Fishery Data Series No. 13-06

Assessment of Coho Salmon from the Kenai River, Alaska, 2007

by

Robert Massengill

March 2013

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)

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

FISHERY DATA SERIES NO. 13-06

ASSESSMENT OF COHO SALMON FROM THE KENAI RIVER, ALASKA, 2007

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ABSTRACT

Wild coho salmon (*Onchorhynchus kisutch*) smolt were captured at the Moose River within the Kenai River drainage in spring 2006, marked with an adipose finclip, and injected with a coded wire tag (CWT); 81,953 live adipose-clipped smolt were subsequently released. Some of these fish were recovered as adults from fish wheel sampling conducted within the Kenai River in 2007. Of 1,075 adult coho salmon sampled from the Kenai River fish wheels, 135 were missing an adipose fin. Based on the number of adults examined and the number of these adults missing adipose fins, an estimated 648,400 (SE 51,735) smolt emigrated from the Kenai River in 2006. A fish wheel–based index was used periodically inseason and once postseason to predict the end-of-season abundance of adult coho salmon passing river kilometer 45 of the Kenai River in 2007. The index used log-transformed cumulative catch-per-unit-of-effort (lnCCPUE) for coho salmon and was plotted into a regression of historic lnCCPUE and associated mark–recapture abundance estimates. The predictions classified abundance into one of three ordinal categories (low, medium, or high). The final 2007 adult coho salmon end-of-season abundance prediction was "low" and was based on the log-transformed cumulative fish wheel catch per unit of effort (lnCCPUE) value of 3.85 taken over the period 1 August through 30 September 2007.

Key words: coho salmon, *Oncorhynchus kisutch*, population assessment, fish wheel, weir, adult abundance, index, coded wire tag, Kenai River, smolt abundance, wild salmon, mark–recapture experiment

INTRODUCTION

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 annually in mixed-stock commercial and sport marine fisheries. Sport and personal use harvests also occur in fresh water. From 1996 to 2006, Cook Inlet ranked second in average sport harvest of coho salmon, sixth in commercial harvest, and third in overall harvest among all regions of the state (Figure 2) (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995-1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, 2009a-b).

The Alaska Department of Fish and Game (ADF&G) initiated a program to assess the status of UCI coho salmon stocks in 1991.[1] 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 components (A + B + C) provides the desired estimate of annual adult production. The sum of the two harvest components (A + B) divided by the estimated production provides an estimate of exploitation rate. Smolt abundance estimates were originally produced ancillary to commercial harvest estimates but have become integral to the current assessment program.

Commercial harvest estimates (A) were generated annually from 1993 through 2005 by means of a coded wire tag release and recovery program (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004a-b, 2007a-b; Massengill 2007a-b). Inriver sport and personal use fishery harvests (B) were estimated annually by angler surveys (Hammarstrom 1977, 1978, 1988-1992; Schwager-King 1993; Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995-1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004; Reimer and Sigurdsson 2004; Jennings et al. 2006a-b, 2007, 2009a-b). Mark–recapture studies were used to estimate inriver adult abundance from 1999 through 2004 (Carlon and Evans, 2007). Attempts to estimate abundance using sonar have been unsuccessful (Bendock and Vaught 1994).

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[1] 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.

The Kenai River assessment program revealed an overall decline in coho salmon smolt abundance between 1992 and 1995.[2] 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 BOF responded by adopting the *Kenai River Coho Salmon Conservation Management Plan* (Alaska Fish and Game Laws and Regulations Annotated, 2000–2001; Alaska Administrative Code 5 AAC 21.357 [repealed]). This plan modified the 1997 version and included additional restrictions to both commercial and sport fisheries.

Kenai River coho salmon assessments since 2000 have indicated that exploitation rates have remained sustainable, and adult returns have increased since the late 1990s. In 2005, BOF repealed the *Kenai River Coho Salmon Conservation Management Plan,* thus liberalizing opportunity for both the commercial and sport fisheries. The current management plan is the *Kenai River Coho Salmon Management Plan* (Alaska Fish and Game Laws and Regulations Annotated, 2007–2008; 5 AAC 57.170).

Beginning in 2005, inriver adult assessment changed from estimating abundance via mark–recapture methodology to indexing of abundance into one of three ordinal levels (low, medium, or high) using fish wheel catches. The index provides managers with an inseason tool to classify general abundance that is less costly than mark–recapture abundance estimates.

OBJECTIVES

This study had three primary objectives:

1. Estimate the number of coho salmon smolt that emigrated from the Kenai River drainage in 2006.
2. Census the coho salmon smolt emigration from the Moose River from 15 May through 30 June 2006.
3. Index the 2007 inriver abundance of adult coho salmon into one of three ordinal levels.

TASKS

1. Collect scales and fork lengths (FL) from smolt in the 2006 emigration and from adults returning inriver in 2007.
2. Estimate the tagged fraction of the 2007 inriver adults captured in fish wheels that were tagged as smolt in the Moose River in 2006.

[2] 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.

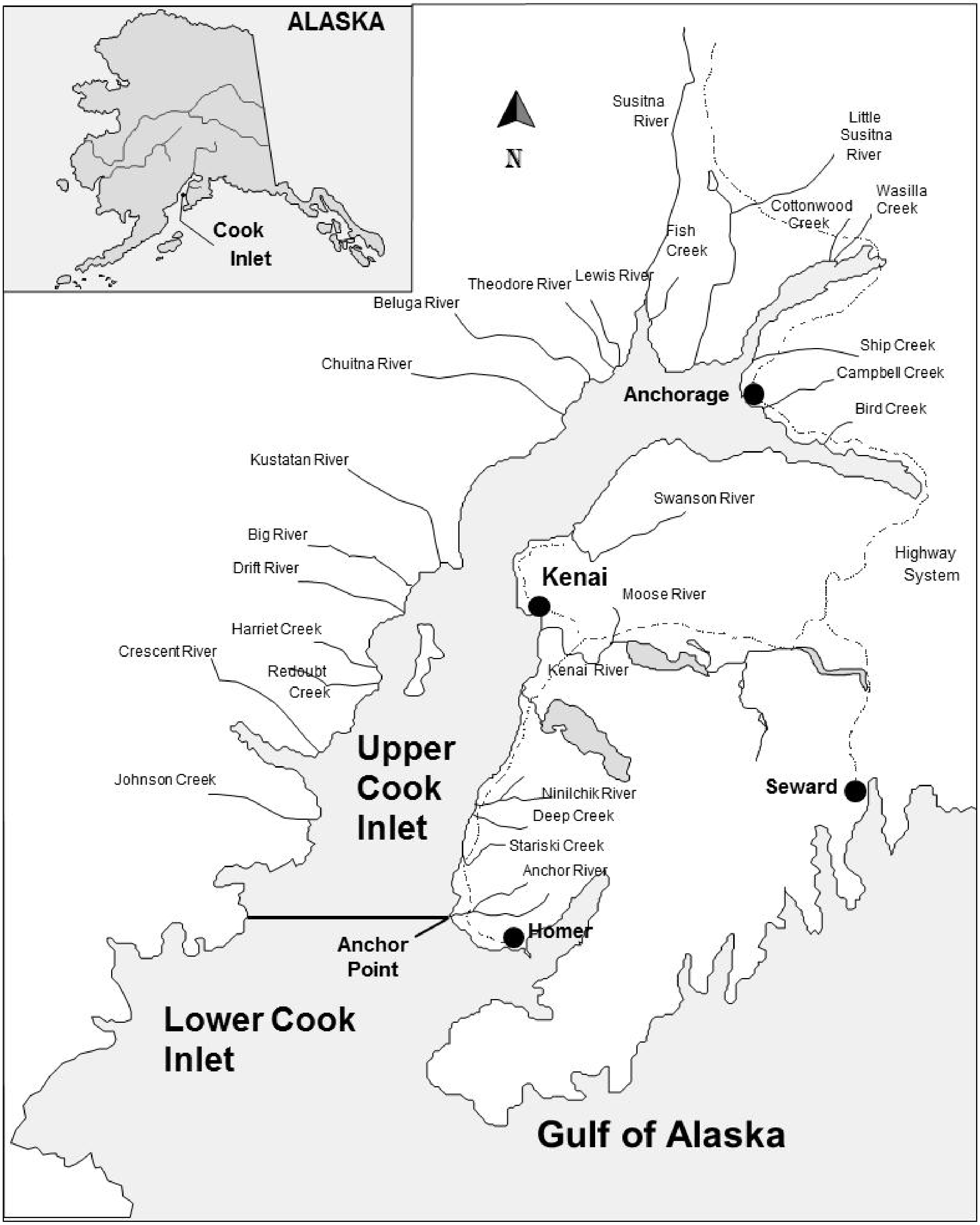

Figure 1.–Cook Inlet Basin with tributaries known to support coho salmon.

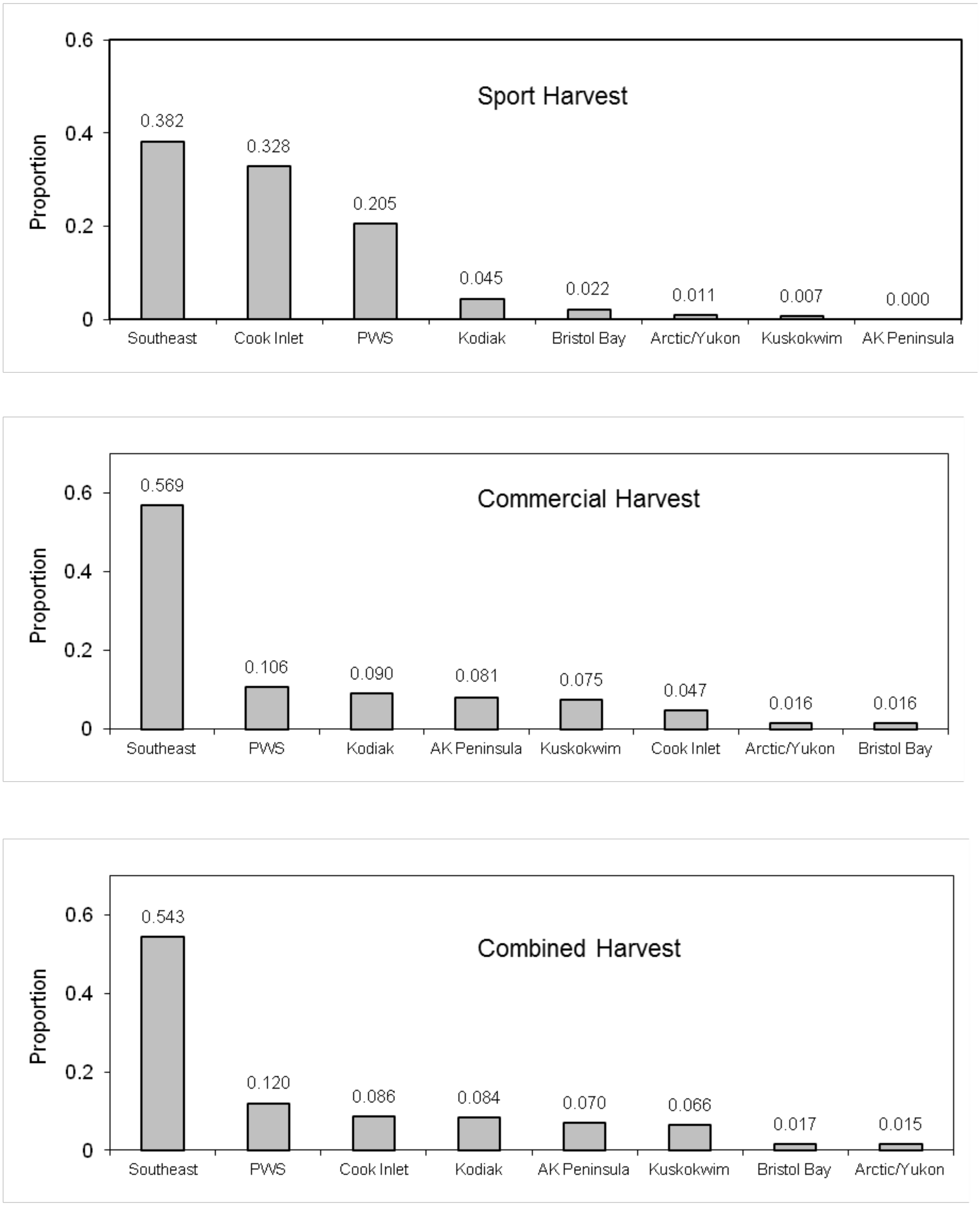

Figure 2.–Average proportions by region of the statewide sport (top), commercial (middle), and combined (bottom) harvests of coho salmon, 1996–2006.

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995-1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, 2009a-b.

METHODS

2006 SMOLT ABUNDANCE AND CENSUS

A weir was used to trap and census coho salmon smolt as they emigrated from the Moose River (a tributary of the Kenai River) from late May to mid-June 2006. Smolt abundance was estimated with a two-event mark–recapture experiment. In the first event, a subsample of smolt were marked with an adipose finclip and a coded wire tag (CWT). In the second event, adults were recaptured and examined for a missing adipose fin.

Smolt Marking

In 2006, coho salmon smolt were captured and marked at a weir located on the Moose River 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, based on inriver sport harvest recoveries of marked adults, only smolt marked at the Moose River were recovered in sufficient numbers to estimate a marked proportion. The Moose River also provided a single location where an adequate number of smolt could be captured for marking purposes. Finally, the Moose River was the only location that provided fish representative of Kenai River stocks with respect to run timing (Carlon and Hasbrouck 1994).

A weir with a trap was installed in the mainstem of the Moose River on 22 May 2006 to capture smolt as they emigrated downstream from wintering habitats. An attempt to install the weir earlier (17 May) failed due to high water conditions. The weir was a complete barrier to fish migration until 22 June 2006. Smolt were marked with both CWTs and adipose finclips beginning 23 May and ending 17 June 2006. The primary mark was removal of the adipose fin but a secondary mark, use of a CWT implant, was used to avoid confounding other studies elsewhere that might also recover adipose finclipped fish.

Although coho salmon at younger life stages were present in the Moose River, an effort was made to identify, capture, and tag only smolt. Coho salmon at younger life stages can be identified by size (shorter than 100 mm FL) and appearance (parr marks highly visible and substantially less silver skin pigmentation). The identity of smolt can be confirmed because most Kenai River coho salmon smolt after two years in fresh water and exhibit two scale annuli (Hammarstrom 1988-1992); most scale samples from fish shorter than 100 mm exhibit only one annulus. Further evidence that smolt were correctly identified is that most (greater than 99.9%) CWTs recovered from adults returning to spawn from 1993 through 2005 were implanted in fish emigrating from the Moose River the previous year (Carlon and Hasbrouck 1998; Carlon 2000, 2003; 2004a-b; Massengill and Carlon 2007a-b; Massengill 2007a-c). The recovery of an adult tagged at the Moose River two years prior has never been documented.

In the past, we have observed temporal variation in the marked proportion of the inriver adult run. Although there is evidence that the run timing of marked adults is independent of the marking date, we have changed our marking strategy so that tagging is now more evenly distributed throughout the emigration, instead of primarily tagging during the first half of the emigration. This strategy reduces any biases in the tagging schedule that might influence observed temporal changes in the marked fraction of adults. The 2006 tagging goal was to tag 3,500 smolt per day for three weeks (75,000 total).

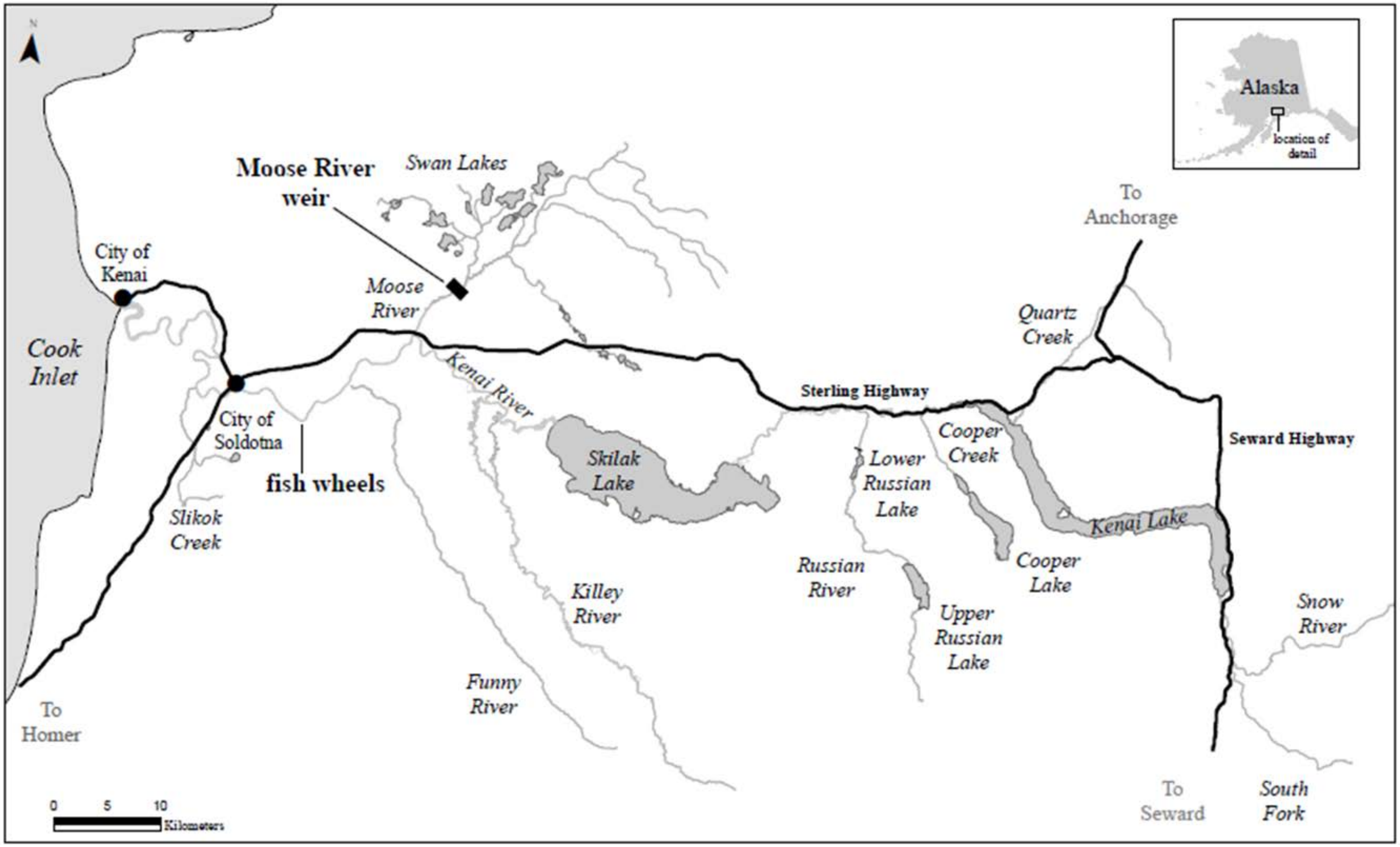

Figure 3.–The Kenai River drainage showing the Moose River weir site where marked coho salmon smolt were released in 2006, and the Kenai River fish wheels location in 2007.

Smolt captured in the weir were partially immobilized by sedation with Trican Methanesulfate (MS-222) to a level-2 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 then re-sedated to a level-3 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[3] fitted with the optimal head mold. Head molds were chosen for proper and precise tag placement in fish of each length group (Northwest Marine Technologies Inc. 1990; Peltz and Hansen 1994). Fish 100–125 mm FL were tagged using a 30-per-pound head mold; those greater than 125 mm and less than or equal to 150 mm were tagged with a 20-per-pound head mold. Smolt greater than 150 mm were rarely captured and were released untagged because of the additional time required to sedate them. Because these larger smolt were rarely captured, there was likely no significant 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 2006 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.

2006 Smolt Age and Length Sampling

Smolt scales were collected and archived in 2006. While current procedures used to determine ages from smolt scales are imperfect, radical changes in age class compositions are believed to be detectable. Although this approach is qualitative, it may provide important perspective when assessing population status. Archived scales will allow accurate scale reading in the event such techniques are developed.

Because of the uncertainty in scale estimates, it was not possible to place objective criteria on estimates of age-class composition, so scale collection was designated a task and not an objective of this study. Sample size calculations (Thompson 1987) were, however, used to guide the number of scales collected. Assuming an illegibility rate of 15% and perfect identification of scale ages, 150 scales were needed such that the estimates by age group were within 10 percentage points of their true values with 95% confidence.

To minimize age and length bias during sampling, samples were collected throughout the coho salmon smolt emigration by systematically sampling 50 smolt midway through each increment

[3] Product names used in this publication are included for completeness but do not constitute product endorsement.

of 10,000 smolt passing the weir. This strategy provided a larger sample size (approximately 1,200 samples) than needed.

RECOVERY OF MARKED ADULTS IN THE 2007 RUN

Adult coho salmon were captured and examined for missing adipose fins using two fish wheels operated in the mainstem of the Kenai River (Figure 3). Each fish wheel (one operated adjacent to each riverbank) was operated daily during most daylight hours from 1 August through 30 September, 2007 to minimize seasonal sampling bias. Telemetry data indicates that nearly 90% of coho salmon migrate upriver during daylight hours (Carlon and Evans 2007). From 1 August through 14 September, each fish wheel was operated 12.5 hours per day. Fish wheel operation was reduced one hour each week beginning 15 September to avoid boating at night.

To minimize handling stress and increase crew safety, a two-person crew was used to process coho salmon. To minimize confinement-induced stress on coho salmon, other species were quickly removed from the fish wheel livebox. All coho salmon were inspected in a dip net to check for an adipose fin and a caudal fin 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 fish received a caudal fin punch to avoid duplicate sampling. Additionally, every tenth fish was sampled for age (scales) and length (FL). 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 detectable tag was sacrificed to determine the rate of false-negative wand results. This sample was used to adjust the CWT-tagged fraction estimate. The false-positive rate was assumed to be zero. Daily fish wheel catches for all species, by bank, were recorded in 2007.

All tag recovery data were submitted electronically and archived by the Alaska Department of Fish and Game Mark, Tag and Age Laboratory. The raw data are accessible at http://mtalab.adfg.alaska.gov/CWT/Reports/noncomsurvey.asp.

2007 ADULT INRIVER INDEX

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 near RKM 45 from 1 August through 30 September 2007. Fish wheel effort and coho salmon catch provided a daily cumulative catch per unit of effort (CCPUE). The log-transformed CCPUE for 2007 was used inseason to predict an end-of-season abundance classification. The end-of-season log-transformed CCPUE was also used to predict the end-of-season abundance classification. The abundance classifications were determined using a fitted regression of historic (1999–2004) inriver abundance estimates on log-transformed CCPUE (lnCCPUE). Since 2005, the fishwheel index has served as a gross indicator of inriver run strength although no management objectives are tied to it.

Coho salmon CPUEs were calculated from the catch and effort data from two fish wheels described above. To maintain similar operational 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 stops for crew meal breaks and shift changes occurred only during set times, as first implemented in 2004 (Appendix A1) (Massengill and Evans 2007). The historic (1999–2004) fish wheel effort and catch data used in the regression of abundance on log cumulative CPUE were truncated to include only CPUE data collected during standardized daylight-only operational times.

DATA ANALYSIS

Smolt Abundance in 2006

The following steps were used to estimate smolt abundance: 1) estimate the number of smolt marked in 2006 that survived the marking process, 2) record the number of adult coho salmon sampled in the fish wheels in the inriver run of 2007, and 3) record how many of those adults were adipose finclipped.

To determine the number of smolt marked with an adipose finclip and released alive in 2006 (*M*), short-term survival rates were estimated. Representative samples (approximately 800–1000 smolt per batch of approximately 11,000 smolt, or about 200 per day), were detained in holding pens for 18 to 24 hours after marking. The short-term survival rate for smolt marked and released from each marking batch was estimated as the fraction of marked smolt that survived detainment. *M* was estimated by summing the individual estimates of the number of marked fish that survived the marking process:

$$\hat{M} = \sum_{k} m'_k \hat{s}_k , \qquad (1)$$

where s_k is the number of smolt marked from each marking batch k, and $\left(m'_k\right)$ is the fraction of marked smolt that survived detainment.

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

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1 , \qquad (2)$$

where

M = the number of smolt marked in 2006 with an adipose finclip that survived to emigrate,

C = the number of adult coho salmon examined for an adipose finclip in the 2007 return sample, and

R = the number of adult coho salmon in the 2007 sample that had an adipose finclip.

The variance of the smolt abundance estimate was estimated as follows:

$$\text{var}(\hat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} . \qquad (3)$$

In equations 2 and 3, $\hat{M}$ from equation 1 was used in place of M; the estimate was very precise, with a 95% relative precision of 0.4%.

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

1) Adult coho salmon examined for finclips were a random sample of the 2007 inriver run, or marked smolt were representative of the drainage-wide smolt emigration in 2006, or there was complete mixing of individuals between the mark and recapture events.
2) All juveniles marked at the Moose River in 2006 were actually smolt and that they returned to the Kenai River the following year.
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 the adipose fin at any time during the life of the examined salmon.
6) Fish were correctly categorized for the presence or absence of an adipose fin when examined at the fish wheels.
7) Inriver adult coho salmon missing an adipose fin originated from the Moose River in 2006.

Independence between the timing of smolt tagging and adult run timing has been observed in both inriver and commercial recoveries (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000). The independence observed indicates that marked and unmarked fish mixed at least temporally after tagging. Recoveries of marked adults from all major Kenai River tributaries have occurred during genetic sampling efforts for the U.S. Fish and Wildlife Service, supporting the idea that emigrating smolt from the Moose River contain representatives from the entire Kenai River population. While independence between release and return timing and the presence of smolt from other Kenai River drainages in the Moose River do not guarantee complete mixing of fish between tagging and recapture or representative tagging of the entire Kenai River smolt population, they are consistent with the latter two conditions of assumption 1. Also, the inriver fish wheel samples are assumed to mimic random samples because both banks were fished with similar effort throughout the season. Therefore, it is likely that at least one of the three conditions of assumption 1 was fulfilled.

The other six assumptions were also likely valid. Experience and observations indicate that most juveniles marked at the Moose River each year are smolt, and only two Moose River tags have been recovered in the same year they were released (Carlon and Hasbrouck 1998; Carlon 2000, 2003) (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 and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004a-b, 2007a-b; Massengill 2007a-c; Massengill 2008). Hatchery-produced coho salmon marked with adipose finclips and CWTs and released in an eastern Kenai Peninsula drainage experienced similar smolt-to-adult survival as unmarked coho salmon (Vincent-Lang 1993) (assumption 3). 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 about 1,500,000 Kenai River drainage coho salmon juveniles handled since 1991, only a few have been found missing the adipose fin naturally. Also, the short-term and long-term tag retention rates have been nearly identical (Carlon and Hasbrouck 1994, 1996-1998; Carlon 2000, 2003; Massengill and Carlon 2004a-b, 2007a-b; Massengill 2007a-c; Massengill 2008). This observation supports the supposition that naturally missing adipose fins are rare in coho salmon of the Kenai River drainage. 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 (assumption 7).

2007 Adult Inriver Index

Adult coho salmon were captured with two fish wheels near RKM 45 in the Kenai River from 1 August to 30 September 2007 (61 days) as they migrated upstream to spawn. The cumulative catch per unit of effort (CCPUE) at the fish wheels was calculated as follows:

$$CCPUE = \sum_{i=1}^{S} CPUE_i = \sum_{i=1}^{S} \frac{c_i}{h_i}, \qquad (4)$$

where

c_i = the catch of coho salmon on day *i*,

h_i = the hours of fish wheel operation on day *i*, and

S = the number of days in the prediction period; there were 4 such prediction periods: 4 weeks (S = 28; 1–28 August), 6 weeks (S = 42; 1 August–11 September), 8 weeks (S = 56; 1 August–25 September), and the post-season period (S = 61; 1 August–30 September).

CCPUE was used to make three inseason predictions of end-of-season abundance classification and one postseason classification of abundance. For each of the periods listed above, a weighted regression of historic lnCCPUE on abundance estimates was fitted (weighted regression fits are provided in Table 1). The 2007 lnCCPUE for each inseason period and for the end-of-season period was then used with the appropriate fitted regression from Table 1 to classify the end-of-season abundance into 1 of 3 ordinal 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 less than 50,000; medium = abundance greater than 50,000 and less than 120,000; high = abundance greater than 120,000.

Table 1.–Fit of weighted regression of estimated abundance on lnCCPUE by temporal interval.

Period	Equation[a]	R^2	*P*-value (H_o:Slope = 0)
1–28 Aug	$\hat{N} = -90{,}722 + 39{,}456\ ln(CCPUE)$	0.70	0.038
1 Aug–11 Sep	$\hat{N} = -105{,}248 + 39{,}574\ ln(CCPUE)$	0.87	0.007
1 Aug–25 Sep	$\hat{N} = -114{,}169 + 39{,}475\ ln(CCPUE)$	0.91	0.003
1 Aug–30 Sep	$\hat{N} = -115{,}531 + 39{,}410\ ln(CCPUE)$	0.91	0.003

[a] $\hat{N}$ is the 2007 predicted abundance of adult coho salmon arriving at river kilometer 45 of the Kenai River.

The regression models were developed using data collected from 1 August through 30 September from all adult abundance study years (1999–2004). 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 1 August and 30 September 1999. The interpolated CPUE for day *j* in 1999 was calculated as described in Appendix B1. A summary containing both the actual and adjusted fish wheel data for 1999–2004 is found in Appendix C1.

Model Details

Heterogeneity in the variance of abundance estimates could theoretically cause a problem with the accuracy of regressing abundance estimates on lnCCPUE. In fact, variability increased markedly for estimates that were partially stratified. This problem was addressed by using a weighted regression, with weights proportional to the inverse of the variance of the abundance estimates. However, the 2000–2002 abundance estimates were not within the 90% confidence interval (Figure 4) because abundance estimates with higher variability receive less weight in the fitting process.

Measurement error in the CCPUE observations, or our inability to duplicate CCPUE results exactly in a given year, could also cause problems. Nothing was done to mitigate the measurement error in the CCPUE. It was assumed that the effect of this error was small, given the comprehensive schedule of fish wheel operations each year, and that measurement error was 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.

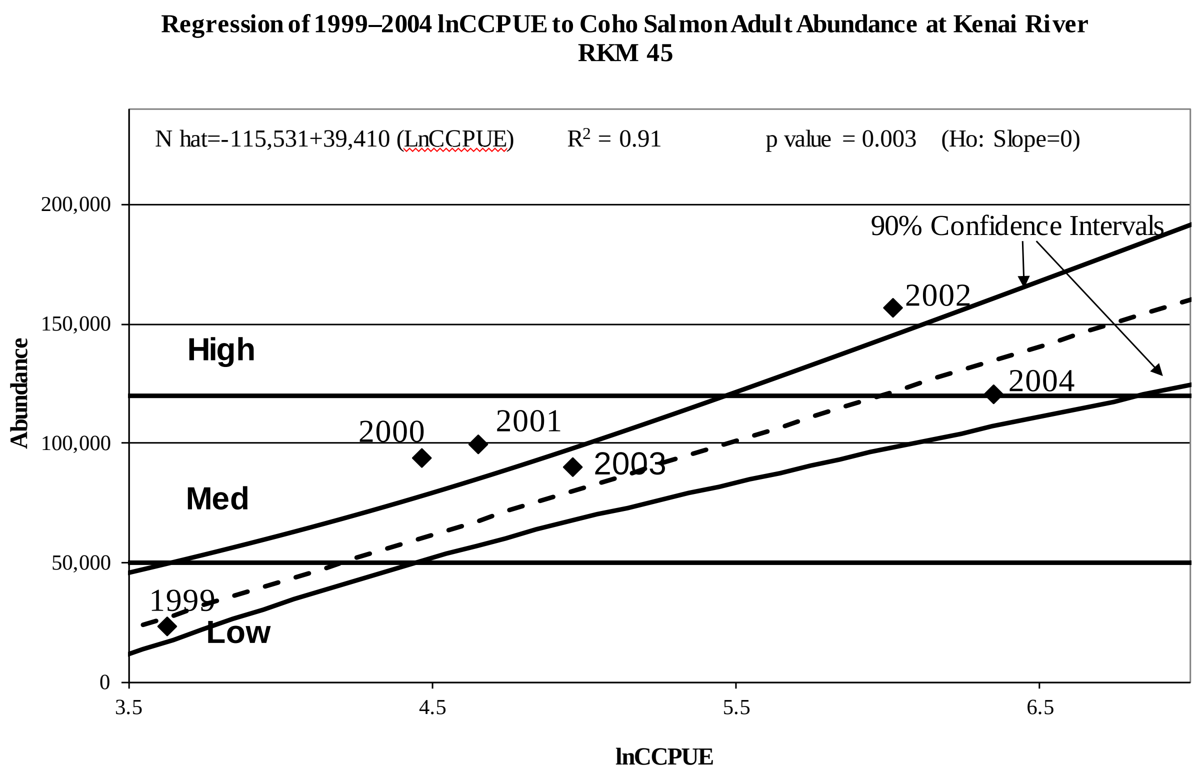

Figure 4.–Regression of 1999–2004 annual log-transformed fish wheel CCPUE of adult coho salmon at RKM 45 Kenai River to abundance estimates.

RESULTS

SMOLT MARKING AND CENSUS IN 2006

Smolt were marked (and released) with both CWTs and adipose finclips as they emigrated from the Moose River from 23 May through 17 June 2006; the last release of marked smolt occurred on 18 June 2006 after the last fish that were held for determining the overnight tag retention rate were released. Seven different tag codes (batches) were released; the estimated number of surviving marked fish per batch ranged from 11,521 to 12,041 (Table 2).

Table 2.–Moose River weir coho salmon smolt passage and marking data, 2006.

Date range	Tag codes	Smolt marked	Surviving marked smolt[a]
19–27 May	310342	11,749	11,749
28–31 May	310343	11,521	11,521
31 May–4 June	310344	11,898	11,880
4–7 June	310345	11,544	11,535
7–10 June	310346	11,587	11,579
10–14 June	310347	12,059	12,041
14–17 June	310348	11,648	11,648
Total		82,006	81,953

Note: The “mark” was removal of an adipose fin; a coded wire tag was also implanted into marked smolt to avoid confounding other studies that might recover adipose finclipped coho salmon.

[a] “Surviving marked smolt” is an estimate of the number of the live marked smolt released and it is adjusted based on the short term survival of a sample of smolt marked with an adipose finclip and a specific coded-wire-tag code.

An estimated total of 81,953 (>99%) of the 82,006 marked smolt survived the marking process and were released. The primary mark was removal of an adipose fin but a coded wire tag was used as a secondary mark to avoid confounding other studies that might recover adipose finclipped fish. A daily subsample of tagged coho salmon smolt were held overnight to estimate short-term tag loss and mortality. Of the 6,370 coho salmon smolt held overnight, 6,288 retained their tags (95%) which yielded an estimated 80,964 fish that had short-term retention of their coded-wire tag. Although marking was discontinued after the goal was achieved on 17 June 2006, the weir remained in place until 23 June to census the smolt emigration. A total of 196,567 coho salmon smolt arrived at the weir between 17 May and 23 June 2006. Of these smolt, 195,718 (>99%) passed through alive. A very small number of the total smolt counted passed the weir during the period 17–23 May; during that time, the weir was only a partial barrier to fish passage due to breaches caused by high water. The actual passage during this period was therefore unknown but likely very low. Scale and length samples from 1,250 smolt were collected as planned, and archived.

INRIVER RECOVERY OF MARKED ADULTS IN 2007

Adult coho salmon marked as smolt at the Moose River in 2006 were sampled from 1 August through 30 September 2007 using fish wheels in the Kenai River near RKM 45. Of the 1,075 coho salmon captured in fish wheels, 135 had missing adipose fins (Table 3, Appendix D1).

Significant bycatch included 3,506 sockeye salmon (*Oncorhynchus nerka*) (Appendix D4). Of the 1,075 coho salmon sampled, 650 were captured in the north bank fish wheel and 425 were captured in the south bank fish wheel (Appendices D2–D4).

Table 3.–Recoveries and marked proportion estimates of coho salmon from the Kenai River drainage, 1 August–30 September 2007.

Fish wheel	Weekly period	Number examined	Marked Fish observed	Marked fraction
North bank				
	1–7 Aug	3	0	0.000
	8–14 Aug	32	3	0.094
	15–21 Aug	93	8	0.086
	22–28 Aug	68	10	0.147
	29 Aug–4 Sep	49	3	0.061
	5–11 Sep	151	25	0.166
	12–18 Sep	140	18	0.129
	19–25 Sep	87	13	0.149
	26–30 Sep	27	1	0.037
	Total	650	81	0.12
South bank				
	1–7 Aug	2	0	0.000
	8–14 Aug	25	1	0.040
	15–21 Aug	82	9	0.110
	22–28 Aug	73	9	0.123
	29 Aug–4 Sep	79	12	0.152
	5–11 Sep	74	9	0.122
	12–18 Sep	65	13	0.200
	19–25 Sep	24	1	0.042
	26–30 Sep	1	0	0.000
	Total	425	54	0.127
Combined				
	1–7 Aug	5	0	0.000
	8–14 Aug	57	4	0.070
	15–21 Aug	175	17	0.097
	22–28 Aug	141	19	0.135
	29 Aug–4 Sep	128	15	0.117
	5–11 Sep	225	34	0.151
	12–18 Sep	205	31	0.151
	19–25 Sep	111	14	0.126
	26–30 Sep	28	1	0.036
	Total	1,075	135	0.126

SMOLT ESTIMATE IN 2006

An estimated 648,400 (SE 51,735) smolt emigrated from the Kenai River in 2006. This is 11% below the 1992–2005 average of 729,267 smolt and is 26% below the 2001–2005 average of 874,508 smolt (Table 4 and Figure 5).

Table 4.–Kenai River coho salmon smolt abundance estimates, including sample sizes, 1999-2006.

Smolt marking year	Number of marked fish released	Adult sampling year	Inriver adult sample size	Marked adults observed[a]	Estimated smolt abundance	Standard error	95% Confidence limits	
							Lower	Upper
1992	73,580	1993	4,626	477	879,290	42,607	795,780	962,800
1993	99,525	1994	5,395	644	977,964	39,407	900,726	1,055,203
1994	170,058	1995	4,838	1,355	628,909	14,788	599,924	657,893
1995	94,535	1996	3,687	765	465,075	15,091	435,496	494,654
1996	98,032	1997	604	110	534,323	45,597	444,953	623,693
1997	96,486	1998	3,552	915	374,255	10,597	353,485	395,024
1998	101,133	1999	2,476	313	797,798	41,940	715,596	880,000
1999	114,885	2000	3,387	672	578,355	19,884	539,383	617,328
2000	103,319	2001	2,670	458	601,236	25,454	551,346	651,126
2001	147,931	2002	6,523	1,503	641,693	14,436	613,400	669,987
2002	108,520	2003	2,475	428	626,335	27,409	572,613	680,057
2003	120,305	2004	9,217	926	1,196,310	37,100	1,123,594	1,269,027
2004	83,674	2005	5,517	432	1,066,324	49,009	970,267	1,162,381
2005	79,932	2006	6,034	572	841,876	33,309	776,590	907,163
2006	81,953	2007	1,075	135	648,400	51,735	547,000	749,799

[a] The mark of interest beginning in 1997 has been a missing adipose fin. Prior to 1997, detection of a coded-wire tag that was implanted the prior year provided the mark of interest.

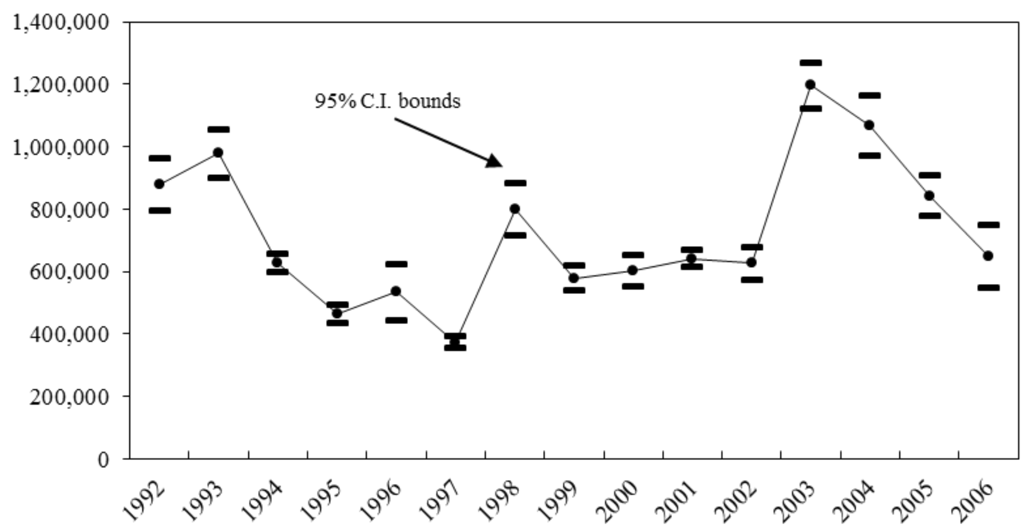

Figure 5.–Kenai River coho salmon smolt abundance estimates, 1992–2006.

2007 INRIVER ADULT INDEX

The combined fish wheel operating effort from 1 August through 30 September 2007 was 1,348.0 hours (Figure 6, Appendix D5). Daily hours of operation varied based on fish wheel maintenance and available daylight, but averaged 11.4 hours per day for both the north bank and south bank fish wheels. 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 average rpm was 4.1 for the north bank fish wheel and 3.5 for the south bank fish wheel (Appendix D6). Kenai River water transparency and river flow (Figure 7) indicate that fishing conditions in 2007 were similar to previous years (Appendix E1).

The coho salmon catch utilized for the adult inriver index was the same catch used for the inriver recovery of marked adult sampling. The lnCCPUE values for the three inseason periods and the total season in 2007 were 2.83 (1–28 August), 3.44 (1 August–11 September), 3.80 (1 August–25 September), and 3.85 (1 August–30 September) (Appendix F3). All 4 periods classified a level of abundance defined as low (<50,000 fish) for coho salmon arriving at RKM 45. The 1 August–30 September 2007 fitted regression plot with 90% confidence intervals is shown in Figure 8.

DISCUSSION

SMOLT ABUNDANCE

History

The 2006 smolt abundance estimate is the 15th annual estimate since 1992. It also represents the fifth estimate of smolt production that can be associated with an estimated parent-year escapement for the Kenai River. Because most Kenai River coho salmon develop into age-2 smolt, the primary parent year for the 2006 smolt emigration is 2003. The escapement estimate for 2003 is 79,915 (Carlon and Evans 2007), and is similar to the 1999–2004 average. The 2003 escapement is associated with an 11% below average production of smolt in 2006 (Figure 9).

Relationship Between Total Harvest and Smolt Abundance

The relationship between parent-year harvest of Kenai River coho salmon and smolt production was examined. No discernable relationship between smolt production and the parent-year harvests in 1993 (1996 age-2 smolt migration) through parent-year harvests in 2003 (2006 age-2 smolt migration) emerged (Figure 10). The highest known harvest of Kenai River coho salmon in 1994 (Table 5) did, however, produce the lowest recorded smolt abundance estimate (1997).

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.

Adult Inriver Index

Variables that can affect fish wheel CPUE obviously can affect the predictive utility of the adult inriver abundance index. Although attempts are made to maintain fish wheel location, effort, and spin rate, other uncontrollable variables such as water clarity, channel scouring, crew experience, boat traffic, weather, fish behavior, among others, also affect catch rates.

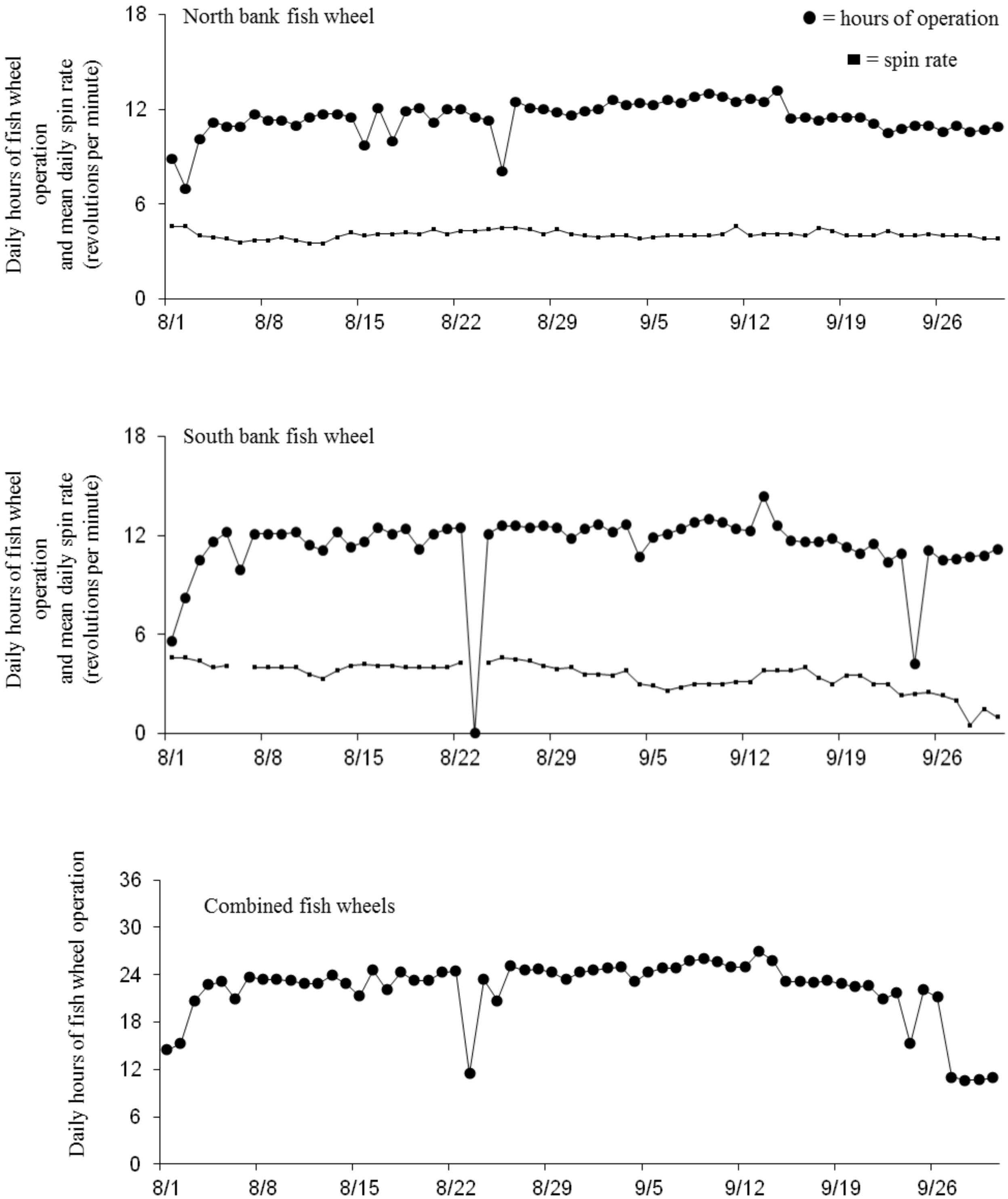

Figure 6.–Daily hours of operation and mean spin rate for north bank (top), south bank (middle), and combined (bottom) fish wheels operating on the Kenai River near RKM 45, 1 August–30 September 2007.

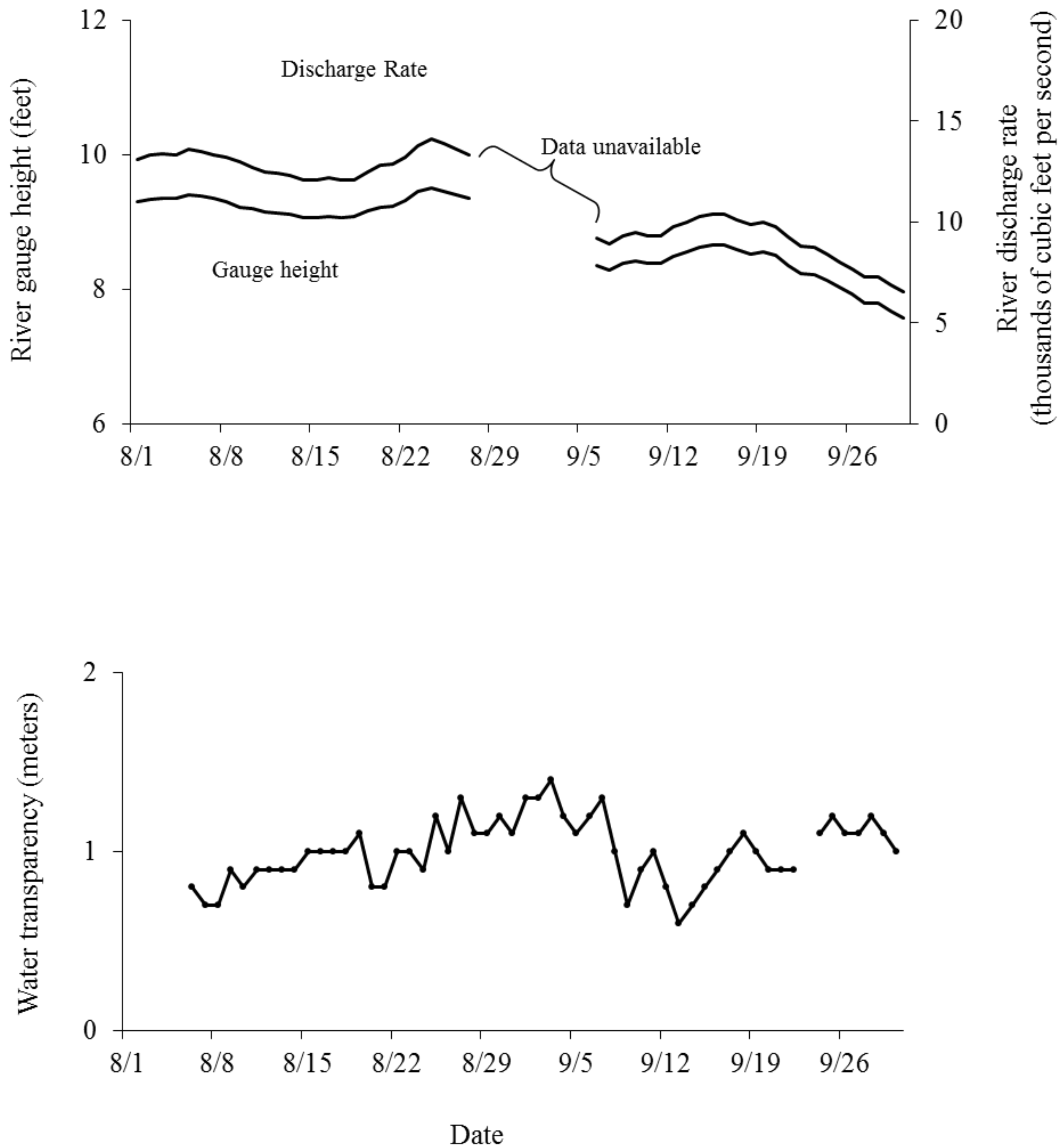

Figure 7.–Daily Kenai River stage and discharge as measured by a USGS gauging station at RKM 34 (top) and water transparency as measured with a Secchi disk near RKM 45 (bottom), 1 August–30 September 2007.

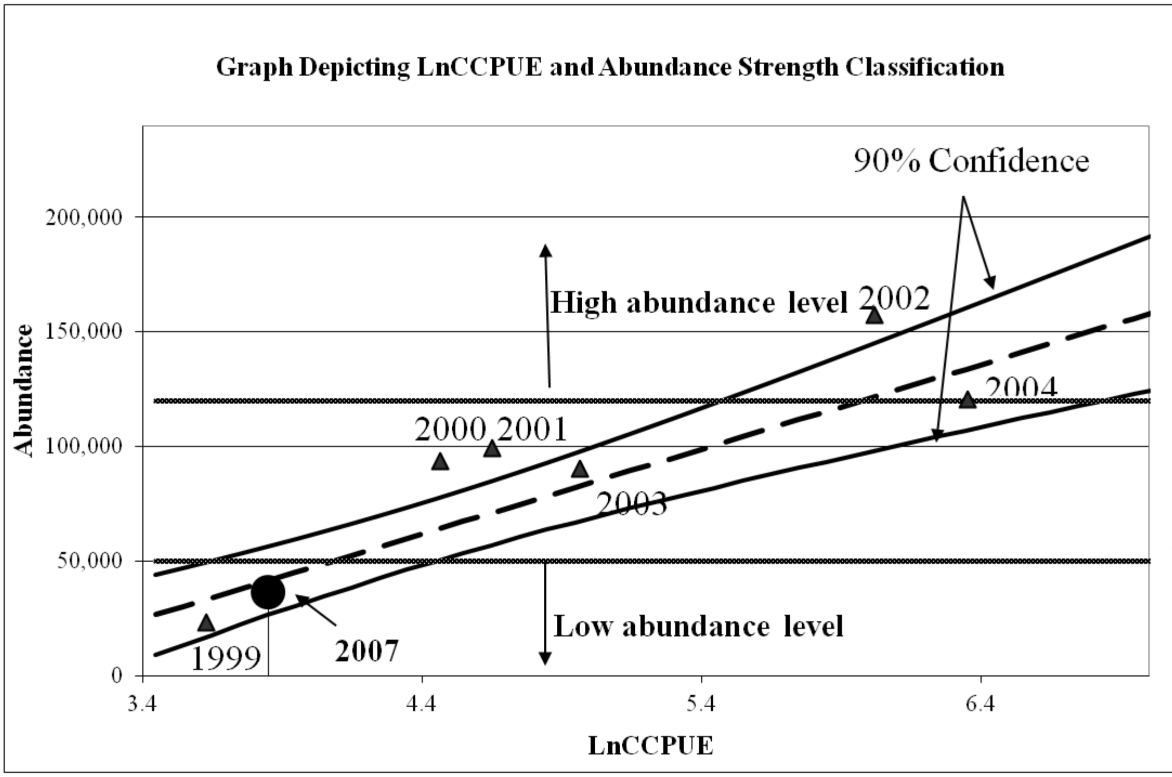

Figure 8.–Regression of the 1999–2004 Kenai River coho salmon fish wheel lnCCPUE to abundance estimates passing RKM 45 (including a trend line) and the 2007 end-of-season abundance classification.

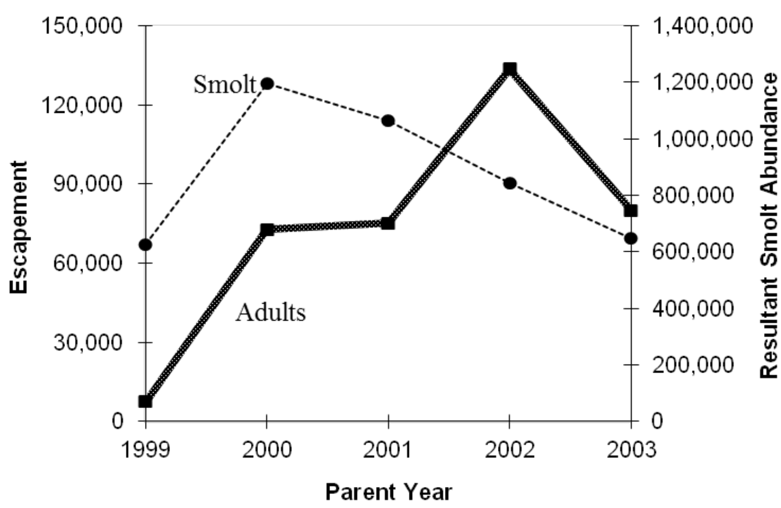

Figure 9.–Kenai River coho salmon smolt production resulting from 1999–2003 escapements.

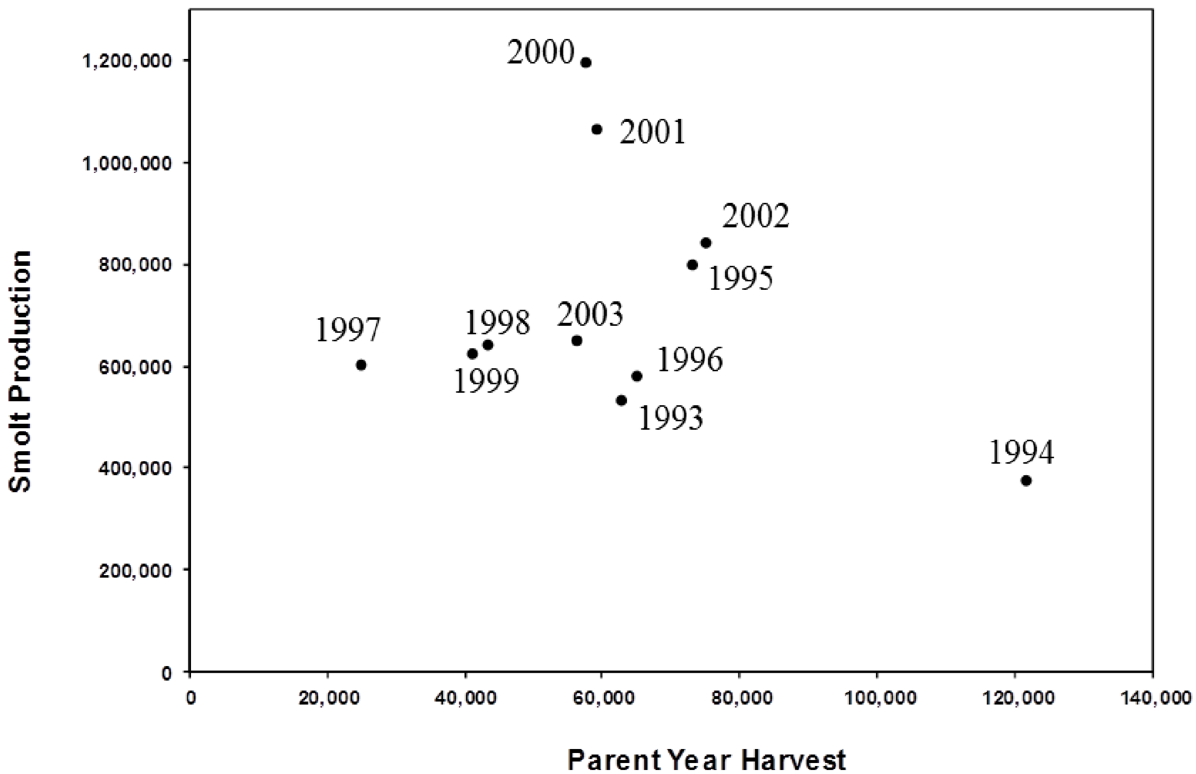

Figure 10.–Parent-year harvest and annual smolt production of Kenai River coho salmon.

In 2007, the index consistently predicted an abundance classification level of “low” (<50,000 fish) throughout the season. Confidence in this classification was poor, however, and it is suspected of being a biased and underestimating abundance. Fish wheel catch efficiency change amongst years was investigated by comparison of the 2000–2007 RKM 45 fish wheel sockeye salmon CCPUE efficiency (defined as CCPUE divided by the cumulative sockeye salmon passage at the RKM 19 sonar site) (Table 6). The period of 1–10 August was chosen for comparison because both sockeye sonar passage estimates and RKM 45 fish wheel CCPUE data were available for that period in all years. Recent pit tag and radio tag data (Willette et al. 2012) estimated that sockeye salmon arriving to RKM 31 require, on average, nearly two days to reach the RKM 45 fish wheel site, so the cumulative sockeye passage at RKM 45 during 1–10 August was estimated by using sonar counts from 30 July through 8 August (D. Westerman, ADF&G, personnel communication) (Appendix G1).

The sockeye salmon CCPUE efficiency was lowest in 2007 by a factor ranging from 1.9 to 8.3 (Table 6). It is assumed that the variable(s) causing the decrease in sockeye salmon CCPUE efficiency in 2007 also decreased the coho salmon CCPUE efficiency.

Table 5.–Estimated total harvest of Kenai River coho salmon in Upper Cook Inlet 1993–2005 and inriver harvest in 2006.

	Kenai River										UCI Marine Commercial[b]				
	Sport[a]														
	Mainstem							Personal							
Year	Unguided[a]	Guided	Unk[c]	Hidden and Skilak lakes	Total	Russian River	Total	use or subsistence	Inriver total	Ed[d]	Eastside set gillnet	Drift gillnet	Northern District	Comm. total	Grand total
1993	26,795	23,743		27	50,565	2,290	52,855	1,597[e]	54,452	427	6,806	930	148	7,884	62,763
1994	45,541	41,170		127	86,838	4,607	91,445	2,535[f]	93,980	829	14,673	11,732	477	26,882	121,691
1995	22,596	23,587		67	46,250	4,077	50,327	1,261[g]	51,588	868	13,152	6,956	582	20,690	73,146
1996	28,565	13,728		899	43,192	4,599	47,791	1,932[h]	49,723	592	11,856	2,671	29	14,556	64,871
1997	13,063	3,101		0	16,164	4,586	20,750	559[h]	21,309	191	2,093	1,236	36	3,365	24,865
1998	21,750	5,217		0	26,967	4,612	31,579	1,011[h]	32,590	638	8,096	1,974	175	10,245	43,473
1999	23,550	8,087		7	31,644	3,910	35,554	1,009[h]	36,563	530	2,905	818	171	3,894	40,987
2000	39,170	9,349		32	48,551	3,938	52,489	1,449[h]	53,938	656	2,351	531	83	2,965	57,559
2001	36,264	13,518		0	49,782	5,222	55,004	1,555[h]	56,559	572	349	282	1,303	1,934	59,065
2002	45,206	14,444		361	60,011	6,093	66,104	1,721[h]	67,825	921	4,688	1,370	57	6,115	74,861
2003	34,658	11,964		125	46,747	5,197	51,944	1,332[h]	53,276	439	2,122	330	126	2,578	56,293
2004	51,070	14,845	37	39	65,991	6,574	72,565	2,661[i]	75,226	765	5,921	4,251	977	11,149	87,140
2005	38,071	12,285		44	50,400	3,868	54,268	2,512[i]	56,780	489	3,310	1,533	176	5,019	62,288
2006	28,281	9,233		136	37,650	5,431	43,081	2,235[i]	45,316	689	Commercial harvest no longer estimated				
Mean	32,470	14,591			47,197	4,643	51,840	1,669	53,509	615	6,025	2,663	334	9,021	63,769

[a] Source is Statewide Harvest Survey (Mills 1994; Howe et al. 1995, 1996, 2001 a-d [1996–2000 are revised estimates); Walker et al. 2003; Jennings et al. 2004, 2006 a-b, 2007, 2009 a-b). Mainstem unguided includes Skilak Lake and Hidden Lake.

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

[c] Kenai River coho harvest from unknown guide or unguided status.

[d] Kenai River harvest in the Kenaitze Tribal educational fishery (Larry Marsh, ADF&G, personal communication). Prior to 2002, these harvests included Kasilof and Swanson rivers harvests.

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

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

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

[h] Reimer and Sigurdsson (2004).

[i] Dunker and Lafferty (2007).

Table 6.–Sockeye salmon fish wheel CCPUE efficiency (2000–2006) based on comparison to the 2007 CCPUE efficiency for the period 1–10 August at RKM 45 of the Kenai River, Alaska.

	Combined fish wheels								
Year	Actual sockeye salmon catch	Actual effort in hours	Standardized effort[a]	Standardized effort/actual effort	Adjusted sockeye salmon catch[b]	CCPUE[c, d]	Sockeye salmon sonar count[e]	CCPUE efficiency[f]	Comparative CCPUE efficiency[g]
2000	2,167	273.80	248.85	0.909	1,970	86.97	72,665	0.12%	3.423
2001	2,439	259.00	236.17	0.912	2,224	107.80	122,748	0.09%	2.512
2002	2,302	189.60	183.48	0.968	2,228	131.74	148,939	0.09%	2.530
2003	2,553	240.70	232.22	0.965	2,463	110.69	165,142	0.07%	1.917
2004	12,101	175.40	175.40	1.000	12,101	721.49	248,944	0.29%	8.290
2005	14,148	235.19	235.19	1.000	14,148	616.60	246,593	0.25%	7.152
2006	13,364	164.48	164.48	1.000	13,364	1,023.14	413,706	0.25%	7.074
2007	1,204	210.62	210.62	1.000	1,204	57.67	164,949	0.03%	1.000

[a] Hours of fish wheel effort occurring during standardized operating times; see Appendix A1 for standardized fish wheel operating times.

[b] Adjusted catch = actual sockeye catch × proportional fish wheel effort.

[c] Source data from Carlon and Evans (2007) and Massengill and Evans (2007).

[d] CCPUE = sum of daily CPUE from 1 August through 10 August found in Appendix 10. These data were selected because sonar counts for sockeye were available during this period for all years.

[e] David Westerman (Division of Commercial Fisheries, ADF&G, Soldotna, personal communication) provided the estimated count of sockeye salmon passing the Kenai River RM 19 sonar station during the period 30 July–8 August (2000–2007).

[f] CCPUE efficiency = CCPUE / sockeye salmon sonar count.

[g] The comparative CCPUE efficiency is calculated by dividing the catch efficiency for the year of interest by the 2007 catch efficiency.

Inseason concern regarding the low fish wheel CPUE index prompted us to periodically fish a boat-deployed drift gillnet to collect coho salmon CPUE. The gillnet was fished in the same manner and area as gillnets were fished in the years 2000–2004; a period when coho salmon abundance and gillnet CPUE was estimated by coho salmon mark–recapture studies (Carlon and Evans 2007, Massengill and Evans 2007). Results indicated coho salmon gillnet CPUE was generally better in 2007 than during the years 2000–2004, when coho salmon abundance was estimated at levels higher than "low" (<50,000 coho salmon), further supporting the idea that fish wheel catch efficiency decreased relative to abundance in 2007. In addition, anecdotal Kenai River angler reports in 2007 indicated fishing success was generally good, and better than expected if the coho abundance was actually what the index predicted (<50,000 fish).

It is unknown what may have caused a significant decrease in fish wheel efficiency; environmental variables that were recorded for the fish wheel operation during the years 2000–2007 were generally similar among years. One suspected cause is the exceptionally large ice dams and subsequent flooding that occurred in the middle and lower sections of the Kenai River during the winter of 2007. This may have altered the river channel enough to change fish travel routes; unfortunately, channel maps don't exist to verify this. There were no obvious visible changes in the river channel or exposed substrate (boulders, gravel bars, etc.) near the fish wheel locations, although shoreline vegetation was severely scoured in many areas.

The index is designed to classify abundance into one of three ordinal levels. The index is not generally sensitive to sporadic and subtle sampling-induced changes in CPUE because drastically changed CPUE values must be sustained for the lnCCPUE to be significantly affected. A drastic change in CCPUE efficiency appears probable during the 2007 study and is cause for concern as to whether fish wheel CPUE can accurately classify inriver abundance.

Finally, collecting and archiving age information from adult and juvenile coho salmon is complicated by the difficulty in discerning years of freshwater development through standard scale aging techniques. Without a reliable means to determine the freshwater age of coho salmon from scales, meaningful brood table construction is not possible. A coho salmon age-validation study could provide a means to accurately decipher age patterns and allow for accurate brood table construction using scales already archived from adult returns and smolt emigrations. It would be prudent to continue to collect and archive Kenai River adult coho salmon scales and lengths through fall 2008 so that scale samples are available from the offspring for all estimated escapement years (1999–2004).

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The following people comprised the team that marked smolt at the Moose River in 2006: Kurt Strausbaugh was the field project leader and participated in all phases of field investigation. Sandee Simons, Will Newberry, and Jake Glotfelty, assisted with all phases of the field investigation including logistical support, weir operation and maintenance, and smolt tagging and enumeration. "Cotton" and Lorrayne Moore and Dr. Bill West graciously provided convenient access to the Moose River.

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APPENDIX A: FISH WHEEL OPERATIONAL TIMES

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
1 Aug–7 Sep	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
8–14 Sep	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
15–21 Sep	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
22–30 Sep	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 may have been less due to unpredictable fishing conditions.

[a] Beginning 8 September 2004, the fish wheels were operated between 13:30 and 14:30 hours. Before 8 September 2004, the fish wheels were not operated during this period. Total adjusted effort for each year was equal.

APPENDIX B: METHOD USED TO INTERPOLATE CATCH FOR DAYS THE FISH WHEELS WERE NOT IN OPERATION

Appendix B1.–Method used to interpolate Kenai River coho salmon catch for days fish wheels were not in operation, 1 August–30 September 1999.

Step 1 (square brackets in equation 1): estimate the cumulative CPUE missed on all days the fish wheels did not operate in 1999. Step 2: assign a portion of this quantity to day *j* (multiply step 1 by p_j).

$$CPUE_j = \left[\frac{T_{99}}{p} - T_{99} \right] p_j \quad , \qquad (1)$$

where

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

and

$$p = \sum_i \bar{p}_i \quad , \qquad (2)$$

for *i* days when wheels operated in 1999 and

where

$$\bar{p}_i = \frac{\sum_{y=2000}^{2004} p_{yi}}{5} \quad , \qquad (3)$$

and

$$p_{yi} = \frac{CPUE_{yi}}{\sum_{k=1}^{61} CPUE_{yk}} \quad , \qquad (4)$$

where $CPUE_{yi}$ is the CPUE for year *y* on day *i* and *k* denotes days that fish wheels were to operate.

$$p_j = \frac{\bar{p}_j}{\sum_m \bar{p}_m} \quad , \qquad (5)$$

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

APPENDIX C: SUMMARY OF ACTUAL AND ADJUSTED FISH WHEEL EFFORT, CATCH, AND CPUE BY TEMPORAL PERIOD AND BANK

Appendix C1.–Summary of actual and adjusted fish wheel effort, coho salmon catch and catch per hour (CPUE) by temporal period and bank near RKM 45, Kenai River, Alaska, 1999–2007.

		Temporal interval										Combined banks end-of-season grand total
		North bank fish wheel					South bank fish wheel					
Year	Data type [a,b]	1–14 Aug	1–28 Aug	1 Aug– 11 Sep	1 Aug– 25 Sep	1 Aug–30 Sep	1–14 Aug	1–28 Aug	1 Aug– 11 Sep	1 Aug– 25 Sep	1 Aug– 30 Sep	
1999 [c,d,e]	Actual effort (h)	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 h		0.157	0.366	0.443	0.413	0.378	1.264	0.590	0.458	0.424	0.419
	Adjusted effort (h)											
	Adjusted total catch											
	Adjusted catch per h											0.617
	% change [e]											47.4%
2000 [f]	Actual effort (h)	188.6	369.2	497.4	659.7	735.8	187.2	379.1	528	708	784.8	1520.6
	Actual total catch	331	783	1372	2345	2518	53	108	415	787	828	3346
	Actual catch per h	1.755	2.121	2.758	3.555	3.422	0.283	0.285	0.786	1.112	1.055	2.200
	Adjusted effort (h)	172.6	339.0	452.4	596.2	655.9	169.8	343.2	477.8	635.1	695.0	1350.9
	Adjusted total catch	320	755	1293	2182	2322	46	86	345	661	700	3022
	Adjusted catch per h	1.854	2.227	2.858	3.660	3.540	0.271	0.251	0.722	1.041	1.007	2.237
	% change [e]	5.7%	5.0%	3.6%	3.0%	3.4%	-4.3%	-12.0%	-8.1%	-6.4%	-4.5%	1.7%
2001 [f]	Actual effort (h)	186.3	397.1	603.9	809.1	880.3	188.5	395.4	597.1	784.8	855.1	1735.4
	Actual total catch	176	500	663	821	848	164	923	1600	1,759	1,819	2667
	Actual catch per h	0.945	1.259	1.098	1.015	0.963	0.870	2.334	2.680	2.241	2.127	1.537
	Adjusted effort (h)	171.2	365.6	557.1	736.5	794.7	173.3	365.2	552.9	714.1	772.3	1567.1
	Adjusted total catch	164	449	578	685	705	153	859	1469	1571	1626	2331
	Adjusted catch per h	0.958	1.228	1.037	0.930	0.887	0.883	2.352	2.657	2.200	2.105	1.488
	% change [e]	1.4%	-2.5%	-5.5%	-8.3%	-7.9%	1.5%	0.8%	-0.8%	-1.8%	-1.0%	-3.2%

-continued-

Appendix C1.–Part 2 of 3.

Year	Data type [a,b]	North bank fish wheel: 1–14 Aug	North bank fish wheel: 1–28 Aug	North bank fish wheel: 1 Aug– 11 Sep	North bank fish wheel: 1 Aug– 25 Sep	North bank fish wheel: 1 Aug– 30 Sep	South bank fish wheel: 1–14 Aug	South bank fish wheel: 1–28 Aug	South bank fish wheel: 1 Aug– 11 Sep	South bank fish wheel: 1 Aug– 25 Sep	South bank fish wheel: 1 Aug– 30 Sep	Combined banks end-of-season grand total
2002 [d,f]	Actual effort (h)	131.0	254.6	352.9	501.5	567.4	141.3	264.8	371.3	527.1	594.3	1161.7
	Actual total catch	41	844	2065	3731	3910	277	1256	1996	2520	2630	6540
	Actual catch per h	0.313	3.315	5.852	7.440	6.891	1.960	4.743	5.376	4.781	4.425	5.630
	Adjusted effort (h)	128.0	250.1	345.8	475.9	528.7	137.7	266.7	364.2	501.3	554.9	1083.6
	Adjusted total catch	33	826	2027	3520	3679	273	1252	1978	2640	2558	6237
	Adjusted catch per h	0.258	3.303	5.862	7.397	6.958	1.983	4.694	5.431	5.267	4.610	5.756
	% change [e]	-17.6%	-0.4%	0.2%	-0.6%	1.0%	1.2%	-1.0%	1.0%	10.2%	4.2%	2.2%
2003 [f]	Actual effort (h)	172.3	338.7	503.9	666.4	741.9	168.6	316.2	479.3	629.9	704.5	1446.4
	Actual total catch	37	167	239	278	288	479	1754	2123	2148	2174	2462
	Actual catch per h	0.215	0.493	0.474	0.417	0.388	2.841	5.547	4.429	3.410	3.086	1.702
	Adjusted effort (h)	166.5	329.1	488.7	624.9	684.9	165.1	312.5	471.2	599.4	659.4	1344.3
	Adjusted total catch	29	143	197	224	231	481	1749	2114	2130	2154	2385
	Adjusted catch per h	0.174	0.435	0.403	0.358	0.337	2.913	5.598	4.487	3.553	3.266	1.774
	% change [e]	-18.9%	-11.9%	-15.0%	-14.1%	-13.1%	2.5%	0.9%	1.3%	4.2%	5.9%	4.2%
2004 [f,g]	Actual effort (h)	110.1	197.9	313.4	469.2	526.6	121.4	231.1	353.6	495.2	553.2	1079.8
	Actual total catch	252	1241	2247	3663	4100	577	3014	4521	5028	5137	9237
	Actual catch per h	2.289	6.271	7.170	7.807	7.786	4.753	13.042	12.786	10.153	9.286	8.554
	Adjusted effort (h)	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	1223	2223	3639	4076	577	2998	4498	5005	5114	9190
	Adjusted catch per h	2.202	6.258	7.173	7.817	7.795	4.754	12.991	12.780	10.147	9.277	8.555
	% change [e]	-3.8%	-0.2%	0.0%	0.1%	0.1%	0.0%	-0.4%	0.0%	-0.1%	-0.1%	0.0%

Temporal interval

-continued-

Appendix C1.–Part 3 of 3.

		Temporal interval										Combined banks end-of-season grand total
		North bank fish wheel					South bank fish wheel					
Year	Data type [a,b]	1–14 Aug	1–28 Aug	1 Aug– 11 Sep	1 Aug– 25 Sep	1 Aug– 30 Sep	1–14 Aug	1–28 Aug	1 Aug– 11 Sep	1 Aug– 25 Sep	1 Aug– 30 Sep	
2005 [h]	Actual effort (h)	161.7	322.4	489.7	642.6	695.8	168.3	338.6	510.4	673.4	726.6	1422.4
	Actual total catch	107	1888	2683	2963	3023	39	954	2062	2417	2494	5517
	Actual catch per h	0.662	5.856	5.479	4.611	4.345	0.232	2.817	4.040	3.589	3.432	3.879
2006 [h]	Actual effort (h)	125.6	237.6	353.4	505.1	556.3	125.5	235.1	373.8	527	580.5	1136.8
	Actual total catch	55	519	1098	2019	2179	239	1301	2271	3597	3855	6034
	Actual catch per h	0.438	2.184	3.107	3.997	3.917	1.904	5.534	6.075	6.825	6.641	5.308
2007[h]	Actual effort (h)	150.7	309.1	482.2	643.8	697.5	152.3	311.4	483.7	640	650.5	1348
	Actual total catch	35	196	396	623	650	27	182	335	424	425	1075
	Actual catch per h	0.232	0.634	0.821	0.968	0.932	0.177	0.584	0.693	0.663	0.653	0.797

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

[b] Totals do not include coho salmon recaptured, escaped, or considered unsuitable for marking (i.e., severely injured or dead) with the exception of 1999 when 2 recaptured fish are included.

[c] The 1999 fish wheel sites varied in location between RKM 43 and RKM 45 and were located slightly downstream of the 2000–2007 sites.

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

[e] "% change" = change between actual and adjusted CPUE.

[f] Source of "actual" catch and effort data for 1999–2003 from Carlon and Evans (2007) and for 2004 from Massengill and Evans (2007).

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

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

APPENDIX D: FISH WHEEL DATA FOR 1 AUGUST–30 SEPTEMBER 2007

Appendix D1.–Daily summary of adult coho salmon captured by two fish wheels located along the north and south banks of the Kenai River near RKM 45, 1 August–30 September 2007.

		August				September				
Bank	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	1 Aug					1 Sep	6	1	1	1
	2 Aug					2 Sep	17			
	3 Aug	1				3 Sep	5	2	2	2
	4 Aug					4 Sep	11			
	5 Aug					5 Sep	10	1	1	1
	6 Aug					6 Sep	10	1	1	1
	7 Aug	2				7 Sep	14	1	1	1
	8 Aug	3				8 Sep	38	8	8	8
	9 Aug	1				9 Sep	44	6	6	6
	10 Aug	2				10 Sep	21	4	4	4
	11 Aug					11 Sep	14	4	4	4
	12 Aug	3				12 Sep	18	2	2	2
	13 Aug	7				13 Sep	40	7	7	7
	14 Aug	16	3	3	3	14 Sep	28	2	2	2
	15 Aug	13	2	2	2	15 Sep	18	4	4	4
	16 Aug	12	1	1	1	16 Sep	11			
	17 Aug	12				17 Sep	6			
	18 Aug	12				18 Sep	19	3	3	3
	19 Aug	3				19 Sep	22	2	2	2
	20 Aug	13				20 Sep	28	5	5	5
	21 Aug	28	5	5	4	21 Sep	7	1	1	1
	22 Aug	9	1	1	1	22 Sep	9	2	2	2
	23 Aug	19				23 Sep	6			
	24 Aug	13	2	2	2	24 Sep	8	2	2	2
	25 Aug	4	2	2	1	25 Sep	7	1	1	1
	26 Aug	5	1	1	1	26 Sep	3			
	27 Aug	13	3	3	3	27 Sep	11			
	28 Aug	5	1	1	1	28 Sep	4			
	29 Aug	1				29 Sep	7	1	1	1
	30 Aug	1				30 Sep	2			
	31 Aug	8								
Month subtotal		206	21	21	19		444	60	60	60
North bank subtotal							650	81	81	79

-continued-

Appendix D1.–Part 2 of 2.

		August					September			
Bank	Date	Number captured and examined	Marked fish observed[a]	Marked fish checked with tag detector[b]	Coded wire tag detected	Date	Number captured and examined	Marked fish observed[a]	Marked fish checked with tag detector[b]	Coded wire tag detected
South	1 Aug					1 Sep	14	3	3	3
	2 Aug	1				2 Sep	10			
	3 Aug					3 Sep	11			
	4 Aug					4 Sep	14	6	6	5
	5 Aug					5 Sep	19	2	2	2
	6 Aug					6 Sep	2	1	1	1
	7 Aug	1				7 Sep	6			
	8 Aug					8 Sep	16	1	1	1
	9 Aug					9 Sep	17	3	3	3
	10 Aug	2				10 Sep	4	1	1	1
	11 Aug	1				11 Sep	10	1	1	1
	12 Aug	4				12 Sep	5	2	2	2
	13 Aug	11	1	1	1	13 Sep	23	6	6	6
	14 Aug	7				14 Sep	12	3	3	3
	15 Aug	8				15 Sep	9	1	1	1
	16 Aug	11	1	1	1	16 Sep	8			
	17 Aug	13	2	2	2	17 Sep	3			
	18 Aug	12	2	2	2	18 Sep	5	1	1	1
	19 Aug	12	1	1	1	19 Sep	8			
	20 Aug	18	1	1	1	20 Sep	4			
	21 Aug	8	2	2	2	21 Sep	4	1	1	1
	22 Aug	6	1	1	1	22 Sep	1			
	23 Aug					23 Sep	4			
	24 Aug	8				24 Sep	1			
	25 Aug	11	2	2	2	25 Sep	2			
	26 Aug	11	2	2	2	26 Sep	1			
	27 Aug	16	3	3	3	27 Sep				
	28 Aug	21	1	1	1	28 Sep				
	29 Aug	12				29 Sep				
	30 Aug	10	1	1	1	30 Sep				
	31 Aug	8	2	2	2					
Month subtotal		212	22	22	22		213	32	32	31
South bank subtotal							425	54	54	53
Grand total (both banks)							1075	135	135	132

[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 D2.–North bank fish wheel catch by species near RKM 45, Kenai River, 1 August–30 September 2007.

Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead
1 Aug		34					
2 Aug		100					
3 Aug	1	37	1			1	
4 Aug		41		1	1		
5 Aug		112					
6 Aug		136					
7 Aug	2	116	1				
8 Aug	3	78					
9 Aug	1	121					
10 Aug	2	80		1			
11 Aug		69					
12 Aug	3	205					
13 Aug	7	159					
14 Aug	16	165	4	1			
15 Aug	13	93			1		
16 Aug	12	93					
17 Aug	12	114	1	1		1	
18 Aug	12	135			1	2	
19 Aug	3	75			1	1	
20 Aug	13	101	1			1	
21 Aug	28	60					
22 Aug	9	26					
23 Aug	19	49	1		1	1	
24 Aug	13	29	1			1	
25 Aug	4	14	2				
26 Aug	5	29	1			1	
27 Aug	13	32	2			1	
28 Aug	5	31			1	1	
29 Aug	1	30	4		1	3	
30 Aug	1	22	1		1	1	
31 Aug	8	39			2	1	
1 Sep	6	37	1		4	4	
2 Sep	17	51			1	2	
3 Sep	5	18	1		2	1	
4 Sep	11	15	1		1	1	1
5 Sep	10	6	3		2	4	
6 Sep	10	15	2	1	4	1	
7 Sep	14	15	2		2	4	
8 Sep	38	19			7	1	
9 Sep	44	11			5		
10 Sep	21	3			3		
11 Sep	14	2			2		
12 Sep	18	2		1	2		

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Appendix D2.–Part 2 of 2.

Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead
13 Sep	40	4			3		2
14 Sep	28	1			1		1
15 Sep	18	4					
16 Sep	11						1
17 Sep	6	4					1
18 Sep	19	3	1		2	1	1
19 Sep	22				1		
20 Sep	28	1			2		
21 Sep	7	1			2		
22 Sep	9	2			1		1
23 Sep	6	2	1		3		
24 Sep	8	1					
25 Sep	7	1			1		2
26 Sep	3				1		
27 Sep	11						
28 Sep	4				2	1	1
29 Sep	7	1					
30 Sep	2						
Total	650	2644	32	6	64	36	11

Note: Chinook salmon are *Oncorhyncus tshawytscha*, pink salmon are *Onchorhynchus gorbuscha*, Rainbow trout and steelhead are *Onchorhyncus mykiss*, and Dolly Varden are *Salvelinus malma*.

Note: Catch includes only morning and evening shift totals, and not the grave shift. The grave shift was operated strictly for a companion sockeye salmon project and is outside the standardized sampling times for the coho salmon index study.

Appendix D3.–South bank fish wheel catch by species near RKM 45, Kenai River, 1 August–30 September 2007.

Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead
1 Aug		13	1		1		
2 Aug	1	56	1				
3 Aug		43	1				
4 Aug		21	2		1		
5 Aug		11					
6 Aug		14		1			
7 Aug	1	34					
8 Aug		29	1				
9 Aug		49			1		
10 Aug	2	79	2	1			
11 Aug	1	54				2	
12 Aug	4	59		1	1		
13 Aug	11	80	1	1		4	
14 Aug	7	31	2			3	
15 Aug	8	46				1	
16 Aug	11	41	3		2		
17 Aug	13	36	4		1	4	
18 Aug	12	27	3			1	
19 Aug	12	16	4		1		
20 Aug	18	22	2				1
21 Aug	8	18	5				
22 Aug	6	2	1		1		
23 Aug							
24 Aug	8	11	2		1		
25 Aug	11	4	2	1		1	
26 Aug	11	8	2		3	2	
27 Aug	16	5	1		4	3	
28 Aug	21	5	2				
29 Aug	12	11	1			2	
30 Aug	10	7	1			2	
31 Aug	8	8	1				
1 Sep	14	3				2	1
2 Sep	10	2	1	1	1		
3 Sep	11	5	1			3	
4 Sep	14	3			1		
5 Sep	19		1				
6 Sep	2						
7 Sep	6	1					1
8 Sep	16				1		
9 Sep	17	1			2	1	
10 Sep	4					1	
11 Sep	10	2					1
12 Sep	5	2	1			1	

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Appendix D3.–Part 2 of 2.

Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead
13 Sep	23						
14 Sep	12				2		
15 Sep	9						
16 Sep	8						
17 Sep	3			1			
18 Sep	5	1			1		
19 Sep	8	1				1	
20 Sep	4	1			2		
21 Sep	4						
22 Sep	1				1		
23 Sep	4						
24 Sep	1						
25 Sep	2						
26 Sep	1						
27 Sep							
28 Sep							
29 Sep							
30 Sep							
Total	425	862	49	7	28	34	4

Note: Catch includes only morning and evening shift totals, and not the grave shift. The grave shift was operated strictly for a companion sockeye salmon project and is outside the standardized sampling times for the coho salmon index study.

Appendix D4.–Combined bank fish wheel catch by species near RKM 45, 1 August–30 September 2007.

Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead
1 Aug	0	47	1	0	1	0	0
2 Aug	1	156	1	0	0	0	0
3 Aug	1	80	2	0	0	1	0
4 Aug	0	62	2	1	2	0	0
5 Aug	0	123	0	0	0	0	0
6 Aug	0	150	0	1	0	0	0
7 Aug	3	150	1	0	0	0	0
8 Aug	3	107	1	0	0	0	0
9 Aug	1	170	0	0	1	0	0
10 Aug	4	159	2	2	0	0	0
11 Aug	1	123	0	0	0	2	0
12 Aug	7	264	0	1	1	0	0
13 Aug	18	239	1	1	0	4	0
14 Aug	23	196	6	1	0	3	0
15 Aug	21	139	0	0	1	1	0
16 Aug	23	134	3	0	2	0	0
17 Aug	25	150	5	1	1	5	0
18 Aug	24	162	3	0	1	3	0
19 Aug	15	91	4	0	2	1	0
20 Aug	31	123	3	0	0	1	1
21 Aug	36	78	5	0	0	0	0
22 Aug	15	28	1	0	1	0	0
23 Aug	19	49	1	0	1	1	0
24 Aug	21	40	3	0	1	1	0
25 Aug	15	18	4	1	0	1	0
26 Aug	16	37	3	0	3	3	0
27 Aug	29	37	3	0	4	4	0
28 Aug	26	36	2	0	1	1	0
29 Aug	13	41	5	0	1	5	0
30 Aug	11	29	2	0	1	3	0
31 Aug	16	47	1	0	2	1	0
1 Sep	20	40	1	0	4	6	1
2 Sep	27	53	1	1	2	2	0
3 Sep	16	23	2	0	2	4	0
4 Sep	25	18	1	0	2	1	1
5 Sep	29	6	4	0	2	4	0
6 Sep	12	15	2	1	4	1	0
7 Sep	20	16	2	0	2	4	1
8 Sep	54	19	0	0	8	1	0
9 Sep	61	12	0	0	7	1	0
10 Sep	25	3	0	0	3	1	0
11 Sep	24	4	0	0	2	0	1
12 Sep	23	4	1	1	2	1	0

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Appendix D4.–Part 2 of 2.

Date	Coho salmon	Sockeye salmon	Chinook salmon	Pink salmon	Rainbow trout	Dolly Varden	Steelhead
13 Sep	63	4	0	0	3	0	2
14 Sep	40	1	0	0	3	0	1
15 Sep	27	4	0	0	0	0	0
16 Sep	19	0	0	0	0	0	1
17 Sep	9	4	0	1	0	0	1
18 Sep	24	4	1	0	3	1	1
19 Sep	30	1	0	0	1	1	0
20 Sep	32	2	0	0	4	0	0
21 Sep	11	1	0	0	2	0	0
22 Sep	10	2	0	0	2	0	1
23 Sep	10	2	1	0	3	0	0
24 Sep	9	1	0	0	0	0	0
25 Sep	9	1	0	0	1	0	2
26 Sep	4	0	0	0	1	0	0
27 Sep	11	0	0	0	0	0	0
28 Sep	4	0	0	0	2	1	1
29 Sep	7	1	0	0	0	0	0
30 Sep	2	0	0	0	0	0	0
Total	1075	3506	81	13	92	70	15

Note: Catch includes only morning and evening shift totals, and not the grave shift. The grave shift was operated strictly for a companion sockeye salmon project and is outside the standardized sampling times for the coho salmon index study.

Appendix D5.–Coho salmon catch, hours of effort, and catch per hour for two fish wheels operated adjacent to each bank of the Kenai River near RKM 45, 1 August–30 September 2007.

	North bank			South bank			Combined banks			Cumulative
Date	Catch	Hours	Catch/ hour	Catch[a]	Hours	Catch/ hour	Catch[a]	Hours	Catch/ hour	daily catch /hour
1 Aug		8.9			5.6	0.00	0	14.5	0.00	0.00
2 Aug		7.0	0.00	1	8.2	0.12	1	15.2	0.07	0.07
3 Aug	1	10.1	0.10		10.5	0.00	1	20.6	0.05	0.11
4 Aug		11.2	0.00		11.6	0.00	0	22.7	0.00	0.11
5 Aug		10.9	0.00		12.2	0.00	0	23.1	0.00	0.11
6 Aug		10.9	0.00		9.9	0.00	0	20.9	0.00	0.11
7 Aug	2	11.7	0.17	1	12.1	0.08	3	23.7	0.13	0.24
8 Aug	3	11.3	0.27		12.1	0.00	3	23.4	0.13	0.37
9 Aug	1	11.3	0.09		12.1	0.00	1	23.4	0.04	0.41
10 Aug	2	11.0	0.18	2	12.2	0.16	4	23.2	0.17	0.58
11 Aug		11.5	0.00	1	11.4	0.09	1	22.9	0.04	0.63
12 Aug	3	11.7	0.26	4	11.1	0.36	7	22.8	0.31	0.93
13 Aug	7	11.7	0.60	11	12.2	0.90	18	23.9	0.75	1.69
14 Aug	16	11.5	1.40	7	11.3	0.62	23	22.8	1.01	2.70
Subtotal	35	150.7	3.06	27	152.3	2.34	62	303.0	2.70	
15 Aug	13	9.7	1.34	8	11.6	0.69	21	21.3	0.98	3.68
16 Aug	12	12.1	0.99	11	12.5	0.88	23	24.6	0.93	4.62
17 Aug	12	10.0	1.20	13	12.1	1.08	25	22.1	1.13	5.75
18 Aug	12	11.9	1.01	12	12.4	0.97	24	24.3	0.99	6.74
19 Aug	3	12.1	0.25	12	11.2	1.07	15	23.3	0.64	7.39
20 Aug	13	11.2	1.16	18	12.1	1.48	31	23.3	1.33	8.72
21 Aug	28	12.0	2.34	8	12.4	0.65	36	24.3	1.48	10.20
22 Aug	9	12.0	0.75	6	12.5	0.48	15	24.4	0.61	10.81
23 Aug	19	11.5	1.65		0.0	0.00	19	11.5	1.65	12.46
24 Aug	13	11.3	1.15	8	12.1	0.66	21	23.4	0.90	13.36
25 Aug	4	8.1	0.49	11	12.6	0.87	15	20.7	0.72	14.08
26 Aug	5	12.5	0.40	11	12.6	0.87	16	25.1	0.64	14.72
27 Aug	13	12.1	1.08	16	12.5	1.28	29	24.6	1.18	15.90
28 Aug	5	12.0	0.4	21	12.6	1.66	26	24.7	1.05	16.95
Subtotal	196	309.1	17.28	182	311.4	14.99	378	620.5	16.95	
29 Aug	1	11.8	0.08	12	12.5	0.96	13	24.3	0.54	17.49
30 Aug	1	11.6	0.09	10	11.8	0.85	11	23.4	0.47	17.96
31 Aug	8	11.9	0.67	8	12.4	0.65	16	24.3	0.66	18.62
1 Sep	6	12.0	0.50	14	12.7	1.11	20	24.6	0.81	19.43
2 Sep	17	12.6	1.35	10	12.2	0.82	27	24.8	1.09	20.52
3 Sep	5	12.3	0.41	11	12.7	0.87	16	24.9	0.64	21.16
4 Sep	11	12.4	0.89	14	10.7	1.31	25	23.1	1.08	22.24
5 Sep	10	12.3	0.81	19	11.9	1.59	29	24.3	1.20	23.44
6 Sep	10	12.6	0.79	2	12.1	0.17	12	24.8	0.48	23.92
7 Sep	14	12.4	1.13	6	12.4	0.48	20	24.8	0.81	24.73
8 Sep	38	12.8	2.96	16	12.8	1.25	54	25.7	2.11	26.84
9 Sep	44	13.0	3.39	17	13.0	1.31	61	26.0	2.35	29.19
10 Sep	21	12.8	1.64	4	12.8	0.31	25	25.6	0.98	30.16
11 Sep	14	12.5	1.12	10	12.4	0.80	24	25.0	0.96	31.12
Subtotal	396	482.2	33.12	335	483.7	27.47	731	965.9	31.12	

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Appendix D5.–Part 2 of 2.

	North bank			South bank			Combined banks			Cumulative
Date	Catch	Hours	Catch/ hour	Catch[a]	Hours	Catch/ hour	Catch[a]	Hours	Catch/ hour	daily catch /hour
12 Sep	18	12.7	1.42	5	12.3	0.41	23	25.0	0.92	32.04
13 Sep	40	12.5	3.20	23	14.4	1.60	63	26.9	2.34	34.39
14 Sep	28	13.2	2.12	12	12.6	0.95	40	25.8	1.55	35.94
15 Sep	18	11.4	1.57	9	11.7	0.77	27	23.1	1.17	37.11
16 Sep	11	11.5	0.96	8	11.6	0.69	19	23.1	0.82	37.93
17 Sep	6	11.3	0.53	3	11.6	0.26	9	23.0	0.39	38.32
18 Sep	19	11.5	1.65	5	11.8	0.42	24	23.3	1.03	39.35
19 Sep	22	11.5	1.91	8	11.3	0.71	30	22.8	1.32	40.67
20 Sep	28	11.5	2.43	4	10.9	0.37	32	22.5	1.43	42.09
21 Sep	7	11.1	0.63	4	11.5	0.35	11	22.6	0.49	42.58
22 Sep	9	10.5	0.86	1	10.4	0.10	10	20.9	0.48	43.06
23 Sep	6	10.8	0.56	4	10.9	0.37	10	21.7	0.46	43.52
24 Sep	8	11.0	0.73	1	4.2	0.24	9	15.2	0.59	44.11
25 Sep	7	11.0	0.64	2	11.1	0.18	9	22.1	0.41	44.52
Subtotal	623	643.8	52.32	424	640.0	34.87	1,047	1283.7	44.52	
26 Sep	3	10.6	0.28	1	10.5	0.10	4	21.1	0.19	44.71
27 Sep	11	11.0	1.00				11	11.0	1.00	45.71
28 Sep	4	10.6	0.38				4	10.6	0.38	46.09
29 Sep	7	10.7	0.66				7	10.7	0.66	46.74
30 Sep	2	10.9	0.18				2	10.9	0.18	46.93
Total	650	697.5	54.82	425	650.5	34.97	1075	1348.0	46.93	

[a] After 26 September, the south bank fish wheel rotation (rpm) had fallen so low as to be deemed ineffective for catching fish (due to water conditions), therefore, south bank fish wheel effort and catch data after 26 September was not used in calculating daily catch-per-unit-effort.

Appendix D6.–Fish wheel spin rate, and selected water conditions by river bank (north or south) near RKM 45 of the Kenai River, Alaska, 1 August–30 September 2007.

	Fish wheel spin rate (rpm by bank)				
Date	North	South	Water transparency (m by bank)	River gage height[a] (feet)	River discharge[a] (CFS)
1 Aug	4.6	4.6		9.30	13,100
2 Aug	4.6	4.6		9.34	13,300
3 Aug	4.0	4.4		9.36	13,400
4 Aug	3.9	4.0		9.35	13,300
5 Aug	3.8	4.1		9.40	13,600
6 Aug	3.6		0.8	9.38	13,500
7 Aug	3.7	4.0	0.7	9.35	13,300
8 Aug	3.7	4.0	0.7	9.31	13,200
9 Aug	3.9	4.0	0.9	9.21	13,000
10 Aug	3.7	4.0	0.8	9.20	12,700
11 Aug	3.5	3.6	0.9	9.15	12,500
12 Aug	3.5	3.3	0.9	9.14	12,400
13 Aug	3.9	3.8	0.9	9.11	12,300
14 Aug	4.2	4.1	0.9	9.07	12,100
15 Aug	4.0	4.2	1.0	9.07	12,100
16 Aug	4.1	4.1	1.0	9.09	12,200
17 Aug	4.1	4.1	1.0	9.06	12,100
18 Aug	4.2	4.0	1.0	9.08	12,100
19 Aug	4.1	4.0	1.1	9.16	12,500
20 Aug	4.4	4.0	0.8	9.22	12,800
21 Aug	4.1	4.0	0.8	9.24	12,900
22 Aug	4.3	4.3	1.0	9.32	13,200
23 Aug	4.3		1.0	9.45	13,800
24 Aug	4.4	4.3	0.9	9.51	14,100
25 Aug	4.5	4.6	1.2	9.46	13,900
26 Aug	4.5	4.5	1.0	9.40	13,600
27 Aug	4.4	4.4	1.3	9.35	13,300
28 Aug	4.1	4.1	1.1		
29 Aug	4.4	3.9	1.1		
30 Aug	4.1	4.0	1.2		
31 Aug	4.0	3.6	1.1		
1 Sep	3.9	3.6	1.3		
2 Sep	4.0	3.5	1.3		
3 Sep	4.0	3.8	1.4		
4 Sep	3.8	3.0	1.2		
5 Sep	3.9	2.9	1.1		
6 Sep	4.0	2.6	1.2	8.35	9,210
7 Sep	4.0	2.8	1.3	8.28	8,940
8 Sep	4.0	3.0	1.0	8.38	9,330
9 Sep	4.0	3.0	0.7	8.42	9,460
10 Sep	4.1	3.0	0.9	8.38	9,330
11 Sep	4.6	3.1	1.0	8.38	9,310
12 Sep	4.0	3.1	0.8	8.49	9,740

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Appendix D6.–Part 2 of 2.

Date	Fish wheel spin rate (rpm by bank) North	South	Water transparency (m by bank)	River gage height[a] (feet)	River discharge[a] (CFS)
13 Sep	4.1	3.8	0.6	8.56	10,000
14 Sep	4.1	3.8	0.7	8.62	10,300
15 Sep	4.1	3.8	0.8	8.66	10,400
16 Sep	4.0	4.0	0.9	8.65	10,400
17 Sep	4.5	3.4	1.0	8.59	10,100
18 Sep	4.3	3.0	1.1	8.52	9,880
19 Sep	4.0	3.5	1.0	8.56	10,000
20 Sep	4.0	3.5	0.9	8.50	9,770
21 Sep	4.0	3.0	0.9	8.36	9,240
22 Sep	4.3	3.0	0.9	8.24	8,800
23 Sep	4.0	2.3		8.22	8,720
24 Sep	4.0	2.4	1.1	8.13	8,400
25 Sep	4.1	2.5	1.2	8.03	8,040
26 Sep	4.0	2.3	1.1	7.93	7,700
27 Sep	4.0	2.0	1.1	7.80	7,270
28 Sep	4.0	0.5	1.2	7.80	7,280
29 Sep	3.8	1.5	1.1	7.68	6,880
30 Sep	3.8	1.0	1.0	7.57	6,540
Average	4.1	3.5	1.0	8.8	11,064

[a] As measured at the Kenai River bridge at Soldotna (United States Geological Survey River Gaging Station Site 15266300). CFS = cubic feet per second.

APPENDIX E: AVERAGE BI-WEEKLY FISH WHEEL SPIN RATES AND SELECTED WATER CONDITIONS BY BANK NEAR RKM 45, KENAI RIVER, ALASKA, 1 AUGUST–30 SEPTEMBER 1999–2007.

Appendix E1.–Average bi-weekly fish wheel spin rate, and selected water conditions by river bank (north or south) near RKM 45 of the Kenai River, Alaska, 1 August–30 September 1999–2007.

Year	Period	Fish wheel spin rate (rpm) North bank	Fish wheel spin rate (rpm) South bank	Water transparency (meters by bank)	River Gage Height[b] (feet)	River Discharge[b]
1999[a]	1–15 Aug	n/a	3.69	0.72	9.72	14,573
	16–31 Aug	5.13	2.58	0.99	9.39	13,019
	1–15 Sep	4.62	3.16	1.03	8.88	10,763
	16–30 Sep	5.47	4.38	0.88	9.49	13,480
	Entire Season	5.03	3.44	0.91	9.37	12,960
2000	1–15 Aug	5.24	4.18	1.18	9.57	13,767
	16–31 Aug	4.08	3.52	1.15	8.68	10,161
	1–15 Sep	3.48	4.55	0.83	7.80	7,215
	16–30 Sep	3.03	4.39	0.68	7.28	5,444
	Entire Season	3.96	4.15	0.90	8.34	9,163
2001	1–15 Aug	2.61	3.42	1.53	10.07	16,273
	16–31 Aug	3.06	3.28	0.90	10.11	16,469
	1–15 Sep	3.00	3.82	0.86	10.12	16,573
	16–30 Sep	2.93	3.83	0.90	9.67	14,327
	Entire Season	2.90	3.58	0.94	10.00	15,920
2002	1–15 Aug	3.09	3.79	1.45	9.57	13,757
	16–31 Aug	3.63	3.12	1.41	9.16	11,894
	1–15 Sep	3.21	4.04	1.27	8.76	10,225
	16–30 Sep	3.42	4.81	0.88	8.76	10,489
	Entire Season	3.36	3.93	1.22	9.06	11,560
2003	1–15 Aug	3.22	4.17	0.66	9.44	12,813
	16–31 Aug	3.64	4.36	0.71	9.76	14,188
	1–15 Sep	3.35	3.43	0.94	9.00	10,821
	16–30 Sep	3.04	3.76	1.14	7.44	5,397
	Entire Season	3.32	3.94	0.91	8.92	10,860
2004	1–15 Aug	3.49	3.84	1.04	9.76	14,907
	16–31 Aug	3.11	3.62	1.01	9.39	13,206
	1–15 Sep	3.23	3.09	0.94	8.54	9,712
	16–30 Sep	2.91	3.11	0.81	7.36	5,709
	Entire Season	3.18	3.40	0.95	8.77	10,922
2005	1–15 Aug	3.27	4.70	1.26	9.36	13,367
	16–31 Aug	3.14	4.34	0.87	9.10	12,231
	1–15 Sep	3.75	3.52	0.66	8.69	10,530
	16–30 Sep	3.67	3.59	0.82	8.67	10,353
	Entire Season	3.45	4.04	0.92	8.95	11,630
2006	1–15 Aug	3.73	4.11	1.08	9.79	15,227
	16–31 Aug	3.65	4.09	0.88	9.86	15,550
	1–15 Sep	3.46	3.61	0.84	9.33	13,120
	16–30 Sep	3.10	3.26	0.83	8.96	11,472
	Entire Season	3.50	3.78	0.91	9.49	13,870
2007	1–15 Aug	3.90	4.06	0.83	9.25	12,920
	16–31 Aug	4.23	4.13	1.02	9.28	13,042
	1–15 Sep	4.03	3.24	1.00	8.45	9,602
	16–30 Sep	4.04	2.51	1.03	8.17	8,601
	Entire Season	4.05	3.48	0.98	8.79	11,064

[a] Water transparency recorded at RKM 31; fish wheel spin rate recorded at RKM 43–45.

[b] As measured at the Kenai River bridge at Soldotna (United States Geological Survey River Gaging Station Site 15266300).

APPENDIX F: SUMMARY OF THE CUMULATIVE FISH WHEEL CATCH PER UNIT EFFORT (CCPUE) AND THE NATURAL LOG-TRANSFORMED CCPUE OF COHO SALMON, KENAI RIVER, ALASKA, 1999–2007.

Appendix F1.–Summary of the cumulative fish wheel catch per unit effort (CCPUE) and the natural log-transformed CCPUE (lnCCPUE) of coho salmon using adjusted data for north bank fish wheel near RKM 45, Kenai River, Alaska, 1999–2007.

Year	Measure of catch	North bank fish wheel				
		1–14 Aug	1–28 Aug	1 Aug–11 Sep	1 Aug–25 Sep	1 Aug–30 Sep
1999[a]	CCPUE					
	LnCCPUE					
2000	CCPUE	26.24	63.66	128.16	215.27	227.03
	LnCCPUE	3.27	4.15	4.85	5.37	5.43
2001	CCPUE	12.31	32.85	42.16	50.48	52.18
	LnCCPUE	2.51	3.49	3.74	3.92	3.95
2002	CCPUE	2.88	116.58	312.42	491.23	507.18
	LnCCPUE	1.06	4.76	5.74	6.20	6.23
2003	CCPUE	2.27	11.83	16.78	19.62	20.21
	LnCCPUE	0.82	2.47	2.82	2.98	3.01
2004	CCPUE	37.43	197.83	323.18	451.03	489.15
	LnCCPUE	3.62	5.29	5.78	6.11	6.19
2005	CCPUE	9.12	163.75	230.93	256.07	261.69
	LnCCPUE	2.21	5.10	5.44	5.55	5.57
2006	CCPUE	6.07	65.18	139.59	224.87	240.41
	LnCCPUE	1.80	4.18	4.94	5.42	5.48
2007	CCPUE	3.06	17.28	33.12	52.32	54.82
	LnCCPUE	1.12	2.85	3.50	3.96	4.00

Note: Summary of 1999–2004 CCPUE includes only standardized daily fish wheel operation and does not include coho salmon recaptured, escaped, or considered unsuitable for marking (i.e., severely injured or dead).

[a] Fish wheel locations in 1999 were RKM 31, and between RKM 43 and 45. "Adjusted" daily catch and effort are available only for combined banks (Appendix F3).

Appendix F2.–Summary of the cumulative fish wheel catch per unit effort (CCPUE) and the natural log-transformed CCPUE (lnCCPUE) of coho salmon using adjusted data for south bank fish wheel near RKM 45, Kenai River, Alaska, 1999–2007.

Year	Measure of catch	South bank fish wheel 1–14 Aug	1–28 Aug	1 Aug–11 Sep	1 Aug–25 Sep	1 Aug–30 Sep
1999[a]	CCPUE					
	LnCCPUE					
2000	CCPUE	3.37	6.43	36.92	65.11	68.37
	LnCCPUE	1.21	1.86	3.61	4.18	4.22
2001	CCPUE	11.32	62.83	108.77	117.43	122.05
	LnCCPUE	2.43	4.14	4.69	4.77	4.80
2002	CCPUE	24.34	152.43	270.33	322.00	331.14
	LnCCPUE	3.19	5.03	5.60	5.77	5.80
2003	CCPUE	39.62	163.57	195.95	197.37	199.37
	LnCCPUE	3.68	5.10	5.28	5.29	5.30
2004	CCPUE	73.89	390.20	566.06	615.12	624.47
	LnCCPUE	4.30	5.97	6.34	6.42	6.44
2005	CCPUE	3.23	78.25	170.54	201.10	208.30
	LnCCPUE	1.17	4.36	5.14	5.30	5.34
2006	CCPUE	24.79	163.64	263.30	384.22	408.56
	LnCCPUE	3.21	5.10	5.57	5.95	6.01
2007	CCPUE	2.34	14.99	27.47	34.87	34.97
	LnCCPUE	0.85	2.71	3.31	3.55	3.55

Note: Summary of 1999–2004 CCPUE includes only standardized daily fish wheel operation and does not include coho salmon recaptured, escaped, or considered unsuitable for marking (i.e., severely injured or dead).

[a] Fish wheel locations in 1999 were RKM 31, and between RKM 43 and 45. Adjusted daily catch and effort are available only for combined banks (Appendix F3).

Appendix F3.–Summary of the cumulative fish wheel catch per unit effort (CCPUE) and the natural log-transformed CCPUE (lnCCPUE) of coho salmon using adjusted data for combined banks fish wheels near RKM 45, Kenai River, Alaska, 1999–2007.

Year	Measure of catch	Combined banks fish wheels				
		1–14 Aug	1–28 Aug	1 Aug–11 Sep	1 Aug–25 Sep	1 Aug–30 Sep
1999[a]	CCPUE	4.46	25.86	30.34	36.19	37.63
	LnCCPUE	1.50	3.25	3.41	3.59	3.63
2000	CCPUE	14.79	34.86	79.87	135.90	143.40
	LnCCPUE	2.69	3.55	4.38	4.91	4.97
2001	CCPUE	11.84	47.78	75.13	83.87	87.07
	LnCCPUE	2.47	3.87	4.32	4.43	4.47
2002	CCPUE	13.52	133.71	287.93	399.00	411.33
	LnCCPUE	2.60	4.90	5.66	5.99	6.02
2003	CCPUE	20.54	83.17	101.36	103.47	104.76
	LnCCPUE	3.02	4.42	4.62	4.64	4.65
2004	CCPUE	58.17	305.68	459.94	550.89	574.55
	LnCCPUE	4.06	5.72	6.13	6.31	6.35
2005	CCPUE	6.18	119.86	199.75	228.34	234.75
	LnCCPUE	1.82	4.79	5.30	5.43	5.46
2006	CCPUE	15.63	113.54	200.82	303.99	324.02
	LnCCPUE	2.75	4.73	5.30	5.72	5.78
2007	CCPUE	2.70	16.95	31.12	44.52	46.93
	LnCCPUE	0.99	2.83	3.44	3.80	3.85

Note: Summary of 1999–2004 CCPUE includes only standardized daily fish wheel operation and does not include coho salmon recaptured, escaped, or considered unsuitable for marking (i.e., severely injured or dead).

[a] Fish wheel locations in 1999 were RKM 31, and between RKM 43 and 45. Adjusted daily catch and effort are available only for combined banks.

APPENDIX G: DAILY COMBINED FISH WHEEL EFFORT AND CATCH AT RKM 45 AND PREVIOUS DAY SONAR COUNTS FROM RKM 31 FOR SOCKEYE SALMON, KENAI RIVER, ALASKA, 2000–2007.

Appendix G1.–Daily combined fish wheel effort and sockeye salmon catch during standardized periods at RKM 45 and previous day sockeye salmon sonar counts from RKM 31, Kenai River, Alaska, 2000–2007.

Year	Day	Fish wheel effort in hours	Sockeye salmon catch	Daily sockeye salmon CPUE	Sockeye salmon CCPUE	Sonar sockeye salmon count[a,b]
2000	1 Aug	17.25	142	8.23	8.23	6,886
2000	2 Aug	27.05	331	12.24	20.47	7,314
2000	3 Aug	27.87	376	13.49	33.96	5,119
2000	4 Aug	27.00	374	13.85	47.81	8,776
2000	5 Aug	14.00	125	8.93	56.74	9,709
2000	6 Aug	24.83	154	6.20	62.94	8,028
2000	7 Aug	27.35	228	8.34	71.28	6,988
2000	8 Aug	28.00	155	5.54	76.82	6,014
2000	9 Aug	28.00	149	5.32	82.14	4,899
2000	10 Aug	27.50	133	4.84	86.97	4,561
2001	1 Aug	5.03	53	10.53	10.53	14,943
2001	2 Aug	17.33	416	24.00	34.53	14,203
2001	3 Aug	27.25	314	11.52	46.05	14,821
2001	4 Aug	27.75	375	13.51	59.57	11,111
2001	5 Aug	26.62	333	12.51	72.08	12,914
2001	6 Aug	26.58	323	12.15	84.23	8,789
2001	7 Aug	27.00	283	10.48	94.71	9,206
2001	8 Aug	26.42	142	5.38	100.08	9,714
2001	9 Aug	27.67	96	3.47	103.55	9,086
2001	10 Aug	24.52	104	4.24	107.80	4,549
2002	1 Aug	7.97	268	33.64	33.64	13,878
2002	2 Aug	8.83	210	23.77	57.41	12,417
2002	3 Aug	0.00	0	0.00	57.41	13,770
2002	4 Aug	26.58	485	18.24	75.66	15,363
2002	5 Aug	26.35	458	17.38	93.04	16,473
2002	6 Aug	21.33	217	10.17	103.21	17,281
2002	7 Aug	24.05	157	6.53	109.74	14,301
2002	8 Aug	22.62	157	6.94	116.68	15,157
2002	9 Aug	23.90	244	10.21	126.89	19,177
2002	10 Aug	21.85	106	4.85	131.74	24,016
2003	1 Aug	15.32	75	4.90	4.90	18,273
2003	2 Aug	14.50	246	16.97	21.86	19,193
2003	3 Aug	20.67	287	13.89	35.75	22,697
2003	4 Aug	25.88	525	20.28	56.03	20,265
2003	5 Aug	26.52	243	9.16	65.20	15,245
2003	6 Aug	25.73	300	11.66	76.85	10,702
2003	7 Aug	26.30	281	10.68	87.54	17,827
2003	8 Aug	25.40	216	8.50	96.04	13,680
2003	9 Aug	26.40	190	7.20	103.24	9,370
2003	10 Aug	25.50	190	7.45	110.69	8,904

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Appendix G1. Part 2 of 2.

Year	Day	Fish wheel effort in hours	Sockeye salmon catch	Daily sockeye salmon CPUE	Sockeye salmon CCPUE	Sonar sockeye salmon count[a,b]
2004	1 Aug	13.93	248	17.80	17.80	19,498
2004	2 Aug	22.85	604	26.43	44.23	13,483
2004	3 Aug	22.53	2082	92.40	136.63	17,838
2004	4 Aug	18.08	1783	98.60	235.23	39,009
2004	5 Aug	15.45	1659	107.38	342.61	43,784
2004	6 Aug	15.18	1692	111.44	454.04	29,016
2004	7 Aug	20.75	806	38.84	492.89	27,525
2004	8 Aug	18.75	731	38.99	531.87	21,543
2004	9 Aug	16.13	994	61.61	593.49	12,077
2004	10 Aug	11.73	1502	128.01	721.50	30,261
2005	1 Aug	19.54	1795	91.86	91.86	35,725
2005	2 Aug	24.15	1136	47.04	138.90	24,704
2005	3 Aug	23.63	788	33.35	172.25	15,052
2005	4 Aug	23.65	1553	65.67	237.92	21,349
2005	5 Aug	24.20	1444	59.67	297.59	17,563
2005	6 Aug	23.96	1610	67.20	364.78	15,494
2005	7 Aug	21.44	2703	126.07	490.85	37,665
2005	8 Aug	24.96	1324	53.04	543.90	33,614
2005	9 Aug	24.41	1186	48.59	592.48	14,048
2005	10 Aug	25.25	609	24.12	616.60	11,524
2006	1 Aug	9.33	2499	267.75	267.75	48,861
2006	2 Aug	12.02	1794	149.29	417.04	59,350
2006	3 Aug	14.65	1721	117.47	534.52	49,360
2006	4 Aug	11.00	1632	148.36	682.88	41,831
2006	5 Aug	13.50	2083	154.30	837.18	43,931
2006	6 Aug	13.23	768	58.04	895.21	46,260
2006	7 Aug	22.83	1121	49.09	944.31	30,163
2006	8 Aug	21.10	843	39.95	984.26	21,990
2006	9 Aug	22.83	583	25.53	1009.79	13,860
2006	10 Aug	23.98	320	13.34	1023.14	13,297
2007	1 Aug	14.52	47	3.24	3.24	19,122
2007	2 Aug	15.20	156	10.26	13.50	19,436
2007	3 Aug	20.60	80	3.88	17.38	14,422
2007	4 Aug	22.73	62	2.73	20.11	8,741
2007	5 Aug	23.08	123	5.33	25.44	12,540
2007	6 Aug	20.87	150	7.19	32.63	18,479
2007	7 Aug	23.72	150	6.32	38.95	23,445
2007	8 Aug	23.35	107	4.58	43.54	15,681
2007	9 Aug	23.37	170	7.28	50.81	13,134
2007	10 Aug	23.18	159	6.86	57.67	24,429

Note: Standardized fish wheel operating periods are found in Appendix A1.

[a] Counts reflect sockeye salmon passage estimates obtained from the Kenai River RKM 31 sonar site occurring two days prior to "Day" listed for "Sockeye salmon catch" in order to account for salmon travel time to reach the RKM 45 fish wheel site.

[b] RKM 31 sockeye sonar data provided by David Westerman, ADF&G Division of Commercial Fisheries, Soldotna.