46,183	0	0	0.000
26 July-1 August	70,809	439	233	0.006
2-10 August	16,798	1,094	571	0.065
>10 August	10,952	0	0	0.000
Total	144,742	1,533	617	0.011

Note: Does not include the drift gillnet catch of 69 coho salmon from the Kasilof River mouth, statistical area 244-25.

The 8,517 coho salmon in the Central District eastside set gillnet harvest before August 1 represents 44% of the total harvest in this fishery. In general, both the proportion of the harvest comprised of Kenai River origin coho salmon and the total harvest was greatest after July 30 (Figure 9).

The total coho salmon harvest in the Central District eastside set gillnet fishery ranged from 1,964 in statistical area 244-21 to 11,790 in statistical area 244-41/42 (Table 4, Figure 10). Within the eastside fisheries, the portion of the seasonal harvest comprised of Kenai River coho salmon ranged from 10.8 to 25.5% (Table 7).

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 commercial harvest estimates were calculated and examined for differences (Table 8). The pooled seasonal tagged proportion estimate was 0.078, the minimum tagged proportion from the first 7 weeks was 0.071, and the maximum tagged proportion from the last week was 0.226. The minimum and maximum harvest estimates represent +11% and -65% of the pooled estimate, respectively.

2005 INRIVER ADULT INDEX

The combined fish wheel effort from August 1 through September 30, 2005, was 1,422.4 hours (Figure 11, Appendix A9). Daily hours of operation varied based on fish wheel maintenance and available daylight, but averaged 11.4 hours per day for the fish wheel adjacent to the north bank and 11.9 hours per day for the fish wheel adjacent to the south bank. The fish wheel spin rate in revolutions per minute (rpm) was generally maintained between 2.75 and 4.5 rpm. This range is believed to be most efficient at catching fish and is similar to previous years. The 2005 average rpm was 3.5 for the north bank fish wheel and 4.0 for the south bank fish wheel (Appendix A10). Kenai River water transparency and river flow (Figure 12) indicate that fishing conditions in 2005 were similar to 1999-2004 (Appendix A11).

Table 7.-Total harvest and estimated contribution of Kenai River coho salmon in the Upper Cook Inlet eastside set gillnet fishery by statistical area and selected time intervals, 2005.

Interval	Total harvest	Estimated contribution	Standard error	Proportion of total harvest
Statistical Area 244-21				
< 24 July	257	0		
24-30 July	584	0		
31 July-6 August	692	283	130	0.409
>7 August	431	0		
Total	1,964	283	130	0.144
Statistical Area 244-22				
< 24 July	47	0		
24-30 July	1,675	0		
31 July-6 August	943	124	124	0.131
>7 August	714	240	150	0.336
Total	3,379	364	194	0.108
Statistical Area 244-31/32				
< 24 July	52	0		
24-30 July	636	0		
31 July-6 August	528	0		
>7 August	1,136	600	388	0.528
Total	2,352	600	388	0.255
Statistical Area 244-41/42				
< 24 July	1,865	0		
24-30 July	3,401	81	80	0.024
31 July-6 August	3,107	504	235	0.162
>7 August	3,417	1,478	444	0.433
Total	11,790	2,063	509	0.175
Combined Statistical Areas				
< 24 Jul	2,221	0		
24-30 July	6,296	81		0.013
31 Jul-6 August	5,270	911	489	0.173
>7 August	5,698	2,318	982	0.407
Total	19,485	3,310	681	0.170

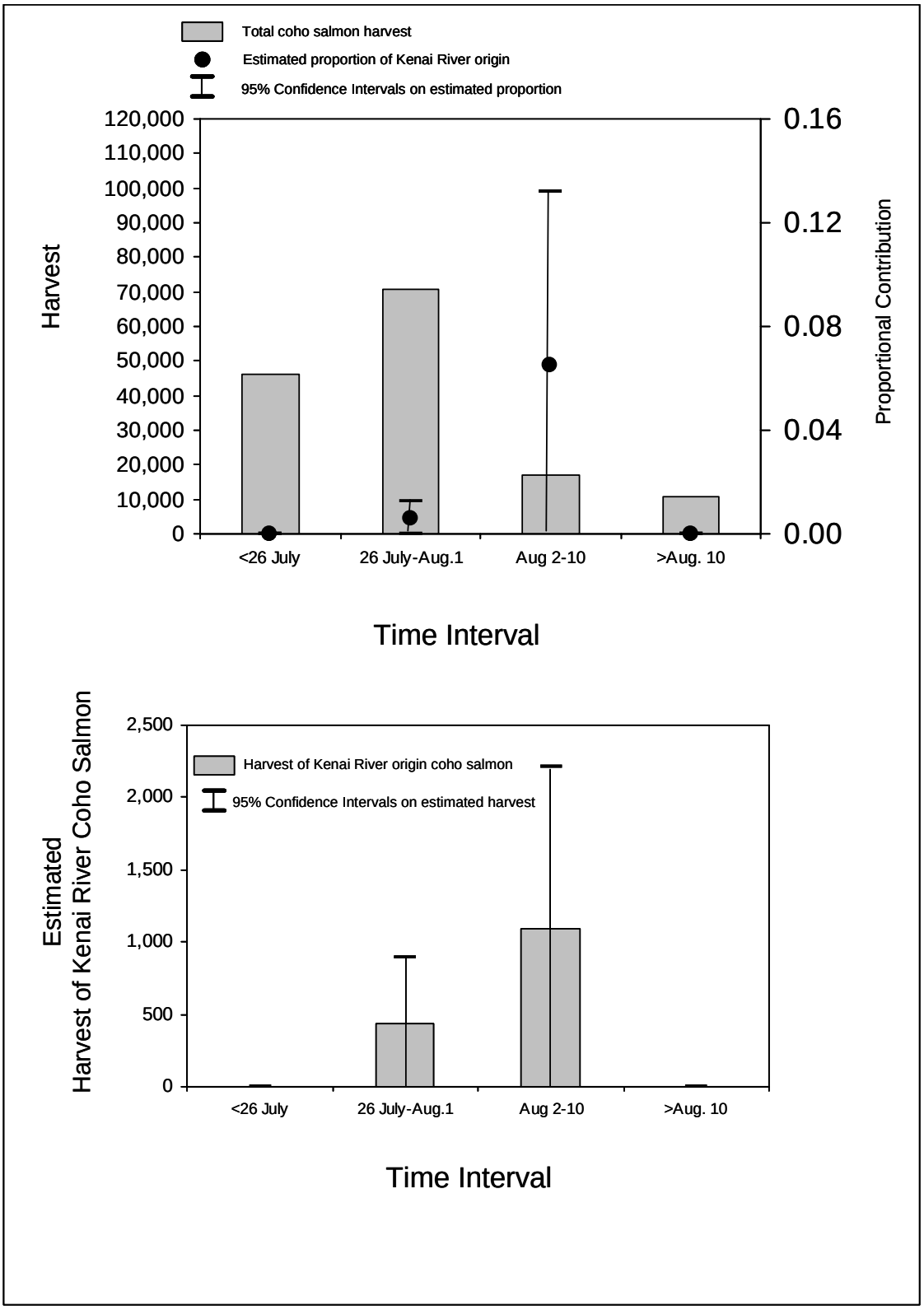

Figure 8.-Temporal trend in proportional contribution of Kenai River coho salmon to the total harvest (top) and the trend in absolute contribution (bottom) occurring in the drift gillnet fishery of the Upper Cook Inlet Central District, 2005.

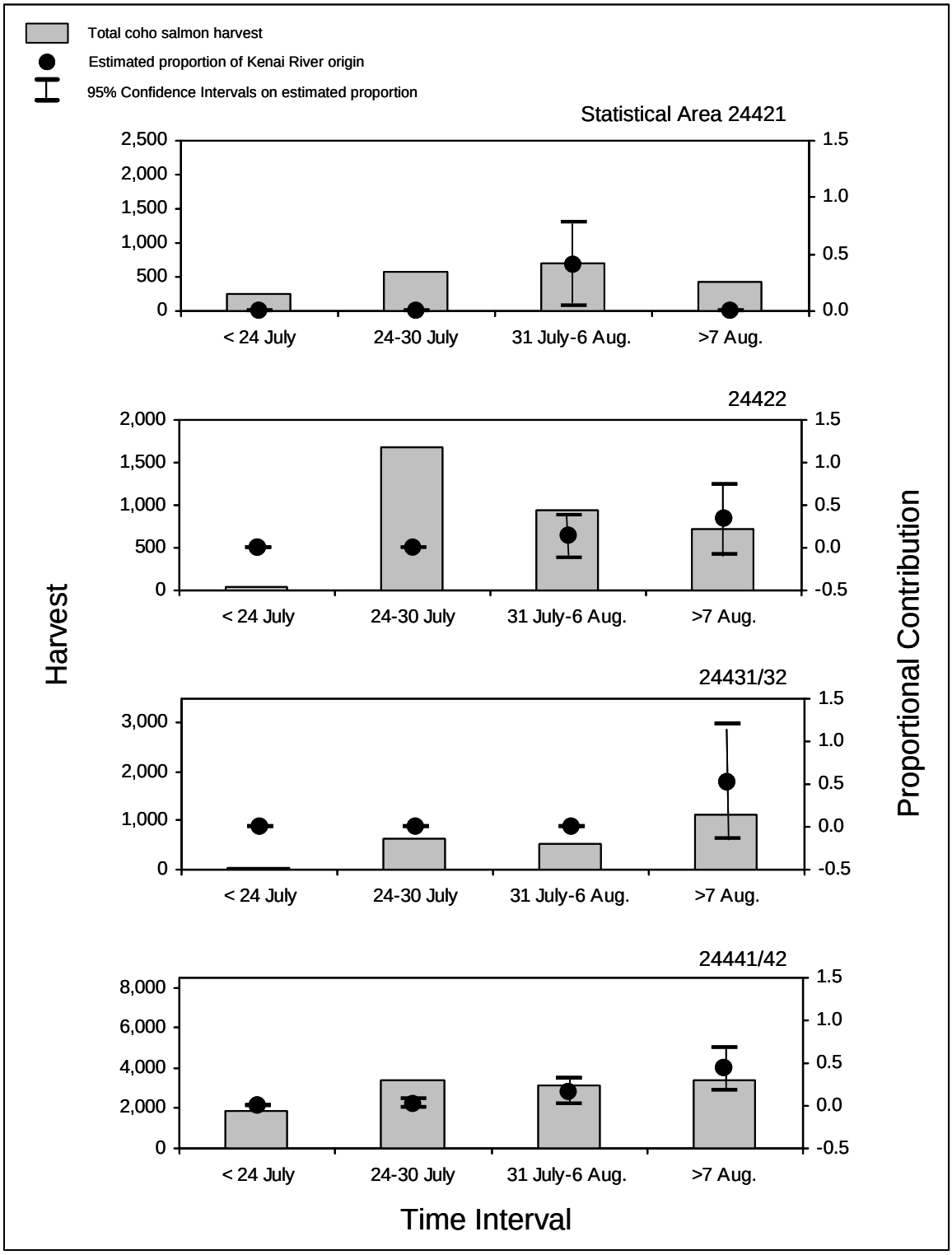

Figure 9.-Temporal trends in total harvest of coho salmon and proportional contribution of coho salmon from the Kenai River to the total harvest occurring in four statistical areas of the Upper Cook Inlet Central District eastside set gillnet fishery during four similar time periods in 2005.

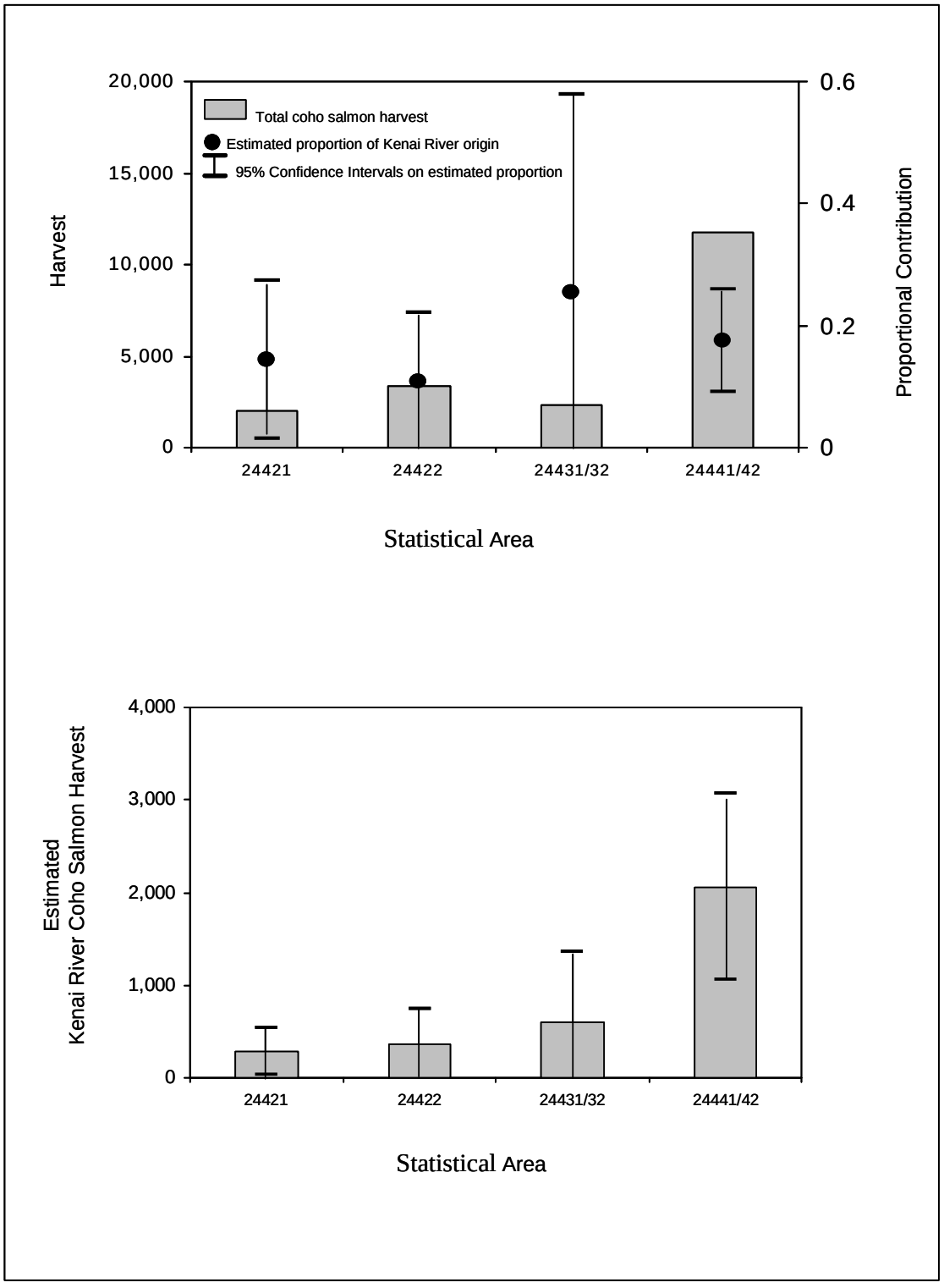

Figure 10.-Geographic trends in total coho salmon harvest and proportional contribution of coho salmon of Kenai River origin (top) and in estimated number of coho salmon of Kenai River origin (bottom) harvested among statistical areas in the eastside set gillnet fishery of the Central District of Upper Cook Inlet, 2005.

Table 8.-Sensitivity of 2005 commercial harvest estimates to variations in the tagged proportion.

Fishery	Total harvest	Pooled marked proportion (0.078) Estimated contribution [c]	Marked proportion: minimum [a] (0.071) Estimated contribution [c]	Difference from pooled	% Difference from pooled	Difference from pooled as % of total harvest	Marked proportion: maximum [b] (0.226) Estimated contribution [c]	Difference from pooled	% Difference from pooled	Difference from pooled as % of total harvest
Central District drift gillnet	144,742	1,533	1,696	163	11%	0.1%	528	-1,005	-66%	0.7%
Central District eastside set gillnet [d]										
244-21	1,964	283	314	31	11%	1.6%	99	-184	-65%	9.4%
244-22	3,379	364	404	40	11%	1.2%	126	-238	-65%	7.0%
244-31/32	2,352	600	665	65	11%	2.8%	207	-393	-66%	16.7%
244-41/42	11,790	2,063	2,286	223	11%	1.9%	713	-1,350	-65%	11.5%
Combined	19,485	3,310	3,669	359	11%	1.8%	1,145	-2,165	-65%	11.1%
Northern District eastside set gillnet [e]	7,811	176	196	20	11%	0.3%	61	-115	-65%	1.5%
Total [f]	172,038	5,019	5,561	542	11%	0.3%	1,734	-3,285	-65%	1.9%

[a] The minimum marked proportion determined from the pooled fish wheel data collected August 1-September 18.

[b] The maximum marked proportion determined from the fish wheel data collected from September 24-30.

[c] Kenai River population-specific harvest estimate.

[d] By statistical area and combined areas.

[e] Includes only the Northern District eastside set gillnet estimates. Other Northern District fisheries were not sampled or were sampled incidentally, therefore, no estimates were generated for those areas.

[f] Sum of estimates for Central District drift gillnet, Central District eastside set gillnet, and Northern District eastside set gillnet fisheries. Does not include Central District westside set gillnet, Kalgin Island set gillnet, statistical area 244-25 (Kasilof River mouth), Northern District westside set gillnet, Point MacKenzie/Susitna Flats, or Fire Island set gillnet. All fisheries without estimates are areas that were not sampled or were incidentally sampled because of a history of insignificant harvest of Kenai River origin coho salmon.

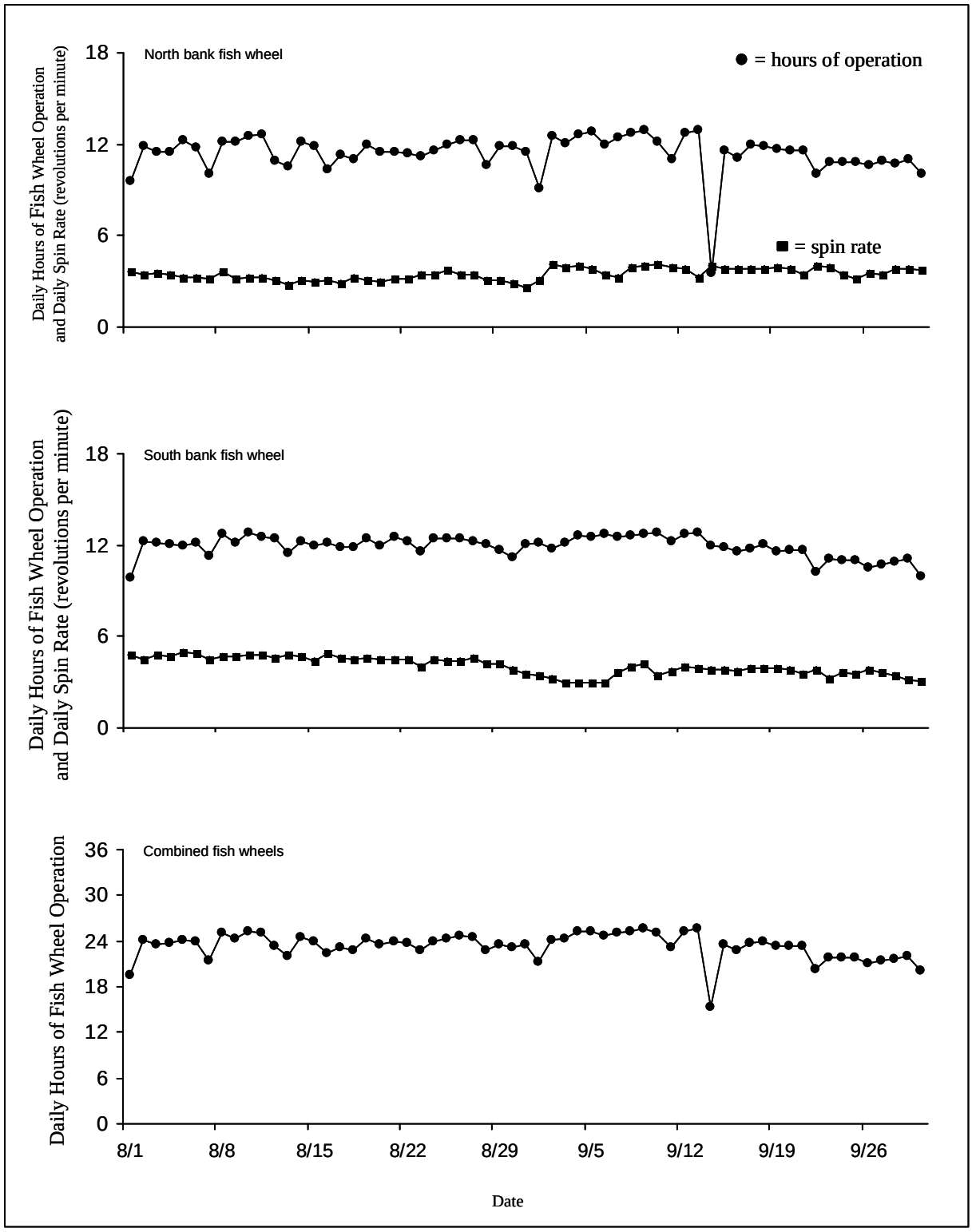

Figure 11.-Daily hours of operation and rotational rate for fish wheels operating adjacent to each bank on the Kenai River near river kilometer 45, August 1–September 30, 2005.

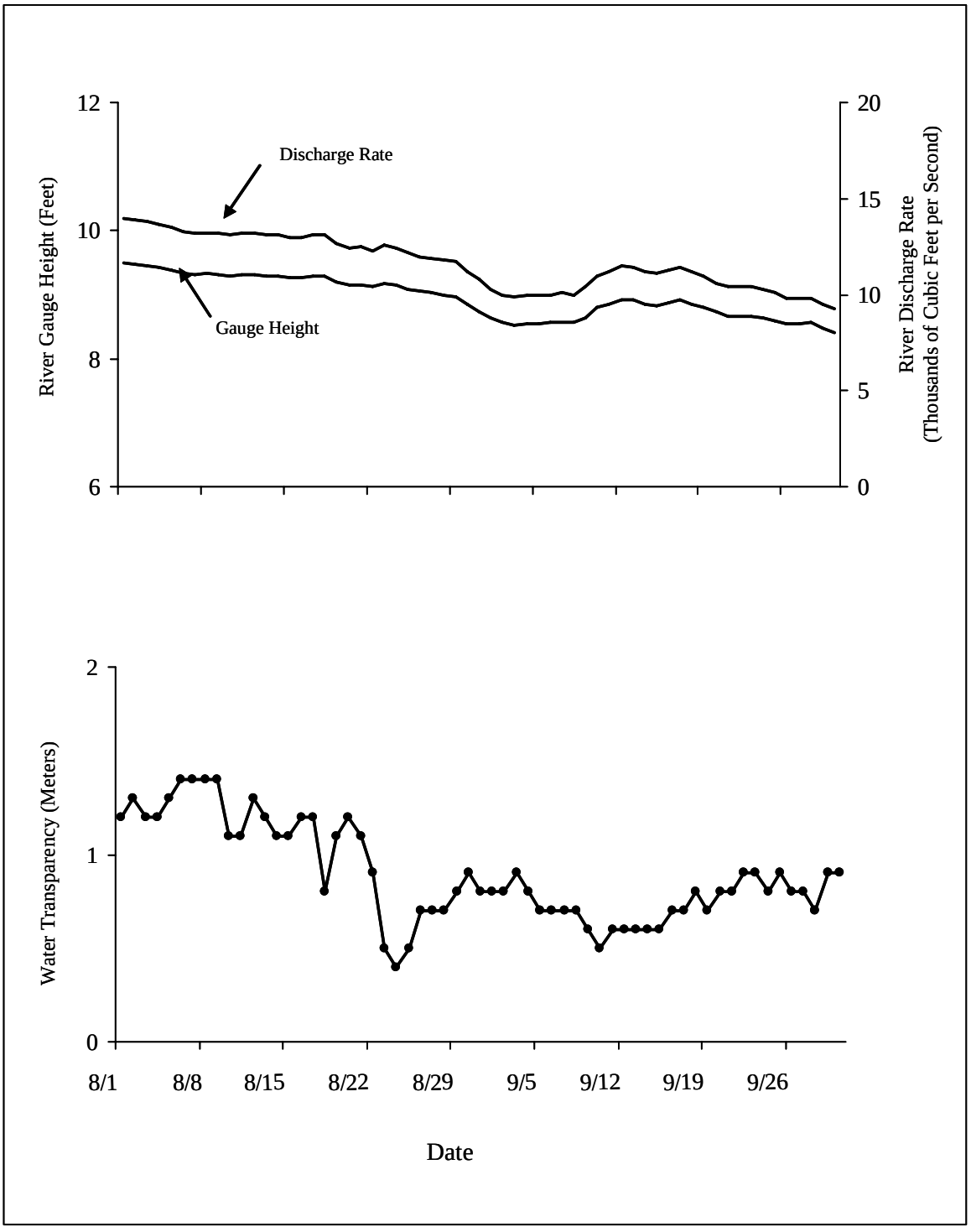

Figure 12.-Daily Kenai River stage and discharge as measured by USGS gauging station at river kilometer (rkm) 34 (top) and water transparency as measured with a Secchi disk near rkm 45 (bottom), August 1–September 30, 2005.

There were 5,517 coho salmon caught in the fish wheels from August 1 through September 30, 2005 (Table 3, Appendices A5 and A6): 3,023 coho salmon were captured in the north bank fish wheel and 2,494 in the south bank fish wheel.

The log-transformed CCPUE (LnCCPUE) values for the three inseason prediction periods and the final end of season classification in 2005 were 4.79 (August 1-28), 5.30 (August 1–September 11), 5.43 (August 1–September 25), and 5.46 (August 1–September 30) (Appendix A12). All four periods classified a level of abundance defined as medium (>50,000 and <120,000) for coho salmon arriving at rkm 45. The August 1–September 30, 2005, fitted regression plot with 90% confidence intervals is shown in Figure 13.

DISCUSSION

COMMERCIAL HARVEST

There is potential bias in the estimates for the Kenai River's contribution to the commercial harvest of coho salmon because of the temporal variability in the tagged proportion from the inriver samples. Significant inriver variability of the tagged proportion has occurred every year since 1999 (Massengill *In prep a-b*; Massengill and Carlon 2004a-b, 2007a-b). However, minimally biased estimates are still of value for assessment, management, and research planning purposes. The similarity between the maximum commercial harvest estimate (5,561) and the pooled commercial harvest estimate (5,019), relative to harvest magnitudes and total return, illustrates the intrinsic value of the estimates regardless of bias.

Since 2001, the harvest contribution of Kenai River coho salmon to the Central District drift and eastside set gillnet fisheries has not exceeded 2% and 21%, respectively (Figure 14). The total harvest (commercial, sport and personal use) of Kenai River coho salmon peaked in 1994 at 121,564 and has averaged 64,570 since 1993 (Table 9, Figure 15). The estimated commercial harvest of Kenai River coho salmon since 1993 has averaged 9,355, which is 86% greater than the 2005 harvest of 5,019 (Table 10).

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 during the first week of August in the Central District eastside set gillnet fishery (Carlon 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill *In prep a-b*; Massengill and Carlon 2004a-b, 2007a-b). The Kenai River population has comprised a minority of the total harvest in Central District commercial fisheries since 1993. Since additional restrictions were imposed in 2000, the commercial harvest of Kenai River-bound coho salmon has not exceeded 6,000 fish.

The Northern District harvest of Kenai River coho salmon has averaged <5% of the total UCI commercial harvest of Kenai River coho salmon since 1994. One notable exception occurred in 2004 when the commercial harvest of Kenai River coho salmon from the Northern District was 63% (Massengill *In prep* b). The harvest of 176 Kenai River coho salmon in the Northern District eastside set gillnet fishery in 2005 is 79% of the 1994-2004 average of 223 (Carlon 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill *In prep a-b*; Massengill and Carlon 2004a-b, 2007a-b). These 176 fish represent only 3.5% of the total harvest of Kenai River fish from all UCI fisheries sampled in 2005, indicating the Northern District is still a minor contributor to the total harvest of Kenai River coho salmon.

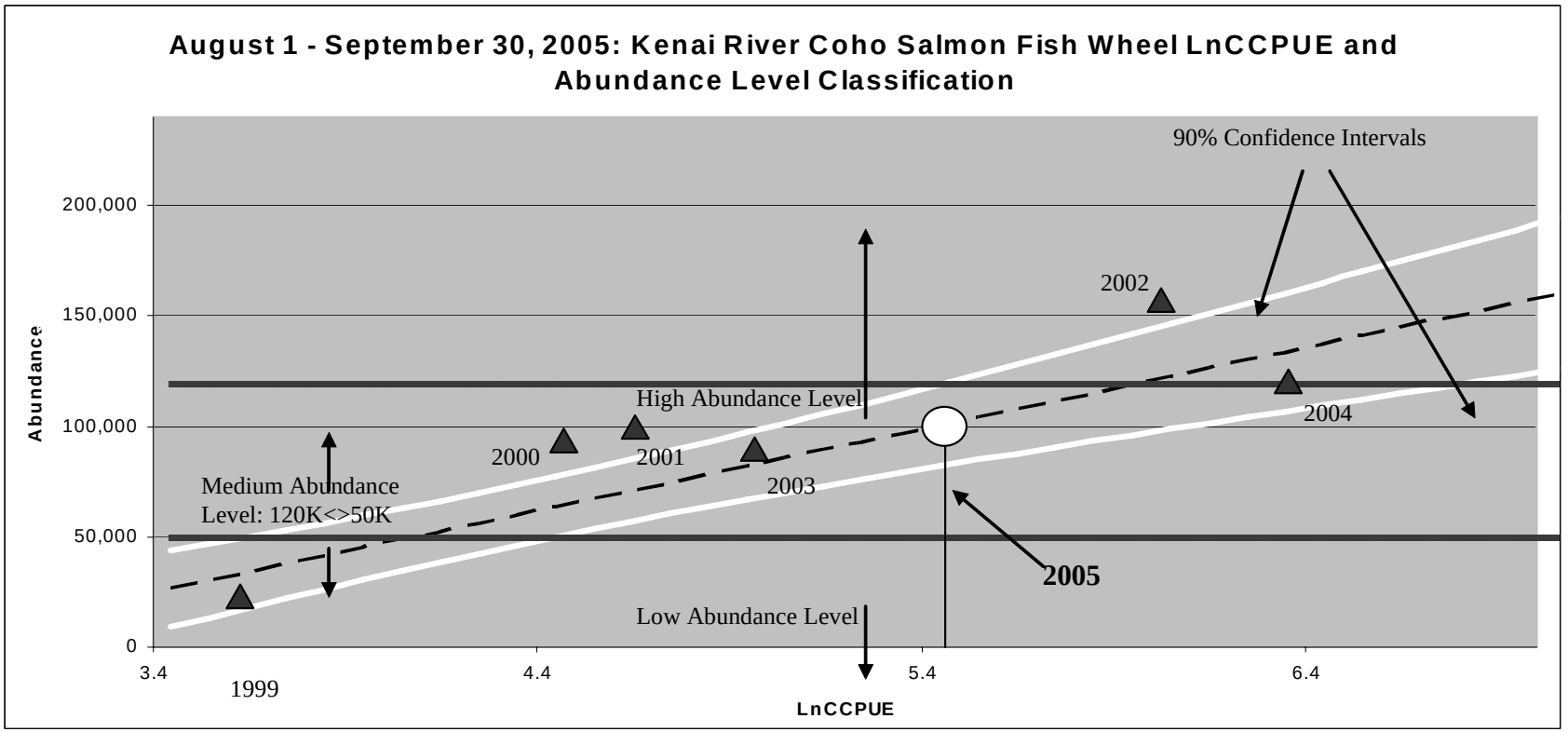

Figure 13.-Regression of the 1999-2004 Kenai River coho salmon fish wheel LnCCPUE to abundance estimates passing river kilometer 45, including a trend line with the 2005 end-of-season abundance classification.

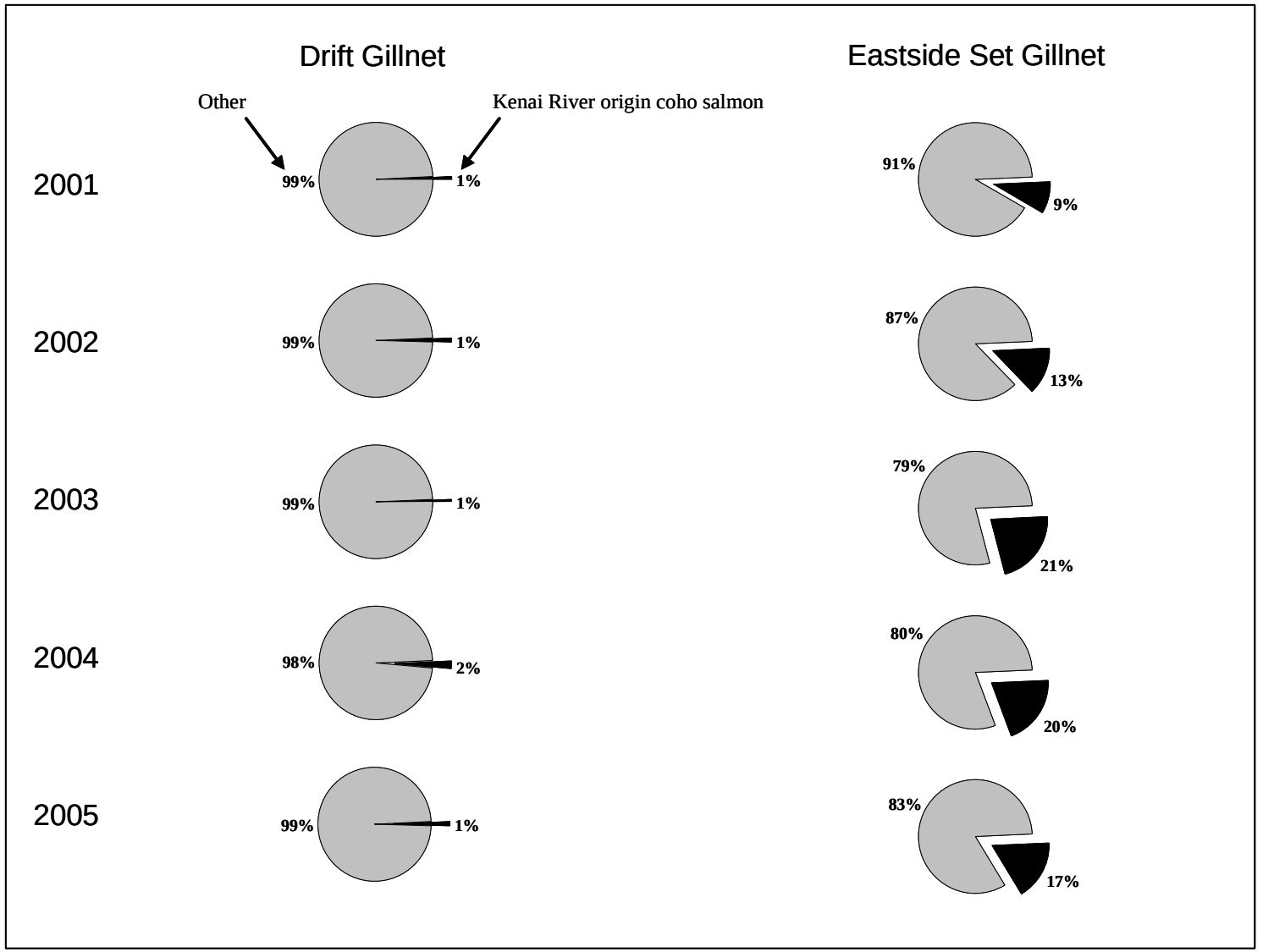

Figure 14.-Contribution of Kenai River coho salmon to the drift and eastside set gillnet commercial fisheries of Upper Cook Inlet, 2001-2005.

Table 9.-Estimated harvest of Kenai River coho salmon in Upper Cook Inlet (UCI) inriver and marine commercial fisheries, 1993-2004.

	Inriver								UCI Marine Commercial[b]				
	Sport[a]					Personal							
	Mainstem			Russian		use/	Inriver		Eastside	Drift	Northern	Commercial	Grand
Year	Unguided[a]	Guided	Total	River	Total	Subsistence	total	Educational	set gillnet	gillnet	District	total	total
1993	26,795	23,743	50,538	2,290	52,828	1,597 [c]	54,425	427	6,806	930	148	7,884	62,736
1994	45,541	41,170	86,711	4,607	91,318	2,535 [d]	93,853	829	14,673	11,732	477	26,882	121,564
1995	22,596	23,587	46,183	4,077	50,260	1,261 [e]	51,521	1,261	13,152	6,956	582	20,690	73,472
1996	28,565	14,645	43,210	4,599	47,809	1,932 [f]	49,741	1,932	11,856	2,671	29	14,556	66,229
1997	13,063	3,107	16,170	4,586	20,756	559 [f]	21,315	559	2,093	1,236	36	3,365	25,239
1998	21,750	5,217	26,967	4,612	31,579	1,011 [f]	32,590	1,011	8,096	1,974	175	10,245	43,846
1999	23,557	8,087	31,644	3,910	35,554	1,009 [f]	36,563	1,009	2,905	818	171	3,894	41,466
2000	39,202	9,349	48,551	3,938	52,489	1,449 [f]	53,938	1,449	2,351	531	83	2,965	58,352
2001	36,264	13,518	49,782	5,222	55,004	1,555 [f]	56,559	1,555	349	282	1,303	1,934	60,048
2002	45,567	14,444	60,011	6,093	66,104	1,721 [f]	67,825	1,721	4,688	1,370	57	6,115	75,661
2003	34,783	11,964	46,747	5,197	51,944	1,332 [f]	53,276	1,332	2,122	330	126	2,578	57,186
2004	51,148	14,845	65,993	6,574	72,567	2,661 [g]	75,228	2,661	5,921	4,251	977	11,149	89,038
Average	32,403	15,306	47,709	4,642	52,351	1,552	53,903		6,251	2,757	347	9,355	64,570

[a] Source is Statewide Harvest Survey (Howe et al. 1995 and 1996, 2001 a-d [1996-2000 are revised estimates]; Jennings et al. 2004, 2006 a, b; 2007; Mills 1994; Walker et al. 2003). Mainstem unguided includes Skilak Lake and Hidden Lake.

[b] Carlon 2000, 2003; Carlon and Hasbrouck 1994, 1996-1998; Massengill and Carlon 2004 a, b, 2007 a, b.

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

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

[e] Kenai River personal use dip net fishery harvest (Ruesch and Fox 1996).

[f] Reimer and Sigurdsson (2004).

[g] Preliminary estimate (personal communication, Kathrin Sundet, ADF&G, Division of Sport Fish, Research and Technical Services, Anchorage).

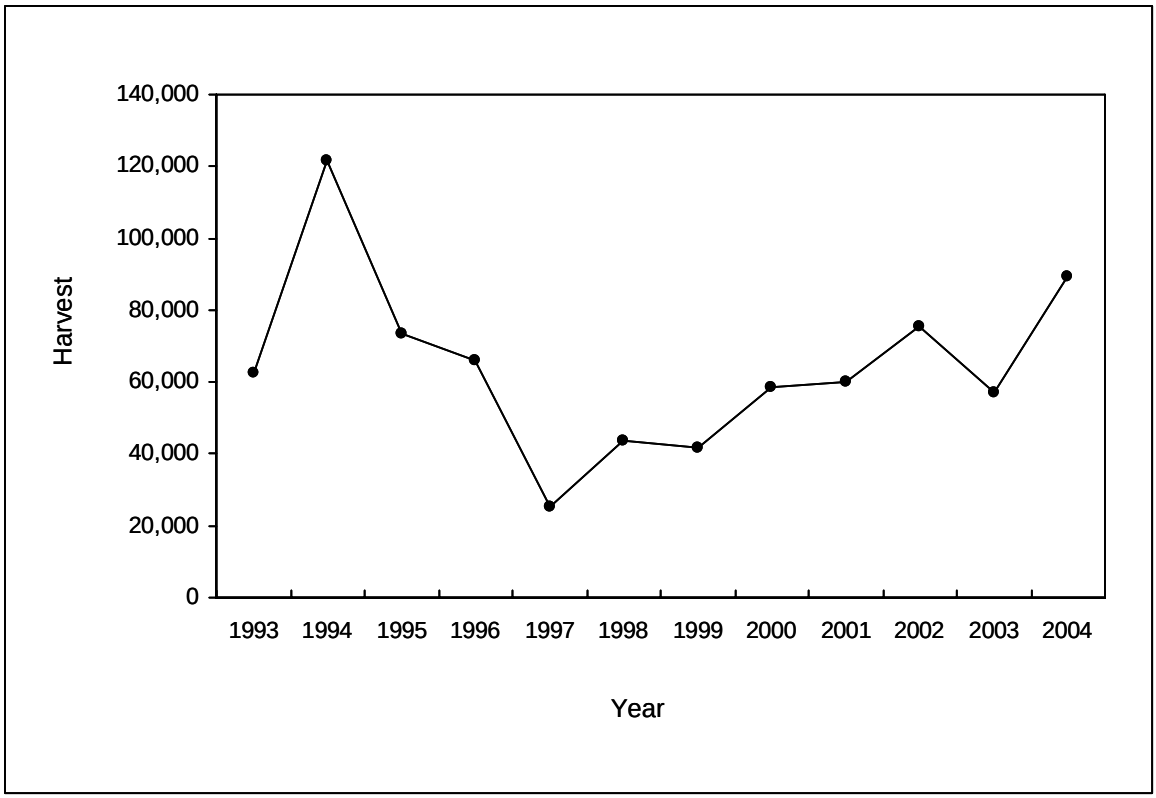

Figure 15.-Annual estimated harvest of Kenai River coho salmon, 1993-2004. Totals include harvest estimates of commercial marine, inriver personal-use, mainstem sport, and Russian River sport fisheries.

The final year of the UCI commercial harvest estimate for Kenai River coho salmon was 2005. Assuming inriver productivity remains stable and the current UCI salmon management plans remain essentially intact, it is likely that the contribution of Kenai River coho salmon to the UCI commercial harvest will be sustainable. Since 1993, the average UCI commercial harvest of Kenai River coho salmon represents 14% of the total harvest of these fish. Inriver sport fishing has been the primary source of harvest, representing an average 81% of all Kenai River coho salmon harvested since 1993.

SMOLT ABUNDANCE

History

The smolt abundance estimate is 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. Recommendations based on a decline in smolt abundance were presented to the BOF in spring 1997. At that time, the first Kenai River-specific management plan was developed, adopted into regulation, and implemented. Although declining smolt abundance was the impetus for developing the first Kenai River Coho Salmon Management Plan in 1997, the original intent was to determine a link between parent-year harvest and smolt abundance. The plan has been revised several times. Current BOF regulatory liberalizations extend sport fishing for coho salmon in the Kenai River through October 31, and commercial fishing has the potential

Table 10.-Harvest of all coho salmon and coho salmon of Kenai River origin in selected Upper Cook Inlet marine commercial fisheries, 1993–2005.

	Central District				Northern District			
	Drift gillnet[a]		Eastside set gillnet		Set gillnet		Total	
Year	All	Kenai River	All	Kenai River	All	Kenai River[b]	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
2004	198,465	4,251	30,117	5,921	44,677	977	273,259	11,149
Average	134,940	2,757	28,171	6,251	63,110	347	226,221	9,355
2005	144,742	1,533	19,485	3,310	30,859	176	195,086	5,019

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

[a] Does not include 69 coho salmon harvested from the special drift gillnet area 244-25 (Kasilof River mouth).

[b] The harvest contribution estimate for the Northern District is only for the eastside set gillnet fishery. Other Northern District fisheries were not sampled because the number of Kenai River origin fish harvested in those areas has been historically insignificant.

to fish some additional days late in the season (5 AAC 56.080, Kenai River Coho Salmon Management Plan, 2005-2006 Alaska Fish and Game Laws and Regulations Annotated).

The 2004 smolt abundance estimate is the thirteenth annual estimate since 1992. It also represents the third estimate of smolt production that can be associated with an estimate of parent-year escapement for the Kenai River coho salmon population. Because most Kenai River coho salmon develop into smolt at age 2, the primary parent year for the 2004 smolt emigration is 2001. The escapement estimate for 2004 is preliminary (Massengill *In prep* b), but will be about 75,000 adults. This escapement is associated with the second largest smolt abundance estimate (1,066,324). Note that the 1999 adult escapement estimate of 7,700 (reported as 20,422 in 2004 report) was unusually low (Carlon and Evans *In prep*), yet was the primary parent-year class that produced a near-average estimate of 626,335 (reported as 627,347 in 2004 report) smolt in 2002.

Smolt abundance estimates provided the only stock assessment for Kenai River coho salmon from 1992 through 1998 and in 2005 (years when inriver abundance and total return were not estimated). Without adult abundance estimates, it will continue to provide the only means for stock assessment.

Relationship Between Total Harvest and Smolt Abundance

There are 13 smolt abundance estimates and 12 total adult harvest estimates between 1993 and 2004 (Figure 16). The 2004 smolt abundance estimate, when paired with the 2001 total harvest estimate, is the ninth available pairing. 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 and is associated with the lowest recorded smolt production in 1997.

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 nine pairs of estimates available, there is no statistically significant link between harvest and smolt production. However, the lowest smolt abundance on record (1997) is associated with the record adult harvest in 1994 which suggests that this approach may be sensitive enough to provide 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 determine if freshwater production is adequate.

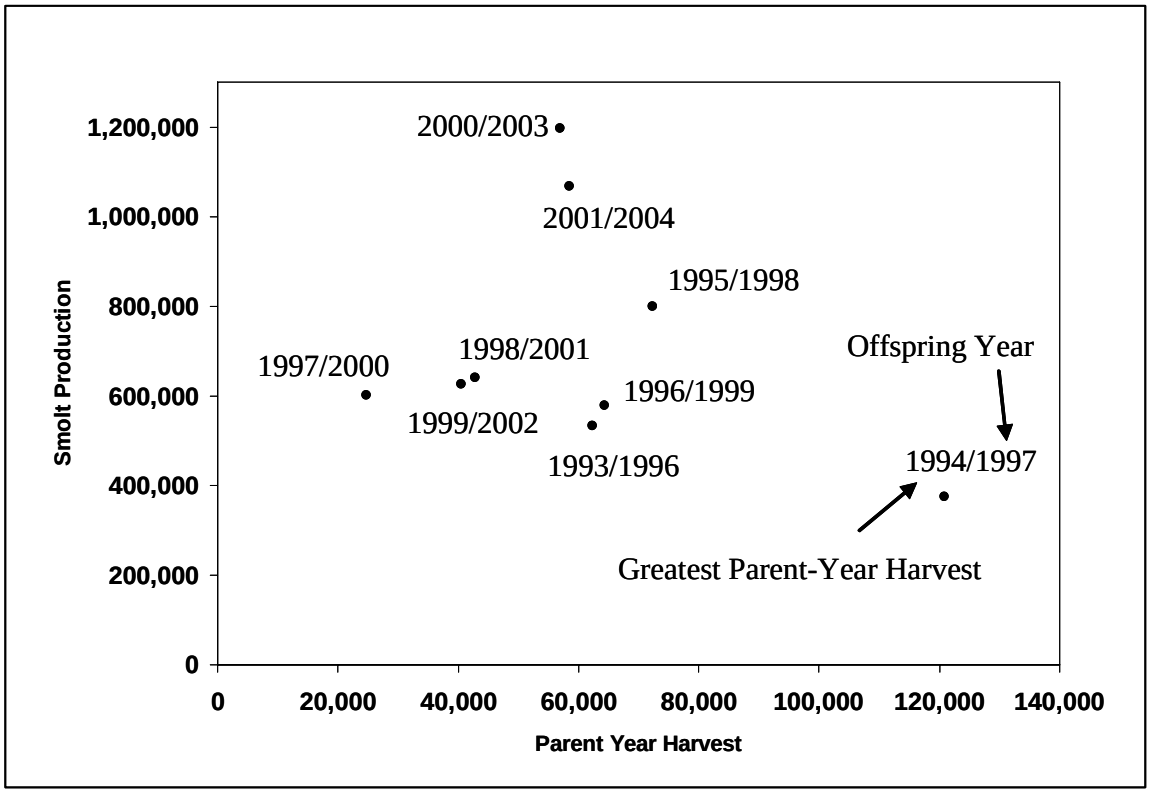

Figure 16.-Parent-year harvest and annual smolt production for Kenai River coho salmon.

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Likewise, the team of people conducting the Kenai River coho salmon fish wheel index in 2005 consisted of: Jerry Strait (crew leader), Sandee Simons, Jake Glotfelty, Stan Walker, Sean Boyer, Jennifer Nelson, Ali Eskelin, Anne Eskelin, T.D. Hacklin, and Stacie Mallette.

The commercial harvest was examined in 2005 by technicians of the Commercial Fisheries (CFD) Division. Kim Rudge-Karic supervised commercial harvest sampling, provided logistical support, and collated commercial sampling data. Personnel of the CFD Mark, Tag, and Aging Laboratory in Juneau processed all coded wire tag data collected in 2004 and 2005. All CFD personnel contributed to the successful achievement of study objectives.

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REFERENCES CITED

Bendock, T. N., and K. Vaught. 1994. Feasibility of using sonar to estimate adult coho salmon returns to the Kenai River. Alaska Department of Fish and Game, Fishery Data Series No. 94-50, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-50.pdf

Bernard, D. R., and J. E. Clark. 1996. Estimating salmon harvest based on return of coded-wire tags. Canadian Journal of Fisheries and Aquatic Sciences 53:2323-2332.

Brannian, L., and J. Fox. 1996. Upper Cook Inlet subsistence and personal use fisheries, report to the Alaska Board of Fisheries, 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development. Regional Information Report N0. 2A96-03, Anchorage.

Carlon, J. A. 1992. Feasibility of capturing and marking juvenile coho salmon for stock assessment in the Kenai River. Alaska Department of Fish and Game, Fishery Data Series No. 92-57, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-57.pdf

Carlon, J. A. 2000. Assessment of coho salmon from the Kenai River, Alaska, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 00-15, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-15.pdf

Carlon, J. A. 2003. Assessment of coho salmon from the Kenai River, Alaska, 1998. Alaska Department of Fish and Game, Fishery Data Series No. 03-06, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-06.pdf

Carlon, J. A., and R. Clark. *Unpublished*. Stock status of Kenai River coho salmon: A report to the Alaska Board of Fisheries. Wasilla, Alaska October Work Session, 1996. Available at Alaska Department of Fish and Game, Division of Sport Fish, Anchorage.

Carlon, J. A., and D. Evans. *In prep*. Abundance of adult coho salmon in the Kenai River, Alaska, 1999-2003. Alaska Department of Fish and Game, Fishery Data Series report, Anchorage.

Carlon, J. A., and J. J. Hasbrouck. 1993. Marking juvenile coho salmon in the Kenai River with coded microwire tags. Alaska Department of Fish and Game, Fishery Data Series No. 93-52, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-52.pdf

Carlon, J. A., and J. J. Hasbrouck. 1994. The contribution of Kenai River coho salmon to commercial fisheries of upper Cook Inlet, Alaska in 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-52, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-52.pdf

Carlon, J. A., and J. J. Hasbrouck. 1996. Estimated harvest of coho salmon of Kenai River origin in commercial fisheries of Upper Cook Inlet, Alaska, 1993-1994. Alaska Department of Fish and Game, Fishery Data Series No. 96-7, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-07.pdf

Carlon, J. A., and J. J. Hasbrouck. 1997. Assessment of coho salmon from the Kenai River, Alaska, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 97-7, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-07.pdf

Carlon, J. A., and J. J. Hasbrouck. 1998. Assessment of coho salmon from the Kenai River, Alaska, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 98-4, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-04.pdf

Clark, J. E., and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in Southeastern Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 261, Juneau.

Hammarstrom, S. L. 1977. Inventory and cataloging of Kenai Peninsula, and Cook Inlet drainages and fish stocks. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1976-1977, Project F-9-9, 18 (G-I-C), Juneau.

Hammarstrom, S. L. 1978. Inventory and cataloging of Kenai Peninsula, Cook Inlet and fish stocks. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1977-1978, Project F-9-10, 19 (G-I-C), Juneau.

REFERENCES CITED (Continued)

Hammarstrom, S. L. 1988. Angler effort and harvest of Chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch* by the recreational fisheries in the lower Kenai River, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 50, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-050.pdf

Hammarstrom, S. L. 1989. Angler-effort and harvest of Chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 100, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-100.pdf

Hammarstrom, S. L. 1990. Angler-effort and harvest of Chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-22, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-22.pdf

Hammarstrom, S. L. 1991. Angler effort and harvest of Chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-44.pdf

Hammarstrom, S. L. 1992. Angler effort and harvest of Chinook salmon by the recreational fisheries in the Lower Kenai River, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-25, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-25.pdf

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-32.pdf

Howe, A. L., G. Fidler, and M. J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds95-24.pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001a. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-29 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-29(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001b. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-25 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-25(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001c. Revised Edition. Participation, catch, and harvest in Alaska sport fisheries during 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-41 (revised), Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-41(revised).pdf

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001d. Participation, catch, and harvest in Alaska sport fisheries during 1999. Alaska Department of Fish and Game, Fishery Data Series No. 01-8, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-08.pdf

Jennings, G. B., K. Sundet, and A. E. Bingham. 2007. Participation, catch, and harvest in Alaska sport fisheries during 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-40.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2004. Participation, catch, and harvest in Alaska sport fisheries during 2001. Alaska Department of Fish and Game, Fishery Data Series No. 04-11, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-11.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006a. Participation, catch, and harvest in Alaska sport fisheries during 2002. Alaska Department of Fish and Game, Fishery Data Series No. 06-34, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-34.pdf

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006b. Participation, catch, and harvest in Alaska sport fisheries during 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-44.pdf

REFERENCES CITED (Continued)

King, M. A. 1993. Angler effort and harvest of coho salmon during the recreational fisheries in the lower Kenai River, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-31, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-31.pdf

Massengill, R. *In prep* a. Assessment of coho salmon from the Kenai River, Alaska, 1999. Alaska Department of Fish and Game, Fishery Data Series, Anchorage

Massengill R. *In prep* b. Assessment of coho salmon from the Kenai River, Alaska, 2004. Alaska Department of Fish and Game, Fishery Data Series report, Anchorage.

Massengill, R., and J. A. Carlon. 2004a. Assessment of coho salmon from the Kenai River, Alaska, 2000. Alaska Department of Fish and Game, Fishery Data Series No. 04-23, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-23.pdf

Massengill, R., and J. A. Carlon. 2004b. Assessment of coho salmon from the Kenai River, Alaska, 2001. Alaska Department of Fish and Game, Fishery Data Series No. 04-24, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-24.pdf

Massengill, R., and J. A. Carlon. 2007a. Assessment of coho salmon from the Kenai River, Alaska, 2002. Alaska Department of Fish and Game, Fishery Data Series No. 07-35, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-35.pdf

Massengill, R., and J. A. Carlon. 2007b. Assessment of coho salmon from the Kenai River, Alaska, 2003. Alaska Department of Fish and Game, Fishery Data Series No. 07-38, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-38.pdf

Massengill R. L., and D. Evans. *In prep*. Abundance of adult coho salmon in the Kenai River, Alaska, 2004. Alaska Department of Fish and Game, Fishery Data Series report, Anchorage.

Meyer, S. C., D. Vincent-Lang, and D. McBride. *Unpublished*. Goal statement and study plan for the development of a stock assessment program for upper Cook Inlet coho salmon stocks. November 1991. Located at: Alaska Department of Fish and Game, Division of Sport Fish, 333 Raspberry Road, Anchorage.

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1978-1979, Project F-9-11, 20 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-11(20)SW-I-A.pdf

Mills, M. J. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-12(21)SW-I-A.pdf

Mills, M. J. 1981a. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-13(22a)SW-I-A.pdf

Mills, M. J. 1981b. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-13(22b)SW-I-A.pdf

Mills, M. J. 1982. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1981-1982, Project F-9-14, 23 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-14(23)SW-I-A.pdf

Mills, M. J. 1983. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1982-1983, Project F-9-15, 24 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-15(24)SW-I-A.pdf

Mills, M. J. 1984. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1983-1984, Project F-9-16, 25 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-16(25)SW-I-A.pdf

REFERENCES CITED (Continued)

Mills, M. J. 1985. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1984-1985, Project F-9-17, 26 (SW-I-A), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-17(26)SW-I-A.pdf

Mills, M. J. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1985-1986, Project F-10-1, 27 (RT-2), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-10-1(27)RT-2.pdf

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-002.pdf

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-052.pdf

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-122.pdf

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-44.pdf

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-58.pdf

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-40.pdf

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-42.pdf

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-28.pdf

Moberly, S. A., R. Miller, K. Crandall, and S. Bates. 1977. Marking tag manual for salmon. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, Juneau.

Northwest Marine Technologies Inc. 1990. Operations manual: Mark IV tag injector and Mark IV quality control device. Northwest Marine Technologies, Inc., Shaw Island, Washington.

Peltz, L., and P. A. Hansen. 1994. Marking, enumeration, and size estimation for coho and Chinook salmon smolt releases into upper Cook Inlet, Alaska in 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-21, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-21.pdf

Reimer, A. M., and D. Sigurdsson. 2004. Upper Cook Inlet personal use salmon fisheries, 1996-2003. Alaska Department of Fish and Game, Fishery Data Series No. 04-31, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-31.pdf

Ruesch, P. H., and J. Fox. 1996. Upper Cook Inlet commercial fisheries annual management report, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 2A96-27, Anchorage.

Seber, G. A. F. 1982. On the estimation of animal abundance and related parameters, *second edition.* Griffin and Company, Ltd. London.

Shields, P. 2006. Upper Cook Inlet commercial fisheries annual management report, 2005. Alaska Department of Fish and Game, Fishery Management Report No. 06-42, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr06-42.pdf

REFERENCES CITED (Continued)

Thompson, D. A., and H. L. Blankenship. 1997. Regeneration of adipose fins given complete and incomplete clips. North American Journal of Fisheries Management 17: 467-469.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41(1):42-46.

Vincent-Lang, D. 1993. Relative survival of unmarked and fin-clipped coho salmon from Bear Lake, Alaska. The Progressive Fish-Culturist 55(3):141-148.

Vincent-Lang, D., M. Alexandersdottir, and D. McBride. 1993. Mortality of coho salmon caught and released using sport tackle in the Little Susitna River, Alaska. Fisheries Research 15:339-356

Walker, R. J., C. Olnes, K. Sundet, A. L. Howe, and A. E. Bingham. 2003. Participation, catch, and harvest in Alaska sport fisheries during 2000. Alaska Department of Fish and Game, Fishery Data Series No. 03-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-05.pdf

Yoshikawa, H., Y. Ishida, S. Ueno, and H. Mitsuda. 1988. Changes in depth of anesthesia of the carp anesthetized with a constant level of carbon dioxide. Bulletin of the Japanese Society of Scientific Fisheries 54:457-462.

APPENDIX A

Appendix A1.-Standardized fish wheel operational times used to generate adjusted 1999-2004 fish wheel catch and effort.

	Morning shift				Evening shift				
Date [a]	Start	Stop: before meal break	Restart: after meal break	Stop: end of shift	Start	Stop: before meal break	Restart: after meal break	Stop: end of shift	Daily total hours of effort
8/1-9/7	6:30:00	10:22:30	11:07:30	13:30:00	14:30:00	18:22:30	19:07:30	21:30:00	12.5
9/8-9/14	7:00:00	10:22:30	11:07:30	14:00:00	14:00:00	18:22:30	19:07:30	21:00:00	12.5
9/15-9/21	7:30:00	10:22:30	11:07:30	14:30:00	13:30:00	18:22:30	19:07:30	20:30:00	11.5
9/22-9/30	8:00:00	10:22:30	11:07:30	15:00:00	13:00:00	18:22:30	19:07:30	20:00:00	10.5

Note: The standardized fish wheel operational periods are theoretical; actual operational times can be less due to unpredictable fishing conditions.

[a] Beginning September 8, 2004, and in 2005, the fish wheels were operated between 13:30 and 14:30; prior to September 8, 2004, the fish wheels were not operated during this period.

Appendix A2.-Method used to interpolate Kenai River coho salmon catch for days the fish wheels were not operated between August 1 and September 30, 1999.

The first step (square brackets in equation 1) estimated the cumulative CPUE missed on all days the fish wheels did not operate in 1999. The second step assigned a portion of this quantity to day *j* (multiplication by p_j in equation 1):

$$CPUE_j = \left[\frac{T_{99}}{p} - T_{99} \right] p_j, \tag{1}$$

where:

T_{99} = CCPUE for 1999 (i.e., cumulative CPUE for days when wheels operated in 1999),

$$p = \sum_i \overline{p}_i, \tag{2}$$

for *i* denoting days when wheels operated in 1999

where:

$$\overline{p}_i = \frac{\sum_{y=2000}^{2004} p_{yi}}{5}, \tag{3}$$

and

$$p_{yi} = \frac{CPUE_{yi}}{\sum_{k=1}^{61} CPUE_{yk}}, \tag{4}$$

where $CPUE_{yi}$ is the CPUE for year *y* on day *i*

and

$$p_j = \frac{\overline{p}_j}{\sum_m \overline{p}_m}, \tag{5}$$

for *m* denoting days when the wheels did not operate in 1999.

Appendix A3.-Summary of actual and adjusted cumulative fish wheel effort, coho salmon catch, and catch per hour (CPUE) by bank near river kilometer 45, Kenai River, Alaska, 1999-2005.

			Temporal interval										Combined banks
			North bank fish wheel					South bank fish wheel					end-of-season
Year	Data type [a,b]		8/ 1 - 8/14	8/1 - 8/28	8/1 - 9/11	8/1 - 9/25	8/1 - 9/30	8/ 1 - 8/14	8/1 - 8/28	8/1 - 9/11	8/1 - 9/25	8/1 - 9/30	Grand total
1999 [c,d]	Actual	hours of effort	0.0	12.7	164	302.2	358.7	23.8	99.7	220.3	360.3	403.4	762.1
	Actual	total catch	0	2	60	134	148	9	126	130	165	171	319
	Actual	catch per hour		0.157	0.366	0.443	0.413	0.378	1.264	0.590	0.458	0.424	0.419
	Adjusted	hours of effort											
	Adjusted	total catch											
	Adjusted	catch per hour											0.617
	% change between actual and adjusted CPUE												47.4%
2000 [e]	Actual	hours of effort	188.6	369.2	497.4	659.7	735.8	187.2	379.1	528	708	784.8	1,520.6
	Actual	total catch	331	783	1,372	2,345	2,518	53	108	415	787	828	3,346
	Actual	catch per hour	1.755	2.121	2.758	3.555	3.422	0.283	0.285	0.786	1.112	1.055	2.200
	Adjusted	hours of effort	172.6	339.0	452.4	596.2	655.9	169.8	343.2	477.8	635.1	695.0	1,350.9
	Adjusted	total catch	320	755	1,293	2,182	2,322	46	86	345	661	700	3,022
	Adjusted	catch per hour	1.854	2.227	2.858	3.660	3.540	0.271	0.251	0.722	1.041	1.007	2.237
	% change between actual and adjusted CPUE		5.7%	5.0%	3.6%	3.0%	3.4%	-4.3%	-12.0%	-8.1%	-6.4%	-4.5%	1.7%
2001 [e]	Actual	hours of effort	186.3	397.1	603.9	809.1	880.3	188.5	395.4	597.1	784.8	855.1	1,735.4
	Actual	total catch	176	500	663	821	848	164	923	1,600	1,759	1,819	2,667
	Actual	catch per hour	0.945	1.259	1.098	1.015	0.963	0.870	2.334	2.680	2.241	2.127	1.537
	Adjusted	hours of effort	171.2	365.6	557.1	736.5	794.7	173.3	365.2	552.9	714.1	772.3	1,567.1
	Adjusted	total catch	164	449	578	685	705	153	859	1469	1571	1626	2,331
	Adjusted	catch per hour	0.958	1.228	1.037	0.930	0.887	0.883	2.352	2.657	2.200	2.105	1.488
	% change between actual and adjusted CPUE		1.4%	-2.5%	-5.5%	-8.3%	-7.9%	1.5%	0.8%	-0.8%	-1.8%	-1.0%	-3.2%
2002 [d,e]	Actual	hours of effort	131.0	254.6	352.9	501.5	567.4	141.3	264.8	371.3	527.1	594.3	1,161.7
	Actual	total catch	41	844	2,065	3,731	3,910	277	1,256	1,996	2,520	2,630	6,540
	Actual	catch per hour	0.313	3.315	5.852	7.440	6.891	1.960	4.743	5.376	4.781	4.425	5.630
	Adjusted	hours of effort	128.0	250.1	345.8	475.9	528.7	137.7	266.7	364.2	501.3	554.9	1,083.6
	Adjusted	total catch	33	826	2,027	3,520	3,679	273	1,252	1,978	2,640	2,558	6,237
	Adjusted	catch per hour	0.258	3.303	5.862	7.397	6.958	1.983	4.694	5.431	5.267	4.610	5.756
	% change between actual and adjusted CPUE		-17.6%	-0.4%	0.2%	-0.6%	1.0%	1.2%	-1.0%	1.0%	10.2%	4.2%	2.2%
2003 [e]	Actual	hours of effort	172.3	338.7	503.9	666.4	741.9	168.6	316.2	479.3	629.9	704.5	1,446.4
	Actual	total catch	37	167	239	278	288	479	1,754	2,123	2,148	2,174	2,462
	Actual	catch per hour	0.215	0.493	0.474	0.417	0.388	2.841	5.547	4.429	3.410	3.086	1.702
	Adjusted	hours of effort	166.5	329.1	488.7	624.9	684.9	165.1	312.5	471.2	599.4	659.4	1,344.3
	Adjusted	total catch	29	143	197	224	231	481	1,749	2,114	2,130	2,154	2,385
	Adjusted	catch per hour	0.174	0.435	0.403	0.358	0.337	2.913	5.598	4.487	3.553	3.266	1.774
	% change between actual and adjusted CPUE		-18.9%	-11.9%	-15.0%	-14.1%	-13.1%	2.5%	0.9%	1.3%	4.2%	5.9%	4.2%
2004 [e,f]	Actual	hours of effort	110.1	197.9	313.4	469.2	526.6	121.4	231.1	353.6	495.2	553.2	1,079.8
	Actual	total catch	252	1,241	2,247	3,663	4,100	577	3,014	4,521	5,028	5,137	9,237
	Actual	catch per hour	2.289	6.271	7.170	7.807	7.786	4.753	13.042	12.786	10.153	9.286	8.554
	Adjusted	hours of effort	108.1	195.4	309.9	465.6	522.9	121.4	230.8	352.0	493.3	551.3	1074.2
	Adjusted	total catch	238	1,223	2,223	3,639	4,076	577	2,998	4,498	5,005	5,114	9,190
	Adjusted	catch per hour	2.202	6.258	7.173	7.817	7.795	4.754	12.991	12.780	10.147	9.277	8.555
	% change between actual and adjusted CPUE		-3.8%	-0.2%	0.0%	0.1%	0.1%	0.0%	-0.4%	0.0%	-0.1%	-0.1%	0.0%
2005 [g,h]	Actual	hours of effort	161.7	322.4	489.7	642.6	695.8	168.3	338.6	510.4	673.4	726.6	1,422.4
	Actual	total catch	107	1,888	2,683	2,963	3,023	39	954	2,062	2,417	2,494	5,517
	Actual	catch per hour	0.662	5.856	5.479	4.611	4.345	0.232	2.817	4.040	3.589	3.432	3.879

-continued-

[a] "Actual" hours of effort, total catch, and catch per hour (CPUE) is generated using all data, including any collected outside the standardized fish wheel operation times that were implemented in 2004. "Adjusted" hours of effort, total catch, and catch per hour (CPUE) refers to data collected only within the new standardized daily fish wheel operation periods.

[b] Totals do not include coho salmon recaptured, escaped, or considered unsuitable for marking (i.e., injured severely or dead) with the exception of 1999 where two recaptured fish are included.

[c] The 1999 fish wheel sites varied between river kilometer 43 and 45 and were located slightly downstream of the sites used in 2000-2005.

[d] The 1999 adjusted end-of-season grand total catch per hour was calculated by including interpolated CPUE for the days when no effort occurred (8/1-8/9, 8/12-8/16, 8/27, 8/30, and 9/13). Adjusted bi-weekly effort and catch data are not available for 1999. In 2002, interpolation was required to estimate CPUE on 8/3 when no fishing effort occurred.

[e] Source of "actual" catch and effort data 1999-2003 from Carlon and Evans (*In prep*) and 2004 from Massengill and Evans (*In prep*).

[f] Although new standardized fish wheel operational times were implemented in 2004, some truncation of the data were required to "adjusted" catch and effort because some fishing occurred outside scheduled periods.

[g] After accounting for recaptures, the estimated number of fish examined is 5,117. However, 5,517 has been used in other reports and we continue to report 5,517 for consistency, with the understanding it makes no practical difference to the tagged proportion estimates, commercial harvest estimates, smolt abundance, or the inriver abundance index.

[h] The "actual" hours of effort and total catch occurred within strictly observed standardized fishing periods and truncation of the data was not needed to produce "adjusted" catch or effort.

Appendix A4.-Number of coho salmon smolt captured from the Moose River, marked with adipose finclips and coded wire tag, and released in 2004, and tag codes identified in the sample of 65 Moose River marked fish recovered from known, unmixed Upper Cook Inlet (UCI) commercial fishery strata in 2005.

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 2005 [d]
310319	05/21	05/27	11,755	99.86%	11,739	98.50%	11,563	11
310320	05/26	05/30	11,979	100.00%	11,979	98.9%	11,847	8
310321	05/29	06/03	12,189	99.75%	12,159	99.3%	12,074	10
310322	06/02	06/06	11,891	100.00%	11,891	99.3%	11,808	7
310323	06/05	06/10	11,948	100.00%	11,948	99.8%	11,924	12
310324	06/09	06/13	11,932	100.00%	11,932	99.9%	11,920	12
310325	06/12	06/18	12,041	99.88%	12,026	91.4%	10,992	5
Total			83,735	99.93%	83,674	98.2%	82,128	65

[a] 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 coded wire tag after release.

[d] Number of coded wire tags recovered from known fishery areas of UCI by commercial fishing in 2005 and decoded as Moose River coho salmon released in 2004.

Appendix A5.-Daily summary of adult coho salmon captured by two fish wheels near river kilometer 45 Kenai River, August 1–September 30, 2005.

	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
				North Bank						
08/01	1					09/01	40	4	4	4
08/02	2					09/02	39	1	1	1
08/03	4					09/03	38	7	7	7
08/04	8					09/04	26	3	3	3
08/05	1					09/05	44	3	3	3
08/06	1					09/06	44	7	7	7
08/07	2	1	1	1		09/07	22	3	3	3
08/08	2					09/08	17			
08/09	2	1	1	1		09/09	34	6	6	5
08/10	3					09/10	45	1	1	1
08/11	2					09/11	15	1	1	1
08/12	4					09/12	27	2	2	2
08/13	22					09/13	27	1	1	1
08/14	53	4	4	4		09/14	4			
08/15	121	4	4	4		09/15	24	2	2	2
08/16	95	4	4	4		09/16	21	5	5	5
08/17	101	4	4	4		09/17	24	5	5	5
08/18	99	4	4	4		09/18	12	1	1	1
08/19	50	4	4	4		09/19	13	3	3	3
08/20	68	5	5	5		09/20	13	1	1	1
08/21	63	9	9	9		09/21	27	6	6	6
08/22	97	4	4	4		09/22	10	1	1	1
08/23	161	4	4	4		09/23	27	5	5	5
08/24	151	9	9	9		09/24	26	4	4	4
08/25	167	14	14	14		09/25	25	6	6	6
08/26	217	19	19	19		09/26	10	5	5	5
08/27	215	16	16	16		09/27	13	2	2	2
08/28	176	13	13	13		09/28	15	2	2	2
08/29	176	15	15	15		09/29	13	4	4	4
08/30	173	9	9	9		09/30	9	3	3	3
08/31	82	5	5	5						
Subtotal	2,319	148	148	148			704	94	94	93
North Bank Subtotal							3,023	242	242	241

-continued-

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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
				South Bank					
08/01					09/01	92	6	6	6
08/02					09/02	96	8	8	8
08/03					09/03	95	4	4	4
08/04	1				09/04	67	6	6	6
08/05					09/05	64	6	6	6
08/06	2				09/06	58	3	3	3
08/07	3				09/07	33	3	3	3
08/08					09/08	31			
08/09	4				09/09	36	5	5	5
08/10	3				09/10	43	1	1	1
08/11	4				09/11	20	1	1	1
08/12	6	1	1	1	09/12	21	1	1	1
08/13	9				09/13	34			
08/14	7				09/14	45	2	2	2
08/15	14				09/15	40	4	4	4
08/16	26	3	3	3	09/16	32	5	5	5
08/17	31	1	1	1	09/17	18	3	3	3
08/18	29	1	1	1	09/18	16	4	4	4
08/19	36				09/19	15			
08/20	38	1	1	1	09/20	20	3	3	3
08/21	40	1	1	1	09/21	9	2	2	2
08/22	23	2	2	2	09/22	25	3	3	3
08/23	85	8	8	8	09/23	29			
08/24	73	7	7	7	09/24	29	1	1	1
08/25	147	15	15	15	09/25	22	6	6	6
08/26	129	15	15	15	09/26	14	3	3	3
08/27	106	3	3	3	09/27	15	4	4	4
08/28	138	9	9	9	09/28	26	5	5	5
08/29	141	10	10	10	09/29	12	2	2	2
08/30	209	10	10	10	09/30	10	1	1	1
08/31	123	11	11	11					
Subtotal	1,427	98	98	98		1,067	92	92	92
South bank subtotal						2,494	190	190	190
Grand total (both banks)						5,517	432	432	431

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

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

Appendix A6.-Fish wheel catch by species and bank near river kilometer 45, Kenai River, August 1–September 30, 2005.

	South bank fish wheel catch							
Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead	Unknown
08/01/05	0	355	0	0	0	0	0	0
08/02/05	0	198	0	0	0	0	0	0
08/03/05	0	204	0	0	0	0	0	0
08/04/05	1	454	0	0	1	0	0	0
08/05/05	0	222	0	0	0	0	0	0
08/06/05	2	280	0	0	1	0	0	0
08/07/05	3	631	0	1	0	1	0	0
08/08/05	4	241	0	0	0	0	0	0
08/09/05	3	144	0	0	0	0	0	0
08/10/05	4	106	0	0	0	0	0	0
08/11/05	6	131	0	0	0	0	0	0
08/12/05	9	454	0	0	0	0	0	0
08/13/05	7	709	0	0	1	1	0	0
08/14/05	14	319	1	0	0	0	0	0
08/15/05	26	343	0	0	0	0	0	0
08/16/05	31	552	0	0	0	0	0	0
08/17/05	29	358	0	0	0	1	0	0
08/18/05	36	344	2	0	2	2	0	0
08/19/05	38	173	0	1	1	0	0	0
08/20/05	40	91	2	2	0	0	0	0
08/21/05	23	149	0	0	0	1	0	0
08/22/05	85	143	0	0	1	1	0	0
08/23/05	73	177	1	0	1	0	0	0
08/24/05	147	197	3	0	2	0	0	0
08/25/05	129	192	0	0	1	0	0	0
08/26/05	106	174	1	0	3	0	0	0
08/27/05	138	218	1	0	1	0	0	0
08/28/05	141	205	0	0	0	1	0	0
08/29/05	209	240	0	0	0	0	0	0
08/30/05	123	176	0	0	0	2	0	0
08/31/05	92	60	1	0	1	0	0	0
09/01/05	96	34	0	0	2	2	0	0
09/02/05	95	43	0	0	0	1	0	0
09/03/05	67	43	1	0	3	4	0	0
09/04/05	64	27	0	0	6	2	0	0
09/05/05	58	8	0	0	2	4	0	0
09/06/05	33	9	1	0	5	1	0	0
09/07/05	31	0	0	0	1	0	0	0
09/08/05	36	4	0	0	2	0	0	0
09/09/05	43	10	0	0	7	0	0	0
09/10/05	20	5	0	0	3	0	0	0
09/11/05	21	3	0	0	0	0	0	0
09/12/05	34	1	0	0	1	0	0	0
09/13/05	45	2	0	0	4	0	0	0
09/14/05	40	0	0	0	1	0	0	0
09/15/05	32	1	0	0	0	0	0	0
09/16/05	18	2	0	0	0	1	0	0
09/17/05	16	1	0	0	0	0	0	0
09/18/05	15	3	0	0	3	0	0	0
09/19/05	20	1	0	0	1	0	0	0
09/20/05	9	1	0	0	1	0	0	0
09/21/05	25	0	0	0	0	0	0	0
09/22/05	29	0	0	0	2	0	0	0
09/23/05	29	0	0	0	1	0	0	0
09/24/05	22	0	0	0	0	0	0	0
09/25/05	14	3	0	0	2	0	0	0
09/26/05	15	1	0	0	0	0	0	0
09/27/05	26	0	0	0	1	0	0	0
09/28/05	12	0	0	0	2	0	0	0
09/29/05	10	1	0	0	1	0	0	0
09/30/05	0	0	0	0	0	0	0	0
Total	2,494	8,443	14	4	67	25	0	0

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	North bank fish wheel catch							
Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead	Unknown
08/01/05	1	1,440	0	1	1	2	0	0
08/02/05	2	938	1	2	0	2	0	0
08/03/05	4	584	1	1	0	2	0	0
08/04/05	8	1,099	0	5	0	1	0	0
08/05/05	1	1,222	0	0	1	0	0	0
08/06/05	1	1,330	0	0	0	1	0	0
08/07/05	2	2,072	0	0	0	0	0	0
08/08/05	2	1,083	0	1	1	1	0	0
08/09/05	2	1,042	0	0	0	0	0	0
08/10/05	3	503	0	0	0	0	0	0
08/11/05	2	614	0	0	1	0	0	0
08/12/05	4	1,607	0	0	0	0	0	0
08/13/05	22	5,990	0	2	1	2	0	0
08/14/05	53	5,346	1	1	1	0	0	0
08/15/05	121	6,839	0	1	0	0	0	0
08/16/05	95	4,290	0	3	2	0	1	0
08/17/05	101	3,999	0	0	0	0	0	0
08/18/05	99	2,666	0	2	0	0	0	0
08/19/05	50	722	1	0	3	0	0	0
08/20/05	68	594	0	0	0	0	0	1
08/21/05	63	932	0	0	0	0	0	0
08/22/05	97	1,124	0	0	2	0	0	0
08/23/05	161	1,129	0	0	2	1	0	0
08/24/05	151	1,175	1	0	1	0	0	0
08/25/05	167	789	0	0	3	1	0	0
08/26/05	217	1,180	0	1	4	1	0	0
08/27/05	215	1,514	0	1	4	0	0	0
08/28/05	176	1,016	0	0	1	1	0	0
08/29/05	176	1,206	0	1	1	2	0	0
08/30/05	173	720	0	0	1	0	0	0
08/31/05	82	282	1	0	0	0	0	0
09/01/05	40	75	0	0	1	0	0	0
09/02/05	39	99	0	0	5	0	0	0
09/03/05	38	153	0	0	3	2	0	0
09/04/05	26	79	1	0	4	4	0	0
09/05/05	44	25	1	0	5	2	0	0
09/06/05	44	11	0	0	7	0	0	0
09/07/05	22	3	0	0	4	0	0	0
09/08/05	17	7	0	0	3	0	0	0
09/09/05	34	7	0	0	2	0	0	0
09/10/05	45	4	0	0	6	0	0	0
09/11/05	15	2	0	0	4	0	0	0
09/12/05	27	0	0	0	2	0	0	0
09/13/05	27	1	0	0	1	0	1	0
09/14/05	4	1	0	0	1	0	0	0
09/15/05	24	4	0	0	2	0	0	0
09/16/05	21	2	0	0	1	0	0	0
09/17/05	24	0	0	0	3	0	0	0
09/18/05	12	2	0	0	1	0	0	0
09/19/05	13	0	0	0	0	0	0	0
09/20/05	13	2	0	0	1	0	0	0
09/21/05	27	1	0	0	1	0	0	0
09/22/05	10	3	0	0	1	0	0	0
09/23/05	27	0	0	0	1	0	0	0
09/24/05	26	1	0	0	1	0	0	0
09/25/05	25	0	0	0	1	0	0	0
09/26/05	10	1	0	0	1	1	0	0
09/27/05	13	0	0	0	0	0	0	0
09/28/05	15	2	0	0	1	0	0	0
09/29/05	13	1	0	0	1	0	0	0
09/30/05	9	0	0	0	0	1	0	0
Total	3,023	55,533	8	22	94	27	2	1

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	Combined bank fish wheel catch							
Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead	Unknown
08/01/05	1	1,795	0	1	1	2	0	0
08/02/05	2	1,136	1	2	0	2	0	0
08/03/05	4	788	1	1	0	2	0	0
08/04/05	9	1,553	0	5	1	1	0	0
08/05/05	1	1,444	0	0	1	0	0	0
08/06/05	3	1,610	0	0	1	1	0	0
08/07/05	5	2,703	0	1	0	1	0	0
08/08/05	6	1,324	0	1	1	1	0	0
08/09/05	5	1,186	0	0	0	0	0	0
08/10/05	7	609	0	0	0	0	0	0
08/11/05	8	745	0	0	1	0	0	0
08/12/05	13	2,061	0	0	0	0	0	0
08/13/05	29	6,699	0	2	2	3	0	0
08/14/05	67	5,665	2	1	1	0	0	0
08/15/05	147	7,182	0	1	0	0	0	0
08/16/05	126	4,842	0	3	2	0	1	0
08/17/05	130	4,357	0	0	0	1	0	0
08/18/05	135	3,010	2	2	2	2	0	0
08/19/05	88	895	1	1	4	0	0	0
08/20/05	108	685	2	2	0	0	0	1
08/21/05	86	1,081	0	0	0	1	0	0
08/22/05	182	1,267	0	0	3	1	0	0
08/23/05	234	1,306	1	0	3	1	0	0
08/24/05	298	1,372	4	0	3	0	0	0
08/25/05	296	981	0	0	4	1	0	0
08/26/05	323	1,354	1	1	7	1	0	0
08/27/05	353	1,732	1	1	5	0	0	0
08/28/05	317	1,221	0	0	1	2	0	0
08/29/05	385	1,446	0	1	1	2	0	0
08/30/05	296	896	0	0	1	2	0	0
08/31/05	174	342	2	0	1	0	0	0
09/01/05	136	109	0	0	3	2	0	0
09/02/05	134	142	0	0	5	1	0	0
09/03/05	105	196	1	0	6	6	0	0
09/04/05	90	106	1	0	10	6	0	0
09/05/05	102	33	1	0	7	6	0	0
09/06/05	77	20	1	0	12	1	0	0
09/07/05	53	3	0	0	5	0	0	0
09/08/05	53	11	0	0	5	0	0	0
09/09/05	77	17	0	0	9	0	0	0
09/10/05	65	9	0	0	9	0	0	0
09/11/05	36	5	0	0	4	0	0	0
09/12/05	61	1	0	0	3	0	0	0
09/13/05	72	3	0	0	5	0	1	0
09/14/05	44	1	0	0	2	0	0	0
09/15/05	56	5	0	0	2	0	0	0
09/16/05	39	4	0	0	1	1	0	0
09/17/05	40	1	0	0	3	0	0	0
09/18/05	27	5	0	0	4	0	0	0
09/19/05	33	1	0	0	1	0	0	0
09/20/05	22	3	0	0	2	0	0	0
09/21/05	52	1	0	0	1	0	0	0
09/22/05	39	3	0	0	3	0	0	0
09/23/05	56	0	0	0	2	0	0	0
09/24/05	48	1	0	0	1	0	0	0
09/25/05	39	3	0	0	3	0	0	0
09/26/05	25	2	0	0	1	1	0	0
09/27/05	39	0	0	0	1	0	0	0
09/28/05	27	2	0	0	3	0	0	0
09/29/05	23	2	0	0	2	0	0	0
09/30/05	9	0	0	0	0	1	0	0
Total	5,517	63,976	22	26	161	52	2	1

Note: Accounting for recaptures, the estimated number of fish examined is 5,117. However, 5,517 has been used previously and we continue to report 5,517 for consistency, understanding it makes no practical difference to estimates of the tagged proportion, commercial harvest estimates, smolt abundance or to the inriver abundance index.

Appendix A7.-Coho salmon examined, coded wire tags recovered, and recovery of marked Kenai River coho salmon in commercial harvest samples from mixed Cook Inlet statistical areas in 2005.

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 2004
		Mixed Central District Statistical Areas[a]					
Eastside Set							
7/27/2005	Mixed(ESS)-24421/22	2	0	0	0	0	
8/8/2005	Mixed(ESS)-24421/22	41	1	1	1	1	1
8/9/2005	Mixed(ESS)-24421/22	32	2	2	2	2	2
7/28/2005	Mixed(ESS)-24422/31	64	1	1	0	0	
Total		139	4	4	3	3	3
Central District Drift and Eastside Set, Westside Set or Kalgin Island Set							
7/18/2005	Mixed(CDD/ESS)-244CDD-24441	165	0	0	0	0	
8/1/2005	Mixed(CDD/WSS)-24530/50/80	292	2	2	0	0	
7/22/2005	Mixed(CDD/WSS/KIS)-244CDD-24530-24610/20	641	5	5	5	5	
Total		1,098	7	7	5	5	
Westside Set and Kalgin Island Set							
7/14/2005	Mixed(WSS/KIS)-24530-24610/20	240	1	1	0	0	
7/21/2005	Mixed(WSS/KIS)-24530-24610/20	196	1	1	0	0	
7/25/2005	Mixed(WSS/KIS)-24530-24610/20	1,534	8	8	6	6	
7/28/2005	Mixed(WSS/KIS)-24530-24610/20	21	0	0	0	0	
8/1/2005	Mixed(WSS/KIS)-24530-24610/20	2,114	7	7	4	4	
8/4/2005	Mixed(WSS/KIS)-24530-24610/20	1,339	6	6	3	3	
8/8/2005	Mixed(WSS/KIS)-24530-24610/20	4	0	0	0	0	
8/11/2005	Mixed(WSS/KIS)-24530-24610/20	863	0	0	0	0	
Total		6,311	23	23	13	13	
Mixed Central District Total		7,548	34	34	21	21	3

[a] These data were excluded from the analyses and estimates of harvest contribution because the statistical areas were unknown.

[b] No samples from mixed Northern District statistical areas were taken.

Appendix A8.-Upper Cook Inlet commercial and test fishery coho salmon harvest in 2005, 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 2004.

Date (2004)[a]	(H) Total harvest	(n_i) Number examined[b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Commercial Harvest									
Central District									
Drift Gillnet									
Central									
06/20 - 06/30	128	1	0	0	0	0		0	0
07/04 - 07/07	1,311	202	0	0	0	0		0	0
07/09 - 07/12	1,816	130	0	0	0	0		0	0
07/13 - 07/15	2,095	478	0	0	0	0		0	0
07/16 - 07/19	6,120	789	7	7	3	3		0	0
07/20 - 07/21	15,261	3,591	15	15	9	9		0	0
07/22 - 07/23	2,201	226	2	2	1	1		0	0
07/24 - 07/25	17,251	3,731	19	19	14	14		0	0
07/26	1,587	47	2	2	2	2		0	0
07/27	4,750	543	9	9	8	8		0	0
07/28	39,827	7,012	50	50	42	42	1	73	5,256
07/29 - 07/30	13,074	1,119	11	11	9	9	2	299	44,498
07/31 - 08/01	11,571	2,213	25	25	22	22	1	67	4,422
08/02	139	33	0	0	0	0		0	0
08/03	953	109	1	1	1	1		0	0
08/04	8,613	1,961	9	9	8	8	1	56	3,080
08/05 - 08/06	1,054	34	1	1	1	1	2	794	315,102
08/07 - 08/08	5,487	2,129	20	19	19	19		0	0
08/09	450	178	3	3	2	2	5	162	5,132
08/10	102	32	1	1	1	1	2	82	3,287
08/11	3,951	742	2	2	2	2		0	0
08/15	3,160	653	3	3	1	1		0	0
08/18 - 09/05	3,841	130	2	2	1	1		0	0
Total	144,742	26,083	182	181	146	146	14	1,533	380,778

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Date (2004)[a]	(H) Total harvest	(n_i) Number examined[b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Eastside Set Gillnet									
Statistical Area 24421									
06/29 - 07/11	9	1	0	0	0	0		0	0
07/12 - 07/15	199	1	0	0	0	0		0	0
07/16 - 07/19	34	3	0	0	0	0		0	0
07/20	2	1	0	0	0	0		0	0
07/21 - 07/23	13	1	0	0	0	0		0	0
07/24 - 07/25	18	1	0	0	0	0		0	0
07/26 - 07/27	74	9	0	0	0	0		0	0
7/28 - 07/30	492	96	0	0	0	0		0	0
07/31 - 08/01	455	68	1	1	1	1	1	86	7,310
08/03	89	29	1	1	1	1	1	39	1,482
08/04 - 08/06	148	36	3	3	3	3	3	158	8,199
08/07 - 08/09	292	2	0	0	0	0		0	0
08/10	139	17	0	0	0	0		0	0
Total	1,964	265	5	5	5	5	5	283	16,991
Statistical Area 24422									
06/22 - 07/15	25	1	0	0	0	0		0	0
07/16 - 07/18	6	3	0	0	0	0		0	0
07/19 - 07/21	16	2	0	0	0	0		0	0
07/23 - 07/25	32	8	0	0	0	0		0	0
07/26 - 07/27	98	12	0	0	0	0		0	0
07/28 - 07/30	1,545	438	1	1	1	1		0	0
07/31 - 08/01	636	193	1	1	1	1		0	0
08/03	142	35	1	1	1	1		0	0
08/04 - 08/06	165	17	1	1	1	1	1	124	15,253
08/07 - 08/08	413	41	2	2	2	2	1	129	16,512
08/09	187	43	2	2	2	2	2	111	6,063
08/10	114	9	0	0	0	0	2	0	0
Total	3,379	802	8	8	8	8	6	364	37,828

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Date (2004)[a]	(H) Total harvest	(n_i) Number examined[b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Statistical Area 24431/32									
07/06 - 07/18	52	1	0	0	0	0		0	0
07/19 - 07/25	40	5	0	0	0	0		0	0
07/26 - 07/27	73	14	0	0	0	0		0	0
07/28 - 07/30	523	103	1	1	0	0		[e]	NA
07/31 - 08/01	294	19	0	0	0	0		0	0
08/03	57	7	0	0	0	0		0	0
08/04 - 08/06	177	9	0	0	0	0		0	0
08/07 - 08/08	564	20	0	0	0	0		0	0
08/09	242	9	1	1	1	1	1	344	117,993
08/10	330	33	3	3	2	2	2	256	32,583
Total	2,352	220	5	5	3	3	3	600	150,576
Statistical Area 24441/42									
07/11	23	9	0	0	0	0		0	0
07/12 - 07/13	69	4	0	0	0	0		0	0
07/14 - 07/16	269	8	0	0	0	0		0	0
07/18	662	82	0	0	0	0		0	0
07/19	88	39	0	0	0	0		0	0
07/20	152	32	0	0	0	0		0	0
07/21 - 07/23	602	142	0	0	0	0		0	0
07/24 - 07/25	562	68	0	0	0	0		0	0
07/26	227	22	0	0	0	0		0	0
07/27	244	12	0	0	0	0		0	0
07/28 - 07/30	2,368	375	5	5	2	2	1	81	6,480
07/31 - 08/01	1,968	199	1	1	1	1	1	127	16,002
08/03	246	76	1	1	1	1	1	41	1,641
08/04 - 08/06	893	102	4	4	4	4	3	336	37,459
08/07 - 08/08	1,723	99	3	3	3	3	3	668	148,714
08/09	594	100	4	4	4	4	4	304	22,950
08/10	1,100	278	10	10	10	10	10	506	25,594
Total	11,790	1,647	28	28	25	25	23	2,063	258,839

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Date (2004)[a]	(H) Total harvest	(n_i) Number examined [b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Eastside Set Gillnet Total	19,485	2,934	46	46	41	41	37	3,310	464,234
Statistical Area 24425 [f]									
07/08 - 07/30	69	0	0	0	0	0	0	0	0
Kalgin Island Set Area 24610/20									
08/15 - 09/13	1,778	181	2	2	1	1	0	0	0
6/27 - 08/11	19,265	327	4	4	4	4	1	754	567,764
Total	21,043	508	6	6	5	5	1	754	567,764
West Side Set Areas 24520/30/40/50/55/60									
06/27 - 07/12	93	3	0	0	0	0		0	0
07/14 - 07/17	287	45	1	1	1	1		0	0
07/18 - 07/28	1,952	134	0	0	0	0		0	0
07/29 - 08/05	2,394	418	0	0	0	0		0	0
08/08	819	727	4	4	0	0		[e]	NA
08/11 - 08/25	2,914	676	1	1	0	0		[e]	NA
									0
Total	8,459	2,003	6	6	1	1	0	0	0

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Date (2004)[a]	(H) Total harvest	(n_i) Number examined[b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Central District East Side Set Net and Drift Gillnet Fishery Total	164,227	29,017	228	227	187	187	51	4,843	845,012
Entire Central District Total	193,798	31,528	240	239	193	193	52	5,597	1,412,776
Northern District									
East Side Set Areas 24770/80/90									
07/04 - 07/07	7	5	0	0	0	0		0	0
07/11	9	1	0	0	0	0		0	0
07/14	32	21	0	0	0	0		0	0
07/18	373	148	1	1	1	1		0	0
08/08	629	49	1	1	1	1		0	0
08/11	332	198	1	1	1	1		0	0
08/15	2,446	1,119	5	5	4	4	1	28	756
08/18	828	487	5	5	4	4		0	0
08/22	677	659	0	0	0	0		0	0
08/25	1,131	1,214	4	4	4	4		0	0
08/29	984	969	4	4	4	4	4	52	628
09/01	1,435	1,182	5	5	2	2	4	62	905
09/05	566	651	2	2	1	1	2	22	224
09/08	830	895	1	1	1	1	1	12	133
09/12 - 09/15	491	213	0	0	0	0	1	0	0
Total	10,770	7,811	29	29	23	23	13	176	2,646

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Date (2004)[a]	(H) Total harvest	(n_i) Number examined [b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Fire Island Set Area 247/43									
07/11 - 08/29	4,028	0	0	0	0	0	0		0
Pt. MacKenzie/Su Flats Set Area 24741/42									
06/27 - 09/05	7,729	0	0	0	0	0	0		0
West Side Set Area 24710/20/30									
06/27 - 08/18	8,332	245	0	0	0	0	0	0	0
Northern District Total	30,859	8,056	29	29	23	23	13	176	2,646
Northern District Total and Central District Drift/East Side Set Total [g]	195,086	37,073	257	256	210	210	64	5,019	847,659
Commercial Harvest Grand Total	224,657	39,584	269	268	216	216	65	5,773	1,415,422

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Date (2004)[a]	(H) Total harvest	(n_i) Number examined[b]	(a_i) Adipose finclips observed	(a'_i) Heads recovered	(t_i) Heads with tags[c]	(t'_i) Decodable tags[d]	(mi) Source= Moose R 2004	(r_i) Harvest estimate	$V(r_i)$ Variance
Test Fishery									
Central District									
Drift Gillnet Test Fishery[h]									
07/02 - 07/30	553								
Test Fishery total	553	0	0	0	0	0	0	0	0
Commercial and Test Fishery total	225,210	39,584	269	268	216	216	65	5,773	1,415,422

Note: The Central District set gillnet fisheries of Kalgin Island and the West Side were not sampled or were sampled incidentally, but are included here to add perspective to information from sampled fisheries.

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

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

[c] Denotes heads with coded wire tags magnetically detected.

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

[e] Adipose fin was missing, but coded wire tag was lost, not readable, or was missing.

[f] Denotes an Alaska Department of Fish and Game drift gillnet fishery located within the mouth of the Kasilof River and opened by emergency order only. Harvest estimate is biased due to mixing of fish from other statistical areas.

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

[h] Denotes an Alaska Department of Fish and Game offshore drift gillnet test fishery occurring in statistical areas 24590 and 24470.

Appendix A9.-Coho salmon catch, hours of effort, and catch per hour for two fish wheels operated near river kilometer 45, Kenai River, Alaska, August 1–September 30, 2005.

	Fish wheel coho salmon catch, hours of effort, and catch per hour by river bank									
	North bank			South bank			Combined banks			Cumulative
Date	Catch[a]	Hours	Catch/hour	Catch[a]	Hours	Catch/hour	Catch[a]	Hours	Catch/hour	Catch/hour
08/01/05	1	9.6			9.9	0.00	1	19.5	0.05	0.05
08/02/05	2	11.9	0.17		12.3	0.00	2	24.2	0.08	0.13
08/03/05	4	11.5	0.35		12.2	0.00	4	23.6	0.17	0.30
08/04/05	8	11.5	0.69	1	12.1	0.08	9	23.7	0.38	0.68
08/05/05	1	12.3	0.08		12.0	0.00	1	24.2	0.04	0.73
08/06/05	1	11.8	0.08	2	12.2	0.16	3	24.0	0.13	0.85
08/07/05	2	10.1	0.20	3	11.3	0.27	5	21.4	0.23	1.08
08/08/05	2	12.2	0.16		12.7	0.00	2	25.0	0.08	1.16
08/09/05	2	12.2	0.16	4	12.2	0.33	6	24.4	0.25	1.41
08/10/05	3	12.5	0.24	3	12.8	0.23	6	25.3	0.24	1.65
08/11/05	2	12.6	0.16	4	12.5	0.32	6	25.1	0.24	1.89
08/12/05	4	10.9	0.37	6	12.4	0.48	10	23.3	0.43	2.32
08/13/05	22	10.5	2.09	9	11.5	0.78	31	22.0	1.41	3.73
08/14/05	53	12.2	4.36	7	12.3	0.57	60	24.5	2.45	6.18
Subtotal	107	161.7	9.12	39	168.3	3.23	146	330.0	6.18	
08/15/05	121	11.9	10.15	14	12.0	1.17	135	23.9	5.65	11.83
08/16/05	95	10.3	9.25	26	12.2	2.13	121	22.5	5.39	17.21
08/17/05	101	11.3	8.98	31	11.9	2.62	132	23.1	5.71	22.93
08/18/05	99	11.0	9.04	29	11.9	2.44	128	22.8	5.61	28.54
08/19/05	50	12.0	4.16	36	12.4	2.91	86	24.4	3.53	32.07
08/20/05	68	11.5	5.90	38	12.0	3.16	106	23.6	4.50	36.57
08/21/05	63	11.5	5.49	40	12.5	3.20	103	24.0	4.29	40.86
08/22/05	97	11.4	8.50	23	12.3	1.87	120	23.7	5.06	45.92
08/23/05	161	11.2	14.38	85	11.6	7.31	246	22.8	10.77	56.69
08/24/05	151	11.6	13.02	73	12.4	5.89	224	24.0	9.33	66.03
08/25/05	167	12.0	13.97	147	12.4	11.87	314	24.3	12.90	78.93
08/26/05	217	12.3	17.67	129	12.4	10.42	346	24.7	14.03	92.96
08/27/05	215	12.3	17.46	106	12.3	8.62	321	24.6	13.04	106.00
08/28/05	176	10.6	16.66	138	12.1	11.42	314	22.7	13.86	119.86
Subtotal	1,888	322	164	954	339	78	2,842	661	120	

-continued-

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	Fish wheel coho salmon catch, hours of effort, and catch per hour by river bank									
	North bank			South bank			Combined banks			Cumulative
Date	Catch[a]	Hours	Catch/hour	Catch[a]	Hours	Catch/hour	Catch[a]	Hours	Catch/hour	Catch/hour
08/29/05	176	11.9	14.83	141	11.7	12.03	317	23.6	13.44	133.30
08/30/05	173	11.9	14.52	209	11.2	18.61	382	23.2	16.50	149.80
08/31/05	82	11.5	7.14	123	12.1	10.18	205	23.6	8.70	158.50
09/01/05	40	9.1	4.41	92	12.2	7.57	132	21.2	6.22	164.73
09/02/05	39	12.5	3.13	96	11.8	8.17	135	24.2	5.58	170.30
09/03/05	38	12.1	3.14	95	12.2	7.81	133	24.3	5.48	175.78
09/04/05	26	12.6	2.06	67	12.6	5.31	93	25.2	3.69	179.47
09/05/05	44	12.8	3.45	64	12.5	5.13	108	25.3	4.28	183.75
09/06/05	44	12.0	3.68	58	12.7	4.57	102	24.7	4.14	187.88
09/07/05	22	12.4	1.77	33	12.5	2.63	55	25.0	2.20	190.09
09/08/05	17	12.7	1.34	31	12.6	2.46	48	25.3	1.90	191.99
09/09/05	34	12.9	2.65	36	12.7	2.83	70	25.6	2.74	194.72
09/10/05	45	12.2	3.69	43	12.8	3.36	88	25.0	3.52	198.25
09/11/05	15	11.0	1.37	20	12.3	1.63	35	23.2	1.51	199.75
Subtotal	2,683	490	231	2,062	510	171	4,745	1,000	200	
09/12/05	27	12.7	2.13	21	12.7	1.66	48	25.3	1.89	201.65
09/13/05	27	12.9	2.10	34	12.8	2.66	61	25.7	2.38	204.02
09/14/05	4	3.5	1.15	45	12.0	3.77	49	15.4	3.17	207.20
09/15/05	24	11.6	2.07	40	11.9	3.37	64	23.5	2.73	209.92
09/16/05	21	11.1	1.89	32	11.6	2.77	53	22.7	2.34	212.26
09/17/05	24	12.0	2.01	18	11.8	1.52	42	23.8	1.77	214.03
09/18/05	12	11.9	1.01	16	12.1	1.33	28	23.9	1.17	215.20
09/19/05	13	11.7	1.11	15	11.6	1.29	28	23.3	1.20	216.40
09/20/05	13	11.6	1.12	20	11.7	1.70	33	23.4	1.41	217.81
09/21/05	27	11.6	2.33	9	11.7	0.77	36	23.3	1.54	219.36
09/22/05	10	10.1	0.99	25	10.2	2.45	35	20.3	1.72	221.08
09/23/05	27	10.8	2.51	29	11.1	2.62	56	21.8	2.56	223.65
09/24/05	26	10.8	2.41	29	11.0	2.65	55	21.8	2.53	226.18
09/25/05	25	10.8	2.32	22	11.0	2.01	47	21.8	2.16	228.34
Subtotal	2,963	643	256	2,417	673	201	5,380	1,316.0	228	
09/26/05	10	10.6	0.94	14	10.5	1.33	24	21.1	1.14	229.47
09/27/05	13	10.9	1.20	15	10.7	1.41	28	21.5	1.30	230.78
09/28/05	15	10.7	1.40	26	10.9	2.39	41	21.6	1.90	232.67
09/29/05	13	11.0	1.19	12	11.1	1.08	25	22.1	1.13	233.81
09/30/05	9	10.1	0.90	10	10.0	1.00	19	20.1	0.95	234.75
Subtotal	3,023	696	262	2,494	726.6	208	5,517	1,422.4	235	

[a] Repeated from Appendix A3 and Table 3 for convenience.

Appendix A10.-Daily fish wheel spin rate, and water conditions by river bank near river kilometer 45, Kenai River, Alaska, August 1–September 30, 2005.

	Fish wheel spin rate (rpm)		Water transparency (m)		River gauge	River
	North	South	North	South	height[a]	discharge[a]
Date	bank	bank	bank	bank	(ft)	(cfs)
08/01	3.6	4.8	1.2		9.5	14,000
08/02	3.4	4.5	1.3		9.47	13,900
08/03	3.5	4.8	1.2		9.46	13,800
08/04	3.4	4.7	1.2		9.43	13,700
08/05	3.3	5.0	1.3		9.39	13,500
08/06	3.3	4.9	1.4		9.34	13,300
08/07	3.2	4.5	1.4		9.32	13,200
08/08	3.6	4.7	1.4		9.33	13,200
08/09	3.2	4.7	1.4		9.31	13,200
08/10	3.3	4.8	1.1		9.3	13,100
08/11	3.3	4.8	1.3	1.0	9.32	13,200
08/12	3.1	4.6	1.3		9.32	13,200
08/13	2.8	4.8	1.2		9.29	13,100
08/14	3.1	4.7	1.1		9.29	13,100
08/15	3.0	4.4		1.1	9.27	13,000
Subaverage	3.3	4.7	1.3	1.0	9.36	13,367
08/16	3.1	4.9	1.2		9.26	13,000
08/17	2.9	4.6	1.4	0.9	9.29	13,100
08/18	3.3	4.5	0.8	0.9	9.29	13,100
08/19	3.1	4.6	1.1	1.1	9.2	12,700
08/20	3.0	4.5	1.1	1.3	9.15	12,400
08/21	3.2	4.5	1.3	0.9	9.15	12,500
08/22	3.2	4.5	0.9		9.12	12,300
08/23	3.4	4.0	0.6	0.5	9.18	12,600
08/24	3.4	4.5	0.4	0.5	9.14	12,400
08/25	3.7	4.4	0.6	0.5	9.09	12,200
08/26	3.4	4.4	0.7	0.8	9.06	12,000
08/27	3.4	4.6	0.7	0.8	9.03	11,900
08/28	3.1	4.2	0.7	0.8	9	11,800
08/29	3.1	4.2	0.8	0.8	8.97	11,700
08/30	2.9	3.8	0.9	0.9	8.85	11,200
08/31	2.6	3.5	0.8	0.8	8.74	10,800
Subaverage	3.1	4.3	0.9	0.8	9.10	12,231
09/01	3.1	3.4	0.8	0.7	8.64	10,300
09/02	4.1	3.3		0.8	8.56	10,000
09/03	3.9	3.0	0.9	1.0	8.52	9,860
09/04	4.0	3.0	0.8		8.55	9,960
09/05	3.8	3.0	0.6	0.8	8.54	9,930
09/06	3.4	3.0	0.5	1.0	8.57	10,000
09/07	3.3	3.6	0.7	0.7	8.57	10,100
09/08	3.9	4.0	0.7		8.56	10,000
09/09	4.0	4.2		0.6	8.65	10,400
09/10	4.1	3.4	0.5		8.8	11,000
09/11	3.9	3.7		0.6	8.86	11,200
09/12	3.8	4.0		0.6	8.92	11,500
09/13	3.3	3.9	0.6	0.6	8.91	11,400
09/14	4.0	3.8	0.6		8.86	11,200
09/15	3.8	3.8	0.6		8.83	11,100
Subaverage	3.7	3.5	0.7	0.7	8.69	10,530
09/16	3.8	3.7		0.7	8.88	11,300
09/17	3.8	3.9	0.7		8.91	11,400
09/18	3.8	3.9		0.8	8.86	11,200
09/19	3.9	3.9		0.7	8.81	11,000
09/20	3.8	3.8	0.8	0.8	8.73	10,600
09/21	3.4	3.5		0.8	8.67	10,400
09/22	4.0	3.8	0.9		8.67	10,400
09/23	3.9	3.3	0.9		8.67	10,400
09/24	3.4	3.6	0.8		8.65	10,300
09/25	3.2	3.5	0.9	0.9	8.6	10,100
09/26	3.5	3.8	0.8		8.55	9,830
09/27	3.4	3.6		0.8	8.55	9,820
09/28	3.8	3.4	0.7	0.7	8.56	9,820
09/29	3.8	3.2	0.9		8.47	9,480
09/30	3.7	3.1	0.9	0.9	8.41	9,240
Subaverage	3.7	3.6	0.8	0.8	8.67	10,353
Grand average	3.5	4.0	0.9	0.8	8.95	11,630

[a] As measured at the Kenai River bridge at Soldotna (U.S. Geological Survey River Gauging Station Site 15266300).

Appendix A11.-Average bi-weekly fish wheel spin rate, and water conditions by river bank near river kilometer 45, Kenai River, Alaska, August 1–September 30, 1999-2005.

		Fish wheel spin rate (rpm)		Water transparency (m)		River gauge	River
Year	Period	North bank	South bank	North bank	South bank	height[b] (ft)	discharge[b] (cfs)
1999[a]	8/1 to 8/15	n/a	3.69	0.72	0.72	9.72	14,573
	8/16 to 8/31	5.13	2.58	0.99	0.99	9.39	13,019
	9/1 to 9/15	4.62	3.16	1.03	1.03	8.88	10,763
	9/16 to 9/30	5.47	4.38	0.88	0.88	9.49	13,480
	Entire season	5.03	3.44	0.91	0.91	9.37	12,960
2000	8/1 to 8/15	5.24	4.18	1.18	1.45	9.57	13,767
	8/16 to 8/31	4.08	3.52	1.15	1.14	8.68	10,161
	9/1 to 9/15	3.48	4.55	0.83	0.81	7.80	7,215
	9/16 to 9/30	3.03	4.39	0.68	0.65	7.28	5,444
	Entire season	3.96	4.15	0.90	0.89	8.34	9,163
2001	8/1 to 8/15	2.61	3.42	1.53	2.43	10.07	16,273
	8/16 to 8/31	3.06	3.28	0.90	1.00	10.11	16,469
	9/1 to 9/15	3.00	3.82	0.86	0.88	10.12	16,573
	9/16 to 9/30	2.93	3.83	0.90	0.89	9.67	14,327
	Entire season	2.90	3.58	0.94	1.03	10.00	15,920
2002	8/1 to 8/15	3.09	3.79	1.45	1.55	9.57	13,757
	8/16 to 8/31	3.63	3.12	1.41	1.47	9.16	11,894
	9/1 to 9/15	3.21	4.04	1.27	1.15	8.76	10,225
	9/16 to 9/30	3.42	4.81	0.88	0.91	8.76	10,489
	Entire season	3.36	3.93	1.22	1.22	9.06	11,560
2003	8/1 to 8/15	3.22	4.17	0.66	0.68	9.44	12,813
	8/16 to 8/31	3.64	4.36	0.71	0.71	9.76	14,188
	9/1 to 9/15	3.35	3.43	0.94	0.94	9.00	10,821
	9/16 to 9/30	3.04	3.76	1.14	1.14	7.44	5,397
	Entire season	3.32	3.94	0.91	0.90	8.92	10,860
2004	8/1 to 8/15	3.49	3.84	1.04	1.00	9.76	14,907
	8/16 to 8/31	3.11	3.62	1.01	1.03	9.39	13,206
	9/1 to 9/15	3.23	3.09	0.94	0.96	8.54	9,712
	9/16 to 9/30	2.91	3.11	0.81	0.81	7.36	5,709
	Entire season	3.18	3.40	0.95	0.94	8.77	10,922
2005	8/1 to 8/15	3.27	4.70	1.26	1.04	9.36	13,367
	8/16 to 8/31	3.14	4.34	0.87	0.81	9.10	12,231
	9/1 to 9/15	3.75	3.52	0.66	0.73	8.69	10,530
	9/16 to 9/30	3.67	3.59	0.82	0.78	8.67	10,353
	Entire season	3.45	4.04	0.92	0.79	8.95	11,630

[a] Water transparency recorded at river kilometer 31, fish wheel spin rate at river kilometer 43 to 45.

[b] Measured at the Kenai River bridge in Soldotna (U.S. Geological Survey River Gauging Station Site 15266300).

Appendix A12.-Summary of cumulative fish wheel catch per unit effort (CCPUE), and the natural log-transformed CCPUE (LnCCPUE) of coho salmon using "adjusted' data, Kenai River, Alaska, near river kilometer 45, 1999-2005.

		Location and temporal interval													
		North bank fish wheel					South bank fish wheel					Combined banks fish wheel			
Year		8/ 1 - 8/14	8/1 - 8/28	8/1 - 9/11	8/1 - 9/25	8/1 - 9/30	8/ 1 - 8/14	8/1 - 8/28	8/1 - 9/11	8/1 - 9/25	8/1 - 9/30	8/ 1 - 8/14	8/1 - 8/28	8/1 - 9/11	8/1 - 9/25
1999 [a,b]	CCPUE											4.46	25.86	30.34	36.19
	LnCCPUE											1.50	3.25	3.41	3.59
2000	CCPUE	26.24	63.66	128.16	215.27	227.03	3.37	6.43	36.92	65.11	68.37	14.79	34.86	79.87	135.90
	LnCCPUE	3.27	4.15	4.85	5.37	5.43	1.21	1.86	3.61	4.18	4.22	2.69	3.55	4.38	4.91
2001	CCPUE	12.31	32.85	42.16	50.48	52.18	11.32	62.83	108.77	117.43	122.05	11.84	47.78	75.13	83.87
	LnCCPUE	2.51	3.49	3.74	3.92	3.95	2.43	4.14	4.69	4.77	4.80	2.47	3.87	4.32	4.43
2002	CCPUE	2.88	116.58	312.42	491.23	507.18	24.34	152.43	270.33	322.00	331.14	13.52	133.71	287.93	399.00
	LnCCPUE	1.06	4.76	5.74	6.20	6.23	3.19	5.03	5.60	5.77	5.80	2.60	4.90	5.66	5.99
2003	CCPUE	2.27	11.83	16.78	19.62	20.21	39.62	163.57	195.95	197.37	199.37	20.54	83.17	101.36	103.47
	LnCCPUE	0.82	2.47	2.82	2.98	3.01	3.68	5.10	5.28	5.29	5.30	3.02	4.42	4.62	4.64
2004	CCPUE	37.43	197.83	323.18	451.03	489.15	73.89	390.20	566.06	615.12	624.47	58.17	305.68	459.94	550.89
	LnCCPUE	3.62	5.29	5.78	6.11	6.19	4.30	5.97	6.34	6.42	6.44	4.06	5.72	6.13	6.31
2005	CCPUE	9.12	163.75	230.93	256.07	261.69	3.23	78.25	170.54	201.10	208.30	6.18	119.86	199.75	228.34
	LnCCPUE	2.21	5.10	5.44	5.55	5.57	1.17	4.36	5.14	5.30	5.34	1.82	4.79	5.30	5.43

Notes: Summary of 1999-2004 CPUE includes only standardized daily fish wheel operation periods implemented in 2004.

1999-2004 summary does not include coho salmon recaptured, escaped, or considered unsuitable for marking (i.e., severely injured or dead).

Fish wheel locations in 1999 were at river kilometer 31, and between river kilometer 43 and 45.

CPUE consists of the daily catch divided by the daily hours of fish wheel effort and CCPUE is the cumulative daily CCPUE for a given period.

[a] An explanation of how CCPUE was calculated for days not fished can be found in the Data Analysis section under "2005 Adult Inriver Index" heading.

[b] "Adjusted" daily catch and effort are available only for combined banks.