Fishery Data Series No. 12-07

Anchor River Chinook and Coho Salmon Escapement, 2009

by

Carol M. Kerkvliet

and

Michael D. Booz

March 2012

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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by
Carol M. Kerkvliet
Division of Sport Fish, Homer
and
Michael D. Booz
Division of Sport Fish, Homer

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

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Carol M. Kerkvliet
Alaska Department of Fish and Game, Division of Sport Fish,
3298 Douglas Place, Homer, AK 99603, USA

and

Michael D. Booz
Alaska Department of Fish and Game, Division of Sport Fish,
3298 Douglas Place, Homer, AK 99603, USA

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ABSTRACT

In 2009, the escapement of Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) was censused using a resistance board weir. The Chinook salmon escapement was 3,455 fish, less than the lower bound sustainable escapement goal (SEG) of 5,000 fish. The midpoint of the Chinook salmon run (23 June) was 16 days later in 2009 than the 2004–2008 average (8 June). The dominant age class of Chinook salmon in 2009 was ocean age 2 (51.1%, SE = 5.3%) and the overall age composition was significantly different ($P < 0.001$) than the 2003–2008 average annual age composition. The 2009 coho salmon escapement (2,692 fish) is considered low based on historic counts. This count is considered minimal because 13% of the run was counted on the last day of weir operation. The midpoint of the coho salmon run (29 August) was 5 days later than the average of 3 prior runs for which a full count was made (2004, 2007, 2008). The dominant age class of coho salmon in 2009 was age 2.1 (84.1%, SE = 4.4%). The variation in Chinook and coho salmon counts was significantly correlated ($P = 0.017$ and $P = 0.001$, respectively) with average river stage. In 2009, 605 post-spawning steelhead trout (*O. mykiss* kelts) were enumerated as they migrated downstream from the weir. Had the Dual frequency IDentification SONar (DIDSON) been used to estimate Chinook salmon escapement in 2009, the estimate would have been biased low by about 600 fish (because 605 kelts were counted emigrating). The DIDSON count would have been about 2,850 fish versus the actual escapement of 3,455 (17% negative bias).

Key words: Anchor River, Chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, *steelhead trout, Onchorhynchus mykiss, kelt, emigration*, run timing, diel, diurnal, lower bound SEG stock status, weir, sonar, DIDSON.

INTRODUCTION

The Anchor River is located on the southern portion of the Kenai Peninsula (Figure 1) and it 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 kilometers (RKM) of anadromous streams (Table 1). The Anchor River has 2 major forks (South and North forks) and their confluence is located approximately 3.8 RKM upstream from the mouth. The South Fork watershed is approximately twice the size as the North Fork watershed. Water flows in the Anchor River can rise substantially following heavy rains because of the river's small size, channel geometry, and vegetation.

The earliest Anchor River fishery study (R.W. Allin, U.S. Fish and Wildlife Service, *unpublished*[1]; Allin 1957) was conducted in the early 1950s after the construction of the Sterling Highway to Homer in 1949 (Appendix A1); the highway increased access to the Anchor River fishery. Allin and his coworkers operated weirs, did creel surveys, investigated spawning locations and investigated juvenile fish movements and abundance. Following statehood in 1959, the state took control of fisheries management and the Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (SF) continued Anchor River fisheries investigations, which includes this data series. This data series contains the primary data sets used to evaluate the Anchor River Chinook and coho salmon trends in the 1990s through the early 2000s:

1) Since 1977, SF has conducted an annual mail survey (Statewide Harvest Survey [SWHS]) to estimate total sport fishing effort and harvest by species for locations throughout the state (including the Anchor River) (Table 2; Appendix A2). In 1990, the SWHS began to estimate catch by species.

[1] Allin, R. W. *Unpublished*. Stream survey of Anchor River. U. S. Fish and Wildlife Service. Quarterly Progress Report F-1-R-4 4(2): 47-66, Territory of Alaska.

2) Index counts of Chinook salmon escapement from combined aerial and ground surveys were taken from 1976 through 1994 and thereafter, only from aerial survey (Appendix A1).

3) Fish were counted for 9 years (1987–1995) from a weir located approximately 1.6 RKM (1 mile) upstream from the mouth of the Anchor River. The weir was operated for 1 to 4 months beginning in July. In 4 of 9 years (1987–1989, 1992), the weir was operated throughout the entire coho salmon run (Table 3; Appendix A1).

In 2003, a project was initiated to estimate Chinook salmon escapement using Dual frequency IDentification SONar (DIDSON) (Appendix A1). In 2004, the project was expanded to include monitoring of coho salmon escapement. This escapement project has substantially increased SF's knowledge of the stock status for Anchor River Chinook and coho salmon. The following 2 sections provide background information on the Anchor River Chinook and coho salmon stocks.

CHINOOK SALMON BACKGROUND

Anchor River Chinook salmon are primarily harvested during an inriver sport fishery that has been restricted by only allowing fishing on weekends and the following Mondays, limiting the area open to fishing, and with small daily and seasonal bag limits. The average harvest from 2003 to 2008 was 1,494 fish (Table 2). An unknown number of Anchor River Chinook salmon are also harvested in a mixed stock sport troll fishery within Cook Inlet near the river mouth, but this number is assumed to be small (Szarzi et al. 2007a).

Enumerating Anchor River Chinook salmon escapement over the entire run has been problematic. Fixed picket or resistance board weirs, commonly used in small streams, could not be installed in the Anchor River in May and early June because the river was typically too high and swift. Traditional sonar methods (e.g., split beam sonar), commonly used in large Alaskan rivers (e.g. Kenai River), would not be suited for smaller streams like the Anchor River for 2 reasons: because its rocky and uneven substrate causes high turbulence during high flows and because there are extended periods of very shallow conditions (less than 1 m in depth). Therefore, SF has flown an annual aerial survey during peak spawning to index Chinook salmon escapement (Appendix A1). However, because of the inherent biases associated with aerial surveys (e.g., differences in survey conditions and between-surveyor biases), Chinook salmon aerial escapement counts are imprecise.

In 2003, a Dual-frequency IDentification SONar (DIDSON) was deployed in the Anchor River to test its utility for monitoring Chinook salmon escapement (Appendix A1; Kerkvliet et al. 2008). The DIDSON was located on the mainstem of the river just below the North and South forks confluence, upstream of the fishery and at a site where the river profile was relatively level (Figures 2 and 3). The DIDSON was activated as Chinook salmon began entering the river in late May and when river levels were high due to snow/ice melt runoff. The DIDSON proved to be a useful tool for estimating Chinook salmon escapement.

From 2004 through 2008, the DIDSON was only used in May and June when river levels were high and when the river level dropped, a resistance board weir was installed (Figure 4; Kerkvliet et al. 2008; Kerkvliet and Burwen 2010; Kerkvliet et al. *In prep*). The Chinook salmon escapement based on DIDSON was biased low because all sonar images of fish swimming upstream and downstream were assumed to be Chinook salmon even though an unknown portion of the sonar images included post-spawned steelhead (*Oncorhynchus mykiss*, kelts) emigrating

from the Anchor River (Kerkvliet and Burwen 2010; Kerkvliet et al. *In prep*). From 2003 to 2008, estimated escapement ranged from 5,806 (SE = 169) to 12,016 (SE = 283) fish and inriver exploitation rates (percent harvest per total run) were low (range 9.9%–21.7%) (Table 4) compared to the higher exploitation (range 28%–46%) on Ninilchik River Chinook salmon estimated from 1999 to 2005 (Kerkvliet and Booz 2010).

In the fall of 2007, under the guidelines established in the *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) and *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223), SF established a lower bound[2] sustainable escapement goal (SEG) of 5,000 Chinook salmon. The goal was derived from a full probability spawner-recruit model using all available data including 31 years (1977–2007) of aerial survey escapement indices and inriver recreational harvest estimates, plus 5 years (2003–2007) of weir/sonar estimates of escapement and age composition (Szarzi et al. 2007a). Additionally, the Alaska Board of Fisheries (BOF) liberalized the fresh- and saltwater fisheries to provide additional harvest opportunities on Anchor River Chinook salmon through several regulation changes (Appendix A2; Appendix A3). In 2008, Chinook salmon escapement (5,806, SE = 169) reached the lower bound SEG and the inriver exploitation rate was 21.7% (Table 4).

COHO SALMON BACKGROUND

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

Anchor River coho salmon escapement was opportunistically monitored from 1987 through 1995 at a weir operated for the purpose of counting Dolly Varden (*Salvelinus malma*) and immigrating steelhead trout (Table 3; Larson 1990-1995, 1997). The weir was located approximately 1.6 RKM from the river mouth, within the river section open to sport fishing. For 4 years (1987–1989, 1992), the weir was operated throughout the coho salmon run and reported weir counts of coho salmon ranged from 2,409 to 20,187 fish (Table 3). These counts are considered maxima because of the unknown level of harvest that occurred upstream of the weir. The relationship of the counts to the actual escapement of coho salmon for the remaining years (1990–1991 and 1993–1995) in Table 3 is unknown; the counts themselves are underestimates and there is also harvest upstream.

In 2004, escapement enumeration at the sonar/weir site was expanded to include coho salmon and is currently the only LCIMA coho salmon stock monitored by SF (Kerkvliet et al. 2008). No harvest occurs above this weir site. Of the 5 previous years of escapement monitoring (2004–2008), the weir washed out twice (2005 and 2006). The count of the 2005 coho salmon run (18,977, Table 5) was considered a reasonable approximation of actual escapement because the weir washed out late in the run (Kerkvliet and Burwen 2010). However, the same was not true in 2006 because the weir washed out in mid-August, near the peak of the coho salmon run, which was projected to be exceptionally large. For years when the weir operation was maintained throughout the run (2004, 2007–2008), estimates of coho salmon escapement ranged from 5,728 fish (2004) to 8,226 fish (2007) (Table 5). Run timing comparisons from 2004 through 2008 at

[2] Terminology revised from "threshold" to "lower bound" to prevent confusion with a "SET" or sustained escapement threshold defined in the Sustainable Salmon Fisheries policy.

the sonar/weir site have been highly correlated with river stage, with the highest passage occurring during high flows (Kerkvliet et al. 2008; Kerkvliet and Burwen 2010; Kerkvliet et al. *In prep*).

The inriver minimum exploitation (percent harvest per total run) of Anchor River coho salmon from 1987 to 1989 and 1992 ranged from 11.5% to 45.5% based on weir counts and estimated freshwater harvest above and below the weir combined (Table 5). From 2004 to 2008, inriver exploitation has ranged from less than 22% in 2005 to 44.6% in 2008 (Table 5). Currently no coho salmon stock in the LCIMA has an escapement goal.

This report continues the series designed to evaluate the Chinook and coho salmon escapement to the Anchor River. The Chinook salmon escapement estimates will be used in future escapement goal analyses. The escapement will be used to manage Chinook and coho salmon sport fisheries according to the *Policy for the Management of Sustainable Salmon Fisheries* and *Policy for Statewide Salmon Escapement Goals*.

OBJECTIVES AND TASKS

OBJECTIVES

1) Census the Anchor River Chinook salmon passing upstream of 2.8 RKM (~ 2 river miles) from the mouth of the Anchor River from approximately 12 May through 11 September. This census is used to estimate Chinook salmon escapement.
2) Census the Anchor River coho salmon passing upstream of 2.8 RKM from the mouth of the Anchor River from approximately 12 May through 11 September. This census is used to estimate coho salmon escapement.
3) Estimate the age and sex composition of the Chinook salmon escapement.
4) Estimate the age and sex composition of the coho salmon escapement.

TASKS

1) Estimate length-at-age and sex of the Chinook and coho salmon escapement.
2) Record presence or absence of an adipose fin for all Chinook and coho salmon sampled for age, sex, and length (ASL).
3) Determine diurnal run timing of Chinook and coho salmon from weir counts.
4) Measure water depth and temperature throughout the project operation.

METHODS

OPERATION DATES

In mid-May 2009, low river conditions allowed for the immediate installation of a resistance board weir, negating the need for the Dual-frequency IDentification SONar (DIDSON) for Chinook salmon enumeration (Figure 4). The weir was operated from 12 May through 11 September. The early weir installation not only provided an opportunity to census Chinook salmon escapement, but it also provided an opportunity to census the outmigration of postspawning steelhead trout (kelts) and to determine their diel and emigration run timing. Kelt counts were collected from 13 May through 25 June using a combination of methods. The

primary method was a “steelhead chute” (here after referred to as “the chute”) that was formed by weighting down a weir panel on the downstream end and positioning an above-water video camera over the chute (Figure 5). The only way for steelhead trout to migrate downstream past the weir was through the chute; passage was recorded by video camera. On 31 May, as a backup to the video camera, the DIDSON was installed downstream of the weir, aimed at the chute and was continuously operated through 25 June (Figure 6). Additionally, all kelts that were either found dead on the weir or assisted downstream of the weir were enumerated. From 17 July to 20 July, the DIDSON was also used at night (19 hours, 10 minutes total) in conjunction with an open weir gate to allow the migration of Dolly Varden and pink salmon (*O. gorbuscha*).

During the kelt emigration, a standard reach of the North Fork and South Fork tributaries was selected for weekly beach seining from 20 May to 25 June. The purpose of this activity was to obtain an index of steelhead abundance upstream of the weir. This data collection was initiated outside of the original planning process and was only conducted once it became apparent that we could count the emigration of steelhead trout at the weir site.

EQUIPMENT, ESCAPEMENT AND ENUMERATION

Mainstem Resistance Board Weir

A resistance board weir (length ~ 31 m) was installed approximately 0.02 RKM downstream of the North and South forks confluence (Figures 4 and 6). Picket spacing for the resistance board weir and the live boxes was approximately 2.8 cm (1.5 inches) to block the passage of all but the smallest ocean-age-1 Chinook salmon. All bottom irregularities along the base of the resistance board weir were sealed using sand bags and a fencing skirt. Two live boxes were incorporated into the weir to trap upstream migrating fish. One live box was placed in relatively shallow water near the left bank (defined as the left side of the river facing downstream) and a second in mid-channel. The left bank live box enabled the crew to pass fish through the weir during high water events that prevented safe access to the mid-channel live box or when visibility was limited due to high turbidity and/or deeper water. The left bank live box was also used during periods of low water to provide an additional avenue that fish could use to move upstream.

A downstream live box and partial weir were briefly incorporated into the mainstem weir near the left bank in an attempt to capture emigrating steelhead trout. However, the live box and partial weir proved to be unsuccessful in capturing steelhead trout and were dismantled.

The weir was visually inspected on a daily basis to ensure no fish could migrate past undetected. The gates to the live boxes were opened daily from approximately 0800 hours to approximately midnight or earlier depending on darkness. To avoid impeding fish passage, technicians periodically checked the live boxes and processed all fish as quickly as possible. All fish were identified to species and tallied by each hour for the daily escapement counts.

DIDSON and Resistance Board Weir

In 2009, the DIDSON was used to monitor Chinook salmon escapement at night from 17 July to 20 July when the weir was opened to allow migration of Dolly Varden and pink salmon. During this 4-day period, both gates (upstream and downstream) of the mid-channel live box were left open for a total of 19 hours 10 minutes during hours of suppressed light. 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 operation.

The DIDSON files collected over the 4-day period were reviewed to estimate Chinook salmon escapement. Large fish images were assumed to be Chinook salmon. Smaller fish images were assumed to be either Dolly Varden or pink salmon and were apportioned by the counts from the daily weir operation (Appendix B1).

Steelhead Chute and DIDSON

The chute was formed by placing 1 or 2 sandbags on the downstream end of one of the floating weir panels (Figures 5 and 6). The weight of the sandbags created a shallow stream of water that fish could use to swim downstream over the weir. The placement of the sandbags was used to adjust the water depth flowing over the weir panel so that it was deep enough to allow steelhead trout to swim downstream, but shallow enough to prevent upstream migration. The chute was repositioned several times in order to find the section of the weir that most steelhead trout would pass.

Near the downstream edge of the chute, a wooden tripod was anchored so an above-water video splash camera could be secured and aimed at the chute (Figure 5). The cable of the camera was fed to a tent and images were recorded on VHS tapes. From 13 May to 26 May, the chute was closed at night. During hours of suppressed light, personnel assisted emigrating steelhead over the weir. The chute was left open throughout 27 May, and a light (a component of the video camera) was used to illuminate the chute. We found poor image quality during suppressed light and again closed the chute at night from 28 May to 30 May. On 30 May, the DIDSON was installed downstream of the weir near the left bank and aimed upstream at the end of the chute and the chute was left open continuously. The DIDSON was operated continuously through 25 June as a backup to the video camera. On 31 May, the video camera malfunctioned and the DIDSON was the only method used to monitor the chute. The video was repaired on 1 June and operated from 1600 hours to midnight. On 2 June and 3 June, the video was operated from approximately 0500 hours to midnight (~ 19 hours per day) and then continuously through noon, 25 June with the advantage of longer daylight.

A technician viewed 753 hours of video recordings of the chute to enumerate fish passage. All fish were identified to species, and then tallied by hour to determine the daily counts. Five Chinook salmon passed downstream over the chute and were subtracted from the weir count.

DIDSON counts were used during the periods when the chute was operational and the video was not recording. Video counts showed that 95% of the steelhead emigration passed through the chute between midnight and 0359 and DIDSON files were counted only over this period. All of the downstream fish counts between midnight and 0359 were assumed to be steelhead trout because other species such as pink salmon and Dolly Varden run later in the summer and because only 5 Chinook salmon were observed going downstream through the chute. Comparison of simultaneous DIDSON and video counts revealed a small negative bias in the DIDSON counts and these were adjusted via a linear regression of DIDSON counts on paired video counts (Appendix B1). Subsequently, the DIDSON counts were also modified to account for emigration between 0000 and 0400 hours (multiplied by 1/0.95). The DIDSON was used over a 4-day period between midnight and 0359 (4 hours per day) from 31 May to 3 June (Appendix B1). The May 31 estimate of steelhead trout was based only on sonar counts.

River Temperature and Stage

Cook Inletkeeper (CIK), a citizen-based nonprofit group, collected water temperature in degrees Celsius every 15 minutes using a temperature logger. The logger was installed approximately 0.1 RKM downstream of the sonar/weir site (Figure 2).

The U.S. Geological Survey (USGS) collected river stage data every hour from the gauge station (USGS 15239900) located on the South Fork at approximately 11.4 RKM from the mouth of the Anchor River at a New Sterling Highway bridge (Figure 2).

BIOLOGICAL SAMPLING

Mainstem Resistance Board Weir Samples

Sampling began at 0800 or later, when fish were captured in the live box. Chinook and coho salmon were sampled continuously until the sampling goal was met. Sampling of Chinook and coho salmon occurred every other day throughout the weir operation by applying a sampling proportion (0.025 Chinook salmon and 0.027 coho salmon) to the respective cumulative weir count based on the last sampling event and rounding up to the nearest whole number. The following data were collected from Chinook and coho salmon:

1) length measurement from mid eye to tail fork (MEFT) to the nearest 5 mm
2) sex through external characteristics
3) scales sampled to estimate age (Welander 1940; Mosher 1969) without reference to size, sex, or other data

When the chute was in operation, the caudal fin of sampled Chinook salmon and all steelhead trout captured was clipped before release to prevent double sampling.

Coded Wire Tag Samples

Throughout the full weir operation, all Chinook and coho salmon sampled for age, sex, and length (ASL) data were also inspected for the presence or absence of an adipose fin. Each Chinook salmon captured with a beach seine was inspected for the presence of an adipose fin. Fish missing an adipose fin were sacrificed to identify the release site.

Beach Seine Samples

Three river sections (1 on the North Fork and 2 on the South Fork) were sampled once a week to index steelhead trout kelts (Figure 2). The sections of river sampled for this project had been routinely sampled from 2003 through 2008 during the DIDSON operation (~ 0.5 RKM upstream).

Each river section was sampled by drifting a beach seine (abbreviated below as “netting”) 30.5 m long by 2 m deep with 5.1 cm stretched mesh size. Netting techniques are described in (Kerkvliet et al. 2008). Each net set was standardized by using the same techniques to deploy and purse the net. If no fish were caught on the first net set, the net was deployed again. A stop watch was used to time each net set. The start time began as soon as the net was deployed. The end time was marked as soon as the net stopped fishing. The catch from each net set was recorded by species. The river sections were each sampled 6 times (May 20, May 29, June 4, June 11, June 18, and June 25).

DATA ANALYSIS

Escapement, Enumeration and Run Timing

Chinook and coho salmon

Chinook and coho salmon escapements were calculated as the summation of all weir counts through the season along with estimated counts afforded by the DIDSON (4 nights; Chinook salmon only). The counts were considered censuses of the escapement and without error.

Run timing of Chinook and coho salmon at the sonar/weir site was described using cumulative daily counts and associated percentiles. The 50^{th} percentile was used to describe the midpoint of the run. Diurnal run timing was calculated from the number of Chinook and coho salmon that passed through the weir live boxes from 0800 through midnight. Diel timing was based on weir and DIDSON counts collected from July 17 to July 20.

The duration of the Chinook and coho salmon run was defined as the number of days it took the run to progress from the 10^{th} to 90^{th} percentile (middle-80 duration). Pearson's correlation coefficient (r) was used to compare daily counts within the middle-80 duration to daily river temperature and stage averages.

Steelhead Trout

Steelhead trout have a complex life history. Steelhead trout in Southcentral Alaska are commonly referred to "fall run" fish, which means they immigrate into freshwater streams in the fall and overwinter before spawning in the spring. Steelhead trout spawning distribution in the Anchor River is unknown but thought to mostly occur upstream of the North Fork and South Fork confluence. After spawning, kelts emigrate from the river to salt water in May and June. Steelhead trout may be divided into 3 components:

1) Fall immigrants: Steelhead trout counted moving upstream through the weir from 1 July through the end of the project operation; these fish overwinter in the Anchor River.
2) Pre-spawning immigrants: Steelhead trout counted moving upstream through the weir from the beginning of the project operation through 30 June.
3) Post-spawning emigrants (kelts): Kelts counted moving downstream through the weir from the beginning of the project operation through 30 June.

The enumeration of steelhead trout kelts was calculated as the sum of all chute counts through the season, plus those estimated from the DIDSON, when the video camera was not used, and those assisted over the weir by hand. The counts were considered a census of the emigration and without error. Fall immigrating steelhead trout were also counted, although counts were not possible over the entire migration because the weir is dismantled before the run was complete.

Kelt run timing was evaluated in a similar fashion as that for Chinook salmon. Diel run timing of kelts was also examined using video counts for 20 days (27 May and from 4 June to 23 June) when the entire day could be enumerated. Counts were tallied for each hour then expressed as a percentage related to the entire day. Pearson's correlation coefficient (r) was used to compare daily kelt counts to daily river temperature and stage averages.

Age and Sex Composition and Length-at-Age

The age, sex, and length (ASL) composition of the Chinook and coho salmon escapement was based on a systematic sample collected at the mainstem weir only. The estimated proportion ($\hat{p}_K$) of Chinook and coho salmon of age-sex class *k* in the escapement (*N*) was calculated from the sample taken at the mainstem weir (*n*) using Equation 1:

$$\hat{p}_k = \frac{n_k}{n} \tag{1}$$

where n_k is the number of Chinook salmon out of *n* sampled that were of age-sex class *k*, with estimated variance

$$\text{var}(\hat{p}_k) = \left(\frac{N - n}{N} \right) \frac{\hat{p}_k (1 - \hat{p}_k)}{n - 1} \tag{2}$$

.

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

$$\text{var}(\hat{N}_k) = N^2\ \text{var}(\hat{p}_k). \tag{3}$$

Mean and variance for length-at-age were estimated using standard summary statistics.

The within-reader variability of scale age-estimates were calculated using a coefficient of variation (*CV*) expressed as the ratio of the standard deviation over the mean age (Campana 2001):

$$CV_j = \frac{\sqrt{\sum_{i=1}^{R} \frac{(X_{ij} - X_j)^2}{R-1}}}{X_j} \tag{4}$$

where

X_{ij} = *i*th age estimate of the *j*th fish

X_j = mean age estimate of the *j*th fish, and

R = number of times each fish is aged.

River Temperature and Stage

The correlation between the average daily river temperature and average river stage during the project operation was estimated using Pearson's correlation coefficient (*r*). The hypothesis that $r = 0$ was tested.

RESULTS

CHINOOK SALMON

Escapement

The 2009 Chinook salmon escapement of 3,455 fish was below the sustainable escapement goal (SEG) lower bound of 5,000 fish and was the lowest since the start of the project (Table 4). Most (97%) of the escapement estimate was based on weir counts; but 3% was based on DIDSON counts for 4 nights (19 hours 10 minutes, total). Over this 4-day period (17–20 July), 27 Chinook salmon were counted during the day and 111 Chinook salmon (large-sized fish) were counted with DIDSON (Appendix C1).

Run Timing

The midpoint (50th percentile) of the Chinook salmon run was 23 June, which was 16 days later than average (2003–2008) (Figure 7; Appendix C1). The 2009 Chinook salmon run timing was similar to average (2003–2008) based on the middle-80 duration (41 days versus 39 days, respectively). When the weir was operated from about 0800 hours to midnight, most (79%) of the Chinook salmon were counted passing through the weir between hours 1700 and 2359 (Figure 8). From 17 July through 20 July, when the weir was left open 24 hours a day, most (80%) of the Chinook salmon were counted between midnight and 0259 hours. Daily passage of Chinook salmon through the weir indicated a positive correlation with river stage (r = 0.37, df = 39, P = 0.017) but not river temperature (r = -0.23, df = 39, P = 0.15; Figure 9; Appendices D1 and D2). River stage during the middle-80th percentile of the Chinook salmon run averaged 30.8 cm and ranged from 20.7cm to 42.7cm (Appendix D1).

COHO SALMON

Escapement

The coho salmon escapement in 2009 was the lowest (2,692 fish) since 2004 (Table 5). The escapement is considered a minimum because on the last day the weir was operated (11 September), a relatively high number of coho salmon (353 fish; 13%) were counted passing through the weir (Appendix C1).

Run Timing

The first coho salmon was counted passing through the weir on 26 July (Appendix C1). The midpoint of the coho salmon run was 29 August (Figure 10). Before the weir was scheduled to be removed on 12 September, daily counts of coho salmon from 6 September to 10 September were low (range 3 to 13 fish). Rains caused the river level to rise on 11 September and counts also rose. The diurnal passage of coho salmon through the weir was greatest (54%) between 1600 and 1959 hours (Figure 11). Daily passage of coho salmon was positively correlated with river stage (r = 0.6, df = 25, P = 0.001) but not river temperature (r = -0.426, df = 25, P = 0.83; Figure 12). River stage during the middle-80th percentile of the coho salmon run averaged 26.5 cm and range from 18.9 cm to 43.9 cm. Peak coho salmon counts occurred when river stage exceeded 32 cm.

STEELHEAD TROUT

Enumeration

The first complete enumeration of emigrating steelhead trout (605 fish) from the Anchor River was accomplished in 2009 (Appendix E1; Figure 13). Most of the steelhead trout counted were from video recordings (492 fish) and from manual counts (65 fish) when fish were assisted downstream over the weir. The number of steelhead trout estimated from DIDSON counts was 48.

The spawning condition was assessed on 14 steelhead trout counted moving upstream through the weir from 12 May through 30 June; there were 13 pre-spawning immigrants and 1 kelt. From 1 July through 11 September, there were 85 fall immigrants counted moving upstream through the weir.

Run Timing

The midpoint of the kelt emigration at the weir site was 7 June (Figure 7). Most of the kelts (95%; N = 435; SE = 0.49%) emigrated downstream of the weir between midnight and 0359 hours, of which 72% (N = 331; SE = 0.78%) emigrated between midnight and 0259 hours (Figure 14). The kelt emigration timing was not correlated with river stage (r = 0.03, df = 40, P = 0.86); timing was, however, positively correlated with river temperature (r = 0.35, df = 40, P = 0.02; Figure 15).

Beach Seine Sampling

A total of 20 steelhead trout (5 from the North Fork and 15 from the South Fork) were captured during beach seine sampling and all were kelts (Table 6). The average duration of each set was 01:12 minutes. No obvious pattern emerged between the weekly catch of kelts from nets and daily counts of kelts passing through the chute (Figure 16).

BIOLOGICAL SAMPLING

Age and Sex Composition and Length-at-Age

Chinook Salmon

Ocean age 2 was the dominant age class (51.1%, SE = 5.3%) for the Chinook salmon escapement in 2009 (Table 7). Ocean age 2 was also the dominant age class for males (42.7%, SE = 5.3%), while ocean age 3 was the dominant age class for females (20.2%, SE = 4.3%). The coefficient of variation of all age estimates from Chinook salmon scales was 4.2%. The male to female ratio was 1.7:1.0. Lengths (mid eye to tail fork, MEFT) were similar between males and females (P = 0.617) for ocean-age-2 fish and for ocean-age-3 fish (P = 0.819). The dominant age class of Chinook salmon in 2009 was ocean age 2 (51.1%, SE = 5.3%) and the overall age composition was significantly different (χ^2 = 1114, df = 3, P < 0.001) than the 2003–2008 average annual age composition (Table 8).

Coho Salmon

The dominant age class for coho salmon was age 2.1 (84.1%; SE = 4.4%, Table 9). The coefficient of variation of all age estimates from coho salmon scales was 1.7%. The male to female ratio was 0.8:1.0. Length measurements (MEFT) were similar between males and females (P = 0.316) for ocean-age-1.1 and for ocean-age-2.1 fish (P = 0.119).

Strays

No adipose finclipped fish were detected from the 85 Chinook salmon and 171 coho salmon examined in 2009.

RIVER TEMPERATURE AND STAGE

Average daily river stage and temperature were significantly negatively correlated (r = -0.67, P < 0.001) (Figure 17; Appendix D1 and D2). The average river temperature was approximately 11^{o}C (range 4^{o} C to 20^{o} C) and the average stage was approximately 30 cm (range 11 cm to 51 cm).

DISCUSSION

The 2009 Anchor River Chinook salmon escapement was the first that has been censused and was the seventh in this data series. The large percentage (13%) of coho salmon counted on the last day of weir operation suggests that the 2009 coho salmon escapement was likely an incomplete census. The 2009 enumeration of steelhead trout kelts was the first time the entire emigration was counted for the Anchor River.

The 2009 Anchor River Chinook salmon fishery was closed by emergency order (EO 2-KS-7-08-09). The EO closed the Anchor River to fishing and increased the closed area in the salt waters of Cook Inlet at the mouth of the Anchor River from 2 miles to 4 miles beginning 0001 hours on 6 June through 2359 hours on 30 June 2009. The EO was issued because the run was projected to fall below the lower bound sustainable escapement goal (SEG).

Overall, escapements for Cook Inlet Chinook salmon were low in 2009. In LCIMA, the Ninilchik River Chinook salmon escapement failed to reach the sustainable escapement goal (SEG) (Booz and Kerkvliet *In prep*). Additionally in 2009, the poor run of hatchery-reared Chinook salmon to the saltwater terminal fisheries in Kachemak Bay suggests poor marine survival for the 2004–2008 broods which composed the 2009 run.

The dominant age class shift from ocean age 3 to ocean age 2 was also observed in 2009 for Chinook salmon sampled at the Ninilchik River weir (Booz and Kerkvliet *In prep*) and Deshka River weir (S. Hayes, Sport Fish Biologist, ADF&G, Palmer, personal communication).

The offspring from a single spawning year (brood year) of Anchor River Chinook salmon will mature within 6 years. Examination of Chinook salmon abundance of by age class suggests poor survival for the 2003 and 2004 brood years. The Chinook salmon produced from the 2003 brood year returned in years 2006 through 2009, after spending 1 to 4 years in the ocean. Overall, the returns from the 2003 brood year were weaker than the historic average based on the abundances of each age class (Table 8). Returns from the 2004 brood year were lower than average based on returns of ocean-age-1 fish in 2007, ocean-age-2 fish in 2008, and ocean-age-3 fish in 2009.

The run timing of Chinook salmon in 2009 was the latest since the first use of the Dual frequency IDentification SONar (DIDSON) and weir in 2004, and 17 days later than the midpoint of the kelt emigration (Figure 7). Most of the kelts emigrated during the first half of the Chinook salmon run in 2009.

In 2009, the number of coho salmon that passed upstream of the weir site after 11 September is unknown. However, the 2009 escapement is probably lower than the lowest escapement recorded at the current sonar/weir site since 2004 based on reports of poor fishing in mid-September

(Table 5). Even though the 2009 escapement was considered low for recent years, it is similar to those of 1987 (2,409) and 1988 (2,805) when the weir was operated downstream of the fishery. Based on escapement counts through 11 September, the inriver exploitation was 59.1%; however, exploitation was likely slightly lower because of the unknown escapement after 11 September.

Coho salmon of age 2.1 have been the dominant age class every year that age composition has been estimated for the coho salmon escapement (2004–2009; Table 10). Because of the low coho salmon escapement, fewer fish than expected were sampled in 2009. Future sampling rates will be based on lower escapement expectations. Diurnal timing in 2009 (Figure 11) was similar to timing from 2004–2008. The positive correlation between river levels and coho salmon weir counts found from 2004 through 2008, continued in 2009; although it was less dramatic due to the small run size (Kerkvliet et al. 2008; Kerkvliet and Burwen 2010; Kerkvliet et al. *In prep*).

With the full enumeration of kelts, we can estimate the bias that would have occurred if we had used the DIDSON at the beginning of the operation. Given a typical weir installation date of early- to mid-June, the majority of the kelt emigration would have occurred during the DIDSON operation. Because all downstream DIDSON images are counted as milling Chinook salmon, the estimate would have been biased low by about 600 fish (605 kelts were counted emigrating); and would have been about 2,850 fish, versus the 3,455 actual escapement. The number of kelts counted in 2009 could be used to estimate the number of steelhead trout that immigrated into the Anchor River in 2008 if the sex ratio of immigrating and emigrating fish were known as well as overwinter and spawning mortality. Male and female adult steelhead trout have different spawning survival rates (Gates and Boersma 2010; Begich 2007), therefore a simple expansion of kelt number by assumed overwinter and spawning survival rates is inaccurate.

The Division of Sport Fish will continue estimating the Anchor River Chinook and coho salmon escapements using DIDSON and weir counts from mid-May through mid-September. The combination of video camera and chute provided a method for enumerating emigrating kelts at the weir site. If river levels allow early weir installation in the future, we recommend that monitoring kelts at the weir site be included as a project objective so a model can be established to reduce the bias to the Chinook salmon estimate caused by emigrating kelts.

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TABLES

Table 1.–Drainage characteristics of the North Fork and South Fork of the 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, Research Analyst, Kachemak Bay Research Reserve, Homer, AK, *unpublished data*, 2006.

Note: "RKM" = river kilometers.

Table 2.–Estimated Anchor River freshwater sport harvest (or catch) by species and effort, 1977–2009.

Year	Effort (days fished)	Harvest						Catch
		Chinook salmon	Coho salmon	Pink salmon	Sockeye salmon	Dolly Varden	Rainbow trout /steelhead	Rainbow trout /steelhead [a]
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[b]
1990	28,829	1,479	2,782	163	136	2,821	0	1,978
1991	22,187	1,047	3,169	125	152	1,409	0	2,349
1992	24,028	1,685	2,267	92	66	2,532	0	2,720
1993	29,338	2,787	4,003	98	45	1,031	0	4,156
1994	27,856	2,478	3,360	79	82	1,574	0	4,035
1995	25,888	1,475	3,080	47	94	1,537	0	2,232
1996	16,016	1,483	1,762	78	218	963	0	7,570
1997	17,020	1,563	1,636	321	165	1,575	0	3,103
1998	14,310	783	2,386	7	174	2,105	0	3,878
1999	21,184	1,409	1,780	54	174	1,061	0	3,920
2000	22,971	1,730	2,604	123	127	1,903	0	8,693
2001	19,195	889	2,960	11	61	1,652	0	3,045
2002	19,245	1,047	3,830	124	52	662	0	3,501
2003	17,482	1,011	3,999	68	504	1,124	0	3,409
2004	20,452	1,561	4,383	146	11	736	0	3,710
2005	20,079	1,432	5,314	69	156	675	0	2,524
2006	17,065	1,394	3,920	112	54	897	0	4,513
2007	34,390	2,081	3,962	298	53	1,327	0	8,365
2008	26,182	1,486	4,790	179	652	822	0	8,733
2009	22,057	737	3,882	267	169	1,123	0	4,119
Averages								
2003–2008	22,608	1,494	4,395	145	238	930	0	5,209
1989–2008	22,143	1,470	3,231	115	156	1,394	0	4,225
1977–1988	33,042	1,105	2,075	135	360	10,377	1,119	ND
1977–2002	27,066	1,296	2,429	118	183	5,647	516	3,803
1977–2008	26,230	1,333	2,798	123	197	4,763	420	4,225

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, 2010a-b 2011).

Note: "harvest" = fish kept; "catch" = fish harvested plus fish released; "ND" = no data. Scientific names of species not previously identified: pink salmon *Oncorhynchus gorbuscha* and sockeye salmon *O. nerka*.

[a] Rainbow trout/steelhead caught and released only since 1989; retention of this species is prohibited.

[b] 1989 estimate from Gretchen Jennings (project manager, SWHS, ADF&G, SF, Anchorage, unpublished data).

Table 3.–Anchor River weir/DIDSON fish counts by species, 1987–1995 and 2003–2009.

Year	Project dates	Location (RKM) [a]	Method	Fish counts						
				Chinook salmon [b]	Dolly Varden [c]	Pink salmon [c]	Chum salmon	Sockeye salmon	Coho salmon [d]	Rainbow trout /steelhead [e]
1987[f]	4 Jul–10 Sep	1.6	fixed picket weir	204	19,062	2,084	19	33	2,409	136
1988[f]	3 Jul–5 Oct	1.6	fixed picket weir	245	14,935	777	24	30	2,805	878
1989[f]	6 Jul–5 Nov	1.6	resistance board weir	95	11,384	4,729	165	212	20,187	769
1990[f]	4 Jul–15 Aug	1.6	resistance board weir	144	10,427	355	17	39	190	3
1991[f]	4 Jul–15 Aug	1.6	resistance board weir	39	18,002	1,757	9	46	13	5
1992[f]	4 Jul–1 Oct	1.6	resistance board weir	129	10,051	992	39	174	4,596	1,261
1993[f]	3 Jul–16 Aug	1.6	resistance board weir	90	8,262	1,019	12	71	290	1
1994[f]	3 Jul–16 Aug	1.6	resistance board weir	111	17,259	723	2	61	420	1
1995[f]	4 Jul–12 Aug	1.6	resistance board weir	112	10,994	1,094	4	73	725	10
2003[g]	30 May–9 Jul	2.8	DIDSON	9,238 [h]	–	–	–	–	–	–
2004[g]	16 May–13 Sep	2.8	DIDSON/ resistance board weir	12,016 [h/i]	7,846	1,079	79	45	5,728	20
2005[g]	13 May–9 Sep	2.8	DIDSON/ resistance board weir	11,156 [h/i]	5,719	4,916	146	319	18,977	107
2006[g]	15 May–24 Aug	2.8	DIDSON/ resistance board weir	8,945 [h/i]	234	954	45	38	10,181[j]	4
2007	14 May–12 Sep	2.8	DIDSON/ resistance board weir	9,622 [h/i]	1,309	3,916	156	200	8,226	344
2008	13 May–11 Sep	2.8	DIDSON/ resistance board weir	5,806 [h/i]	1,344	2,017	66	52	5,951	262
2009	12 May–11 Sep	2.8	resistance board weir	3,455	1,404	4,975	68	62	2,692	85

[a] River kilometers (RKM) from mouth of Anchor river.

[b] Escapement is only partially counted due to weir operation dates and weir location (1987–1995) and due to weir operation dates (2003).

[c] Incomplete counts due to picket spacing of the weir (2004–2008) because smaller fish were able to pass through the weir pickets undetected.

[d] Incomplete counts due to project operation dates (1987, 1991, 1993–1995, 2005–2006).

[e] Incomplete counts due to project operation dates and/or weir location (1987, 1990–1991, 1993–1995, and 2004–2008).

[f] Sources: Larson et al. (1988), Larson and Balland (1989), Larson (Larson 1990-1995, 1997); escapement weir was located about 1.6 RKM from mouth.

[g] Sources: Kerkvliet et al. (2008; years 2003–2004), Kerkvliet and Burwen (2010; years 2005-2006), Kerkvliet et al. (*In prep*; years 2007–2008).

[h] All DIDSON images and the associated counts were assumed to be Chinook salmon.

[i] Chinook salmon estimate based on combined DIDSON and weir census. If DIDSON was operated in July, counts were apportioned between large fish (Chinook salmon) and small fish (Dolly Varden and pink salmon).

[j] No counts collected Aug 19–21; the weir washed out due to flooding. The DIDSON operated again Aug 22–24; an estimated 3,292 coho salmon were counted.

Table 4.–Anchor River Chinook salmon escapement, freshwater harvest, total run, and exploitation estimates, 2003–2009.

		Chinook salmon						
						Total run [a]		
		Escapement		Freshwater harvest			Exploitation	Fishing
Year	Project dates	Estimate	SE	Estimate	SE	Estimate	rate (%) [b]	days
2003	30 May–9 Jul	9,238	0 [c]	1,011	157	10,249	9.9	12
2004	15 May–15 Sep	12,016	283 [d]	1,561	198	13,577	11.5	15
2005	13 May–9 Sep	11,156	229 [d]	1,432	233	12,588	11.4	15
2006	15 May–24 Aug	8,945	289 [d]	1,394	197	10,339	13.5	15
2007	14 May–12 Sep	9,622	238 [d]	2,081	326	11,703	17.8	15
2008	13 May–12 Sep	5,806	169 [d]	1,612	241	7,418	21.7	20
2009	12 May–11 Sep	3,455	0 [e]	737	212	4,192	17.6	12
Averages								
2003–2008		9,464		1,515		10,979	13.8	15
2004–2007		10,435		1,617		12,052	13.4	15
2008–2009		4,631		1,175		5,805	20.2	16

Source: Harvest estimates from statewide harvest survey (Jennings et al. 2006b, 2007, 2009a-b; 2010a-b, 2011).

Note: Estimates of escapement for 2003–2008 may be low because of DIDSON bias.

[a] Total run = escapement + freshwater harvest; total does not account for the marine harvest.

[b] Percent harvest per total run

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

[d] The estimate is based on expanded DIDSON counts and weir counts.

[e] The run was censused over the entire run with weir counts.

Table 5.–Anchor River coho salmon escapement, freshwater harvest, total run, and exploitation estimates, 1987–1989, 1992, 2004–2009.

		Coho salmon				
					Total run [a]	
		Escapement	Freshwater harvest			Exploitation
Year	Project dates	estimate [b]	Estimate	SE	Estimate	rate (%) [c]
1987	5 Jul–11 Sep	2,409	2,010	ND	4,419 [d]	45.5
1988	3 Jul–6 Oct	2,805	2,219	ND	5,024 [d]	44.2
1989	6 Jul–7 Nov	20,187	2,635	ND	22,822 [d]	11.5
1992	4 Jul–2 Oct	4,596	2,267	ND	6,863 [d]	33.0
2004	15 May–15 Sep	5,728	4,383	722	10,111	43.3
2005	13 May–9 Sep	18,977 [e]	5,314	949	24,291	21.9
2006	15 May–24 Aug	10,181 [e]	3,920	975	14,101	27.8
2007	14 May–12 Sep	8,226	3,962	679	12,188	32.5
2008	13 May–12 Sep	5,951	4,790	821	10,741	44.6
2009	12 May–11 Sep	2,692 [e]	3,882	737	6,574	59.1
Averages						
1987–1992		7,499	2,283		9,782	23.3
2004–2008		9,813	4,474		14,286	31.3
1987–2009		8,175	3,538		11,713	30.2

Source: Harvest estimates from statewide harvest survey (Jennings et al. 2006b, 2007, 2009a-b, 2010a-b, 2011).

[a] Total run = escapement + freshwater harvest; this total does not account for the marine harvest.

[b] Escapement weir location from 1987–1989 and 1992 ~1.6 RKM and from 2004–2009 ~ 2.8 RKM upstream from the Anchor River mouth.

[c] Percent harvest per total run.

[d] Estimates are biased and may be high because an unknown number of fish in the escapement estimate were harvested after they were counted passing through the weir.

[e] Minimum escapement estimate for 2005 and 2006 because weir washed out; 2009 is a minimum because counts were high when weir was removed.

Table 6.–Beach seine catches by species from standard river reaches on the North Fork and South Fork of the Anchor River, 2009.

		South Fork			North Fork		
Sampling dates	Number of sets	Chinook salmon	Dolly Varden	Steelhead (kelts)	Chinook salmon	Dolly Varden	Steelhead (kelts)
20 May	7	0	0	0	0	0	3
29 May	6	0	0	4	0	0	0
4 Jun	10	1	0	4	1	0	2
11 Jun	5	2	0	1	4	0	0
18 Jun	6	1	0	6	3	0	0
25 Jun	6	1	0	0	2	1	0
Total	40	5	0	15	10	1	5

Table 7.–The estimated ocean age, sex, and length composition of the Anchor River Chinook salmon escapement, 2009.

	Ocean age				Sex
	1	2	3	4	composition [a]
Females					
Number sampled	0	8	18	1	43
Percent	0.0	9.0	20.2	1.1	36.8
SE percent	0.0	3.0	4.3	1.1	4.5
Abundance	0	311	698	38	1,271
SE abundance	0	104	149	38	155
Mean length	NA	653	815	825	780
SE mean length	NA	46	11	NA	15
Males					
Number sampled	7	38	14	3	74
Percent	7.9	42.7	15.7	3.4	63.2
SE percent	2.9	5.3	3.9	1.9	4.5
Abundance	273	1,475	542	117	2,184
SE abundance	100	183	135	66	155
Mean length	538	611	776	812	663
SE mean length	14	15	27	32	14
All					
Number sampled	7	46	33	4	117
Percent	7.8	51.1	36.7	4.4	NA
SE percent	2.8	5.3	5.1	2.2	NA
Abundance	269	1,766	1,268	152	3,455
SE abundance	97	183	176	76	0
Mean length	538	619	799	815	707
SE mean length	14	15	13	23	12

Note: "NA" = not applicable.

[a] Sex/age components do not necessarily sum to equal sex composition column numbers due to missing values for age and sex data.

Table 8.–Anchor River Chinook salmon escapement estimated annual ocean-age composition and abundance, 2003–2009.

	Percent ocean age				SE percent ocean age				Ocean-age abundance				Ocean-age abundance SE			
Year	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
2003	5.1	23.0	57.8	13.8	1.1	2.1	2.5	1.8	471	2,125	5,340	1,275	92	195	232	166
2004	8.8	20.7	48.6	21.9	1.9	2.6	3.2	2.6	1,057	2,487	5,840	2,632	224	313	406	321
2005	5.0	23.9	52.2	18.9	1.2	2.1	2.5	2.0	558	2,666	5,823	2,108	134	241	303	227
2006	6.4	16.5	52.1	25.0	2.1	2.7	3.8	3.5	572	1,476	4,660	2,236	189	246	372	321
2007	0.5	22.0	53.4	24.1	0.5	3.1	3.7	3.2	48	2,116	5,138	2,319	48	303	378	313
2008	4.4	21.8	68.5	5.2	1.9	3.7	4.3	2.1	255	1,266	3,977	302	111	218	275	122
2009	7.8	51.1	36.7	4.4	2.8	5.3	5.1	2.2	269	1,766	1,268	152	97	183	176	76
Average 2003–2008	5.0	21.3	55.4	18.1					461	1,986	4,578	1,567				

Table 9.–The estimated age, sex, and length composition of the Anchor River coho salmon escapement, 2009.

	Age class		Sex composition [a]
	1.1	2.1	
Females			
Number sampled	7	30	47
Percent	10.3	44.1	54.7
SE percent	3.7	6.1	5.4
Abundance	124	964	1,473
SE abundance	100	164	145
Mean length	566	572	565
SE mean length	26	6	6
Males			
Number sampled	3	28	39
Percent	4.4	41.2	45.3
SE percent	2.5	6.0	5.4
Abundance	118	1,109	1,219
SE abundance	67	162	145
Mean length	555	570	573
SE mean length	10	9	7
All			
Number sampled	11	58	86
Percent	15.9	84.1	100.0
SE percent	4.4	4.4	0
Abundance	428	2,264	2,692
SE abundance	118	118	0
Mean length	560	571	568
SE mean length	17	5	5

Note: "NA" = not applicable.

[a] Sex/age components do not necessarily sum to equal sex composition column numbers due to missing values for age and sex data.

Table 10.–Anchor River coho salmon escapement estimated annual ocean-age composition and abundance, 2003–2009.

	Percent age class					SE percent age class				
Year	1.1	2.1	3.1	1.2	2.2	1.1	2.1	3.1	1.2	2.2
2004	11.2	84.4	3.4	0	1.0	2.2	2.5	1.3	0	0.7
2005	13.6	84.9	1.0	0.2	0.2	1.7	1.8	0.5	0.2	0.2
2006	10.6	89.4	0.0	0	0.7	2.7	2.7	0.0	0.0	0.7
2007	15.2	84.2	0.0	0.0	0.0	2.8	2.8	0.0	0.0	0.0
2008	20.0	80.0	0.0	0.0	0.0	3.6	3.6	0.0	0.0	0.0
2009	15.9	84.1	0.0	0.0	0.0	4.4	4.4	0.0	0.0	0.0
Average 2004–2008	14.1	84.6	0.9	0.0	0.4	2.6	2.7	0.4	0.0	0.3

FIGURES

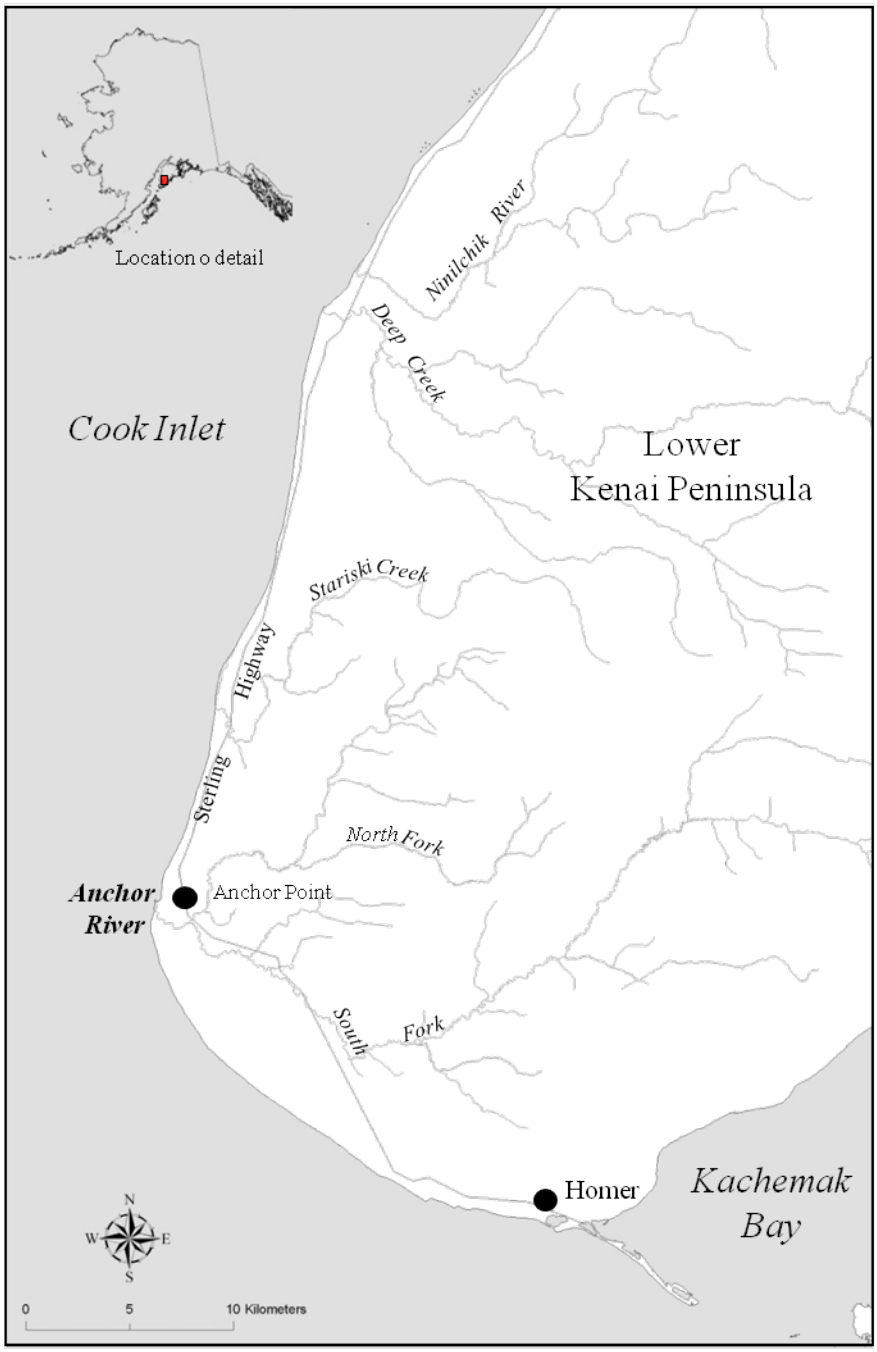

Figure 1.–Location of the Anchor River and other roadside tributaries within the Lower Cook Inlet Management Area.

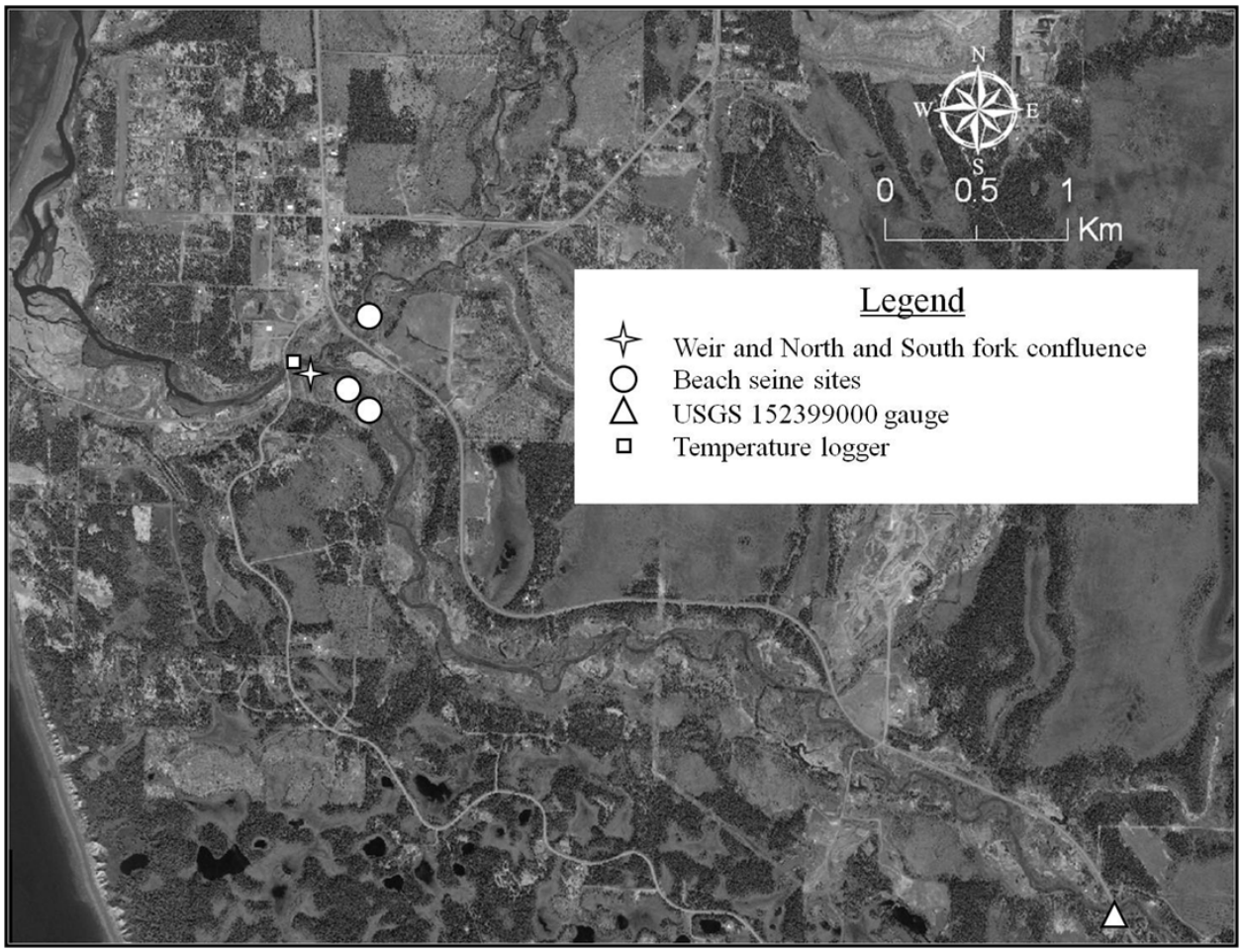

Figure 2.–Anchor River sampling locations, 2009.

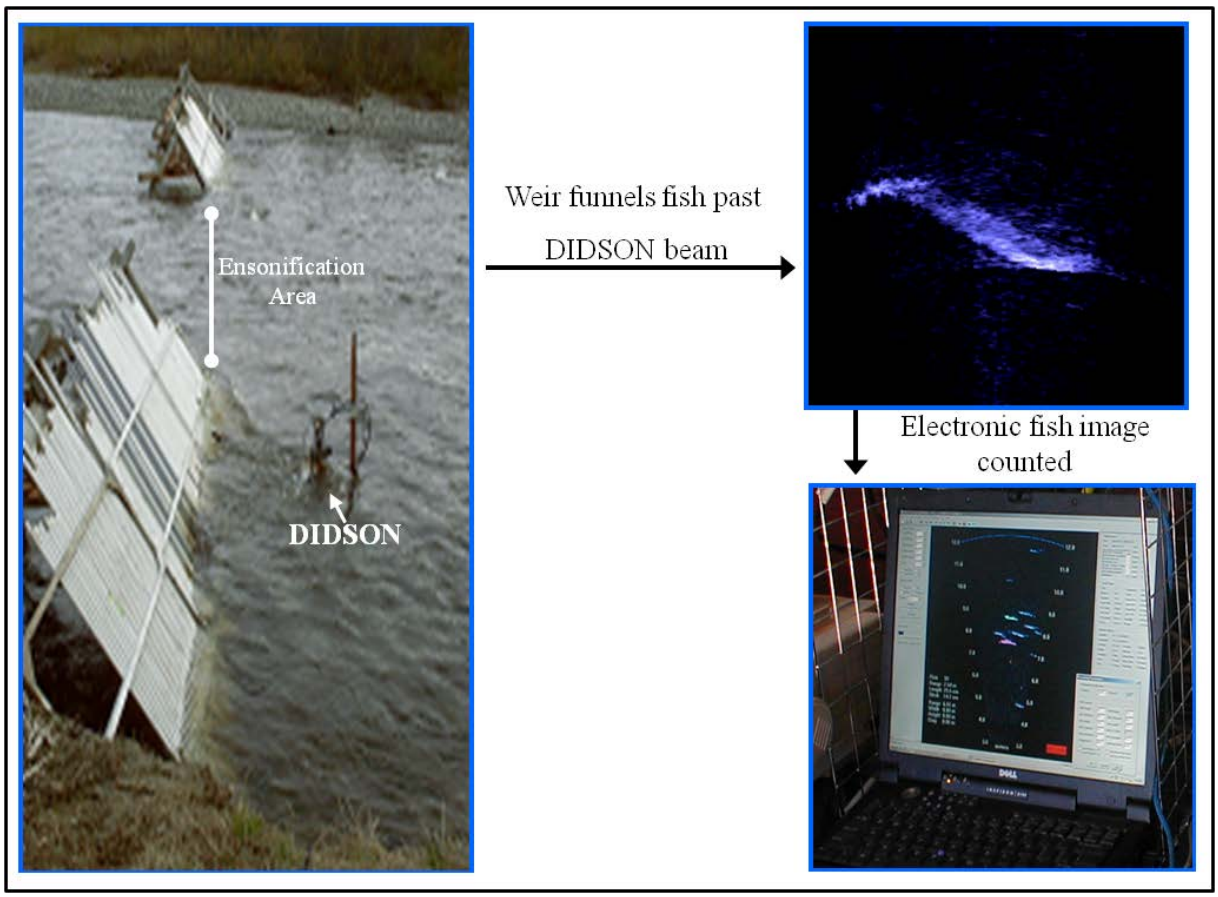

Figure 3.–DIDSON is used with a partial weir to funnel fish past the DIDSON beam.

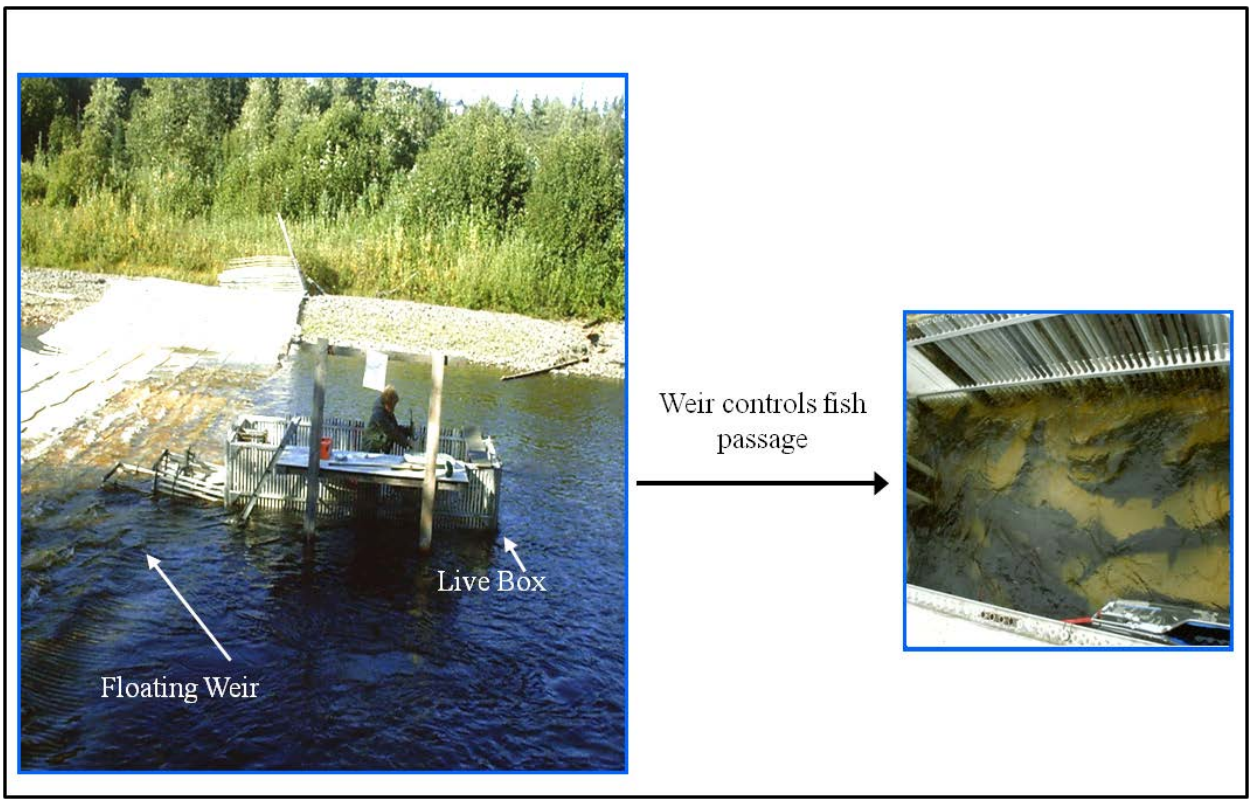

Figure 4.–Resistance board weir used to count fish.

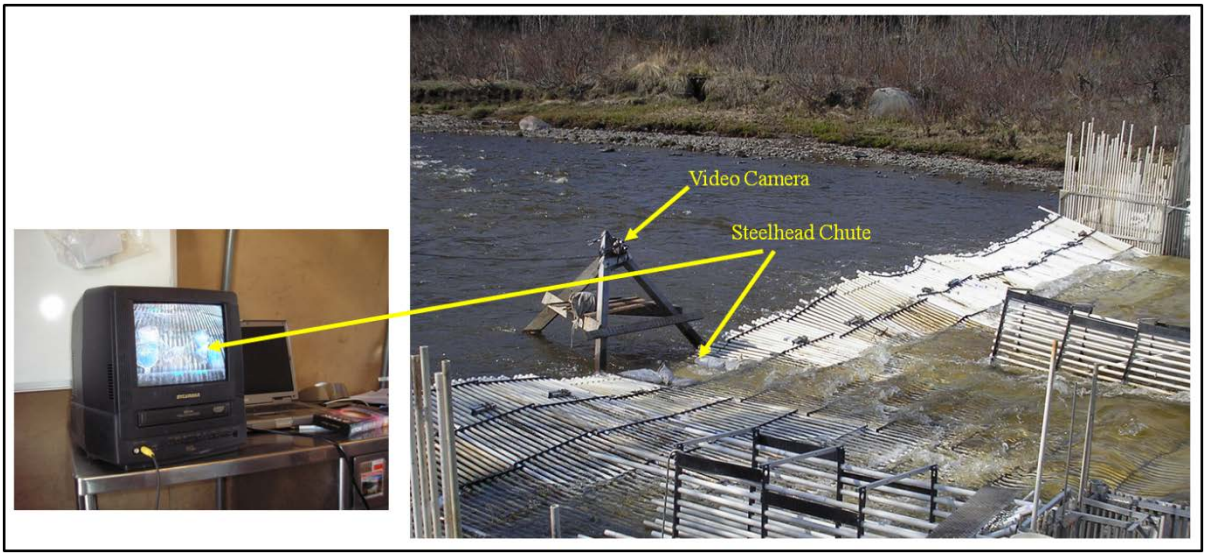

Figure 5.–Location of the “steelhead chute” and video camera, Anchor River, 2009.

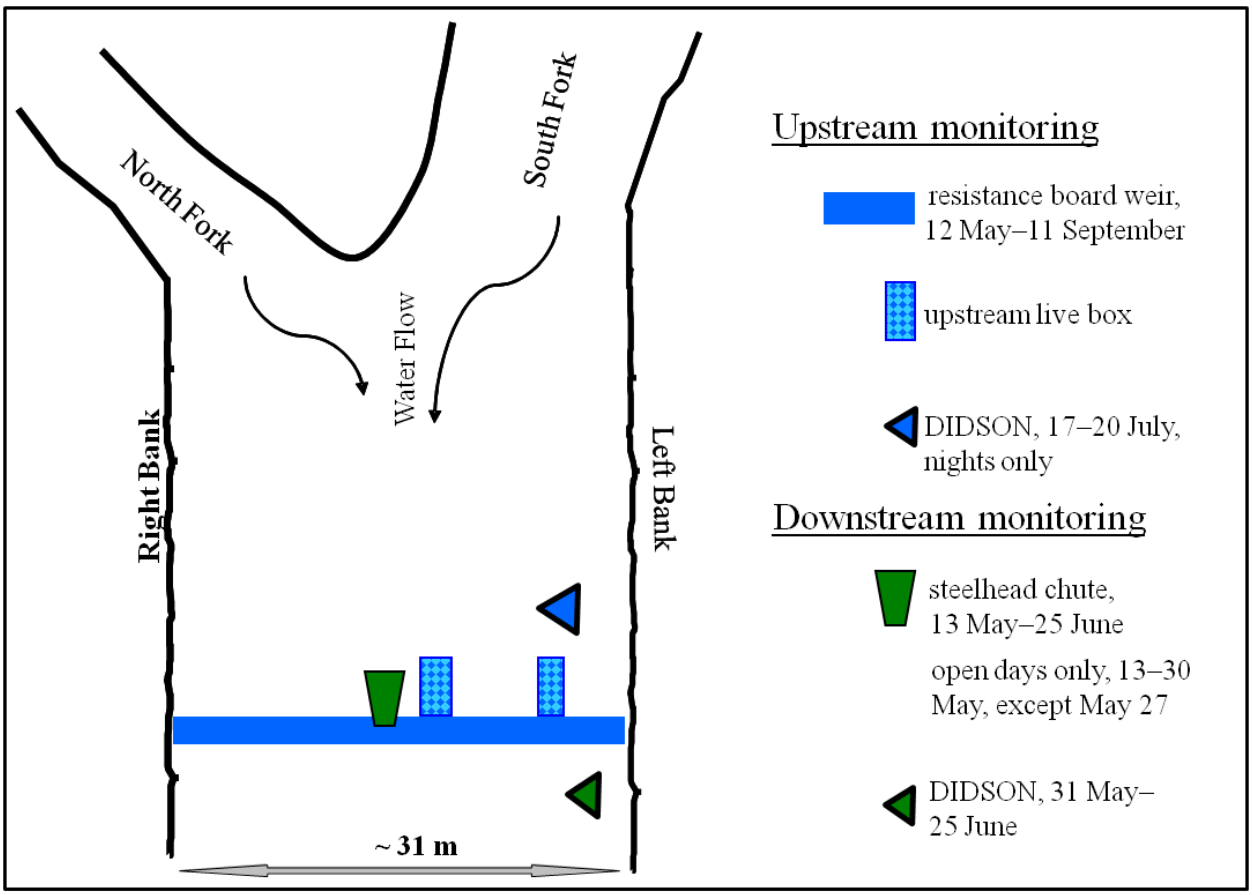

Figure 6.–Locations of mainstem resistance board weir and upstream live box used to enumerate fish migrating upstream, and locations of "steelhead chute" and DIDSON used to enumerate the steelhead trout emigration, Anchor River, 2009.

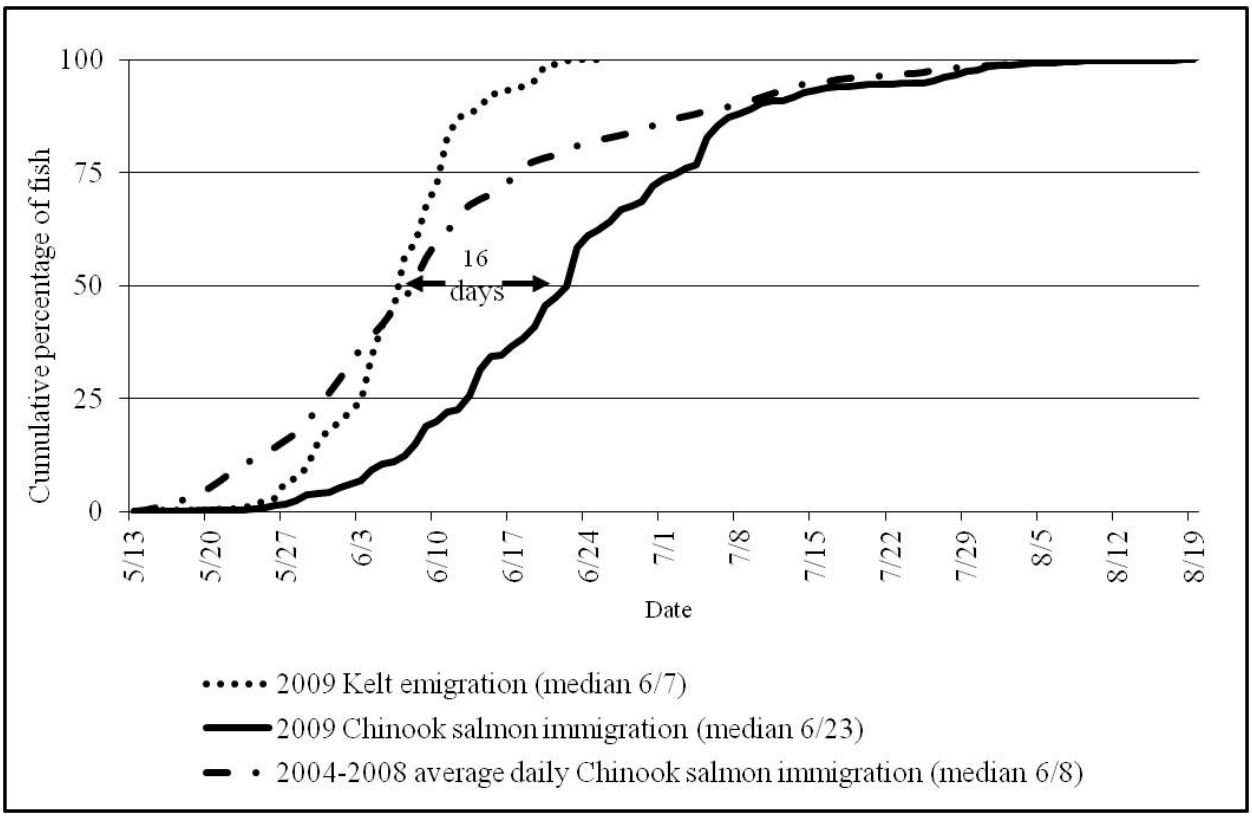

Figure 7.–Chinook salmon run timing of the 2009 immigration compared to the average (2004–2008) and to the 2009 kelt emigration at the Anchor River sonar/weir site.

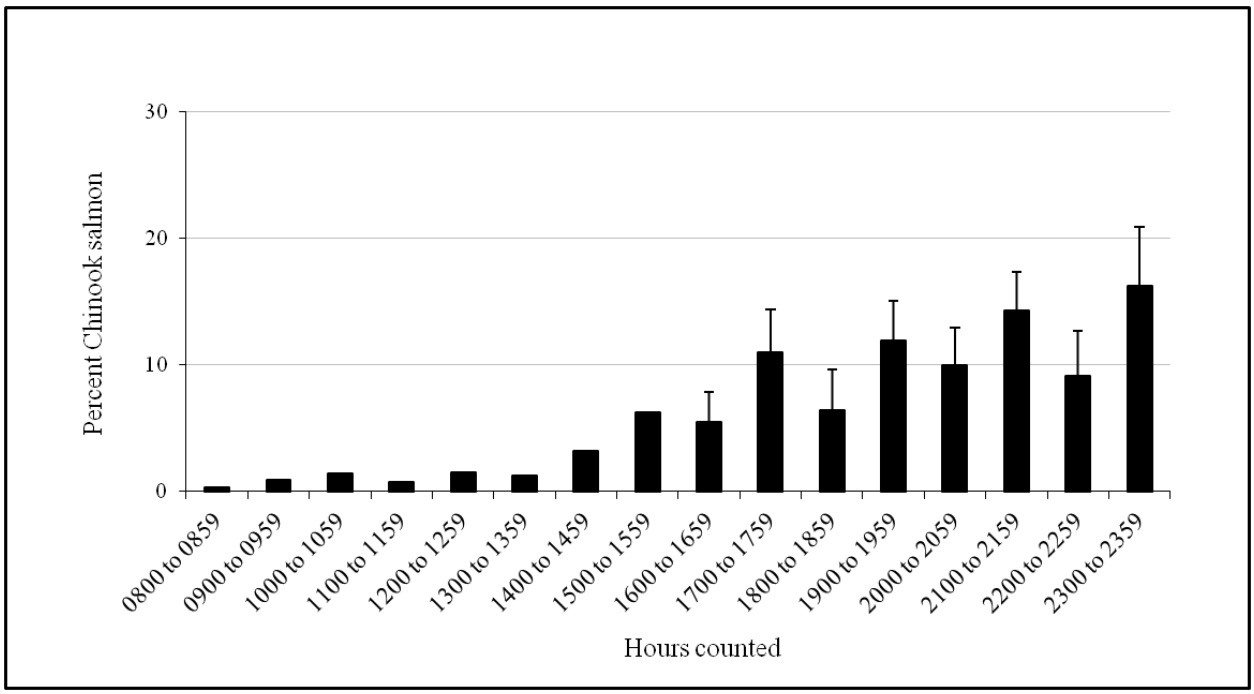

Figure 8.–The number of Chinook salmon counted through the Anchor River weir each hour from 0800 hours through midnight expressed as the percentage of fish counted each hour and the standard error, 2009.

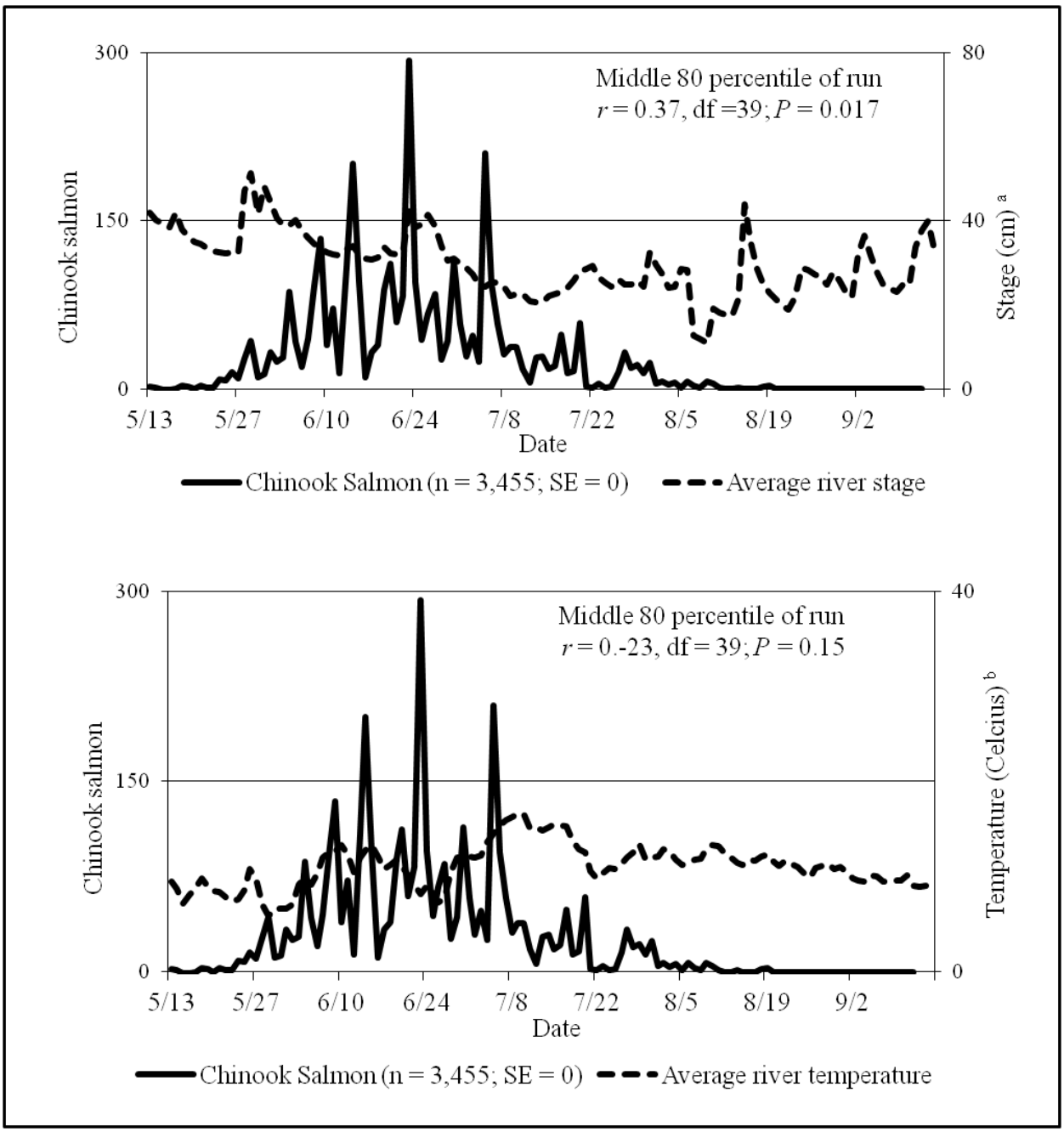

Figure 9.–Daily counts of Anchor River Chinook salmon plotted against average daily river stage and temperature, 2009.

[a] Stage data collected at gauge station USGS 15239900 located at approximately 11.4 RKM on the South Fork, Anchor River.

[b] Temperature data collected approximately 0.1 RKM downstream of the South Fork and North Fork confluence of the Anchor River.

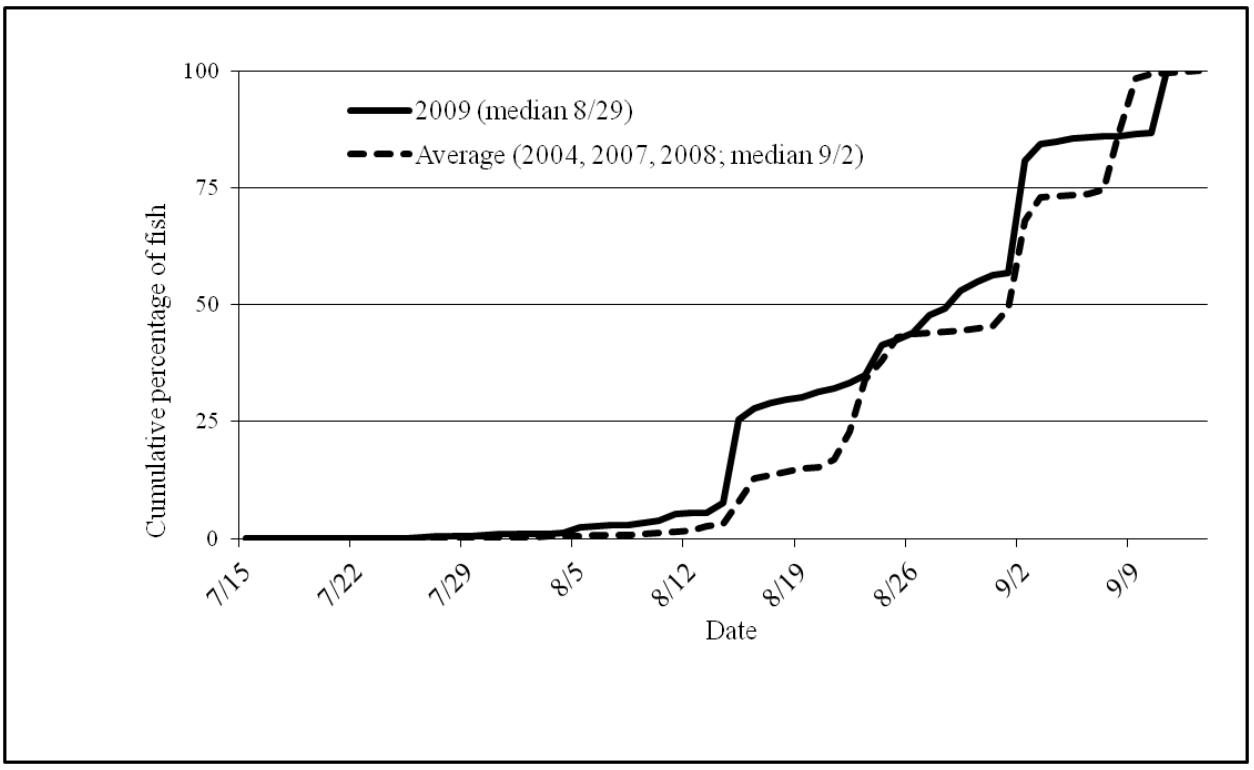

Figure 10.–Coho salmon run timing comparisons between 2009 and averages for years when the weir was operated through 11 September at the Anchor River sonar/weir site.

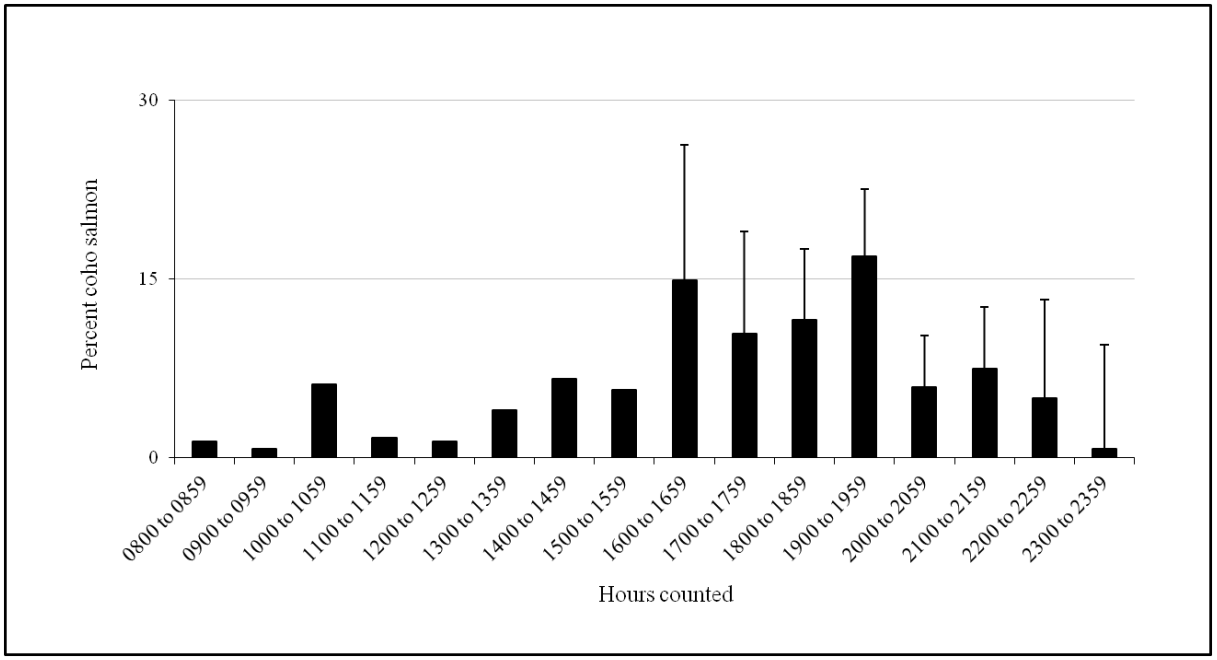

Figure 11.–The number of coho salmon counted through the Anchor River weir each hour from 0800 hours through midnight expressed as the percentage of fish counted each hour and the standard error, 2009.

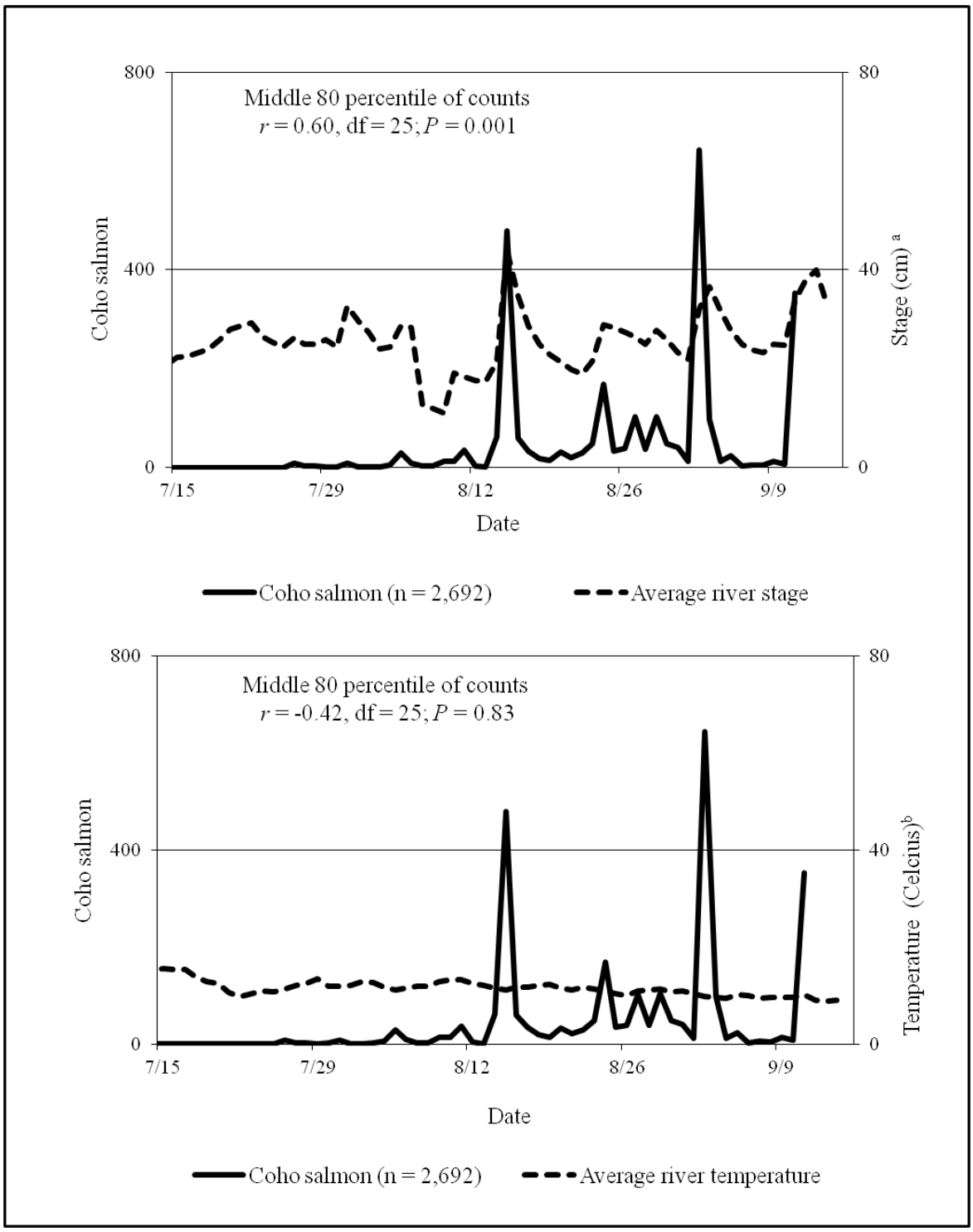

Figure 12.–Daily counts of Anchor River coho salmon plotted against average daily river stage and temperature, 2009.

[a] Stage data collected at gauge station USGS 15239900 located at approximately 11.4 RKM on the South Fork, Anchor River.

[b] Temperature data collected approximately 0.1 RKM downstream of the South Fork and North Fork confluence of the Anchor River.

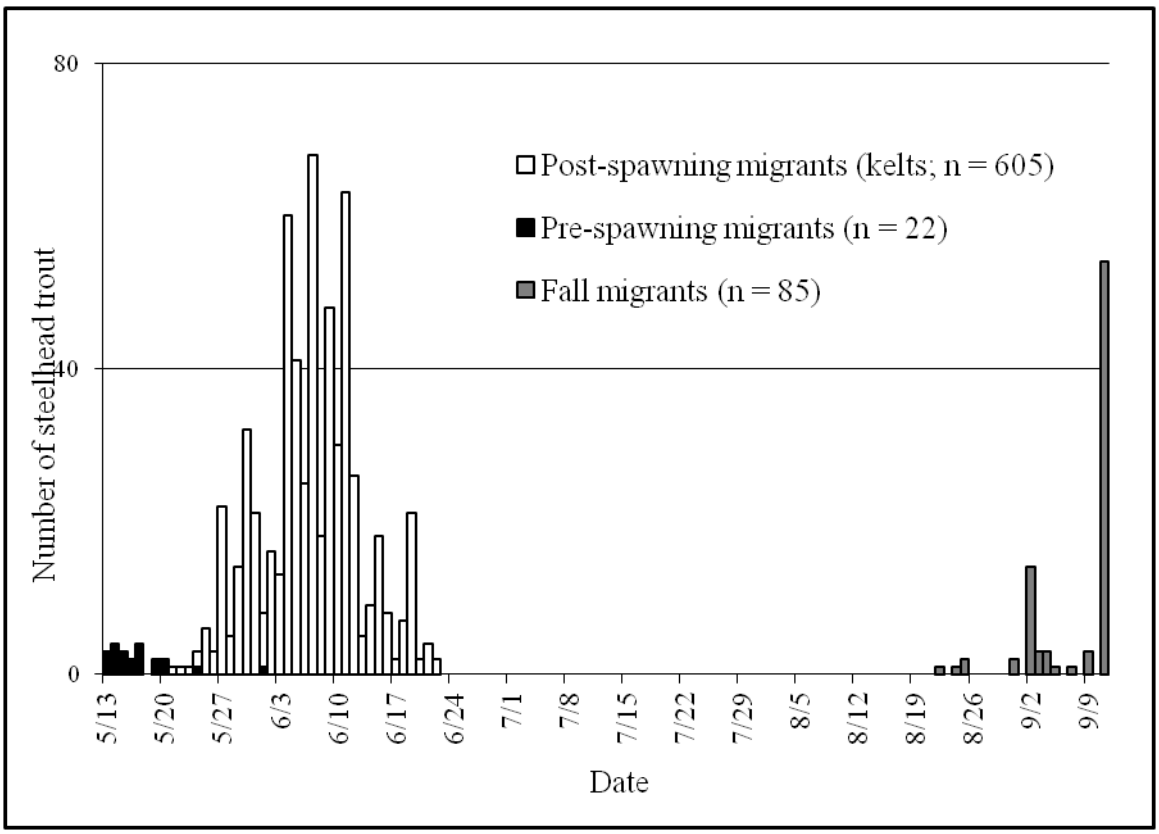

Figure 13.–Anchor River steelhead trout counts at the sonar/weir site, 2009.

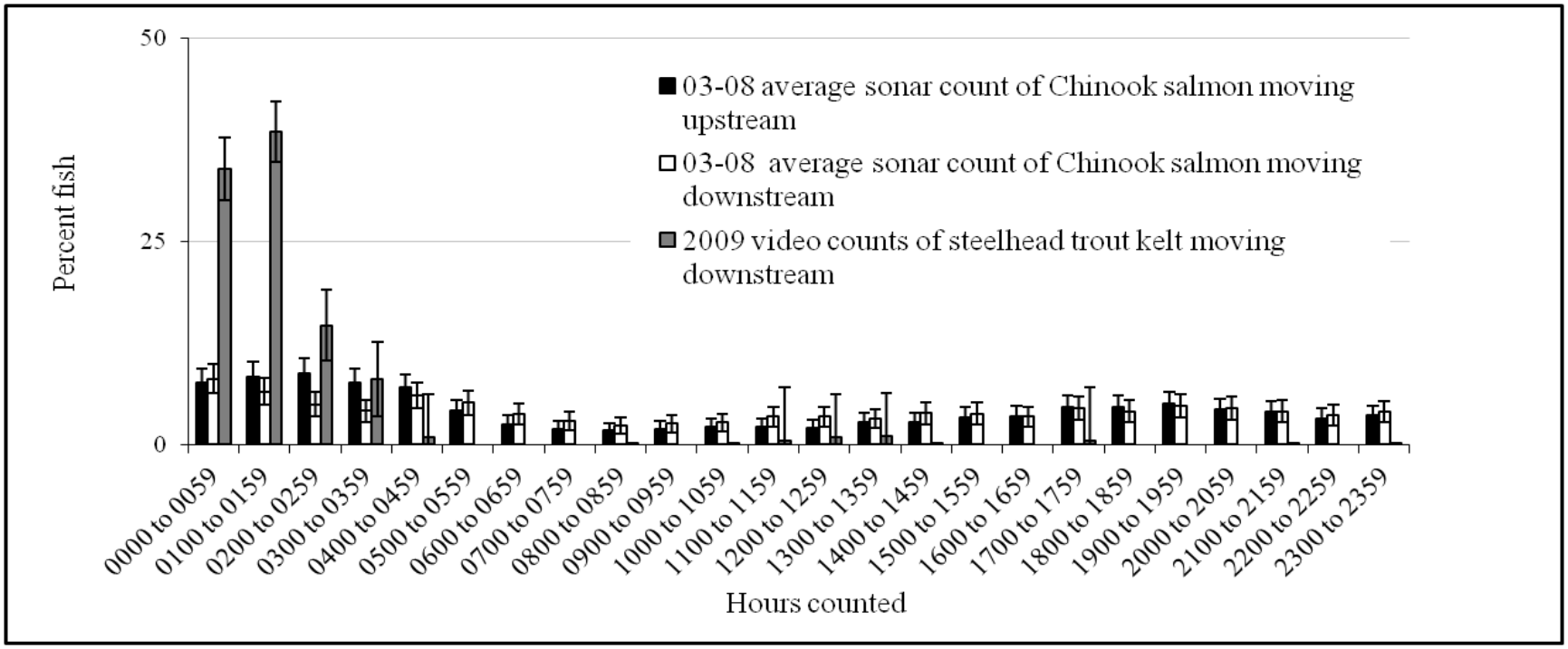

Figure 14.–The 2003–2008 average number of Chinook salmon estimated each hour of the day (diel) that were counted swimming upstream and downstream based on DIDSON images compared to the hourly count of steelhead trout swimming downstream based on video recordings of which all are expressed as the percentage of fish counted and the standard error, 2009.

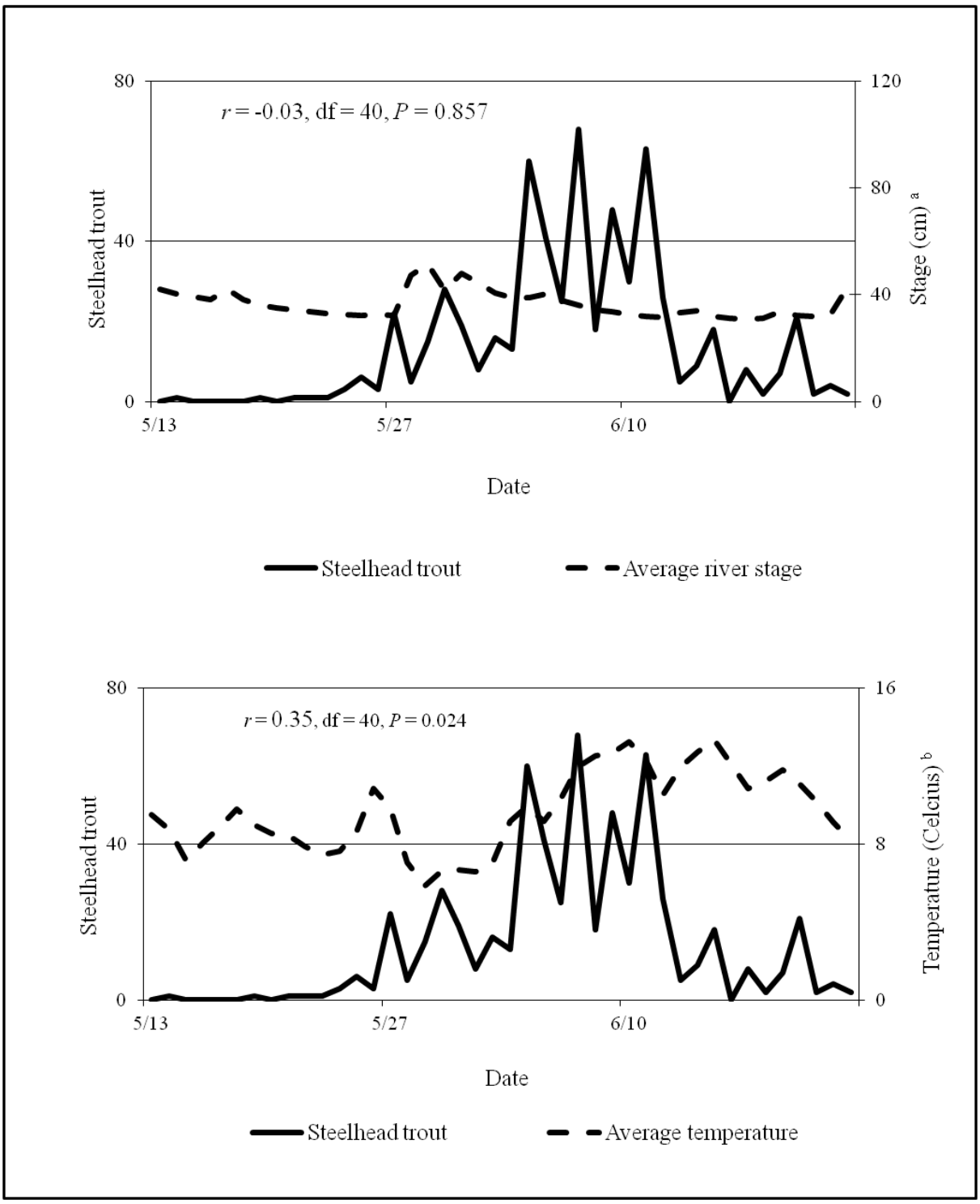

Figure 15.–Daily counts of emigrating steelhead trout from the Anchor River plotted against average daily river stage and temperature, 2009.

[a] Stage data collected at gauge station USGS 15239900 located at approximately 11.4 RKM on the South Fork, Anchor River.

[b] Temperature data collected approximately 0.1 RKM downstream of the South and North Fork confluence of the Anchor River.

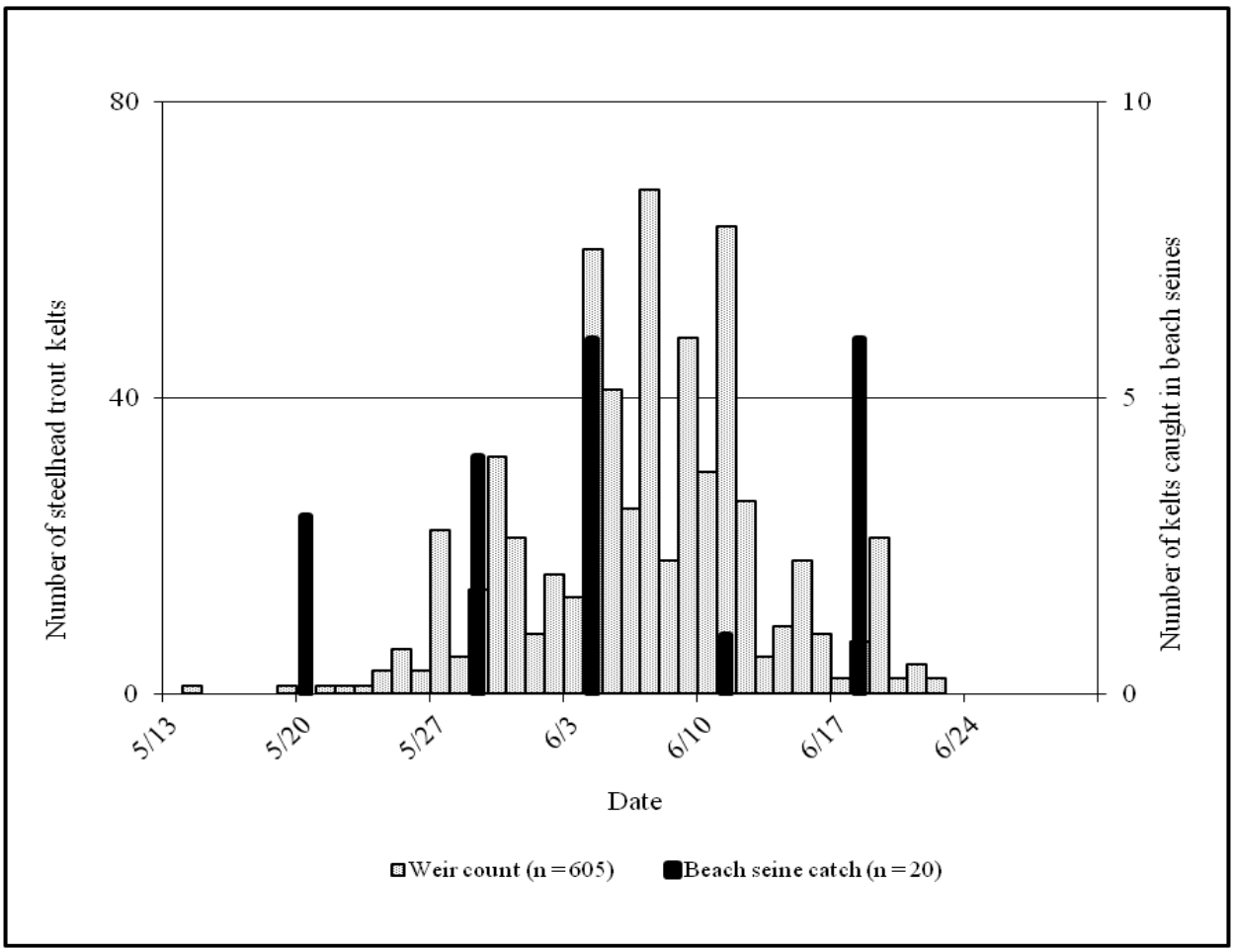

Figure 16.–Daily counts of kelts at the Anchor River sonar/weir site compared to the weekly beach seine catch of kelts from standard river sections on the North and South forks approximately 0.5 RKM upstream of the weir site, 2009.

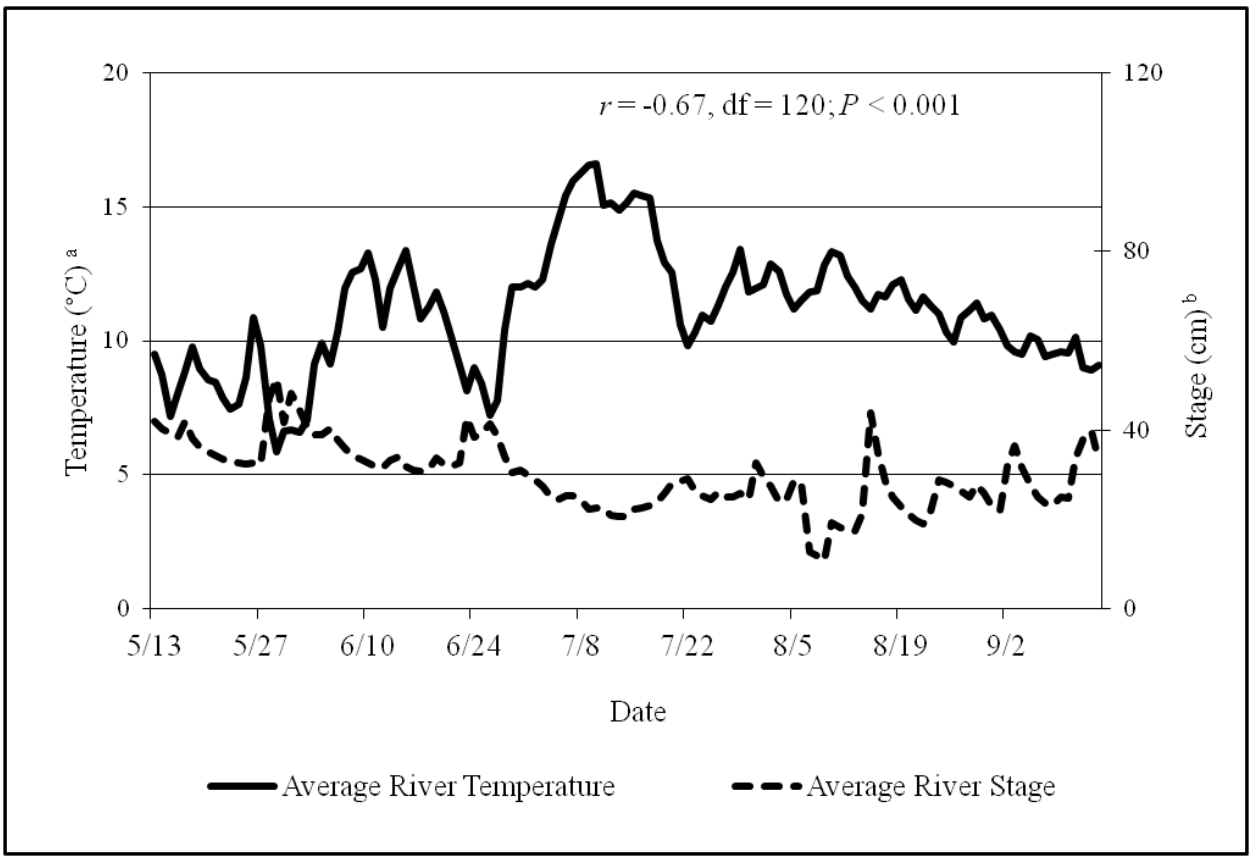

Figure 17.–Anchor River average daily river temperatures plotted against average daily river stage, 2009.

APPENDIX A: MONITORING TIMELINES FOR ANCHOR RIVER CHINOOK SALMON

Appendix A1.–Timeline of escapement monitoring for Chinook salmon on the Anchor River, 1950–2009.

Year (s)	Escapement Monitoring
1950s	Periodic fisheries investigations in the Anchor River were conducted by U.S. Fish and Wildlife Service. Chinook salmon escapement was monitored with weirs at various lower river locations on the North and South forks and mainstem. Aerial and foot surveys were also conducted.
1962–1969	Annual Chinook salmon escapement was estimated with a combination aerial and ground index survey. Surveys were conducted once annually over a standard length of river. Aerial surveys were done from a fixed-wing aircraft (super cub). Foot surveys were conducted within a subsection of the aerial survey from the Sterling Highway bridge upstream approximately 4 river kilometers (RKM) to forks. Where the foot survey was conducted, if the foot survey counts were greater than the aerial counts, the total aerial count was expanded by the difference. In 1966, no aerial surveys were conducted due to poor viewing conditions. Note: "standard length" and the location of the Sterling Highway bridge (old versus new) could not be determined.
1970–1974	The ground index subsection was expanded to approximately 8 RKM from Glanville lumber to forks. No aerial survey was conducted in 1970 or 1971. Note: "forks" is assumed to be the North and South forks confluence.
1975–1982	Aerial surveys were conducted using rotary-wing aircraft to index Chinook salmon escapement. Surveys were conducted once annually over a standard section of the South Fork of the Anchor River. Foot surveys continued as before. Note: "forks" is assumed to be the North and South forks confluence.
1983–1994	The index subsection for combined aerial and foot surveys was reduced back to approximately 4 RKM from Sterling Highway Bridge to forks. Note: "standard length" and the location of the Sterling Highway bridge (old versus new) could not be determined.
1995–2002	The foot survey was discontinued. Periodic foot surveys were conducted over additional stream reaches such as North Fork, Beaver Creek, and above forks. Aerial surveys continued.
2003	In addition to the aerial survey, the feasibility of using DIDSON[3] sonar as an escapement monitoring tool was tested on the mainstem of the Anchor River just below the confluence of the North and South forks at 2.8 RKM. DIDSON was only operated from 30 May through 9 July, not over the entire run.
2004	Chinook salmon escapement was monitored over the entire run at approximately RKM 2.8 through a combination of DIDSON, during periods of high water levels, and resistance board weir, during periods of low water levels. A weir was operated on the North Fork to monitor the entire run at approximately RKM 6.2. Aerial surveys of the North Fork and South Fork index area were used to compare index to total escapement estimates.
2005–2009	Chinook salmon escapement was monitored over the entire run at approximately RKM 2.8 through a combination of DIDSON, during periods of high water levels, and resistance board weir during periods of low water levels. Aerial surveys were continued through 2008 to compare index to total run estimates. In 2009, a foot survey of the historical index area was conducted from the new Sterling Highway Bridge (lat 59.746895, lon -151.754319) to the confluence of the North and South forks (lat 59.772253, lon -151.834263).

[3] Dual frequency IDentification SONar (DIDSON).

Appendix A2.–Timeline of sport harvest monitoring and escapement goals for Chinook salmon on the Anchor River, 1950–2009.

Year (s)	Sport Harvest Assessment
1950s	Periodic fisheries investigations in the Anchor River were conducted by U.S. Fish and Wildlife Service. Chinook salmon harvest was monitored through creel surveys.
1966–1977	Punch cards were used to enforce daily and/or seasonal limits (Hammarstrom et al. 1985).
1971–1977	Punch card returns were the primary source of harvest data. Effort was estimated by car counts each day at campgrounds and parking areas from 1971–1976.
1972–1986	Creel surveys were conducted at the Deep Creek access from 1972–1986 and 1994 (Nelson 1994, 1995). A Creel survey at the Anchor River/Whiskey Gulch access was conducted in 1986 (Nelson 1994).
1976–1983	Age composition of the Chinook salmon harvest was estimated for the Anchor River, Deep Creek, and Ninilchik River (Hammarstrom et al. 1985).
1977 to present	Statewide Harvest Surveys (SWHS) were conducted and produced annual estimates of total catch and harvest for Chinook salmon in the Anchor River.

Year (s)	Escapement Goals
1993–1997	The first Biological Escapement Goal (BEG) of 1,790 Chinook salmon was adopted in 1993. The BEG was the average of the expanded estimates from aerial and foot survey index counts conducted from 1966 to 1969 and from 1972 to 1991.
1998–2000	In 1998, the BEG was rescaled to a range of 1,050 to 2,200 Chinook salmon and was based on historic aerial survey counts and their relationship to the sport harvest. Escapement range was approximated with a median aerial survey count of 1,211 Chinook salmon. The upper end of the range was the value that 20% of the annual aerial counts were above. The lower end was the value that 40% of the annual aerial counts were below (Szarzi and Begich 2004b, p. 22).
2001–2004	In 2001, the Sustainable Escapement Goal (SEG) of 750 to 1500 Chinook salmon was adopted. The SEG was the 25th and 75th percentiles of the annual aerial counts from 1976 through 2000 (Szarzi and Begich 2004b, p. 22). During the Alaska Board of Fisheries (BOF) meeting in February 1999, in response to the guidelines established in the Sustainable Salmon Fisheries Policy, BOF designated Anchor River Chinook salmon as a stock of "management concern" defined in the policy as "a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG, BEG, [optimal escapement goal] OEG, or other specified management objectives for the fishery" (5 AAC 39.222 [f] [21]) (Szarzi and Begich 2004a, p. 66).
2005–2007	In 2005, the SEG was repealed and no new goal was adopted in anticipation that SF would collect sufficient escapement data with the DIDSON/weir project to recommend an escapement goal (Szarzi et al. 2007a).
2008	ADF&G adopted a lower bound SEG of 5,000 Chinook salmon. The SEG was based on a full probability spawner/ recruit model that incorporated aerial survey data and SWHS harvest estimates from 1977–2007, and the total escapement estimates and age composition data collected from DIDSON/weir project from 2003–2007 (Szarzi et al. 2007b).

Appendix A3.–Timeline of the freshwater fishing regulations and emergency orders for Chinook salmon on the Anchor River, 1960–2009.

Year	Chinook salmon Fishing Regulations
Closed Areas for Chinook salmon	
1960–2009	Salmon fishing closed upstream of the junction of North and South forks.
1996–2009	The area above forks was closed to all fishing until 1 August to protect spawning salmon.
Recording Requirements	
1966–1980	A Chinook salmon punch card was required by all anglers, including those under 16 years of age.
1981–2009	Anglers recorded Chinook salmon harvest on the back of a sport fishing license or harvest card.
Open Season for Chinook salmon	
1960	7 May–31 December.
1961	7 May–1 July only.
1962–1963	7 May–8 July only.
1964–1965	Closed
1966	28 May– 26 June and limited to weekends and holidays or until 500 Chinook salmon 20 in or longer was attained among the Anchor River, Deep Creek, Ninilchik and Kenai Rivers.
1967	27 May–11 June opened continuously or until 500 Chinook salmon 20 in or longer were attained among the Anchor River, Deep Creek, Ninilchik, and Kenai Rivers.
1968	25 May–9 June opened continuously or until 500 Chinook salmon 20 in or longer were attained among the Anchor River, Deep Creek, Ninilchik, and Kenai Rivers. .
1969	24 May–8 June opened continuously or until 200 Chinook salmon 20 in or longer were attained among the Anchor River, Deep Creek, Ninilchik, and Kenai Rivers.
1970	30 May–14 June opened continuously or until 200 Chinook salmon 20 in or longer were attained among the Anchor River, Deep Creek, Ninilchik, and Kenai Rivers.
1971	Beginning on the Memorial Day weekend for 2 consecutive 2-day weekends (Saturday and Sunday). Quota eliminated.
1972	Beginning on Memorial Day weekend for 2 consecutive 2-day weekends.
1973–1975	Beginning on Memorial Day weekend for 3 consecutive 2-day weekends.
1976–1977	Beginning on Memorial Day weekend for 4 consecutive 2-day weekends.
1978–1988	Beginning on Memorial Day weekend for 4 consecutive 3-day weekends (weekends include Monday).
1989–2001	Beginning on Memorial Day weekend for 5 consecutive 3-day weekends (weekends include Monday).

2002–2003	Beginning on Memorial Day weekend for 4 consecutive 3-day weekends (weekends include Monday) (Szarzi and Begich 2004b).
2004–2007	In 2004, the fishery was open for a fifth 3-day weekend by emergency order (EO) based on weir count. The fishery was open by regulation for five 3-day consecutive weekends beginning on the weekend prior to Memorial Day weekend 2005–2007 (Szarzi et al. 2007b).Szarzi et al. 2007a; Szarzi et al. 2007bSzarzi et al. 2007a;
2008–2009	The 3-day weekend before Memorial Day weekend and 4 consecutive 3-day weekends. Also the Wednesdays following each weekend opening.
Bag, Possession, and Season Limits	
1960	Bag and possession limit: 3 salmon over a length of 16 in, of which not more than 2 could be Chinook salmon 20 in or more in length.
1961–1962	Bag and possession limit: 3 salmon over a length of 20 in, of which not more than 1 could be a Chinook salmon 20 in or more in length.
1963	Bag and possession limit: salmon 16 in or more in length; 6 coho salmon, 3 pink, chum, or sockeye salmon; or 1 Chinook salmon.
1964–1965	Closed
1966–1978	Bag and possession limit: 1 Chinook salmon 20 in or more in length. Bag and possession limit: 10 Chinook salmon less than 20 in long. Season limit: 2 Chinook salmon 20 in or more in length.
1979–1985	Bag and possession limit: 1 Chinook salmon 20 in or more in length. Bag and possession limit: 10 Chinook salmon less than 20 in long. Season limit: 5 Chinook salmon 20 in or more in length.
1986–1995	Bag limit: 1 Chinook salmon 16 in or more in length. Bag and possession limit: 10 Chinook salmon less than 16 in long. Season limit: 5 Chinook salmon 16 in or more in length.
1996–1998	Bag limit: 1 Chinook salmon 16 in or more in length. Bag and possession limit: 10 Chinook salmon less than 16 in long. Season limit: 2 Chinook salmon 16 in or more in length from Deep Creek or the Anchor River combined. After harvesting a Chinook salmon 16 in or more in length from Deep Creek or the Anchor River, an angler may not fish in either drainage for the rest of that day.

1999–2007	Bag limit: 1 Chinook salmon 20 in or more in length. Bag and possession limit: 10 Chinook salmon less than 20 in long. Season limit: 2 Chinook salmon 20in or more in length from Deep Creek or the Anchor River combined. After harvesting a Chinook salmon 20 in or more in length from Deep Creek or the Anchor River an angler may not fish in either drainage for the rest of that day.
2008–2009	Bag limit: 1 Chinook salmon 20 in or more in length. Bag and possession limit: 10 Chinook salmon less than 20 in long. Season limit: 5 Chinook salmon 20 in or more in length.

Emergency Orders (EOs)

1971	EO: extended the Chinook salmon fishery on Anchor River and Deep Creek an additional 2-day weekend due to low catches (Nelson 1972).
1972	EO: extended the Chinook salmon fishery on Anchor River and Deep Creek an additional 2-day weekend due to low catches (Nelson 1972).
1988	EO 2-KS-1-04-88: extended the Chinook salmon fishery on Anchor River and Deep Creek an additional weekend. Highly turbid river conditions early in the season depressed angler success rates and managers' expectations (Nelson *Unpublished.*).
2004	EO 2-KS-7-07-04: opened the Anchor River Chinook salmon fishery from 0000 hours on Saturday, 26 June through 2359 hours on 28 June from the mouth of the Anchor River to 600 ft downstream of the confluence of the North and South forks. Bag limit: 1 Chinook salmon per day.
2009	EO: 2-KS-7-08-09: closed the Anchor River drainage from its mouth upstream to the North and South forks to fishing and increased the closed area in the salt waters of Cook Inlet at the mouth of the Anchor River from 2 miles to 4 miles beginning 0001 hours on Saturday, 6 June through 2359 hours Tuesday, 30 June.

APPENDIX B: DETAILED DESCRIPTION OF DIDSON OPERATION

The DIDSON can operate at 2 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. Overall beam dimensions are 29° in the horizontal axis and 12° 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° wide, compared to low frequency (1.0 MHz) that forms the image using only 48 beams that are 0.6° wide. Image quality is 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 high frequency (1.8 MHz) with smaller window lengths (2.5, 5.0, and 10.0 m) are preferable to low frequency and larger window lengths. Partial weirs were used on each bank to redirect fish through the shortest ensonification range possible that was determined by the prevailing water level.

The two cables were plugged into the DIDSON and then strung into the weather port to the electronic equipment, which were powered by a generator. The DIDSON was then bolted to an adjustable mast that had been welded to a steel tripod. DIDSON images were received on a Dell[4] desktop computer. Once the DIDSON was secured to the mast tripod assembly, it was deployed. DIDSON software (version V5.21.09; provided by the manufacturer, Sound Metrics Corporation) was set at high frequency during all sonar operation. The DIDSON software was programmed to collect images into 3 20-minute files for each hour.

Steelhead Chute Operation:

DIDSON Settings

The DIDSON was anchored downstream of the weir and approximately 5 m from the steelhead chute to maximize image resolution. Data were collected using the following software parameters: 10801 total frames, receiver gain 40, window start 2.50 m, window length 5 m, and focus 4.98 m. During sonar file counts, only the fish observed in the range of the steelhead chute (4.5–5.5 m) were evaluated.

Daily Counts

DIDSON counts of steelhead were used when the video camera malfunctioned. The following criteria were used to estimate the daily count of steelhead with the DIDSON:

1) Sonar files were reviewed in the echogram view because the direction of individual fish was easily tracked
2) If a fish track was only observed within the 4.5 to 5.5 m range (i.e. fish did not swim into the 4.5 to 5.5 range from 7.5 m), the fish was then selected and viewed in the movie view.
3) In the movie view, if the fish was observed backing downstream from under the weir, it was not counted, but if it seemed to just appear, it was counted as steelhead trout.

A comparison of simultaneous DIDSON counts (93 20-minute files) and video counts (31 hours) collected between midnight and 0359, showed the DIDSON missed a small number of fish. DIDSON counts from midnight to 0359 were adjusted upwards based on a simple linear regression of DIDSON counts on paired video counts.

DIDSON and Live Box:

DIDSON Settings

The DIDSON was upstream of the resistance board weir and approximately 5 m from the upstream end of the live box to maximize image resolution. Data was collected using the following software parameters:

[4] Vendor names provided in this publication are included for completeness but do not constitute product endorsement.

10801 total frames, receiver gain 40, window start 2.50 m, window length 5 m, and focus 0.71 m. During sonar file counts, only the fish observed coming out of the live box were evaluated.

Daily Counts

The sonar was operated at night to prevent impeding the migration of Dolly Varden and pink salmon. The primary focus of the sonar counts was to identify Chinook salmon to achieve objective 1 (estimate Chinook salmon escapement). Due to low counts of Chinook salmon, and to eliminate the need to expand counts, all 20-minute sonar files were counted. During this period, large fish were counted as Chinook salmon and smaller fish were grouped as Dolly Varden and pink salmon. Because there is a size overlap between pink salmon and ocean-age-1 to ocean-age-2 Chinook salmon, it is unknown if some of the smaller fish may have actually been Chinook salmon. However, based on the large number of pink salmon that were counted passing the weir during this period, it is assumed that most of the smaller fish were either pink salmon or Dolly Varden. Because ocean-age-3 Chinook salmon are significantly larger than Dolly Varden and pink salmon, images of large fish were counted as Chinook salmon. Smaller fish were apportioned by species by the number of Dolly Varden and pink salmon counted passing through the live box the day before.

APPENDIX C: WEIR COUNTS

Appendix C1.–Daily escapement of Chinook salmon, Dolly Varden, and pink, chum, sockeye, and coho salmon, and steelhead trout counted at the Anchor River sonar/weir site, 2009.

	Chinook salmon [a]			Dolly Varden [a]			Pink salmon [a]			Chum salmon			Sockeye salmon			Coho salmon			Steelhead trout [b]		
	Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv	
Date	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%
12 May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3
13 May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	7
14 May	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	9
15 May	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12	11
16 May	-1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	16	15
17 May	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	15
18 May	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	18	17
19 May	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	20	19
20 May	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	19
21 May	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	19
22 May	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	19
23 May	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21	20
24 May	1	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
25 May	9	20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
26 May	8	28	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
27 May	15	43	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
28 May	10	53	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
29 May	27	80	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
30 May	43	123	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	20
31 May	11	134	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	22	21
1 Jun	33	180	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
2 Jun	25	205	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
3 Jun	28	233	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
4 Jun	87	320	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
5 Jun	42	362	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
6 Jun	20	382	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
7 Jun	45	427	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
8 Jun	92	519	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
9 Jun	134	653	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
10 Jun	39	692	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
11 Jun	72	764	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21

-continued-

Appendix C1.–Page 2 of 4.

	Chinook salmon [a]			Dolly Varden [a]			Pink salmon [a]			Chum salmon			Sockeye salmon			Coho salmon			Steelhead trout [b]		
	Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv	
Date	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%
12 Jun	14	778	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
13 Jun	109	887	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
14 Jun	201	1,088	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
15 Jun	95	1,183	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
16 Jun	11	1,194	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
17 Jun	33	1,227	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
18 Jun	39	1,266	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
19 Jun	89	1,355	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
20 Jun	112	1,467	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
21 Jun	60	1,527	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
22 Jun	83	1,610	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
23 Jun	293	1,903	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
24 Jun	95	1,998	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
25 Jun	44	2,042	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
26 Jun	67	2,109	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
27 Jun	85	2,194	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
28 Jun	26	2,220	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	21
29 Jun	43	2,263	65	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	22	21
30 Jun	114	2,377	69	0	0	0	6	9	0	0	0	0	0	0	0	0	0	0	0	22	21
1 Jul	58	2,435	70	0	0	0	5	14	0	0	0	0	0	0	0	0	0	0	0	22	21
2 Jul	29	2,464	71	0	0	0	6	20	0	0	0	0	0	0	0	0	0	0	0	22	21
3 Jul	48	2,512	73	0	0	0	17	37	1	0	0	0	0	0	0	0	0	0	0	22	21
4 Jul	25	2,537	73	0	0	0	15	52	1	0	0	0	0	0	0	0	0	0	0	22	21
5 Jul	210	2,747	80	0	0	0	52	104	2	0	0	0	0	0	0	0	0	0	0	22	21
6 Jul	94	2,841	82	12	12	1	66	170	3	0	0	0	1	1	2	0	0	0	0	22	21
7 Jul	58	2,899	84	6	18	1	4	174	3	0	0	0	0	1	2	0	0	0	0	22	21
8 Jul	31	2,930	85	2	20	1	3	177	4	0	0	0	0	1	2	0	0	0	0	22	21
9 Jul	38	2,968	86	1	21	1	31	208	4	0	0	0	0	1	2	0	0	0	0	22	21
10 Jul	38	3,006	87	0	21	1	58	266	5	0	0	0	0	1	2	0	0	0	0	22	21
11 Jul	18	3,024	88	0	21	1	42	308	6	0	0	0	0	1	2	0	0	0	0	22	21
12 Jul	6	3,030	88	1	22	2	63	371	7	0	0	0	0	1	2	0	0	0	0	22	21
13 Jul	28	3,058	89	8	30	2	84	455	9	0	0	0	0	1	2	0	0	0	0	22	21

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	Chinook salmon [a]			Dolly Varden [a]			Pink salmon [a]			Chum salmon			Sockeye salmon			Coho salmon			Steelhead trout [b]		
	Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv	
Date	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%
14 Jul	29	3,087	89	158	188	13	295	750	15	0	0	0	0	1	2	0	0	0	0	22	21
15 Jul	18	3,105	90	331	519	37	475	1,225	25	0	0	0	1	2	3	0	0	0	0	22	21
16 Jul	21	3,126	90	126	645	46	240	1,465	29	0	0	0	0	2	3	0	0	0	0	22	21
17 Jul	49	3,175	92	424	1,069	76	775	2,240	45	0	0	0	0	2	3	0	0	0	0	22	21
18 Jul	14	3,189	92	172	1,241	88	324	2,564	52	0	0	0	0	2	3	0	0	0	0	22	21
19 Jul	16	3,205	93	20	1,261	90	102	2,666	54	1	1	1	0	2	3	0	0	0	0	22	21
20 Jul	59	3,264	94	131	1,392	99	654	3,320	67	0	1	1	0	2	3	0	0	0	0	22	21
21 Jul	2	3,266	95	2	1,394	99	52	3,372	68	3	4	6	0	2	3	0	0	0	0	22	21
22 Jul	1	3,267	95	2	1,396	99	9	3,381	68	0	4	6	0	2	3	0	0	0	0	22	21
23 Jul	5	3,272	95	0	1,396	99	6	3,387	68	0	4	6	0	2	3	0	0	0	0	22	21
24 Jul	1	3,273	95	0	1,396	99	20	3,407	68	3	7	10	0	2	3	0	0	0	0	22	21
25 Jul	2	3,275	95	0	1,396	99	58	3,465	70	0	7	10	0	2	3	0	0	0	0	22	21
26 Jul	15	3,290	95	0	1,396	99	126	3,591	72	5	12	18	1	3	5	8	8	0	0	22	21
27 Jul	33	3,323	96	0	1,396	99	75	3,666	74	0	12	18	0	3	5	3	11	0	0	22	21
28 Jul	19	3,342	97	0	1,396	99	82	3,748	75	5	17	25	0	3	5	3	14	1	0	22	21
29 Jul	22	3,364	97	0	1,396	99	52	3,800	76	2	19	28	3	6	10	1	15	1	0	22	21
30 Jul	14	3,378	98	1	1,397	100	66	3,866	78	1	20	29	4	10	16	2	17	1	0	22	21
31 Jul	24	3,402	98	4	1,401	100	124	3,990	80	6	26	38	6	16	26	8	25	1	0	22	21
1 Aug	5	3,407	99	1	1,402	100	18	4,008	81	3	29	43	1	17	27	1	26	1	0	22	21
2 Aug	7	3,414	99	1	1,403	100	15	4,023	81	1	30	44	0	17	27	1	27	1	0	22	21
3 Aug	4	3,418	99	0	1,403	100	8	4,031	81	0	30	44	1	18	29	2	29	1	0	22	21
4 Aug	6	3,424	99	0	1,403	100	25	4,056	82	0	30	44	0	18	29	6	35	1	0	22	21
5 Aug	1	3,425	99	0	1,403	100	45	4,101	82	4	34	50	1	19	31	29	64	2	0	22	21
6 Aug	7	3,432	99	0	1,403	100	21	4,122	83	3	37	54	2	21	34	9	73	3	0	22	21
7 Aug	3	3,435	99	0	1,403	100	21	4,143	83	0	37	54	1	22	35	3	76	3	0	22	21
8 Aug	1	3,436	99	0	1,403	100	52	4,195	84	2	39	57	1	23	37	3	79	3	0	22	21
9 Aug	7	3,443	100	0	1,403	100	18	4,213	85	2	41	60	2	25	40	13	92	3	0	22	21
10 Aug	5	3,448	100	0	1,403	100	24	4,237	85	0	41	60	1	26	42	13	105	4	0	22	21
11 Aug	1	3,449	100	0	1,403	100	23	4,260	86	0	41	60	1	27	44	36	141	5	0	22	21
12 Aug	0	3,449	100	0	1,403	100	6	4,266	86	0	41	60	0	27	44	4	145	5	0	22	21
13 Aug	0	3,449	100	0	1,403	100	8	4,274	86	0	41	60	0	27	44	1	146	5	0	22	21
14 Aug	1	3,450	100	0	1,403	100	67	4,341	87	0	41	60	1	28	45	62	208	8	0	22	21

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	Chinook salmon [a]			Dolly Varden [a]			Pink salmon [a]			Chum salmon			Sockeye salmon			Coho salmon			Steelhead trout [b]		
	Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv		Dly	Cumltv	
Date	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%	Cnt	Cnt	%
15 Aug	0	3,450	100	0	1,403	100	69	4,410	89	2	43	63	11	39	63	479	687	26	0	22	21
16 Aug	0	3,450	100	0	1,403	100	66	4,476	90	1	44	65	1	40	65	60	747	28	0	22	21
17 Aug	0	3,450	100	0	1,403	100	15	4,491	90	2	46	68	7	47	76	34	781	29	0	22	21
18 Aug	2	3,452	100	0	1,403	100	5	4,496	90	1	47	69	0	47	76	19	800	30	0	22	21
19 Aug	3	3,455	100	0	1,403	100	6	4,502	90	0	47	69	0	47	76	14	814	30	0	22	21
20 Aug	0	3,455	100	1	1,404	100	8	4,510	91	0	47	69	0	47	76	32	846	31	0	22	21
21 Aug	0	3,455	100	0	1,404	100	7	4,517	91	1	48	71	0	47	76	21	867	32	0	22	21
22 Aug	0	3,455	100	0	1,404	100	25	4,542	91	0	48	71	1	48	77	29	896	33	1	23	21
23 Aug	0	3,455	100	0	1,404	100	28	4,570	92	1	49	72	3	51	82	48	944	35	0	23	21
24 Aug	0	3,455	100	0	1,404	100	40	4,610	93	5	54	79	2	53	85	169	1,113	41	1	24	22
25 Aug	0	3,455	100	0	1,404	100	22	4,632	93	1	55	81	1	54	87	34	1,147	43	2	26	24
26 Aug	0	3,455	100	0	1,404	100	15	4,647	93	0	55	81	0	54	87	39	1,186	44	0	26	24
27 Aug	0	3,455	100	0	1,404	100	36	4,683	94	0	55	81	0	54	87	102	1,288	48	0	26	24
28 Aug	0	3,455	100	0	1,404	100	34	4,717	95	0	55	81	0	54	87	38	1,326	49	0	26	24
29 Aug	0	3,455	100	0	1,404	100	29	4,746	95	2	57	84	2	56	90	103	1,429	53	0	26	24
30 Aug	0	3,455	100	0	1,404	100	22	4,768	96	2	59	87	0	56	90	49	1,478	55	0	26	24
31 Aug	0	3,455	100	0	1,404	100	43	4,811	97	0	59	87	1	57	92	40	1,518	56	2	28	26
1 Sep	0	3,455	100	0	1,404	100	20	4,831	97	0	59	87	1	58	94	12	1,530	57	0	28	26
2 Sep	0	3,455	100	0	1,404	100	90	4,921	99	1	60	88	0	58	94	643	2,173	81	14	42	39
3 Sep	0	3,455	100	0	1,404	100	17	4,938	99	2	62	91	1	59	95	97	2,270	84	3	45	42
4 Sep	0	3,455	100	0	1,404	100	12	4,950	99	1	63	93	1	60	97	12	2,282	85	3	48	45
5 Sep	0	3,455	100	0	1,404	100	1	4,951	100	0	63	93	1	61	98	23	2,305	86	1	49	46
6 Sep	0	3,455	100	0	1,404	100	4	4,955	100	1	64	94	0	61	98	3	2,308	86	0	49	46
7 Sep	0	3,455	100	0	1,404	100	9	4,964	100	1	65	96	0	61	98	6	2,314	86	1	50	47
8 Sep	0	3,455	100	0	1,404	100	3	4,967	100	0	65	96	0	61	98	5	2,319	86	0	50	47
9 Sep	0	3,455	100	0	1,404	100	0	4,967	100	0	65	96	0	61	98	13	2,332	87	3	53	50
10 Sep	0	3,455	100	0	1,404	100	2	4,969	100	0	65	96	0	61	98	7	2,339	87	0	53	50
11 Sep	0	3,455	100	0	1,404	100	6	4,975	100	3	68	100	1	62	100	353	2,692	100	54	107	100

Note: Dly = Daily, Cumltv = Cumulative, Cnt = Count.

[a] Escapement estimated from DIDSON counts from 17 July through 20 July during hours of suppressed light (19 hours 10 minutes total).

[b] Total steelhead trout counted moving upstream (spawning migrants through 31 June and fall migrants 1 July through 11 September).

APPENDIX D: RIVER STAGE AND WATER TEMPERATURE

Appendix D1.–Average daily river stage for South Fork Anchor River, 2009.

	Stage gauge averages (cm)				
Day	May	June	July	August	September
1	100.6	44.5	29.9	29.6	21.9
2	71.6	40.8	29.0	27.4	32.0
3	70.4	39.0	27.4	24.1	36.6
4	64.3	39.0	25.0	24.4	31.7
5	57.0	40.2	24.4	28.7	27.7
6	53.6	37.8	25.3	28.3	25.0
7	55.8	36.0	25.3	12.8	23.8
8	56.4	34.4	24.4	11.9	23.2
9	49.1	33.5	22.3	11.0	25.0
10	45.4	32.6	22.6	19.2	24.7
11	43.6	32.0	22.6	18.3	33.8
12	43.0	31.7	21.0	17.7	37.8
13	42.1	33.2	20.7	17.4	39.9
14	40.2	34.1	20.7	21.3	33.2
15	39.3	32.0	22.3	43.9	29.3
16	38.4	31.1	22.6	34.7	27.1
17	42.1	30.8	23.2	28.7	27.7
18	38.1	31.4	24.1	25.0	28.3
19	36.3	33.8	25.9	22.9	27.7
20	35.1	32.3	28.0	21.3	26.2
21	34.4	32.0	28.7	19.8	25.0
22	33.5	32.6	29.3	18.9	23.8
23	32.9	42.7	26.5	21.6	22.9
24	32.6	38.4	25.3	29.0	22.6
25	32.3	39.3	24.4	28.3	25.3
26	32.6	41.5	26.2	27.4	27.1
27	32.3	38.7	25.0	26.5	25.0
28	47.2	34.1	25.0	25.0	27.4
29	51.5	30.5	25.9	27.7	27.1
30	41.8	31.1	24.4	25.9	31.7
31	48.2		32.6	23.2	

Source: Ben Balk (U. S. Geological Survey (USGS), unpublished data).

Note: Stage data were collected at gauge station USGS 15239900, located approximately 11.4 RKM on the South Fork, Anchor River.

Appendix D2.–Daily temperature of Anchor River near sonar/weir site, 2009.

	Daily Temperatures (^{o} C)														
	May			June			July			August			September		
Day	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1	4.84	2.28	7.23	6.59	4.97	8.57	12.16	9.24	15.44	12.12	9.76	14.84	10.42	9.53	11.32
2	5.25	2.28	7.82	7.03	6.08	7.95	12.00	10.05	14.24	12.88	11.08	15.18	9.81	9.41	10.35
3	5.76	2.88	8.39	9.16	6.36	12.80	12.27	9.06	15.80	12.61	10.71	14.05	9.58	8.44	11.08
4	6.14	4.34	7.82	9.92	9.19	10.88	13.60	10.49	17.06	11.74	11.25	12.80	9.49	7.49	11.69
5	6.42	3.76	8.97	9.15	7.24	11.71	14.52	11.27	17.94	11.19	10.59	11.83	10.19	8.57	12.63
6	5.78	4.92	7.23	10.32	7.29	13.88	15.41	12.65	18.77	11.49	9.11	14.63	10.04	7.75	12.56
7	5.31	3.17	7.82	11.96	8.54	15.61	15.97	13.02	19.27	11.83	9.06	14.91	9.43	8.17	10.69
8	5.90	3.46	8.39	12.55	10.00	15.44	16.24	13.35	19.37	11.88	8.94	14.79	9.51	8.67	10.37
9	6.98	4.92	9.55	12.70	9.73	16.18	16.55	13.67	19.91	12.84	10.20	15.68	9.61	8.82	10.66
10	7.16	4.63	9.83	13.27	9.81	16.92	16.61	13.71	19.98	13.33	10.37	16.68	9.57	8.52	10.81
11	8.20	5.50	11.27	12.29	11.27	13.95	15.06	13.67	16.61	13.18	10.10	16.42	10.16	9.06	11.57
12	9.04	6.08	12.42	10.51	9.34	11.42	15.16	12.65	18.30	12.41	9.68	14.84	9.02	7.95	9.98
13	9.51	6.66	12.71	11.97	9.11	15.77	14.88	12.94	17.70	12.02	11.30	12.80	8.91	8.00	10.10
14	8.73	6.66	10.98	12.74	10.59	15.06	15.15	12.97	17.82	11.49	10.93	12.10	9.09	8.39	10.03
15	7.18	6.37	8.97	13.35	11.13	15.92	15.49	11.69	19.77	11.18	10.35	12.29	9.40	7.87	10.98
16	8.05	5.21	11.56	12.11	10.71	13.38	15.44	13.71	17.63	11.73	10.57	13.67	10.25	9.21	11.61
17	8.87	5.50	12.42	10.83	9.11	12.61	15.33	13.62	17.70	11.65	9.46	14.22	9.54	8.82	10.22
18	9.78	6.37	13.58	11.26	9.31	13.59	13.72	13.06	14.98	12.08	10.27	14.58	9.36	8.00	11.13
19	8.96	7.82	10.12	11.83	8.67	15.41	12.90	12.10	13.55	12.29	10.35	14.86	7.90	5.98	9.95
20	8.55	6.37	10.74	11.12	9.71	12.63	12.54	11.93	13.21	11.55	8.82	14.48	7.29	6.05	8.54
21	8.44	6.71	10.10	10.19	8.74	11.88	10.59	9.83	12.12	11.15	8.32	14.29	7.81	6.56	9.31
22	7.87	6.48	9.39	9.10	8.34	10.42	9.81	9.14	10.79	11.64	9.41	14.22	6.88	5.85	8.12
23	7.43	5.98	8.64	8.16	7.29	9.06	10.33	9.31	11.30	11.34	10.69	12.03	4.82	3.06	6.56
24	7.62	6.08	9.56	9.00	7.32	10.86	10.95	9.68	12.41	10.99	9.31	13.16	4.01	3.35	4.56
25	8.65	6.15	12.17	8.41	6.61	9.88	10.75	10.25	11.37	10.33	8.39	11.78	5.24	4.35	6.64
26	10.84	7.09	15.08	7.24	6.18	8.52	11.31	9.78	13.91	9.98	9.04	10.79	5.32	4.19	6.61
27	9.83	8.20	11.98	7.76	5.64	10.37	12.00	10.74	14.10	10.85	9.56	12.61	5.24	4.69	5.85
28	7.07	5.59	8.12	10.42	7.80	13.45	12.57	11.90	13.35	11.15	10.03	12.32	4.63	3.46	5.67
29	5.85	4.30	8.17	12.01	8.97	15.44	13.42	11.71	16.11	11.40	10.03	13.35	4.86	4.17	5.67
30	6.61	4.92	7.90	12.01	9.95	14.67	11.84	11.20	13.45	10.80	8.49	13.35	5.25	4.61	6.28
31	6.66	6.13	7.09				11.96	10.12	14.55	10.98	9.68	12.58			

Source: Sue Mauger (Cook Inletkeeper, unpublished data).

Note: Temperature data were collected approximately 0.1 RKM downstream of sonar/weir site.

APPENDIX E: EMIGRATION COUNTS OF STEELHEAD TROUT

Appendix E1.–Daily counts of steelhead trout kelts at the Anchor River sonar/weir site, 2009.

Date	Daily Count	Cumulative Count	Cumulative %	Date	Daily Count	Cumulative Count	Cumulative %
13 May [a]	0	0	0.0	1 Jun [b]	8	119	19.7
14 May [a]	1	1	0.2	2 Jun [b]	16	135	22.3
15 May [a]	0	1	0.2	3 Jun [b]	13	148	24.5
16 May [a]	0	1	0.2	4 Jun [a]	60	208	34.4
17 May [a]	0	1	0.2	5 Jun [a]	41	249	41.2
18 May [a]	0	1	0.2	6 Jun [a]	25	274	45.3
19 May [a]	1	2	0.3	7 Jun [a]	68	342	56.5
20 May [a]	0	2	0.3	8 Jun [a]	18	360	59.5
21 May [a]	1	3	0.5	9 Jun [a]	48	408	67.4
22 May [a]	1	4	0.7	10 Jun [a]	30	438	72.4
23 May [a]	1	5	0.8	11 Jun [a]	63	501	82.8
24 May [a]	3	8	1.3	12 Jun [a]	26	527	87.1
25 May [a]	6	14	2.3	13 Jun [a]	5	532	87.9
26 May [a]	3	17	2.8	14 Jun [a]	9	541	89.4
27 May [a]	22	39	6.4	15 Jun [a]	18	559	92.4
28 May [a]	5	44	7.3	16 Jun [a]	0	559	92.4
29 May [a]	14	58	9.6	17 Jun [a]	8	567	93.7
30 May [a]	32	90	14.9	18 Jun [a]	2	569	94.0
31 May [b]	21	111	18.3	19 Jun [a]	7	576	95.2
				20 Jun [a]	21	597	98.7
				21 Jun [a]	2	599	99.0
				22 Jun [a]	4	603	99.7
				23 Jun [a]	2	605	100.0
				24 Jun [a]	0	605	100.0
				25 Jun [a]	0	605	100.0

[a] Daily count based on video and manual counts.

[b] Daily count based on video, manual counts, and DIDSON estimate.