Fishery Data Series No. 10-26

Anchor River Chinook and Coho Salmon Escapement Project, 2005-2006

by

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and

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

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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

Anchor River Chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch* escapement estimates were generated in 2005 and 2006 from Dual-frequency IDentification SONar (DIDSON) counts during high spring flows and counts through resistance board weir thereafter. The Chinook salmon escapement estimates were compared to annual aerial index counts in 2005 (11,156 fish [SE = 229] to 651 fish, respectively) and 2006 (8,945 fish [SE = 289] to 899 fish, respectively). Ocean age-3 Chinook salmon dominated the 2005 (52.2%; SE = 2.5) and 2006 (52.1%; SE = 3.8) runs. In 2005, the weir washed out late in the coho salmon run in early September when fish passage was still high. The 2005 coho salmon escapement (18,977 fish) was close to the 1989 record (20,187 fish). In 2006, the weir washed out in mid-August when the run was building. Age class 2.1 coho salmon dominated the 2005 (84.9%; SE = 1.8) and 2006 (70.7%; SE = 3.9) runs.

Key words: Anchor River, Chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, run timing, diel, stock status, weir, sonar, DIDSON.

INTRODUCTION

Anchor River, located on the southern portion of the Kenai Peninsula (Figure 1), supports the largest freshwater Chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch* sport fisheries in the Lower Cook Inlet Management Area (LCIMA). The Anchor River watershed is approximately 587 km^2, with about 266 river km (rkm) of anadromous streams (Table 1). Anchor River has two major forks (North and South Forks) whose confluence is located approximately 2.8 rkm upstream from the mouth. The South Fork watershed is approximately twice as big as the North Fork watershed. Flow in the Anchor River can rise substantially following heavy rains because of its small size, channel geometry, and vegetation.

After the construction of a highway to Homer in 1949, the first known fish studies for Anchor River were conducted by federal biologist in the early 1950s to assess the effects of increased access on Anchor River fisheries (R.W. Allin, U.S. Fish and Wildlife Service, *unpublished*[1]).

From 1976 to 2002, the tools used to evaluate fishing pressures and run size of Anchor River fish stocks were limited to the following:

1. Sport harvest (or catch) for each species and effort from the Statewide Harvest Survey (SWHS) estimates collected annually through the use of mail questionnaires since 1977 (Table 2).
2. Index counts of Chinook salmon escapement from combined aerial and ground counts (1976-1995) and then from aerial counts only thereafter (Table 3).
3. Nine years (1987 to 1995) of fish counts from a weir operated approximately 1.6 rkm (1 mile) upstream from the mouth. The weir was installed in July and operated for 1 to 4 months. This weir yielded a partial count of the Chinook salmon run, but monitored the entire run of coho salmon over 4 years. (Table 4).

In 2003, a dual frequency identification sonar (DIDSON) and weir project was initiated to estimate Chinook salmon escapement. In 2004, the duration of the DIDSON/weir project was extended to include monitoring of coho salmon escapement through mid-September. This escapement project has substantially increased our knowledge of the stock status for Anchor

[1] Allin, R. W. *Unpublished*. Stream survey of Anchor River. U. S. Fish and Wildlife Service. Federal Aid in Fish Restoration Project. Job Completion Report (circa 1954), 4(2): 47-66, Territory of Alaska.

River Chinook and coho salmon. The following two sections provide background information on Anchor River Chinook and coho salmon stocks.

CHINOOK SALMON BACKGROUND

Chinook salmon return to LCIMA streams from approximately early May through late July with a peak in early June. Anchor River, Deep Creek, and Ninilchik River produce the highest return of Chinook salmon in the LCIMA. Of these three drainages, Anchor River is the highest producer of Chinook salmon.

Historically, monitoring Chinook salmon for the entire run in Anchor River has been problematic because traditional methods were not suitable to operate in both the high water conditions in May and during the recurring periods of low water in June and July. For example, traditional sonar technologies (e.g. spit beam sonar) commonly used to monitor escapement in large Alaskan rivers (e.g. Kenai River) were not suited for smaller streams like Anchor River. Also traditional weir methods (fixed picket or resistance board weirs) commonly used to monitor escapement in small streams could not be installed in Anchor River in May and early June because river levels were typically too high and the current too swift for installation. Therefore, the Department elected to fly aerial surveys annually during peak spawning to index Chinook salmon escapement and provided a means for evaluating escapement trends. However, because of the inherent biases associated with aerial surveys (e.g. differences in survey conditions and surveyor biases) year-to-year comparisons of escapements remained imprecise.

The Alaska Board of Fisheries (BOF) listed Anchor River Chinook salmon as a stock of "management concern" in 1999 in response to the guidelines established in the *Sustainable Salmon Fisheries Policy* (5 AAC 39.222). The BOF also restricted the fishery from five to four 3-day weekends because of the chronic inability to maintain the escapement within the bounds of the sustainable escapement goal (SEG) that was established in 2000, which was based on index counts (Szarzi and Begich 2004a; Table 3). The stock of management concern listing highlighted the need for investigating an alternative method for monitoring Anchor River Chinook salmon escapement.

In 2003, a DIDSON was deployed in the Anchor River to test its utility for monitoring Chinook salmon escapement (Kerkvliet et al. 2008). The DIDSON was located on the mainstem of the river just below the North and South Fork confluence, upstream of the fishery (~ 2.8 rkm from the mouth) at a site where the river profile was relatively level (Figures 2 and 3). The DIDSON was activated soon after ice-out in late May when river levels were high and early run Chinook salmon were beginning to enter the river. The DIDSON proved to be a useful tool for estimating Chinook salmon escapement.

In 2004, the DIDSON was only used in May and June when river levels were high. Later when the river level dropped a resistance board weir was installed and the DIDSON was removed. The benefit of using the resistance board weir was that it provided a census rather than an estimate of the escapement. The resistance board weir was selected over a fixed picket weir, because debris could be removed more easily.

The Chinook salmon escapements in 2003-2004 were much higher than previously suggested from aerial index counts (Kerkvliet et al. 2008). The 2003 Chinook salmon escapement (9,238 fish) represented a partial count because counts were high on the first day the DIDSON became operational (May 30) and were similarly high when the DIDSON was removed (July 9; Table 4).

In 2004, the DIDSON was activated in mid-May and monitoring continued using the resistance board weir through early September. Therefore, the 2004 Chinook salmon escapement estimate represented a full count (12,016 fish; SE = 283). Because of the low exploitation in 2004, the Alaska Department of Fish and Game, Division of Sport Fish (DSF) issued an emergency order (EO) that added a fifth weekend of fishing for Chinook salmon. Since then, Anchor River management decisions have been based on DIDSON/weir counts rather than on the sustainable escapement goal (SEG) derived from index counts. Despite the EO, the freshwater exploitation remained low (<12%) on Anchor River Chinook salmon (Table 5).

In the fall of 2004 significant changes were made that affected the Anchor River Chinook salmon sport fishery: the BOF rescinded the stock of concern listing, the BOF also liberalized the Chinook salmon sport fishery by adding a fifth opening weekend before Memorial Day, and the DSF rescinded the SEG (Szarzi and Begich 2004b).

COHO SALMON BACKGROUND

Coho salmon stocks are distributed widely in streams throughout the Lower Kenai Peninsula, and they spawn in a variety of freshwater habitats. Run timing of coho salmon in the LCIMA is approximately mid-July through mid-September with a peak in mid-August.

Anchor River coho salmon escapement counts were collected opportunistically from 1987 through 1995 at a weir operated for counting Dolly Varden *Salvelinus malma* or immigrating steelhead *Oncorhynchus mykiss* (Table 4). The weir was located approximately 1.6 rkm (1 mile) from the river mouth, within the river section open to sport fishing. The weir was operated for 4 years (1987, 1988, 1989, and 1992) throughout the coho salmon immigration, and weir counts for these years ranged from 2,409 to 20,187 fish. Because the weir was located within the river section open to sport fishing, counts were considered maximum escapement counts because of the unknown harvest upstream.

Escapement monitoring at the Anchor River DIDSON/weir site was expanded in 2004 to include coho salmon and is currently the only coho salmon stock monitored by the DSF in the LCIMA (Kerkvliet et al. 2008). In 2004, most (78%) of the coho salmon escapement (5,728 fish, Table 4) was counted in early September during high flows.

The freshwater exploitation on Anchor River coho salmon from 1987 to 1989 and 1992 ranged from 11.7% to 45.5% based on the maximum escapement weir counts and estimated freshwater harvest (Table 6). In 1999, the BOF adopted the current daily bag and possession limit of 2 coho salmon 16 inches and longer for all eastside Cook Inlet streams (Szarzi and Begich 2004a). The 2004 exploitation level (43.3%) was similar to historic levels. Currently no coho salmon stock has an escapement goal in the LCIMA.

This report is part of a series providing information that will be used in Chinook salmon escapement goal analyses and in coho salmon management according to the Sustainable Fisheries and Escapement Goal Policy.

OBJECTIVES AND TASKS

OBJECTIVES FOR 2005 AND 2006

1. Estimate the adult Chinook salmon escapement that passes upstream of rkm 2.8 (≈ 2 river miles) on Anchor River from approximately May 15 through September 13.

2. Census the adult coho salmon escapement that passes upstream of rkm 2.8 on Anchor River from approximately May 15 through September 13.
3. Estimate the age and sex composition of the Anchor River Chinook salmon escapement.
4. Estimate the age and sex composition of the Anchor River coho salmon escapement.
5. Conduct an aerial survey count of the Chinook salmon escapement upstream of rkm 2.8 of Anchor River on approximately July 28.

TASKS

1. Estimate length-at-age of the escapement of Chinook and coho salmon into the Anchor River upstream of rkm 2.8.
2. Examine all Chinook and coho salmon sampled for age, sex, and length (ASL) data for an adipose fin.
3. Calculate between-reader and within-reader variation of the DIDSON recordings used to estimate the escapement.
4. Determine diel[2] timing of Chinook and coho salmon passage at the Anchor River mainstem DIDSON weir site during DIDSON operation and determine diurnal[3] timing of Chinook and coho salmon passage at the same site from weir counts.
5. Measure water depth and temperature throughout the DIDSON and mainstem weir operations.

METHODS

OPERATION DATES AND EQUIPMENT

2005

In 2005 the Chinook salmon escapement was estimated from 1200 hours May 13 through 1300 hours June 3 using the DIDSON system (Figure 4). The Chinook and coho salmon escapement was censused from June 3 through July 8 using a resistance board weir. From July 8 to 11, Chinook salmon were estimated at night (0000–0700 hours) using the DIDSON and censused during the day (0701–2359 hours) using the resistance board weir. Thereafter Chinook and coho salmon were censused through September 9. The project ended on September 9 when high water caused a cottonwood tree to float downstream to the mid-channel live box breaking it free from the weir. Details of the different methods used for monitoring are listed below.

2006

In 2006 the Chinook salmon escapement was estimated from 1700 hours May 15 through 0200 hours June 13 using the DIDSON system (Figure 4). The Chinook and coho salmon escapement was censused from June 13 through August 18 using the resistance board weir. On August 19, the river rose overnight and by early that morning about 75% of the weir was beneath the flood waters, and at approximately 0820 hours the earth anchors holding the weir in place pulled free

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[2] "Diel" – of or pertaining to a 24-h period. Source: Dictionary.com website. Available at http://dictionary.reference.com (March 2010).

[3] "Diurnal" – occurring daily during the daytime rather than at night. Source: The American Heritage dictionary of the English Language, fourth edition.

from the right bank. After the right bank portion of the weir broke free, we opted to use the DIDSON to continue monitoring the escapement because high numbers of coho salmon were still entering the river. From 1800 hours August 22 through 1920 hours August 24, the DIDSON was used in combination with one section of the partial floating weir that had remained anchored and a newly constructed section of fixed picket weir so we could continue monitoring coho salmon.

Both years, during the DIDSON operation, beach seines were used to capture Chinook salmon for ASL data from the North and South Fork (Table 7). With the installation of the resistance board weir, live boxes were used to capture Chinook and coho salmon for ASL samples.

DIDSON and Partial Picket Weirs

The DIDSON system gives a near video-quality image of fish and is well suited for counting migrating salmon in the Anchor River. Because the width of Anchor River at the monitoring site (~31 m) is greater than the effective 20-m detection range of the DIDSON (Burwen et al. 2007), two partial picket weirs were installed to restrict the width of the fish passage area at the monitoring site to 20 m (Figure 4). Set-up details for the DIDSON and partial picket weirs are described in Appendix A1.

DIDSON and Resistance Board Weir

In 2005, large numbers of Dolly Varden migrated past the sonar/weir site at night in early July. In order to prevent the building up of Dolly Varden above or below the weir during this time we operated the DIDSON from sunset to sunrise and left the upstream and downstream gates of the live box open during hours of darkness (Figure 5). The DIDSON was aimed at the upstream opening of the live box and used to record fish as they passed through the gate. During the day, the DIDSON was turned off and a census was collected via normal weir operations.

In 2006 after the resistance board weir washed out in August, we used a combination of a fixed picket weir on the right bank and a section of the resistance board weir that had not broken free from the earth anchors to reduce fish passage to approximately 9 m.

Mainstem Resistance Board Weir

River levels dropped sufficiently for installation of the resistance board weir on June 3, 2005 and June 2, 2006. In both years, the resistance board weir (length ~31 m) was installed approximately 6 m below the DIDSON (Figures 3 and 5). The spacing between the pickets of the resistance board weir and live box were approximately 2.8 cm (1.5 in) to block the passage of all but the smallest ocean-age-1 Chinook salmon. Two live boxes were built into the weir. In 2005, we placed one live box near the right bank and the second in the middle of the river; the bank-oriented live box enabled the crew to pass fish during high water levels, when the mid-channel box was inoperable. In 2006, we placed one live box near the left bank and the second in the middle of the river. For both years, all bottom irregularities at the base of the weir were sealed using a wire mesh skirt and sand bags. Once the weir was fish tight, the partial picket weirs and DIDSON equipment were removed.

In June 2006, a “steelhead chute” was used to allow emigrating post spawning steelhead (kelts) to swim downstream. The “steelhead chute” was created by weighting the downstream end of one of the floating weir panels with a sand bag, which provided a shallow opening for fish to swim downstream over the weir. The placement of the sand bag was used to adjust the water depth flowing over the panel so that kelts could swim downstream over the weir panel, yet prevent immigrating fish from swimming upstream over the panel. The "steelhead chute" was positioned near the thalweg.

ESCAPEMENT COUNTS

DIDSON and Partial Picket Weirs

Both years, DIDSON images were automatically saved to files and uniquely named by date and time using the DIDSON data collection software provided by the manufacturer (Sound Metrics Corporation[4]). The DIDSON software was programmed to collect images in three 20-min files each hour.

Each year, upstream and downstream fish images were counted for one 20-min file every hour. If the first 20-min file was incomplete or missing, then the second or third 20-min file was counted and used in the analysis.

The Chinook salmon component of the DIDSON counts were determined by the following method: (1) upstream images were assumed to be Chinook salmon. This assumption was tested, by examining the salmon species composition from samples collected on the South and North Fork of the Anchor River (Kerkvliet et al. 2008), and (2) downstream images were assumed to be Chinook salmon. This assumption was not verified and it is likely that a portion of the downstream counts included post-spawning steelhead. The 2005 and 2006 Chinook salmon estimates are based on expanded 20-min DIDSON net counts (upstream-downstream) per hour.

In 2005, deviations of the counting protocol consisted of (1) 5 h period that contained less than twenty minutes of data for a given hour; counts were expanded to full hours; and (2) 8 h of data were lost because of a computer malfunction and counts were linearly interpolated.

In 2006, deviations of the counting protocol consisted of (1) 23 h of files could not be counted due to silting of the lens; counts were linearly interpolated; and (2) 7 h of data were lost because of a computer malfunction and counts were interpolated.

DIDSON and Mainstem Resistance Board Weir

During the 4-d period in 2005 and 3-d period in 2006 when the DIDSON was operated in combination with the resistance board weir, DIDSON files were saved and counted as described above.

In 2005 because of the significant size differences between Dolly Varden and salmon, images of small fish were counted as Dolly Varden and images of large fish were counted as Chinook salmon, which was the dominant salmonid migrating.

In 2006, just before the weir washed out, approximately 93% of the fish counted through the live boxes were coho salmon; therefore, all large fish images were counted as coho salmon.

Mainstem Resistance Board Weir

Escapement counts were collected during daylight hours. The downstream gates to both live boxes were opened on or before 0800 hours and closed just before dark. Technicians periodically checked the live boxes and processed all fish as quickly as possible to prevent

[4] Company and product names used in this report are included for scientific completeness, but do not constitute an endorsement.

impeding the migration of the fish. The technician recorded the hour that fish were counted through the live box. All fish were identified to species and tallied for the daily escapement counts. In 2006, the daily counts of emigrating steelhead observed passing downstream through the "steelhead chute" were collected opportunistically.

Aerial Index Count

In 2005 and 2006, helicopter surveys were flown on July 25 over the South Fork of the Anchor River to index Chinook salmon escapement. Different pilots flew each survey, but the surveyors were the same individual for both years, although the index count was based on a different surveyor each year (see below). The index area started at Beaver Creek and the South Fork confluence (lat 59°46.517N, long 151°28.530W) and stopped at the Old Sterling Highway Bridge (lat 59°46.329N, long 151°50.200W). The following conditions were evaluated and recorded for each aerial survey flight: percent cloud cover, water clarity, and water glare. Index counts included the number of live and dead Chinook salmon observed. In 2006, an additional section of the river was flown upstream of the Beaver Creek and South Fork confluence to the following geographic coordinate (lat 59°48.05N, long 151°17.82W) to see how many additional Chinook salmon were upstream of the index area.

One surveyor (A) had conducted the counts since 1997 from the front seat of the helicopter. The second surveyor (B) had flown the survey once in 2004. The index count was based on the surveyor sitting in the front seat of the helicopter (surveyor A in 2005 and surveyor B in 2006).

River Temperature and Stage

In 2005 and 2006 Cook Inlet Keeper (CIK, a citizen based nonprofit organization) collected river temperatures using a temperature logger, which was programmed to collect the average, minimum, and maximum water temperature in Celsius every 15 min at a site (AR-3) located approximately 0.1 rkm downstream of the sonar/weir site (Mauger 2004). In this report, daily temperatures are averages of all the 15-min temperature readings collected (average, minimum, and maximum).

In 2005 and 2006, river stage[5] measurements were taken each day at approximately 2000 hours from a meter stick attached to a fence post (staff gauge) secured near the left bank upstream from the weir site in an eddy during the DIDSON operation, then secured to the left side of the mid-channel live box once the floating weir was installed.

BIOLOGICAL SAMPLING

Netting Samples

ASL data were collected from Chinook salmon captured by a beach seine upstream of the sonar site on the North and South Forks of the Anchor River during the DIDSON period (Figure 2).

In 2005, the South Fork was sampled twice (May 31 and June 8) and the North Fork three times (May 19 and June 2 and 10). In 2006, the South Fork was sampled three times (May 31, June 8, and June 15) and the North Fork was sampled four times (May 27, May 30, June 6, and June 13).

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[5] River stage – the height or elevation of the river's water surface above a reference level (e.g., sea level, gauge level, stream bed, etc.).

A 30.5 m long by 2 m deep beach seine with 5.1 cm stretched mesh size (abbreviated below as "net") was drifted through deep pools to capture fish on the North and South Forks of the Anchor River. Captured fish were processed as quickly as possible.

All fish captured in the beach seine from the North and South Forks were identified by species, and their length from mid eye to tail fork (METF) was measured to the nearest 5 mm. Sex was determined by examining morphological characteristics (e.g., presence of an ovipositor, kype, and girth) and scale samples were collected (Welander 1940) from all Chinook salmon captured. The caudal fin was clipped on all Chinook salmon and steelhead before release to prevent double sampling. Scales were pressed and age determined using methods described by Mosher (1969). Scales were aged without reference to size, sex, or other data.

Mainstem Resistance Board Weir Samples

In 2005 and 2006, ASL data were generally collected from every 40th Chinook and every 35th coho salmon that passed the live boxes. Scales were collected, processed, and read as described above. However on days when large numbers of fish passed the weir, ASL sampling was modified based on the daily fish count. For example whenever 350 coho salmon were counted through the weir, the next 10 coho salmon were sampled as a batch for ASL data.

Coded Wire Tag Samples

All Chinook salmon captured with a beach seine and Chinook and coho salmon sampled for ASL data were checked for the presence or absence of an adipose fin. Fish with missing adipose fins were sacrificed for coded wire tag (CWT) information. Heads were labeled with a numbered cinch strap, frozen, and sent to the Alaska Department of Fish and Game Mark, Tag and Age Laboratory in Juneau for analysis. The CWT data indicating the origin of the fish sampled were queried from the tag lab website[6].

DATA ANALYSIS

Chinook Salmon Escapement

A DIDSON sonar was used during periods of high water, until a resistance board weir could be installed that allowed a census of the Chinook salmon count thereafter.

Net upstream passage for the period counted by the DIDSON within the j^{th} hour (j=1,..,24) of the k^{th} day of the season was calculated as:

$$n_{jk} = u_{jk} - d_{jk}\,, \tag{1}$$

where:

u_{jk} = upstream counts for the period counted in hour j of day k

d_{jk} = downstream counts for the period counted in hour j of day k.

Net upstream counts for each hour were estimated as:

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[6] Mark, Tag and Age Laboratory Database [Internet]. Juneau, AK: ADF&G. 2006. [11:49:00 AM 22 Dec 2006 update]. Available from http://tagotoweb.adfg.state.ak.us/CWT/reports/.

$$\hat{c}_{jk} = \frac{60}{t_{jk}} n_{jk}, \tag{2}$$

where:

t_{jk} = number of minutes sampled during the j^{th} hour on day k (target=20 min).

In the rare situations where entire hours were not counted due to computer malfunction, silting of sonar lens etc., counts were linearly interpolated. The number of hours for which there is no count is very small and we do not believe that these adjustments contribute any meaningful bias or variance to the season-end estimates.

Hourly count estimates ($\hat{c}_{jk}$) were summed to provide daily (C_k) estimates of escapement and an estimate of the total escapement passage (C_D) during DIDSON system operation:

$$\hat{C}_k = \sum_{j=1}^{24} \hat{c}_{jk}, \tag{3}$$

$$\hat{C}_D = \sum_{k=1}^{K} \hat{C}_k, \tag{4}$$

where K is the number of days of operation of the DIDSON system in the year in question. The variance of $\hat{C}_D$ was estimated as:

$$\text{var}(\hat{C}_D) = \sum_{k=1}^{K} \text{var}(\hat{C}_k) = \sum_{k=1}^{K} \sum_{j=1}^{24} \text{var}(\hat{c}_{jk}), \tag{5}$$

where:

$$\text{var}(\hat{c}_{jk}) = \left[\frac{60}{t_{jk}}\right]^2 \text{var}(n_{jk}) = \left[\frac{60}{t_{jk}}\right]^2 s^2 \left[1 - \frac{t_{jk}}{60}\right], \tag{6}$$

where s^2 is calculated as the successive difference estimate of variance for a systematic sample (Wolter 1985):

$$s^2 = \frac{\sum_{h=2}^{H} (n_h - n_{h-1})^2}{2(H-1)} \tag{7}$$

where n_n is the h^{th} sample count (h=2 corresponds to the second count of the season (j=2,k=1) and h=H corresponds to the last count of the season (j=24 and k=K).

The estimated total Chinook salmon passage over the entire season was calculated as

$$\hat{C}_T = \hat{C}_D + C_W \,, \qquad (8)$$

where C_W is the count of Chinook salmon through the full weir; the variance of $\hat{C}_T$ was estimated as

$$\text{var}(\hat{C}_T) = \text{var}(\hat{C}_D) \,. \qquad (9)$$

Count Diagnostics-Chinook Salmon

In 2005 and 2006, the net counts of the three crewmembers primarily responsible for counting the DIDSON files were compared.

Between-reader variability was assessed by comparing counts from 1-hour per day (three 20-min DIDSON files). Two different crewmembers read the same files and their counts were compared. Within-reader variability was assessed by comparing counts from 40 minutes per day (two 20-min DIDSON files) made by each of the readers (each file read twice by a reader). Files were chosen to represent challenging counting conditions (high upstream and downstream counts and milling activity); the analysis therefore revealed worst-case scenarios of variability. The following statistics were calculated for the between reader analysis:

1. An estimate of the correlation coefficient for each pair of readers counting the same files, as well as an estimate of the overall correlation coefficient of first and second readings.
2. Average actual and average absolute differences in counts among readers. These calculations helped identify readers that had a tendency to disagree with their colleagues.
3. Test the hypothesis that there was no difference between first and second readings (paired *t*-test).

A within-reader analysis analogous to 1, 2, and 3 above was also conducted.

Run Timing

Chinook Salmon

Run timing of Chinook salmon at the sonar/weir site was evaluated using cumulative daily counts and associated percentiles. In 2005 and 2006, diel run timing was evaluated during the DIDSON period using 24-h DIDSON counts. During the weir period run timing through the day was restricted to the hours of weir operation and was calculated from the number of Chinook salmon that were passed through the weir live boxes. The hourly DIDSON and weir counts were grouped into 2-h increments.

Coho Salmon

The date the first coho salmon was counted through the weir marked the beginning of the run at the weir/sonar site. Run timing of coho salmon at the sonar/weir site was evaluated using cumulative daily counts and associated percentiles. In 2005, run timing through the day was restricted to the hours of weir operation and was calculated from the number of coho salmon that were passed through the weir live boxes. In 2006, run timing through the weir was evaluated as in 2005, with the addition of an evaluation of the diel run timing during the DIDSON period using 24-h DIDSON counts. The hourly DIDSON and weir counts were grouped into 2-h increments.

Age and Sex Composition and Length-at-Age

Chinook Salmon in 2005 and 2006

Estimation of age and sex composition during the DIDSON period was derived from pooled samples obtained from netting in the North and South Forks upstream of the sonar. In 2005, we planned to weight the North and South Fork sample estimates by the proportion of fish migrating up the North and South Forks during the sonar operation. We assumed that the proportion migrating up each fork would be identical to that measured in 2004, when a full weir was operated in the North Fork (North Fork proportion=0.11 in 2004). However in 2005 very few fish were observed migrating up the North Fork, and we determined that it would be inappropriate to apply the 2004 weighting to other years. Further, while statistically significant, the age composition differences between the forks in 2003 and 2004 were not substantial and we believe that pooling netting samples from equal netting effort for the North and South Forks was the best way to obtain a representative sample of the migration upstream of rkm 2.8 occurring during sonar operation (Kerkvliet et al. 2008). Age and sex estimation during the mainstem weir operation were derived from direct systematic sampling at the weir.

The estimated proportion of Chinook salmon of age or sex class k (or combination of), in the escapement during a given period X (X=W (Weir) or D (DIDSON)) was calculated by:

$$\hat{p}_{Xk} = \frac{n_{Xk}}{n_X}, \tag{10}$$

where:

n_{Xk} = the total number of salmon of age or sex class k in n_x and

n_X = the number of salmon sampled during period X.

The estimated proportion of Chinook salmon of age or sex class k (or combination of) in the entire escapement to the Anchor River was calculated as:

$$\hat{p}_k = \phi_D \hat{p}_{Dk} + (1-\phi_D)\hat{p}_{Wk}, \tag{11}$$

where:

ϕ_D = the proportion of the entire escapement that migrates during the DIDSON operation (treated as a constant), and the estimated variance of proportion ($\hat{p}_k$) was calculated as:

$$\text{var}(\hat{p}_k) = \phi_D^2\left[\left(\frac{\hat{N}_D - n_D}{\hat{N}_D}\right)\frac{\hat{p}_{Dk}(1-\hat{p}_{Dk})}{n_D - 1}\right] + (1-\phi_D)^2\left(\frac{N_W - n_W}{N_W}\right)\frac{\hat{p}_{Wk}(1-\hat{p}_{Wk})}{n_W - 1}. \tag{12}$$

The estimated total number of Chinook salmon of age or sex class *k* was calculated as:

$$\hat{N}_k = \hat{N}_T \hat{p}_k . \tag{13}$$

The estimated variance of $\hat{N}_k$ was calculated as (Goodman 1960):

$$\text{var}(\hat{N}_k) = \hat{N}_T{}^2 \text{var}(\hat{p}_k) + \hat{p}_k^2 \text{var}(\hat{N}_T) - \text{var}(\hat{p}_k)\,\text{var}(\hat{N}_T) . \tag{14}$$

Mean lengths at age and its variance were estimated using standard summary statistics.

Coho Salmon

The age, sex, and length composition of the coho salmon escapement was based on a systematic sample collected at the mainstem weir only; the mainstem weir was installed before any coho salmon began their migration. The estimated proportion of coho salmon of age/sex class *k* ($\hat{p}_K$) in the escapement (*N*) was calculated from the sample taken at the mainstem weir (*n*) using Equation 10. Its estimated variance was calculated as:

$$\text{var}(\hat{p}_k) = \left(\frac{N - n}{N}\right)\frac{\hat{p}_k(1-\hat{p}_k)}{n - 1} \tag{15}$$

The estimated total number of coho salmon of age or sex class *k* was calculated as $\hat{N}_k = N\,\hat{p}_k$ with its variance estimated by:

$$\text{var}(\hat{N}_k) = N^2 \text{var}(\hat{p}_k) . \tag{16}$$

Mean lengths-at-age and its variance were estimated using standard summary statistics.

RESULTS

ESCAPEMENT-CHINOOK SALMON

DIDSON and Weir Escapement

A total of 11,156 (SE = 229) Chinook salmon were counted in 2005 at the sonar/weir site from May 13 through September 9; of which 4,581 Chinook salmon were estimated from sonar files collected at high frequency and 6,575 Chinook salmon were censused from the weir (Table 8). In 2006, a total of 8,945 (SE = 289) Chinook salmon were counted from May 15 through August 24; of which 5,403 Chinook salmon were estimated from low (n = 1,231) and high (n = 4,172) frequency sonar files and 3,542 fish were censused from weir counts (Table 8).

A major component of the Chinook salmon escapement was estimated from the DIDSON system in 2005 (41%) and 2006 (60%) (Table 8). These counts are conservative because all downstream counts were assumed to be Chinook salmon. However, we know a portion of these counts were emigrating post-spawning steelhead (kelts) because of their emigration timing (May to June) and because kelts were caught in beach seines upstream in the South and North Fork (Table 9). In 2005 kelts represented approximately 6% (11/179 fish) of the total beach seine catch and downstream counts represented approximately 33% (down = 1,416; up = 2,919) of the total DIDSON count. In 2006, kelts represented 18% (21/119 fish) of the total beach seine catch and downstream counts represented 30% (down = 1,375; up = 3,147) of the total DIDSON count.

In 2006, we observed 151 steelhead (kelts) swimming downstream through the "steelhead chute". The highest passage (73 kelts) was observed between June 16 and June 17.

Sonar Diagnostics

Reader Variability

Re-counted DIDSON files provided a measure of the reproducibility of the escapement count and a quality control measure.

A total of 167 DIDSON files were used to evaluate between-reader variability. We found high correlations of DIDSON counts re-read by different individuals (Table 10). The overall correlation pooled between readers was slightly lower in 2005 (0.91) than in 2006 (0.97), which is attributed to the high correlation between Reader 4 and Reader 5 (0.99) in 2006. Average differences in counts per 20-min file were small in all cases; average absolute differences were expectedly higher. A pooled *t*-test of the hypothesis of equality between first and repeat readings was not rejected for either 2005 or 2006 (P = 0.25 and P = 0.06, respectively) (Table 11).

Ninety-two DIDSON files were used to evaluate within reader differences. Similar to the between reader results, we found high correlations of DIDSON counts re-read by the same reader (Table 10). The overall correlation pooled within readers was slightly lower in 2005 (0.90) than in 2006 (0.98), which is attributed to Reader 5's high correlation (1.0). Average differences in counts per 20-min file were small in all cases; average absolute differences were expectedly higher. A pooled *t*-test of the hypothesis of equality between first and repeat readings was not rejected for either 2005 or 2006 (P = 0.14 and P = 0.65, respectively) (Table 11).

Run Timing

The run timing of Chinook salmon in 2005 and 2006 was similar based on the mid-point of the respective run (June 8 and June 9; Figure 6; Appendices B1 and B2). However, based on the peak passage (25 to 75 percentile range), the 2005 run was earlier and less protracted (peak passage=14 d from May 30 to June 12) than the 2006 run (peak passage=20 d from June 2 to June 21).

Diel patterns were similar in 2005 and 2006 with the highest DIDSON counts occurring during hours of darkness (Figures 7 and 8; Appendices C1 and C2). Chinook salmon counts were highest from 1700 hours to 0600 hours accounting for most of the 2005 counts (DIDSON upstream=89.8%; downstream=82.9%; weir=81.6%) and 2006 counts (DIDSON upstream=81.7%; downstream= 71%; weir=85.5%). Chinook salmon passages through the weir were also similar for both years with more Chinook salmon migrating during hours of suppressed light (Appendices C3 and C4).

The Anchor River water temperature during the peak passage of Chinook salmon was higher in 2005 (mean=11.6^{o}C; min=9.5 ^{o}C; max=14.0^{o}C; Table 8; Figure 9; Appendix D1) than in 2006 (mean=10.1 ^{o}C; min=8.5^{o}C; max=12.0^{o}C; Table 8; Figure 10; Appendix D2) at the AR-3 site. In general during peak passage, water levels in Anchor River were lower and fluctuated less in 2005 (range= 42 cm to 49 cm; Appendix E1) than in 2006 (range 53 cm to 79 cm; Appendix E2).

Aerial Survey Escapement Index

The 2005 helicopter survey was flown on July 25 and the visibility was described as good (Appendix F1). The index count was 651 Chinook salmon based on Surveyor A's counts from the front seat of the helicopter. Surveyor B counted approximately 39% (903-651)/651)) more Chinook salmon from the back seat of the helicopter than Surveyor A. The 2006 helicopter survey was flown on July 27 and the overall visibility was described as excellent (Appendix F2). The index count was 899 Chinook salmon based on Surveyor B's count from the front seat of the helicopter. The count between surveyors was closer in 2006 than in 2005. Surveyor B counted approximately 12% ((899-800)/800) more Chinook salmon than Surveyor A (n = 800). A survey count was also flown upstream of the index area in 2006 and Surveyor B counted 380 Chinook salmon and Surveyor A counted 360.

ESCAPEMENT-COHO SALMON

Weir Escapement

The Anchor River coho salmon escapement estimates for 2005 and 2006 are partial counts because high water washed out the weir both years while high numbers of coho salmon were still moving upstream.

In 2005, the census of coho salmon was 18,977 fish through September 9 based on weir counts only (Table 12; Appendix B1). On September 9, 2005 the daily passage of coho salmon was still high (842 fish) when high water washed out the weir (Table 12).

The 2006 coho salmon escapement of 10,181 is a minimum estimate, which was based a census from the weir (6,889; June 18 to August 18) and estimate from DIDSON counts (3,292; August 22 to August 24). High water washed the weir out August 19. Before the weir washed out, the count of coho salmon on August 18 was 423 and the cumulative count was 6,889 (Appendix B2). Escapement counts were not collected in 2006 from August 19 through August 21 because the weir was breached. The DIDSON was operated from August 22-24 and an additional 3,292 coho salmon were estimated.

Run Timing

The run timing of coho salmon in 2005 was later than in 2006 based on the date the first coho salmon was counted at the weir (July 22, 2005 versus July 11, 2006) and based on the cumulative count through August 14 (2005; n = 272 versus 2006; n = 904; Appendices B1 and B2). Because the 2006 project ended 16 days earlier (end date=August 24) than in 2005 (end date=September 9) escapement percentiles are not comparable.

Figure 11 shows an association between rising river water levels and higher counts of coho salmon at the weir. In 2005, approximately 72% of the escapement was counted during high water. In 2006, the river rose approximately 34 cm from August 15 to August 17. During this period approximately 81% of our partial escapement count was recorded (Table 12).

On August 19, 2006 when the weir washed out, technicians reported seeing large numbers of coho salmon swimming upstream pass the sonar/weir site near the right bank of the river. After the weir washed out, the water level began to drop. However soon after the DIDSON became operational (1800 hours August 22) the river began rising again. This surge of coho salmon (3,291 fish) was estimated through August 24 from 33 h of DIDSON files. During the second surge, milling activity was low based on the high upstream counts (1,320 fish) and low downstream counts (233 fish) (Appendix G1).

Most of the coho salmon counted in 2005 (55.6%) and 2006 (53.2%) passed through the weir between noon and 1700 hours (Figures 12 and 13; Appendices G2 and G3). This diurnal migration pattern was also observed in 2004, where the passage rate of coho salmon through the weir began building in the early afternoon, peaked in the late afternoon, and then declined before midnight. In 2006, migration patterns of coho salmon were similar between weir counts (diurnal) and the DIDSON upstream counts (diel) with 42.7% of the upstream counts coming from file recordings between noon and 1700 hours. In addition, the highest hourly DIDSON estimate (n = 648) was counted from a file recorded at 1700 hours.

BIOLOGICAL SAMPLING

Age and Sex Composition and Length-at-Age

Chinook Salmon

In 2005 and in 2006, Chinook salmon ASL samples from the North and South Fork were pooled. Age, sex, and age by sex compositions did not change over time (P>0.05) within either the netting or weir samples. Age and age by sex compositions differed significantly between the netting and weir periods and estimates were weighted accordingly (see Methods). Sex did not differ between netting and weir periods and these data were pooled (P = 0.1 and P = 0.2, for 2005 and 2006, respectively).

Overall, ocean age 3 was the dominant age class in 2005 (52.2%, SE = 2.5%) and 2006 (52.1%; SE = 3.8) for the Chinook salmon escapement (Tables 13 and 14). In 2005 and 2006 ocean age-3 females was the dominant age by sex class (33.4%, SE = 2.4; 29.9%; SE = 3.3, respectively). The age composition varied for males sampled in 2005 and 2006. In 2005, ocean age-2 (19.8%, SE = 1.9) males were dominant and ocean age-3 males (18.6%, SE = 1.9) were second; in 2006, ocean age-3 (22.2%, SE = 3.3) males were dominant and ocean age-4 (13.3%, SE = 2.8) males were second.

We anticipated that the 100-year flood that affected LCI streams in October and November in 2002 would reduce the survival of Chinook salmon eggs, fry, and pre-smolt life stages. We believed that the highest impact would be on the 2002 brood year, through disturbance of eggs and pre-emergent fry. The surviving Chinook salmon from brood year 2002 returned to the Anchor River in 2006 as ocean-age 2 (Table 14). Returns from this brood year will continue to be monitored.

The percentages of females and males changed slightly in 2005 (46.7%:53.3%) and 2006 (50.7%:49.3%) (Tables 13 and 14). Mean lengths between Chinook salmon sampled in 2005 and 2006 were similar for males (694 mm; SE = 10 versus 674mm; SE = 17) and for females (775 mm; SE = 5 versus 767 mm; SE = 9) respectively (P>0.05).

Coho Salmon

In 2005 and 2006, age-sex compositions did not change over time (P>0.05). Age class 2.1 was the dominant age in 2005 (84.9%; SE = 1.8%) and in 2006 (89.4%; SE = 2.7%; Tables 15 and 16). Only one male age-2.2 coho salmon was sampled each year. In 2005 three age-3.1 females

(0.7%; SE = 0.4) and one male (0.2%) were aged; also, only one female was age 1.2. In contrast, no age-3.1 or -1.2 coho salmon were detected in 2006.

Age-2.1 coho salmon that returned to Anchor River in 2006 were a product of eggs from the 2002 brood year that survived the 100-year flood in October–November 2002.

The percentages of females and males were similar in 2005 (42.7%:57.3%) and 2006 (37.9%:62.1%) (P = 0.27) (Tables 15 and 16). The mean length of male coho salmon were 18 mm smaller in 2006 (576 mm; SE = 5) than in 2005 (594; SE = 3), and 11 mm smaller for females in 2006 (580 mm; SE = 4) than in 2005 (591 mm; SE = 3) (P<0.05).

Straying

One stray was detected from three Chinook salmon that had a missing adipose fin in 2005 (Table 17). The stray, from the Ninilchik River supplementation program, was one of 498 Chinook salmon recovered at the Anchor River weir and checked for a missing adipose fin. In 2006, all 486 Chinook salmon that were checked had an intact adipose fin. One coho salmon stray originating from Ship Creek were recovered from the 728 coho salmon checked in 2005 and 2006 for a missing adipose fin.

DISCUSSION

The 2005 and 2006 Chinook salmon estimates marks the third and fourth consecutive years of the total escapement data series. The addition of a fifth weekend opening for Chinook salmon did not substantially increase the freshwater harvest, and exploitation remained low (11.4% for 2005 and 13.5% for 2006; Table 5). Because Anchor River weir washed out late in the coho salmon run in 2005, the coho salmon escapement estimate is considered a reasonable approximation. However, the Anchor River coho salmon escapement estimate for 2006 is considered a minimal estimate because the weir washed out near the peak of the coho salmon run. The early run strength of coho salmon in 2006 and reports that fishing continued to be exceptionally good after the weir washed out, suggests the 2006 escapement of coho salmon was much higher.

Beach seine catches of steelhead kelts indicate that some portion of the downstream DIDSON counts should be apportioned as steelhead. However even if the number of kelts is large 500+ (a number based on the 1992 weir count of 1,261 fish), and 33% (a high value) of these are repeat spawners (Balland 1986 and Larson 1992), the number of kelts potentially contaminating the Chinook salmon count is low at current escapement levels. Furthermore, daily escapement counts and the diel migratory patterns of Chinook salmon do not suggest that DIDSON counts are severely biased by emigrating kelts. For example, one would expect to see a distinct increase in daily Chinook salmon escapement counts when the DIDSON is replaced by the weir, when steelhead can be identified unequivocally and counted at the weir. This pattern was not observed on June 3, 2005 or June 13, 2006 (Appendices B1 and B2). Also for both years, the upstream and downstream diel patterns were similar with the highest counts recorded in hours of darkness or suppressed light (Figures 7 and 8). The similarity in the pattern of upstream and downstream counts is consistent with the idea that those fish responsible for upstream counts (Chinook salmon) are also those responsible for downstream counts. The regularity of the diel upstream and downstream patterns throughout the operation of the DIDSON also does not show a change during the steelhead migratory period. Additionally when the sonar files are read for counting fish images, milling activity is often observed. The milling behavior is easily distinguishable because on the computer screen individual fish images can be tracked swimming upstream and then downstream. This milling behavior may be a function of the proximity of the sonar site to the confluence of the North and South Fork of Anchor River.

The relationship between the Chinook salmon escapement estimates and aerial index counts is not apparent even with the two additional years of aerial survey data (Table 8). One of the problems in assessing this relationship is the lack of contrast in the Chinook salmon escapement estimates; escapement only ranged from 8,945 to 12,016 fish from 2003 through 2006. The Chinook salmon aerial survey index was lower in 2005 than 2006 even though the escapement estimate was higher in 2005. Even though there was no expectation that the surveyors would be able to count all the Chinook salmon in the index area, the number of Chinook salmon seen from the air compared to the sonar/weir estimates is very low. In 2004 we estimated that 84% of the Chinook salmon counted at the sonar/weir site spawned in the South Fork (Kerkvliet et al. 2008). In order to compare the number of Chinook salmon that could potentially be seen during the 2005 and 2006 aerial survey of the South Fork we first allocated 84% of the mainstem estimates for the given year to the South Fork. Based on the allocation we estimated that in 2005, only 6% of the escapement was seen during the aerial survey. In contrast in 2006, approximately 12% of the escapement was seen even though the escapement was lower than 2005. The disparity between the number of fish counted during the 2005 and 2006 surveys compared to their respective escapement highlights the inherent biases associated with aerial survey data.

We anticipated the 100-year flood of LCI streams in October and November 2002 would reduce the survival of Chinook salmon eggs, fry, and pre-smolt life stages, with the highest impact on the 2002 brood year because eggs and pre-emergent fry would be most vulnerable to the scouring of the river substrate. Adverse affects of the flood may account for the lower than usual contribution of ocean age-2 Chinook salmon in 2006. In 2007, the impact of the floods may be made clearer because the surviving Chinook salmon from brood year 2002 will return as ocean age 3, the age class that has historically returned in the highest numbers in the Anchor River escapement.

The majority of coho salmon that returned to the Anchor River from 2004 to 2006 were age 2.1. The effect of the flood on the coho salmon return from brood year 2002 was not obvious based on the high 2006 escapement. In addition, the age class (age 2.1) predicted to have the lowest survival from the flood remained the dominant age in the 2006 return.

Coho salmon escapements to Anchor River in 2005 and 2006 were dramatic, not only because of the high return, but also because high river levels coincided with the highest passage of fish (Figure 11). Overall exploitation was low (<22% in 2005 and <28% in 2006; Table 6). It is conceivable that the 2005 escapement (18,977 fish) would have matched or exceeded the 1989 record coho salmon escapement (20,187) if counts could have been collected into November as was the case in 1989 (Table 12). The highest daily count of coho salmon from 2004 through 2006 occurred during high river flows. Unlike the high milling behavior observed in Chinook salmon (described above), milling of coho salmon was low in 2006 based on the high upstream and low downstream DIDSON counts and observations of individual fish on the computer screen when DIDSON files were counted.

The passage of coho salmon through the weir could vary widely from one day to the next, with the highest passage occurring during high river conditions (Table 12). On days when large numbers of coho salmon were migrating upstream there was concern of fish accumulating downstream of the weir. On high passage days the mid-channel live box could not always be used for passing fish upstream because river levels were high and turbid. On days when high counts occurred simultaneously with high flows, the mid-channel live box was only used to collect ASL samples. Additional staff were called in on high count days to monitor the bank live box so the gates could be left open and allow fish to pass upstream continuously.

The coho salmon counts collected from August 22-24 in 2006 using the DIDSON provided a useful method for evaluating the diurnal passage of coho salmon through the weir. The similarities in diel patterns between DIDSON and weir upstream counts indicate that although the weir is disruptive to upstream migration, the disruption is minimized by the way the weir is operated (Figures 12 and 13). In 2005 and 2006, maintaining a functional weir through the middle of September was challenging. To meet this challenge, we are planning a back-up system to anchor the rail and live boxes.

The Department will continue estimating the Anchor River Chinook and coho salmon escapements using sonar and weir counts from mid-May through mid-September. Ultimately, we will develop a Chinook salmon biological escapement goal (BEG) as additional years of escapement data are collected for two complete generations of fish.

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TABLES

Table 1.-Drainage characteristics of the North and South Fork of Anchor River.

	Anchor River		
Drainage characteristics	North Fork	South Fork	Total
Watershed area	181 .5 km^2	405.3 km^2	586.8 km^2
Wetland area	92.9 km^2	189.0 km^2	281.9 km^2
Percent wetland	51.2%	46.6%	48.0%
Stream length	149 rkm	352 rkm	501 rkm
Anadromous stream length	90 rkm	176 rkm	266 rkm

Source: S. Baird, Kachemak Bay Research Reserve in Homer, Alaska, *unpublished data*, 2006.

Note: "rkm" = river kilometer.

Table 2.-Estimated Anchor River freshwater sport harvest (or catch) by species and effort, 1977–2006.

		Harvest						Catch
Year	Effort (days fished)	Chinook salmon	Coho salmon	Pink salmon	Sockeye salmon	Dolly Varden	Rainbow trout/ Steelhead	Rainbow trout/ Steelhead
1977	31,515	1,077	1,339	27	ND	9,222	2,099	ND
1978	42,671	2,109	1,559	139	ND	17,357	2,305	ND
1979	44,220	1,913	4,006	18	ND	21,364	1,782	ND
1980	33,272	605	2,649	339	ND	10,948	1,186	ND
1981	34,257	1,069	2,949	11	ND	15,271	928	ND
1982	24,709	718	2,379	161	ND	10,375	698	ND
1983	28,881	1,269	1,395	252	ND	17,277	1,605	ND
1984	26,919	998	1,135	249	167	5,599	985	ND
1985	31,715	672	2,239	124	224	7,716	475	ND
1986	34,938	1,098	1,021	136	39	3,914	520	ND
1987	39,045	761	2,010	54	1,263	2,735	643	ND
1988	24,356	976	2,219	109	109	2,746	200	ND
1989	19,145	578	2,635	115	136	1,476	0	2,066 [a]
1990	28,829	1,479	2,782	163	136	2,821	0	1,978 [a]
1991	22,187	1,047	3,169	125	152	1,409	0	2,349 [a]
1992	24,028	1,685	2,267	92	66	2,532	0	2,720 [a]
1993	29,338	2,787	4,003	98	45	1,031	0	4,156 [a]
1994	27,856	2,478	3,360	79	82	1,574	0	4,035 [a]
1995	25,888	1,475	3,080	47	94	1,537	0	2,232 [a]
1996	16,016	1,483	1,762	78	218	963	0	7,570 [a]
1997	17,020	1,563	1,636	321	165	1,575	0	3,103 [a]
1998	14,310	783	2,386	7	174	2,105	0	3,878 [a]
1999	21,184	1,409	1,780	54	174	1,061	0	3,920 [a]
2000	22,971	1,730	2,604	123	127	1,903	0	8,693 [a]
2001	19,195	889	2,960	11	61	1,652	0	3,045 [a]
2002	19,245	1,047	3,830	124	52	662	0	3,501 [a]
2003	17,482	1,011	3,999	68	504	1,124	0	3,409 [a]
2004	20,452	1,561	4,383	146	11	736	0	3,710 [a]
2005	20,079	1,432	5,314	69	156	675	0	2,524 [a]
2006	17,065	1,394	3,920	112	54	897	0	4,525 [a]
Averages								
2001-2006	18,920	1,222	4,068	88	140	958	0	3,452
1989-2006	21,238	1,435	3,104	102	134	1,430	0	3,745
1977-1988	33,042	1,105	2,075	135	360	10,377	1,119	ND
1977-2000	27,720	1,323	2,349	122	198	6,021	559	3,892
1977-2006	25,960	1,303	2,692	115	183	5,009	448	3,745

Note: "harvest" = fish kept; "catch" = fish harvested plus fish released; "ND" = no data.

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

[a] Rainbow trout/Steelhead caught and released only from 1989 to present; retention of this species is prohibited. Catch estimates for 1989-2006 from (Gretchen Jennings, project manager, Alaska Statewide Harvest Survey *unpublished data*, ADF&G, Division of Sport Fish, Anchorage).

Table 3.-Anchor River Chinook salmon aerial survey indices and escapement goals, 1976–2006.

	Aerial Survey		Escapement	
Year	Date	Index [a] (no. of fish)	Goal or range (no. of fish)	Type
1976	Aug 02	2,125	NA	Index
1977	Jul 27	3,585	NA	Index
1978	Aug 04	2,209	NA	Index
1979	Jul 29	1,335	NA	Index
1980 [b]	[b]	[b]	NA	Index
1981 [b]	Jul 30	1,066	NA	Index
1982	Jul 28	1,493	NA	Index
1983	Jul 29	1,033	NA	Index
1984	Aug 05	1,087	NA	Index
1985	Aug 09	1,328	NA	Index
1986	Jul 29	2,287	NA	Index
1987	Jul 28	2,524	NA	Index
1988	Jul 30	1,458	NA	Index
1989	Jul 26	940	NA	Index
1990	Jul 21	967	NA	Index
1991	Jul 27	589	NA	Index
1992	Aug 10	99	NA	Index
1993	Jul 21	1,110	1,790	BEG [c]
1994	Jul 30	837	1,790	BEG [c]
1995 [b]	[b]	[b]	1,790	BEG [d]
1996	Aug 02	277	1,790	BEG [d]
1997	Jul 30	477	1,790	BEG [d]
1998	Jul 28	789	1,050-2,200	BEG [d]
1999	Jul 28	685	1,050-2,200	BEG [d]
2000	Jul 27	752	750-1500	SEG [e]
2001	Jul 27	414	750-1500	SEG [e]
2002	Jul 30	748	750-1500	SEG [e]
2003 [f]	Jul 23	647	750-1500	SEG [e]
2004 [f]	Jul 31	834	750-1500	SEG [e g]
2005 [f]	Jul 25	651		[g]
2006 [f]	Jul 27	899		[g]
Averages				
2003-2006		758		
1989-2002		668		
1976-1988		1,794		
1976-2006		1,146		

-continued-

Table 3.-Page 2 of 2.

[a] Index = aerial index counts from a standard section of river where the majority of spawning was thought to occur. Ground index counts were also made (ground counts not included in this table) from a standard subsection. If the ground count was higher, the aerial count were expanded by the difference between the aerial counts and ground counts of the same subsection. If the aerial count was higher, it was used as the escapement index.

[b] Escapement counts not conducted or considered minimal due to high turbid water during the aerial escapement survey.

[c] BEG = biological escapement goal; based on combined aerial and ground counts. Ground counts were discontinued in 1995.

[d] Based on South Fork aerial counts.

[e] SEG = sustainable escapement goal, based on South Fork aerial count.

[f] Aerial survey flown in conjunction with escapement monitoring on Anchor River mainstem.

[g] SEG removed in November 2004.

Table 4.-Estimated Anchor River escapement by species, 1987-1995 and 2003-2006.

Year	Project dates	Escapement (no. of fish)						
		Chinook salmon	Dolly Varden	Pink salmon	Chum salmon	Sockeye salmon	Coho salmon	Rainbow trout/ Steelhead
1987 [a]	Jul 4 - Sep 10	204	19,062	2,084	19	33	2,409	136
1988 [a]	Jul 3 - Oct 5	245	14,935	777	24	30	2,805	878
1989 [a]	Jul 6 - Nov 5	95	11,384	4,729	165	212	20,187	769
1990 [a]	Jul 4 - Aug 15	144	10,427	355	17	39	190	3
1991 [a]	Jul 4 - Aug 15	39	18,002	1,757	9	46	13	5
1992 [a]	Jul 4 - Oct 1	129	10,051	992	39	174	4,596	1,261
1993 [a]	Jul 3 - Aug 16	90	8,262	1,019	12	71	290	1
1994 [a]	Jul 3 - Aug 16	111	17,259	723	2	61	420	1
1995 [a]	Jul 4 - Aug 12	112	10,994	1,094	4	73	725	10
2003 [b]	May 30 - Jul 9	9,238	[b]	[b]	[b]	[b]	[b]	[b]
2004 [c]	May 16 - Sep 13	12,016	7,846	1,079	79	45	5,728	20
2005 [c]	May 13 - Sep 9	11,156	5,719	4,916	146	319	18,977	107
2006 [c d]	May 15 - Aug 24	8,945	234	954	45	38	10,181	4

[a] Source: Larson et al. (1988) Larson and Balland (1989); and Larson (1990-1995, 1997) when escapement weir was located approximately 1.5 rkm upstream from Anchor River mouth.

[b] Chinook salmon escapement was estimated using a DIDSON system located approximately 2.8 km upstream from Anchor River mouth. All DIDSON images and the associated counts were assumed to be Chinook salmon; therefore, escapement counts were not apportioned to other species.

[c] Chinook salmon estimate is based on combined DIDSON and weir count.

[d] DIDSON operated from May 15-Jun 12; an estimated 5,325 Chinook salmon were counted. Fish counts were conducted at the weir from Jun 13-Aug 18. No counts collected from Aug 19-21; the weir washed out due to flooding. The DIDSON operated again from Aug 22-24; an estimated 3,292 coho salmon were counted.

Table 5.-Estimates for Anchor River Chinook salmon escapement, freshwater harvest, total run, and exploitation from 2003 to 2006.

		Chinook salmon					
						Total run [a]	
		Escapement [b]		Freshwater harvest [b]			Exploitation
Year	Project dates	Estimate	SE	Estimate	SE	Estimate [b]	rate (%)
2003 [c]	May 30–Jul 09	9,238	0 [d]	1,011	157	10,249	9.9
2004 [c]	May 15–Sep 15	12,016	283	1,561	198	13,577	11.5
2005 [c]	May 13–Sep 09	11,156	229	1,432	233	12,588	11.4
2006 [e]	May 15–Aug 24	8,945	289	1,394	197	10,339	13.5
Average		10,339		1,350		11,688	11.6

[a] Total run = escapement + freshwater harvest; does not account for the marine harvest. Source: Jennings et al. (2006b, 2007, 2009a-b).

[b] Units = number of fish.

[c] Source: Kerkvliet et al. (2008). Chinook salmon estimated using combined counts from DIDSON/weir operated approximately 2.8 rkm upstream from Anchor River mouth. All DIDSON images and the associated counts were assumed to be Chinook salmon.

[d] The estimate is based on a census of all DIDSON files.

[e] Chinook salmon estimated using combined counts from DIDSON/weir operated approximately 2.8 rkm upstream from Anchor River mouth. All DIDSON images and the associated counts were assumed to be Chinook salmon.

Table 6.-Estimates for Anchor River coho salmon escapement, freshwater harvest, total run, and exploitation from 1987 to 1989, 1992, and 2004 to 2006.

		Coho salmon					
						Total run [a]	
		Escapement [b]		Freshwater harvest [b]			Exploitation
Year	Project dates	Estimate	SE	Estimate	SE	Estimate [b]	rate (%)
1987 [c]	Jul 05–Sep 11	2,409	-	2,010	-	4,419	45.5
1988 [c]	Jul 03–Oct 06	2,805	-	2,219	-	5,024	44.2
1989 [c]	Jul 06–Nov 07	20,187	-	2,685	-	22,969	11.7
1992 [c]	Jul 04–Oct 02	4,596	-	2,267	-	6,863	33.0
2004 [d]	May 15–Sep 15	5,728	-	4,383	722	10,111	43.3
2005 [d]	May 13–Sep 9	18,977 [e]	-	5,314	949	24,291	21.9
2006 [d]	May 15–Aug 24	10,181 [e]	-	3,920	975	14,101	27.8
Average		9,269		3,257		12,540	32.5

Note: "-" = cannot be calculated due to limitations of the data.

[a] Total run = escapement + freshwater harvest; does not account for the marine harvest. Source: Alaska Statewide Harvest Surveys (Mills 1988-1990, 1993; Jennings et al. 2007, 2009a-b).

[b] Units = number of fish.

[c] Source: Larson et al. (1988, 1989) and Larson (1990-1995, 1997); escapement weir was located approximately 1.6 rkm upstream from Anchor River mouth.

[d] Source: Kerkvliet et al. (2008). DIDSON and escapement weir were located approximately 2.8 rkm upstream from Anchor River mouth. From Jun 13-Aug 18 the weir was used for census; from Aug 19-21 no counts were obtained because the weir was washed out by flooding. The DIDSON operated Aug 22-24; counted 3,292 coho salmon.

[e] Minimum escapement estimate because the weir washed out.

Table 7.-Anchor River Chinook and coho salmon escapement project sampling methods and dates, 2005-2006.

	Escapement enumeration		Biological sampling of beach seine catch [a]	
Year	DIDSON and partial picket (only)	DIDSON and resistance board weir	South Fork Anchor River	North Fork Anchor River
2005 [b]	May 13–Jun 03	Jun 03–Sep 09	May 31–Jun 8 (number of sampling events =2)	May 19–Jun 10 (number of sampling events =3)
		Jul 08–11	ND	ND
2006 [c]	May 15–Jun 13	Jun 02–Aug 18	May 31–Jun 15 (number of sampling events =3)	May 24–Jun 13 (number of sampling events =4)

[a] Biological parameters collected: catch by species and age, sex, and length of Chinook salmon.

[b] DIDSON used at night with full weir and live box open to allow numerous Dolly Varden to move upstream.

[c] DIDSON used with partial weir from Aug 22-24 to count coho salmon after a flood washed out the weir on Aug 19, 2006.

Table 8.-Chinook salmon aerial survey, mainstem escapement, and associated river temperature data for Anchor River, 2003-2006.

	Aerial survey		Mainstem escapement									River temperature[b] (°C)		
				Estimate (no. of fish)					Run timing					
				DIDSON sonar[a]										
		South Fork	Project	Low	High	Weir			Median	25-75 Percentile				
Year	Date	index	dates[c]	freq	freq	count	Total	(SE)	date	dates	[d]	Mean	Min	Max
2003	6/28	647	5/30-7/09	9,238	ND	ND	9,238	(0)[e]	6/10	6/04-6/19	(16)	10.2	6.6	14.8
2004	7/31	834	5/15-9/13	ND	7,674	4,342	12,016	(283)	6/06	5/28-6/13	(17)	11.7	8.4	17.4
2005	7/25	651	5/13-9/09	ND	4,581	6,575	11,156	(229)	6/08	5/30-6/12	(14)	11.6	9.5	14.0
2006	7/27	899	5/15-8/24	1,231	4,172	3,542	8,945	(289)	6/09	6/02-6/21	(20)	10.1	8.5	12.0

Note: "ND" = no data.

[a] Low freq (frequency) = 1.0 MHz (for observations from 15 m to 30 m; lower image resolution) ; high freq = 1.8 MHz (for observations less than 15 m; greater image resolution).

[b] Source: temperature data collected by Sue Mauger at site AR-3 (described in Mauger [2004]). River temperatures associated with the 25–75 percentile period.

[c] Duration of escapement monitoring.

[d] Number of days.

[e] The estimate is based on a census of all DIDSON files.

Table 9.-Beach seine catches by species on the North and South Fork of Anchor River, 2005-2006.

		South Fork					North Fork				
Year	Sampling period	Sampling date	Chinook salmon	Dolly Varden	Steelhead (kelts)[a]	Pink salmon	Sampling date	Chinook salmon	Dolly Varden	Steelhead (kelts)[a]	Pink salmon
2005	May 19–Jun 10	31-May	28	0	1	0	19-May	0	0	2	0
		8-Jun	127	0	6	0	2-Jun	5	0	0	0
		NA	NA	NA	NA	NA	10-Jun	8	0	2	0
2006	May 24–Jun 15	31-May	16	0	7	0	24-May	1	0	1	0
		8-Jun	24	1	3	0	30-May	2	0	3	0
		15-Jun	39	0	3	0	6-Jun	8	0	3	0
		NA	NA	NA	NA	NA	13-Jun	7	0	1	0

Note: "NA" = not applicable.

[a] "kelts" = post-spawn steelhead.

Table 10.-Correlations (number of 20-min files counted) for between and within reader comparisons, 2005-2006.

Year	Reader test	Reader	1	2	3	4	5	Overall correlation between first and second reading
2005	Between	1		0.92 (42)	0.93 (33)			0.91 (87)
		2		0.97 (17)				
	Within							0.90 (87)
		3			0.98 (25)			
2006	Between	1				0.93 (35)		
								0.97 (75)
		4					0.99 (31)	
		1	0.95 (24)					
	Within							0.98 (75)
		5					1.00 (21)	

Note: Insufficient recounted files available for comparison of readers 2 and 3 for 2005 and of 4 and 5 for 2006.

Table 11.-Average differences among readers' counts per 20-min DIDSON dat file.

Year	Reader test	Reader	1	2	3	4	5	*P* value: Ho 1st vs 2nd reading
2005	Between	1		0.19 (2.5, 7.5)	-1.21 (3.5, 12.7)			0.25
		2		0.00 (1.8, 8.9)				
	Within							0.14
		3			-0.44 (1.4, 10.62)			
2006	Between	1				-1.69 (3.1, 10.2)		
								0.057
		4					-0.19 (1.5, 14.2)	
		1	0.25 (2.3, 10.7)					
	Within							0.652
		5					-0.71 (1.4, 14.8)	

Note: numbers in parentheses are average absolute and average count in assessed 20-min files. See Table 10 for number of 20-min files counted.

Table 12.-A summary of Anchor River coho salmon escapement counts and run timing from 1987-1989, 1992, and 2004-2006.

	Escapement (no. of coho salmon) [a]						
Date(s)	1987	1988	1989	1992	2004	2005	2006
Subtotal (before 8/14)	254	241	128	60	156	249	899
8/14	30	31	15	9	12	23	5
8/15	18	15	56	16	8	46	1,658 [b]
8/16	16	55	9	19	46	80	2,683 [b]
8/17	64	21	90	83	82	124	1,221 [b]
8/18	26	169	4	198	117	157	423
8/19	19	55	63	55	97	156	ND [d]
8/20	33	426	3	17	41	47	ND [d]
8/21	60	200	27	156	204	88	ND [d]
8/22	33	147	137	202	59	60	639 [e]
8/23	18	450	11	327	30	4,134 [b]	1,618 [b e]
8/24	25	10	573	210	19	542	1,035 [b e]
8/25	83	14	1,298 [b]	523	55	101	ND
8/26	55	306	2,356 [b]	365	37	65	ND
8/27	33	46	904	21	30	254	ND
8/28	8	20	908	470	14	101	ND
8/29	13	26	1,214 [b]	172	20	740	ND
8/30	20	21	1,035 [b]	361	23	93	ND
8/31	36	56	706	315	28	88	ND
9/01	53	17	3,010	322	30	1,552 [b]	ND
9/02	16	179	802	15	3,666	449	ND
9/03	36	11	844	3	825	176	ND
9/04	410	2	1,018 [b]	23	11	517	ND
9/05	120	1	162	4	1	4,601 [b]	ND
9/06	27	4	701	102	9	2,367 [b]	ND
9/07	658	3	1,160 [b]	248	12	1,028 [b]	ND
9/08	228	6	297	15	13	297	ND
9/09	2	6	41	2	7	842 [c]	ND
9/10	8	10	1,091 [b]	0	5	ND [c]	ND
9/11	7	13	128	1	16	ND [c]	ND
Subtotal (after 9/11)	0	244	1,396	282	55	0	0
Total	2,409	2,805	20,187	4,596	5,728	18,977	10,181
Project starting & ending dates	7/05-9/11	7/03-10/06	7/06-11/07	7/04-10/02	5/15-9/13	5/13-9/09	5/15-8/24
25-75 Percentile dates (range in grey)	8/24-9/07	8/21-8/26	8/27-9/04	8/23-8/31	9/02	8/23-9/05	8/15-8/23
25-75 Percentile (no. of days)	(15)	(7)	(9)	(9)	(1)	(14)	(8)
Median date (cell with black border)	9/04	8/23	9/01	8/28	9/02	9/04	8/16

[a] Source: 1987-1989 data from Larson et al. (1988); Larson and Balland (1989); and Larson (1990); 1992 data from Larson (1993); and 2004 data from Kerkvliet et al. (2008). "ND" = no data.

[b] Coho salmon surges defined as a daily escapement count of 1,000 or more coho salmon.

[c] The Anchor River weir was washed out by flood waters on September 9, 2005 and no additional fish were counted thereafter.

[d] The Anchor River weir was breached by flood waters from August 19-21 and no additional fish were counted through the weir after that date.

[e] DIDSON sonar estimates.

Table 13.-The estimated ocean age, sex, and length composition of Anchor River Chinook salmon 2005 escapement.

	Ocean Age [a]				
	1	2	3	4	Total [b]
Female	0	15	139	46	231
Percent	0.0	4.2	33.4	11.2	46.7
SE percent	0.0	1.1	2.4	1.6	2.2
Abundance	0	469	3,726	1,249	5,210
SE abundance	0	123	278	180	268
Mean length	NA	620	773	835	775
SE mean length	NA	10	3	4	5
Male	17	88	80	30	264
Percent	5.0	19.8	18.6	7.7	53.3
SE percent	1.2	1.9	1.9	1.4	2.2
Abundance	558	2,209	2,075	859	5,946
SE abundance	134	217	216	157	274
Mean length	362	607	781	876	694
SE mean length	6	6	4	9	10
All	17	103	219	76	495
Percent	5.0	23.9	52.2	18.9	NA
SE percent	1.2	2.1	2.5	2.0	NA
Abundance	558	2,666	5,823	2,108	11,156
SE abundance	134	241	303	227	229
Mean length	362	608	776	853	NA
SE mean length	6	5	3	5	NA

Note: "NA" = not applicable.

[a] Age and length-at-age compositions based on weighted samples collected with nets from South and North Forks and from a weir on the Anchor River mainstem.

[b] Based on unweighted (pooled) samples collected from nets on the South and North Forks and from a weir on the Anchor River mainstem. Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

Table 14.-The estimated ocean age, sex, and length composition of the Anchor River Chinook salmon 2006 escapement.

	Ocean Age [a]				
	1	2	3	4	Total [b]
Female	1	9	73	21	228
Percent	0.8	5.1	29.9	11.7	50.7
SE percent	0.8	1.8	3.3	2.6	2.4
Abundance	72	456	2,675	1,047	4,535
SE abundance	72	162	308	235	260
Mean length	0	724	752	812	767
SE mean length	0	37	15	17	9
Male	9	31	43	20	222
Percent	5.6	11.4	22.2	13.3	49.3
SE percent	1.9	2.1	3.3	2.8	2.4
Abundance	501	1,020	1,986	1,190	4,410
SE abundance	171	191	302	253	258
Mean length	435	569	733	754	674
SE mean length	32	45	24	37	17
All	10	40	116	41	450
Percent	6.4	16.5	52.1	25.0	NA
SE percent	2.1	2.7	3.8	3.5	NA
Abundance	572	1,476	4,660	2,236	8,945
SE abundance	189	246	372	321	289
Mean length	473	640	744	776	NA
SE mean length	48	34	14	23	NA

Note: "NA" = not applicable.

[a] Age and length-at-age compositions based on weighted samples collected with nets from South and North Forks and from a weir on the Anchor River mainstem.

[b] Based on unweighted (pooled) samples collected from nets on the South and North Forks and from a weir on the Anchor River mainstem. Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

Table 15.-The estimated age, sex, and length composition of the Anchor River coho salmon 2005 escapement.

	Age Class [a]					
	1.1	2.1	3.1	1.2	2.2	Total [b]
Female	19	147	3	1	0	222
Percent	4.6	35.8	0.7	0.2	0	42.7
SE percent	1	2.4	0.4	0.2	0	2.2
Abundance	873	6,794	133	38	0	8,103
SE abundance	190	455	76	38	0	417
Mean length	585	589	612	622	NA	591
SE mean length	11	3	14	NA	NA	3
Male	37	202	1	0	1	298
Percent	9.0	49.1	0.2	0.0	0.2	57.3
SE percent	1.4	2.5	0.2	0.0	0.2	2.2
Abundance	1,708	9,318	38	0	38	10,874
SE abundance	266	474	38	0	38	417
Mean length	587	593	702	NA	540	594
SE mean length	6	3	NA	NA	NA	3
All	56	349	4	1	1	520
Percent	13.6	84.9	1.0	0.2	0.2	100.0
SE percent	1.7	1.8	0.5	0.2	0.2	0
Abundance	2,581	16,111	190	38	38	18,977
SE abundance	323	342	95	38	38	0
Mean length	586	591	634	622	540	593
SE mean length	6	2	25	NA	NA	2

Note: "NA" = not applicable.

[a] Age and length-at-age compositions based on samples collected systematically from an Anchor River mainstem weir.

[b] Sex composition is based on unweighted (pooled) samples collected from an Anchor River mainstem weir. Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

Table 16.-The estimated age, sex and length composition of the Anchor River coho salmon 2006 escapement.

	Age Class [a]					
	1.1	2.1	3.1	1.2	2.2	Total [b]
Female	7	46	0	0	0	78
Percent	5.3	35.1	0	0	0	37.9
SE percent	2	4.2	0	0	0	3.4
Abundance	540	3,574	0	0	0	3,859
SE abundance	204	428	0	0	0	346
Mean length	580	579	NA	NA	NA	580
SE mean length	13	5	NA	NA	NA	4
Male	7	71	0	0	1	128
Percent	5.3	54.2	0.0	0.0	0.7	62.1
SE percent	2.0	4.4	0.0	0.0	0.7	3.4
Abundance	540	5,518	0	0	71	6,322
SE abundance	204	448	0	0	71	346
Mean length	569	576	NA	NA	NA	576
SE mean length	20	7	NA	NA	NA	5
All	14	118	0	0	1	206
Percent	10.6	89.4	0.0	0.0	0.7	100.0
SE percent	2.7	2.7	0.0	0.0	0.7	0
Abundance	1,079	9,102	0	0	71	10,181
SE abundance	275	275	0	0	71	0
Mean length	575	578	NA	NA	570	578
SE mean length	12	5	NA	NA	NA	4

Note: "NA" = not applicable.

[a] Age and length-at-age compositions based on samples collected systematically from an Anchor River mainstem weir.

[b] Sex composition is based on unweighted (pooled) samples collected from an Anchor River mainstem weir. Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

Table 17.-Coded wire tag data for Chinook and coho salmon recovered at Anchor River, 2005-2006.

		Sampling data			Coded wire tag data [a]					
				CWT	CWT	Brood		Released		
Year	Species	Checked [b]	Sampled [c]	detected [d]	code	Year	Hatchery	Date	Location	Statistical area
2005	Chinook salmon	498	3	1	310260	2000	Fort Richardson	6/13/2001	Ninilchik R	244-20
	Coho salmon	520	1	1	310281	2002	Fort Richardson	5/24/2004	Ship Ck	247-50
2006	Chinook salmon	486	0	0						
	Coho salmon	208	1	ND						

Note: "ND" = no data; "CWT" = coded wire tag.

[a] Source: Mark, Tag and Age Laboratory Database [Internet]. Juneau, AK. ADF&G. 2006. [11:49:00 AM 22 Dec 2006 update]. Available from: http://tagotoweb.adfg.state.ak.us/CWT/reports/.

[b] Number of fish checked for the presence of an adipose fin.

[c] Number of fish detected and sampled where the adipose fin was missing.

[d] Number of sampled fish where CWT was detected.

FIGURES

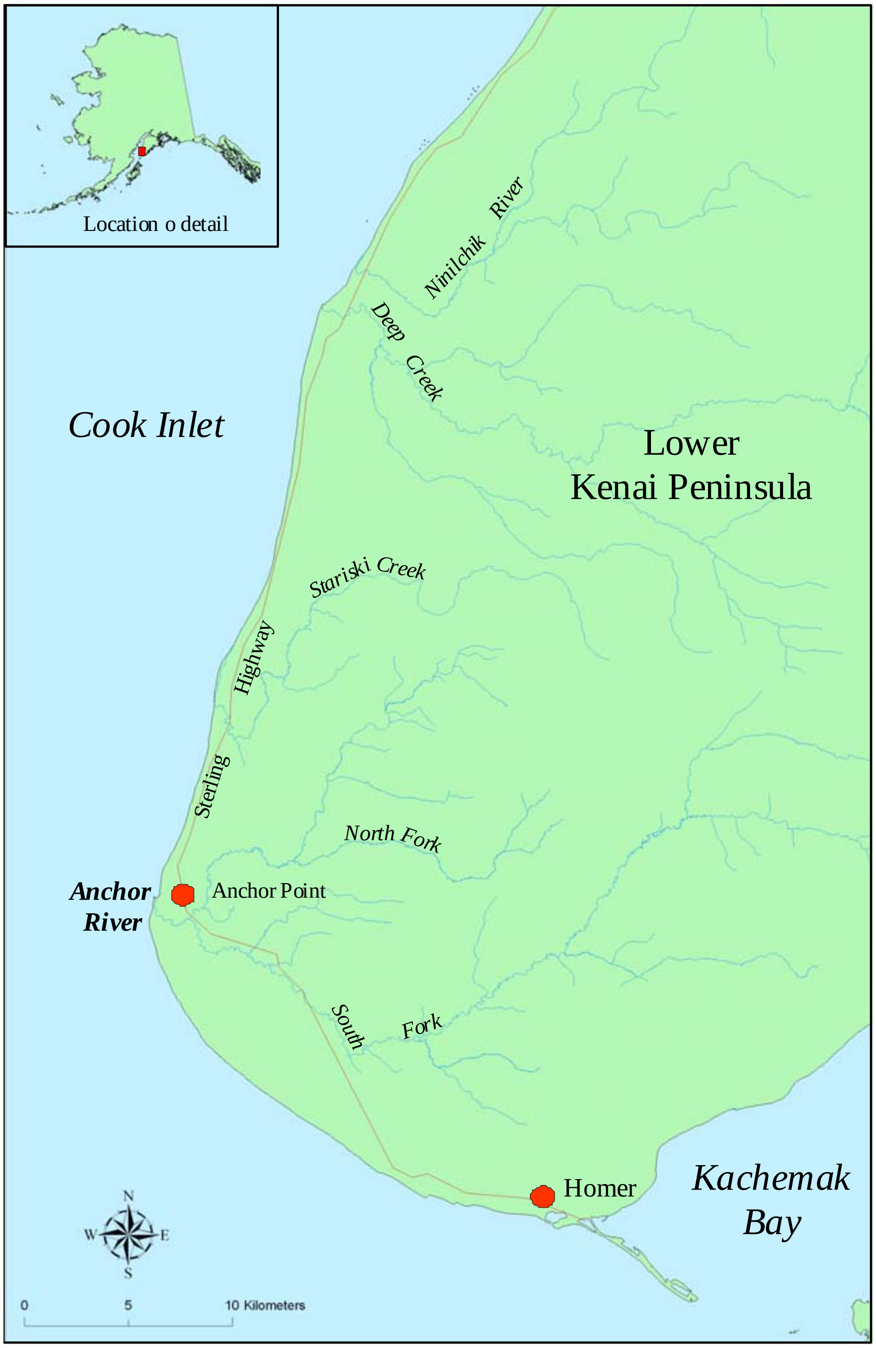
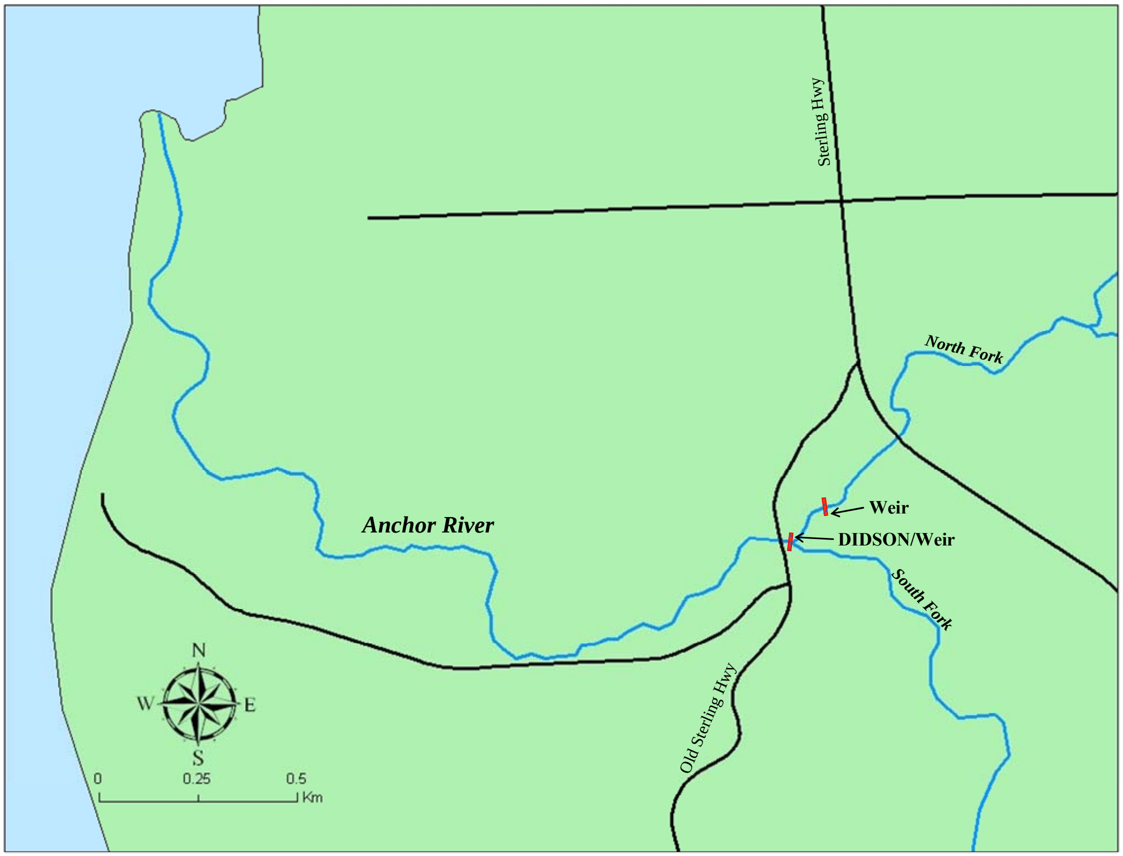


Figure 1.-Location of the Anchor River and other Lower Cook Inlet roadside tributaries.



Note: Global Positioning System coordinates for the mainstem DIDSON (lat 59°77.220'N, long 151° 83.485'W), and weir site (lat 59°77.224'N, long 151° 83.495'W), and the North Fork weir site (lat 59°77.655'N, long 151° 82.607'W).

Figure 2.-Locations of the mainstem DIDSON and weir site, and the North Fork weir site on Anchor River.

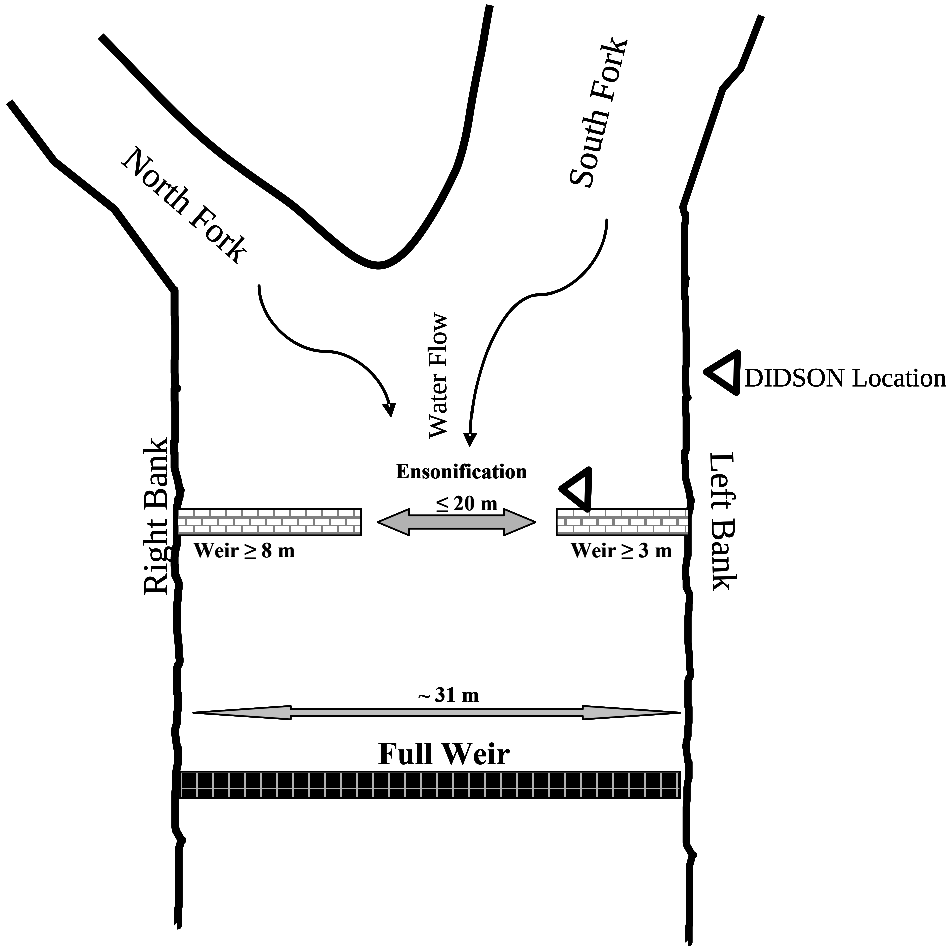


Figure 3.-Locations of the mainstem DIDSON, partial weirs and mainstem full weir site on the mainstem of the Anchor River, 2005 and 2006.

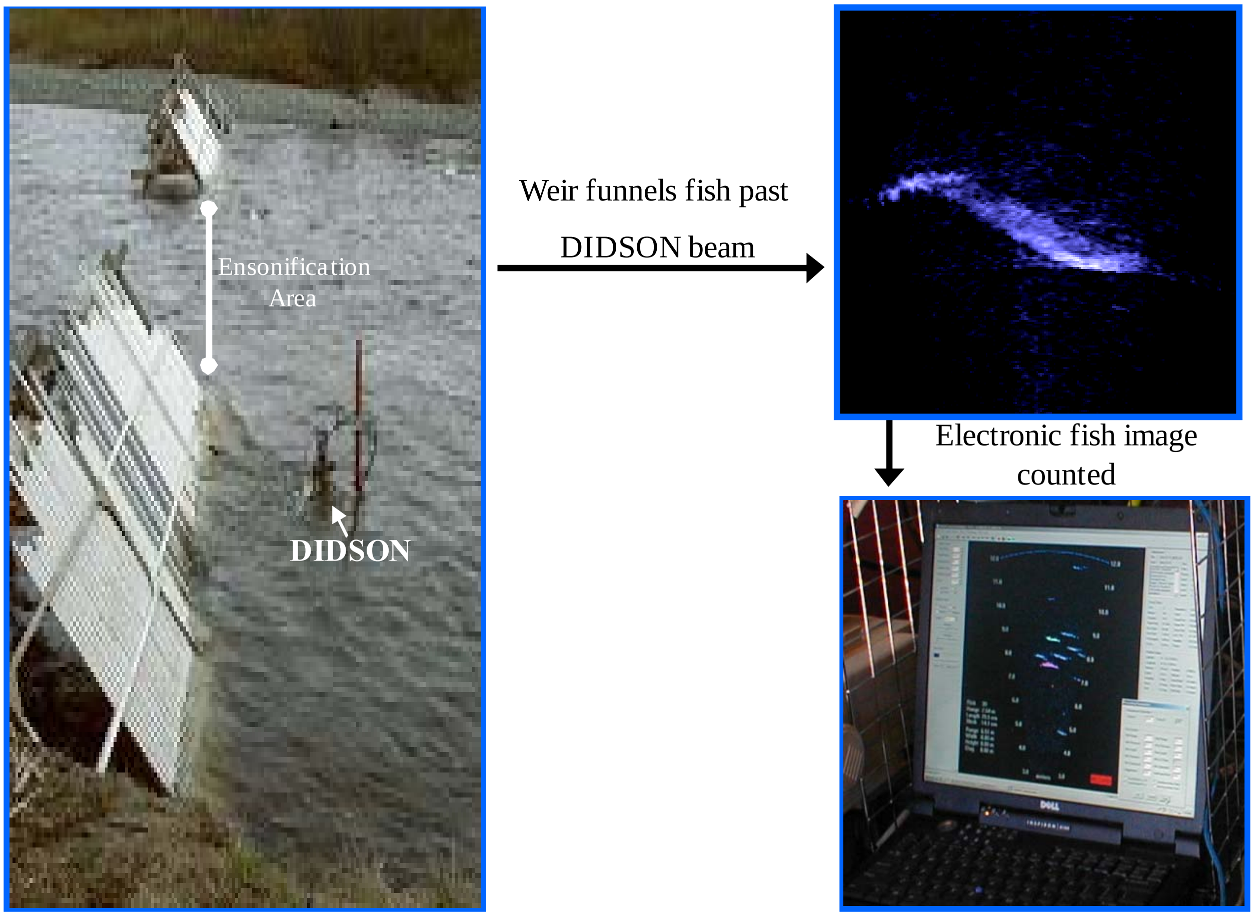


Figure 4.-DIDSON is used with a partial weir to funnel fish past the DIDSON beam.

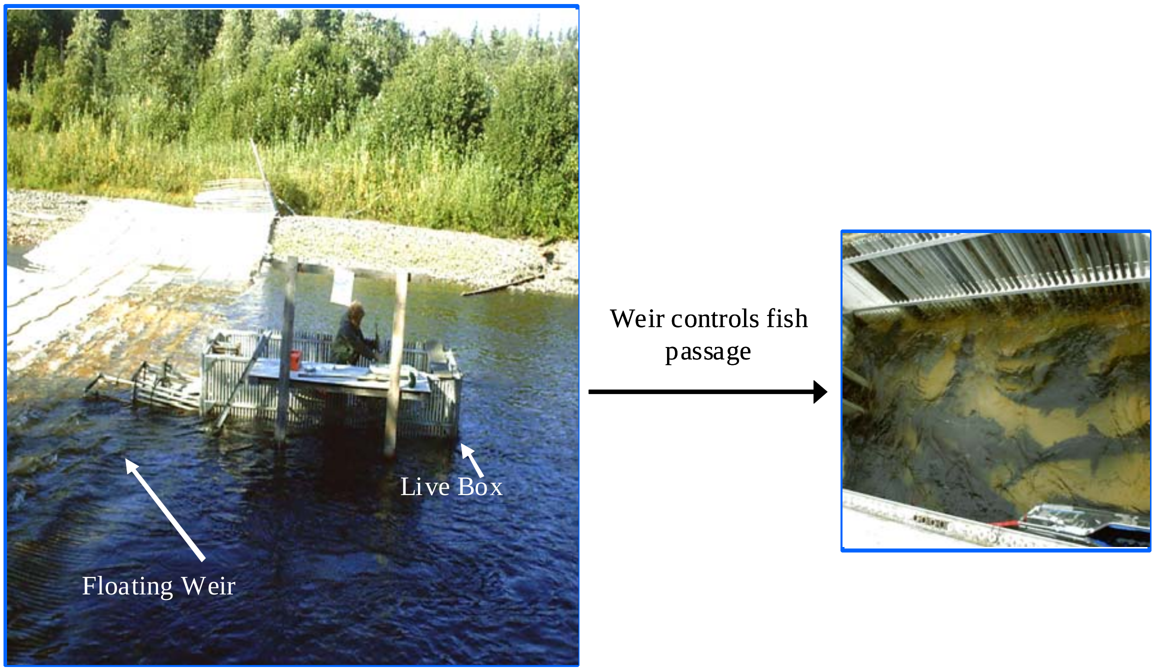


Figure 5.-Resistance board weir used to count fish.

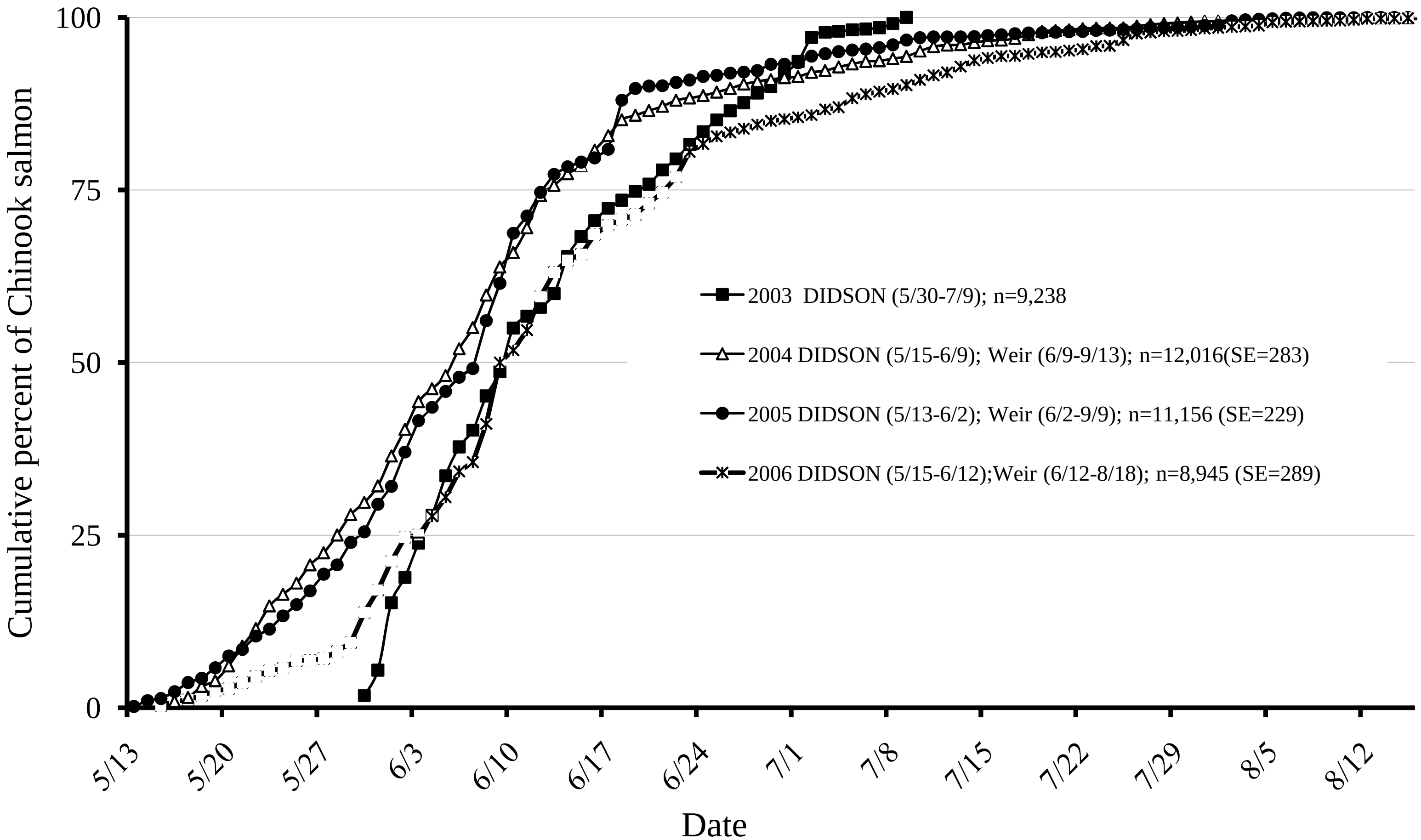


Figure 6.-Run timing of Anchor River Chinook salmon at the mainstem sonar/weir approximately 2.8 rkm upstream from the mouth, 2003-2006.

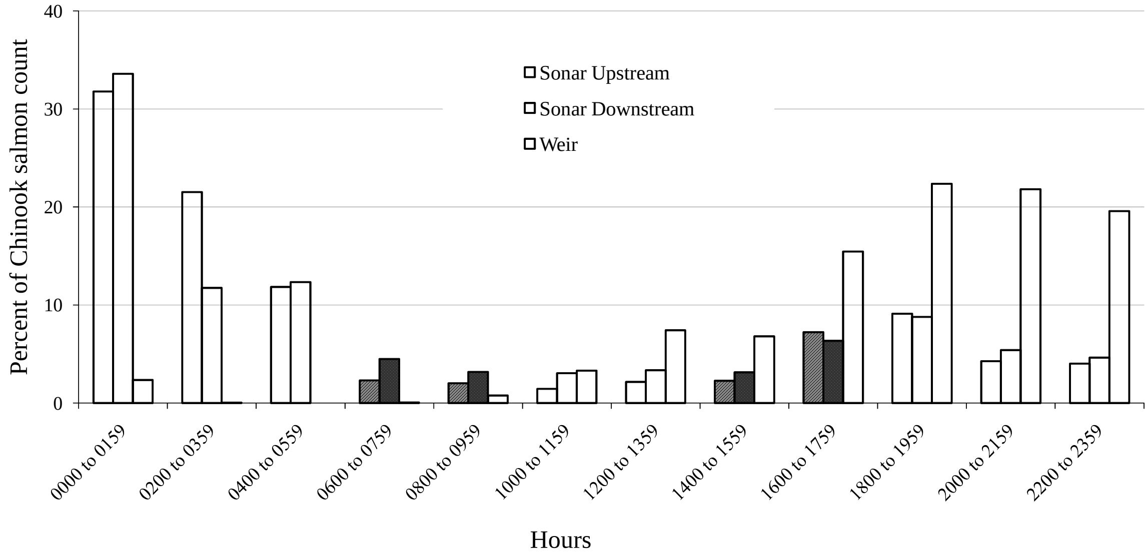


Figure 7.-The 2005 diel migration pattern of Anchor River Chinook salmon based on full 20-min DIDSON counts (May 13 to June 3) and weir counts (June 3 to September 9) collected approximately 2.8 rkm upstream from the mouth of Anchor River.

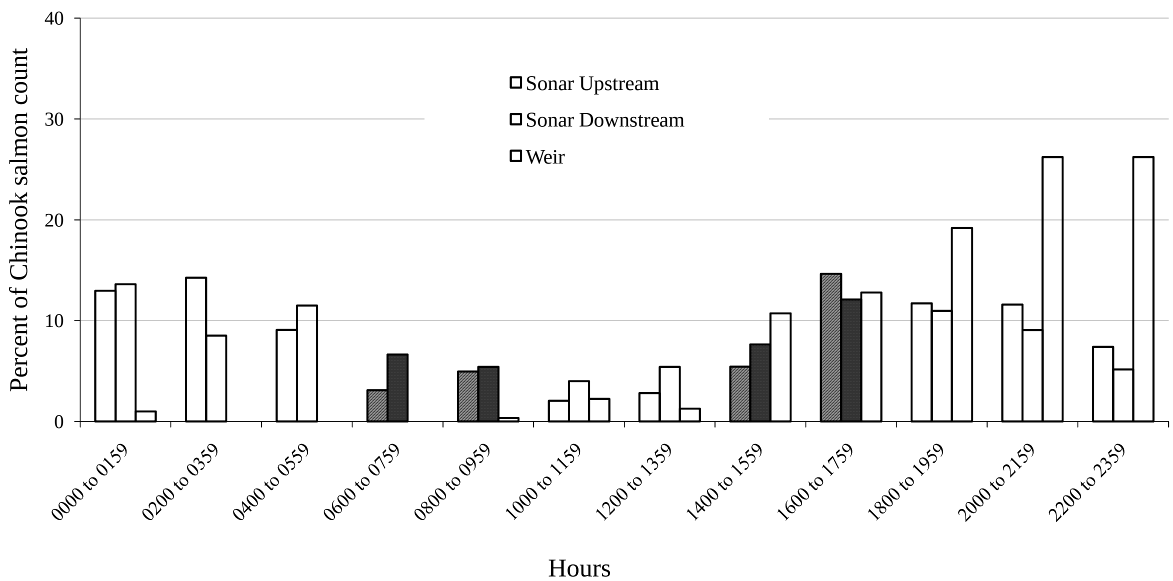
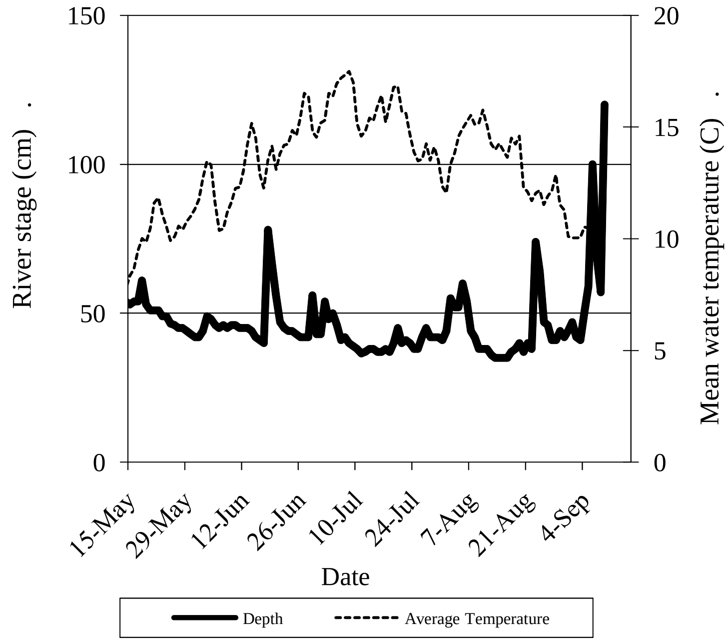
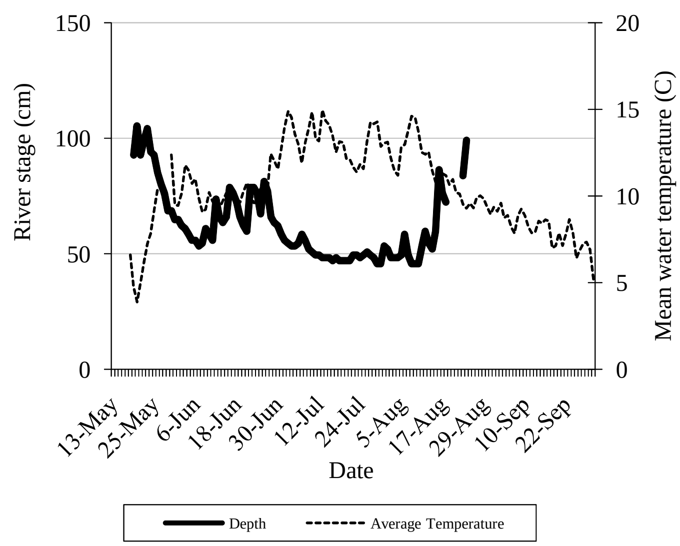


Figure 8.-The 2006 diel migration pattern of Anchor River Chinook salmon based on full 20-min DIDSON counts (May 15 to June 13) and weir counts (June 13 to August 18) collected approximately 2.8 rkm upstream from the mouth of Anchor River.



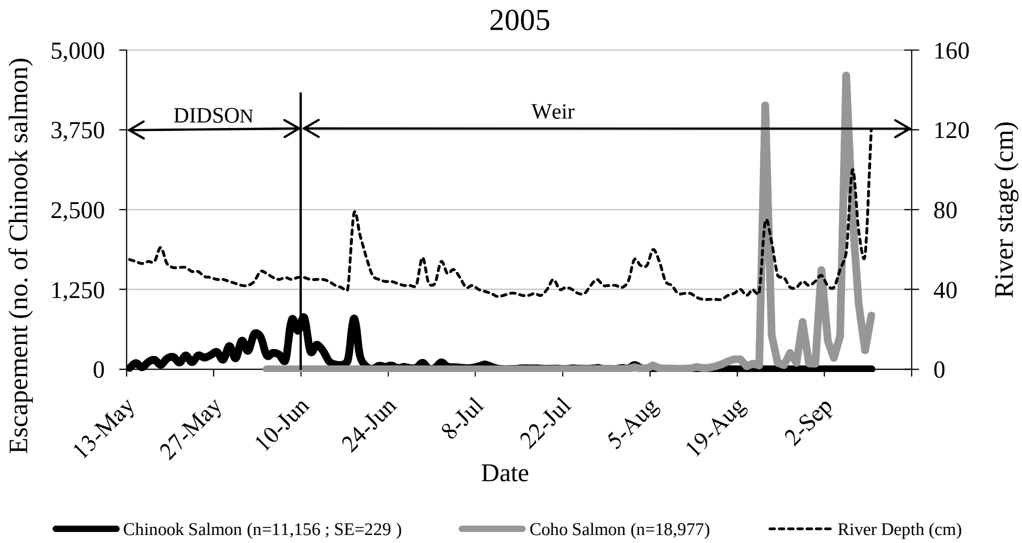
Source: Water temperatures collected by Sue Mauger at CIK site AR-3.

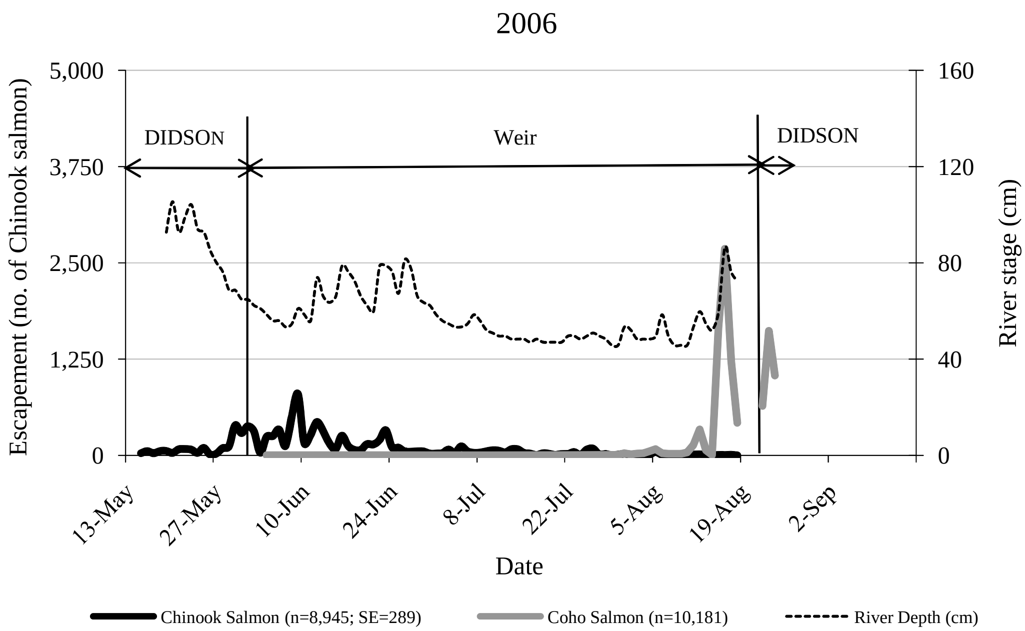
Figure 9.-River stage and mean water temperature at Anchor River sonar/weir site, 2005.



Source: Water temperatures collected by Sue Mauger at CIK site AR-3.

Figure 10.-River stage and mean water temperature at Anchor River sonar/weir site, 2006.





Note: 2005 operating dates: DIDSON (May 13 to Jun 3) and weir (Jun 3 to Sep 9);
2006 operating dates: DIDSON (May 15 to Jun 13), weir (Jun 13 to Aug 18), and DIDSON (Aug 22 to Aug 24).

Figure 11.-Comparison of Anchor River Chinook and coho salmon escapement estimates with corresponding daily river stage changes at the DIDSON/weir site located 2.8 rkm upstream from the mouth, 2005 and 2006.

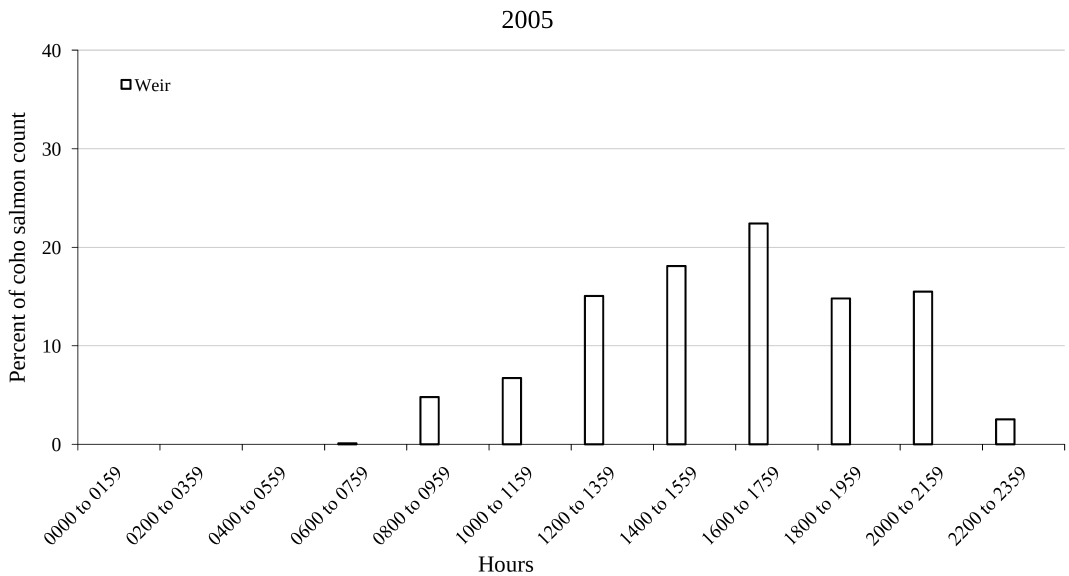


Figure 12.-The 2005 diel migration pattern of Anchor River coho salmon based on weir counts (June 3 to September 9) collected approximately 2.8 rkm upstream from the mouth of Anchor River.

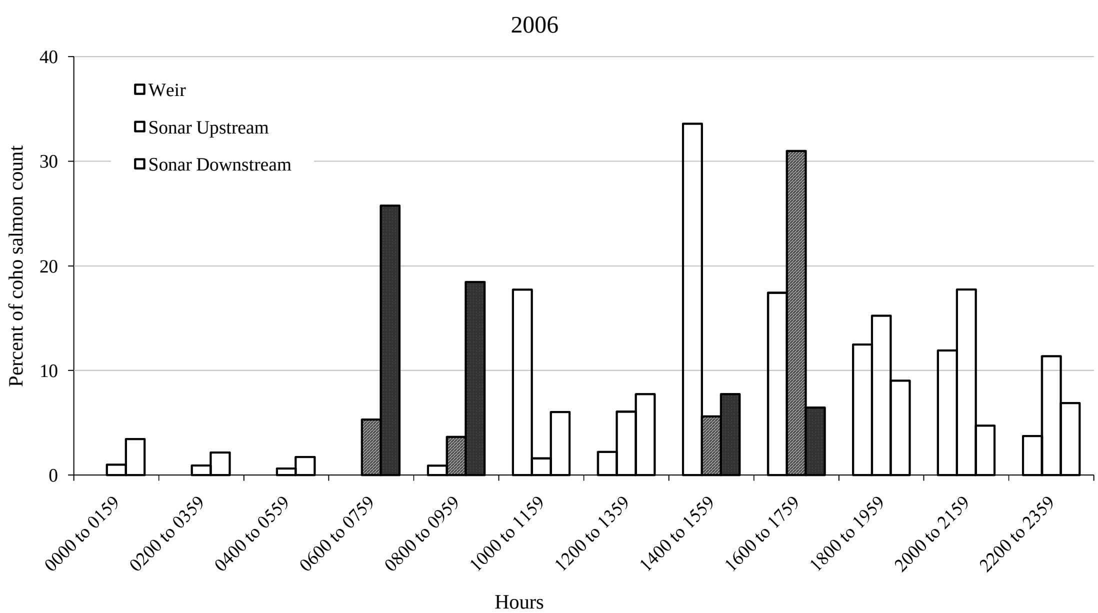


Figure 13.-The 2006 diel migration pattern of Anchor River coho salmon based on full 20-min DIDSON counts (August 22 to 24) and weir counts (June 13 to August 18) collected approximately 2.8 rkm upstream from the mouth of Anchor River.

APPENDIX A. DESCRIPTION OF DIDSON AND PARTIAL WEIR USED AT ANCHOR RIVER IN 2005 AND 2006

DIDSON Specifications

The DIDSON specifications allow detection up to 30 m (low frequency), however it can effectively detect fish only to 20 m (Burwen et al. 2007). The DIDSON operates at two frequencies, 1.8 MHz for close range observations (less than 15 m) and 1.0 MHz for observations from 15 m up to 30 m. Image resolution is greater at high frequency. Overall beam dimensions are 29^{o} in the horizontal axis and 12^{o} in the vertical axis. At high frequency (1.8 MHz), image resolution is enhanced because the image is formed using 96 beams, each 0.3^{o} wide, compared to low frequency (1.0 MHz) that forms the image using only 48 beams that are 0.6^{o} wide. Image quality was also influenced by the data collection window length, which is implemented in discrete lengths of 2.5, 5.0, 10.0, 20.0, and 40.0 m. Consequently, images collected at smaller window lengths (2.5, 5.0, and 10.0 m) and high frequency (1.8 MHz) are preferable to their counterparts (20m and 40m, 1.0 MHz).

Before the DIDSON was deployed, it was fitted with communication cables then bolted to an adjustable mast that had been welded to a steel tripod. In 2006, the DIDSON was place in a silt box before it was bolted to the mast because of the high silt load in the river. The communication cables were connected to electronic equipment in a WeatherPort[7] and the entire system was powered by a generator. DIDSON images were received on a Dell[4] desktop computer. Once the DIDSON was secured to the mast tripod assembly, it was deployed then anchored with two of the tripod legs oriented downstream approximately 0.5 m upstream of the left bank weir. The offshore distance the tripod was anchored was determined by the offshore end of the left bank weir (Figure 4). The tripod was anchored approximately 1 to 2 m inshore from the end of the weir in order to allow the width of the beam to spread to its full size. The DIDSON beam was then aimed toward the offshore end of the right bank weir. If the right bank weir could not be seen even after the DIDSON was re-aimed, we checked the alignment of the DIDSON on the mast and if necessary moved the tripod closer to the end of the left bank weir.

Partial Picket Weir Specifications

Partial weirs were used in 2005 and 2006 to redirect fish through the shortest ensonification range possible. The ensonification range was determined by the prevailing water level. Two partial picket weirs were built to reach outward from each riverbank. Each picket weir was oriented horizontally to the current to constrict fish passage below 20 m and funnel fish through the sonar beam (Figure 4).

The distance each partial picket weir extended from the bank varied among years but we aimed to achieve the greatest constriction possible (<10 m) so the DIDSON could record high-resolution fish images using high frequency. In cases where river levels were too high for us to constrict the distance to <10 m, the DIDSON was set to record low-resolution fish images using the low frequency setting. All bottom irregularities at the base of the partial weir were sealed using sand bags to prevent fish from migrating past the DIDSON undetected.

In 2005, fish passage was constricted to approximately 9 m, and the DIDSON began receiving images at 1200 hours on May 13 using high frequency. The DIDSON was used to collect escapement data through 1500 hours June 3.

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[7] Manufacturer and product names used in this report are included for scientific completeness but do not constitute product endorsement.

In 2006, fish passage was constricted to approximately 20 m on May 15, and the DIDSON began receiving images at 1700 hours on low frequency. On May 30 after the partial weir was lengthened and fish passage was constricted to approximately 9 m, the DIDSON was set to high frequency at 1300 hours.

APPENDIX B. ANCHOR RIVER ESCAPEMENT ESTIMATES BY SPECIES FOR 2005 AND 2006

Appendix B1.-Estimated daily, cumulative, and cumulative percent for escapement by species at Anchor River DIDSON/weir site, 2005.

Date	Chinook salmon [a]			Dolly Varden			Pink salmon			Chum salmon			Sockeye salmon			Coho salmon			Steelhead		
	Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)		
(m/dd)	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %
5/13 [b]	21	21	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/14 [b]	96	117	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/15 [b]	30	147	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/16 [b]	114	261	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/17 [b]	147	408	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/18 [b]	69	477	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/19 [b]	168	645	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/20 [b]	192	837	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/21 [b]	105	942	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/22 [b]	216	1,158	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/23 [b]	111	1,269	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/24 [b]	216	1,485	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/25 [b]	182	1,667	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/26 [b]	222	1,889	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/27 [b]	270	2,159	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/28 [b]	150	2,309	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/29 [b]	363	2,672	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/30 [b]	171	2,843	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/31 [b]	447	3,290	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/01 [b]	288	3,578	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/02 [b]	555	4,133	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/03 [c]	507	4,640	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/04 [d]	215	4,855	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/05 [d]	257	5,112	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/06 [d]	228	5,340	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/07 [d]	141	5,481	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/08 [d]	775	6,256	56	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/09 [d]	603	6,859	61	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/10 [d]	809	7,668	69	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11 [d]	278	7,946	71	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12 [d]	384	8,330	75	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/13 [d]	290	8,620	77	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/14 [d]	123	8,743	78	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/15 [d]	75	8,818	79	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/16 [d]	68	8,886	80	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17 [d]	137	9,023	81	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/18 [d]	795	9,818	88	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/19 [d]	189	10,007	90	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/20 [d]	39	10,046	90	10	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21 [d]	6	10,052	90	15	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/22 [d]	54	10,106	91	8	39	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/23 [d]	38	10,144	91	31	70	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24 [d]	58	10,202	91	135	205	4	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0

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Date		Chinook salmon [a]			Dolly Varden			Pink salmon			Chum salmon			Sockeye salmon			Coho salmon			Steelhead		
		Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)		
(m/dd)		Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %
6/25	d	17	10,219	92	6	211	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
6/26	d	37	10,256	92	49	260	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
6/27	d	17	10,273	92	40	300	9	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
6/28	d	23	10,296	92	220	520	11	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
6/29	d	101	10,397	93	129	649	11	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
6/30	d	4	10,401	93	3	652	13	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0
7/01	d	22	10,423	93	109	761	18	12	21	0	0	0	0	0	0	0	0	0	0	0	0	0
7/02	d	107	10,530	94	241	1,002	20	19	40	1	0	0	0	0	0	0	0	0	0	0	0	0
7/03	d	38	10,568	95	118	1,120	21	10	50	1	0	0	0	0	0	0	0	0	0	0	0	0
7/04	d	35	10,603	95	89	1,209	23	11	61	1	0	0	0	0	0	0	0	0	0	0	0	0
7/05	d	25	10,628	95	124	1,333	33	2	63	1	0	0	0	0	0	0	0	0	0	0	0	0
7/06	d	18	10,646	95	540	1,873	42	39	102	2	0	0	0	0	0	0	0	0	0	0	0	0
7/07	d	22	10,668	96	520	2,393	63	60	162	3	2	2	1	0	0	0	0	0	0	0	0	0
7/08	e	46	10,714	96	1,198	3,591	80	39	201	4	1	3	2	0	0	0	0	0	0	0	0	0
7/09	f	74	10,788	97	972	4,563	89	19	220	4	0	3	2	0	0	0	0	0	0	0	0	0
7/10	g	40	10,828	97	547	5,110	94	0	220	4	0	3	2	0	0	0	0	0	0	0	0	0
7/11	h	11	10,839	97	260	5,370	94	0	220	4	0	3	2	0	0	0	0	0	0	0	0	0
7/12	d	1	10,840	97	0	5,370	94	0	220	4	0	3	2	0	0	0	0	0	0	0	0	0
7/13	d	1	10,841	97	0	5,370	94	0	220	4	0	3	2	0	0	0	0	0	0	0	0	0
7/14	d	6	10,847	97	31	5,401	97	9	229	5	0	3	2	0	0	0	0	0	0	0	0	0
7/15	d	17	10,864	97	141	5,542	98	9	238	5	0	3	2	0	0	0	0	0	0	0	0	0
7/16	d	11	10,875	97	64	5,606	99	7	245	5	0	3	2	0	0	0	0	0	0	0	0	0
7/17	d	18	10,893	98	43	5,649	99	26	271	6	0	3	2	1	1	0	0	0	0	0	0	0
7/18	d	10	10,903	98	21	5,670	99	18	289	6	0	3	2	2	3	1	0	0	0	0	0	0
7/19	d	6	10,909	98	0	5,670	99	16	305	6	0	3	2	0	3	1	0	0	0	0	0	0
7/20	d	9	10,918	98	14	5,684	99	15	320	7	0	3	2	0	3	1	0	0	0	0	0	0
7/21	d	8	10,926	98	2	5,686	100	4	324	7	1	4	3	0	3	1	0	0	0	0	0	0
7/22	d	3	10,929	98	8	5,694	100	10	334	7	0	4	3	1	4	1	1	1	0	0	0	0
7/23	d	15	10,944	98	14	5,708	100	13	347	7	0	4	3	0	4	1	0	1	0	1	1	1
7/24	d	7	10,951	98	4	5,712	100	10	357	7	1	5	3	2	6	2	1	2	0	0	1	1
7/25	d	10	10,961	98	2	5,714	100	17	374	8	4	9	6	0	6	2	0	2	0	0	1	1
7/26	d	6	10,967	98	0	5,714	100	9	383	8	0	9	6	0	6	2	0	2	0	0	1	1
7/27	d	21	10,988	98	0	5,714	100	22	405	8	3	12	8	1	7	2	1	3	0	0	1	1
7/28	d	5	10,993	99	0	5,714	100	17	422	9	0	12	8	0	7	2	1	4	0	0	1	1
7/29	d	7	11,000	99	0	5,714	100	5	427	9	1	13	9	0	7	2	4	8	0	0	1	1
7/30	d	5	11,005	99	0	5,714	100	10	437	9	0	13	9	0	7	2	3	11	0	0	1	1
7/31	d	20	11,025	99	0	5,714	100	14	451	9	0	13	9	1	8	3	1	12	0	0	1	1
8/01	d	8	11,033	99	0	5,714	100	96	547	11	7	20	14	7	15	5	4	16	0	0	1	1
8/02	d	66	11,099	99	0	5,714	100	125	672	14	7	27	18	5	20	6	34	50	0	0	1	1
8/03	d	18	11,117	100	0	5,714	100	23	695	14	2	29	20	0	20	6	9	59	0	0	1	1
8/04	d	8	11,125	100	0	5,714	100	45	740	15	5	34	23	3	23	7	13	72	0	0	1	1
8/05	d	10	11,135	100	3	5,717	100	142	882	18	12	46	32	17	40	13	59	131	1	0	1	1
8/06	d	6	11,141	100	0	5,717	100	74	956	19	6	52	36	4	44	14	13	144	1	0	1	1

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Appendix B1.-Page 3 of 4.

Date	Chinook salmon [a]			Dolly Varden			Pink salmon			Chum salmon			Sockeye salmon			Coho salmon			Steelhead		
	Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)		
(m/dd)	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %
8/07 [d]	5	11,146	100	0	5,717	100	72	1,028	21	4	56	38	3	47	15	10	154	1	0	1	1
8/08 [d]	6	11,152	100	0	5,717	100	36	1,064	22	6	62	42	2	49	15	9	163	1	1	2	2
8/09 [d]	1	11,153	100	0	5,717	100	36	1,100	22	9	71	49	9	58	18	4	167	1	0	2	2
8/10 [d]	0	11,153	100	0	5,717	100	22	1,122	23	6	77	53	2	60	19	12	179	1	0	2	2
8/11 [d]	0	11,153	100	0	5,717	100	27	1,149	23	7	84	58	12	72	23	13	192	1	0	2	2
8/12 [d]	1	11,154	100	0	5,717	100	46	1,195	24	4	88	60	3	75	24	39	231	1	1	3	3
8/13 [d]	0	11,154	100	0	5,717	100	67	1,262	26	4	92	63	7	82	26	18	249	1	0	3	3
8/14 [d]	1	11,155	100	0	5,717	100	45	1,307	27	1	93	64	16	98	31	23	272	1	0	3	3
8/15 [d]	0	11,155	100	0	5,717	100	59	1,366	28	5	98	67	8	106	33	46	318	2	1	4	4
8/16 [d]	0	11,155	100	0	5,717	100	70	1,436	29	7	105	72	12	118	37	80	398	2	1	5	5
8/17 [d]	0	11,155	100	0	5,717	100	271	1,707	35	7	112	77	2	120	38	124	522	3	2	7	7
8/18 [d]	0	11,155	100	0	5,717	100	301	2,008	41	3	115	79	8	128	40	157	679	4	0	7	7
8/19 [d]	0	11,155	100	1	5,718	100	246	2,254	46	3	118	81	13	141	44	156	835	4	1	8	7
8/20 [d]	0	11,155	100	0	5,718	100	289	2,543	52	4	122	84	16	157	49	47	882	5	0	8	7
8/21 [d]	1	11,156	100	0	5,718	100	257	2,800	57	2	124	85	13	170	53	88	970	5	0	8	7
8/22 [d]	0	11,156	100	0	5,718	100	157	2,957	60	6	130	89	5	175	55	60	1,030	5	0	8	7
8/23 [d]	0	11,156	100	0	5,718	100	1,156	4,113	84	4	134	92	15	190	60	4,134	5,164	27	2	10	9
8/24 [d]	0	11,156	100	0	5,718	100	114	4,227	86	0	134	92	2	192	60	542	5,706	30	5	15	14
8/25 [d]	0	11,156	100	0	5,718	100	28	4,255	87	0	134	92	1	193	61	101	5,807	31	3	18	17
8/26 [d]	0	11,156	100	0	5,718	100	44	4,299	87	0	134	92	1	194	61	65	5,872	31	0	18	17
8/27 [d]	0	11,156	100	0	5,718	100	31	4,330	88	3	137	94	2	196	61	254	6,126	32	0	18	17
8/28 [d]	0	11,156	100	0	5,718	100	95	4,425	90	3	140	96	3	199	62	101	6,227	33	2	20	19
8/29 [d]	0	11,156	100	0	5,718	100	72	4,497	91	3	143	98	6	205	64	740	6,967	37	4	24	22
8/30 [d]	0	11,156	100	0	5,718	100	26	4,523	92	0	143	98	2	207	65	93	7,060	37	2	26	24
8/31 [d]	0	11,156	100	0	5,718	100	28	4,551	93	0	143	98	1	208	65	88	7,148	38	2	28	26
9/01 [d]	0	11,156	100	0	5,718	100	123	4,674	95	0	143	98	2	210	66	1,552	8,700	46	7	35	33
9/02 [d]	0	11,156	100	0	5,718	100	15	4,689	95	0	143	98	2	212	66	449	9,149	48	1	36	34
9/03 [d]	0	11,156	100	0	5,718	100	4	4,693	95	0	143	98	1	213	67	176	9,325	49	0	36	34
9/04 [d]	0	11,156	100	0	5,718	100	20	4,713	96	0	143	98	21	234	73	517	9,842	52	14	50	47
9/05 [d]	0	11,156	100	0	5,718	100	97	4,810	98	1	144	99	29	263	82	4,601	14,443	76	41	91	85
9/06 [d]	0	11,156	100	0	5,718	100	53	4,863	99	0	144	99	47	310	97	2,367	16,810	89	1	92	86
9/07 [d]	0	11,156	100	1	5,719	100	30	4,893	100	0	144	99	5	315	99	1,028	17,838	94	11	103	96
9/08 [d]	0	11,156	100	0	5,719	100	16	4,909	100	2	146	100	2	317	99	297	18,135	96	0	103	96
9/09 [d]	0	11,156	100	0	5,719	100	7	4,916	100	0	146	100	2	319	100	842	18,977	100	4	107	100

-continued-

Note: "-"= value cannot be computed due to limitations of the data.

[a] Escapement estimate of Chinook salmon is 11,156 (SE = 229).

[b] Daily count estimated from 20-min DIDSON counts expanded to the hour of fish passage between partial picket weirs from May 13 to June 3.

[c] Daily count estimated from 20-min DIDSON counts expanded to the hour (294) of fish passage between partial picket weirs from 0001 to 1300 and fish speciated in the weir live box from 1301 hours through midnight June 3.

[d] Daily count of fish speciated in the weir live box.

[e] Daily count estimated from the three 20-min DIDSON counts of each hour (0001 to 0700 hours) of fish estimate (39 Chinook salmon and 1,032 Dolly Varden) passing through the live box and fish speciated in the weir live box from 0701 to midnight on July 8.

[f] Daily count estimated from the three 20-min DIDSON counts of each hour (0001 to 0700 hours) of fish estimate (72 Chinook salmon and 867 Dolly Varden) passing through the live box and fish speciated in the weir live box from 0701 to midnight on July 9.

[g] Daily count estimated from the three 20-min DIDSON counts of each hour (0001 to 0700 hours) of fish estimate (39 Chinook salmon and 531 Dolly Varden) passing through the live box and fish speciated in the weir live box from 0701 to midnight on July 10.

[h] Daily count estimated from the three 20-min DIDSON counts of each hour (0001 to 0700 hours) of fish estimate (7 Chinook salmon and 259 Dolly Varden) passing through the live box and fish speciated in the weir live box from 0701 to midnight on July 11.

Appendix B2.-Estimated daily, cumulative, and cumulative percent for escapement by species at Anchor River DIDSON/weir site, 2006.

Date	Chinook salmon [a]			Dolly Varden			Pink salmon			Chum salmon			Sockeye salmon			Coho salmon			Steelhead		
	Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)		
(m/dd)	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %
5/13 [b]	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/14 [b]	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/15 [b]	27	27	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/16 [b]	54	81	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/17 [b]	26	107	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/18 [b]	54	161	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/19 [b]	57	218	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/20 [b]	30	248	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/21 [b]	78	326	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/22 [b]	81	407	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/23 [b]	74	481	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/24 [b]	31	512	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/25 [b]	96	608	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/26 [b]	9	617	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/27 [b]	21	638	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/28 [b]	93	731	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/29 [b]	114	845	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/30 [b]	389	1,234	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/31 [b]	288	1,522	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/01 [b]	377	1,899	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/02 [b]	309	2,208	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/03 [b]	33	2,241	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/04 [b]	240	2,481	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/05 [b]	249	2,730	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/06 [b]	333	3,063	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/07 [b]	120	3,183	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/08 [b]	495	3,678	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/09 [b]	795	4,473	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/10 [b]	159	4,632	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/11 [b]	261	4,893	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/12 [b]	432	5,325	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/13 [c]	317	5,642	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/14 [d]	156	5,798	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/15 [d]	80	5,878	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	25
6/16 [d]	255	6,133	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	50
6/17 [d]	121	6,254	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	50
6/18 [d]	71	6,325	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	50
6/19 [d]	68	6,393	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	50
6/20 [d]	145	6,538	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	50
6/21 [d]	140	6,678	75	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	50
6/22 [d]	199	6,877	77	6	3	1	2	0	2	2	4	4	0	0	0	0	0	0	0	2	50
6/23 [d]	326	7,203	81	8	3	3	5	1	2	4	9	9	0	0	0	0	0	0	0	2	50
6/24 [d]	101	7,304	82	8	3	0	5	1	0	4	9	9	0	0	0	0	0	0	0	2	50

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Date	Chinook salmon [a] Count (no. of fish)			Dolly Varden Count (no. of fish)			Pink salmon Count (no. of fish)			Chum salmon Count (no. of fish)			Sockeye salmon Count (no. of fish)			Coho salmon Count (no. of fish)			Steelhead Count (no. of fish)		
(m/dd)	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %
6/25 [d]	100	7,404	83	12	5	1	6	1	0	4	9	9	0	0	0	0	0	0	0	2	50
6/26 [d]	52	7,456	83	14	6	0	6	1	0	4	9	9	0	0	0	0	0	0	0	2	50
6/27 [d]	47	7,503	84	14	6	1	7	1	0	4	9	9	0	0	0	0	0	0	0	2	50
6/28 [d]	52	7,555	84	15	6	0	7	1	0	4	9	9	0	0	0	0	0	0	0	2	50
6/29 [d]	51	7,606	85	16	7	3	10	1	0	4	9	9	0	0	0	0	0	0	0	2	50
6/30 [d]	21	7,627	85	16	7	5	15	2	0	4	9	9	0	0	0	0	0	0	0	2	50
7/01 [d]	24	7,651	86	19	8	1	16	2	0	4	9	9	0	0	0	0	0	0	0	2	50
7/02 [d]	27	7,678	86	21	9	16	32	3	0	4	9	9	0	0	0	0	0	0	0	2	50
7/03 [d]	75	7,753	87	27	12	14	46	5	0	4	9	9	0	0	0	0	0	0	0	2	50
7/04 [d]	30	7,783	87	30	13	6	52	5	0	4	9	9	0	0	0	0	0	0	0	2	50
7/05 [d]	116	7,899	88	47	20	6	58	6	0	4	9	9	0	0	0	0	0	0	0	2	50
7/06 [d]	51	7,950	89	72	31	13	71	7	0	4	9	9	0	0	0	0	0	0	0	2	50
7/07 [d]	32	7,982	89	73	31	5	76	8	0	4	9	9	0	0	0	0	0	0	0	2	50
7/08 [d]	36	8,018	90	74	32	14	90	9	0	4	9	9	0	0	0	0	0	0	0	2	50
7/09 [d]	50	8,068	90	113	48	12	102	11	0	4	9	9	0	0	0	0	0	0	0	2	50
7/10 [d]	68	8,136	91	122	52	9	111	12	0	4	9	9	0	0	0	0	0	0	0	2	50
7/11 [d]	58	8,194	92	128	55	4	115	12	0	4	9	9	0	0	0	1	1	0	0	2	50
7/12 [d]	37	8,231	92	165	71	4	119	12	0	4	9	9	0	0	0	0	1	0	0	2	50
7/13 [d]	78	8,309	93	174	74	9	128	13	0	4	9	9	1	1	3	0	1	0	0	2	50
7/14 [d]	79	8,388	94	183	78	1	129	14	0	4	9	9	0	1	3	0	1	0	0	2	50
7/15 [d]	32	8,420	94	183	78	2	131	14	0	4	9	9	0	1	3	1	2	0	0	2	50
7/16 [d]	23	8,443	94	190	81	0	131	14	0	4	9	9	0	1	3	0	2	0	0	2	50
7/17 [d]	3	8,446	94	192	82	1	132	14	1	5	11	11	1	2	5	0	2	0	0	2	50
7/18 [d]	26	8,472	95	193	82	4	136	14	0	5	11	11	0	2	5	0	2	0	0	2	50
7/19 [d]	21	8,493	95	193	82	4	140	15	0	5	11	11	0	2	5	0	2	0	0	2	50
7/20 [d]	4	8,497	95	195	83	0	140	15	0	5	11	11	0	2	5	1	3	0	0	2	50
7/21 [d]	17	8,514	95	195	83	4	144	15	0	5	11	11	0	2	5	0	3	0	0	2	50
7/22 [d]	17	8,531	95	198	85	1	145	15	0	5	11	11	0	2	5	2	5	0	0	2	50
7/23 [d]	42	8,573	96	199	85	7	152	16	0	5	11	11	0	2	5	3	8	0	0	2	50
7/24 [d]	4	8,577	96	200	85	10	162	17	2	7	16	16	2	4	11	0	8	0	0	2	50
7/25 [d]	73	8,650	97	203	87	30	192	20	1	8	18	18	2	6	16	1	9	0	0	2	50
7/26 [d]	87	8,737	98	209	89	66	258	27	3	11	24	24	0	6	16	3	12	0	0	2	50
7/27 [d]	12	8,749	98	214	91	4	262	27	0	11	24	24	0	6	16	3	15	0	0	2	50
7/28 [d]	17	8,766	98	217	93	4	266	28	1	12	27	27	0	6	16	4	19	0	0	2	50
7/29 [d]	4	8,770	98	218	93	2	268	28	0	12	27	27	1	7	18	4	23	0	0	2	50
7/30 [d]	10	8,780	98	218	93	1	269	28	0	12	27	27	0	7	18	4	27	0	0	2	50
7/31 [d]	20	8,800	98	218	93	14	283	30	2	14	31	31	0	7	18	27	54	1	0	2	50
8/01 [d]	11	8,811	99	218	93	9	292	31	0	14	31	31	0	7	18	10	64	1	0	2	50
8/02 [d]	9	8,820	99	219	94	2	294	31	1	15	33	33	1	8	21	24	88	1	0	2	50
8/03 [d]	9	8,829	99	219	94	10	304	32	0	15	33	33	0	8	21	25	113	1	0	2	50
8/04 [d]	9	8,838	99	219	94	27	331	35	0	15	33	33	0	8	21	54	167	2	0	2	50
8/05 [d]	43	8,881	99	223	95	30	361	38	7	22	49	49	1	9	24	78	245	2	0	2	50
8/06 [d]	7	8,888	99	223	95	9	370	39	3	25	56	56	0	9	24	28	273	3	0	2	50

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Appendix B2.-Page 3 of 3.

Date		Chinook salmon [a]			Dolly Varden			Pink salmon			Chum salmon			Sockeye salmon			Coho salmon			Steelhead		
		Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)			Count (no. of fish)		
(m/dd)		Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %	Daily	Cum	Cum %
8/07	d	5	8,893	99	223	95	4	374	39	0	25	56	56	0	9	24	18	291	3	0	2	50
8/08	d	4	8,897	99	223	95	1	375	39	0	25	56	56	3	12	32	20	311	3	0	2	50
8/09	d	3	8,900	99	223	95	2	377	40	1	26	58	58	0	12	32	18	329	3	0	2	50
8/10	d	4	8,904	100	223	95	5	382	40	0	26	58	58	0	12	32	38	367	4	0	2	50
8/11	d	9	8,913	100	223	95	49	431	45	1	27	60	60	3	15	39	131	498	5	0	2	50
8/12	d	13	8,926	100	224	96	58	489	51	3	30	67	67	1	16	42	337	835	8	0	2	50
8/13	d	4	8,930	100	224	96	18	507	53	1	31	69	69	4	20	53	64	899	9	0	2	50
8/14	d	0	8,930	100	225	96	5	512	54	0	31	69	69	0	20	53	5	904	9	0	2	50
8/15	d	5	8,935	100	227	97	68	580	61	9	40	89	89	14	34	89	1,658	2,562	25	0	2	50
8/16	d	4	8,939	100	231	99	243	823	86	1	41	91	91	0	34	89	2,683	5,245	52	0	2	50
8/17	d	6	8,945	100	234	100	101	924	97	2	43	96	96	2	36	95	1,221	6,466	64	2	4	100
8/18	d	0	8,945	100	234	100	30	954	100	2	45	100	100	2	38	100	423	6,889	68	0	4	100
8/19	e, f	0	8,945	100	234	100	0	954	100	0	45	100	100	0	38	100	0	6,889	68	0	4	100
8/20	f	0	8,945	100	234	100	0	954	100	0	45	100	100	0	38	100	0	6,889	68	0	4	100
8/21	f	0	8,945	100	234	100	0	954	100	0	45	100	100	0	38	100	0	6,889	68	0	4	100
8/22	g	0	8,945	100	234	100	0	954	100	0	45	100	100	0	38	100	639	7,528	74	0	4	100
8/23	g	0	8,945	100	234	100	0	954	100	0	45	100	100	0	38	100	1,618	9,146	90	0	4	100
8/24	g, h	0	8,945	100	234	100	0	954	100	0	45	100	100	0	38	100	1,035	10,181	100	0	4	100

Note: "-"= value cannot be computed due to limitations of the data.

[a] Escapement estimate of Chinook salmon is 8,945 (SE = 289).

[b] Daily count estimated from 20-min DIDSON counts expanded to the hour from low frequency files from 1700 hours May 15 to 1300 hours May 30, and high frequency from 1400 hours May 30 to 1300 hours June 12 of fish passage between partial picket weirs.

[c] Daily count estimated from 20-min DIDSON counts expanded to the hour from high frequency files of fish passage (81) between partial picket weirs from 0001 to 1300 and fish speciated in the weir live box from 1301 hours through midnight June 13 .

[d] Daily count of fish speciated in the weir live box.

[e] Increased flows resulting from an overnight rise in the river stage pulled the earth anchor system free and caused half of the weir panels and rail to swing away from the right bank.

[f] No escapement counts.

[g] Based on a partial weir and expanded 20-min counts of DIDSON files collected at high frequency from 1800 hours August 22 to 1900 hours August 24.

[h] DIDSON removed at 1940 hours August 24 because of increased flows and rising river stage.

APPENDIX C. DIEL AND DIURNAL TIMING OF ANCHOR RIVER CHINOOK SALMON FOR 2005 AND 2006

Appendix C1.-Diel timing of Anchor River Chinook salmon based on DIDSON upstream and DIDSON downstream counts, May 13 to June 3, 2005.

DIDSON upstream counts [a]								
			Range		Mean (SE) count per 20-min file			
Hours counted	n[b]	Total	Min	Max			Percent (SE)	
0000 to 0159	98	1,674	0	65	17.1	1.4	31.8	4.7
0200 to 0359	72	1,134	0	49	15.8	1.4	21.5	4.9
0400 to 0559	62	624	0	42	10.1	1.3	11.8	4.1
0600 to 0759	50	122	0	10	2.4	0.4	2.3	2.1
0800 to0959	43	106	0	12	2.5	0.5	2.0	2.2
1000 to 1159	46	76	0	13	1.7	0.4	1.4	1.8
1200 to 1359	47	114	0	15	2.4	0.5	2.2	2.1
1400 to 1559	47	120	0	12	2.6	0.4	2.3	2.2
1600 to 1759	50	381	0	57	7.6	1.9	7.2	3.7
1800 to1959	56	480	0	27	8.6	0.9	9.1	3.9
2000 to 2159	44	225	0	35	5.1	1.1	4.3	3.1
2200 to2359	51	212	0	21	4.2	0.7	4.0	2.8
Total	666	5,268	0	65				

DIDSON downstream counts [a]								
			Range		Mean (SE) count per 20-min file			
Hours counted	n[b]	Total	Min	Max			Percent (SE)	
0000 to 0159	98	784	0	26	8.0	0.7	33.6	4.8
0200 to 0359	72	274	0	19	3.8	0.5	11.7	3.8
0400 to 0559	62	288	0	17	4.6	0.5	12.3	4.2
0600 to 0759	50	105	0	9	2.1	0.4	4.5	3.0
0800 to0959	43	74	0	9	1.7	0.3	3.2	2.7
1000 to 1159	46	71	0	13	1.5	0.4	3.0	2.6
1200 to 1359	47	78	0	14	1.7	0.4	3.3	2.6
1400 to 1559	47	73	0	10	1.6	0.3	3.1	2.6
1600 to 1759	50	148	0	25	3.0	0.7	6.3	3.5
1800 to1959	56	205	0	15	3.7	0.4	8.8	3.8
2000 to 2159	44	126	0	14	2.9	0.5	5.4	3.4
2200 to2359	51	108	0	8	2.1	0.3	4.6	3.0
Total	666	2,334	0	26				

[a] DIDSON counts in 2-h increments.

[b] n = number of full 20-min counts.

Appendix C2.-Diel timing of Anchor River Chinook salmon based on DIDSON upstream and DIDSON downstream counts, May 15 to June 13, 2006.

DIDSON upstream counts [a]								
			Range		Mean (SE) count per 20-min file			
Hours counted	n[b]	Total	Min	Max			Percent (SE)	
0000 to 0159	75	676	0	41	9.0	1.1	13.0	3.9
0200 to 0359	76	743	0	47	9.8	1.3	14.3	4.0
0400 to 0559	67	473	0	26	7.1	1.0	9.1	3.5
0600 to 0759	60	162	0	19	2.7	0.5	3.1	2.3
0800 to0959	60	258	0	50	4.3	1.4	4.9	2.8
1000 to 1159	55	107	0	17	1.9	0.5	2.1	1.9
1200 to 1359	58	147	0	11	2.5	0.4	2.8	2.2
1400 to 1559	63	283	0	26	4.5	0.6	5.4	2.9
1600 to 1759	74	763	0	91	10.3	2.2	14.6	4.1
1800 to1959	78	611	0	53	7.8	1.3	11.7	3.7
2000 to 2159	71	604	0	60	8.5	1.5	11.6	3.8
2200 to2359	69	386	0	40	5.6	1.1	7.4	3.2
Total	806	5,213	0	91				

DIDSON downstream counts [a]								
			Range		Mean (SE) count per 20-min file			
Hours counted	n[b]	Total	Min	Max			Percent (SE)	
0000 to 0159	75	269	0	22	3.6	0.5	13.6	4.0
0200 to 0359	76	168	0	15	2.2	0.3	8.5	3.2
0400 to 0559	67	227	0	13	3.4	0.5	11.5	3.9
0600 to 0759	60	131	0	15	2.2	0.4	6.6	3.2
0800 to0959	60	107	0	11	1.8	0.3	5.4	2.9
1000 to 1159	55	79	0	16	1.4	0.4	4.0	2.7
1200 to 1359	58	107	0	14	1.8	0.4	5.4	3.0
1400 to 1559	63	151	0	14	2.4	0.4	7.6	3.4
1600 to 1759	74	239	0	21	3.2	0.6	12.1	3.8
1800 to1959	78	217	0	18	2.8	0.5	11.0	3.6
2000 to 2159	71	179	0	21	2.5	0.5	9.1	3.4
2200 to2359	69	102	0	8	1.5	0.2	5.2	2.7
Total	806	1,976	0	22				

[a] DIDSON counts in 2-h increments.

[b] n = number of full 20-min counts.

Appendix C3.-Diurnal timing of Anchor River Chinook salmon based on weir counts, June 3 to September 9, 2005.

Weir counts [a]								
			Range		Mean (SE) count per 20-min file			
Hours counted	n[b]	Total	Min	Max			Percent (SE)	
0000 to 0159	25	154	1	20	6.2	1.2	2.3	3.1
0200 to 0359	1	3	3	3	3.0		0.0	NA
0400 to 0559							0.0	0.0
0600 to 0759	2	4	1	3	2.0	1.0	0.1	2.5
0800 to0959	18	51	1	15	2.8	0.8	0.8	2.1
1000 to 1159	56	218	1	80	3.9	1.4	3.3	2.4
1200 to 1359	70	488	1	60	7.0	1.2	7.4	3.2
1400 to 1559	56	447	1	59	8.0	1.7	6.8	3.4
1600 to 1759	132	1,016	1	100	7.7	1.6	15.5	3.2
1800 to1959	151	1,471	1	100	9.7	1.7	22.4	3.4
2000 to 2159	142	1,434	1	100	10.1	1.6	21.8	3.5
2200 to2359	159	1,288	1	100	8.1	1.0	19.6	3.2
Total	812	6,574	1	100				

[a] Weir counts in 2-h increments.

[b] n = number of weir checks.

Appendix C4.-Diurnal timing of Anchor River Chinook salmon based on weir counts, June 13 to August 8, 2006.

Weir counts [a]								
			Range		Mean (SE) count per			
Hours counted	n[b]	Total	Min	Max	20-min file		Percent (SE)	
0000 to 0159	4	35	2	16	8.8	2.9	1.0	5.7
0200 to 0359							0.0	0.0
0400 to 0559							0.0	0.0
0600 to 0759							0.0	0.0
0800 to0959	4	12	1	5	3.0	1.2	0.3	3.4
1000 to 1159	56	79	1	13	1.4	0.2	2.2	2.0
1200 to 1359	32	45	1	3	1.4	0.1	1.3	2.0
1400 to 1559	114	380	1	81	3.3	0.8	10.7	2.9
1600 to 1759	168	453	1	37	2.7	0.4	12.8	2.6
1800 to1959	139	680	0	49	4.9	0.7	19.2	3.4
2000 to 2159	118	929	1	101	7.9	1.4	26.2	4.1
2200 to2359	102	929	1	42	9.1	0.9	26.2	4.4
Total	737	3,542	0	101				

[a] Weir counts in 2-h increments.
[b] n = number of weir checks.

APPENDIX D. ANCHOR RIVER WATER TEMPERATURES FOR 2005 AND 2006

Appendix D1.-Daily water temperatures for Anchor River near the sonar/weir site, 2005.

Date	Daily water temperature (° C)														
	May			June			July			August			September		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1				11.0	8.3	14.3	14.8	14.0	16.4	13.5	12.9	14.3	11.3	9.4	13.4
2				11.3	8.3	14.3	14.5	12.0	17.5	12.3	12.0	13.2	10.1	7.4	12.6
3				11.8	8.6	15.2	15.2	12.6	18.4	12.1	11.1	13.2	10.0	9.1	10.9
4				12.8	9.4	16.4	15.3	13.4	17.5	13.3	11.4	15.5	10.0	9.4	10.9
5				13.5	10.3	16.9	16.5	13.7	19.9	13.8	11.4	16.6	10.1	9.4	10.9
6				13.3	11.4	15.5	16.4	13.4	19.3	14.6	12.0	17.5	10.5	10.0	11.7
7				11.6	10.6	13.4	16.9	13.7	20.5	15.0	12.3	18.1	10.5	9.4	11.7
8				10.4	9.4	11.4	17.2	14.3	20.5	15.2	12.3	18.7	10.2	8.8	11.7
9				10.4	9.4	11.7	17.3	13.7	21.1	15.5	12.9	18.7	10.1	9.7	10.6
10				11.2	10.0	12.6	17.5	14.9	20.5	15.1	12.0	18.4	10.5	9.7	11.1
11	11.5	10.6	12.0	11.6	9.7	13.4	17.0	14.3	20.5	15.2	12.3	18.7	9.8	9.4	10.6
12	10.1	8.8	11.7	12.3	9.1	15.8	15.2	14.3	17.2	15.8	12.6	19.3	10.0	9.4	10.9
13	8.9	7.7	10.0	12.3	10.3	14.3	14.6	12.6	16.9	15.1	14.6	16.6	9.8	8.8	10.9
14	8.6	7.1	10.0	13.0	9.7	16.9	14.8	11.7	17.8	14.3	13.2	16.4	9.9	8.6	11.4
15	8.4	7.1	9.4	14.3	10.9	18.1	15.4	12.3	19.0	14.0	12.9	16.1	9.5	9.4	9.7
16	7.8	6.5	9.4	15.2	12.3	18.4	15.3	14.3	16.4	14.3	12.9	15.8	9.3	9.1	9.4
17	8.4	6.5	10.6	14.5	12.3	16.6	15.9	13.4	19.6	14.0	13.2	15.2	9.1	8.3	9.7
18	8.6	6.2	11.1	12.9	11.7	14.3	16.4	13.4	19.3	13.6	12.9	14.6	9.2	8.6	10.0
19	9.5	6.8	12.6	12.3	10.3	14.9	15.2	14.3	16.9	14.5	12.3	17.5	8.1	7.1	9.1
20	10.0	8.8	11.4	13.5	10.9	16.6	16.0	13.2	19.6	14.2	12.6	16.4	7.9	6.5	9.4
21	9.9	8.0	12.0	14.1	11.1	17.5	16.8	14.3	19.3	14.6	12.9	16.9	7.6	6.2	8.8
22	10.5	8.6	12.9	13.1	12.3	14.6	16.8	13.7	20.2	12.3	10.6	14.3	8.5	8.0	8.8
23	11.6	8.8	14.9	13.8	10.9	17.5	15.7	12.6	18.1	12.1	11.4	12.9	8.9	8.6	9.1
24	11.8	9.7	14.6	14.2	11.1	17.8	15.6	14.6	16.9	11.7	10.6	12.9	8.7	8.3	9.1
25	11.1	9.1	14.0	14.2	11.7	17.2	14.7	13.4	15.8	12.1	10.3	14.3	8.3	7.7	8.8
26	10.5	9.4	11.7	14.8	11.1	19.0	13.9	12.9	15.2	12.2	10.6	14.3	7.1	6.2	8.0
27	9.9	8.8	11.1	14.6	12.0	17.5	13.5	12.6	14.6	11.5	8.8	14.3	6.8	6.5	7.1
28	10.1	8.8	11.4	15.4	11.7	19.6	13.6	10.9	16.1	11.9	11.1	12.6	6.8	6.2	7.7
29	10.6	9.1	12.0	16.5	14.0	18.7	14.2	12.9	16.1	12.2	10.6	14.0	7.2	6.5	8.0
30	10.4	9.4	11.4	16.4	14.6	18.7	13.5	11.4	15.8	12.9	11.4	14.9	6.9	6.0	8.0

Source: Temperature data collected at the A3 site, described in Mauger (2004).

Note: Peak passage (25 to 75 percentile range) for Chinook salmon occurred from May 30 to June 12, 2005.

Appendix D2.-Daily water temperatures for Anchor River near the sonar/weir site, 2006.

	Daily water temperatures (^{o} C)														
	May			June			July			August			September		
Date	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1				9.4	7.7	12.0	12.7	9.7	16.1	13.1	12.0	14.3	9.4	7.7	11.4
2				10.2	6.8	13.7	14.0	10.6	17.9	12.2	11.1	13.2	9.1	7.7	10.6
3				11.8	8.8	14.9	14.9	12.6	17.9	11.5	11.1	12.3	9.6	8.5	10.8
4				11.5	8.8	14.3	14.5	11.7	17.6	11.2	10.0	12.6	8.7	8.0	9.7
5				10.7	7.7	13.7	13.5	12.0	15.2	12.8	10.6	15.8	8.9	8.3	9.7
6				11.0	7.7	14.9	13.0	11.7	14.3	13.0	10.0	16.4	8.2	7.7	8.8
7				9.9	9.1	11.4	11.9	11.4	12.9	13.8	10.8	17.3	7.9	6.8	8.8
8				9.1	8.3	10.0	13.1	10.6	16.7	14.6	12.0	18.2	8.9	8.0	10.0
9				9.2	8.3	10.8	13.9	11.1	17.0	14.5	12.9	16.4	9.2	8.8	10.0
10				10.2	8.5	12.9	14.8	12.6	17.6	13.8	12.9	14.6	8.9	7.7	10.3
11				9.7	8.8	10.6	13.3	12.3	14.9	12.5	12.0	13.2	8.2	6.8	9.7
12				9.4	8.5	10.3	13.2	9.4	17.6	12.4	11.1	14.3	7.9	6.2	10.0
13				9.3	8.3	10.6	15.0	11.7	18.5	12.5	11.1	13.7	7.9	5.9	10.3
14				9.7	8.5	11.1	14.3	12.3	16.7	11.5	11.1	12.0	8.6	8.3	8.8
15				10.2	8.8	11.1	14.1	11.7	17.0	10.8	10.3	11.1	8.4	8.0	9.1
16				10.0	9.1	11.1	13.5	12.0	14.9	10.8	10.3	11.4	8.6	8.3	9.1
17				10.0	8.8	11.1	12.5	11.1	14.3	11.3	10.0	12.9	8.5	7.7	9.7
18	6.6	5.7	7.2	9.9	9.4	10.6	13.2	11.4	14.9	11.2	10.6	11.7	7.0	6.2	8.3
19	4.8	2.5	6.3	9.6	8.5	10.6	13.1	11.1	15.2	10.7	9.7	11.7	7.1	6.8	7.7
20	3.9	3.1	5.4	10.2	8.3	12.9	12.2	10.8	13.4	11.0	10.3	12.0	7.9	6.8	9.4
21	4.9	2.8	7.5	10.8	8.8	13.2	12.1	11.1	13.2	10.2	8.3	12.0	7.1	6.5	7.7
22	6.2	3.1	9.2	10.4	9.7	11.4	11.6	11.1	12.3	10.1	9.7	10.8	7.8	6.8	9.4
23	7.2	4.0	10.6	9.6	8.5	10.8	11.4	10.0	12.9	9.5	7.7	11.4	8.6	7.7	10.0
24	7.8	5.2	10.3	9.6	8.0	10.8	11.8	10.8	12.6	9.3	8.8	10.0	7.9	7.1	8.8
25	9.2	6.3	12.1	10.4	8.5	12.9	11.6	10.6	12.6	9.6	8.3	10.8	6.4	4.8	8.0
26	10.4	7.5	13.2	9.8	8.8	10.8	13.1	10.3	16.7	9.3	8.8	10.0	6.9	6.2	7.4
27	12.8	8.3	27.6	10.4	7.7	13.4	14.3	11.1	17.9	9.9	8.3	12.0	7.3	6.8	7.7
28	4.8	2.2	8.6	12.4	10.0	15.5	14.2	11.7	16.7	10.0	8.3	12.0	7.3	7.1	7.7
29				12.0	10.8	12.9	14.3	11.7	17.3	9.9	7.7	12.0	6.9	5.9	7.4
30	12.4	11.1	13.2	11.6	10.3	13.2	12.9	11.7	14.6	9.4	9.1	10.3	5.2	4.2	5.9

Source: Temperature data collected at the A3 site, described in Mauger (2004).
Note: Peak passage (25 to 75 percentile range) for Chinook salmon occurred from June 2 to June 21, 2006.

APPENDIX E. DAILY RIVER STAGE READINGS FOR ANCHOR RIVER, 2005 AND 2006

Appendix E1.-Daily river stage measurements at Anchor River DIDSON/weir site, May 13 through September 9, 2005.

	River stage (cm) [a]				
Date	May	Jun	Jul	Aug	Sep
1		42.0 [b]	43.0	44.0	47.0
2		44.0 [b]	54.0	55.0	42.0
3		49.0 [b]	48.0	52.0	41.0
4		48.0 [b]	50.0	52.0	50.0
5		46.0 [b]	46.0	60.0	59.0
6		45.0 [b]	41.0	54.0	100.0 +
7		46.0 [b]	42.0	44.0	69.0
8		45.0 [b]	40.0	42.0	57.0
9		46.0 [b]	39.0	38.0	120.0
10		46.0 [b]	38.0	38.0	
11		45.0 [b]	36.5	38.0	
12		45.0 [b]	37.0	36.0	
13	55.0	45.0	38.0	35.0	
14	54.0	44.0	38.0	35.0	
15	53.0	42.0	37.0	35.0	
16	54.0	41.0	37.0	35.0	
17	54.0	40.0	38.0	37.0	
18	61.0	78.0	37.0	38.0	
19	53.0	67.0	40.0	40.0	
20	51.0	56.0	45.0	37.0	
21	51.0	47.0	40.0	40.0	
22	51.0	45.0	41.0	38.0	
23	49.0	44.0	40.0	74.0	
24	49.0	44.0	38.0	64.0	
25	46.5	43.0	38.0	47.0	
26	46.0	42.0	42.0	46.0	
27	45.0	42.0	45.0	41.0	
28	45.0	42.0	42.0	41.0	
29	44.0	56.0	42.0	44.0	
30	43.0 [b]	43.0	42.0	42.0	
31	42.0 [b]	42.0	41.0	44.0	

[a] River stage visually measured each day at approximately 2000 hours at a common staff gauge located below the weir near the left bank.

[b] Peak passage (25 to 75 percentile range) occurred from May 30 to June 12, 2005.

Appendix E2.-Daily river stage measurements at Anchor River DIDSON/weir site, May 17 through August 24, 2006.

	River stage (cm) [a]				
Date	May	Jun	Jul	Aug	Sep
1		65.0	58.0	52.0	
2		62.0 [b]	56.0	48.0	
3		61.0 [b]	55.0	48.0	
4		58.0 [b]	53.0	48.0	
5		56.0 [b]	53.0	50.0	
6		56.0 [b]	55.0	58.0	
7		53.0 [b]	58.0	50.0	
8		55.0 [b]	56.0	46.0	
9		61.0 [b]	52.0	46.0	
10		58.0 [b]	51.0	46.0	
11		56.0 [b]	50.0	53.0	
12		74.0 [b]	50.0	60.0	
13		66.0 [b]	48.0	55.0	
14		64.0 [b]	48.0	52.0	
15		66.0 [b]	48.0	60.0	
16		79.0 [b]	47.0	86.0	
17	92.0	76.0 [b]	48.0	76.0	
18	ND	72.0 [b]	47.0	72.0	
19	93.0	66.0 [b]	47.0	ND	
20	105.0	62.0 [b]	47.0	ND	
21	93.0	60.0 [b]	47.0	ND	
22	99.0	79.0	50.0	ND	
23	104.0	79.0	50.0	84.0	
24	94.0	76.0	48.0	99.0	
25	93.0	67.0	50.0		
26	85.0	81.0	51.0		
27	80.0	77.0	50.0		
28	76.0	66.0	48.0		
29	69.0	64.0	46.0		
30	69.0	62.0	46.0		
31	65.0	65.0	53.0		

Note: "ND" = no data.

[a] River stage visually measured each day at approximately 2000 hours at a common staff gauge located below the weir near the left bank.

[b] Peak passage (25 to 75 percentile range) occurred from June 2 to June 21, 2006.

APPENDIX F. AERIAL SURVEY COUNTS FOR ANCHOR RIVER CHINOOK SALMON IN 2005 AND 2006

Appendix F1.-Helicopter surveys flown to index Anchor River Chinook salmon escapement on July 25, 2005.

	Aerial index counts [a]					
	Surveyor A			Surveyor B		
Survey Areas:	Live	Dead	Total	Live	Dead	Total
South Fork Anchor River						
Beaver Creek confl. to Orange bluff (lat 59°46.517' N, long 151°28.530' W)	40	3	43	52	0	52
North Fork Rd bridge (Englebretsen bridge) to Beaver Creek	300	12	312	348	5	353
Kurka bridge to North Fork Rd bridge (Englebretsen)	42	1	43	94	2	96
New Sterling Hwy bridge to Kurka bridge	154	1	155	208	4	212
Gravel pit to New Sterling Hwy bridge	91	7	98	185	5	190
Old Sterling Hwy bridge to Gravel pit [b]	ND	ND	ND	ND	ND	ND
Subtotal	627	24	651	887	16	903
North Fork Anchor River [b]						
South Fork confluence to North Fork bridge	ND	ND	ND	ND	ND	ND
North Fork bridge to Little bridge (lat 59°48.163' N)	ND	ND	ND	ND	ND	ND
Little bridge to Following bridge	ND	ND	ND	ND	ND	ND
Subtotal	ND	ND	ND	ND	ND	ND
Total	627	24	651	887	16	903

Aerial Survey Conditions:	
Cloud cover	Overcast
Glare on the water surface	Visibility OK; better than 2004.
Water clarity	Light murky
Other	Misting upstream of North Fork bridge.

Note: "ND" = no data.

[a] Aerial index counts (number of Chinook salmon) - derived from aerial counts from standard sections of river where the majority of spawning was thought to occur and a ground count from a subsection of a standard section. If the ground count was higher; the aerial count was expanded by the difference between the aerial and ground counts in the subsection. If the aerial count was higher, it was used as the escapement index.

[b] Not surveyed; no data collected.

Appendix F2.-Helicopter surveys flown to index Anchor River Chinook salmon escapement on July 27, 2006.

	Aerial index counts [a]					
	Surveyor A			Surveyor B		
Survey Areas:	Live	Dead	Total	Live	Dead	Total
South Fork Anchor River						
Beaver Creek confl. to Orange bluff (lat 59°46.517' N, long 151°28.530' W) [b]	17	1	18	19	1	20
North Fork Rd bridge (Englebretsen bridge) to Beaver Creek	396	3	399	407	7	414
Kurka bridge to North Fork Rd bridge (Englebretsen)	63	1	64	83	6	89
New Sterling Hwy bridge to Kurka bridge	152	0	152	205	0	205
Gravel pit to New Sterling Hwy bridge	167	0	167	171	0	171
Old Sterling Hwy bridge to Gravel pit [c]	ND	ND	ND	ND	ND	ND
Subtotal	795	5	800	885	14	899
North Fork Anchor River [c]						
South Fork confluence to North Fork bridge	ND	ND	ND	ND	ND	ND
North Fork bridge to Little bridge (lat 59°48.163' N)	ND	ND	ND	ND	ND	ND
Little bridge to Following bridge	ND	ND	ND	ND	ND	ND
Subtotal	ND	ND	ND	ND	ND	ND
Total	795	5	800	885	14	899

Aerial Survey Conditions:	
Cloud cover	Overall excellent counting conditons
Glare on the water surface	Bad shadowing under cottonwoods
Water clarity	About as good as it gets
Other	Left outside river bends not counted well due to pilot inexperience.

Note: "ND" = no data.

[a] Aerial index counts (number of Chinook salmon) - derived from aerial counts from standard sections of river where the majority of spawning was thought to occur and a ground count from a subsection of a standard section. If the ground count was higher; the aerial count was expanded by the difference between the aerial and ground counts in the subsection. If the aerial count was higher, it was used as the escapement index.

[b] Survey count upstream of Orange bluff to lat 59° 48.05' N, long 151°17.82' W: Surveyor A (352 live + 8 dead = 360); Surveyor B (364 live + 16 dead = 380).

[c] Not surveyed; no data collected.

APPENDIX G. DIURNAL AND DIEL TIMING FOR ANCHOR RIVER CHINOOK AND COHO SALMON IN 2005 AND 2006

Appendix G1.-Diel timing of Chinook salmon based on combined 2006 DIDSON upstream and downstream, and net counts in 2-h increments during DIDSON operation in May, June, and July on the Anchor River.

DIDSON upstream counts								
			Range		Mean (SE) count per 20 min file			
Hours counted	n[a]	Total	Min	Max			Percent (SE)	
0000 to 0159	4	13	1	6	3.3	1.1	1.0	5.7
0300 to 0359	4	12	2	6	3.0	1.0	0.9	5.5
0500 to 0559	4	8	0	4	2.0	0.9	0.6	4.5
0700 to 0759	4	70	5	31	17.5	5.3	5.3	12.9
0900 to 0959	4	48	6	20	12.0	2.9	3.6	10.8
1100 to 1159	3	21	3	12	7.0	2.6	1.6	8.8
1300 to 1359	4	80	4	32	20.0	6.9	6.1	13.8
1500 to 1559	4	74	5	44	18.5	8.8	5.6	13.3
1700 to 1759	4	409	19	216	102.3	49.2	31.0	26.7
1900 to 1959	6	201	16	56	33.5	5.9	15.2	16.1
2100 to 2159	4	234	13	90	58.5	16.3	17.7	22.0
2300 to 2359	4	150	9	96	37.5	20.3	11.4	18.3
Total	33	1,320	3	216				

DIDSON downstream counts								
			Range		Mean (SE) count per 20 min file			
Hours counted	n[a]	Total	Min	Max			Percent (SE)	
0000 to 0159	4	8	1	3	2.0	0.4	3.4	10.5
0300 to 0359	4	5	0	4	1.3	0.9	2.1	8.4
0500 to 0559	4	4	0	3	1.0	0.7	1.7	7.5
0700 to 0759	4	60	2	21	15.0	4.4	25.8	25.2
0900 to 0959	4	43	6	17	10.8	2.4	18.5	22.4
1100 to 1159	3	14	3	7	4.7	1.2	6.0	16.8
1300 to 1359	4	18	0	10	4.5	2.1	7.7	15.4
1500 to 1559	4	18	2	7	4.5	1.0	7.7	15.4
1700 to 1759	4	15	2	5	3.8	0.8	6.4	14.2
1900 to 1959	6	21	1	5	3.5	0.7	9.0	12.8
2100 to 2159	4	11	1	6	2.8	1.1	4.7	12.2
2300 to 2359	4	16	0	12	4.0	2.8	6.9	14.6
Total	33	233	0	21				

[a] n = number of full 20 min counts.

Appendix G2.-Diurnal timing of coho salmon in 2005: weir counts in 2-h increments from June 3 to September 9.

Hours counted	n[a]	Total	Range Min	Range Max	Mean (SE)		Percent (SE)	
0000 to 0159							NA	NA
0300 to 0359							NA	NA
0500 to 0559							NA	NA
0700 to 0759	1	19	19	19	19.0		0.1	NA
0900 to 0959	56	909	1	539	16.2	9.6	4.8	2.9
1100 to 1159	119	1,275	1	403	10.7	4.1	6.7	2.3
1300 to 1359	132	2,859	1	569	21.7	6.8	15.1	3.1
1500 to 1559	189	3,433	1	670	18.2	4.9	18.1	2.8
1700 to 1759	146	4,251	1	831	29.1	8.6	22.4	3.5
1900 to 1959	147	2,810	1	416	19.1	3.9	14.8	2.9
2100 to 2159	112	2,939	1	811	26.2	8.0	15.5	3.4
2300 to 2359	32	482	1	234	15.1	7.7	2.5	2.8
Total	934	18,977	1	831				

Weir counts

[a] n = number of weir checks; "NA" = not applicable.

Appendix G3.-Diurnal timing of coho salmon in 2006: weir counts in 2-hour increments from June 13 to August 13.

Hours counted	n[a]	Total	Range Min	Range Max	Mean (SE)		Percent (SE)	
0000 to 0159							NA	NA
0300 to 0359							NA	NA
0500 to 0559							NA	NA
0700 to 0759							NA	NA
0900 to 0959	4	62	1	35	15.5	4	0.9	5.5
1100 to 1159	60	1,221	1	1,094	20.4	60	17.7	5.0
1300 to 1359	23	152	1	71	6.6	23	2.2	3.1
1500 to 1559	82	2,315	1	1,513	28.2	82	33.6	5.2
1700 to 1759	72	1,201	1	336	16.7	72	17.4	4.5
1900 to 1959	58	860	1	214	14.8	58	12.5	4.4
2100 to 2159	44	821	1	206	18.7	44	11.9	4.9
2300 to 2359	33	257	1	56	7.8	33	3.7	3.4
Total	376	6,889	1	1,513		376		

Weir counts

[a] n = number of weir checks; "NA" = not applicable.