Fisheries Data Series No. 08-06

Anchor River 2003 and 2004 Chinook Salmon and 2004 Coho Salmon Escapement

by

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March 2008

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

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

FISHERIES DATA SERIES 08-06

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ABSTRACT

A decline during the 1990s in aerial counts of the Chinook salmon *Oncorhynchus tshawytscha* escapements at the Anchor River, Alaska created concern about overexploitation of this stock. In 2001, this apparent decline prompted the Alaska Board of Fisheries to: (1) designate Anchor River Chinook salmon as a stock of management concern, (2) impose more conservative restrictions on the sport fishery, and (3) recommend the Alaska Department of Fish and Game, Division of Sport Fish quantify stock status. High discharge caused by snowmelt run-off and turbid water conditions prevents use of conventional weir technology to assess escapement during the Chinook salmon return during May and early June. Consequently, a Dual Frequency Identification Sonar (DIDSON) was deployed in 2003 to estimate escapement. Escapement was estimated at 9,238 Chinook salmon, compared to an aerial count of 647 Chinook salmon. In 2004, the project expanded to include coho salmon escapement monitoring. To meet this new objective, the DIDSON system was used during the high discharge period in conjunction with a full-weir during the lower stream discharge period. The Chinook salmon escapement estimate for 2004 was 12,016 (SE = 283), while the aerial index was 834, and the coho salmon *O. kisutch* count was 5,728. Because this more accurate assessment of stock status indicated that escapements are greater and exploitation lower than previously thought, the Board of Fisheries repealed the management concern designation, eliminated the SEG, and liberalized the fishery in November 2004. In the future, relationship between aerial indices and escapement estimates will be evaluated.

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

INTRODUCTION

The Anchor River is located on the southern portion of the Kenai Peninsula and it supports the largest freshwater sport fishery in the Lower Cook Inlet (LCI) Management Area (Szarzi and Begich 2004b, Figure 1). The Anchor River watershed is approximately 587 km^2, which holds about 266-river km (rkm) of anadromous streams (Table 1). There are two major forks of the Anchor River: the South Fork and North Fork, with the South Fork watershed approximately twice the size as the North Fork.

Until 2003, three tools were used to manage the Anchor River fishery and monitor salmon escapement: (1) the Statewide Harvest Survey (SWHS), which has provided postseason harvest and effort since 1977 (Table 2; Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006a, b, 2007; Mills 1979-1980, 1981a-b, 1982-1994; Walker et al. 2003), (2) aerial survey index counts of Chinook salmon *Oncorhynchus tshawytscha* escapement since 1976 (Table 3), and (3) weir counts from 1987 to 1995, of which 4 years monitored the entire coho salmon *O. kisutch* escapement (Table 4).

In 2001 the aerial count of 414 (the lowest in 5 years; Table 3), created concern regarding the overexploitation of the Anchor River Chinook salmon stock. This apparent decline in abundance prompted the Alaska Board of Fisheries (Board) to: (1) designate Anchor River Chinook salmon as a stock of management concern, (2) restrict the sport fishery, and (3) recommend that the Alaska Department of Fish and Game (Department), Division of Sport Fish quantify stock status.

Toward the goal of quantifying the Anchor River Chinook salmon stock, a Dual Frequency Identification Sonar (DIDSON) was tested on the Anchor River in 2002 as a potential method for monitoring the escapement of Chinook salmon. Quantifying this Chinook salmon stock has been problematic because the run timing typically coincides with peak water discharge in spring. In 2003 and 2004, the DIDSON system was used to estimate Chinook salmon escapement on the mainstem of the Anchor River approximately 2.8 rkms (1.7 miles) upstream from the mouth. In 2004, a full weir replaced the DIDSON when water levels subsided enough for installation to be completed. The purpose of the weir was to continue monitoring Chinook salmon escapement and to include coho salmon escapement monitoring as an additional project objective.

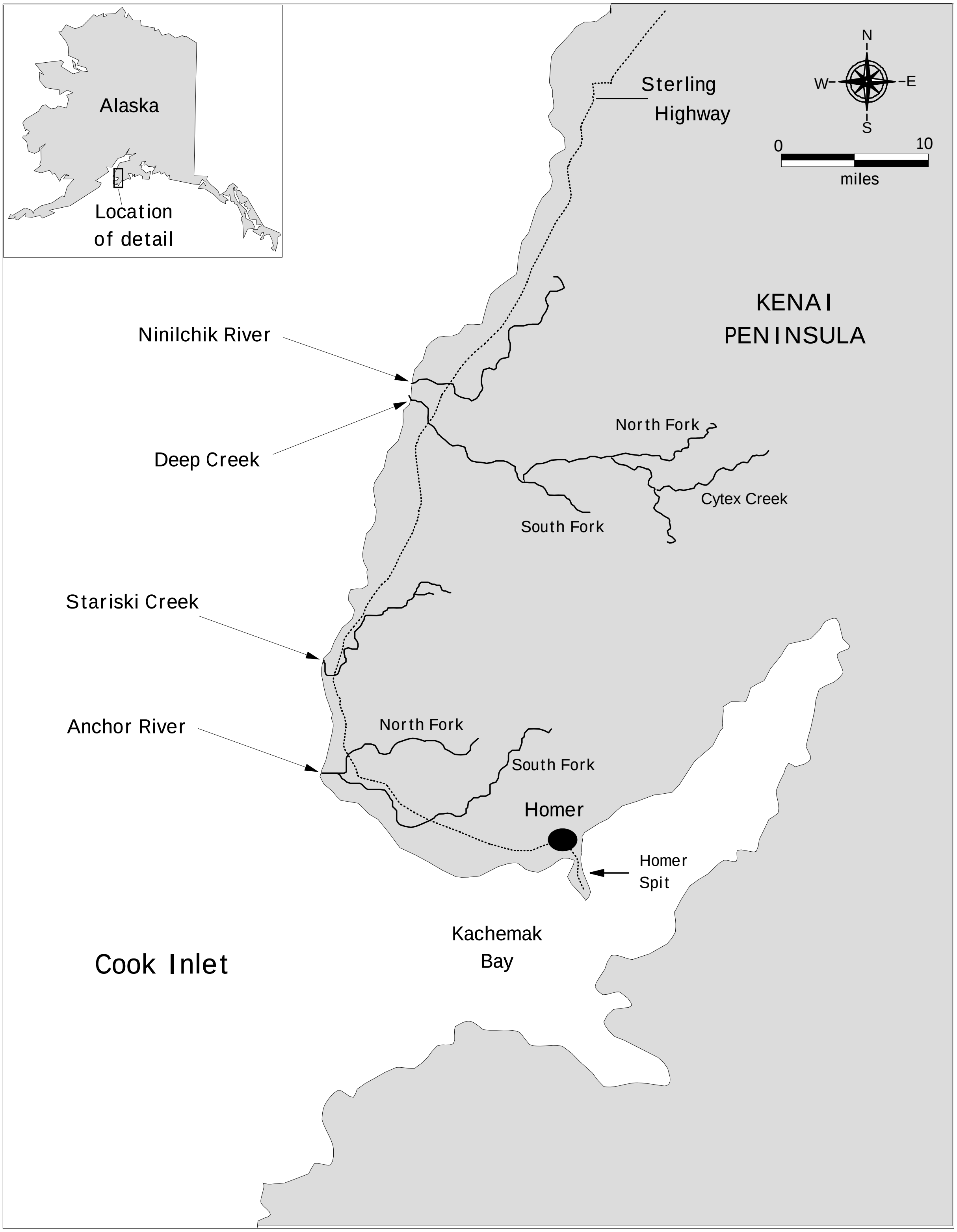


Figure 1.–Location of Anchor River and other Lower Cook Inlet roadside tributaries.

Table 1.–Drainage characteristics of the North and South forks of Anchor River.

Drainage description	North Fork	South Fork	Total
Watershed area	181.5 km^2	405.3 km^2	586.8 km^2
Wetland area	97.8 km^2	188.6 km^2	286.4 km^2
Percent wetlands	53.9%	46.5%	48.8%
Stream length	149 rkm	352 rkm	501 rkm
Anadromous stream length	90 rkm	176 rkm	266 rkm

Source: Unpublished data produced by Steve Baird of Kachemak Bay Research Reserve in Homer, Alaska, 2006.

The following two sections provide historic summaries of Chinook and coho salmon stock status and the sport fishery performance.

CHINOOK SALMON FISHERY BACKGROUND

The major Chinook salmon stocks in the LCI area are found in Ninilchik River, Deep Creek, and Anchor River, with the Anchor River stock being the largest. The run timing of Chinook salmon in LCI streams is approximately early May through late July with a peak in early June.

The Anchor River supports the largest sport harvest of wild Chinook salmon within the LCI area. The harvest has ranged from 578 (in 1989) to 2,787 (in 1993) Chinook salmon and the average harvest in recent years (average = 1,295; 1995-2004) is essentially the same (average = 1,296; 1977-1994) as the historic harvest (Table 2).

Angler effort at Anchor River peaked in the late 1970s and then declined (Table 2). The reduced effort was attributed to the development of Kenai River and Northern Cook Inlet freshwater Chinook salmon fisheries as well as the Cook Inlet marine sport fishery. From 1978 through 1988, Anchor River was open to fishing from its mouth upstream to the junction of the North and South forks (approximately 3 rkms), during Memorial Day weekend and the next consecutive 3 weekends (4 weekends in total).

The Alaska Board of Fisheries liberalized fishing on the Anchor River in 1989 by adding a fifth consecutive 3-day weekend, because of a declining trend in fishing effort during the late 1980s (Table 2). The Chinook salmon sport harvest on the Anchor River increased substantially following the extension of the fishing season and peaked in 1993 and 1994. Concurrent with the increased harvest (Figure 2) was a decline in aerial survey index counts of Chinook salmon (Table 3, Figure 3). In 1993, a biological escapement goal (BEG) of 1,790 Chinook salmon was adopted for Anchor River. The BEG was based on an average of annual counts from aerial and ground index surveys that were conducted from 1966 to 1969 and 1972 to 1991.

In 1996, the Board adopted several regulations designed to decrease Chinook salmon harvest on the Anchor River in the face of repeatedly low escapements. The new regulations included: (1) reducing the combined Chinook salmon annual bag limit from five to two for Anchor River and Deep Creek, (2) restricting anglers from fishing for the remainder of the day in either stream after harvesting a Chinook salmon from Anchor River or Deep Creek, and (3) the closure of the

Table 2.–Angler participation and harvest of Chinook, coho, pink, and sockeye salmon; Dolly Varden; rainbow trout and steelhead trout, Anchor River, 1977-2004.

	Harvest					Rainbow trout/Steelhead [a]		
Year	Chinook salmon	Coho salmon	Pink salmon	Sockeye salmon	Dolly Varden	Harvest	Catch	Angler-days fished [b]
1977	1,077	1,339	27	ND	9,222	2,099	ND	31,515
1978	2,109	1,559	139	ND	17,357	2,305	ND	42,671
1979	1,913	4,006	18	ND	21,364	1,782	ND	44,220
1980	605	2,649	339	ND	10,948	1,186	ND	33,272
1981	1,069	2,949	11	ND	15,271	928	ND	34,257
1982	718	2,379	161	ND	10,375	698	ND	24,709
1983	1,269	1,395	252	ND	17,277	1,605	ND	28,881
1984	998	1,135	249	167	5,599	985	ND	26,919
1985	672	2,239	124	224	7,716	475	ND	31,715
1986	1,098	1,021	136	39	3,914	520	ND	34,938
1987	761	2,010	54	1,263	2,735	643	ND	39,045
1988	976	2,219	109	109	2,746	200	ND	24,356
1989	578	2,635	115	136	1,476	0	2,066 [c]	19,145
1990	1,479	2,782	163	136	2,821	0	1,978	28,829
1991	1,047	3,169	125	152	1,409	0	2,349	22,187
1992	1,685	2,267	92	66	2,532	0	2,720	24,028
1993	2,787	4,003	98	45	1,031	0	4,156	29,338
1994	2,478	3,360	79	82	1,574	0	4,035	27,856
1995	1,475	3,080	47	94	1,537	0	2,232	25,888
1996	1,483	1,762	78	218	963	0	7,570	16,016
1997	1,563	1,636	321	165	1,575	0	3,103	17,020
1998	783	2,386	7	174	2,105	0	3,878	14,310
1999	1,409	1,780	54	174	1,061	0	3,920	21,184
2000	1,730	2,604	123	127	1,903	0	8,693	22,971
2001	889	2,960	11	61	1,652	0	3,045	19,195
2002	1,047	3,830	124	52	662	0	3,501	19,245
2003	1,011	3,999	68	504	1,124	0	3,409	17,482
2004	1,561	4,383	146	11	736	0	3,710	20,452
Avg. (1999-2003)	1,217	3,035	76	184	1,280		4,514	20,015
Avg. (1995-2004)	1,295	2,842	98	158	1,332		4,306	19,376
Avg. (1977-1994)	1,296	2,395	127		7,520	746		30,438
Avg. (1977-1998)	1,301	2,363	125		6,434			28,233
Avg. (1977-2004)	1,295	2,555	117		5,310			26,487

Source: Statewide Harvest Survey (SWHS; Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006a, b, 2007; Mills 1979-1980, 1981a-b, 1982-1994; Walker et al. 2003). Harvest = fish kept (number of fish). Catch = fish harvested plus fish released (number of fish). ND = no data collected.

[a] Since 1989, the Anchor River rainbow trout/steelhead sport fishery has been catch and release only. Possession or retention of this species is prohibited; all rainbow trout/steelhead must be released immediately.

[b] Angler-days fished are not species-specific; angler-days fished values are for all species combined.

[c] 1989 rainbow trout/steelhead catch estimate from unpublished SWHS data.

Table 3.–Anchor River Chinook salmon aerial survey indices and escapement goals, 1976-2004.

	Aerial Survey		Escapement [a]		
Year	Date	Index [b]	Goal	Type	
1976	Aug 02	2,125	NA	Index	
1977	Jul 27	3,585	NA	Index	
1978	Aug 04	2,209	NA	Index	
1979	Jul 29	1,335	NA	Index	
1980[c]	[c]	[c]	NA	Index	
1981[c]	Jul 30	1,066	NA	Index	
1982	Jul 28	1,493	NA	Index	
1983	Jul 29	1,033	NA	Index	
1984	Aug 05	1,087	NA	Index	
1985	Aug 09	1,328	NA	Index	
1986	Jul 29	2,287	NA	Index	
1987	Jul 28	2,524	NA	Index	
1988	Jul 30	1,458	NA	Index	
1989	Jul 26	940	NA	Index	
1990	Jul 21	967	NA	Index	
1991	Jul 27	589	NA	Index	
1992	Aug 10	99	NA	Index	
1993	Jul 21	1,110	1,790	BEG	d e
1994	Jul 30	837	1,790	BEG	d e
1995[c]	[c]	[c]	1,790	BEG	d f g
1996	Aug 02	277	1,790	BEG	d g
1997	Jul 30	477	1,790	BEG	d g
1998	Jul 28	789	1,050-2,200	BEG	d g
1999	Jul 28	685	1,050-2,200	BEG	d g
2000	Jul 27	752	750-1500	SEG	h
2001	Jul 27	414	750-1500	SEG	h
2002	Jul 30	748	750-1500	SEG	h
2003	Jul 23	680	750-1500	SEG	h
2004	Jul 31	834	750-1500	SEG	h
Average (1976-1999)		1,286			
Average (2000-2004)		686			

Source: Szarzi et al. (2007).

[a] NA = not applicable.

[b] Aerial survey index = estimated number of fish from standard sections of river (Szarzi and Begich 2004b).

[c] Escapement counts not conducted or considered minimal because of high turbid water during the surveys.

[d] BEG = Biological Escapement Goal

[e] BEG based on combined aerial and ground survey indices from 1993-1994.

[f] Ground survey was discontinued in 1995.

[g] BEG based on South Fork aerial survey indices from 1995-1999.

[h] SEG = Sustainable Escapement Goal, based on South Fork aerial survey indices.

Table 4.–Fish escapements for Anchor River, 1987-2004.

		Escapement (number of fish)						
Year	Project dates	Chinook salmon	Coho salmon	Pink salmon	Chum salmon	Sockeye salmon	Dolly Varden	Rainbow trout/ Steelhead
1987[a]	Jul 04-Sep 10	204	2,409	2,084	19	33	19,062	136
1988[a]	Jul 03-Oct 05	245	2,805	777	24	30	14,935	878
1989[a]	Jul 06-Nov 05	95	20,187	4,729	165	212	11,384	769
1990[a]	Jul 04-Aug 15	144	190	355	17	39	10,427	3
1991[a]	Jul 04-Aug 15	39	13	1,757	9	46	18,002	5
1992[a]	Jul 04-Oct 01	129	4,596	992	39	174	10,051	1,261
1993[a]	Jul 03-Aug 16	90	290	998	12	71	8,262	1
1994[a]	Jul 03-Aug 16	111	420	723	2	61	17,259	1
1995[a]	Jul 04-Aug 12	112	725	1,094	4	73	10,994	10
2003[b]	May 30-Jul 09	9,238	[b]	[b]	[b]	[b]	[b]	[b]
2004[c]	May 16-Sep 13	12,016	5,728	1,079	79	45	7,846	20

[a] Sources: Larson (1990-1995, 1997); Larson and Balland (1989); Larson et al. (1988). Escapement was monitored using a weir located approximately 1.5 rkm from mouth.

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

[c] Escapement was estimated approximately 2.8 rkm from the mouth using DIDSON and weir counts for the Chinook salmon estimate, and weir counts for the coho salmon estimate.

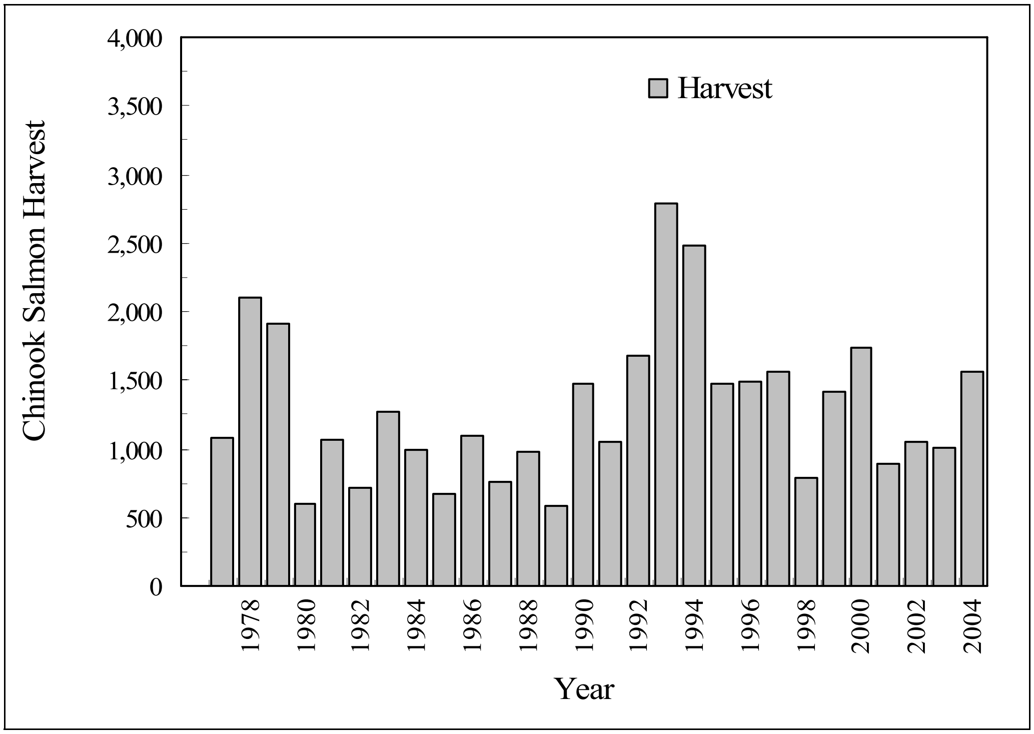


Figure 2.–Freshwater harvest of Chinook salmon in Anchor River, 1976-2004.

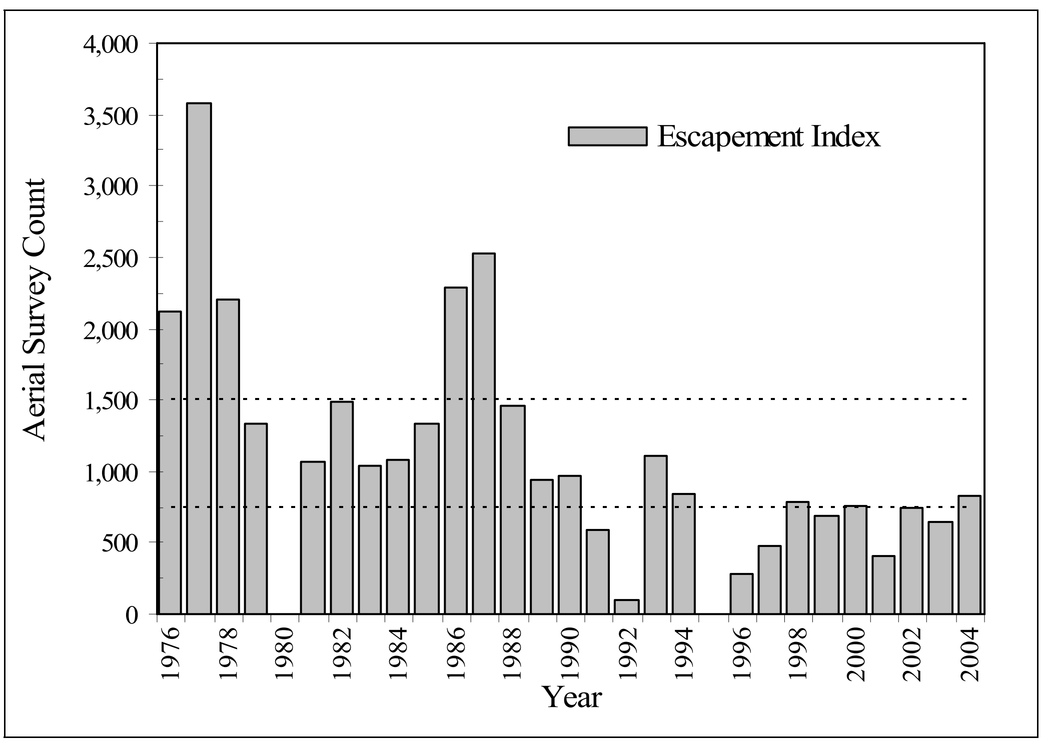


Figure 3.–Escapement index of Chinook salmon in Anchor River (bars) relative to the SEG range of 750-1,500 fish (dotted lines), 1976-2004.

North and South forks of the Anchor River to all sport fishing until August 1 to protect spawning Chinook salmon. However, the Board left the regulatory weekend openings unchanged, which allowed fishing for five weekend periods (Szarzi and Begich 2004a).

In addition to the freshwater restrictions implemented in 1996, the Board created the Upper Cook Inlet Marine Early Run King Salmon Management Plan (5 AAC 58.055). The Plan was intended to control the growing harvest of mixed stocks of Chinook salmon in nearshore marine waters from Bluff Point to Ninilchik, where the annual harvest had more than doubled from 1976 to 1989 (average harvest = 3,166) to 1990 to 1995 (average harvest = 6,807). The Plan also sought to prevent overexploitation by freshwater fisheries of stocks thought to be fully utilized. Some of these stocks, such as Deep Creek and Anchor River, were experiencing below average returns. Szarzi and Begich (2004a) discuss the details of the Upper Cook Inlet Early King Salmon Management Plan and how it employs time, area, and harvest restrictions to prevent overharvest of early-run Chinook salmon stocks in the nearshore marine and freshwater fisheries.

In 1998, the Anchor River BEG was modified based only on historical aerial survey index counts and their relationship to sport fishing harvests. This resulted in a BEG range of 1,050 to 2,200 Chinook salmon (Table 3). In 2001, escapement goals were reevaluated for Cook Inlet salmon stocks in accordance with the Sustainable Salmon Fisheries Policy (SSFP; 5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223). Since the total return of Anchor River Chinook salmon was unknown, the Escapement Goal Review Team evaluated this stock using a standard set of criteria from salmon stocks where total returns were known. Based on this analysis, the 25^{th} to 75^{th} percentiles of annual helicopter escapement surveys for the Anchor River were used to set a sustainable escapement goal (SEG) between 750-1,500 Chinook salmon for the Anchor River.

During the Alaska Board of Fisheries meeting in November 2001, the Board designated Anchor River Chinook salmon as a stock of "management concern." The "management concern" designation was the outcome of the following: (1) escapement indexes had been below the SEG range in 8 of 13 years surveyed from 1989-2001 (Table 3; (Szarzi and Begich 2004a), and (2) despite the Board actions in 1995-1996 to correct the downward trends, escapement indexes remained below the SEG range in 1996, 1997, 1999, and 2001 and near the lower point value of the SEG range in 1998 and 2000. As a result, the Board reduced the regulatory weekend openings for Chinook salmon from five to four 3-day weekends.

COHO SALMON FISHERY BACKGROUND

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

The Anchor River supports the largest sport harvest of coho salmon in the LCI area (Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006a, b, 2007; Mills 1979-1980, 1981a-b, 1982-1994; Walker et al. 2003). In recent years the average coho salmon harvest (3,035 fish; from 1999 to 2003) has been 27% higher than the historical harvest (2,363 fish; from 1977 to 1998; Table 2).

The number of coho salmon returning to Anchor River was counted at a weir operated to count Dolly Varden returns from 1987-1995 (Table 4). The weir was located approximately 1.6 rkms (1 mile) from the river mouth. Based on the dates the weir was operated, it is estimated that the majority of the coho salmon escapement was counted in 1987-1989 and 1992, but not in other years because the weir was removed in mid-August during the peak of the coho salmon run. During the years the weir was operated throughout the coho salmon immigration, the counts ranged from 2,409 to 20,187 fish and averaged 7,499 fish. With the exception of these 4 years, data to quantify the coho salmon escapement to the Anchor River are not available.

OBJECTIVES AND TASKS

This report documents estimation of the escapement of Chinook salmon in the Anchor River in 2003 using only the DIDSON system and in 2004 using a combination of the DIDSON system and mainstem weir. The report also documents the census of the coho salmon escapement in 2004. Age and sex compositions and length-at-age and sex of the Chinook escapements in 2003 and 2004 and of the coho salmon escapement in 2004 are also outlined.

OBJECTIVES

1. Estimate the adult Chinook salmon escapement that passes upstream of rkm 2.8 on the Anchor River from approximately May 30 through June 10, 2003 and approximately May 15 through September 15, 2004.
2. Census the adult coho salmon escapement that passes upstream of rkm 2.8 on the Anchor River from approximately May 15 through September 15, 2004.
3. Estimate the age and sex composition of the Chinook salmon escapement upstream of rkm 3.2 of Anchor River in 2003 and 2004.
4. Estimate the age and sex composition of the coho salmon escapement upstream of rkm 2.8 of Anchor River in 2004.

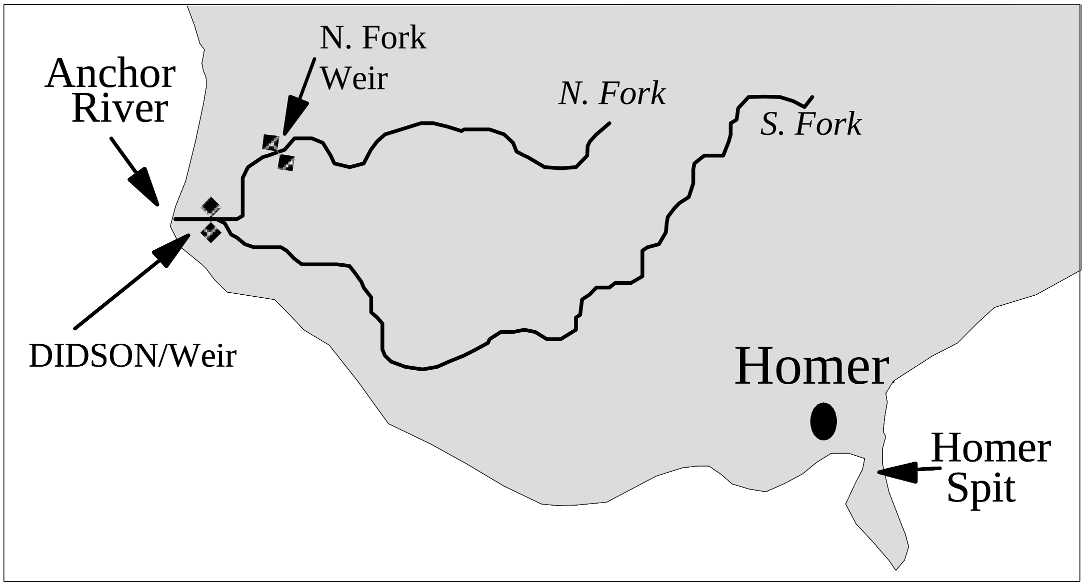
TASKS

1. Install and operate a partial weir and DIDSON counter approximately rkm 2.8 upstream of the Anchor River mouth from May 15 to June 15 in 2003 and 2004.
2. Examine all Chinook salmon captured in gillnets and beach seines for a missing adipose fin, and examine Chinook and coho salmon sampled for age, sex, and length (ASL) data for a missing adipose fin.
3. Conduct an aerial survey count of the Chinook salmon escapement upstream of rkm 2.8 of the Anchor River on approximately July 29 in 2003 and 2004.
4. Examine between-reader variation of the DIDSON sonar recordings used to enumerate the escapement.
5. Estimate length-at-age for Chinook and coho salmon.

METHODS

SITE AND EQUIPMENT SELECTION

The mainstem DIDSON and weir study site was selected because it is above the fishery (~ 2.8 rkm upstream from the mouth) and below the confluence of the North and South Fork (Figure 4). The river width at the study site is approximately 31 m during peak spring flows (Figure 5). The mainstem site has a cut bank on the left side of the river and a sloping bank on the right side. The left bank is defined as the left side of the river when facing downstream. The river substrate is composed of smooth cobbles, gravel, and sand.



Note: GPS coordinates for major project components. DIDSON (lat 59°77.220' N, long 151° 83.485' W); mainstem weir (lat 59°77.224' N, long 151°83.495' W); North Fork weir (lat 59°77.655' N, long 151°82.607' W)

Figure 4.–Locations of the mainstem DIDSON, mainstem weir, and North Fork weir sites on Anchor River.

The DIDSON system was selected over conventional weir technology to monitor the Chinook salmon escapement because weir installation was unfeasible from May to mid-June when discharge is typically high and turbid because of snowmelt run-off (Figure 6). In 2003, biological samples were collected above the mainstem site from the North and South fork using a gillnet and a beach seine; in 2004, samples were collected from the North Fork weir and from the South Fork using a beach seine. In 2004, a floating weir was included in the project design to replace the DIDSON system when river discharge subsided and counting was extended through the coho salmon immigration (Figure 7). The operations by year and specific dates are described in Table 5.

The Anchor River North Fork weir (Figure 4) was funded by the Exxon Valdez Oil Spill, Gulf Ecosystem Monitoring (EVOS GEM) program (Walker et al. 2004). In addition to escapement monitoring at the North Fork weir, samples of juvenile fish, invertebrates, and streamside vegetation for analysis of marine-derived nutrients (MDN) were collected throughout the salmon migration period at stations located along the North Fork. In a separate report, the results from this study will determine if adult salmon abundance can be indexed with marine derived carbon, nitrogen, and sulfur transported by adult salmon and taken up by freshwater vegetation and vertebrate and invertebrate residents.

Operational dates differed between methods used to monitor escapement and for collecting biological samples. The following sections detail the 2003 and 2004 operational dates by method.

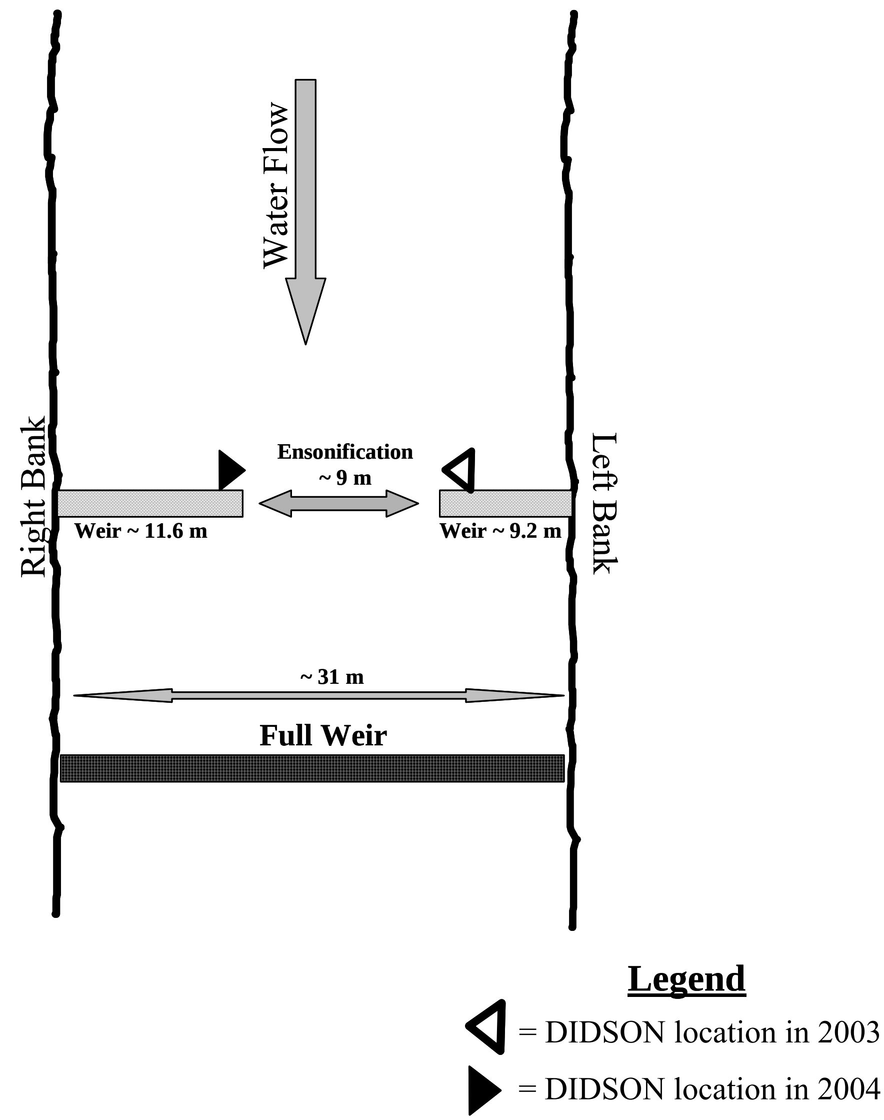


Figure 5.–Locations of the mainstem DIDSON, partial weirs, and mainstem full weir site on Anchor River, 2003 and 2004.

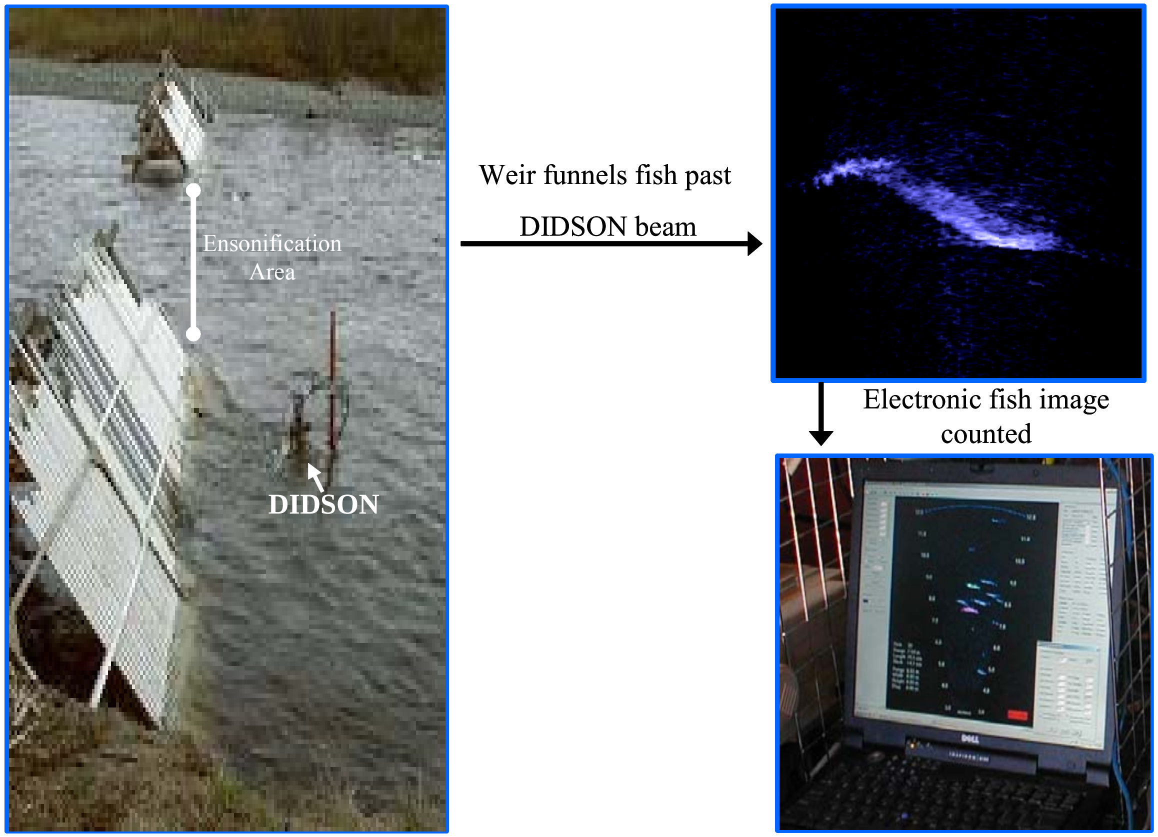


Figure 6.–DIDSON was used with partial weir to funnel fish past the DIDSON beam.

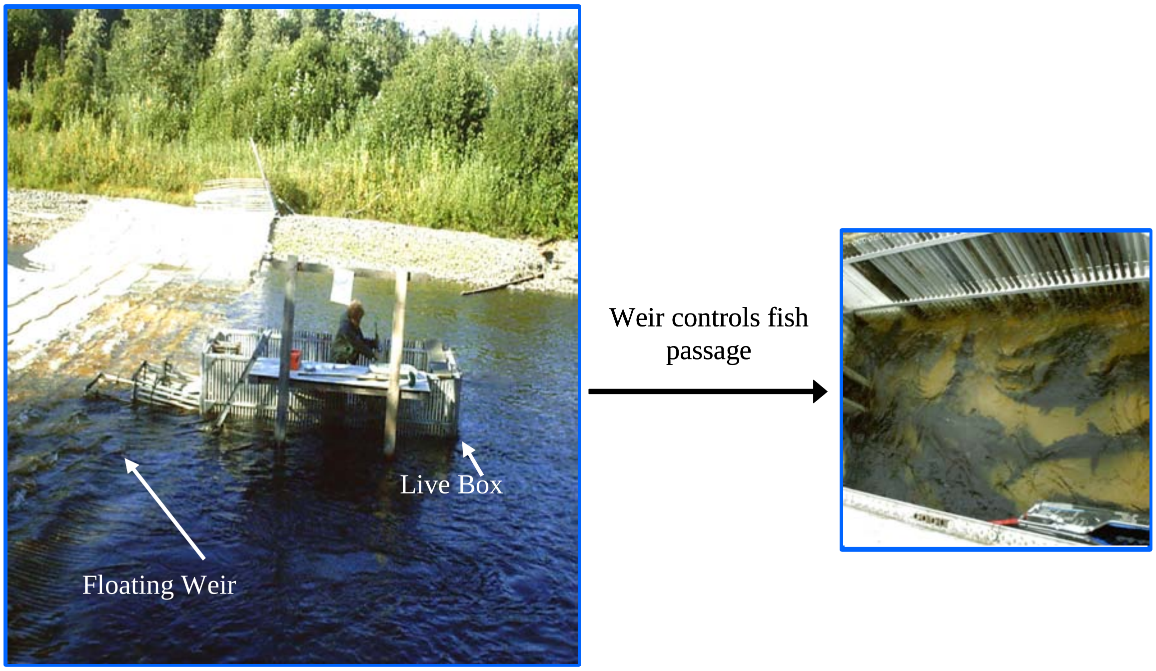


Figure 7.–Resistance board weir used to count fish.

DIDSON and Mainstem Weir

The 2003 and 2004 start dates for estimating Chinook escapement using the DIDSON system were determined by historic run timing of Chinook salmon in Lower Cook Inlet (LCI) streams. With the inclusion of coho salmon escapement monitoring in 2004, historic weir data for Anchor River coho salmon were used to determine the likely duration of the project. The specific end dates of the field operation were determined as the third consecutive day for which the number of Chinook salmon in 2003 or coho salmon in 2004 counted at the sonar/weir site contributed less than 1% to the cumulative escapement count.

In 2003, Chinook salmon escapement was estimated using a DIDSON system from May 30 to July 9 (Table 5). In 2004, escapement was monitored using the DIDSON system from May 15 to June 8 during peak spring flows. On June 9 and 10, 2004, crews installed a complete floating weir because water levels had subsided. While the weir was being installed, escapement was monitored using a combination of DIDSON and weir counts; thereafter escapements of Chinook and coho salmon were monitored using a complete resistance board weir from June 11 to September 13.

South Fork and North Fork Sampling

Fish were captured by gillnet and/or beach seine upstream of the sonar site on the North and South forks of Anchor River to apportion DIDSON counts by species and to collect ASL data (Table 6). In 2003, the North Fork was sampled seven times (May 22 and 29; June 5, 20, 26; and July 3 and 9) and the South Fork was sampled seven times (May 21 and 28; June 3, 18, 24; and

Table 5.–Project dates for estimating Anchor River Chinook salmon escapement in 2003 using only the DIDSON system and in 2004 using a combination of the DIDSON system and a mainstem weir.

		Weir		Netting[a]	
Year	DIDSON	Mainstem	North Fork	North Fork	South Fork
2003	May 30-Jul 09	None	None	May 22-Jul 09 [b]	May 21-Jul 10 [b]
2004 [c]	May 15-Jun 08	Jun 11-Sep 13	May 15-Sep 15	None	Jun 01-Jun 24 [d]

[a] A gillnet and beach seine were used in 2003 to capture fish samples to apportion DIDSON counts and collect biological data. Only beach seines were used in 2004 because they captured fish effectively and did not stress fish as much as a gillnet.

[b] Periodic sampling (n = 7).

[c] During the weir installation (June 09-10) escapement counts were collected using the DIDSON and weir.

[d] Periodic sampling (n = 5).

Table 6.–Fish catches from netting the North and South fork of Anchor River that were used to apportion DIDSON counts in 2003 and 2004.

	South Fork					North Fork				
		Catch					Catch			
Year (DIDSON dates)	Sample date (Gear)	Chinook salmon	Dolly Varden	Rainbow trout/ Steelhead	Pink salmon	Sample date (Gear)	Chinook salmon	Dolly Varden	Rainbow trout/ Steelhead	Pink salmon
2003	5/21 (GN)	22	0	0	0	5/22 (GN)	12	0	0	0
(5/30-7/09)	5/28 (GN)	41	0	0	0	5/29 (GN)	25	0	0	0
	6/03 (GN)	50	0	0	0	6/05 (GN)	71	0	0	0
	6/18 (GN/BS)	93	0	0	0	6/20 (BS)	108	0	5	0
	6/24 (BS)	140	0	0	0	6/26 (GN/BS)	84	0	0	0
	7/02 (GN/BS)	19	24	0	6	7/03 (GN/BS)	19	0	0	0
	7/10 (GN/BS)	18	3	0	13	7/09 (GN)	29	0	0	0
	Total	383	27	0	19		348	0	5	0
2004	6/01 (BS)	54	0	0	0	[a]	[a]	[a]	[a]	[a]
(6/01-6/24)	6/03 (BS)	77	0	0	0	[a]	[a]	[a]	[a]	[a]
	6/15 (BS)	110	0	0	0	[a]	[a]	[a]	[a]	[a]
	6/18(BS)	85	0	0	0	[a]	[a]	[a]	[a]	[a]
	6/24(BS)	101	0	0	0	[a]	[a]	[a]	[a]	[a]
	Total	427	0	0	0	[a]	[a]	[a]	[a]	[a]

Note: Catch = fish harvested plus fish released. Gear: GN = gillnet, BS = beach seine, GN/BS = both used.

[a] In 2004, all North Fork samples were collected at a weir. North Fork weir counts are available in Appendix A3.

July 2 and 10) using beach seines and gillnets. In 2004 sampling occurred systematically at the North Fork weir from May 18 to September 15, and the South Fork was sampled five times (June 1, 3, 15, 18, and 24) using beach seines.

Aerial Survey

Helicopter surveys used to index Chinook salmon escapements are flown over the South Fork upstream of the Beaver Creek and Anchor River confluence (lat 59o46.517’ N, long 151o28.530’ W) to the Old Sterling Highway bridge (Table 3). These surveys are typically flown in a Bell[1], Model 206 JetRanger helicopter chartered from local air charter companies with experienced pilots. The door on the surveyor’s side of the helicopter is removed prior to the survey for optimal viewing. New ADF&G surveyors undergo training with an experienced surveyor prior to taking over these surveys so that they are familiar with the Anchor River drainage and its Chinook salmon run. Presently, the same individual has conducted these counts since 1997. Counts are conducted from low altitudes (100-200 ft) at a consistent air speed throughout the survey. The surveyor wears polarized sunglasses and the pilot repositions the aircraft during survey to minimize the effects of glare off the water. The following conditions were used to describe survey conditions: percent cloud cover, water clarity, glare on the surface of the water, and other (e.g., light conditions, wind, precipitation, etc.).

Aerial survey flights for Anchor River Chinook salmon are scheduled to coincide as closely as possible with the historical peak spawning period; however weather, water conditions, and aircraft/pilot availability also affect survey dates. Counts of live and dead Chinook salmon are tallied separately on hand tally counters for each section of river. This information is then transferred to a survey data form (similar to Appendix D1) during the survey or upon return to the office.

Although aerial surveys have been conducted for the North Fork, surveys have not been conducted annually and therefore are not included in the index. Index counts are based on the number of live and dead Chinook salmon observed.

EQUIPMENT

DIDSON

The DIDSON system gives a near video quality image for differentiating fish underwater (Figure 6). The DIDSON operates at two frequencies, 1.8 MHz for close range observations (less than 15 m) and 1.0 MHz for observations from 15 m up to 30 m. Overall beam dimensions were 29^o in the horizontal axis and 12^o in the vertical axis (Burwen et al. 2007). At the high frequency setting (1.8 MHz) the image resolution is enhanced because the image is formed using 96 beams each 0.3^o wide compared to the low frequency (1.0 MHz) that forms the image using only 48 beams that are 0.6^o wide. Although the Chinook salmon escapement data could have been collected using either frequency, on the Anchor River the high frequency setting was selected for its superior image quality.

Before the DIDSON was deployed in 2003, large boulders were removed from the river to allow unobstructed ensonification. Furthermore, a partial weir was used to reduce the ensonification area to 9 m (Figure 5).

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[1] Product names used in this report are included for scientific completeness but do not constitute product endorsement.

In 2003, the DIDSON transducer was placed approximately 7 m from the left bank (near the cut bank) on the upstream of the weir (Figure 5). In 2004, the DIDSON transducer was placed on the right bank (near the sloping bank). The benefits of placing the DIDSON on the right bank were: (1) to easily reposition the transducer when water levels changed, and (2) the sloping bank was better suited to the DIDSON beam configuration.

Partial and Mainstem Weirs

Throughout the DIDSON operation, partial fixed picket weirs were installed on the right bank (length ~ 11.6 m) and left bank (length ~ 9.2 m) to direct fish through the DIDSON's ensonification path (Figures 5 and 6). All bottom irregularities at the base of the weirs were sealed with sandbags.

Once water levels subsided in 2004, a complete resistance board weir (length ~ 31 m) was installed approximately 6 m below the DIDSON site (Figures 5 and 7). Gaps between the pickets in the weir and live trap were approximately 2.8 cm (1.5 inches) to block the passage of all but the smallest 0-ocean-age Chinook salmon.

Two live boxes were incorporated into the weir, one near the right bank and the second in the middle of the river. The purpose of the right bank live box was to enable the crew to pass fish through the weir if high water levels prohibited fish passage through the mid channel live box. All bottom irregularities at the base of the complete weir were sealed using sand bags. Once the weir was fish tight, the partial weir and DIDSON equipment were removed.

Gillnet and Beach Seine

In 2003, a gillnet (15-fathom net of 2-in [5.08 cm] mesh) was initially used to collect fish samples to apportion DIDSON counts and collect biological samples. However, to minimize stress on fish, a 15-fathom beach seine was also used. Both gear types were fished in the same way. Nets were drifted through deep pools to capture fish on the North and South forks of the Anchor River. A net was deployed upstream of a pool from a raft (length ~ 3 m). The end of the net deployed first was walked by a crewmember to the cut bank side of the pool, and then the net was drifted with the current through the hole while the upstream end of the net was held near the sloping bank by a second crewmember. Meanwhile, a third crewmember agitated the water downstream of the hole to scare fish into the net. Afterwards the crewmember holding the downstream end of the net would walk the net back to the sloping bank. In 2004, only beach seines were used because they were thought to cause less stress on fish and they were effective in capturing fish. Beach seining was conducted on the South Fork only because a weir was installed on the North Fork.

River Temperature and Stage

In 2003 and 2004, Cook Inlet Keeper (CIK, a citizen based nonprofit organization) collected river temperatures using a temperature logger, programmed to collect the average, minimum, and maximum water temperature in degrees Celsius every 15 minutes at a sampling location[1] approximately 0.1 rkm downstream of the DIDSON/weir site (Mauger 2004). The daily river temperatures in this report are averages of the 15 minute temperature readings. In 2004, river

[1] Cook Inlet Keeper, Anchor River water temperature logger, AR-3 site.

stage[1] measurements were taken each day at approximately 2000 hours from a meter stick attached to a fence post (staff gauge) secured near the left bank downstream from the weir site.

ESCAPEMENT MONITORING

DIDSON and Weir Counts

DIDSON images were received on a Dell-Latitude[2] notebook computer where they were automatically saved to files, uniquely named by date and time using DIDSON data collection software version 4.43 in 2003, and version 4.44 in 2004.

In 2003, DIDSON images were collected. Files were saved every 20 minutes and designated as first, second, and third 20-minute counts. In 2004, the DIDSON software was programmed to collect images for only the first 20 minutes of each hour from May 15 to May 23. On May 24 the software was re-programmed to collect counts for the entire hour so that the second or third 20-minute counts could be used in case the first 20-minute count was lost due to an equipment malfunction.

To count fish images moving upstream and downstream, crewmembers reviewed the DIDSON files. The 2003 data set was counted one time, while the 2004 data set was counted two times by different crewmembers.

The Chinook salmon component of the DIDSON counts was determined by the following method: (1) upstream images were assumed to be Chinook salmon. This assumption was tested, and adjustments made as necessary, using the species composition from samples collected on the South and North fork of Anchor River (Table 6), and (2) downstream images were assumed to be Chinook salmon. This assumption was not verified and it is likely that a portion of the downstream counts included post-spawning steelhead trout. The Chinook salmon estimate is based on the DIDSON net counts (upstream count – downstream count = net count).

In 2004 once the full weir was installed, escapement was monitored and biological samples collected as fish passed through the left bank live box. The right bank live box was not used in 2004.

Adjustments to DIDSON counts

Count adjustments were made in 2003 for the following reasons: (1) 134-hours had less than full hour counts and were expanded to full hours; (2) 4 hours of counts were missing because of high water and were interpolated; (3) 17 days of counts were adjusted downwards because netting samples from the South Fork contained pink salmon and Dolly Varden.

Count adjustments were made in 2004 for the following reasons: (1) 557-files contained only the first 20 minutes for a given hour and counts were expanded to full hours; (2) 10 hours of data were unreadable by the crews and it was interpolated; (3) 5 hours of data were lost because of a computer malfunction and counts were interpolated.

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

[2] Product names used in this report are included for scientific completeness but do not constitute product endorsement.

Aerial Survey

Helicopter surveys were used to index Chinook salmon escapement for the Anchor River. In 2003, two aerial surveys were flown. On July 23, the South and North forks of Anchor River were aerial surveyed and on July 28 the South Fork survey was flown again. In 2004, one helicopter survey was flown on July 31.

BIOLOGICAL SAMPLING

Gillnet and Beach Seine

All fish captured in gillnets and beach seines in the North and South Forks were speciated and measured for mideye-to-tail-fork (METF) length to the nearest millimeter. Sex was determined by examining morphological characteristics (e.g., presence of an ovipositor, kype, and girth) and scales samples were collected (Welander 1940) from all Chinook salmon captured. Scales were pressed and the age determined using procedures described by Mosher (1969). The caudal fin was also clipped on all Chinook salmon before release to prevent double sampling.

Weirs

In 2004, ASL data were collected from a subsample of Chinook and coho salmon that passed the North Fork and mainstem weir. At the North Fork weir ASL data were collected from every 25th Chinook salmon and at the mainstem weir from every 30th Chinook salmon and every 24th coho salmon.

Straying

The presence of an adipose fin was checked on all Chinook salmon captured with a gillnet or a beach seine. Throughout the full weir operation, the presence of an adipose fin was checked on all Chinook and coho salmon sampled for ASL data. Fish with missing adipose fins were sacrificed for coded wire tag (CWT) information. Heads were labeled with a numbered cinch strap, frozen, and sent to the Department Mark, Tag and Age Laboratory in Juneau for analysis. Results were accessed from the Department's tag lab website[1], using parameters specific to the Anchor River salmon escapement project.

DATA ANALYSIS

DIDSON Counts

Net Counts

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

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

where:

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

[1] ADF&G. 2004. Online coded wire tag report, updated September 3, 2004 at 1:19:05 PM. Alaska Department of Fish and Game, Mark Tag and Age Laboratory, Juneau. http://tagotoweb.adfg.state.ak.us/CWT/reports/d

d_{jk} = downstream counts for the period counted in hour j of day k. For 2003, n_{jk} will represent the count for entire hour or some subset of that hour. For 2004 n_{jk} will represent the count for the first 20-minute period, or some subset of that 20 minute period.

Expanded Counts

For hours with less than 60 minutes of counts, the estimated expanded hourly count for hour j in day k ($\hat{c}_{jk}$) was calculated as:

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

where:

t_{jk} = number of minutes sampled during the j^{th} hour on day k. The following formula was used to linearly interpolate the count for hour j in the (rare) situations where entire hours were not counted due to computer malfunction, silting of sonar lens etc.:

$$\hat{I}_j = C_p + \left[\frac{C_m - C_p}{m - p}\right]\left[j - p\right] \tag{3}$$

where:

p = last hour for which a count was available ($j > p$),

m = next hour for which a count was available ($j < m$),

C_p = average of the expanded counts in hour p and p-1,

C_m = average of the expanded counts in hour m and m+1.

The number of hours for which there is no count is very small and these adjustments are not thought to contribute any meaningful bias or variance to the season-end estimates.

Chinook Salmon Escapement Estimates

Escapement in 2003 was estimated using only the DIDSON sonar; in 2004 escapement was estimated as the sum of a DIDSON sonar estimate and the count from a weir installed on the mainstem Anchor River part way through the season. Hourly count estimates ($\hat{c}_{jk}$) were summed to provide daily (C_k) estimates of escapement and an estimate of the total escapement passage (C) during DIDSON system operation:

$$\hat{C}_k = \sum_{j=1}^{24} \hat{c}_{jk}(1 - p_k) \tag{4}$$

$$\hat{C} = \sum_{k=1}^{K} \hat{C}_k \tag{5}$$

where K is the number of days of operation of the DIDSON system in the year in question and p_k is the proportion of pink salmon and Dolly Varden determined to be passing upstream at the

DIDSON site on day k of operation. p_k was taken as the proportion of the netting catch on day k comprising pink salmon and Dolly Varden. Values of p_k were interpolated between netting events in a manner similar to those for missing counts (Equation 3). This adjustment was only required for 2003, when the DIDSON system was used to count the entire Chinook salmon run (no mainstem weir), and then only towards the end of the run, at approximately 85% of the season cumulative count. No such adjustments were required for 2004 (p_k = 0), when a mainstem weir was installed in time to allow direct identification of all non-Chinook upstream passage.

The variance of $\hat{C}$ was estimated as:

$$\operatorname{var}(\hat{C}) = \sum_{k=1}^{K} \operatorname{var}(\hat{C}_k) = \sum_{k=1}^{K} \sum_{j=1}^{24} \operatorname{var}(\hat{c}_{jk}(1-p_k)) = \sum_{k=1}^{K} \sum_{j=1}^{24} (1-p_k)^2 \operatorname{var}(\hat{c}_{jk}), \tag{6}$$

where:

$$\operatorname{var}(\hat{c}_{jk}) = \left[\frac{60}{t_{jk}}\right]^2 \operatorname{var}(n_{jk}) = \left[\frac{60}{t_{jk}}\right]^2 s^2 \left[1 - \frac{t_{jk}}{60}\right], \tag{7}$$

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

$$s^2 = \frac{\sum_{h=2}^{H} (n_h - n_{h-1})^2}{2(H-1)} \tag{8}$$

where n_h is the h^{th} sample count (h = 1 corresponds to j = 1,k = 1, and $h = H$ corresponds to j = 24 and $k = K$). For the vast majority of samples for 2003, $\frac{t_{jk}}{60}=1$ and the variance of the season count for 2003 is zero (essentially all images counted). No account is taken of the variability of the estimates of pink salmon and Dolly Varden in 2003; the adjustments were small and were only required after about 85% of the Chinook migration had occurred. For 2004, $\frac{t_{jk}}{60} = \frac{1}{3}$ was used in calculations described in Equations 6-8.

Count Diagnostics

Adequacy of twenty-minute sub-sampling

The 2003 data set was used to evaluate the adequacy of sampling 20 minute segments from each hour. An estimate of the season upstream passage was made from each of three subsampling schemes: the first, second, and third 20-minute segments of each hour. The relative difference between each subsample estimate of the season upstream passage and the population upstream passage (using all available counts) was calculated as:

$$b_s = \frac{\hat{C}_s - C}{C} \qquad (9)$$

where $\hat{C}_s$ is the count according to Equations 4-5 using subsampling scheme *s* (first, second or third 20-minute sampling period) and *C* is the (censused) 2003 count. In addition, a paired *t*-test was used to test the null hypothesis that the difference between a daily expanded 20-minute count and the true count was zero; this test was repeated for each of the first, second, and third 20-minute counts.

Among Reader Variability

To evaluate reader variability, the net counts by seven individual crewmembers for a given set of DIDSON files was compared to a second set of counts of the same files. The second reading of a file was made by one of the seven readers not responsible for the first reading. The following analyses were made:

1. An estimate of the correlation of the first reading with the second reading was made for each pair of readers, as well as over all readers.
2. A matrix of average differences in counts among readers was also produced (one triangle of off-diagonal entries in a 7 by 7 matrix). Each entry was calculated as the average difference over the files common to both readers, regardless of which was the first or second reading. Such a matrix had the capacity to identify readers that had a tendency to disagree with their colleagues.

Age and Sex Composition and Length-at-Age

Chinook Salmon in 2003

The age and sex composition and length-at-age of the Chinook salmon escapement in 2003 was based on a combination of samples collected with nets from South and North forks of Anchor River. Age/sex composition were different between the North and South forks and the age/sex proportions for each fork were weighted according to the observed proportion of the escapement passing up North and South forks in 2004, when a weir was placed on North Fork. The assumption was made that the distribution of the escapement between the North and South forks in 2003 was similar to that in 2004.

The estimated proportion of Chinook salmon of age/sex class *k* in the entire escapement to Anchor River was calculated as:

$$\hat{p}_k = \phi_{SF}\,\hat{p}_{SF\,k} + (1-\phi_{SF})\,\hat{p}_{NF\,k}\,, \qquad (10)$$

where:

$$\hat{p}_{SF\,k} = \frac{n_{SF\,k}}{n_{SF}}\,, \qquad (11)$$

where:

$n_{SF\,k}$ = the total number of salmon of age/sex class *k* in $n_{SF,}$

n_{SF} = the number of salmon sampled from the South Fork,

$\hat{p}_{NF\,k}$ refers to the North Fork and was calculated similarly,

and

ϕ_{SF} = the proportion of the escapement that migrates into South Fork during the sonar operation (from the 2004 study, when a weir was placed on North Fork).

The estimated variance of proportion $\hat{p}_k$ was calculated as:

$$\mathrm{var}(\hat{p}_k) = \left[\phi_{SF}^2 \left(\frac{N_{SF} - n_{SF}}{N_{SF}} \right) \frac{\hat{p}_{SF\,k}(1-\hat{p}_{SF\,k})}{n_{SF}-1} + (1-\phi_{SF})^2 \left(\frac{N_{NF} - n_{NF}}{N_{NF}} \right) \frac{\hat{p}_{NF\,k}(1-\hat{p}_{NF\,k})}{n_{NF}-1} \right], \tag{12}$$

where:

N_{SF} = the total number of Chinook salmon migrating into South Fork during the season and was assumed known for purposes of variance estimation and was taken as $\hat{C}\phi_{SF}$; N_{NF} was similarly taken as $\hat{C}(1-\phi_{SF})$.

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

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

The estimated variance of $\hat{N}_k$ was calculated as:

$$V\hat{a}r(N_k) = \hat{C}^2 V\hat{a}r(\hat{p}_k)\,. \tag{14}$$

In 2003, the variance of $\hat{C}$ was essentially zero, allowing its use in Equation 14 as a constant.

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

Chinook Salmon in 2004

The age and sex composition and length-at-age of the Chinook salmon escapement in 2004 was based on a combination of samples collected from nets on South Fork, a weir on North Fork, and a weir on the mainstem of Anchor River which was installed after the DIDSON operation. The age/sex proportions during the DIDSON and mainstem weir operation differed and were weighted according to the escapement proportion counted during the DIDSON and weir operation. Age/sex composition was also found to be different between the North and South forks and the age/sex proportions from each fork during the DIDSON operation were weighted according to the escapement passing up North and South forks in 2004, available from the weir on North Fork.

The estimated proportion of Chinook salmon of age/sex class *k* in the entire escapement to the Anchor River in 2004 was calculated as:

$$\hat{p}_k = \phi_D(\phi_{SF}\,\hat{p}_{SF\,k} + (1-\phi_{SF})\,\hat{p}_{NF\,k}) + (1-\phi_D)\,\hat{p}_{W\,k}\,, \tag{15}$$

where:

ϕ_D = the proportion of the entire escapement that migrated during the sonar operation, and

ϕ_{SF} = the proportion of the escapement that migrates into South Fork during the sonar operation.

The estimated variance of proportion ($\hat{p}_k$) was calculated as:

$$\operatorname{var}(\hat{p}_k) = \phi_D^2 \left[\phi_{SF}^2 \left(\frac{N_{SF} - n_{SF}}{N_{SF}} \right) \frac{\hat{p}_{SF\,k}(1-\hat{p}_{SF\,k})}{n_{SF}-1} + (1-\phi_{SF})^2 \left(\frac{N_{NF} - n_{NF}}{N_{NF}} \right) \frac{\hat{p}_{NF\,k}(1-\hat{p}_{NF\,k})}{n_{NF}-1} \right] +$$

$$(1-\phi_D)^2 \left(\frac{N_W - n_W}{N_W} \right) \frac{\hat{p}_{W\,k}(1-\hat{p}_{W\,k})}{n_W - 1}, \tag{16}$$

where:

$\hat{p}_{Wk}$ = proportion of age/sex class *k* during weir operation (calculated as for $\hat{p}_{Sk}$),

N_{SF} = number of Chinook salmon migrating into South Fork during DIDSON operations and was assumed known for variance estimation; if taken as $\hat{C}\phi_{SF}$,

n_W = number of Chinook salmon sampled age/sex during weir operation, and

N_w = number of Chinook salmon migrating into Anchor River during weir operation.

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

$$\hat{N}_k = \hat{N}_T \hat{p}_k , \tag{17}$$

where $\hat{N}_T = \hat{C} + N_w$ was the estimated total escapement in 2004. The estimated variance of $\hat{N}_k$ was calculated as (Goodman 1960):

$$V\hat{a}r(\hat{N}_k) = \hat{N}_T{}^2 V\hat{a}r(\hat{p}_k) + \hat{p}_k^2 V\hat{a}r(\hat{N}_T) - V\hat{a}r(\hat{p}_k) V\hat{a}r(\hat{N}_T). \tag{18}$$

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

Coho Salmon

The age, sex, and length composition of the coho salmon escapement is based on a systematic sample collected at the mainstem weir only; the mainstem weir was installed before any coho salmon began their migration. The estimated proportion and its variance of coho salmon of age/sex class *k*, in the escapement was calculated from samples taken at the mainstem weir as described in Equations 11 and 12. The estimated total number of coho salmon of age or sex class *k* was calculated as described in Equations 13 and 14. Mean lengths at age and its variance were estimated using standard summary statistics.

RESULTS

ESCAPEMENT-CHINOOK SALMON

DIDSON and Weir Escapement

A total of 9,238 Chinook salmon were counted in 2003 at the mainstem Anchor River DIDSON site from May 30 to July 9 (Table 7; Appendix A1). The 2004 escapement estimate of Chinook salmon was 12,016 (SE = 283) from May 15 through September 13, of which approximately 7,674 Chinooks salmon are based on sonar counts and 4,342 weir counts (Appendix A2). We estimated 16% (1,919/12,016) of the Chinook salmon counted in the mainstem in 2004 used the North Fork for spawning and 84% used the South Fork (Appendix A3).

Sonar Diagnostics

Twenty-Minute Count Comparison

The differences between net upstream counts for 2003 (all three 20-minute periods counted) based on full hour counts versus expanded 20-minute counts (either first, second or third 20-minute period) using 835 hours of data were small (Table 8). The total full-hour net upstream count for the data set was 8,410. In each 20-minute increment of the hour, the expanded net upstream counts and relative difference (RD) were: 8,715 (RD = 3.63%) for the first 20-minute increment, 8,268 (RD = -1.69%) for the second and 8,250 (RD = -1.9%) for the third. All paired *t*-tests used to test the null hypothesis that the difference between a daily expanded 20-minute count and the true count was zero were insignificant (all *P's* > 0.68).

Passage Rate and Count Variability (2003)

Variability of upstream passage among 20-minute periods within an hour for 2003 increased with the total passage rate (upstream + downstream counts) in that hour (Table 9; Figure 8). There was a significant quadratic component to a polynomial line fitted to the data ($p = 0.04$), indicating the effect of total passage increased with total passage.

Reader Variability

A total of 899 DIDSON files were used to evaluate between reader variability. The results of the analyses described in the Methods section (1-2) are given in Tables 10 and 11. Correlations ranged from 0.70 to 0.99 (Table 10). All correlations involving Reader 7 were slightly lower. The average correlations for sample sizes 50 or greater (≥50) was 0.948. The overall correlation pooled over readers was 0.95. The average difference between counts for pairs of readers ranged from 0.12 fish to -3.25 fish (Table 11). The average difference when sample sizes were ≥50 was 0.32.

Run Timing

In 2003, fifty percent of the Anchor River Chinook salmon escapement was counted by June 10 (Table 7; Figure 9, Appendix A1). The peak passage (25 to 75 percentile range) was counted in 16 days (June 4 to June 19). In 2004, 50% of the Chinook salmon escapement was counted at the Anchor River mainstem site by June 6 and the peak passage was counted in 17 days (May 28 to June 13; Appendix A2). In contrast, 50% of the Chinook salmon escapement at the North Fork weir was counted by June 14, which is 8 days later than the mainstem site. Furthermore, peak passage at the North Fork weir was more protracted (peak passage = 29 days; June 3 to July 2) than the mainstem.

Table 7.–Chinook and coho salmon escapement summary for Anchor River, 2003-2004.

		Aerial survey[a]		Mainstem escapement								
							Peak count dates			River temperature[b] (°C)		
Year	Species	Date	S. Fork count	Project dates	Estimate	(SE)	Median	25-75 Percentile	(no. of days)	Mean	Min	Max
2003	Chinook	6/28	647	5/30-7/09	9,238	(0)	6/10	6/04-6/19	(16)	10.2	6.6	14.8
2004	Chinook	7/31	834	5/15-9/13	12,016	(283)	6/06	5/28-6/13	(17)	11.7	8.4	17.4
	Coho	[c]	[c]	5/15-9/13	5,728	(0)	9/02	9/02	(1)	12.8	12.1	13.6

		Aerial survey[a]		North Fork escapement								
							Peak count dates			River temperature[b] (°C)		
Year	Species	Date	N. Fork count	Project dates	Estimate	(SE)	Median	25-75 Percentile	(no. of days)	Mean	Min	Max
2004	Chinook	7/31	117[d]	5/15-9/15	1,919	(0)	6/14	6/03-7/02	(29)	10.9	9.6	12.2
	Coho	[c]	[c]	5/15-9/15	677	(0)	9/03	9/03	(1)	10.9	9.6	12.2

[a] The annual South Fork aerial survey counts are used to index Chinook salmon escapements for Anchor River.

[b] Daily river temperatures from Mauger (2004) during peak (25-75%) counting dates.

[c] No aerial survey for coho salmon.

[d] North Fork aerial survey counts are not used to index Chinook salmon escapements for Anchor River, because they are not done annually.

Table 8.–Expanded twenty-minute counts and percent relative difference to actual counts from 835 hours of data collected in 2003 using the DIDSON system on Anchor River.

Minutes counted per hour	Count	% Relative difference
First 20	8,715 [a]	3.63
Second 20	8,268 [a]	-1.69
Third 20	8,250 [a]	-1.90
Full Hour	8,410	

[a] 20-minute counts expanded to 1 hour for 835 hours of data.

Table 9.–The average variance of net upstream count within an hour by passage rate strata. Data comprise 835 hours of the 2003 data set for which the full 60 minutes was counted.

Passage stratum (# fish per hour)	Hours counted	Average variance of net count within an hour
0-5	323	1.46
6-10	215	3.34
11-15	118	9.66
16-20	85	12.24
21-25	36	19.57
26-30	16	51.16
31-35	17	49.22
>35	25	73.85
Total	835	9.35

A diel difference in fish passage was observed in DIDSON data collected in 2003 and 2004. Higher upstream and downstream counts occurred in the evening than during the day (Table 12; Figure 10). The highest upstream counts (mean = 28; SE = 1.66) and downstream counts (mean = 10; SE = 0.64) were recorded between midnight and 0359 hours. The lowest upstream (mean = 9; SE = 0.74) and downstream (mean = 6; SE = 0.47) counts were recorded between 0800 and 1159 hours.

The average river temperature at the AR-3 site during the 2003 DIDSON operation was 11.7^{o}C (Figure 11; Appendix B1; Mauger 2004). During peak passage from June 4 to June 19, the mean

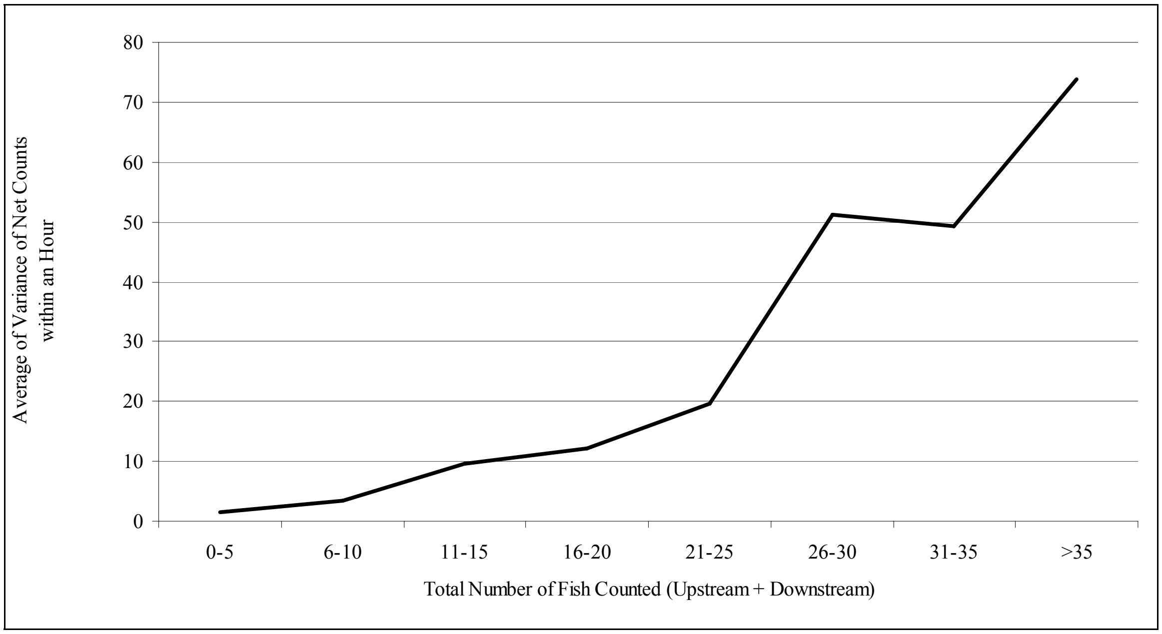


Figure 8.–Average of variance of net DIDSON counts (upstream-downstream) within an hour and the total number (upstream + downstream) of fish counted within an hour at the mainstem Anchor River, 2003.

river temperature was 10.2°C (min = 6.6°C; max = 14.8°C; Table 7). In 2004, the river temperature during peak passage (May 28 to June 13) was approximately 11.7°C (min = 8.4°C; max = 17.4°C) (Figure 12; Appendix B2).

During the 2004 Chinook salmon run, depth readings of river levels were highest in May and they dropped gradually through June as the number of Chinook salmon declined (Figure 13; Appendix C1).

Aerial Survey Escapement Index

The July 23rd aerial survey was used to index the Anchor River Chinook salmon escapement in 2003. Despite good visibility during this survey, the aerial indices (n = 680) fell below the SEG range (Table 3; Figure 3; Appendix D1). Of the 723 Chinook salmon counted on July 23rd, 94% (n = 680) were counts from the South Fork and 6% (n = 43) were from the North Fork. A second aerial survey was flown on July 28, 2003. It was believed that more Chinook salmon were in the river at this time; however, fewer fish were seen and this index was not used as the escapement index because the survey conditions were not as good as the early flight.

One helicopter survey was flown at Anchor River on July 31 to index the 2004 Chinook salmon escapement. The total survey count was 951 Chinook salmon. Eighty-eight percent were counted in the South Fork (n = 834) and 12% in the North Fork (n = 117; Appendix D1). The South Fork count was used to index the 2004 Chinook salmon escapement, which was within the SEG range (Table 3; Figure 3).

Table 10.–Correlations among DIDSON file readers' counts for a given set of 2004 DIDSON dat files.

	DIDSON file reader															
	1		2		3		4		5		6		7		All	
DIDSON file reader	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size	Correlation among readers' counts	Sample size
1			0.97	8	0.97	72	0.88	92	0.97	95	-	0	0.89	4	NA	271
2					0.96	16	-	0	0.81	8	-	0	-	0	NA	24
3							0.97	112	0.94	87	0.99	8	0.70	8	NA	215
4									0.96	73	-	0	0.78	18	NA	91
5											0.98	7	-	0	NA	7
6													-	0	NA	0
All															0.95	608

Note: "-" = the value can't be computed due to limitations of the data; NA = not applicable.

Table 11.–Mean differences among DIDSON file readers' counts for a given set of 2004 DIDSON dat files.

	DIDSON file reader													
	1		2		3		4		5		6		7	
DIDSON file reader	Mean difference among readers' counts	Sample size	Mean difference among readers' counts	Sample size	Mean difference among readers' counts	Sample size	Mean difference among readers' counts	Sample size	Mean difference among readers' counts	Sample size	Mean difference among readers' counts	Sample size	Mean difference among readers' counts	Sample size
1			-1.75	8	0.42	72	0.12	92	-0.12	95	-	0	-0.75	4
2					0.50	16	-	0	-3.25	8	-	0	-	0
3							0.16	112	-0.60	87	0.13	8	-0.50	8
4									-0.47	73	-	0	1.50	18
5											-0.29	7	-	0
6													-	0

Note: "-" = the value can't be computed due to limitations of the data.

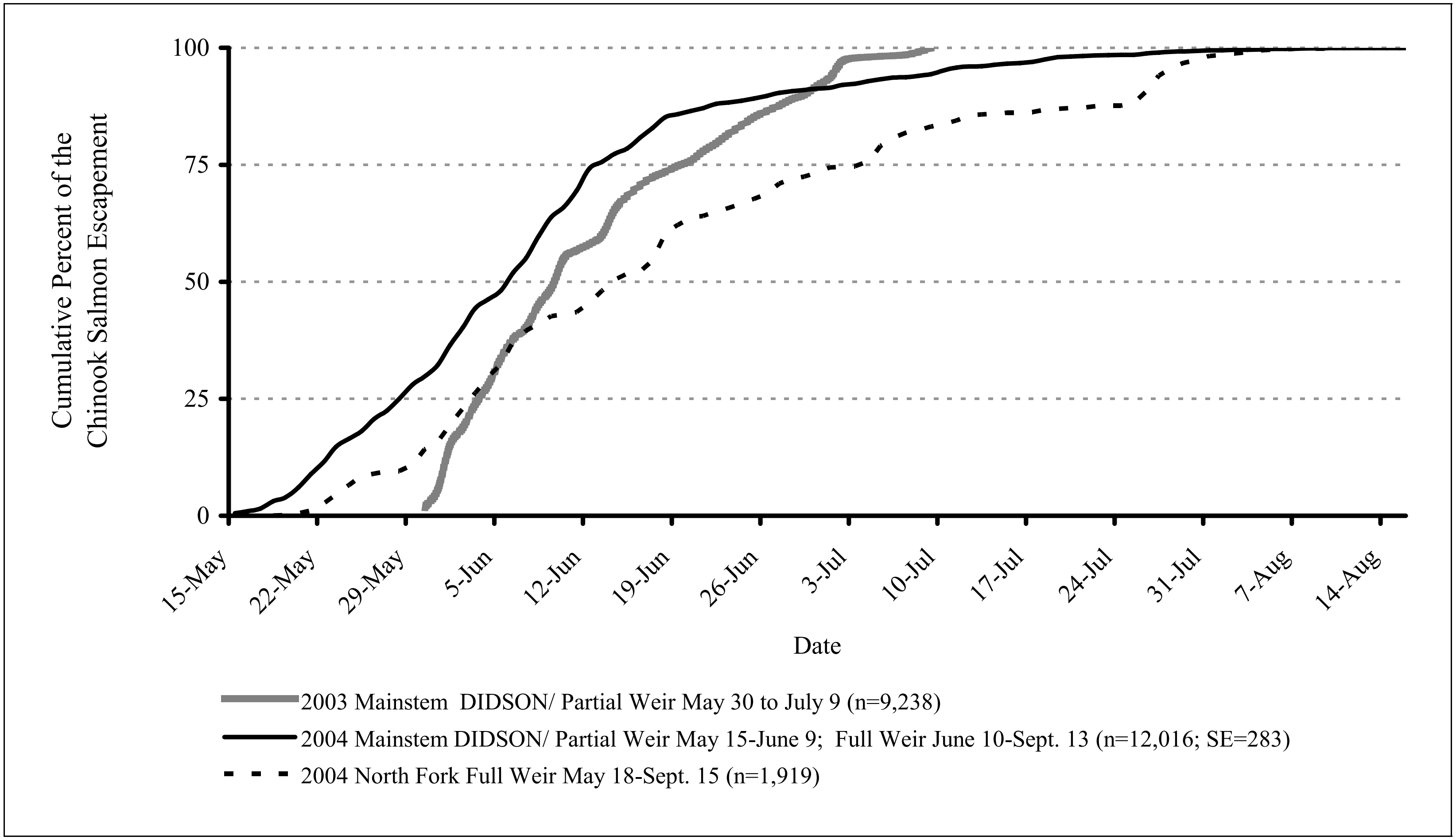


Figure 9.–Run timing of Chinook salmon at the mainstem sonar/weir site in 2003 and 2004, and at the North Fork weir site in 2004.

Table 12.–Combined 2003 and 2004 upstream, downstream, and net count from DIDSON images in 4-hour increments within a 24-hour period from 0000 to 2359 hours on Anchor River.

	Upstream count					
Hours counted	n[a]	Min	Max	Median	Mean	SE
00:00 to 03:59	264	0	143	21	28	1.66
04:00 to 07:59	267	0	95	11	14	0.86
08:00 to 11:59	264	0	87	5	9	0.74
12:00 to 15:59	260	0	116	8	12	0.94
16:00 to 19:59	261	0	150	10	16	1.27
20:00 to 23:59	265	0	72	11	15	0.86

	Downstream counts					
Hours counted	n[a]	Min	Max	Median	Mean	SE
00:00 to 03:59	264	0	54	7	10	0.64
04:00 to 07:59	267	0	47	5	8	0.53
08:00 to 11:59	264	0	49	3	6	0.47
12:00 to 15:59	260	0	88	5	7	0.59
16:00 to 19:59	261	0	43	5	7	0.48
20:00 to 23:59	265	0	29	5	7	0.41

	Net count					
Hours counted	n[a]	Min	Max	Median	Mean	SE
00:00 to 03:59	264	-9	122	12	18	1.25
04:00 to 07:59	267	-8	61	4	6	0.54
08:00 to 11:59	264	-16	54	2	3	0.41
12:00 to 15:59	260	-6	50	2	5	0.54
16:00 to 19:59	261	-7	121	3	9	0.94
20:00 to 23:59	264	-5	61	4	7	0.65

[a] n = number of full 20-minute counts in 2003 and 2004.

ESCAPEMENT-COHO SALMON

Weir Escapement

In 2004, 5,728 coho salmon were counted at the mainstem weir and 677 at the North Fork weir (Table 7; Appendices A2 and A3). Based on a comparison of mainstem versus North Fork weir counts, 88% (5,051/5,728) of the coho salmon counted at the mainstem weir entered the South Fork to spawn.

The coho salmon escapement is primarily based on weir counts. However, from July 20 through July 23, counts were based on a combination of sonar and weir counts because of the following circumstances: On the night of July 20 the DIDSON was used to allow a high number of Dolly Varden to pass through the weir. From July 21 through July 23, the DIDSON was used each night for crew safety because of a bear kill near the sonar site. Although some coho salmon may

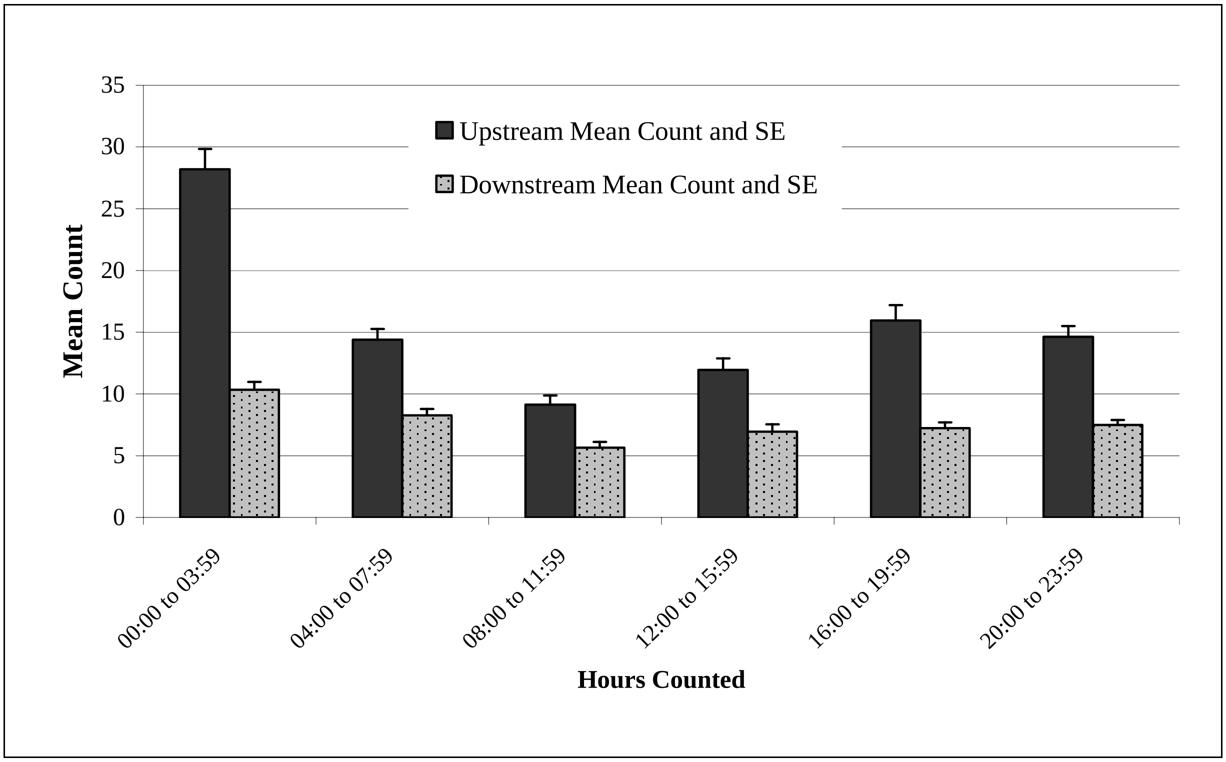
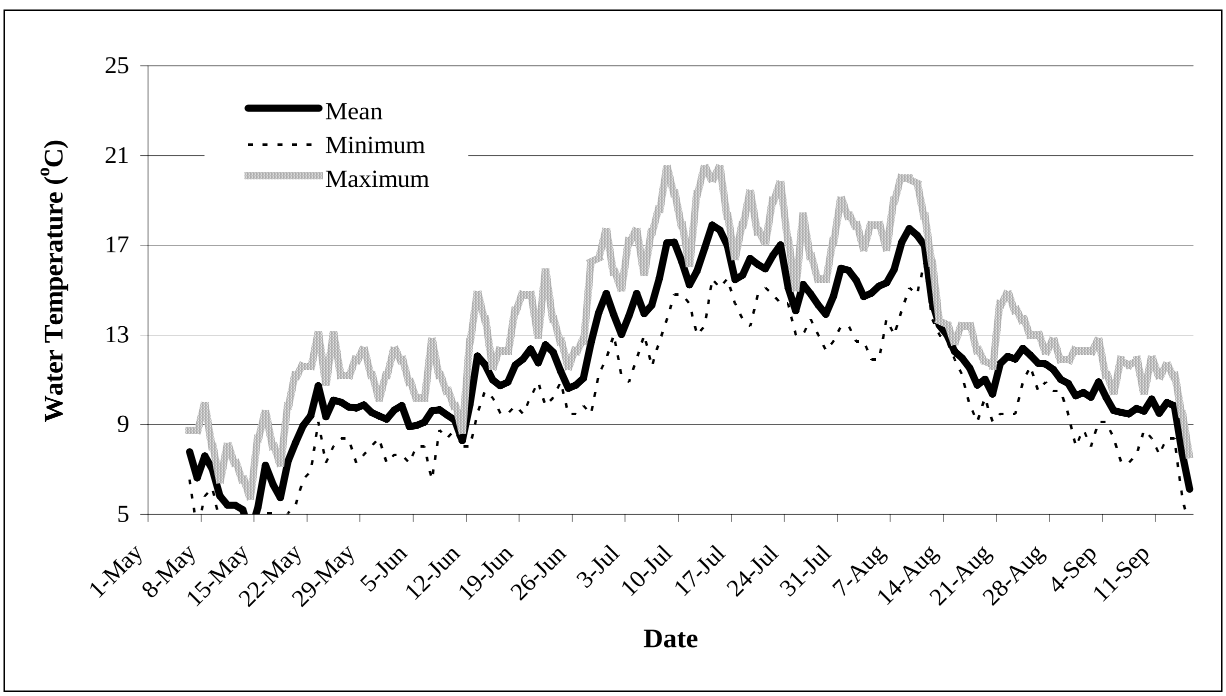
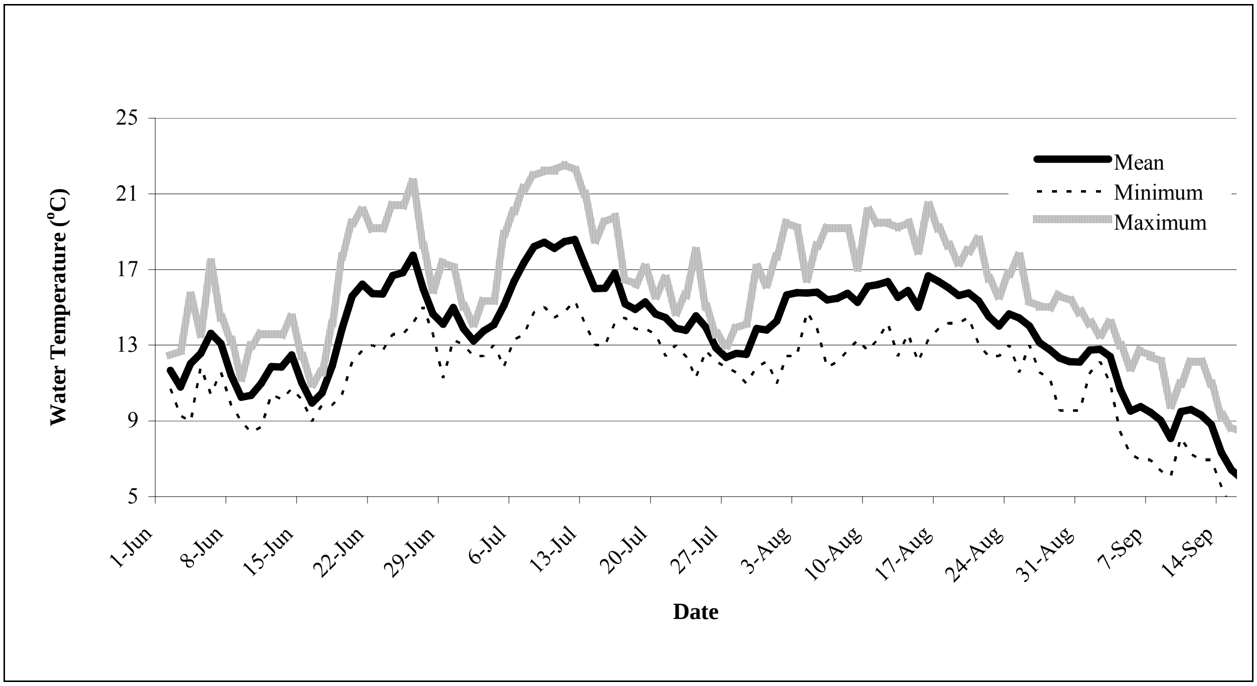


Figure 10.–Combined 2003 and 2004 upstream, downstream, and net count from DIDSON images in 4-hour increments within a 24-hour period on Anchor River.



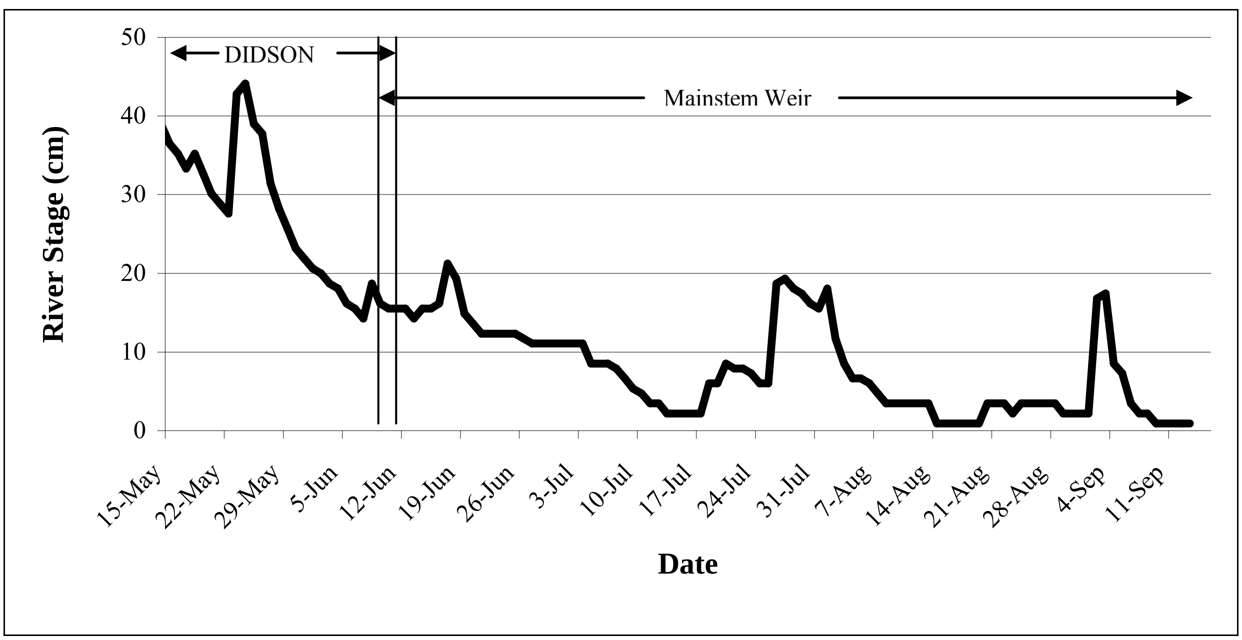
Source: Mauger (2004).

Figure 11.–Water temperatures near Anchor River sonar/weir site, 2003.



Source: Mauger (2004).

Figure 12.–Water temperatures near Anchor River sonar/weir site, 2004.



Note: Operating dates - DIDSON (15 May-8 Jun), Mainstem Weir (11 Jun-13 Sept), both gears (9-10 Jun).

Figure 13.–River stages at Anchor River sonar/weir site, 2004.

have been missed during the nighttime hours when the DIDSON was operated, we believe that the number of missed fish was minimal because of different migrational characteristics and size differences between Dolly Varden and coho salmon. Based on observations of fish passage through the live box, Dolly Varden swam in large pulses at night, while coho salmon typically migrated during daylight hours.

Run Timing

On July 16, two coho salmon were counted at the mainstem weir marking the beginning of the migration at the mainstem weir site (Appendix A2). Eighteen days later (August 2) the first coho salmon was counted at the North Fork weir (Appendix A3). Throughout most of July and August, river temperatures (mean = 17.7^{o}C) were high and river levels were low (mean staff gauge reading = 6 cm) (Appendices B2 and C1). The number of coho salmon counted at the mainstem and North Fork weirs gradually increased from August to September 1 (Figure 14) to a cumulative count of 1,108 coho salmon at the mainstem weir and 130 coho salmon at the North Fork weir (see Appendices A2-A3).

On September 1, heavy rains caused river levels to rise 15 cm (7 inches) before subsiding in the evening of September 2 (Figure 13 and Appendix C1). The rising river triggered a surge of coho salmon into the river. On September 2, the peak coho salmon count (3,666 fish) was recorded at the mainstem weir (Figure 14; Appendix A2). High coho salmon counts (855 fish) continued through September 3rd. In only 2 days (September 2 and 3) approximately 78% (4,491 and 5,728 fish) of the coho salmon escapement was monitored at the mainstem weir site.

Biological Sampling

Age and Sex Composition and Length-at-Age

Chinook Salmon

Age-sex compositions differed between the North and South forks in 2003 ($P < 0.0005$), necessitating weighting of the proportions of each fork of the river separately, as described in the Methods section. The difference between forks is attributed to the presence of ocean age-1 males in the South Fork, and their absence from the North Fork. Within the South fork, age-sex compositions did not change over time, whereas they did on the North Fork ($P < 0.05$). The South Fork samples were pooled as were the North Fork samples in light of our inability to weight the North Fork samples appropriately, and given the fact that the North fork contributed minimally to the overall Anchor River age-sex composition estimates.

Age-sex compositions also differed between the North and South forks in 2004 ($P < 0.05$), necessitating weighting of the fork proportions, as described in the Methods section. The difference between forks is again attributed to the presence of ocean age-1 males in the South Fork, and their absence from the North Fork. Within the South fork, age-sex compositions did not change over time and data were pooled; no tests were conducted for the North Fork since samples were taken systematically at the North Fork and were therefore self-weighting. Age-sex composition was not significantly different between the DIDSON and mainstem weir periods; however, the *p* value was not small (0.12) and given the reliable weighting factor available (sonar vs. weir counts) we decided it would be conservative to weight the DIDSON and mainstem weir proportions, as described in the Methods section. It is also noted that ocean age alone for both the North and South Forks differed significantly between the DIDSON and weir periods ($P < 0.05$).

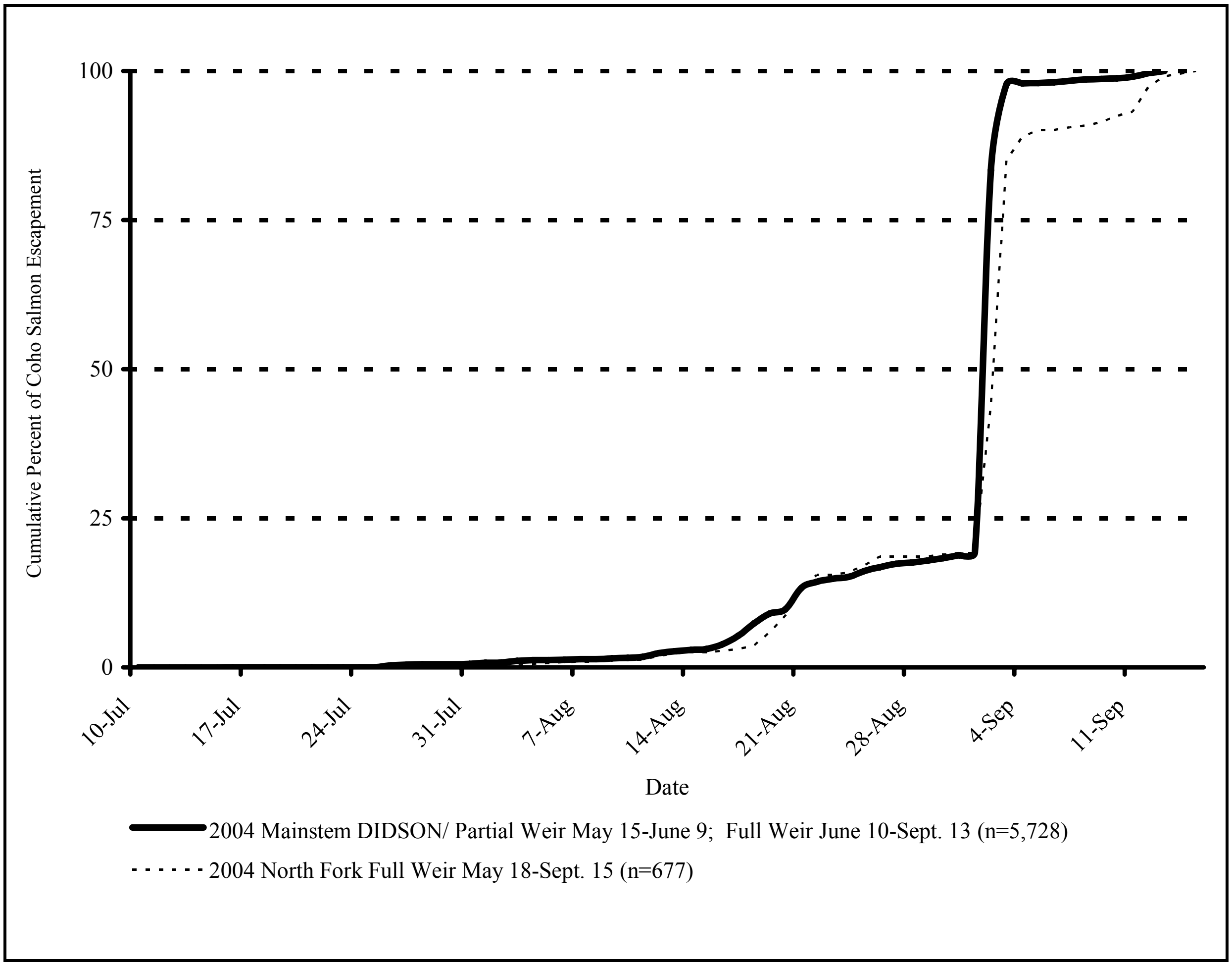


Figure 14.–Coho salmon run timing at the mainstem sonar/weir and North Fork weir sites, 2004.

Overall, ocean age-3 was the dominant age class in 2003 (58.0%, SE = 2.5%) and in 2004 (48.6%; SE = 3.2) for the Chinook salmon escapement (Tables 13 and 14; Figures 15 and 16). In females, ocean age-4 was the second most dominant age class in 2003 (11.0%, SE = 1.6) and in 2004 (15.4%; SE = 2.3); while in males, ocean age-2 was the second most dominant age class in 2003 (22.0%, SE = 2.1) and in 2004 (19.0%; SE = 2.5). Ocean age-1 males were observed in 2003 (5.1%; SE = 1.1) and 2004 (8.8%, SE = 1.9).

Age-sex compositions between 2003 and 2004 were fairly similar (Tables 13-14). Although ages were also similar between years, there was approximately 10% difference for ocean age-3, and 8% difference for ocean age-4 (P < 0.05) Chinook salmon. Also there was a significant difference in the percentage (8%; P < 0.05) for ocean age-3 males between the years. The percentages of females and males were similar in 2003 (40.2%: 59.8%) and 2004 (42.9%: 57.1%) (P = 0.34). Mean lengths at ocean age in 2003 were larger than those in 2004 (Tables 13-14); the largest (and significant) differences were found for ocean age-3 males and females (22 and 26 mm difference, respectively) and for ocean age-1 males (88 mm difference) (P < 0.05).

Table 13.–The estimated ocean age, sex and length composition of Anchor River Chinook salmon 2003 escapement.

	Ocean Age [a]					Sex
	1	2	3	4	Total [b]	composition [c]
Female sampled [d]	0	8	157	51	216	257
Percent	0.0	1.0	29.0	11.0		40.2
SE percent	0.0	0.5	2.3	1.6		2.3
Estimated abundance	0	92	2,679	1,016		3,710
SE abundance	0	46	216	151		209
Mean length	NA	649	792	843	802	
SE mean length	NA	64	4	5	4	
Male sampled [d]	43	159	168	15	385	472
Percent	5.1	22.0	28.8	2.8		59.8
SE percent	1.1	2.1	2.3	0.9		2.3
Estimated abundance	471	2,032	2,661	259		5,528
SE abundance	99	191	214	79		209
Mean length	444	601	780	871	695	
SE mean length	22	7	6	15	8	
Male and Female sampled [d]	43	167	325	66	601	729
Percent	5.1	23.0	57.8	13.8		100.0
SE percent	1.1	2.1	2.5	1.8		
Estimated abundance	471	2,125	5,340	1,275		9,238
SE abundance	92	195	232	166		
Mean length	444	603	786	849	738	
SE mean length	22	7	4	5	6	

[a] Age and length-at-age compositions are based on weighted samples collected with nets from South and North forks.

[b] Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

[c] Sex composition is based on weighted samples collected with nets from South and North forks.

[d] Unweighted sample sizes by age class and sex of Chinook salmon collected with nets from South and North forks.

Table 14.–The estimated ocean age, sex, and length composition of Anchor River Chinook salmon 2004 escapement.

	Ocean Age [a]					
	1	2	3	4	Total [b]	Sex composition [c]
Female sampled [d]	0	7	77	46	130	356
Percent	0.0	1.7	27.6	15.4		42.9
SE percent	0.0	0.8	2.9	2.3		1.7
Estimated abundance	0	204	3,316	1,850		5,155
SE abundance	0	92	353	279		241
Mean length	NA	637	766	838	789	
SE mean length	NA	8	5	6	6	
Male sampled [d]	20	59	58	18	155	452
Percent	8.8	19	21	6.5		57.1
SE percent	1.9	2.5	2.6	1.6		1.7
Estimated abundance	1,057	2,283	2,523	781		6,861
SE abundance	224	304	319	192		264
Mean length	356	601	758	858	670	
SE mean length	10	8	9	13	8	
Male and Female sampled [d]	20	66	135	64	285	808
Percent	8.8	20.7	48.6	21.9		100.0
SE percent	1.9	2.6	3.2	2.6		
Estimated abundance	1,057	2,487	5,840	2,632		12,016
SE abundance	224	313	406	321		
Mean length	398	612	767	838	721	
SE mean length	10	8	5	6	6	

[a] Age and length-at-age compositions are based on weighted samples collected from nets on the South Fork, a weir on the North Fork, and a weir on the mainstem Anchor River which was installed after the DIDSON operation.

[b] Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

[c] Sex composition is based on weighted samples collected from nets on the South Fork, a weir on the North Fork, and a weir on the mainstem Anchor River which was installed after the DIDSON operation.

[d] Unweighted sample sizes by age class and sex of Chinook salmon collected from nets on the South Fork, a weir on the North Fork, and a weir on the mainstem Anchor River which was installed after the DIDSON operation.

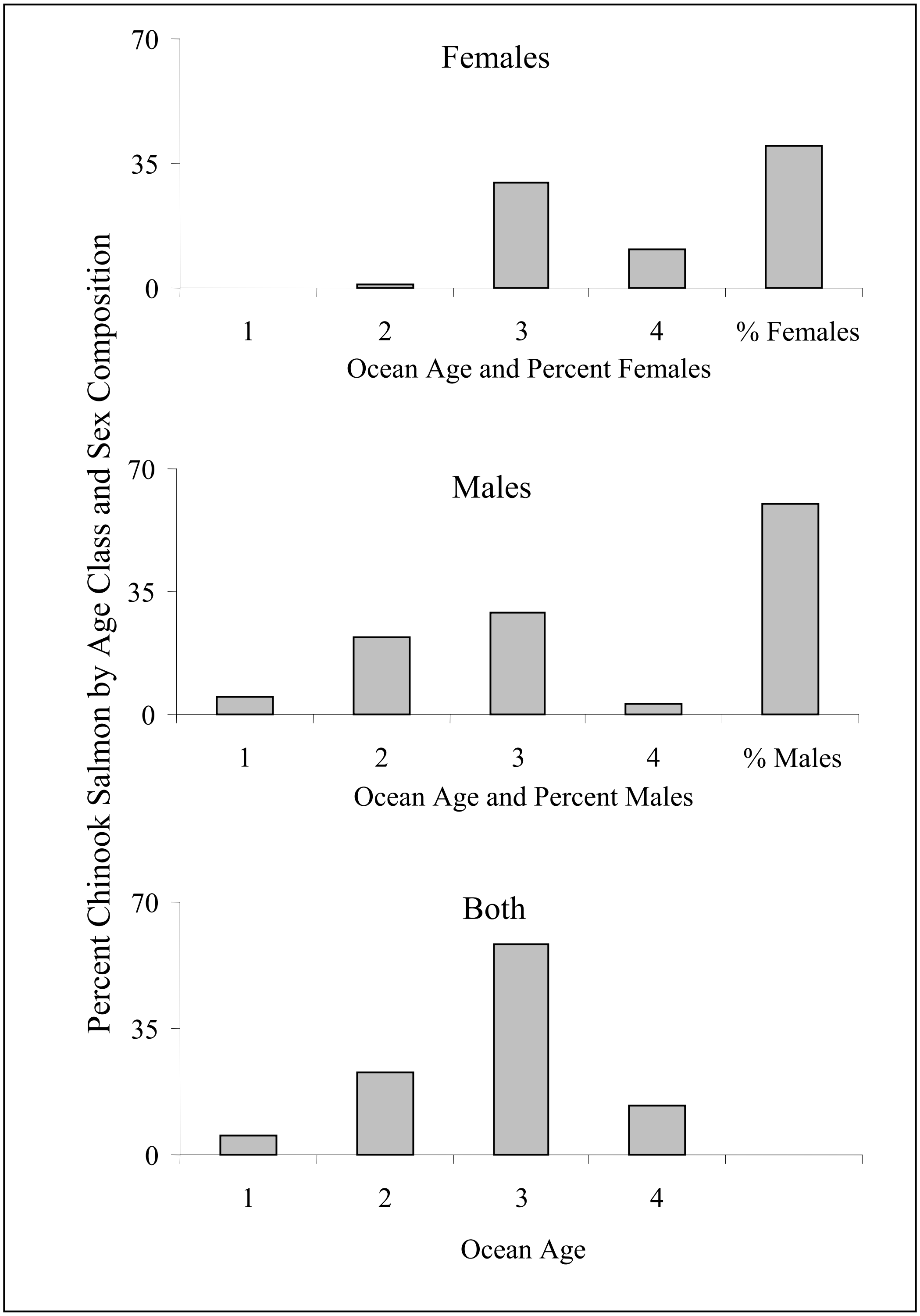


Figure 15.–Estimated age and sex composition of Anchor River Chinook salmon escapement, 2003.

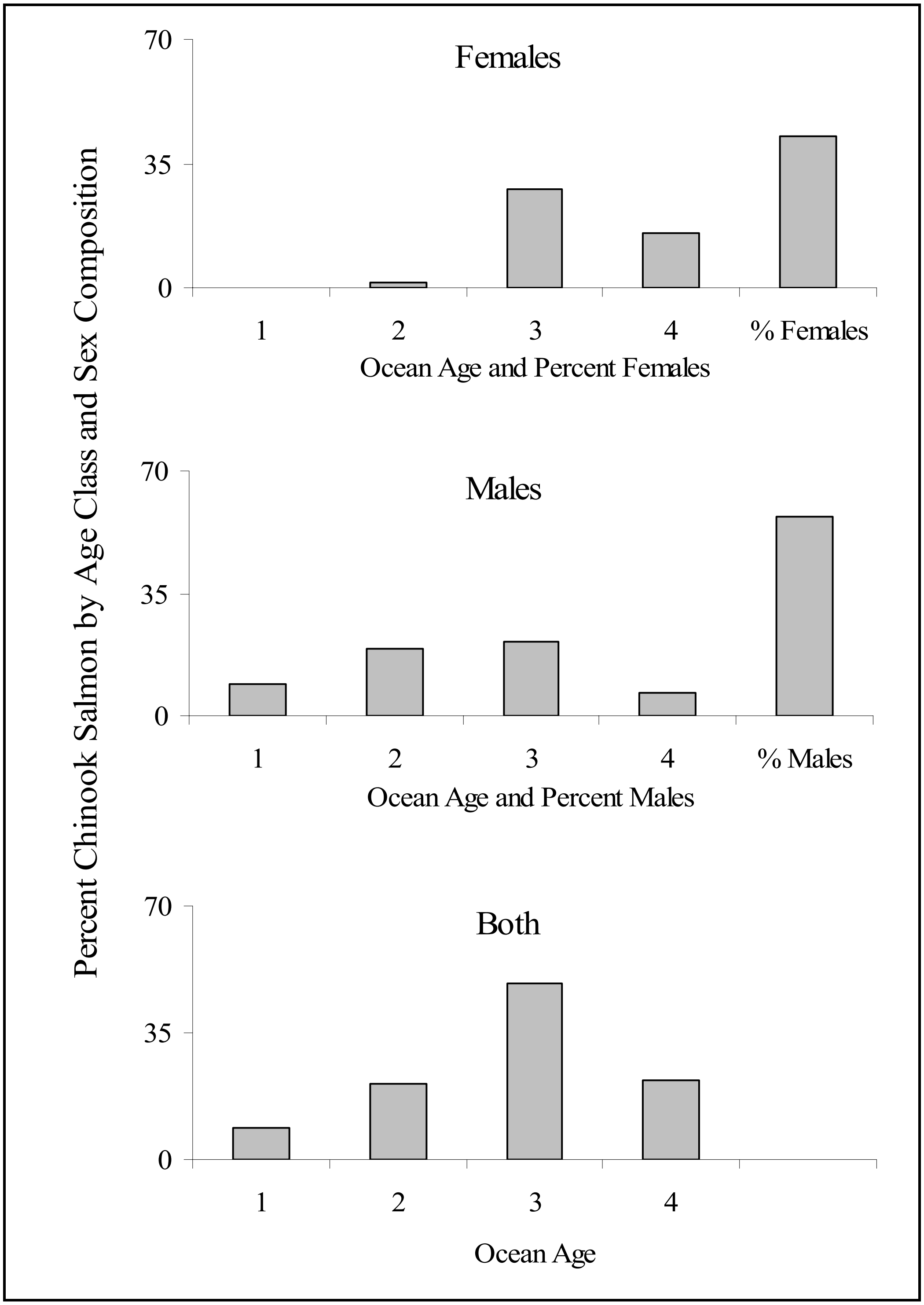


Figure 16.–Estimated age and sex composition of Anchor River Chinook salmon escapement, 2004.

Coho Salmon

Overall, age-2.1 was the dominant age class of Anchor River coho salmon females (50.7%, SE = 3.5%) and males (33.7%, SE = 3.3%; Table 15; Figure 17). The remaining age classes sampled for the escapement were composed of age-1.1 (11.2%, SE = 2.2), 3.1 (3.4%, SE = 1.3), and 2.2 (1.0%, SE = 0.7) classes. The percent of females to males was (60.5%: 39.5%).

Straying

All decoded coded wired tags from the Chinook salmon sample collected in 2003 and 2004 were strays from the Ninilchik River supplementation program (Table 16, from Kerkvliet *In prep*). In 2003, six Chinook salmon missing adipose fins were sampled during netting, of which three CWTs were recovered. In 2004, six Chinook salmon CWT samples were collected from South Fork netting (n = 4) and at the North Fork weir (n = 2). No coho salmon missing an adipose was detected during ASL sampling.

DISCUSSION

The application of the new DIDSON technology in 2003 allowed the Department to estimate Anchor River Chinook salmon escapement for the first time during high spring flows (Table 4). In 2004, initially the DIDSON system was used to estimate Chinook salmon escapement but when water levels receded, a weir was installed to continue monitoring Chinook salmon and to census coho salmon escapement which was last monitored in 1992.

The 2003 and 2004 Chinook salmon escapement estimates were much higher than previously suggested from historic aerial survey data (Tables 3 and 4; Figure 3; Kerkvliet et al. 2004a). Also the high Chinook salmon escapements highlighted the low exploitation rates. In 2003, the fresh water harvest of Anchor River Chinook salmon indicated exploitation was less than 10.9% (1,011/9,238); and in 2004 exploitation was 12.9% (1,561/12,016; Tables 2 and 4; Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006a, b, 2007; Mills 1979-1980, 1981a-b, 1982-1994; Walker et al. 2003). On July 7, 2004 the Department issued an emergency order (EO; 2-KS-7-07-04) because of the high escapement and expected low exploitation of Chinook salmon. The EO added a 5th weekend (June 26 to June 28) of fishing for Chinook salmon and marked a transition from basing decisions for managing Anchor River Chinook salmon on an SEG to basing decisions on DIDSON/weir escapement counts.

At the November 11-13, 2004 Alaska Board of Fisheries meeting, the Board rescinded the stock of management concern designation and removed the SEG for Anchor River Chinook salmon based on recommendations from the Department. The Board also approved a proposal to liberalize the sport fishery for Chinook salmon by increasing the opening weekends from 4 to 5, with the 5th opening weekend added before Memorial Day. The Department advised the 2004 Board that there was insufficient data to establish an escapement goal for Anchor River; however, if the Department could collect the necessary data they will propose a goal for the 2007 Board meeting.

We only have 2 years of data to assess the relationship between Chinook salmon escapement estimates and aerial index counts (Table 7). In 2004 the percentage of the total Chinook salmon escapement counted through the North Fork weir (16%) was close to the percentage calculated from the total aerial survey count (12%) flown on July 31 (Appendix D1). With respect to the number of Chinook salmon seen from the air compared to DIDSON/weir counts, only about 13% (951/12,016) of the escapement was seen during the aerial survey of the North and South fork

Table 15.–The estimated age, sex, and length composition of Anchor River 2004 coho salmon escapement.

	Age Class [a]					Sex
	1.1	2.1	2.2	3.1	Total [b]	composition [c]
Female sampled	11	104	1	5	121	161
Percent	5.4	50.7	0.5	2.4		60.5
SE percent	1.6	3.5	0.5	1.1		3.0
Estimated abundance	309	2,904	29	137		3,465
SE abundance	90	201	28	62		172
Mean length	581	573	618	615	576	
SE mean length	15	4	NA	10	4	
Male sampled	12	69	1	2	84	105
Percent	5.9	33.7	0.5	1		39.5
SE percent	1.6	3.3	0.5	0.7		3.0
Estimated abundance	338	1,930	29	57		2,263
SE abundance	94	190	28	39		172
Mean length	566	578	580	618	577	
SE mean length	10	6	NA	23	5	
Male and Female sampled	23	173	2	7	205	266
Percent	11.2	84.4	1	3.4		100.0
SE percent	2.2	2.5	0.7	1.3		
Estimated abundance	642	4,834	57	195		5,728
SE abundance	127	146	39	73		
Mean length	573	575	594	616	576	
SE mean length	9	3	24	9	9	

[a] Sample size of aged coho salmon collected at the Anchor River mainstem weir.

[b] Sex/age components do not necessarily sum to sex pooled over age or age pooled over sex due to missing sex for age data and missing age for sex data.

[c] Sample size by sex of coho salmon collected at the Anchor River mainstem weir.

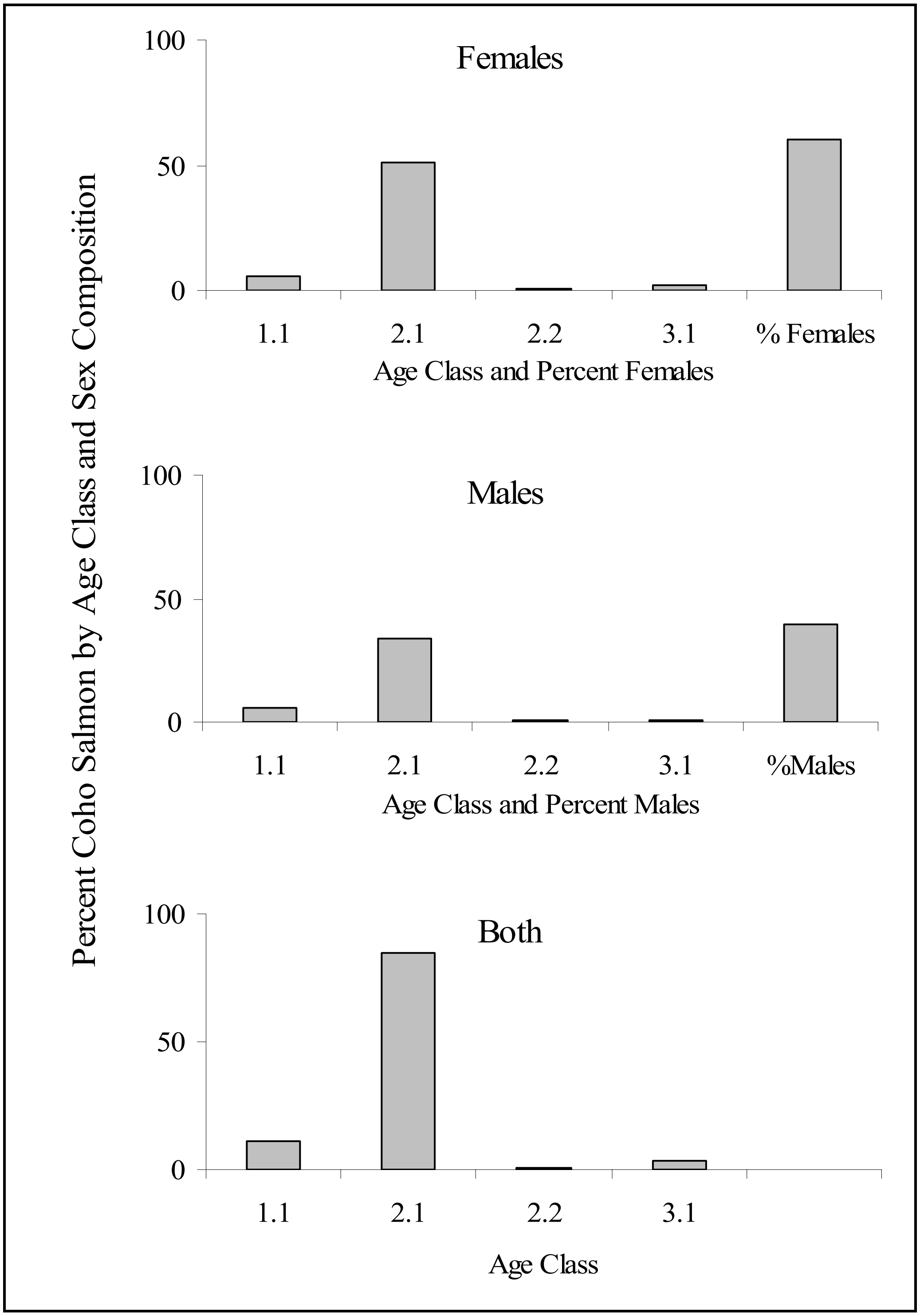


Figure 17.–Estimated age and sex composition of Anchor River coho salmon escapement, 2004.

Table 16.–Coded wire tag data for Chinook salmon recovered at Anchor River, 2003-2004.

Year	CWT Code[a]	Brood Year	Hatchery	Release Date	Release Site	Age[b] Fresh	Age[b] Ocean	Total Samples
2003	310147	2001	Fort Richardson	6/14/02	Ninilchik River[c]	1	4	1
	310260	2000	Fort Richardson	6/13/01	Ninilchik River[c]	1	2	2
	No tag[d]							3
2004	310260	2000	Fort Richardson	6/13/01	Ninilchik River[c]	1	3	6
Total								12

Source: ADF&G. 2004. Online coded wire tag report, updated September 3, 2004 at 1:19:05 PM. Alaska Department of Fish and Game, Mark Tag and Age Laboratory, Juneau. http://tagotoweb.adfg.state.ak.us/CWT/reports/d.

[a] CWT=coded wire tag.

[b] Fresh and ocean ages were determined by comparing brood year, release year, and recovery year.

[c] Statistical area 244-20.

[d] No CWT found in these Chinook salmon with missing adipose fins.

flown on July 31, 2004. Comparisons between the 2003 aerial survey counts and DIDSON counts are more complex. The DIDSON escapement count (9,238) is a minimum count because monitoring did not span the entire run and the aerial escapement index represents less than 8% (723/9,238) of the 2003 escapement estimate.

In 2004, the later and protracted run timing at North Fork weir may be attributed to differences in counting methods (DIDSON versus weir counts), and/or stock differences between Chinook salmon spawning in North Fork versus South Fork. Peak counts were collected on the mainstem with the DIDSON system. The DIDSON allows fish to migrate freely upstream, while the North Fork weirs blocks fish from migration upstream when the live box is closed. Fish that were not allowed to swim upstream when the live box was closed often waited behind the weir even after the live box was opened. This waiting behavior at the weir could partially account for the later run timing of North Fork Chinook salmon.

Stock differences may also account for the later and protracted run timing of North Fork Chinook salmon and may be partially explained by differences in stream length between the North and South fork (Table 1). Chinook salmon radiotelemetry studies conducted on the Kuskokwim and Yukon rivers found that fish tagged early in the season migrate farther upstream than fish tagged later (Stuby 2005; Spencer et al. 2005). Considering that North Fork (149 rkm) is about half as long as the South Fork (352 rkm), the run timing of North Fork Chinook salmon may be later than those returning to South Fork.

Stream length may also partially account for Chinook salmon returning earlier to Anchor River than Ninilchik River. By road, Ninilchik River is located approximately 32 km (20 miles) north of Anchor River. The anadromous stream length of Ninilchik River is approximately 81 rkm, which is about 3 times smaller than Anchor River (Table 1; Figure 1). Ninilchik River Chinook salmon escapement is monitored from a weir located approximately 4 rkm farther upstream than the Anchor River mainstream site (Begich 2007; Kerkvliet *In prep*). Chinook salmon returned later to Ninilchik River than Anchor River in 2003 and 2004 based on the dates when 50% of the escapement was reached. In 2003, 50% of the wild Chinook salmon escapement was counted at Ninilchik River weir by July 4, 25 days after the midpoint of the escapement was reached at the Anchor River DIDSON site (June 10). In 2004, the midpoint of the total wild escapement was again reached later at Ninilchik River weir (July 4) than Anchor River DIDSON/weir site (June 6), a 20 day difference. Also, peak passage (25% to 75%) of Chinook salmon was more protracted in 2003 and 2004 at Ninilchik River weir (36 days, June 14 to July 19; 27 days, June 22 to July 18, respectively) than the Anchor River DIDSON site (16 days, June 4 to June 19; 17 days, May 28 to June 13, respectively). Although run timing differences between the Ninilchik and Anchor River may be partially attributed to differences in counting methods (DIDSON versus weir) and distance from the river mouth, timing differences may not be entirely explained by method or location. Rather, timing differences may signify stock specific behavior.

The diel migratory patterns of Chinook salmon in 2003 and 2004 were not only interesting from the biological aspect; the patterns may prove useful as a means of extrapolation when the DIDSON system malfunctions (Table 12; Figure 10). For example if the DIDSON system malfunctions between 0100 to 1900 hours, hourly counts could be extrapolated from the previous and following days for the same hours rather than using hourly counts surrounding the data gap, as done in this study. Also the diel patterns will prove useful in designing crew schedules to insure the DIDSON system is checked more frequently during peak migration periods.

Culling DIDSON counts due to species other than Chinook salmon was not necessary in 2004, but was necessary in 2003. We culled counts based on the percentage of Chinook salmon captured in the South and North forks. Advances in the DIDSON software are being tested, and we are hopeful of directly culling DIDSON images based on length data in the future (Burwen et al. 2007).

The count diagnostics results from the 2003 data set indicate the bias is low between estimates using 20-minute counts expanded to the hour and hourly counts (Table 8). This result validates the 2004 estimate and helps in future planning. In the future, estimates will be based on expanded 20-minute counts. Furthermore, the low variability between crew counts from the 2004 data set validates the 2003 and 2004 counts and provides a quality control method to use in the future (Tables 10-11).

Variance in counts from the 2003 data set show problems with counting images when a large number of fish are moving through the ensonification zone (Table 9). Fortunately most of the counts (~ 79%) were observed when passage rates were from 0 to 15 fish which is located on x-axis of the plot (Figure 8) before the acceleration of the variance passage relationship. In the future, DIDSON upgrades may include a narrower beam, which should decrease background noise and increase image quality. Any improvement in image quality should help decrease the variance.

The 2004 coho salmon escapement (n = 5,728) was more similar to the 1992 escapement (n = 4,596) than the other years when the coho salmon run was monitored (1987 (n = 2,409), 1988 (n = 2,805) or 1989 (n = 20,187); Table 4). In July and August, anglers reported good to excellent coho salmon fishing at the mouth of the Anchor River, but not in the river where conditions were described as unusually warm and low. The dramatic surge of coho salmon at the mainstem weir site that coincided with rising river levels on September 3 and 4 typifies coho salmon migratory and milling behavior. Milling behavior contributed to differences in travel speed of coho salmon in a Kuskokwim River tagging study; suggesting why some coho salmon tagged early in the run traveled slower than others tagged later in the run (Kerkvliet et al. 2004b). Similar to Anchor River in 2004, when river levels were very low in Kuskokwim River tributaries, large numbers of coho salmon were also reported at or near tributary mouths.

In the future, the department will estimate Anchor River Chinook and coho salmon escapements using sonar and weir counts from mid-May through mid-September. The operation of the North Fork weir to monitor Chinook and coho salmon escapement is not planned. Opportunistic counts of steelhead, pink salmon, and Dolly Varden will be collected throughout the project operation. The department will continue to index Chinook salmon using aerial surveys. The department will attempt to relate Chinook salmon aerial survey indices to DIDSON/weir counts to understand historic escapement levels so that an appropriate escapement goal range can be developed for Anchor River Chinook salmon.

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APPENDIX A. ESCAPEMENT COUNTS FOR 2003 AND 2004

Appendix A1.–Daily escapement of Chinook salmon based on DIDSON counts at Anchor River sonar site, 2003.

Date		DIDSON Counts		Chinook Salmon Estimate		
		Unadjusted [a]	Adjustment [b]	Adjusted Count [c]	Cumulative	Percent
30-May		163	0	163	163	2
31-May		339	0	339	502	5
1-Jun		902	0	902	1,404	15
2-Jun		342	0	342	1,746	19
3-Jun		456	0	456	2,202	24
4-Jun		375	0	375	2,577	28
5-Jun		528	0	528	3,105	34
6-Jun		385	0	385	3,490	38
7-Jun		224	0	224	3,714	40
8-Jun		460	0	460	4,174	45
9-Jun		323	0	323	4,497	49
10-Jun		584	0	584	5,081	55
11-Jun		158	0	158	5,239	57
12-Jun		121	0	121	5,360	58
13-Jun		181	0	181	5,541	60
14-Jun		499	0	499	6,040	65
15-Jun		265	0	265	6,305	68
16-Jun		213	0	213	6,518	71
17-Jun		166	0	166	6,684	72
18-Jun	[d]	107	-1	106	6,790	74
19-Jun		119	0	119	6,909	75
20-Jun		97	0	97	7,006	76
21-Jun		191	0	191	7,197	78
22-Jun		148	0	148	7,345	80
23-Jun		193	0	193	7,538	82
24-Jun		170	0	170	7,708	83
25-Jun	[e]	169	-11	158	7,866	85
26-Jun	[e]	139	-18	121	7,987	86
27-Jun	[e]	135	-26	109	8,096	88
28-Jun	[e]	175	-45	130	8,226	89

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Date		DIDSON Counts		Chinook Salmon Estimate		
		Unadjusted [a]	Adjustment [b]	Adjusted Count [c]	Cumulative	Percent
29-Jun	e	125	-40	85	8,311	90
30-Jun	e	285	-110	175	8,486	92
1-Jul	e	296	-133	163	8,649	94
2-Jul	e	660	-339	321	8,970	97
3-Jul	f	136	-68	68	9,038	98
4-Jul	f	27	-13	14	9,052	98
5-Jul	f	37	-17	20	9,071	98
6-Jul	f	19	-9	10	9,082	98
7-Jul	f	32	-14	18	9,100	99
8-Jul	f	94	-40	54	9,154	99
9-Jul	f	142	-58	84	9,238	100
Total		10,180	-946	9,238		

[a] Daily hourly fish count based on DIDSON files, and a partial weir.

[b] The number of fish subtracted from the daily fish count to adjust for non-Chinook salmon caught in nets in the North Fork or South Fork.

[c] The number of Chinook salmon based on apportioned DIDSON counts.

[d] The first non-Chinook salmon was caught in nets; catch from the South Fork was 1 pink salmon and 92 Chinook salmon.

[e] DIDSON counts were adjusted based on the following net catches:

June 24 (net catch = 140 Chinook salmon) and

July 02 (net catch = 19 Chinook salmon, 6 pink salmon, and 24 Dolly Varden).

[f] DIDSON counts were adjusted based on the following net catches:

July 02 (net catch = 19 Chinook salmon, 6 pink salmon, and 24 Dolly Varden), and

July 10 (net catch = 18 Chinook salmon, 13 pink salmon, and 3 Dolly Varden).

Appendix A2.–Daily escapement of Chinook salmon, Dolly Varden, and pink, chum, sockeye, and coho salmon, and steelhead trout past the Anchor River DIDSON/weir site, 2004.

	Chinook Salmon [a]			Coho Salmon			Pink Salmon			Chum Salmon			Sockeye Salmon			Dolly Varden			Rainbow trout / Steelhead		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent
5/15 [b]	69	69	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/16 [b]	45	114	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/17 [b]	68	182	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/18 [b]	191	373		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/19 [b]	99	472	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/20 [b]	258	730	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/21 [b]	345	1,075	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/22 [b]	303	1,378	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/23 [b]	396	1,774	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/24 [b]	203	1,977	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/25 [b]	195	2,172	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/26 [b]	316	2,488	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/27 [b]	210	2,698	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/28 [b]	310	3,008	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/29 [b]	355	3,363	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/30 [b]	213	3,576	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/31 [b]	287	3,863	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/01 [b]	520	4,383	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/02 [b]	464	4,847	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/03 [b]	482	5,329	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/04 [b]	225	5,554	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/05 [b]	230	5,784	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/06 [b]	465	6,249	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/07 [b]	369	6,618	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/08 [b]	567	7,185	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/09 [c]	489	7,674	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/10 [d]	251	7,925	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11 [e]	428	8,353	70	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
6/12 [e]	563	8,916	74	0	0	0	0	0	0	0	0	0	0	0	0	7	8	0	0	0	0
6/13 [e]	178	9,094	76	0	0	0	0	0	0	0	0	0	0	0	0	2	10	0	0	0	0
6/14 [e]	201	9,295	77	0	0	0	0	0	0	0	0	0	0	0	0	5	15	0	0	0	0
6/15 [e]	140	9,435	79	0	0	0	0	0	0	0	0	0	0	0	0	1	16	0	0	0	0
6/16 [e]	273	9,708	81	0	0	0	0	0	0	0	0	0	0	0	0	5	21	0	0	0	0
6/17 [e]	251	9,959	83	0	0	0	0	0	0	0	0	0	0	0	0	1	22	0	0	0	0
6/18 [e]	275	10,234	85	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0
6/19 [e]	80	10,314	86	0	0	0	0	0	0	0	0	0	0	0	0	10	32	0	0	0	0
6/20 [e]	81	10,395	87	0	0	0	0	0	0	0	0	0	0	0	0	5	37	0	0	0	0
6/21 [e]	75	10,470	87	0	0	0	0	0	0	0	0	0	0	0	0	5	42	1	0	0	0
6/22 [e]	106	10,576	88	0	0	0	0	0	0	0	0	0	0	0	0	9	51	1	0	0	0
6/23 [e]	38	10,614	88	0	0	0	0	0	0	0	0	0	0	0	0	6	57	1	0	0	0

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	Chinook Salmon [a]			Coho Salmon			Pink Salmon			Chum Salmon			Sockeye Salmon			Dolly Varden			Rainbow trout / Steelhead		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent
6/24 [e]	42	10,656	89	0	0	0	0	0	0	0	0	0	0	0	0	5	62	1	0	0	0
6/25 [e]	61	10,717	89	0	0	0	0	0	0	0	0	0	0	0	0	4	66	1	0	0	0
6/26 [e]	63	10,780	90	0	0	0	2	2	0	0	0	0	0	0	0	2	68	1	0	0	0
6/27 [e]	77	10,857	90	0	0	0	1	3	0	0	0	0	0	0	0	8	76	1	0	0	0
6/28 [e]	46	10,903	91	0	0	0	0	3	0	0	0	0	0	0	0	12	88	1	0	0	0
6/29 [e]	31	10,934	91	0	0	0	0	3	0	0	0	0	0	0	0	38	126	2	0	0	0
6/30 [e]	34	10,968	91	0	0	0	2	5	0	0	0	0	0	0	0	18	144	2	0	0	0
7/01 [e]	20	10,988	91	0	0	0	0	5	0	0	0	0	1	1	2	28	172	2	0	0	0
7/02 [e]	73	11,061	92	0	0	0	2	7	1	0	0	0	1	2	4	131	303	4	0	0	0
7/03 [e]	31	11,092	92	0	0	0	9	16	1	0	0	0	0	2	4	34	337	4	0	0	0
7/04 [e]	63	11,155	93	0	0	0	6	22	2	0	0	0	1	3	7	11	348	4	0	0	0
7/05 [e]	52	11,207	93	0	0	0	2	24	2	0	0	0	0	3	7	32	380	5	0	0	0
7/06 [e]	45	11,252	94	0	0	0	7	31	3	0	0	0	0	3	7	68	448	6	0	0	0
7/07 [e]	10	11,262	94	0	0	0	6	37	3	0	0	0	0	3	7	87	535	7	0	0	0
7/08 [e]	37	11,299	94	0	0	0	4	41	4	0	0	0	0	3	7	55	590	8	0	0	0
7/09 [e]	40	11,339	94	0	0	0	12	53	5	0	0	0	1	4	9	97	687	9	0	0	0
7/10 [e]	93	11,432	95	0	0	0	18	71	7	0	0	0	0	4	9	233	920	12	0	0	0
7/11 [e]	76	11,508	96	0	0	0	13	84	8	0	0	0	0	4	9	261	1,181	15	0	0	0
7/12 [e]	27	11,535	96	0	0	0	9	93	9	0	0	0	0	4	9	153	1,334	17	0	0	0
7/13 [e]	7	11,542	96	0	0	0	4	97	9	0	0	0	0	4	9	185	1,519	19	0	0	0
7/14 [e]	38	11,580	96	0	0	0	20	117	11	0	0	0	0	4	9	450	1,969	25	0	0	0
7/15 [e]	31	11,611	97	0	0	0	15	132	12	0	0	0	0	4	9	187	2,156	27	0	0	0
7/16 [e]	12	11,623	97	2	2	0	12	144	13	0	0	0	0	4	9	861	3,017	38	0	0	0
7/17 [e]	29	11,652	97	0	2	0	14	158	15	1	1	1	0	4	9	311	3,328	42	0	0	0
7/18 [e]	64	11,716	98	0	2	0	9	167	15	0	1	1	0	4	9	1,231	4,559	58	0	0	0
7/19 [e]	59	11,775	98	0	2	0	13	180	17	0	1	1	0	4	9	301	4,860	62	0	0	0
7/20 [f]	14	11,789	98	0	2	0	0	180	17	0	1	1	0	4	9	1,004	5,864	75	0	0	0
7/21 [g]	13	11,802	98	0	2	0	4	184	17	0	1	1	0	4	9	153	6,017	77	0	0	0
7/22 [h]	19	11,821	98	0	2	0	10	194	18	0	1	1	0	4	9	394	6,411	82	0	0	0
7/23 [i]	9	11,830	98	0	2	0	0	194	18	0	1	1	0	4	9	708	7,119	91	0	0	0
7/24 [e]	3	11,833	98	0	2	0	12	206	19	1	2	3	1	5	11	68	7,187	92	0	0	0
7/25 [e]	1	11,834	98	0	2	0	5	211	20	0	2	3	0	5	11	51	7,238	92	0	0	0
7/26 [e]	34	11,868	99	20	22	0	131	342	32	8	10	13	2	7	16	211	7,449	95	0	0	0
7/27 [e]	25	11,893	99	4	26	0	201	543	50	8	18	23	0	7	16	86	7,535	96	0	0	0
7/28 [e]	18	11,911	99	5	31	1	20	563	52	4	22	28	0	7	16	48	7,583	97	0	0	0
7/29 [e]	11	11,922	99	0	31	1	30	593	55	12	34	43	0	7	16	109	7,692	98	0	0	0
7/30 [e]	14	11,936	99	1	32	1	6	599	56	0	34	43	0	7	16	33	7,725	98	0	0	0
7/31 [e]	15	11,951	99	2	34	1	18	617	57	8	42	53	0	7	16	40	7,765	99	0	0	0

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	Chinook Salmon [a]			Coho Salmon			Pink Salmon			Chum Salmon			Sockeye Salmon			Dolly Varden			Rainbo
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count
8/01 [e]	2	11,953	99	12	46	1	11	628	58	3	45	57	0	7	16	34	7,799	99	0
8/02 [e]	12	11,965	100	1	47	1	14	642	59	4	49	62	2	9	20	15	7,814	100	1
8/31 [e]	0	11,965	100	16	63	1	9	651	60	1	50	63	6	15	33	0	7,814	100	1
8/03 [e]	7	11,972	100	8	71	1	12	663	61	2	52	66	0	15	33	4	7,818	100	0
8/04 [e]	12	11,984	100	0	71	1	8	671	62	0	52	66	1	16	36	0	7,818	100	0
8/05 [e]	5	11,989	100	2	73	1	7	678	63	0	52	66	3	19	42	4	7,822	100	0
8/06 [e]	6	11,995	100	5	78	1	4	682	63	2	54	68	0	19	42	6	7,828	100	0
8/07 [e]	3	11,998	100	2	80	1	2	684	63	0	54	68	2	21	47	3	7,831	100	0
8/08 [e]	2	12,000	100	6	86	2	0	684	63	0	54	68	0	21	47	2	7,833	100	0
8/09 [e]	8	12,008	100	6	92	2	2	686	64	0	54	68	1	22	49	1	7,834	100	0
8/10 [e]	2	12,010	100	11	103	2	2	688	64	0	54	68	1	23	51	0	7,834	100	0
8/11 [e]	1	12,011	100	34	137	2	1	689	64	0	54	68	0	23	51	0	7,834	100	0
8/12 [e]	1	12,012	100	19	156	3	3	692	64	2	56	71	1	24	53	0	7,834	100	0
8/13 [e]	0	12,012	100	12	168	3	0	692	64	0	56	71	2	26	58	0	7,834	100	0
8/14 [e]	0	12,012	100	8	176	3	1	693	64	1	57	72	3	29	64	1	7,835	100	0
8/15 [e]	0	12,012	100	46	222	4	6	699	65	1	58	73	2	31	69	1	7,836	100	0
8/16 [e]	1	12,013	100	82	304	5	0	699	65	1	59	75	1	32	71	0	7,836	100	0
8/17 [e]	0	12,013	100	117	421	7	0	699	65	0	59	75	2	34	76	0	7,836	100	0
8/18 [e]	0	12,013	100	97	518	9	0	699	65	2	61	77	1	35	78	0	7,836	100	0
8/19 [e]	0	12,013	100	41	559	10	2	701	65	1	62	78	2	37	82	0	7,836	100	0
8/20 [e]	0	12,013	100	204	763	13	20	721	67	2	64	81	2	39	87	0	7,836	100	0
8/21 [e]	0	12,013	100	59	822	14	2	723	67	0	64	81	4	43	96	0	7,836	100	0
8/22 [e]	0	12,013	100	30	852	15	8	731	68	6	70	89	0	43	96	0	7,836	100	0
8/23 [e]	0	12,013	100	19	871	15	8	739	68	0	70	89	0	43	96	0	7,836	100	0
8/24 [e]	0	12,013	100	55	926	16	21	760	70	1	71	90	1	44	98	0	7,836	100	1
8/25 [e]	2	12,015	100	37	963	17	10	770	71	2	73	92	0	44	98	1	7,837	100	0
8/26 [e]	0	12,015	100	30	993	17	20	790	73	0	73	92	0	44	98	0	7,837	100	0
8/27 [e]	0	12,015	100	14	1,007	18	11	801	74	1	74	94	0	44	98	0	7,837	100	0
8/28 [e]	0	12,015	100	20	1,027	18	19	820	76	0	74	94	0	44	98	0	7,837	100	0
8/29 [e]	0	12,015	100	23	1,050	18	10	830	77	0	74	94	0	44	98	0	7,837	100	1
8/30 [e]	0	12,015	100	28	1,078	19	10	840	78	0	74	94	1	45	100	0	7,837	100	0

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	Chinook Salmon [a]			Coho Salmon			Pink Salmon			Chum Salmon			Sockeye Salmon			Dolly Varden			Rainbo
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count
9/01 [e]	0	12,015	100	30	1,108	19	8	848	79	1	75	95	0	45	100	0	7,837	100	0
9/02 [e]	0	12,015	100	3,666	4,774	83	172	1,020	95	0	75	95	0	45	100	5	7,842	100	1
9/03 [e]	0	12,015	100	825	5,599	98	15	1,035	96	1	76	96	0	45	100	3	7,845	100	5
9/04 [e]	0	12,015	100	11	5,610	98	6	1,041	96	0	76	96	0	45	100	0	7,845	100	1
9/05 [e]	0	12,015	100	1	5,611	98	6	1,047	97	0	76	96	0	45	100	1	7,846	100	0
9/06 [e]	0	12,015	100	9	5,620	98	3	1,050	97	3	79	100	0	45	100	0	7,846	100	3
9/07 [e]	0	12,015	100	12	5,632	98	6	1,056	98	0	79	100	0	45	100	0	7,846	100	2
9/08 [e]	0	12,015	100	13	5,645	99	5	1,061	98	0	79	100	0	45	100	0	7,846	100	2
9/09 [e]	0	12,015	100	7	5,652	99	5	1,066	99	0	79	100	0	45	100	0	7,846	100	1
9/10 [e]	0	12,015	100	5	5,657	99	6	1,072	99	0	79	100	0	45	100	0	7,846	100	1
9/11 [e]	0	12,015	100	16	5,673	99	3	1,075	100	0	79	100	0	45	100	0	7,846	100	0
9/12 [e j]	0	12,015	100	33	5,706	100	4	1,079	100	0	79	100	0	45	100	0	7,846	100	0
9/13 [e]	1	12,016	100	22	5,728	100	0	1,079	100	0	79	100	0	45	100	0	7,846	100	0

Note: “-“ = value can’t be computed due to limitations of the data.

[a] Escapement estimate of Chinook salmon is 12,016 (SE = 283)

[b] Based on a partial weir and expanded 20-minute counts of DIDSON files and 1 hour counts (n = 60 hours) from May 15 to June 8.

[c] Based on combined 20-minute counts of DIDSON from 0001 to 1359 hours and on combined DIDSON and weir counts from 1400 to 0000 hours.

[d] Based on combined 20-minute counts of DIDSON and weir counts from 0001 to 0759 hours and on hand counts through a complete resistance weir starting at 0800 hours.

[e] Based on hand counts through a complete resistance board weir.

[f] Based on hourly DIDSON sonar counts through a complete resistance board weir from 0000 to 0700 hours and hand counts.

[g] Based on hourly DIDSON sonar counts through a complete resistance board weir from 1700 to 0000 hours and hand counts.

[h] Based on hourly DIDSON sonar counts through a complete resistance board weir from 0001 to 0800 hours, 1700 to 0000 hours, and hand counts

[i] Based on hourly DIDSON sonar counts through a complete resistance board weir from 0001 to 0700 hours, and hand counts.

[j] 350 fish counted from the weir site downstream to the mouth of Anchor River on 9/12/04.

Appendix A3.–Daily escapement of Chinook salmon, Dolly Varden, and pink, chum, sockeye, and coho salmon, and steelhead trout past the weir on the North Fork of Anchor River, 2004.

	Chinook Salmon			Coho Salmon			Pink Salmon			Sockeye Salmon			Chum Salmon			Dolly Varden			Rainbow trout / Steelhead		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent
5/15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5/16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5/17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5/18	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/19	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/20	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/21	13	22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/22	26	48	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/23	39	87	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/24	38	125	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25	38	163	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26	10	173	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27	10	183	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/28	0	183	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/29	25	208	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/30	65	273	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/31	28	301	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/01	73	374	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/02	67	441	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/03	63	504	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/04	65	569	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/05	50	619	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/06	98	717	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/07	43	760	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/08	29	789	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/09	30	819	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/10	7	826	43	0	0	0	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0
6/11	9	835	44	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/12	37	872	45	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/13	52	924	48	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/14	44	968	50	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/15	25	993	52	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/16	8	1,001	52	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/17	44	1,045	54	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/18	113	1,158	60	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/19	35	1,193	62	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/20	30	1,223	64	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/21	6	1,229	64	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/22	17	1,246	65	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/23	15	1,261	66	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0

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	Chinook Salmon			Coho Salmon			Pink Salmon			Sockeye Salmon			Chum Salmon			Dolly Varden			Rainbow trout / Steelhead		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent
6/24	19	1,280	67	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/25	19	1,299	68	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/26	21	1,320	69	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/27	41	1,361	71	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/28	21	1,382	72	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/29	9	1,391	72	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
6/30	15	1,406	73	0	0	0	0	0	0	1	2	5	0	0	0	3	3	1	0	0	0
7/01	23	1,429	74	0	0	0	0	0	0	0	2	5	0	0	0	0	3	1	0	0	0
7/02	2	1,431	75	0	0	0	0	0	0	0	2	5	0	0	0	2	5	2	0	0	0
7/03	2	1,433	75	0	0	0	0	0	0	0	2	5	0	0	0	2	7	2	0	0	0
7/04	19	1,452	76	0	0	0	0	0	0	0	2	5	0	0	0	4	11	3	0	0	0
7/05	65	1,517	79	0	0	0	0	0	0	0	2	5	0	0	0	4	15	5	0	0	0
7/06	31	1,548	81	0	0	0	0	0	0	0	2	5	0	0	0	3	18	6	0	0	0
7/07	22	1,570	82	0	0	0	1	1	0	0	2	5	0	0	0	1	19	6	0	0	0
7/08	11	1,581	82	0	0	0	1	2	1	0	2	5	0	0	0	1	20	6	0	0	0
7/09	15	1,596	83	0	0	0	0	2	1	0	2	5	0	0	0	1	21	7	0	0	0
7/10	10	1,606	84	0	0	0	0	2	1	0	2	5	0	0	0	0	21	7	0	0	0
7/11	14	1,620	84	0	0	0	0	2	1	0	2	5	0	0	0	0	21	7	0	0	0
7/12	21	1,641	86	0	0	0	0	2	1	0	2	5	0	0	0	2	23	7	0	0	0
7/13	5	1,646	86	0	0	0	0	2	1	0	2	5	0	0	0	9	32	10	0	0	0
7/14	3	1,649	86	0	0	0	0	2	1	0	2	5	0	0	0	8	40	13	0	0	0
7/15	4	1,653	86	0	0	0	0	2	1	0	2	5	0	0	0	19	59	19	0	0	0
7/16	0	1,653	86	0	0	0	0	2	1	0	2	5	0	0	0	9	68	21	0	0	0
7/17	2	1,655	86	0	0	0	0	2	1	0	2	5	0	0	0	0	68	21	0	0	0
7/18	10	1,665	87	0	0	0	0	2	1	0	2	5	0	0	0	4	72	23	0	0	0
7/19	4	1,669	87	0	0	0	0	2	1	0	2	5	0	0	0	2	74	23	0	0	0
7/20	3	1,672	87	0	0	0	0	2	1	0	2	5	0	0	0	1	75	24	0	0	0
7/21	1	1,673	87	0	0	0	0	2	1	0	2	5	0	0	0	2	77	24	0	0	0
7/22	7	1,680	88	0	0	0	2	4	1	0	2	5	0	0	0	21	98	31	0	0	0
7/23	2	1,682	88	0	0	0	0	4	1	0	2	5	0	0	0	20	118	37	0	0	0
7/24	0	1,682	88	0	0	0	1	5	1	0	2	5	0	0	0	1	119	37	0	0	0
7/25	9	1,691	88	0	0	0	1	6	2	0	2	5	0	0	0	3	122	38	0	0	0
7/26	49	1,740	91	0	0	0	9	15	4	0	2	5	0	0	0	16	138	43	0	0	0
7/27	65	1,805	94	0	0	0	50	65	17	3	5	14	0	0	0	52	190	60	0	0	0
7/28	31	1,836	96	0	0	0	22	87	23	0	5	14	0	0	0	15	205	64	0	0	0
7/29	21	1,857	97	0	0	0	4	91	24	0	5	14	0	0	0	6	211	66	0	0	0
7/30	11	1,868	97	0	0	0	6	97	26	0	5	14	0	0	0	15	226	71	0	0	0
7/31	17	1,885	98	0	0	0	5	102	27	0	5	14	0	0	0	6	232	73	0	0	0

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	Chinook Salmon			Coho Salmon			Pink Salmon			Sockeye Salmon			Chum Salmon			Dolly Varden			Rainbow trout / Steelhead		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent
8/01	4	1,889	98	0	0	0	5	107	29	0	5	14	0	0	0	10	242	76	0	0	0
8/02	7	1,896	99	1	1	0	11	118	32	0	5	14	0	0	0	10	252	79	0	0	0
8/03	6	1,902	99	1	2	0	5	123	33	1	6	16	1	1	20	19	271	85	0	0	0
8/04	6	1,908	99	2	4	1	12	135	36	0	6	16	0	1	20	1	272	86	0	0	0
8/05	3	1,911	100	1	5	1	5	140	38	0	6	16	0	1	20	3	275	86	0	0	0
8/06	2	1,913	100	1	6	1	0	140	38	1	7	19	0	1	20	2	277	87	0	0	0
8/07	2	1,915	100	1	7	1	1	141	38	0	7	19	0	1	20	1	278	87	0	0	0
8/08	1	1,916	100	0	7	1	6	147	39	2	9	24	0	1	20	2	280	88	0	0	0
8/09	0	1,916	100	2	9	1	3	150	40	0	9	24	1	2	40	3	283	89	0	0	0
8/10	1	1,917	100	0	9	1	1	151	40	2	11	30	0	2	40	3	286	90	0	0	0
8/11	2	1,919	100	0	9	1	3	154	41	0	11	30	0	2	40	2	288	91	0	0	0
8/12	0	1,919	100	4	13	2	0	154	41	0	11	30	0	2	40	6	294	92	0	0	0
8/13	0	1,919	100	3	16	2	3	157	42	1	12	32	0	2	40	0	294	92	1	1	100
8/14	0	1,919	100	1	17	3	0	157	42	0	12	32	0	2	40	3	297	93	0	1	100
8/15	0	1,919	100	0	17	3	5	162	43	2	14	38	0	2	40	3	300	94	0	1	100
8/16	0	1,919	100	2	19	3	7	169	45	6	20	54	0	2	40	1	301	95	0	1	100
8/17	0	1,919	100	2	21	3	5	174	47	11	31	84	1	3	60	5	306	96	0	1	100
8/18	0	1,919	100	4	25	4	2	176	47	0	31	84	0	3	60	3	309	97	0	1	100
8/19	0	1,919	100	15	40	6	0	176	47	0	31	84	0	3	60	1	310	97	0	1	100
8/20	0	1,919	100	19	59	9	1	177	47	0	31	84	0	3	60	0	310	97	0	1	100
8/21	0	1,919	100	31	90	13	6	183	49	0	31	84	0	3	60	0	310	97	0	1	100
8/22	0	1,919	100	15	105	16	8	191	51	2	33	89	1	4	80	0	310	97	0	1	100
8/23	0	1,919	100	0	105	16	2	193	52	0	33	89	0	4	80	0	310	97	0	1	100
8/24	0	1,919	100	3	108	16	2	195	52	0	33	89	0	4	80	0	310	97	0	1	100
8/25	0	1,919	100	8	116	17	12	207	55	0	33	89	0	4	80	0	310	97	0	1	100
8/26	0	1,919	100	10	126	19	4	211	57	0	33	89	0	4	80	0	310	97	0	1	100
8/27	0	1,919	100	0	126	19	0	211	57	0	33	89	0	4	80	0	310	97	0	1	100
8/28	0	1,919	100	0	126	19	4	215	58	1	34	92	0	4	80	0	310	97	0	1	100
8/29	0	1,919	100	0	126	19	13	228	61	0	34	92	1	5	100	0	310	97	0	1	100
8/30	0	1,919	100	2	128	19	10	238	64	1	35	95	0	5	100	0	310	97	0	1	100
8/31	0	1,919	100	2	130	19	4	242	65	0	35	95	0	5	100	0	310	97	0	1	100

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	Chinook Salmon			Coho Salmon			Pink Salmon			Sockeye Salmon			Chum Salmon			Dolly Varden			Rainbow trout / Steelhead		
	Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent	Count	Count	Percent
9/01	0	1,919	100	0	130	19	4	246	66	0	35	95	0	5	100	0	310	97	0	1	100
9/02	0	1,919	100	168	298	44	35	281	75	2	37	100	0	5	100	1	311	98	0	1	100
9/03	0	1,919	100	277	575	85	9	290	78	0	37	100	0	5	100	0	311	98	0	1	100
9/04	0	1,919	100	27	602	89	3	293	79	0	37	100	0	5	100	0	311	98	0	1	100
9/05	0	1,919	100	8	610	90	8	301	81	0	37	100	0	5	100	1	312	98	0	1	100
9/06	0	1,919	100	0	610	90	17	318	85	0	37	100	0	5	100	0	312	98	0	1	100
9/07	0	1,919	100	3	613	91	10	328	88	0	37	100	0	5	100	0	312	98	0	1	100
9/08	0	1,919	100	2	615	91	5	333	89	0	37	100	0	5	100	1	313	98	0	1	100
9/09	0	1,919	100	4	619	91	2	335	90	0	37	100	0	5	100	0	313	98	0	1	100
9/10	0	1,919	100	7	626	92	4	339	91	0	37	100	0	5	100	0	313	98	0	1	100
9/11	0	1,919	100	5	631	93	0	339	91	0	37	100	0	5	100	0	313	98	0	1	100
9/12	0	1,919	100	28	659	97	9	348	93	0	37	100	0	5	100	0	313	98	0	1	100
9/13	0	1,919	100	12	671	99	11	359	96	0	37	100	0	5	100	2	315	99	0	1	100
9/14	0	1,919	100	3	674	100	6	365	98	0	37	100	0	5	100	2	317	100	0	1	100
9/15	0	1,919	100	3	677	100	8	373	100	0	37	100	0	5	100	1	318	100	0	1	100

Notes: ND = no data collected.

* Based on hand counts through a complete resistance board weir.

* Weir counts ended at 0800 hours 9/15/04.

* 350-400 coho salmon counted from Sterling Highway upstream to weir site on 9/15/04 at 1430 hrs.

APPENDIX B. WATER TEMPERATURES FOR 2003 AND 2004

Appendix B1.–Daily water temperatures near Anchor River sonar/weir site, May 6 through September 15, 2003.

	Daily Water Temperatures (°C)														
	May			**June**			**July**			**August**			**September**		
Date	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1				9.24	7.29	11.20	13.90	13.00	15.80	15.88	13.40	18.30	10.43	8.76	12.30
2				9.65	7.66	12.30	13.02	11.20	15.10	15.44	12.70	17.90	10.22	8.03	12.30
3				9.85	7.66	11.90	13.86	10.90	17.20	14.72	12.70	16.90	10.91	9.12	12.70
4				8.92	7.29	10.90	14.85	11.90	17.60	14.86	11.90	17.90	10.23	9.12	11.20
5				8.97	8.03	10.20	13.95	13.00	15.80	15.18	11.90	17.90	9.63	8.39	10.50
6	7.79	6.55	8.76	9.12	8.03	10.20	14.32	11.60	17.60	15.33	13.70	16.90	9.54	7.29	11.90
7	6.63	4.28	8.76	9.61	6.55	12.70	15.54	12.70	18.60	15.92	13.00	19.00	9.49	7.29	11.60
8	7.60	5.80	9.84	9.67	8.76	11.20	17.10	13.70	20.40	17.13	14.10	20.00	9.73	7.66	11.90
9	7.01	6.18	8.03	9.43	8.39	10.50	17.14	14.80	19.30	17.74	15.10	20.00	9.60	8.76	10.50
10	5.81	4.66	6.55	9.21	8.76	9.84	16.28	14.80	17.90	17.45	14.80	19.70	10.14	8.39	11.90
11	5.41	3.89	8.03	8.29	8.03	8.76	15.23	14.40	16.20	16.99	16.20	18.30	9.51	7.66	11.20
12	5.41	3.51	7.29	9.91	8.03	12.70	15.85	13.00	19.30	14.50	13.70	16.20	9.98	8.39	11.60
13	5.21	3.89	6.55	12.05	9.48	14.80	16.88	13.40	20.40	13.42	13.00	13.70	9.83	8.39	11.20
14	4.16	2.73	5.80	11.68	10.50	13.70	17.90	15.50	20.00	13.01	12.70	13.40	7.75	5.80	9.48
15	5.32	3.12	8.39	11.00	10.20	11.60	17.67	15.10	20.40	12.27	11.90	12.70	6.12	4.28	7.66
16	7.20	5.04	9.48	10.73	9.48	12.30	16.98	15.50	18.30	11.97	11.20	13.40			
17	6.33	5.04	8.03	10.90	9.48	12.30	15.47	14.40	16.50	11.52	9.84	13.40			
18	5.74	3.89	7.29	11.67	9.84	14.10	15.67	13.70	17.90	10.76	9.12	12.30			
19	7.37	5.04	9.84	11.93	9.48	14.80	16.41	13.40	19.30	11.03	10.20	11.90			
20	8.20	5.42	11.20	12.38	10.20	14.80	16.15	14.80	17.60	10.37	9.12	11.60			
21	8.95	6.55	11.60	11.75	10.90	13.00	15.95	15.10	17.20	11.72	9.48	14.40			
22	9.40	6.92	11.60	12.56	9.84	15.80	16.56	14.80	19.00	12.04	9.48	14.80			
23	10.74	9.12	13.00	12.23	10.20	13.70	17.02	14.40	19.70	11.92	9.48	14.10			
24	9.35	7.29	10.90	11.38	10.90	12.70	15.11	14.40	17.20	12.40	10.90	13.70			
25	10.10	8.03	13.00	10.61	9.48	11.60	14.08	13.00	15.10	12.10	11.60	13.00			
26	10.00	8.39	11.20	10.76	9.48	12.30	15.26	13.00	18.30	11.74	10.50	13.00			
27	9.79	8.39	11.20	11.07	9.84	12.70	14.84	13.70	16.50	11.70	10.90	12.30			
28	9.74	7.29	11.90	12.67	9.48	16.20	14.33	13.00	15.50	11.47	10.50	12.70			
29	9.88	7.66	12.30	13.98	11.20	16.50	13.93	12.30	15.50	11.01	10.50	11.90			
30	9.55	8.03	11.20	14.85	11.90	17.60	14.73	12.70	17.20	10.84	9.48	11.90			
31	9.39	8.39	10.20				15.97	13.40	19.00	10.29	8.03	12.30			

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

Appendix B2.–Daily water temperatures near Anchor River sonar/weir site, June 2 through September 15, 2004.

	Daily Water Temperatures (° C)														
	May			**June**			**July**			**August**			**September**		
Date	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1							13.89	13.00	15.03	14.28	10.98	17.69	12.75	11.56	14.16
2				11.68	10.69	12.42	13.23	12.42	14.16	15.66	12.42	19.48	12.78	12.13	13.58
3				10.79	9.26	12.71	13.75	12.42	15.33	15.77	12.42	19.18	12.40	10.98	14.16
4				12.03	8.97	15.62	14.08	13.00	15.33	15.75	14.74	16.51	10.67	8.39	13.00
5				12.57	11.84	13.58	15.11	11.84	18.88	15.81	13.87	18.28	9.52	7.23	11.84
6				13.63	10.41	17.39	16.37	13.29	20.09	15.40	11.84	19.18	9.75	6.94	12.71
7				13.08	11.56	14.45	17.37	13.58	21.31	15.48	12.13	19.18	9.47	6.94	12.42
8				11.41	9.83	13.29	18.21	14.74	21.93	15.73	12.71	19.18	9.03	6.37	12.13
9				10.26	8.97	11.27	18.44	15.03	22.24	15.26	13.29	17.09	8.08	6.08	9.83
10				10.36	8.39	13.00	18.12	14.45	22.24	16.11	12.71	20.09	9.49	8.11	10.98
11				11.00	8.68	13.58	18.48	14.74	22.56	16.19	13.29	19.48	9.60	7.23	12.13
12				11.86	10.41	13.58	18.58	15.33	22.24	16.35	14.16	19.48	9.31	6.94	12.13
13				11.85	10.12	13.58	17.26	14.16	21.01	15.53	12.42	19.18	8.81	6.94	10.98
14				12.48	10.69	14.45	15.98	13.00	18.58	15.89	13.58	19.48	7.33	5.50	9.26
15				11.02	10.12	12.42	16.01	13.00	19.48	15.01	12.13	17.99	6.42	4.34	8.68
16				9.94	8.97	10.98	16.82	14.16	19.79	16.66	13.29	20.39			
17				10.49	9.83	11.56	15.19	14.45	16.51	16.37	13.87	19.18			
18				11.91	9.83	14.16	14.89	13.87	16.21	16.03	14.16	18.28			
19				13.87	10.41	17.69	15.29	13.87	17.09	15.63	14.16	17.39			
20				15.59	12.13	19.48	14.64	13.58	15.62	15.76	14.45	17.99			
21				16.23	12.71	20.09	14.46	12.42	16.51	15.34	13.00	18.58			
22				15.73	13.00	19.18	13.89	13.00	14.74	14.52	12.42	16.51			
23				15.72	12.71	19.18	13.79	12.42	15.62	14.01	12.42	15.62			
24				16.69	13.58	20.39	14.55	11.27	17.99	14.65	13.00	16.80			
25				16.82	13.58	20.39	13.95	12.71	15.03	14.43	11.56	17.69			
26				17.76	14.16	21.62	12.86	12.13	13.58	14.01	13.00	15.33			
27				15.98	15.03	18.28	12.35	11.84	13.00	13.14	11.56	15.03			
28				14.65	13.58	15.92	12.57	11.56	13.87	12.76	11.27	15.03			
29				14.12	11.27	17.39	12.53	10.98	14.16	12.32	9.55	15.62			
30				14.99	13.29	17.09	13.88	11.84	17.09	12.14	9.55	15.33			
31							13.80	12.13	16.21	12.11	9.55	14.74			

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

APPENDIX C. RIVER STAGES FOR 2004

Appendix C1.–Daily river stage measurements at the Anchor River DIDSON/weir site, May 14 through September 13, 2004.

	River Stage (cm) [a]				
Date	May	June	July	Aug.	Sept.
1		21	11	18	2
2		20	11	12	17
3		19	11	9	17
4		18	9	7	9
5		16	9	7	7
6		16	9	6	3
7		14	8	5	2
8		19	7	3	2
9		16	5	3	1
10		16	5	3	1
11		16	3	3	1
12		16	3	3	1
13		14	2	3	1
14	39	16	2	1	
15	36	16	2	1	
16	35	16	2	1	
17	33	21	2	1	
18	35	19	6	1	
19	33	15	6	1	
20	30	14	9	3	
21	29	12	8	3	
22	28	12	8	3	
23	43	12	7	2	
24	44	12	6	3	
25	39	12	6	3	
26	38	12	19	3	
27	31	11	19	3	
28	28	11	18	3	
29	26	11	17	2	
30	23	11	16	2	
31	22		16	2	

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

APPENDIX D. AERIAL SURVEY COUNTS, 2003-2004

Appendix D1.–Helicopter surveys flown to index Anchor River Chinook salmon escapement in 2003 and 2004.

	Aerial Index Counts [a]								
	July 23, 2003			July 28, 2003			July 31, 2004		
Survey Areas:	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total
South Fork Anchor River									
Beaver Creek confl. to Orange bluff (lat 59°46.517' N, long 151°28.530' W)	34	1	35	32	0	32	44	3	47
North Fork Rd bridge (Englebretsen bridge) to Beaver Creek	305	0	305	283	11	294	294	6	300
Kurka bridge to North Fork Rd bridge (Englebretsen)	120	0	120	70	4	74	102	3	105
New Sterling Hwy bridge to Kurka bridge	107	0	107	139	4	143	206	6	212
Gravel pit to New Sterling Hwy bridge	34	0	34	25	2	27	162	8	170
Old Sterling Hwy bridge to Gravel pit	79	0	79 [b]	75	2	77			
Subtotal	679	1	680	624	23	647	808	26	834
North Fork Anchor River									
South Fork confluence to North Fork bridge	7	0	7 [b]	[c]	[c]	[c]	32	3	35
North Fork bridge to Little bridge (lat 59°48.163' N)	36	0	36	[c]	[c]	[c]	11	1	12
Little bridge to Following bridge	0	0	0	[c]	[c]	[c]	66	4	70
Subtotal	43	0	43	[c]	[c]	[c]	109	8	117
Total	722	1	723	624	23	647	917	34	951

Aerial Survey Conditions: [d]	July 23, 2003	July 28, 2003	July 31, 2004
Percent cloud cover	40% and broken	90% and broken	Overcast and partly broken
Glare on the water surface	Mostly sun on riverbed, glare was avoidable	Dark water	ND
Water clarity	Good except in holes.	Secchi depth = 1.75 m	Muddier water further downstream
Other	ND	Evening flight	Calm

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

[b] Flew from Gravel pit to North Fork bridge at high speed due to wind, fish scattered, no big groups

[c] Not surveyed; no data collected.

[d] ND = no data collected.