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Tatlawiksuk River Salmon Studies, 2006

Final Report for Study 04-310
USFWS Office of Subsistence Management
Fisheries Information Services Division and
Bering Sea Fishermen's Association

by

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

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

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TABLE OF CONTENTS

Page

LIST OF TABLES iii

LIST OF FIGURES iii

LIST OF APPENDICES iv

ABSTRACT 1

INTRODUCTION 1

Background 3
Objectives 3

METHODS 4

Study Area 4
Weir Design 5
- Installation Site 5
- Construction 5
- Maintenance 6

Escapement Monitoring 6
- Passage Counts 6
- Estimating Missed Passage 7
  - Single Day Method 7
  - Linear Method 7
  - Proportion Method 7
  - Estimates Required in 2006 8
- Carcasses 8

Age, Sex, and Length Composition 8
- Sample Collection 8
- Estimating Age, Sex, and Length Composition of Escapement 9

Weather and Stream Observations 10
Related Fisheries Projects 11
- Inriver Abundance of Chinook Salmon in the Kuskokwim River 11
- Kuskokwim River Sockeye Salmon Investigations 11
- Kuskokwim River Salmon Mark–Recapture Project 12

RESULTS 13

Escapement Monitoring 13
- Chinook Salmon 13
- Chum Salmon 13
- Coho Salmon 13
- Other Species 14
  - Sockeye Salmon 14
  - Pink Salmon 14
  - Resident Species 14
- Carcasses 14

TABLE OF CONTENTS (Continued)

Age, Sex, and Length Composition 15
Chinook Salmon 15
Chum Salmon 16
Coho Salmon 16
Weather and Stream Observations 17
Related Fisheries Projects 17
Inriver Abundance of Chinook Salmon in the Kuskokwim River 17
Kuskokwim River Sockeye Salmon Investigations 18
Kuskokwim River Salmon Mark–Recapture Project 18
DISCUSSION 19
Escapement Monitoring 19
Chinook Salmon 19
Abundance 19
Run Timing at Weir 22
Chum Salmon 22
Abundance 22
Run Timing at Weir 23
Coho Salmon 24
Abundance 24
Run Timing at Weir 25
Other Species 26
Sockeye Salmon 26
Pink Salmon 26
Resident Species 26
Carcasses 27
Age, Sex, and Length Composition 27
Chinook Salmon 27
Chum Salmon 30
Coho Salmon 32
Weather and Stream Observations 33
Related Projects 35
Inriver Abundance of Chinook Salmon in the Kuskokwim River 35
Kuskokwim River Sockeye Salmon Investigations 35
Kuskokwim River Salmon Mark–Recapture Project 36
Chinook Salmon 36
Sockeye Salmon 37
CONCLUSIONS 38
Escapement Monitoring 38
Age, Sex, and Length Composition 39
Weather and Stream Observations 40
RECOMMENDATIONS 41
Project Operation 41

TABLE OF CONTENTS (Continued)

Project Management 41
Age, Sex, and Length Composition 42
Weather and Stream Observations 42
Spawner-Recruit Analysis 43

ACKNOWLEDGMENTS 43

REFERENCES CITED 44

TABLES AND FIGURES 49

APPENDIX A. STREAM HEIGHT BENCHMARK 85

APPENDIX B. HISTORICAL SALMON PASSAGE AT THE TATLAWIKSUK RIVER WEIR 89

APPENDIX C. PASSAGE OF OTHER SPECIES 99

APPENDIX D. DAILY CARCASS COUNTS 103

APPENDIX E. WEATHER AND STREAM OBSERVATIONS 105

APPENDIX F. HISTORICAL CUMULATIVE PERCENT SALMON PASSAGE 111

LIST OF TABLES

Table **Page**

1. Actual daily and estimated counts of Chinook, chum, and coho salmon at the Tatlawiksuk River weir, 2006. 50
2. Age and sex composition of Chinook salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap. 52
3. Mean length (mm) of Chinook salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap. 53
4. Age and sex composition of chum salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap. 54
5. Mean length (mm) of chum salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap. 55
6. Age and sex composition of coho salmon sampled at the Tatlawiksuk River weir in 2006 that were captured using a live trap. 56
7. Mean length (mm) of coho salmon at the Tatlawiksuk River weir in 2006 that were captured using a live trap. 56
8. Brood table for Tatlawiksuk River Chinook salmon. 57
9. Brood table for Tatlawiksuk River chum salmon. 58
10. Brood table for Tatlawiksuk River coho salmon. 59

LIST OF FIGURES

Figure **Page**

1. Location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Tatlawiksuk River. 60
2. Tatlawiksuk River drainage and the location of the weir. 61
3. Annual run timing of Chinook, chum, and coho salmon based on cumulative percent passage at the Tatlawiksuk River weir, 1999–2006. 62
4. Historical age composition of Chinook, chum, and coho salmon at the Tatlawiksuk River weir, 1998–2006. 63
5. Historical age composition by cumulative percent passage of Chinook salmon at the Tatlawiksuk River weir, 2000–2006. 64

LIST OF FIGURES (Continued)

Figure **Page**

6. Historical percentage of female Chinook, chum, and coho salmon by cumulative percent passage at the Tatlawiksuk River weir. 65
7. Historical intra-annual mean length-at-age of male and female Chinook salmon by cumulative percent passage at the Tatlawiksuk River weir. 66
8. Historical age composition by cumulative percent passage of chum salmon at the Tatlawiksuk River weir, 1999–2006. 67
9. Historical intra-annual mean length-at-age of chum salmon by cumulative percent passage at the Tatlawiksuk River weir. 68
10. Historical average, minimum, and maximum morning river stage and water temperature (observed thermometer measurements) at the Tatlawiksuk River weir from 1998 to 2005, compared to morning river stage and water temperature in 2006. 69
11. Daily Chinook, chum, and coho salmon passage at the Tatlawiksuk River weir relative to daily average river stage height, 2006. 70
12. Daily Chinook, chum, and coho salmon passage at the Tatlawiksuk River weir relative to daily average water temperature (data logger readings), 2006. 71
13. Daily and cumulative percent passage of overall Chinook salmon passage compared to tagged Chinook salmon passage at the Tatlawiksuk River weir in 2006. 72
14. Dates when individual Chinook salmon stocks passed through the Kalskag tagging sites (rkm 271) based on anchor- and radio-tagging studies conducted in 2006. 73
15. Historical annual Chinook salmon escapement into 6 Kuskokwim River tributaries and annual Kuskokwim River Chinook salmon escapement indices, 1991–2006. 74
16. Historical annual chum salmon escapement into 7 Kuskokwim River tributaries, 1991-2006. 75
17. Historical annual coho salmon escapement into 6 Kuskokwim River tributaries, 1991–2006. 76
18. Historical annual sockeye salmon escapement into 6 Kuskokwim River tributaries, 1991-2006. 77
19. Historical Chinook and chum salmon age distribution for common ages at the Tatlawiksuk River weir. 78
20. Historical average annual length with 95% confidence intervals for Chinook salmon at the Tatlawiksuk River weir. 79
21. ASL composition of the 2006 Kuskokwim River Chinook salmon commercial and subsistence harvests, total monitored escapement, and the Tatlawiksuk River weir (+/- 95% confidence interval). 80
22. Historical average annual length with 95% confidence intervals for chum salmon at the Tatlawiksuk River weir. 81
23. Historical intra-annual mean length-at-age of male and female coho salmon by cumulative percent passage at the Tatlawiksuk River weir. 82
24. Daily morning water temperature logged by the data logger compared to daily morning water temperature determined using a thermometer at the Tatlawiksuk River weir in 2006. 83
25. Chinook salmon captured and tagged at the Kalskag tagging sites, by date, compared to Chinook salmon recovered at the Tatlawiksuk River weir, by date tagged, 2006. 84

LIST OF APPENDICES

Appendix **Page**

A1. Locations and descriptions of stream height benchmarks at the Tawiksuk River weir. 86
A2. Photograph illustrating the location of the stream height benchmark currently used. 87
B1. Historical daily and cumulative Chinook salmon passage at the Tatlawiksuk River weir during the target operational period. 90
B2. Historical daily and cumulative chum salmon passage at the Tatlawiksuk River weir during the target operational period. 93
B3. Historical daily and cumulative coho salmon passage at the Tatlawiksuk River weir during the target operational period. 96
C1. Daily passage of sockeye and pink salmon and non-salmon species observed at the Tatlawiksuk River weir, 2006. 100

LIST OF APPENDICES (Continued)

Appendix **Page**

D1. Daily salmon carcass counts at the Tatlawiksuk River weir, 2006.....104
E1. Daily weather and stream observations at the Tatlawiksuk River weir site, 2006.....106
E2. Daily stream temperature summary from the data logger at the Tatlawiksuk River weir, 2006. 109
E3. Worksheet used to calculate river discharge at the Tatlawiksuk River weir site on 9 September, 2006.....110
F1. Historical daily cumulative percent passage of coho salmon at the Tatlawiksuk River weir.....112
F2. Historical daily cumulative percent passage of Chinook salmon at the Tatlawiksuk River weir.....114
F3. Historical daily cumulative percent passage of chum salmon at the Tatlawiksuk River weir.....116

ABSTRACT

The Tatlawiksuk River is a tributary of the Kuskokwim River, and produces Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, and coho salmon *O. kisutch* that contribute to intensive subsistence and commercial salmon fisheries downstream of its confluence. The Tatlawiksuk River weir is one of several projects operated in the Kuskokwim Area that form an integrated geographic array of escapement monitoring projects. Collectively, and in accordance with the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222), this array of projects is a tool to ensure appropriate geographic and temporal distribution of spawners, and provide a means to assess trends in escapement that should be monitored and considered in harvest management decisions. Towards this end, Tatlawiksuk River weir has been operated annually since 1998 to determine daily and total salmon escapements for the target operational period of 15 June through 20 September; to estimate age, sex, and length compositions of Chinook, chum, and coho salmon escapement; to monitor environmental variables that influence salmon productivity; and to serve as part of an integrated platform in support of other Kuskokwim Area fisheries projects.

In 2006, a resistance board weir was successfully operated on the Tatlawiksuk River from 15 June through 18 August, at which time high water levels prevented weir operation for the remainder of the target operational period. Daily passage estimates were calculated to span the remainder of the target operational period. Escapements for the target operational period included 1,700 Chinook and 32,301 chum salmon. A total of 2,362 coho salmon passed upstream of the weir before operations ceased on 19 August, and an estimated 7,091 coho salmon passed after this date based on the best available estimation methods. Formal escapement goals do not exist for the Tatlawiksuk River; however, chum salmon escapement was well above average and Chinook salmon escapement was near average in 2006. Estimated coho salmon escapement was near average in 2006. Age, sex, and length (ASL) samples were collected from 10.5% of the Chinook escapement and 2.9% of the chum escapement. Age, sex, and length data were obtained from 155 coho salmon before the weir became inoperative during the high water event on 19 August. The Chinook salmon escapement consisted of 44.1% age-1.3 fish, 30.4% age-1.4 fish, 21.0% age-1.2 fish, and 41.4% females. The chum salmon escapement consisted of 55.6% age-0.3 fish, 42.3% age-0.4 fish, 1.8% age-0.2 fish, and 42.1% females. The sample obtained for coho salmon consisted of 80.0% age-2.1 fish, 14.8% age-1.1 fish, 5.2% age-3.1 fish, and 38.7% females. In addition to enumerating escapement, estimating ASL composition, and investigating juvenile salmon distribution, the weir served as a platform for several other projects including *Inriver Abundance of Chinook Salmon in the Kuskokwim River* (FIS 05-302), *Kuskokwim River Sockeye Salmon Investigations*, and *Kuskokwim River Salmon Mark–Recapture Project* (FIS 04-308). The Tatlawiksuk River weir successfully contributed to each of these projects in 2006.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *O. keta*, coho salmon, *O. kisutch*, longnose suckers, *Catostomus catostomus*, escapement, age-sex-length, ASL, Tatlawiksuk River, Kuskokwim River, resistance board weir, radiotelemetry, mark–recapture, stock specific run timing, upper Kuskokwim.

INTRODUCTION

The Kuskokwim River is the second largest river in Alaska, draining an area approximately 130,000 km^2, or 11% of the total area of Alaska (Figure 1; Brown 1983). Each year mature salmon *Oncorhynchus spp.* return to the river to spawn, supporting an annual average subsistence and commercial harvest of nearly 1 million salmon (Whitmore et al. 2005). The subsistence salmon fishery in the Kuskokwim Area is one of the largest and most important in the state (ADF&G 2003; Coffing 1991, *Unpublished* a, b; Coffing et al. 2001; Ward et al. 2003; Whitmore et al. 2005) and remains a fundamental component of local culture. The commercial salmon fishery, though modest in value compared to other areas of Alaska, has been an important component of the market economy of lower Kuskokwim River communities (Buklis 1999; Whitmore et al. 2005). Salmon that contribute to these fisheries spawn and rear in nearly every tributary of the Kuskokwim River basin.

Since 1960, management of Kuskokwim River subsistence, commercial, and sport fisheries has been the responsibility of the Alaska Department of Fish and Game (ADF&G). Management

authority for the subsistence fishery was broadened in October 1999 to include the federal government under Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA). The U.S. Fish and Wildlife Service (USFWS) is the federal agency most involved within the Kuskokwim Area. In addition, tribal groups such as the Kuskokwim Native Association (KNA) are charged by their constituency to actively promote a healthy and sustainable subsistence salmon fishery. These and other groups have combined their resources to develop projects such as the Tatlawiksuk River weir to better achieve the common goal of providing for long-term sustainability of salmon fisheries in the Kuskokwim River.

The goal of salmon management is to provide for long-term sustainable fisheries by ensuring that adequate numbers of salmon escape to the spawning grounds each year. This goal requires an array of long-term escapement monitoring projects that reliably measure annual escapement to key spawning systems as well as track temporal and spatial patterns in abundance that influence management decisions. Over time and with sufficient data, escapement goals can be developed as a means to gauge escapement adequacy, but current spawner-recruit models for escapement goal development require many years of data. In the Kuskokwim River, only two long-term, ground-based escapement monitoring projects have operated reliably for more than 10 years (Whitmore et al. 2005). Of the dozens of tributaries known to support spawning populations of salmon, the presence of escapement-monitoring projects on two tributaries clearly does not provide adequate escapement information for the entire Kuskokwim River basin. This deficiency was improved with the inception of several additional projects in the mid to late 1990s, including the Tatlawiksuk River weir, and the data provided by the current array of projects have much greater utility for fishery managers and decreased their reliance on aerial stream surveys which are known to be less reliable (Whitmore et al. 2005). The inception of the Tatlawiksuk River weir in 1998, coupled with other initiatives begun in the late 1990s and beyond (Kerkvliet et al. 2003; Schwanke et al. 2001; Stroka and Brase 2004; Stuby 2003), provides some of the additional escapement monitoring and abundance estimates required for management authorities to assess the adequacy of escapements and the effectiveness of management decisions (Holmes and Burtkett 1996; Mundy 1998).

In recent years, Kuskokwim River Chinook *O. tshawytscha* and chum *O. keta* salmon have received considerable attention by the Alaska Board of Fisheries (BOF) due to erratic run abundance patterns. The BOF designated Kuskokwim River Chinook and chum salmon as "stocks of yield concern" in 2000 due to the chronic inability of managers to maintain expected harvest levels (Burkey et al. 2000a, b; Ward et al. 2003). This "stock of yield concern" designation was upheld during the 2004 BOF meeting but was cancelled during the 2007 BOF meeting at the recommendation of ADF&G following several years of expected harvest levels and relatively strong escapements (Bergstrom and Whitmore 2004; Molyneaux and Brannian 2006). Between 2001 and 2006 subsistence and commercial fisheries were managed conservatively and conducive to the BOF "stocks of yield concern" designations. Efforts were focused on enumerating abundance of these species and obtaining enough data for escapement goal development. Several main-river and regional projects arose that utilized the existing weir infrastructure for data collection. Such projects have since become deeply integrated components of field operations.

Although salmon production is modest, the Tatlawiksuk River contributes to sustainable fisheries both by adding to the annual production and by adding to genetic diversity similar to what Hilborn et al. (2003) described for Bristol Bay. Since fishers tend to harvest fish from the early

part of the salmon runs and the early part of the runs may be dominated by upper river salmon stocks, salmon production from the upper Kuskokwim River may support a disproportionately high fraction of the subsistence harvest, particularly for Chinook salmon. This latter point makes monitoring upper Kuskokwim River salmon escapements, such as on the Tatlawiksuk River, a particularly important tool for maintaining long-term sustainability of the downriver fisheries (Burkey et al. 2000a; Kerkvliet et al. 2003; 2004; Pawluk et al. 2006a; b; Stuby *In prep*).

The utility of weirs extends beyond providing annual escapement estimates. Escapement projects, such as the Tatlawiksuk River weir, commonly serve as platforms for collecting other types of information useful for management and research. Collection of age, sex, and length (ASL) data are typically included in most escapement monitoring projects, and the Tatlawiksuk River weir is no exception (Molyneaux and Folletti *In prep*). Knowledge of ASL composition can provide insights into understanding fluctuations in salmon abundance and is essential in developing spawner-recruit relationships used in formulating escapement goals (DuBois and Molyneaux 2000). The Tatlawiksuk River weir also serves as a platform for collecting information on habitat variables. Water temperature, water chemistry, and stream discharge (level) are fundamental variables of the stream environment that directly or indirectly influence salmon productivity and timing of salmon migrations (Hauer and Hill 1996; Kruse 1998; Quinn 2005). Since these variables can be affected by human activities (i.e., mining, timber harvesting, man-made impoundments, etc.; NRC 1996) or climatic changes (e.g., El Nino and La Nina events), data collection for such variables are included in the project operational plan.

BACKGROUND

The Tatlawiksuk River is a tributary of the middle Kuskokwim River basin and provides spawning and rearing habitat for Chinook, chum, and coho salmon (ADF&G 1998). According to local residents, Athabaskan groups harvested salmon from Tatlawiksuk River using fish fences and traps into the mid-1900s (Andrew Gusty Sr., Resident, Stony River village; personal communication). Since 1968, biologists from ADF&G periodically observed salmon escapements in the mainstem Tatlawiksuk River by means of aerial surveys, which coincided with peak Chinook and chum salmon spawning activity (Burkey and Salomone 1999; Schneiderhan *Unpublished*).

Salmon escapement monitoring began at the Tatlawiksuk River in 1998 through the joint effort of Kuskokwim Native Association and ADF&G (Linderman et al. 2002). Operations in 1998 were incomplete and the fixed-panel weir design was replaced with a resistance board weir in 1999, which improved performance in subsequent years. Since then, the Tatlawiksuk River weir has been collecting information on Chinook, chum, and coho salmon escapement, ASL composition, habitat variables, and has served as a platform for other collaborative research efforts.

OBJECTIVES

The annual objectives for the Tatlawiksuk River escapement monitoring project (FIS 04-310) were to:

1. Determine daily and total annual escapements of Chinook, chum, and coho salmon to Tatlawiksuk River during the target operational period from 15 June through 20 September;
2. Estimate the age, sex, and length composition of total Chinook, chum, and coho salmon escapements to Tatlawiksuk River from a minimum of 3 pulse samples, one collected from

each third of the run, such that simultaneous 95% confidence intervals of age composition in each pulse are no wider than 0.20 ($\alpha = 0.05$ and $d = 0.10$);

3. Monitor habitat variables and determine possible effects of water level and water temperature on salmon migration past the weir; and
4. Provide for collaborative, efficient research in the Kuskokwim River system by:
    a. Serving as a monitoring location for Chinook salmon equipped with radio transmitters deployed as part of *Inriver Abundance of Chinook Salmon in the Kuskokwim River* (FIS 05-302);
    b. Serving as a monitoring location for sockeye salmon equipped with radio transmitters deployed as part of *Kuskokwim River Sockeye Salmon Investigations*; and,
    c. Serving as a recovery location for tagged Chinook and sockeye salmon in support of *Kuskokwim River Salmon Mark–Recapture Project* (FIS 04-308).

The primary goal of this report is to summarize and present the results for the 2006 field season at the Tatlawiksuk River weir. Secondary to this, we intend to provide a more holistic perspective of Kuskokwim Area fisheries by placing the 2006 findings into the broader spatial and temporal context. To do this we draw heavily on data from past years at this project to highlight between year trends, and we draw on data from other escapement monitoring projects, related research projects, and the commercial and subsistence fishery in order to highlight spatial trends. These goals are intended to enhance the utility of this report beyond simply archiving data. It is important to note that some of the data used to make these broader comparisons are preliminary. Effort was made to ensure that all preliminary data was reported as such. In addition, many of the referenced documents are currently being developed. Consequently, most of the reported trends for other projects were determined by the authors of this report based on finalized data sets generously provided by other researchers. At the time of publication of this document all reported estimates and trends are as accurate as possible; however, the final results and conclusions for "*in prep*" documents may change. This highlights the importance for readers to consult the original documents prior to referencing results from other projects. Furthermore, unless stated, the statistical significance of the trends discussed for this and other escapement monitoring projects have not been determined. Many of these trends are subjective and based on low sample sizes with high variance. It is important to remember that sampling methodologies often differ across projects and over time leading to difficulty in comparisons. Throughout this document every effort was made to ensure sound comparisons; however, the reader should be aware of these potential issues and receive broader spatial and temporal trends with caution.

METHODS

STUDY AREA

Tatlawiksuk River originates in the foothills of the Alaska Range and flows southwesterly for 113 km, draining an area of approximately 2,106 km^2 before joining the Kuskokwim River at river kilometer (rkm) 563 (Figure 2; Brown 1983). Throughout most of the river's course, it meanders across wide, flat valleys vegetated with white spruce and scattered birch or aspen. Black spruce is more characteristic in poorly drained areas of the basin, and dense stands of willow and alder occur on sand and gravel bars. Unnamed streams that join the Tatlawiksuk River from the southeast and northeast drain extensive bog flats and swampy lowlands in the

lower reaches of the basin. The channel gradient of the lower 80 km is approximately 1.5 m per km (Brown 1983).

WEIR DESIGN

Installation Site

The Tatlawiksuk River weir is located approximately 16 rkm upstream from Sinka's Landing (Gregory family homestead) and 32 rkm from the village of Stony River. Personnel and supplies are transported to and from the weir via skiff from Stony River or floatplane.

The weir was installed in 2006 in the same location used in previous years, which is about 568 rkm from the mouth of the Kuskokwim River, and 5 km upstream from the confluence with the Kuskokwim River (Figures 1 and 2). Areas further downstream are considered unsuitable due to excessive water depth, poor stream and bank profile, and poor substrate type. At the weir site, the Tatlawiksuk River is about 64 m wide and has a depth of about 1 m during normal summer operations. The weir is positioned in the center of a wide bend, adjacent to a high cut bank to the east and a small floodplain to the west. Dense patches of alder and willow suggest that the floodplain is at an intermediate stage of succession, and terracing of the floodplain indicates that the stream channel has shifted course many times. The floodplain is interspersed with small channels that remain isolated except in periods of extreme high water, presumably during the spring runoff.

Construction

The design and materials used to construct the Tatlawiksuk River resistance board weir are described in detail in Tobin (1994) with panel modifications described in Stewart (2002). The weir was installed across the entire 210-ft (64-m) channel following the techniques described by Stewart (2003). The substrate rail and resistance board panels covered the middle 190-ft (58-m) portion of the channel, and fixed weir materials extended the weir 10 ft (3 m) to each bank. The pickets were 1-5/16 in (3.33 cm) in diameter and spaced at intervals of 2-5/8 in (6.67 cm) to leave a gap of 1-5/16 in (3.33 cm) between each picket.

A live trap and skiff gate were installed within the deeper portion of the channel. The live trap was also designed as the primary means of upstream fish passage. The trap could be easily configured to pass fish freely upstream, capture individual fish for tag recovery, or trap numerous fish for collection of ASL or genetic samples. The skiff gate allowed boat operators to pass with little or no involvement by the weir crew as the weight of a boat submerged the passage panels and allowed boats to pass over the weir. Boats with jet-drive engines were the most common and could pass up or downstream over the skiff gate after reducing their speed to 5 miles per hr (8 km per hr) or less.

To accommodate downstream migration of longnose suckers *Catastomas catostomas* and other resident species, downstream passage chutes were incorporated into the weir once resident species were observed congregating just upstream. At locations where downstream migrants were most concentrated, chutes were created by releasing the resistance boards on one or two adjacent weir panels so the distal ends dipped slightly below the stream surface. The chutes' shallow profile guides downstream migrants while preventing upstream salmon passage. The chutes were monitored and adjusted to ensure that salmon were not passing upstream over them. Downstream passage of salmon was not enumerated; however, few salmon have typically been

observed passing downstream over these chutes, and these numbers are not considered significant.

Maintenance

The weir was cleaned several times each day, typically at the end of a counting shift. A technician walked across the weir partially submerging each panel, thereby allowing the current to wash debris such as sticks, leaves, fibrous root mats, and fish carcasses downstream. A rake was used to push larger debris loads off the weir. Each time the weir was cleaned, a visual inspection was made of weir panels, substrate rail, fish trap, and fixed weir sections to ensure no breaches would allow fish to pass upstream unobserved. If conditions prevented an adequate visual inspection, technicians used snorkel gear to complete their inspection.

ESCAPEMENT MONITORING

The target operational period for the weir is 15 June to 20 September, although actual operational periods may vary. Total annual escapement is defined as the number of fish that passed within this period. In years when the operational period falls short of the target operational period, or when there are inoperable periods during the season, estimates of the daily salmon passage are made for missed days in order to provide consistent comparisons of escapements among years. Total annual escapement was determined from the total observed and estimated fish passage.

Passage Counts

Passage counts were conducted periodically during daylight hours. Delays in fish passage occurred only at night or during ASL sampling. Crew members visually identified each fish as it passed upstream and recorded it by species on a multiple tally counter. Counting continued for a minimum of 1 hr, or until passage waned. This schedule was adjusted as needed to accommodate the migratory behavior and abundance of fish, or operational constraints such as reduced visibility in evening hours late in the season. Crew members recorded the total upstream fish count in a designated notebook and zeroed the tally counter after each counting session. At the end of each day, total daily and cumulative seasonal counts were copied to logbook forms. These counts were reported each morning to ADF&G staff in Bethel via single side band radio or satellite telephone.

The live trap was used as the primary means of upstream fish passage so crew members could capture and recover information from fish tagged in the mainstem Kuskokwim River. A Plexiglas®[1] viewing window was placed on the stream surface to improve visual identification of fish entering the trap. This allowed passage counts to be conducted from the downstream entrance of the trap, and enabled crew members to capture tagged fish once they entered the trap. A secondary passage gate could be employed if fish were hesitant to enter the live trap. Using the trap as a counting platform, a connecting picket would be removed between two neighboring panels. By folding the panels to stand on edge, an opening 6 ft wide would be created. A rigid aluminum weir panel would be lashed to the upstream ends of the panels to serve as an easily removable gate. When removed for counting the gate would be placed on the river bottom, in front of the opening, to act as a flash panel for the identification of passing fish. Alternatively, a weir panel could be removed from anywhere along the weir, and a crew member could wade next to the opening to conduct a passage count.

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

Estimating Missed Passage

To allow comparison among years, upstream salmon passage was estimated in 2006 for days when the weir is inoperable during the target operational period. At this project, three methods for estimating missed passage are consistently used every year when required, but which method chosen depends on the duration and timing of the inoperable periods.

Single Day Method

Passage estimates for a single day are calculated as the average observed passage 2 days before and 2 days after the inoperable day. On occasion when the weir was inoperative for only part of 1 day or a hole was discovered in the weir, estimates of missed passage are generated using the single day method minus any observed passage from the compromised day.

Linear Method

When adequate data exist before and after an inoperable period, a "linear method" is used to interpolate daily estimates from average observed passage 2 days before an inoperable period to average observed passage 2 days after the inoperable period. This method results in a linear increase or decrease in daily estimates over the duration of the inoperable period. Daily estimates from this method are calculated using the formula:

$$\hat{n}_{d_i} = \alpha + \beta \cdot i \tag{1}$$

$$\alpha = \frac{n_{d_1-1} + n_{d_1-2}}{2}$$

$$\beta = \frac{\left(n_{d_I+1} + n_{d_I+2}\right) - \left(n_{d_1-1} + n_{d_1-2}\right)}{2\left(I+1\right)}$$

for (d_1, 2, …, d_i, …d_I)

where

$\hat{n}_{d_i}$ = passage estimate for the ith day of the period (d_1, 2, …, d_i, …d_I) when the weir was inoperative;

n_{d_I+1} = observed passage the first day after the weir was reinstalled;

n_{d_I+2} = observed passage the second day after the weir was reinstalled;

n_{d_1-1} = observed passage of 1 day before the weir was washed out;

n_{d_1-2} = observed passage of the second day before the weir was washed out; and

I = number of inoperative days.

Proportion Method

For meaningful comparisons among years, it is imperative that escapement is determined for the entire target operational period. On the occasions that weir operation is delayed beyond the target start date, or is terminated before the target end date, daily passage estimates are required for the remaining days of the target operational period. In these situations adequate data do not

exist to estimate passage using the linear method; instead, estimates are derived using a model data set. A data set may be selected as a model if it exhibits fish passage characteristics similar to known passage at the Tatlawiksuk River weir. The model data set used could be from a different year at the Tatlawiksuk River weir or from a neighboring project during the same year. In either case, daily passage is based on a model data set's daily passage proportions, and is calculated using the formula:

$$n_{d_i} = \left(\frac{\left(n_{2d_i} \times n_{1t_1} \right)}{n_{2t_1}} \right) - n_{o_i} \tag{2}$$

where

n_{d_i} = passage estimate for a given day (i) of the inoperable period;

n_{2d_i} = passage for the ith day in the model data set 2;

n_{1t_1} = known cumulative passage for the operational time period (t_1) from the estimated data set 1;

n_{2t_1} = known cumulative passage for the corresponding time period (t_1) from the model data set 2; and

n_{o_i} = observed passage (if any) from the given day (i) being estimated.

Estimates Required in 2006

In 2006, the "proportion method" was used to estimate missed chum, coho, and sockeye salmon passage after the weir became inoperative on 19 August. Data sets from previous years at Tatlawiksuk River weir were chosen as models. Estimates were not required for Chinook salmon because few pass upstream during this time based on historical run timing and abundance information.

Carcasses

Spawned out and dead salmon (hereafter referred to as carcasses) that washed up on the weir were counted by species and sex, and passed downstream. The daily carcass count was tallied by species and recorded into the camp log.

AGE, SEX, AND LENGTH COMPOSITION

Age, sex, and length compositions of the total annual Chinook, chum, and coho salmon escapements were estimated by sampling a fraction of fish passage and applying the ASL composition of those samples to the total annual escapement (DuBois and Molyneaux 2000).

Sample Collection

The crew at the Tatlawiksuk River weir employed standard sampling techniques as described by DuBois and Molyneaux (2000). For chum salmon a pulse sampling design was used, in which moderate sampling was conducted for 2 to 5 days followed by a few days without sampling. The goal was to obtain a minimum of 3 pulse samples, 1 pulse from each third of the run, to account for temporal dynamics in ASL composition. A similar pulse sample design was intended for coho salmon, but in 2006 the weir ceased being operational after only one 6-day pulse was

completed. The intended pulse sample size was 200 for chum salmon and 170 for coho salmon. The pulse sample design commonly used at other locations for Chinook salmon where they are more abundant was not strictly followed at Tatlawiksuk River weir in 2006. Optimally, crews would attempt to sample 210 Chinook salmon in 3 pulses, each representing one-third of the total run, but in 2006 a modest Chinook salmon run coupled with a strong chum salmon run made this strategy impractical. As a result, limited sampling was conducted nearly every day of the operational period during periods of greatest Chinook salmon passage in an effort to maximize sample collection while minimizing its effects on chum salmon migration past the weir.

Sample sizes were selected so that the simultaneous 95% confidence interval estimates of age and sex composition proportions would be no wider than 0.20 (Bromaghin 1993) per pulse for Chinook salmon assuming 10 age/sex categories, for chum salmon assuming 8 age/sex categories, and for coho salmon assuming 6 age/sex categories. Target sample sizes for all species were increased by about 10% from that recommended by Bromaghin (1993) to account for scales that could not be aged. The minimum acceptable number of sample periods for Chinook, chum and coho salmon was 3 per species, one sample period representing each third of the run, to account for temporal dynamics in the ASL composition.

Salmon were sampled from the fish trap installed in the weir. The trap included an entrance gate, holding pen, and exit gate. On days when sampling was conducted, the entrance gate was opened while the exit gate remained closed, allowing fish to accumulate inside the 8 by 5-ft (2.4 by 1.5-m) holding pen. The holding pen was typically allowed to fill with fish and sampling was conducted during scheduled counting periods. Every fish of the target species was measured for length to the nearest millimeter from mideye to tail fork (METF) and identified as male or female through visual examination of the external morphology. Three scales were removed from the preferred area of the fish (INPFC 1963), which were placed on gum cards and later used to determine age. Detailed sampling methods were similar to those described by Stewart and Molyneaux (2005).

Additional Chinook samples were collected through active sampling in an attempt to meet the pulse samples size objective. Active sampling consisted of capturing and sampling Chinook salmon while actively passing and enumerating all fish. Further details of the active sampling procedures are described in Linderman et al. (2002). This method was also used for tag recoveries.

After sampling was completed, relevant information such as sex, length, date, and location was copied from hardcopy forms to computer mark-sense forms. Further details of sampling procedures can be found in DuBois and Molyneaux (2000) and Linderman et al. (2003). The completed gum cards and data forms were sent to the Bethel and Anchorage ADF&G offices for processing. The original ASL gum cards, acetates and mark-sense forms were archived at the ADF&G office in Anchorage. The computer files were archived by ADF&G in the Anchorage and Bethel offices. Data were also loaded into the Arctic-Yukon-Kuskokwim (AYK) salmon database management system (Brannian et al. 2005).

Estimating Age, Sex, and Length Composition of Escapement

ADF&G staff in Bethel and Anchorage aged scales, processed the ASL data, and generated data summaries. DuBois and Molyneaux (2000) describe details of the processing and summarizing procedures. These procedures generated two types of summary tables for each species: one described the age and sex composition and the other described length statistics. These

summaries account for changes in the ASL composition throughout the season by first partitioning the season into temporal strata based on pulse sample dates and/or sample size requirements, applying the ASL composition of individual temporal samples to the corresponding temporal strata, and finally summing the strata to generate the estimated ASL composition for the season. This procedure ensures that the ASL composition of the total annual escapement is weighted by abundance of fish in the escapement rather than the abundance of fish in the samples. For example, if samples of coho salmon were collected in 3 pulses, then the season would be partitioned into 3 temporal strata with 1 pulse sample occurring in each stratum. A sample of 140 coho salmon collected from 3 to 6 September would be used to estimate the ASL composition of the 400 coho salmon that passed the weir during the temporal strata that extended from 2 to 7 September. This procedure would be repeated for each stratum, and the estimated age and sex composition for the total annual escapement would be calculated as the sum of coho salmon in each stratum. In similar fashion, the estimated mean length composition for the total annual escapement would be calculated by weighting the mean lengths in each stratum by the escapement of coho salmon that passed the weir during that stratum. Confidence intervals were constructed for the estimated mean lengths according to Thompson (1992; page 105).

Throughout this document, fish ages are reported using European notation. European notation is composed of 2 numerals separated by a decimal where the first numeral indicates the number of winters the juvenile spent in fresh water and the second numeral indicates the number of winters spent in the ocean (Groot and Margolis 1991). Total age of a fish is equal to the sum of both numerals, plus 1 year to account for the winter when the egg was incubating in gravel. For example, a Chinook salmon described as an age-1.4 fish is actually 6 years of age. European notation will be used throughout this document to represent specific age classes, which indicate fish with a particular life history strategy. Total age will be used when discussing brood size because broods often consist of same age fish with different life history strategies. For example a brood of age-6 Chinook salmon may consist of age-1.4 and age-2.3 fish.

WEATHER AND STREAM OBSERVATIONS

Daily weather and stream observations were taken in the morning and usually again in the late afternoon to monitor habitat variables. Air and water temperatures were measured using a thermometer calibrated in degrees Celsius. Stream temperature was determined by submerging the thermometer below the water surface until the temperature reading stabilized and air temperature was obtained by placing the thermometer in a shaded location until the temperature reading stabilized. Temperature readings were recorded in the logbook, along with notations about cloud cover, wind direction and speed, and precipitation. Wind speed was estimated to the nearest 5 miles per hour, and daily precipitation was measured using a rain gauge calibrated in millimeters. As in 2005, water temperature readings were also obtained from a data logger placed midstream just upstream from the weir. The data logger was programmed to record water temperature every hour during the weir operational period. Records were retrieved at the end of the season and archived for future comparisons.

Water level observations represented the stream height in centimeters above an arbitrary datum plane. Water levels were measured using a staff gage secured to a stake driven into the river bottom near the bank just downstream from the weir. The arbitrary datum plane was pegged to the semi-permanent benchmark installed in 2005 (Costello et al. 2006; Appendices A1–A2),

which was ultimately based on the semi-permanent benchmarks installed in previous years (Stewart and Molyneaux 2005).

River discharge was measured once during the season when the river level was just below its seasonal average. Discharge was measured and calculated using the same techniques described by Costello et al. (2006).

RELATED FISHERIES PROJECTS

Inriver Abundance of Chinook Salmon in the Kuskokwim River

The Tatlawiksuk River weir was a component of a radiotelemetry project entitled *Inriver Abundance of Chinook Salmon in the Kuskokwim River* intended to estimate the total abundance of Chinook salmon in the Kuskokwim River (Stuby 2003, 2004, 2005, 2006, *In prep*). Radio transmitters were inserted into select Chinook salmon with lengths greater than 450 mm caught near upper Kalskag (rkm 270) following methods described by Stuby (*In prep*; Figure 1). The Tatlawiksuk River had one of several radio receiver stations intended to monitor passage of radiotagged fish into tributary streams. The Tatlawiksuk River receiver station was placed on the bank, in-line with the weir. Due to the orientation of the receiver station to the weir, fish are detected passing the receiver station at precisely the same time they pass upstream of the weir. Though Chinook salmon were also fitted with a spaghetti tag that allowed the weir crew to recognize a radiotagged fish, no attempt was made to capture these fish since they were monitored by the receiver station and later noted by aerial surveys. The known Chinook salmon passage at the weir, coupled with data collected from the receiver station, were used with similar data collected at other weir projects to develop estimates of the total Chinook salmon abundance upstream from the Lower Kalskag tagging site. Complete methodology is provided by Stuby (*In prep*). Results of this study will be a critical component of a related project entitled *Kuskokwim River Chinook Salmon Run Reconstruction*, which entails a two part approach to develop a statistical model that will use fragments of historical information to estimate a time series of annual Chinook salmon abundance in the Kuskokwim River from the 1970s through 2007.

The Tatlawiksuk River weir and crew facilitated this project by monitoring and downloading a receiver station located near the weir, providing a means to recapture radiotagged Chinook salmon passing upstream of the weir, and enumerating total passage of Chinook salmon upstream of the weir. The receiver was downloaded monthly by the weir crew and data was sent to researchers as often as possible throughout the season. For each recaptured fish, the crew recorded the date of capture, tag number, and the general condition of the fish.

Kuskokwim River Sockeye Salmon Investigations

The Tatlawiksuk River weir was used as a platform for the project entitled *Kuskokwim River Sockeye Salmon Investigations*. This project was designed to address critical knowledge gaps in the biology and ecology of Kuskokwim River sockeye salmon. Specifically, this project aimed to describe the location and relative abundance of sockeye salmon spawning aggregates, estimate stock-specific run-timing in the main stem of the Kuskokwim River, describe and compare habitat use and seasonal migration patterns of river-type and lake-type juveniles, and describe and compare smolt size and growth among tributaries and habitat types. These goals were addressed by conducting a two-sample mark–recapture study within the upper Kuskokwim River drainage above Kalskag and conducting juvenile studies within various habitat types throughout the Holitna drainage.

Similar to the Chinook project, radio transmitters were inserted into sockeye salmon caught near Kalskag. Radiotagged fish were also equipped with a spaghetti tag to assess incidences of tag loss. A combination of radio receiver stations located throughout the upper Kuskokwim River drainage (the same receiver stations used for the Chinook project) and aerial surveys was used to monitor the movement of tagged fish. Juvenile salmon were sampled from various habitat types throughout the Holitna drainage using standard seining techniques. The known sockeye salmon passage at the weir projects located throughout the upper drainage, coupled with data collected from tracking efforts, was used to address distribution, abundance, and run-timing of spawning aggregates. Data from seining efforts were used to address habitat use, out migration timing, and variation in size and growth of juvenile sockeye salmon.

The Tatlawiksuk River weir and crew facilitated this project by monitoring and downloading the receiver station located near the weir, providing a means to recapture radiotagged sockeye salmon passing upstream of the weir (had any been observed), and enumerating total passage of sockeye salmon upstream of the weir. The services performed on the tracking station for the Chinook salmon radiotelemetry project also benefited the radiotelemetry component of *Kuskokwim River Sockeye Salmon Investigations*.

Kuskokwim River Salmon Mark–Recapture Project

The Tatlawiksuk River weir was used as a platform for the project entitled *Kuskokwim River Salmon Mark–Recapture Project.* In 2006 this project was designed to investigate stock-specific run-timing and travel speed of Kuskokwim River Chinook and sockeye salmon (Schaberg et al. *In prep*). These goals were addressed by conducting a two-sample mark–recapture study within the upper Kuskokwim River drainage above Kalskag. Uniquely numbered anchor tags were attached to Chinook and sockeye salmon caught using fish wheels and drift gillnets near Kalskag. Weir crews at projects located throughout the upper Kuskokwim River drainage recaptured observed tagged fish in the same live trap used for ASL sampling. Known recapture dates and tag number from the weirs coupled with known deployment dates of recaptured tags from the Kalskag tagging site were used to develop estimates of stock-specific run timing and travel speed. For the purpose of estimating stock-specific run-timing for each species, fish radiotagged as part of concurrent research efforts were pooled with anchor-tagged fish to increase sample size. This was considered appropriate since similar gear types were used for capture, and the objectives of both projects were considered in the tag deployment schedule. The pooling of both samples likely resulted in a better estimate of stock-specific run-timing than either considered independently because the radio-tag to anchor tag ratio varied from day to day when radio tags were deployed according to a rigid pre-determined schedule and anchor tags were affixed to the remaining catch. Complete methodology is presented by Schaberg et al. (*In prep*).

The Tatlawiksuk River weir and crew facilitated this effort by recapturing observed anchor tagged Chinook and sockeye salmon. For each recaptured fish, the crew recorded date of recapture, tag number, tag color, and the general condition of the fish. In addition, crews randomly examined Chinook salmon through ASL sampling for the presence of a severed adipose fin that served as a secondary mark to assess tag loss. Schaberg et al. (*In prep*) provides details.

RESULTS

ESCAPEMENT MONITORING

Installation of the Tatlawiksuk River weir began on 11 June and was complete at 0000 hours on 15 June, which was the target operational date. High water rendered the weir inoperative on 19 August and water levels did not recede enough for weir operation until around 5 September by which time most of the coho salmon run would have passed, based on historical run timing information. As a result, project leaders decided to remove the weir at the first opportunity realizing the instability of water levels during much of the season. Weir removal began on 9 September and was completed on 11 September. No other holes or inoperative periods compromised escapement monitoring in 2006.

Chinook Salmon

Total annual Chinook salmon escapement upstream of the Tatlawiksuk River weir between 15 June and 18 August 2006, inclusive, was 1,700 fish (Table 1; Appendix B1). No Chinook salmon were thought to have passed after the weir became inoperative based on historical run timing and passage data. Daily passage estimates were not required for any other time. The first Chinook salmon was observed on 25 June and the last Chinook salmon was observed on 10 August, 9 days before the weir became inoperative (Table 1). Daily passage peaked at 228 fish on 9 July. Based on total estimated escapement during the target operational period, the median passage date was 10 July and the central 50% of the run occurred between 6 and 15 July (Table 1; Figure 3).

Chum Salmon

Total annual chum salmon escapement upstream of the Tatlawiksuk River weir between 15 June and 20 September 2006 was 32,301 fish, which includes estimated passage (89 fish) for the remainder of the target operational period after 18 August (Table 1; Appendix B2). Estimates for the inoperative period were derived from the "proportion method" for extrapolating missed passage, using 2002 as a "model data set" as defined in *Methods*. The first chum salmon was observed on 18 June, and the last chum salmon was observed on 18 August, the last day of full weir operations (Table 1). Daily passage peaked at 2,190 on 4 July. The median passage date was 12 July and the central 50% of the run occurred between 6 July and 21 July, based on total annual escapement during the target operational period (Table 1; Figure 3).

Coho Salmon

Total annual coho salmon escapement upstream of the Tatlawiksuk River weir between 15 June and 18 August 2006, inclusive, was 2,362 fish (Table 1; Appendix B3). Passage was estimated for the remainder of the target operational period after the weir became inoperative using the "proportion method" for extrapolating missed passage and 2002 and 2005 as "model data sets" as defined in *Methods.* This method yielded an estimate of 7,089 fish, which is 75% of the total escapement of 9,453 fish for the target operational period that includes this estimate plus the known escapement from earlier in the season (Table 1). The first coho salmon was observed on 16 July. Due to the high proportion of estimated passage, analyses based on cumulative or cumulative percent passage will not be pursued (Figure 3).

Other Species

Sockeye Salmon

Sockeye salmon are uncommon in the Tatlawiksuk River. A total of 38 sockeye salmon passed upstream of the weir while it was operational between 15 June and 18 August, inclusive (Appendix C1). An additional 3 fish were estimated to have passed while the weir was not operational during the target operational period based on the "proportion method" using 2005 as the "model data set" as defined in *Methods*. Thus, total annual sockeye salmon escapement was 41 fish in 2006. The first sockeye salmon was observed on 15 July and daily passage peaked at 7 fish on 14 August. Based on total estimated escapement during the target operational period, the median passage date was 6 August and the central 50% of the run occurred between 29 July and 14 August.

Pink Salmon

Pink salmon *O. gorbuscha* are rare in the Tatlawiksuk River. A total of 20 pink salmon were observed passing upstream in 2006 (Appendix C1). Estimates were not made for pink salmon since they constitute only a minute fraction of total salmon escapement and none were observed after 6 August, still 13 days before the weir became inoperative. The first pink salmon was observed on 17 July, and passage peaked at 3 fish on 22 and 24 July.

Resident Species

Four resident fish species were observed passing upstream of the weir in 2005. Longnose suckers were the most abundant, with 1,293 passing the weir during the operational period (Appendix C1). Other species observed passing upstream of the weir in 2006 included 76 whitefish *Coregonus sp*., 8 Arctic grayling *Thymallus arcticus*, 5 dolly varden *Salvelinus malma*, and 4 northern pike *Esox lucius* (Appendix C1). No estimates were made for resident fish passage when the weir was inoperable.

Carcasses

A total of 1,578 salmon carcasses were recovered from the Tatlawiksuk River weir in 2006 (Appendix D1), representing about 4% of the observed escapement of all Pacific salmon species. A total of 22 Chinook salmon carcasses were recovered (1.3% of the observed annual escapement) between 2 July and 18 August. A total of 1,550 chum salmon carcasses were recovered (4.8% of the observed annual escapement) between 29 June and 18 August. A total of 3 coho salmon carcasses were recovered (0.1% of the observed annual escapement) between 31 July and 18 August, the last day of weir operations. A total of 2 sockeye salmon carcasses were recovered (both on 23 July) and represented 5.2% of the observed annual escapement. One pink salmon carcass was recovered on 21 July and represented 5.0% of the total observed annual escapement. Females accounted for approximately 23% of the Chinook and 32% of the chum salmon carcasses recovered from the weir. Other species recovered included 34 whitefish, 9 northern pike, 3 Arctic grayling, 1 sheefish *Stendous leucichthys nelma*, and 214 longnose suckers.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Chinook salmon ASL sampling at the Tatlawiksuk River weir was conducted periodically on an opportunistic basis from 28 June to 7 August. This effort resulted in a total sample of 195 Chinook salmon. Of those, age was determined for 178 fish (91% of the total sample), or 10.5% of the total Chinook escapement in 2006 (Tables 2 and 3). The total escapement was partitioned into 3 temporal strata based on the temporal distribution of the sampling effort and sample size requirements, with sample sizes of 90 aged fish in the first stratum, and 44 in each of the second two strata (Table 2). Sampling size objectives were not achieved for Chinook salmon, but postseason analysis revealed that sample sizes were adequate for estimating total and intra-annual age, sex, and length composition of Chinook salmon escapement to the Tatlawiksuk River weir in 2006.

Each Chinook salmon age *group* was comprised of only one age *class.* All age-4, -5, -6, and -7 fish were of the -1.2, -1.3, -1.4, and -1.5 age classes, respectively; no age-2.1, -2.2, -2.3, or -2.4 fish were found in 2006 (Table 2), though they are occasionally found in some tributaries (Molyneaux and Folletti *In prep*). The 2006 Chinook salmon escapement was dominated by three age classes, which combined comprised over 95% of the total annual escapement (Table 2; Figure 4). Age-1.3 was the most abundant age class (44.1%), followed by age-1.4 (30.4%) and age-1.2 (21.0%). Age-7 fish comprised only a tiny fraction of escapement in 2006 (4.6%), and no age-3 or -8 fish were observed in the sample. Intra-annual variation in the proportion of age-1.2, -1.3, and -1.4 Chinook salmon was observed, but none followed a uniform increasing or decreasing trend (Table 2; Figure 5). As the run progressed, the proportion of age-1.3 fish remained relatively constant (between 40.9% and 52.3%). The proportion of age-1.4 fish was highest towards the end of the run (40.9% in the last stratum), but the proportion of age-1.2 fish was highest towards the middle of the run (27.3% in the middle stratum). The proportion of the age-1.3 and -1.4 age classes was equal towards the end of the run; otherwise, age-1.3 was consistently dominant.

Based on ASL sampling, the ratio of males to females in the Chinook salmon escapement past the Tatlawiksuk River weir was approximately 3:2 (Table 2). Female Chinook salmon comprised 41.4% of the total annual escapement based on weighted ASL samples. Sex composition varied during the run but did not follow a consistent increasing or decreasing trend (Figure 6). The proportion of females was highest towards the end of the run, becoming more abundant than males during the last sampling stratum with the arrival of more age-1.4 fish. The female escapement was predominately older age-1.4 individuals (53.1%), whereas the male escapement was more equally comprised of younger age-1.3 (45.8%) and -1.2 (35.8%) individuals. None of the sampled age-1.2 fish were females.

Analysis of length composition suggested partitioning by sex and age class. The length of female Chinook salmon ranged from 650 to 935 mm, and males ranged from 495 to 1,005 mm (Table 3). Female Chinook salmon were consistently larger at age than males, and generally average length increased with age for both females and males. Average lengths for female age-1.3, -1.4, and -1.5 Chinook salmon were 724, 810, and 804 mm, respectively. Average lengths for male age-1.2, -1.3, -1.4, and -1.5 Chinook salmon were 575, 682, 766, and 820 mm, respectively. Average length at age varied considerably over the course of the run for both male

and female Chinook salmon, but average lengths did not follow a uniform increasing or decreasing trend (Table 3; Figure 7).

Chum Salmon

Sampling goals for chum salmon were achieved in 2006. Intensive sampling was conducted during 5 sampling pulses distributed evenly throughout the chum salmon run for a total of 1,111 fish. Of those, age was determined for 935 chum salmon (84% of the total sample), or 2.9% of the total annual chum salmon escapement in 2006 (Tables 4 and 5). The chum run was partitioned into 5 temporal strata based on the temporal distribution of the sampling effort, with sample sizes ranging between 176 and 220 aged fish per stratum, respectively (Table 4). Sample sizes were adequate for estimating total and intra-annual age, sex, and length composition of chum salmon escapement to the Tatlawiksuk River weir in 2006.

The chum salmon escapement past the weir was largely represented by two age classes, which combined comprised nearly 98% of the total chum salmon escapement at the Tatlawiksuk River weir. Comprising 55.6% of total annual escapement, age-4 fish were the most abundant, followed by age-5 fish (42.3%; Table 4; Figure 4). Since virtually all chum salmon out-migrate the first spring or summer after emergence, all age-4 fish were of the -0.3 age class, and all age-5 fish were of the -0.4 age class (Table 4). All assumed age/sex categories were represented in the 2006 chum salmon escapement; however, the contribution of 3 year-olds (age-0.2) and 6 year-olds (age-0.5) was only 2% combined. Age composition changed considerably over the course of the run, especially in the proportion of the age-0.3 and -0.4 age classes. The proportion of age-0.3 chum salmon continually increased from 29.8% early in the run to 70.9% near the end (Table 4; Figure 8). Conversely, the proportion of age-0.4 chum salmon continually decreased from 69.6% early in the run to 20.9% near the end.

Based on ASL sampling, the ratio of males to females in the chum salmon escapement past the Tatlawiksuk River weir was approximately 3:2 (Table 4). Female chum salmon comprised 42.1% of the total annual escapement based on weighted ASL samples. Sex composition varied during the run (Figure 6). The proportional contribution of females tended to increase over the course of the run from 40.3% during the first sampling stratum to 55.9% during the last two. The female escapement was dominated (62.1%) by age-0.3 individuals, while the male escapement was more evenly composed of age-0.3 and age-0.4 individuals, representing 50.8% and 47.7% of the total male escapement, respectively.

Analysis of length composition suggested partitioning by sex and age class. The length of female chum salmon ranged from 460 to 650 mm, and males ranged from 440 to 690 mm (Table 5). Among the dominant age classes, male chum salmon were generally larger at age than females, and average length generally increased with age for both males and females. Average lengths for female age-0.2, -0.3, and -0.4 fish were 513, 541, and 555 mm, respectively. Average lengths for male age-0.2, -0.3, -0.4, and -0.5 fish were 498, 566, 588, and 576 mm, respectively. For both males and females, average length at age tended to decrease slightly over the course of the run (Table 5; Figure 9).

Coho Salmon

Sampling goals for coho salmon were not achieved in 2006. One sampling pulse of 188 fish was completed before the weir became inoperative on 19 August. Of those, age was determined for 155 fish (Table 6). Since the best available estimation methods and historical run timing data

revealed that only 25% of the coho salmon run had passed by this date, researchers refrained from applying pulse sample results to the overall escapement.

Of the 155 coho salmon with determined age, 14.9% were age-3 fish, 80.2% were age-4 fish, and 4.9% were age-5 fish (Table 6). Since virtually all coho salmon spend only one winter at sea before returning to spawn, all 3, 4, and 5 year-old fish were of the -1.1, -2.1, and -3.1 age classes, respectively. Females comprised 37.3% of the sample. Analysis of length composition indicated partitioning by sex and age class (Table 7). In the sample, age-1.1 and -2.1 males averaged 509 and 524 mm, respectively, and age-1.1, -2.1, and -3.1 females averaged 508, 525, and 541 mm, respectively. One age-3.1 male was sampled with a length of 490 mm. Average lengths at age were remarkably similar between males and females, but length at age tended to increase with age for both males and females.

WEATHER AND STREAM OBSERVATIONS

In 2006, water levels at the Tatlawiksuk River weir ranged from 27.0 to 195.0 cm, with an average of 64.0 cm for the overall operational period (Appendix E1). Daily morning water levels were generally below average from 15 June to 13 August, but increased rapidly from 13 to 22 August (Figure 10). After 22 August water levels dropped steadily until the weir was removed for the season. There was not an obvious correlation between water level and salmon passage through the weir (Figure 11).

Based on twice-daily thermometer observations, water temperature in the Tatlawiksuk River ranged from 6.0 to 16.5°C and averaged 10.5°C for the overall operational period (Appendix E1). Based on hourly data logger readings, daily average water temperature ranged from 7.7 to 15.7°C and averaged 11.3°C for the overall operational period (Appendix E2). Daily water temperature fluctuated dramatically throughout the 2006 operational period but remained within the historical range and near average until about 13 August when water temperature dropped below the historical range and remained well below average until 7 September (Figure 10). There was not an obvious correlation between water temperature and salmon passage through the weir (Figure 12).

Air temperature at the weir ranged from -1.0 to 28.0°C, with an average air temperature of 13.2°C for the operational period (Appendix E1). Air temperature is not thought to directly affect fish behavior around the Tatlawiksuk River weir, so it will not be discussed in detail in this report.

Stream discharge was measured once during the 2006 season on 9 September when the river stage was 54 cm, 10 cm below the seasonal average, and within normal operating limits for the weir (Appendix E3). Stream discharge at this time and water level was 37.1 m^3/s.

RELATED FISHERIES PROJECTS

Inriver Abundance of Chinook Salmon in the Kuskokwim River

A total of 8 radiotagged Chinook salmon were detected by the receiver station located near the Tatlawiksuk River weir in 2006. Of these, 7 eventually passed upstream of the receiver station and were considered recaptures (Stuby *In prep*). All were later detected upstream of the weir during aerial flights in July and August. The crew observed 5 passing upstream of the weir but efforts were not made to recover spaghetti-tag numbers in order to minimize handling stress. Daily escapement of radiotagged fish past the weir corresponded well to total daily escapement

of Chinook salmon, and run timing of radiotagged fish past the weir was similar to the run timing of the total escapement (Figure 13).

In 2006 this study provided an inriver abundance estimate of 233,233 Chinook salmon (SE = 28,450) that were greater than 450 mm in length for the Kuskokwim River drainage upstream of Kalskag, and an estimate of 165,538 (SE = 22,538) for the drainage upstream of the Aniak River confluence. Based on this estimate, the Tatlawiksuk River stock represented 0.7% of total abundance upstream of Kalskag, and 1.0% of the abundance upstream of the Aniak River confluence. Detailed results for the Chinook salmon radiotelemetry study are reported in Stuby (*In prep*).

In addition to providing a large-scale abundance estimate, radio tag data allowed an opportunity to investigate potential holding time below the weir site by comparing time of initial detection by the receiver station to time of passage at the weir. In 2006, time from initial detection by the receiver station until passage at the weir ranged from 0.9 to 3.6 days (ignoring the 1 fish that did not move past the weir), with an average of 2.1 days.

Kuskokwim River Sockeye Salmon Investigations

No radiotagged sockeye salmon were detected or observed passing the Tatlawiksuk River weir or receiver station in 2006. Tagged sockeye were tracked to tributaries throughout the Kuskokwim River basin using 17 ground-based tracking stations, and 3 aerial tracking surveys conducted in July, August, and September. Of 498 tags deployed, 448 (90%) successfully resumed upstream migration, and 383 (77%) were successfully tracked to tributary streams. Radiotagged sockeye salmon were identified in all major drainages between Kalskag and the Swift River drainage. Large aggregates were observed in the Aniak, Holokuk, Holitna, Hoholitna, and Stony River drainages. The highest concentrations were observed throughout the Holitna River. Complete results of this project can be obtained from Gilk (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Kuskokwim River Salmon Mark–Recapture Project

Tag recovery efforts at the Tatlawiksuk River weir were successful in 2006. The weir remained operational for nearly the entire Chinook and sockeye salmon runs, so few tagged fish of these species were likely to have passed the weir without detection. The effect of the premature end of weir operations on Chinook and sockeye salmon tag recovery (i.e. recording of the unique tag number) was probably minimal if passage estimates for this period are accurate. No Chinook salmon were estimated to have passed after the weir became inoperable, and daily passage estimates for sockeye salmon represented only about 6.5% of annual escapement. In addition, all passage was successfully conducted through the live trap, due to above-average seasonal water levels, allowing crew members to at least observe every tagged fish passing upstream of the weir.

Despite the presumed success of tag recovery at the Tatlawiksuk River weir in 2006, only 3 Chinook salmon and no sockeye salmon were observed with anchor tags. Each of the observed tagged Chinook salmon was successfully captured and its tag number recovered. No secondary tag marks that would have indicated tag loss were found among 195 Chinook salmon examined through the process of ASL sampling. Passing sockeye salmon without tags were not handled because ASL samples are not collected for this species.

Recovery of tag numbers offered an opportunity to study migration characteristics of Tatlawiksuk River Chinook salmon in 2006. Since similar gear types were used for capture, and the objectives of both projects were considered in the tag deployment schedule, the radio tag sample was pooled with the anchor tag sample for assessing run timing of specific Chinook salmon stocks past the tagging site. In fact, the pooling of both samples probably results in a better estimate of stock-specific run timing than either considered independently because the radio-tag to anchor-tag ratio varied from day to day when radio tags were deployed according to a rigid pre-determined schedule and anchor-tags were affixed to the remaining catch. Pooling the data reveals that the median passage date of tagged Tatlawiksuk River Chinook salmon past the tagging site was 29 June, with all of the tagged fish passing between 21 June and 11 July (Schaberg et al. *In prep*; Figure 14).

Due to a potential for different behavioral effects, the two tag samples could not be pooled when calculating travel speed. The anchor-tagged Chinook salmon bound for the Tatlawiksuk River weir exhibited travel speeds of 16.6, 22.9, and 29.8 km/day, with speeds increasing with tag deployment and recovery dates. Detailed results for the Chinook and sockeye salmon tagging study in 2006 will be reported in Schaberg et al. (*In prep*).

DISCUSSION

ESCAPEMENT MONITORING

The reported Chinook, chum, and sockeye escapements in 2006 are considered accurate representations of annual escapements to the Tatlawiksuk River. Based on historical run timing and abundance information, the weir was successfully operated during nearly the entire Chinook salmon run (Table 1). Passage estimates generated using the proportion method revealed that few chum and sockeye salmon passed the weir site after the weir became inoperative on 18 August (Table 1; Appendix B1; Appendix C1). Unfortunately, the weir became inoperative long before the bulk of the coho salmon run had passed; historical run timing and abundance data reveal that usually only about 25% of the total coho salmon run passes by this date annually (Appendix B3; Appendix F1). Coho salmon passage estimates for 19 August to 20 September were generated using the common proportion method, but confidence in the estimate is generally low due to the high percentage of the escapement that this method, along with historical run timing data, revealed was estimated. Daily passage trends indicated few salmon passed the weir site before the operational period (Table 1; Appendices B1–B3).

Chinook Salmon

Abundance

Reported escapement of 1,700 Chinook salmon past the Tatlawiksuk River weir during the operational period of 15 June through 18 August is considered a reliable estimate of the 2006 total annual escapement upstream of the weir (Table 1). Based on the available run timing and passage data, the inoperable period beginning on 19 August occurred after the bulk of the Chinook salmon run had migrated upstream past the weir; few are thought to have passed the weir site during this time (Table 1). In addition, no radiotagged Chinook salmon were detected passing upstream of the weir before operations began or during inoperable periods (Stuby *In prep*; Figure 13).

Chinook salmon escapement in 2006 was near average at the Tatlawiksuk River weir for the 8 years with available escapement information (Figure 15; Appendix B1), but was higher than the 1999 and 2000 escapements that contributed to the BOF classifying Kuskokwim River Chinook salmon as a stock of concern (Burkey et al. 2000a). No formal escapement goals have been established for the Tatlawiksuk River, which precludes assessment of the adequacy of the escapement. However, escapement goals were met or exceeded in 2006 in tributaries where they have been established (ADF&G 2004), and generally escapements have improved in recent years from below-average levels in 1998–2000 (Figure 15; Bergstrom and Whitmore 2004; Molyneaux and Brannian 2006).

Escapement goals have not yet been established for Tatlawiksuk River Chinook salmon due to a recognized lack of historical escapement data, which precludes assessment of the adequacy of the 2006 escapement. At the time of this report, the time series of historical data for the Tatlawiksuk River weir was not sufficient to apply the Bue and Hasbrouck method for developing a sustainable escapement goal (SEG) range, for which a minimum of 10 years of reliable escapement data (one life cycle of returns) are generally required (Molyneaux and Brannian 2006). Escapement data from 1998 and 2003 are lacking due to weir operational shortfalls. If successful weir operation continues, the 10 year minimum requirement for establishing an SEG will be achieved in 2009, and an SEG will likely be proposed to the Alaska Board of Fisheries in 2010. At the time of this report, paired weir and aerial survey data were available for only 1 year, but the simultaneous use of both enumeration methods in future years may provide a foundation on which to estimate escapement during a year when the weir was not successful but aerial surveys were conducted. This estimation method has been used in the past when data were lacking otherwise, and increase the likelihood that proposed escapement goals will be developed before 2010. Using escapement data collected through 2005, the SEG derived from the Bue and Hasbrouck method would range between 1,500 and 2,900, in which existing years of escapement data would be equally distributed above and below the median. This SEG range is considerably below the estimates for the number of spawners at maximum sustained yield (S_{msy}) and spawners at carrying capacity (S_c), 3,695 and 9,839 fish, derived using the habitat-based model developed by Parken et al. (2004) and described by Molyneaux and Brannian (2006). This suggested carrying capacity is slightly below that suggested for the Takotna River using the same method and existing data, though the Chinook salmon escapement at the Tatlawiksuk River weir is generally much greater. For both systems, carrying capacity based on the habitat-based models implies the potential for much higher escapements than currently observed.

The overall Kuskokwim River Chinook salmon escapement was considered above average in 2006 (Figure 15; Linderman et al. *In prep* b). The Kuskokwim River Chinook salmon escapement index was only slightly lower than in 2004 and 2005, which are the highest years on record (Figure 15). The strength of the Chinook salmon run relative to past years was highly variable in 2006. Tatlawiksuk River weir, along with two other weirs, reported a decrease of varying degrees in Chinook salmon abundance from 2005 to 2006, a pattern also apparent in the Chinook salmon composite index (Figure 15; Liller et al. *In prep*; Plumb et al. 2007). However, the George and Takotna river weirs reported slight increases in escapements from 2005 to 2006 (Costello et al. *In prep*; Hildebrand et al. *In prep*). However they differ between this year and last, Chinook salmon escapement at all projects tended to increase between 2000 and 2005, which is a trend also revealed in the Chinook salmon composite index (Figure 15; Linderman et al. *In prep* b).

Abundance estimates provided by the radiotagging of Chinook salmon in the Kuskokwim River have, in general, followed similar trends seen in the other measures of abundance (weir escapement, aerial survey information, and composite index). The estimate of 165,538 Chinook salmon that escaped upstream of the Aniak River confluence in 2006 is the highest on record, but similar to 2005. Prior to 2006, estimates have ranged from 100,733 in 2002 to 145,373 in 2005. This increase in abundance for the entire upper drainage is mirrored in the observed annual escapements at each of the upriver weir projects (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007). This relationship suggests that the combined escapement estimates from the George, Tatlawiksuk, Kogrukluk, and Takotna river weirs provide a suitable index of inriver abundance of Chinook salmon upstream of the Aniak River. Tatlawiksuk River Chinook salmon consistently comprise approximately 1–2% of the total annual estimate upstream of the Aniak River confluence. This proportional contribution is similar to what is reported for the George River weir, but considerably lower than what is consistently reported for the Kogrukluk River weir (about 12%).

Since the late 1980s, Chinook salmon have received little harvest pressure from the commercial fishery. Chinook salmon have not been targeted for commercial exploitation since 1987 and annual harvests since that time have been incidental to other species. When compared to the total of 233,233 Chinook salmon estimated to have migrated past Kalskag in 2006, the harvest of 2,777 Chinook salmon probably had negligible impact on Kuskokwim River Chinook salmon stocks. The 165,538 Chinook salmon estimated to have migrated upstream of the Aniak River confluence in 2006 based on mark–recapture and radiotelemetry was the highest among the recent 5 years with comparable data even though the reported commercial harvest was considerably less than the recent 10-year average of 4,732 fish and the pre-2001 10-year average of 18,081 fish (Linderman et al. *In prep* b). The relatively small harvest in 2006 is likely the combined effect of conservative management and low permit utilization (Linderman et al. *In prep* b). A lack of commercial markets for chum salmon in recent years has depressed exvessel prices and reduced the number of permit holders actively fishing.

The number of Chinook salmon harvested in the subsistence fishery is much greater than the commercial harvest. Estimates are not yet available for the 2006 (or 2005) subsistence harvests, but the 1995–2004 average harvest was 76,980 (Martz and Dull 2006). Harvests have remained relatively stable since the late 1980s, making it likely that the subsistence harvests in 2005 and 2006 were probably near this average. When compared to the number of Chinook salmon estimated to have migrated past Kalskag, the number of Chinook salmon harvested for subsistence use is significant and represents a much larger fraction of total run abundance than the commercial harvest. Recognizing the implications of the BOF stock of concern designation, ADF&G implemented a subsistence fishing schedule in 2001 that was intended to distribute subsistence fishing effort more evenly throughout the Kuskokwim River Chinook salmon run. The subsistence fishing schedule was implemented based on a concern that subsistence fishers were concentrating their efforts towards the beginning of the Chinook salmon run through the lower river and unknowingly targeting some stocks. While it was being practiced, the subsistence fishing schedule was being studied for its effectiveness. After 7 years of implementation, there is now evidence that the fishing schedule was not producing the desired result and has little effect on the timing of subsistence harvest efforts (T. Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication). The subsistence fishing schedule has probably provided no benefit to upper river stocks such as that bound for the Tatlawiksuk River.

Run Timing at Weir

Based on median passage dates, the timing of the Chinook salmon run at Tatlawiksuk River weir in 2006 (10 July) was later than all previous years with the exception of 1999, which was extraordinarily late compared to other years of data (Figure 3; Appendix F2). The median passage date in 1999 was 18 July; otherwise median passage dates have ranged from 4 July in 2002 to 8 July in 2000. With central 50% passage occurring over a 10-day period and central 80% occurring over a 19-day period, the Chinook salmon run in 2006 was similar in duration to previous years. Later than average run timing was observed at most other ground-based escapement monitoring projects in the Kuskokwim River in 2006 (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007).

Chum Salmon

Abundance

Reported escapement of 32,301 chum salmon past the Tatlawiksuk River weir during the target operational period of 15 June through 20 September is considered a reliable estimate of the 2006 total annual escapement (Table 1). Daily passage estimates for the inoperable period that began on 19 August constituted a small percentage of the total estimated escapement (0.3%), a conclusion supported by historical run timing and abundance information (Table 1).

Chum salmon escapement to the Tatlawiksuk River weir in 2006 was slightly less than in 2005 but higher than in all previous years with available escapement information (Figure 16; Appendix B2). Though escapements have been determined for chum salmon in 7 of 9 years the project has operated, no formal escapement goals have been established for the Tatlawiksuk River, which precludes assessment of the adequacy of the escapement. However, in the Aniak and Kogrukluk rivers where escapement goals have been established (ADF&G 2004), escapement goals were exceeded in 2006. Similar to Tatlawiksuk River weir escapements, overall chum salmon escapements to Kuskokwim River tributaries have recovered from below-average levels in 1999 and 2000 to intermediate levels in recent years, and to record high levels in 2005 and 2006, based on escapement data from several weir projects (Figure 16; Bergstrom and Whitmore 2004; Linderman et al. *In prep* a; b).

Escapement goals have not yet been established for Tatlawiksuk River chum salmon due to a recognized lack of historical escapement data. At the time of this report, the time series of historical data for the Tatlawiksuk River weir was not sufficient to apply the Bue and Hasbrouck method for an SEG range, for which a minimum of 10 years of escapement data (one life cycle of returns) are generally required (Molyneaux and Brannian 2006). If successful weir operation continues, the 10 year minimum requirement for establishing an SEG will be achieved in 2009, and an SEG will likely be proposed to the Alaska Board of Fisheries in 2010. Using escapement data collected through 2005, the SEG derived from the Bue and Hasbrouck method would range between 9,000 and 33,000, in which most years of escapement would fall near or below the median. The annual variation observed in Tatlawiksuk River chum salmon escapements may result in changes to this suggested SEG after more years of escapement data are collected.

Commercial harvest pressure on Kuskokwim River chum salmon has been low in the past few years, and the harvest of 44,070 chum salmon in 2006 probably had negligible impact on individual chum salmon stocks (Linderman et al. *In prep* b). The number of chum salmon harvested commercially was only a modest fraction of the total number counted past tributary

weirs (340,098) and the sonar project in the Aniak River (1,108,626; Figure 16; McEwen *In prep*). Despite relatively high chum salmon escapement at all projects and record high escapements at Takotna and George river weirs, the commercial harvest of chum salmon was about 25,000 fewer fish than in 2005 and considerably less than the recent 10-year average of 55,661 fish and the pre-2001 10-year average of 286,134 fish (Linderman et al. *In prep* b). Chum salmon-directed commercial fishing was not permitted during the years immediately following the BOF "stock of yield concern" designation (2001–2003), so the annual harvest during these years of just over 1,000 fish was incidental to the coho salmon-directed commercial openings and the low harvests between 2001 and 2003 are partially responsible for the low recent 10-year average (Linderman et al. *In prep* b). The relatively small harvest in 2006 is likely the combined effect of conservative management and low permit utilization (Linderman et al. *In prep* b). A lack of commercial markets for chum salmon in recent years has depressed exvessel prices and reduced the number of permit holders actively fishing.

As with the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River chum salmon stocks was probably not significant. Subsistence harvest estimates are not yet available for the 2006 (or 2005), but the 1995–2004 average harvest was 57,981 fish (Martz and Dull 2006). Since annual subsistence harvests have varied little in the past 10 years of available data, the recent 10-year average reasonably approximates the total harvest in 2006. Compared to the number of chum salmon counted past tributary weirs and into the Aniak River in 2006, a subsistence harvest near 60,000 chum salmon may not significantly affect escapements of individual stocks. In recent years, chum salmon have generally not been targeted for subsistence use, and the numbers annually harvested since the early 1990s have generally been far less than annual harvests in the 1960s-1980s. In fact, annual subsistence harvests of Chinook salmon have exceeded chum salmon harvests every year since 1993, with the exceptions of 1996 and 2002, despite their lower abundance.

Recognizing the implications of the BOF stock of concern designation, ADF&G implemented a subsistence fishing schedule in 2001 that was intended to distribute subsistence fishing effort more evenly throughout the Kuskokwim River chum salmon run. The subsistence fishing schedule was implemented based on a concern that subsistence fishers were concentrating their efforts towards the beginning of the chum salmon run through the lower river and unknowingly targeting some stocks. While it was being practiced, the subsistence fishing schedule was being studied for its effectiveness. After 7 years of implementation, there is now evidence that the fishing schedule was not producing the desired result and has little effect on the timing of subsistence harvest efforts (T. Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication). The subsistence fishing schedule has probably provided no benefit to upper river chum salmon stocks such as that bound for the Tatlawiksuk River.

Run Timing at Weir

Based on median passage dates, the timing of the chum salmon run at Tatlawiksuk River weir in 2006 (12 July) was about average (Figure 3; Appendix F3). Median passage dates have ranged from 10 July in 2002 to 18 July in 1999. With central 50% passage occurring over a 16-day period and central 80% occurring over a 29-day period, the chum salmon run in 2006 was more protracted than in most previous years. Other Kuskokwim River projects observed median passage dates similar to previous years for chum salmon in 2006, either a little later or earlier than average with no outstanding anomalies (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; McEwen *In prep*; Miller et al. 2007; Plumb et al. 2007).

Coho Salmon

Abundance

The total estimated escapement of 9,453 coho salmon past the Tatlawiksuk River weir during the target operational period of 15 June through 20 September is speculative and is thus not a reliable estimate of the 2006 total annual escapement (Table 1). The common method for estimating missed passage for a long duration at the end of the run, the "proportion method", yielded an estimate three times higher than the known escapement. Little confidence can be placed in an estimate that represents 75% of the total annual escapement. However, total reported escapement until the weir became inoperable is considered reliable because no additional estimates were necessary and the weir was operational well before the first coho salmon passed. Though not available in 2006, inriver abundance estimates provided by the *Kuskokwim River Salmon Mark–Recapture Project* between 2001 and 2005 indicate that Tatlawiksuk River coho salmon comprise about 2.1% of the total return of coho salmon upstream of Kalskag, but the relative contribution varied dramatically from year to year (Pawluk et al. 2006a; b).

Assuming that the derived estimate for coho salmon escapement accurately approximates actual abundance, escapement in 2006 was close to the average of all previous years (Figure 17; Appendix B3). Escapements have been determined in 6 of 9 years the project has operated, but 2 years (2001 and 2006) required substantial estimates to span the target operational period. No formal escapement goals have been established for the Tatlawiksuk River, which precludes assessment of the adequacy of the escapement. In fact, of the 6 weir projects that annually enumerate coho salmon escapement, only the Kogrukluk River weir has an established escapement goal for coho salmon (Figure 17; Linderman et al. *In prep* b). With an escapement similar to 2005, the escapement goal was achieved at the Kogrukluk River weir. The slight increase in estimated escapement from 2005 to 2006 at the Tatlawiksuk River weir was observed at other projects in the drainage, which supports the accuracy of the estimate (Costello et al. *In prep*; Hildebrand et al. *In prep*; Plumb et al. 2007). If Kogrukluk River weir had not ceased operating earlier than usual and if Kwethluk River weir had been operational in 2005, this slight increase may have been observed at these locations as well (Liller et al. *In prep*; Plumb et al. 2007).

Escapement goals have not yet been established for Tatlawiksuk River coho salmon due to a recognized lack of historical escapement data. At the time of this report, the time series of historical data for the Tatlawiksuk River weir was not sufficient to apply the Bue and Hasbrouck method for developing an SEG range, for which a minimum of 10 years of escapement data (one life cycle of returns) are generally required (Molyneaux and Brannian 2006). Following the 2006 season, accurate and reliable coho salmon escapement information was available for only 4 years. The reason this data set is so much shorter than the analogous records for Chinook and chum salmon is because in 1998 the weir was intentionally not operated through the coho salmon run, escapement data from 2000 and 2003 is incomplete and estimates were not performed, and annual escapement data from 2001 and 2006 include inhibitive daily passage estimates. Thus, even continuous successful weir operation through 2009 would not result in a data series long enough to develop an SEG before the 2010 BOF meeting. The earliest SEG development could occur is following the 2012 season, but this is unlikely recognizing the unreliable weir performance due to volatile water levels typical in August and September. However, using escapement data collected through 2005, the SEG derived from the Bue and Hasbrouck method would range between 5,900 and 14,000, in which existing years of escapement data would be

equally distributed above and below the median. However, the annual variation observed in Tatlawiksuk River coho salmon escapements may result in changes to this suggested SEG after more years of escapement data are collected.

Commercial harvest pressure on Kuskokwim River coho salmon has always been considerable. The commercial harvest of 300,280 coho salmon in 2006 was probably sufficient to noticeably detract from observed escapements at tributary weirs, and likely represents an exploitation rate higher than in recent years (Linderman et al. *In prep* b). Total inriver abundance estimates are not available for 2006, but results from the *Kuskokwim River Salmon Mark–Recapture Project* indicated that between 2001 and 2005 inriver abundance of coho salmon ranged from 386,743 (2004) to 928,075 (2003) fish. Assuming these estimates are reasonable, they indicate that the number of coho salmon harvested commercially is a significant portion of the total coho salmon run, especially considering that total annual escapements observed at the weir projects was estimated at about 70,000 fish. Coho salmon-directed commercial fishing has been permitted annually since statehood, but the numbers harvested in recent years have generally remained below harvests in the 1980s through most of the 1990s (Martz and Dull 2006). The recent 10-year average of 369,410 coho salmon in the commercial harvest is lower than all annual harvests between 1986 and 1996. The small harvests in recent years may be partially attributable to relatively low permit utilization and depressed commercial markets for chum salmon. Since Kuskokwim River coho salmon have not been identified as a stock of concern by the Alaska BOF (Bergstrom and Whitmore 2004), they have not been the focus of conservation measures.

Contrary to the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River coho salmon stocks was probably not significant. Subsistence harvest estimates are not yet available for the 2006 (or 2005), but the 1995–2004 average harvest was 31,729 fish (Martz and Dull 2006). Records of coho salmon subsistence harvests have been kept since 1989 and during this time annual subsistence harvests have varied little. Thus, the recent 10-year average reasonably approximates the total harvest in 2006. Compared to the number of coho salmon captured in the commercial fishery and recognizing that escapement at most projects was near average, a subsistence harvest near 30,000 coho salmon probably did not significantly affect escapements of individual stocks. The exploitation rate of coho salmon for subsistence use is undoubtedly much lower than for Chinook salmon. The subsistence fishing schedule that was implemented annually from 2001 to 2006 had no effect on coho salmon subsistence harvest practices. In each year, the schedule was lifted for the season long before coho salmon were passing through the lower river in significant numbers (Burkey et al. 2002; Linderman et al. *In prep* a; b; Ward et al. 2003; Whitmore et al. 2005; Whitmore et al. *In prep*). Indeed, the subsistence fishing schedule was not initiated for coho salmon.

Run Timing at Weir

The run timing of coho salmon past the Tatlawiksuk River weir site was not investigated in 2006. Most of the determined passage was estimated and the resulting cumulative percent passage was manufactured based on estimates.

Historically, annual median passage dates have ranged from 18 August in 2001 to 2 September in 1999 (Linderman et al. 2002; Figure 3; Appendix F1). Compared to more recent years, the median passage date in 1999 was extraordinarily late, and median passage dates since that time have occurred no later than 24 August. Except for 1999, median passage dates have not varied dramatically from year to year. However, the duration of the coho salmon run is highly variable.

The central 50% has occurred in as little as 10 days (2002) and as long as 17 days (2005; Linderman et al. 2003; Costello et al. 2006; Figure 3; Appendix F1). This degree of variability in historical median passage dates and run duration is observed at most other weir projects (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007). Run timing relative to past years was variable in 2006 at other Kuskokwim River escapement projects, but none witnessed significant anomalies.

Other Species

Sockeye Salmon

Few sockeye salmon are observed in the Tatlawiksuk River, and the reported escapement of 41 sockeye salmon in 2006 was well above average and surpassed only by the record escapement in 2005 (Figure 18). Historically, annual sockeye salmon escapement at the Tatlawiksuk River weir has ranged from 0 fish in 2000 to 77 fish in 2005, which is not surprising since the Tatlawiksuk River is not a primary spawning tributary for sockeye salmon. Record high sockeye salmon escapements were reported at most other Kuskokwim River projects in 2006 (Figure 18; Linderman et al. *In prep* b).

Sockeye salmon are not abundant in the Kuskokwim River, and sockeye salmon are not prominent in subsistence and commercial harvests. The 2006 sockeye salmon commercial harvest of 12,618 sockeye salmon was less than the recent 10-year average of 17,525 fish (Linderman et al. *In prep* b). Compared to other species in the drainage, little is known about sockeye salmon in the Kuskokwim River. As a result, escapement goals do not exist, and they have not been considered a stock of concern by the BOF.

Historical run timing comparisons are limited by low abundances, but higher abundances in 2005 and 2006 make comparisons between these years appropriate. Based on median passage dates, the timing of the sockeye salmon run in 2006 was considerably later than in 2005 (Costello et al. 2006). With central 50% passage occurring over an 17-day period and central 80% occurring over 27-day period, the sockeye salmon run in 2006 was similar in duration to 2005. Sockeye salmon run timing at other weirs in the Kuskokwim River drainage was average or slightly earlier than average in 2006.

Pink Salmon

Pink salmon are occasionally observed in the Tatlawiksuk River, but only in small numbers. A total of 20 pink salmon were observed in the Tatlawiksuk River in 2006, which is considerably more than the 0 to 3 observed annually in past years. The Tatlawiksuk River is not a primary spawning tributary for pink salmon; therefore, it is not surprising that few pink salmon were observed in 2006 relative to other tributaries such as the Kogrukluk River (Liller et al. *In prep*).

Resident Species

Other species commonly observed at the Tatlawiksuk River weir include longnose suckers, whitefish, Arctic grayling, and northern pike (Appendix C1). Longnose suckers are historically the most abundant resident species counted at the Tatlawiksuk River weir. During the target operational period, annual longnose sucker passage has ranged from 75 in 2004 to 5,093 in 1999. The passage of 1,293 is considerably less than the historical average of 1,940 fish, but that average is heavily influenced by the extraordinary escapement in 1999.

Abundance estimates are known to be incomplete for longnose suckers because smaller individuals may be able to pass freely between the pickets, and upstream migration appears to start well before the target start date for weir operations. Three points suggest that upstream migration starts before the target operational period. First, in 2005 when the weir was operational for 3 days before the target start date of 15 June longnose sucker passage during this time was almost one-third of the passage observed the entire operational period. Second, longnose sucker passage tends to be highest during the first few days of weir operations, regardless of whether operations begin on the target start date or 3 days before (2005). Third, larger numbers of longnose suckers are observed migrating downstream in August and September than would have been anticipated based on passage during the target operational period. In 2006, about half of the longnose suckers counted upstream through the weir passed during the first 4 days of weir operations, emphasizing that the target operational period is not adequate for estimating annual longnose sucker passage and that recorded longnose sucker abundance is more likely influenced by the start date of weir operations than by actual abundance.

Longnose suckers were a prominent species at only two other monitored tributaries in 2006, but the relative strength of the longnose sucker migration varied between the two. At Takotna River weir, longnose sucker passage was below average for years with comparable operational dates, but reported longnose sucker passage at George River weir was well above average (Costello et al. *In prep*; Hildebrand et al. *In prep*). However, for the reasons cited in the previous paragraph, a significant number of longnose suckers may have passed upstream before operations began, and recorded weir passage generally underestimates the abundance of upstream migrants.

Carcasses

The number of salmon carcasses found on the weir is not a complete census of the number of carcasses that drifted downstream of the weir site (Appendix D1). The sucker chutes installed in late July that are designed to allow downstream migrating suckers to pass over the weir also provide a pathway for post-spawners to pass, and salmon carcasses are commonly observed washing over them. Daily carcass counts noticeably decrease following their installation (Appendix D1). Second, the weir was removed long before coho salmon had completed spawning, so the number of coho salmon carcasses counted on the weir probably significantly underestimates the number of post-spawners that drifted past the weir site. Regardless of these confounding factors, *most* of the spawned-out fish were likely retained in or near the river upstream of the weir for a protracted period of time, thereby contributing to the productivity of the system through the addition of marine derived nutrients as described by Cederholm et al. (1999; 2000).

Females comprised 22.7% and 32.1% of the Chinook and chum salmon carcass count, respectively, compared to the 41.4% and 42.1% derived from ASL sampling. These results indicate that sex composition derived from weir carcass counts is biased low for females (DuBois and Molyneaux 2000).

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Sample collection goals were not achieved in 2006, but the modest abundance of Chinook salmon made the collected sample sizes adequate for estimating total and intra-annual age, sex,

and length composition. Sampling effort was distributed fairly evenly across the run, and the sample sizes and dates were apportioned into strata such that minimum sample sizes in a stratum were met or exceeded relative to total escapement during the same time. ASL composition has been estimated for the total Chinook escapement in only 4 of 9 years the project has operated. Flood damage resulting in premature project termination was cited in 2 of those years, and problems collecting the minimum ASL sample size were cited in other years (Linderman et al. 2002; Stewart and Molyneaux 2005). Increased abundance and improved sampling techniques have resulted in adequate sample collections in 2002, 2004, 2005, and 2006.

The abundance and proportion of age-1.2 (4 year-old) Chinook salmon in 2006 was similar to past years at the Tatlawiksuk River weir, but the abundance of age-1.3 (5 year-old) Chinook salmon decreased considerably between 2005 and 2006 though the proportion was similar to both 2004 and 2005 (Table 2; Figures 4 and 19). The abundance of age-1.4 (6 year-old) Chinook salmon decreased substantially in 2006, to nearly half the numbers from previous years with comparable data, while the proportion to total escapement has remained similar since 2004 (Figures 4 and 19). Age-1.5 (7 year-old) Chinook salmon have contributed little to the total escapement at the Tatlawiksuk River weir, and comprised 4.6% of the escapement in 2006. Both the abundance and proportion of age-1.5 Chinook salmon were similar to 2002.

In 2006, the proportional contribution of each age class to total escapement in a stratum varied considerably throughout the duration of the Chinook salmon run, but stratified sampling revealed no obvious intra-seasonal trend for any age class (Table 2; Figure 5). This is consistent with Tatlawiksuk River Chinook salmon data combined over all years and at all other projects in the Kuskokwim River drainage (Figure 5; Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007). Rarely does an age class consistently increase or decrease during a season, and rarely is the occasional increase or decrease observed among projects. For example, in 2006 only one project reported a definitive intra-annual decrease in the proportion of age-1.3 Chinook salmon, albeit slight, which in the past has been sometimes recognized as a universal phenomenon (Molyneaux et al. 2006). At all others, the proportion of age-1.3 Chinook salmon remained relatively constant throughout the season. Variations between strata are often greater than the total increase or decrease in proportion from the first to the last (Figure 5; Molyneaux and Folletti *In prep*).

Historical trends in age composition tend to vary dramatically among projects. For instance, that the seasonal proportions of age-1.2, -1.3, and -1.4 Chinook salmon were similar to most past years at Tatlawiksuk River weir was a trend observed at no other location (Figure 5). At most locations, the proportion of age-1.2 fish, was higher than average whereas the proportion of age-1.4 fish was lower than average, to varying degrees. Half of the weir projects reported a proportion of age-1.3 fish similar to past years, but others reported a considerable difference. As is usual in the Kuskokwim River drainage, age-1.5 fish constituted only a modest fraction of the overall escapement at all projects in 2006.

Siblings to the cohort that returned in unusually high abundance in 2004 as age-4 fish and 2005 as age-5 fish did not return in unusually high abundance as age-6 fish at the Tatlawiksuk River weir or at any other location in 2006, as evidenced by the dominance of the age-4 and age-5 components (Table 2; Figure 19). In fact, most weir projects reported only a mediocre return of age-6 Chinook salmon in 2006. In this case, the recognized method of using brood years and sibling relationships to forecast escapement failed to predict the relatively low abundance of age-6 Chinook salmon observed throughout the Kuskokwim River drainage in

2006 (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007). However, the high numbers of age-4 fish in 2004 and age-5 fish in 2005 were unexpected because escapements in the 2000 brood year were generally low (Harper and Watry 2001; Linderman et al. 2002; 2003; Schwanke et al. 2001; Ward et al. 2003). Unfortunately, data are not adequate to calculate return per spawner for the 2000 brood year or any other year, which makes it difficult to determine with certainty whether total returns in subsequent years were higher than expected (Table 8). Favorable ocean conditions have been cited as a potential driver for the strong returns of the sibling age classes in the last 2 years due to the wide range of the phenomenon and evidence from juvenile salmon studies, and a moderation of these favorable conditions may have increased mortality of the remaining siblings and explain the surprising modest abundance of age-6 fish in 2006. At the Tatlawiksuk River weir, the modest abundance of age-4 and -5 Chinook salmon in 2006 do not foretell strong returns of age-5 and -6 fish in 2007, which generally comprise the bulk of annual escapement, but overall Chinook salmon escapement will likely remain considerably higher than in the years that contributed to the BOF stock of concern designation. However, in tributaries that received high abundances of age-4 fish in 2006 (such as George, Kogrukluk, and Takotna river weirs), escapements of age-5 fish are expected to be high in 2007, consequently driving overall escapement to above average levels.

At 41% of the total escapement, the percentage of females at Tatlawiksuk River weir in 2006 was higher than all years but 2005 (Molyneaux and Folletti *In prep*). As with age composition, the percentage of females to total stratum escapement varied dramatically throughout the run, ranging from a minimum of 25.0% in the second stratum to 54.5% in the last (Table 2; Figure 6). This dynamic character revealed in only a few temporal samples precludes the presence of an intra-seasonal trend, despite the finding that, throughout the Kuskokwim River drainage, male salmon are reported to migrate earlier than female salmon (Molyneaux and Folletti *In prep*). Similar to age composition, the percentage of females in overall escapement varies dramatically spatially and temporally; rarely is a trend at one location observed at another (Figure 6). The percent females at two projects, including Tatlawiksuk River weir, was higher than average in 2006, but other projects reported similar or decreased female percentage in 2006.

Mean lengths for each age and sex category were similar to past years with sufficient data for comparison (Figure 20). However, Tatlawiksuk River Chinook salmon exhibited length partitioning by age class for male and female fish, a pattern commonly observed throughout the Kuskokwim River drainage (Table 3; Molyneaux and Folletti *In prep*). As expected, mean length increased with age. Intra-annual trends were generally not apparent in 2006. Mean lengths of age-1.2 male Chinook salmon did decrease slightly as the run progressed, a trend common at the Tatlawiksuk River weir and at other weirs in the drainage, but mean lengths of both male and female age-1.3 and age-1.4 Chinook salmon remained fairly steady during the duration of the run (Figure 7; Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007). Among Kuskokwim River tributaries, Chinook salmon rarely show an obvious intra-seasonal trend in lengths by age class over the course of the season, and apparent trends tend to be weak and their significance is unknown (Molyneaux and Folletti *In prep*). However, one obvious conclusion is that female Chinook salmon were generally larger, on average, in both age classes (Table 3).

ASL data obtained from the commercial and subsistence catches allow for comparison and a better understanding of total run dynamics. Annual ASL compositions of weir escapement must

be considered with respect to the ASL compositions of the subsistence and commercial fisheries that harvest a portion of the stock returning to each tributary. The mesh-size restriction imposed on commercial fishers is intended to limit the number and size of Chinook salmon harvested for commercial purposes. As intended, average lengths of Chinook salmon in the commercial harvest are significantly less than those in the subsistence harvests and weir escapements (Figure 21; Molyneaux and Folletti *In prep*). Since smaller fish tend to be younger fish, commercial fishery harvests tend to consist mainly of age-1.2 fish under this restriction (Figure 21). Proportional contribution of total commercial catch decreases steadily with increasing age, so that age-1.3 and -1.4 Chinook salmon comprise much smaller fractions of total harvest despite their relatively high abundance in tributary escapements. Since few age-1.2 and -1.3 Chinook salmon are females, and length-at-age tends to be greater among females, the commercial fishery targets mostly males (0.93 in 2006; Molyneaux and Folletti *In prep*). However, the impact on the commercial fishery to ASL composition of tributary escapement has probably been negligible in recent years due to relatively small commercial harvests.

The subsistence fishery has no limitations on mesh size and most subsistence fishers use nets with a mesh size of 8 inches (stretched mesh) or greater (Martz and Dull 2006). Most fishers use this type of gear because it reduces the harvest of chum salmon which are not generally preferred. This apparent species selectivity is actually a function of size selectivity; large-mesh gear is not effective at capturing large quantities of chum salmon because their smaller size allows them to escape the net. Logically, Chinook salmon similar in size to chum salmon are less likely to be captured, so the use of large-mesh gillnets effectively induces size selectivity of Chinook salmon. Since Chinook salmon exhibit length partitioning by age and sex, and older fish tend to be females, the use of large-mesh gillnets inflates the harvest of older fish, larger fish, and females above the proportions thought to occur in the natural population (Molyneaux and Folletti *In prep*). This selectivity is responsible for most of the disparity between ASL compositions of the subsistence harvest and weir escapement, but these disparities are likely exacerbated because the quantity of Chinook salmon removed through the subsistence harvest is probably large enough to effect the composition of escapements observed at tributary weirs. As a result, average length of the escapement to a given tributary weir is thought to be somewhat less than the average length of the total return bound for that tributary. Conversely, the proportion of younger age classes and males in tributary escapements are thought to be higher than in the total return.

Chum Salmon

The ASL data collected from chum salmon in 2006 were adequate for describing the age composition for the total annual escapement. Sampling was conducted periodically throughout the run and total sample size met or exceeded the minimum goal for each pulse. ASL composition has been estimated in 7 of 9 years the project has operated. Flood damage precluded estimations in 1998 and 2003.

The proportion of age-0.3 (4 year-old) chum salmon in 2006 (55.6%) was similar to most past years, but the abundance of this age class was higher than every year except 2005 (Table 4; Figure 19). Age-0.3 fish comprised nearly 90% of the record high escapement observed at the Tatlawiksuk River weir in 2005, resulting in an abundance triple what was observed any year before, and nearly three times the abundance of the age class in 2006. Generally, unusually high abundances of age-0.3 chum were reported throughout the drainage in 2006, but proportions remained near or slightly below average due to the record high abundances of age-0.4

(5 year-old) chum salmon that were reported throughout the drainage (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007). Reciprocally, the proportion of age-0.4 chum salmon remained near average at Tatlawiksuk River weir and most other projects in the Kuskokwim River drainage due to the unusually high abundance of age-0.3 fish that, in most cases, were thwarted only by the abundance of that age class in 2005 (Table 4; Figure 19). Other age classes, such as age-0.2 (3 year olds) and -0.5 (6 year olds), comprised an insignificant fraction of escapement at all projects in the Kuskokwim River drainage in 2006, comprising no more than 3.5% and 0.4% of escapement, respectively, at all projects (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007).

In 2006, the proportional contribution of each age class to total escapement in a stratum varied considerably throughout the duration of the Tatlawiksuk River weir chum salmon run. As reported, the proportion of age-0.3 chum salmon continually increased during the run while the proportion of age-0.4 fish continually decreased (Table 4; Figure 8), which is a trend consistent with Tatlawiksuk River weir chum salmon age composition combined over all years. This inverse relationship between the proportion of age-0.3 and -0.4 chum salmon is commonly observed throughout the Kuskokwim River drainage, and all projects reported a similar trend in 2006 (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*; Miller et al. 2007; Plumb et al. 2007).

The record high abundance of age-5 chum salmon at Tatlawiksuk River weir and all other locations in the Kuskokwim River drainage was expected following the record high abundance of their age-4 siblings in 2005, but neither phenomenon was anticipated following the relatively low escapements recorded drainage-wide during the 2001 brood year (Figure 16; Burkey et al. 2002). The relatively high abundance of age-4 chum salmon throughout the drainage was expected following a year of above average age-3 abundance in 2005, and may foretell a strong return of age-5 chum salmon in 2007. Unfortunately, data are not adequate to calculate return per spawner ratios for the 2001 brood year or any other year, making it difficult to determine with certainty whether total returns in subsequent years were higher than normal (Table 9). Furthermore, the drainage-wide predictive value of the abundance of age-3 fish in 2006 is uncertain due to the spatial variability in the relative abundance of this age (Molyneaux and Folletti *In prep*). At the Tatlawiksuk River weir, the abundance of age-3 chum salmon was below average and considerably below the improved escapements of this age from 2003 to 2005, suggesting that their siblings will return in lower-than-average abundance as age-4 fish in 2007 and age-5 fish in 2008. However, this speculation is not valid for other tributaries that reported above average or record high escapements of age-3 chum salmon in 2006, such as the George River weir where reported abundance of age-3 chum salmon was higher than any year on record, and Kogrukluk River weir where the abundance of age-3 chum salmon was surpassed only by 2005 (Hildebrand et al. *In prep*; Liller et al. *In prep*). These locations will likely observe high escapements of chum salmon in 2007 as the siblings to the 2006 age-3 and age-4 fish return as 4 and 5 year-olds. In summary, the strength of the 2007 chum salmon run at Tatlawiksuk River weir will likely be considerably below the record-high escapements reported in 2005 and 2006 but will probably remain well above the levels that contributed to the BOF stock of concern designation.

At 42% of the total escapement, the percentage of females at the Tatlawiksuk River weir was near average (Molyneaux and Folletti *In prep*). Female percentage varied dramatically among

projects, ranging from as little as 36.8% at the Salmon River weir (Aniak River drainage) to 57.5% at the George River weir (Hildebrand et al. *In prep*; Molyneaux and Folletti *In prep*). Though the Tatlawiksuk River weir and two other projects reported female percentages that were slightly below average, two others reported female percentages just above average, and still two more reported percentages near average, emphasizing the high degree of variability in sex composition. However, the pattern of increasing female percentage over the duration of the run was common to most locations in 2006, with Kwethluk and Salmon river weirs being two notable exceptions (Table 4; Figure 6; Miller et al. 2007; Molyneaux and Folletti *In prep*).

Annual mean lengths of chum salmon in each age and sex category have been declining since adequate ASL samples were first collected at the Tatlawiksuk River weir in 1999 (Figure 22). On average, chum salmon in every age and sex category were considerably smaller than in most previous years, though mean lengths have generally remained similar between 2004 and 2006 considering confidence intervals. Only the mean length of age-0.4 male chum salmon was significantly less than all previous years (Figure 22). However, despite the overlapping confidence intervals over the last 3 years for male age-0.3 and female age-0.3 and -0.4 chum salmon, the confidence intervals for 2006 length data reach below any other year, further illustrating the historical trend of decreasing mean lengths (Figure 22). Historical length trends have shown a high degree of spatial variability in the Kuskokwim River drainage. In recent years, a similar trend of decreasing mean annual length for all age and sex categories has been observed at Takotna, George, and Kogrukluk river weirs, the three monitored tributaries geographically nearest the Tatlawiksuk River (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*). Monitoring locations further downstream, such as Aniak Sonar Project and Tuluksak and Kwethluk river weirs, have not observed any discernible historical trend and generally mean lengths in 2006 were near historical averages for given age and sex categories (McEwen *In prep*; Miller et al. 2007; Plumb et al. 2007). Regarding intra-annual length trends in 2006, mean lengths tended to increase with age, males tended to be larger than females at a given age, and mean length-at-age tended to decrease over the course of the chum salmon run in 2006 (Figure 9). Such patterns tend to be common in the Tatlawiksuk River weir and other locations where ASL samples have been collected (Molyneaux and Folletti *In prep*).

Coho Salmon

The ASL data collected from coho salmon in 2006 were not adequate for describing the age composition for the total annual escapement. The single coho salmon pulse sample was not sufficient for estimating total age, sex, and length composition, or to assess intra-annual trends, but comparisons between the compositions in this pulse sample to first pulse samples in other years are possible. ASL composition has been estimated in 5 of 9 years the project has operated. Flood damage precluded estimations in 1998, 2000, 2003, and 2006 (Linderman et al. 2002; 2004).

Age composition of the pulse sample in 2006 was considerably different from samples collected around this time in other years. The proportion of age-1.1 (3 year-old) coho salmon was well above average, whereas the proportion of age-2.1 (4 year-old) fish was below average. Proportional contributions of age-3.1 (5 year-old) coho salmon vary considerably from year to year, and the 4.9% reported in the sample for 2006 was near average. Though sampling achievements were not sufficient to apply these proportions to overall escapement, the finding that proportions and abundances of age-3 fish were considerably above average at most locations in the drainage suggests that this age class likely comprised a larger-than-average proportion of total annual coho salmon escapement to the Tatlawiksuk River weir in 2006 (Molyneaux and

Folletti *In prep*). However, unlike the sample collected from the Tatlawiksuk River weir, the proportion of age-4 fish at most projects was near the historical average, and it was instead a below-average proportion of age-5 fish that compensated for the above average proportion of age-3 fish. Unfortunately, data from 2006 and all other years are not adequate for determining the relative productivity of the brood years at the Tatlawiksuk River weir based on return per spawner ratios (Table 10).

Historical data from the Tatlawiksuk River weir indicate that age composition changes little over the course of the coho salmon run (Molyneaux and Folletti *In prep*). Minor changes in proportion between strata do not translate into significant trends here or at any other project in the Kuskokwim River drainage. A relatively weak proportion of age-2.1 fish early in the run usually continues with weaker-than average proportions through the rest of the run, further supporting the speculation that the proportional contribution of age-2.1 coho salmon in the total escapement was probably lower than in past years.

At 37% of the total sample, the percentage of females at the Tatlawiksuk River weir was slightly below the historical average (Molyneaux and Folletti *In prep*). Since historical data collection indicates that sex composition can vary dramatically over the course of the coho salmon run and rarely follows a consistent increasing or decreasing trend, the composition observed in the sample can not be used to predict the composition for the entire escapement. Looking beyond the Tatlawiksuk River weir, female percentage varied dramatically among projects, ranging from as little as 36.9% at the Kwethluk River weir to 55.0% at the Kogrukluk River weir (Liller et al. *In prep*; Miller et al. 2007). However, most projects observed a male to female ratio close to 1:1 in 2006, which is historically consistent (Molyneaux and Folletti *In prep*). As with age composition, sex composition tends to vary less, both spatially and temporally, in coho salmon than in other species.

The mean length of male age-2.1 coho salmon sampled in 2006 was considerably less than in past years during similar times, and even less than the estimated mean lengths of the entire male age-2.1 coho salmon escapement in years with sufficient data (Figure 23; Molyneaux and Folletti *In prep*). The same pattern is true for females of that age class. Similar to what the small sample at the Tatlawiksuk River weir suggests, mean lengths of age-2.1 male and female coho salmon were considerably below average at every sampled location in the drainage and in the commercial and subsistence catches (Molyneaux and Folletti *In prep*). In fact, the mean lengths of male age-2.1 coho salmon were significantly below all previous years at the Kogrukluk River weir, and below nearly every previous year at the George and Takotna River weirs. Additionally, mean lengths for female age-2.1 coho salmon were significantly below all previous years at these locations. Length partitioning was observed within the sample among age classes, but not between sexes. As expected, mean length tended to increase with age. Though not discernible from the 2006 data, length-at-age tends to vary little during the run at Tatlawiksuk river weir compared to other species (Costello et al. 2006). For the most part, this is consistent throughout the drainage. Consequently, the small lengths-at-age among the fish sampled at Tatlawiksuk River weir would have likely persisted in subsequent pulse samples had the weir remained operational.

WEATHER AND STREAM OBSERVATIONS

Daily morning water levels (discharge) in the Tatlawiksuk River were below average at the time of weir installation and generally remained below average until 13 August with the exception of

one high water event between 2 and 4 July (Figure 10). After 13 August, water levels quickly rose to levels above or near maximum historical levels before peaking on 22 August. From 22 August to the time of weir removal water levels receded continuously (Figure 10; Appendix E1). There did not appear to be a strong correlation between daily water level and salmon passage (Figure 11). However, given that fish passage methods change during the season, and that sampling events interfere with daily fish passage, it is uncertain whether daily water level has an influence on salmon passage.

Based on thermometer measurements, morning water temperature at the Tatlawiksuk River weir was near average for the first half of the season in 2006, but fell considerably below average around 1 August and remained at levels near or slightly below historical minimums for the duration of daily monitoring (Figure 10). The record-low water temperatures recorded in mid-August correlated with the flood event that caused weir operations to cease. Any relationship between stream temperature and passage strength or timing is not easily discernable by the available data because the weir was not operational during most of the time of extreme low water temperatures (Figure 12). However, migration timing does change in relation to long term changes in freshwater water temperatures (Quinn 2005).

The two methods for determining morning water temperature at the Tatlawiksuk River weir yielded similar results in 2006 (Figure 24). Daily morning water temperatures derived from both methods paralleled each other for most of the season, but the daily morning water temperature determined from thermometer measurements was about 1° C cooler, on average, than the reading recorded by the data logger around the same time. The data logger is likely more accurate and its use should continue in future years in order to build a historical data set using data logger temperature readings.

Any relationship between water level (or water temperature) and passage strength or timing is not easily discernible by the available data because daily weir operation and ASL sampling effort is not consistent and salmon passage can be influenced by the timing and duration of counting sessions, the level of ASL sampling activity, and cleaning and repair efforts. If the study was designed for these activities to be consistent, the effect of water level on salmon passage may be better revealed.

Knowledge of environmental conditions and a commitment to long-term monitoring may be valuable in understanding migration and survival. Quinn (2005) notes that migration in salmon is likely controlled by genetic factors as an adaptation to long-term average environmental conditions. Keefer et al. (2004) found a positive correlation between river discharge and run timing of Columbia River Chinook salmon stocks, and that Columbia River sockeye salmon have started their inriver migration 2 weeks earlier in response to warmer water conditions resulting from dam construction. We cannot begin to assess the affects of changing environmental conditions on Kuskokwim River salmon without the relatively complete weather and stream observations collected by weir crews such as at the Tatlawiksuk River. Escapement projects must continue to be diligent in the collection of weather and stream data. Perhaps with sufficient data researchers and managers will be able to assess relationships between migration and environmental factors relevant in the broader spatial-temporal context.

RELATED PROJECTS

Inriver Abundance of Chinook Salmon in the Kuskokwim River

The Tatlawiksuk River weir project contributed successfully to *Inriver Abundance of Chinook Salmon in the Kuskokwim River*. Records of reference tag transmission indicate that the receiver station functioned properly throughout the season. Efforts in 2006 mark the 5th year that an abundance estimate was determined for the Kuskokwim River drainage upstream of the Aniak River confluence, but the first year that an abundance estimate could be calculated that includes the Aniak River (Stuby *In prep*). In past years, the Aniak River was excluded from the drainage-wide abundance estimate due to potential bias associated with bank orientation (Stuby 2003, 2004, 2005, 2006, *In prep*). Experimental design was modified annually in an effort to mitigate this bias, but such efforts tended not to be effective. The installation of a weir on the Salmon River in 2006 provided a marked to unmarked ratio that could be expanded for the entire Aniak River drainage, thereby providing an estimate for that drainage as well as an estimate for the entire Kuskokwim River drainage upstream from the Kalskag tagging sites. The resulting estimate for the Aniak River of roughly 68,000 fish represented about 29% of the total abundance estimate for waters upstream of Kalskag (Stuby *In prep*).

As evident from ASL data collected throughout the Kuskokwim River drainage, few Chinook salmon in the Kuskokwim River are smaller than 450 mm. Samples collected from the Takotna, George, Kogrukluk, and Tatlawiksuk river weirs indicate that Chinook salmon less than 450 mm in length comprise only a small fraction of total escapement (Costello et al. *In prep*; Hildebrand et al. *In prep*; Liller et al. *In prep*). None of these small fish were found in the sample collected at the Tatlawiksuk River weir in 2006, so the number in total escapement is assumed to be negligible. Other weirs reported low percentages. These data suggest that the inriver abundance estimate of only Chinook salmon larger than 450 mm is probably close to the total abundance of all Chinook salmon.

The average duration of 2.1 days between the time of initial detection by the receiver station to time of passage at the weir in 2006 was similar to the 2.2 and 3.1 days exhibited at Kogrukluk and George river weirs (ignoring the 1 fish that did not move past the weir at George), but considerably longer than the 0.8 days observed at the Salmon River weir (L. Stuby, Sport Fish Biologist, ADF&G, Fairbanks; personal communication). In past years, the delay between initial detection and passage through the weir was considerably longer at the Tatlawiksuk River weir than other locations. In 2005 the delay averaged 6.7 days, which was in contrast to the 1–3 day average delay time recorded for other projects. The reason for the reduction in average delay time between 2005 and 2006 is not understood, but the higher water levels and lower temperatures in 2006 may have influenced fish behavior around the weir (Figure 10). If the observed reduction in delay time is representative of the entire Chinook salmon escapement, it would seem likely that it would have translated into earlier apparent run timing at the weir. This did not appear to be the case, however, because the late run timing relative to past years observed at the Tatlawiksuk River weir was similar to other projects, not earlier as would be expected (Figure 3). However, this conclusion is confounded by ASL sampling activity because the number and duration of ASL sampling pulses are known to affect run timing at the weir.

Kuskokwim River Sockeye Salmon Investigations

The Tatlawiksuk River weir project contributed successfully to *Kuskokwim River Sockeye Salmon Investigations*. Though no tagged sockeye salmon were detected by the receiver station

or observed passing upstream of the weir, the receiver station functioned properly throughout the season, as evidenced by the successful recording and offloading of the Chinook salmon radiotelemetry data.

Sockeye salmon have been documented in several other tributaries throughout the Kuskokwim River basin (Burkey and Salomone 1999), but little is known about these populations. Rearing ecology of these "river-type" sockeye salmon is not well known in the Kuskokwim Area, though river-spawning behavior among sockeye salmon is documented in other areas of both Asia and North America (Burgner 1991). Wood et al. (1987) found that "river-type" sockeye salmon contributed from 39% to 48% of total sockeye salmon returns to the Stikine River in 1984 and 1985. The contribution of these "river-type" sockeye salmon to the overall Kuskokwim River sockeye salmon production could be substantial. Further research addressing the biology and ecology of Kuskokwim River sockeye salmon will be essential to narrow current knowledge gaps and ensure successful management of a sustainable sockeye salmon fishery.

Kuskokwim River Salmon Mark–Recapture Project

The Tatlawiksuk River weir project contributed successfully to the *Kuskokwim River Salmon Mark–Recapture Project*, which afforded an opportunity to study migration characteristics of Tatlawiksuk River Chinook and sockeye salmon in 2006. Efforts in 2006 mark the 6th year that mark–recapture has been used to assess run timing and travel speed. Details are discussed by Schaberg et al. (*In prep*).

Chinook Salmon

The run timing information derived from pooling the tag samples from *Kuskokwim River Salmon Mark–Recapture Project* and *Inriver Abundance of Chinook Salmon* indicates little variation in stock-specific run timing in 2006 (Figure 14; Schaberg et al. *In prep*). In 2006, stock-specific median passage dates were spatially similar, ranging from 26 June at the Salmon River weir, which is the nearest recovery location to the tagging site, to 4 July at the George River weir, which is the next nearest location to the tagging site (Figure 14; Schaberg et al. *In prep*). Based on the pooled radio and anchor tagged samples, the timing of the Tatlawiksuk River Chinook salmon stock past the Kalskag tagging sites fell perfectly within the bulk of the run passing these sites, as evidenced by the identical median passage dates, and the tagged fish bound for the Tatlawiksuk River weir were well distributed in the total sample tagged near Kalskag (Figures 14 and 25). Run timing results in 2006 do not adhere to the pattern revealed using radiotelemetry in past years when it appeared that Tatlawiksuk River Chinook salmon passed through the Kalskag tagging sites earlier than most other stocks and considerably earlier than the bulk of the mixed stock run past the tagging sites (Schaberg et al. *In prep*). In fact, the Salmon River Chinook salmon stock exhibited the earliest run timing of any investigated in 2006 despite its comparatively close proximity to the tagging sites. Historical radiotelemetry data from 2002 to 2005 suggest an inverse relationship between natal stream distance and stock-specific run timing; that is, Chinook salmon stocks bound for tributaries farthest upriver tend to pass through the tagging site earlier than stocks bound for tributaries nearer the tagging site (Schaberg et al. *In prep*). Though sample sizes are small, the median passage dates for tagged Tatlawiksuk River bound Chinook salmon past the tagging sites have been the earliest of any stock in 2 of the 5 years with comparable data, and later than only the Takotna/Upper Kuskokwim river (locations much further upstream) fish 1 year (Schaberg et al. *In prep*).

Travel speeds calculated using data provided by anchor tagged Chinook salmon ranged from about 17 to 30 km/day, which is similar to past years considering small sample sizes, and to the speeds exhibited by Chinook salmon returning to the Kogrukluk and George rivers (Schaberg et al. *In prep*). Mean stock-specific travel speed does not seem to vary among Tatlawiksuk, George, and Kogrukluk river stocks, but fish bound for the Salmon River exhibited considerably slower travel speeds in 2006, which explains the stock's early run timing through the tagging sites but relatively late run timing at the weir based on cumulative percent passage (Schaberg et al. *In prep*).

Travel speed and run timing indicators provided by the Chinook salmon radiotelemetry and anchor tagging projects are valuable tools for fishery management. The timing of commercial fishery openings and the annual discontinuation of the subsistence fishing schedule are considered with respect to the stock-specific run timing evident through the tagging and tracking of Chinook salmon. Run timing data suggest that in 2006 the bulk of the Chinook salmon bound for the Tatlawiksuk River were still in the lower river and potentially within the boundaries of the commercial fishing district during the 2 fishing periods in late June. Consequently, Tatlawiksuk River Chinook salmon were likely among the 2,493 harvested during these first 2 openings (Schaberg et al. *In prep*). Run timing data collected in other years suggest that ordinarily late-June fishing periods miss stocks bound for the Tatlawiksuk River weir and other upper river tributaries. Though Tatlawiksuk River Chinook salmon may have comprised a minute fraction of the total commercial harvest, the impact of the Kuskokwim River commercial fishery on individual salmon stocks was negligible when compared to the total inriver abundance estimate of 233,233 fish, which does not include stocks downstream of Kalskag. Due to fewer restrictions and greater annual harvest, the subsistence fishery likely had a much greater effect on Tatlawiksuk River Chinook salmon. Late at-the-weir run timing observed at every escapement monitoring project coupled with stock-specific run timing data provided by the tagging projects suggests that the subsistence fishing schedule was probably rescinded before most of the Chinook salmon bound for upper river tributaries (such as the Tatlawiksuk River) had migrated past the lower river where subsistence fishing is most intense. However, recent evidence indicates that the subsistence fishing schedule probably provides little benefit to individual stocks (T. Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication).

Sockeye Salmon

No tagged sockeye salmon were observed at the Tatlawiksuk River weir in 2006, which precludes assessment of travel speed and run timing. This was not unexpected, however, because sockeye salmon escapement past the Tatlawiksuk River weir was not significant in 2006 and observed escapement was probably not stock from the Tatlawiksuk River. In the 5 years that mark–recapture has been conducted for sockeye salmon, tagged sockeye only reached the Tatlawiksuk River weir in 2004 and 2005. The numbers of tags recaptured during these years were too few to formulate any conclusions about these fish (N = 2 in 2004 and N = 3 in 2005), plus the sockeye salmon observed in the Tatlawiksuk River are not thought to be a unique stock but individuals of stocks from other locations, possibly from the Stony River which confluences about 30 km downstream from the Tatlawiksuk on the same bank and is known to be a large sockeye salmon producer.

In both 2004 and 2005, the tagged sockeye observed in the Tatlawiksuk River were tagged during the later half of the tagging effort, after most of the tagged fish bound for the Kogrukluk

River weir and Telaquana Lake (a feeder of the Stony River) were tagged. Unfortunately, only the Kogrukluk River weir has consistently received an adequate tag sample for confident assessment of run timing and travel speed, but despite small sample sizes for other locations trends in run timing tend to be historically consistent. Among the stocks investigated, sockeye salmon stocks bound for locations farthest upriver tend to migrate past the tagging sites earlier than stocks bound for tributaries nearer the tagging sites (Schaberg et al. *In prep*). In each year with comparable data, fish bound for Telaquana Lake are generally the first captured and tagged, followed in order of timing by fish bound for the Kogrukluk, Tatlawiksuk, and George rivers. Incidentally, this trend has been commonly observed in Kuskokwim River chum salmon in years when they were tagged (Schaberg et al. *In prep*).

CONCLUSIONS

ESCAPEMENT MONITORING

- The weir was installed by 15 June and was operational until 19 August.
- Early termination of weir operations in 2006 greatly reduced researchers' confidence in the annual escapement estimate for coho salmon, but was not thought to greatly impair the annual escapement estimate for other salmon species.
- Total annual Chinook salmon escapement in 2006 was similar to 2003 and, as such, near average for the Tatlawiksuk River weir but represents a considerable drop from the escapement reported in 2005.
- Most other escapement monitoring projects reported a decrease (of varying degrees) in Chinook salmon escapement between 2005 and 2006, which is a trend also reflected in the composite index. However, the abundance estimate provided by *Inriver Abundance of Chinook Salmon in the Kuskokwim River* was considerably higher in 2006 than in 2005.
- The commercial fishery probably had a negligible impact on the Chinook salmon escapement, but the subsistence fishery likely had a considerable impact.
- At-the-weir run timing of Chinook salmon at the Tatlawiksuk River weir was later than average, which was a trend observed throughout the drainage.
- Total annual Tatlawiksuk River chum salmon escapement in 2006 was above average but did not reach the level reported for 2005. Throughout the Kuskokwim River drainage, the relative abundance of chum salmon varied dramatically.
- Chum salmon escapements at the Tatlawiksuk River weir and most other locations in recent years have been relatively high.
- The commercial and subsistence fisheries probably had a negligible impact on the chum salmon escapement to the Tatlawiksuk River.
- At-the-weir run timing of chum salmon at the Tatlawiksuk River weir was near average, which was a trend consistent with other escapement monitoring projects in the Kuskokwim River drainage.

- The weir was not operated long enough to confidently estimate coho salmon escapement to the Tatlawiksuk River weir in 2006; however, the estimate derived from the "proportion method" results in a near average annual escapement estimate. Coho salmon escapements tended to be near average at other projects in the Kuskokwim River drainage.
- The commercial fishery probably had a considerable impact on coho salmon escapement, but the subsistence fishery probably had virtually no impact.
- At-the-weir run timing of coho salmon at the Tatlawiksuk River weir was not determined because most of the daily passage determinations were derived from model data sets.
- Sockeye salmon escapement to the Tatlawiksuk River weir was relatively high, but less than in 2006. Sockeye salmon continue to be a rare occurrence in the Tatlawiksuk River.
- Pink salmon are rare in the Tatlawiksuk River; only 20 were observed in 2006.
- Historical escapement records are not sufficient to develop escapement goals for Chinook, chum, or coho salmon at this time, but by 2009 escapement data should be sufficient for escapement goal development for Chinook and chum salmon and for coho salmon data should be sufficient by 2012, if the weir continues to operate successfully.
- The weir is not an effective way of enumerating carcass fall out, and the sex composition of the carcasses found on the weir is not reflective of the sex composition of upstream escapement.

AGE, SEX, AND LENGTH COMPOSITION

- Postseason analysis revealed that ASL sample collections for Chinook and chum salmon were sufficient for estimating the age, sex, and length composition of total annual escapement.
- The abundances of Chinook salmon in each age class were generally below average and below all other years with adequate data for comparison for age-6 fish.
- Age-6 Chinook salmon were expected to be more abundant than what was observed in 2006 based on the abundance of their siblings in 2004 and 2005.
- Considering the abundance of age-4 and -5 fish in 2006, Chinook salmon escapement to the Tatlawiksuk River is not expected to be high in 2007.
- The percentage of females in the Tatlawiksuk River weir Chinook salmon escapement was above average but continues to be male-biased.
- Chinook salmon were similar in length to previous years in all age/sex classes and changed little throughout the duration of the run.
- Despite the exclusive use of small-mesh gear, the commercial fishery probably had no effect on the ASL composition of Tatlawiksuk River weir Chinook salmon escapement, but the dominant use of large-mesh gear in the subsistence fishery likely affected the ASL composition of weir escapement when considering the size of the subsistence harvest.

- The abundance of age-4 chum salmon at the Tatlawiksuk River weir was modest compared to 2005 but was still higher than any other year. The abundance of age-5 chum salmon was higher than all previous years. Age-3 and -6 chum salmon continued to represent only a modest fraction of escapement in 2006.
- The relatively high abundance of age-5 chum salmon was anticipated given the record high abundance of their age-4 siblings in 2005. However, neither phenomena were anticipated following the low abundance recorded drainage-wide during the 2001 brood year.
- The male to female sex ratio of chum salmon at the Tatlawiksuk River weir in 2006 was near average.
- Mean lengths of chum salmon in each age and sex category have been declining at the Tatlawiksuk River weir since 1999, but only the mean length of age-0.4 males was significantly less than all previous years.
- The commercial and subsistence fishery probably had little to no effect on the ASL composition of Tatlawiksuk River weir chum salmon escapement.
- The proportion of age-1.1 coho salmon in the only 2006 pulse sample was well above average for samples from this time in other years, which reduced the proportion of the more common age-2.1 age class to a below-average proportion.
- Return-per-spawner information is not sufficient to assess the relative strength of coho salmon returns to the Tatlawiksuk River in 2006.
- The male to female sex ratio of coho salmon in the pulse sample collected from the Tatlawiksuk River weir in 2006 was slightly below average. Since coho salmon sex composition tends to change little throughout the run at Tatlawiksuk River weir, the sex composition of the single pulse sample may reasonably approximate the composition of the total escapement.
- Only age-2.1 coho salmon return to the Tatlawiksuk River weir in high enough abundance to compare historical mean lengths, and comparing the mean lengths of both males and females of this age class in the pulse sample to samples collected at similar times in other years reveals a considerable decrease in length in 2006.
- The Tatlawiksuk River coho salmon ASL sample did not exhibit length partitioning by age or sex.

WEATHER AND STREAM OBSERVATIONS

- For most of the 2006 season, daily average water levels were near historical averages or below and only exceeded historical daily average levels for a 3 week period in late August and early September.
- Daily water temperatures at the Tatlawiksuk River weir in 2006 were generally near or below average and exceeded historical minimums for most of August and the portion of September when water temperature was monitored.
- No obvious relationship was observed between fish passage and water level or water temperature.

RECOMMENDATIONS

PROJECT OPERATION

- Annual operation of the Tatlawiksuk River weir should continue indefinitely. The Tatlawiksuk River weir project has been a valuable addition to the array of well-distributed escapement monitoring projects throughout the Kuskokwim River drainage. Adequate long-term monitoring of Kuskokwim River salmon escapements is one of many requirements needed for long-term sustainable management of Kuskokwim River stocks. Discontinuation of the Tatlawiksuk River weir, or any other escapement monitoring project, would be a step backward from progress made in recent years toward collecting salmon stock assessment and information needs in the Kuskokwim River drainage. Additionally, the Tatlawiksuk River weir project serves as one of several data collection platforms critical to other Kuskokwim River salmon research projects. *Inriver Abundance of Chinook Salmon in the Kuskokwim River* project (FIS #05-302) is critically dependent on data collected from these weirs to generate total river abundance estimates. *Kuskokwim River Salmon Mark–Recapture Project* (FIS #04-308) uses or has used weir-recaptured spaghetti tagged Chinook, chum, sockeye, and coho salmon to develop and test total river abundance estimates, and these recaptures are critical for determining stock-specific run timing in the mainstem Kuskokwim River. Tatlawiksuk River weir has been a platform for collecting tissue samples as part of the genetic stock identification (GSI) baseline for Chinook, chum, and coho salmon, and could be called upon again for additional sample collection.

- Establish SEG ranges as soon as adequate data is obtained. SEG ranges serve as a means to assess the adequacy of annual escapement, and are goals fishery managers can work to achieve. The minimum 10-years of sound escapement data required by the commonly used Bue and Hasbrouck Model (Bue and Hasbrouck *Unpublished*) should be achieved by 2009 for Chinook and chum salmon and by 2012 for coho salmon. Assuming successful weir operation continues, ADF&G should propose SEG ranges for eligible species to the Alaska BOF during the 2010 meeting.

PROJECT MANAGEMENT

- The Tatlawiksuk River weir should continue to be operated jointly by KNA and ADF&G. The partnership developed between KNA and ADF&G in the operation of fisheries projects, including the Tatlawiksuk River weir, has proven to be a successful strategy. Each organization compliments the partnership by providing an element the other cannot.

  KNA provides a communication link to help its constituents be more informed and less prone to the distrust and misinformation that can result when local organizations and their constituents are not directly involved. Active involvement of KNA adds an element of trust and acceptance toward the projects and ADF&G, which would not exist if ADF&G operated these projects alone. KNA is more effective at hiring technicians for these projects from the local area, and makes these jobs more acceptable and accessible for potential applicants. Additionally, the proximity of KNA facilities to these cooperatively managed projects provides logistical benefits for staging and for responding to various inseason project needs.

Despite these attributes, KNA would have difficulty managing the Tatlawiksuk River weir and other jointly operated fisheries projects without ADF&G involvement. The fisheries staff of ADF&G has a greater depth of experience in fisheries project management; both in terms of on-site field experience, and broader aspects such as planning, data management and analysis, and report writing. The addition of a Partners Fisheries Biologist to the KNA staff has shifted some of these responsibilities to KNA, evident with the inclusion of a KNA biologist as a co-author of this report since 2003. However, the addition of one fisheries biologist to the KNA staff has not replaced all ADF&G personnel involved and the many years of fisheries management experience, scientific expertise, and understanding they contribute. Additionally, KNA's fisheries biologist has a myriad of other responsibilities, and is involved with multiple projects and with multiple cooperative partners. This time limit reduces the direct attention KNA's biologist can contribute to individual project requirements.

Partnership between KNA and ADF&G is a major contributing factor to success of the many fisheries projects for which these organizations are responsible. Dissolution of this partnership would result in a detrimental loss of continuity and support to both inseason and postseason project requirements, and increase the possibility of misunderstanding and mistrust between ADF&G, KNA, and the public. Continued joint operation will help to ensure the success of these projects in the future.

AGE, SEX, AND LENGTH COMPOSITION

- Project leaders and collaborators should adjust sample size objectives for Chinook salmon ASL sampling at the Tatlawiksuk River weir because the target sample size of three 210-fish samples is impractical with such small annual escapement.
- Future project reports for the Tatlawiksuk River weir should continue to include detailed figures depicting trends in age, sex, and length composition. Inclusion of detailed figures such as these allows other researchers and fishery managers to easily compare ASL trends between projects and across years. Future project reports for the Tatlawiksuk River weir should continue to include historical perspectives such as the following:
    - Brood Tables and 3-dimensional graphics that illustrate the number of fish by age class for the recent past,
    - Inter-seasonal differences in sex composition as determined from weighted ASL samples and visual crew counts (both percent and total number),
    - Inter-seasonal trends in the number and percent of females in the escapement,
    - Inter-seasonal trends in average length-at-age and sex.

WEATHER AND STREAM OBSERVATIONS

- Investigators should consider installing a stream gauging station in the Tatlawiksuk River near the weir site similar to that installed in the George River in 2006 (Hildebrand et al. *In prep*). Stream gauging stations provide critical baseline data about river flow that could be used to establish a water reservation on the Tatlawiksuk River. ADF&G is charged with the responsibility to "…manage, protect, maintain, improve, and extend the fish, game, and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020). Toward this end, Alaska State law

(AS 16.05.050) allows ADF&G to acquire water rights based on data and analysis that substantiates the need for the amount of water being requested (Estes 1996). A water reservation is a legal right (or appropriation of water) to maintain a specific flow rate or level in a given body of water for one or a combination of purposes: 1) protection of fish and wildlife habitat, migration, and propagation; 2) recreation and parks purposes; 3) navigation and transportation purposes; and 4) sanitary and water quality purposes (Estes 1996).

- Conduct additional stream discharge surveys to reestablish a link between river flow and stage and to calibrate the stream gauging station recommended above.

SPAWNER-RECRUIT ANALYSIS

- Continue to develop a spawner-recruit analysis for Tatlawiksuk River salmon. One of the caveats in undertaking this initiative in the past was accounting for the unknown fraction of Tatlawiksuk River fish harvested in the commercial and subsistence fisheries. Preliminary findings from the mark–recapture projects operated in 2002, 2003, and 2004 provide insight into the timing of Tatlawiksuk River salmon stocks in the lower Kuskokwim River, which may allow for some assumptions of the temporal fraction of the harvest likely to contain fish bound for the Tatlawiksuk River. Isolating harvest during that time period and applying an estimated spawning stock apportionment to account for Tatlawiksuk River fish may provide the resolution required for identifying a reasonable spawner-recruit relationship.

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REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1998. Catalog of waters important for spawning, rearing or migration of anadromous fishes, Interior region resource management. Alaska Department of Fish and Game, Habitat Division, Juneau.

ADF&G (Alaska Department of Fish and Game). 2003. Alaska Subsistence Fisheries, 2002 Annual Report. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

ADF&G (Alaska Department of Fish and Game). 2004. Escapement goal review of select AYK Region salmon stocks. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 3A04-01, Anchorage.

Bergstrom, D. J., and C. Whitmore. 2004. Kuskokwim River Chinook and chum salmon stock status and action plan, a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 3A04-02, Anchorage.

Brannian, L. K., S. Darr, H. A. Krenz, S. StClair, and C. Lawn. 2005. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2005. Alaska Department of Fish and Game, Special Publication No. 05-10, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp05-10.pdf

Bromaghin, J. F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician. 47(3): 203-206.

Brown, C. M. 1983. Alaska's Kuskokwim River region: a history, draft. Bureau of Land Management, Anchorage.

Bue, B. G., and J. J. Hasbrouck. *Unpublished.* Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Alaska Board of Fisheries, November 2001 (and February 2002), Anchorage.

Buklis, L. S. 1999. A description of economic changes in commercial salmon fisheries in a region of mixed subsistence and market economies. Arctic 52(1):40-48.

Burgner, R. L. 1991. Life history of sockeye salmon (*Oncorhynchus nerka*). *In* Groot, C., and L. Margolis, editors. 1991. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

Burkey, C. Jr., and P. Salomone. 1999. Kuskokwim Area salmon escapement observation catalog, 1984-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A99-11, Anchorage.

Burkey, C. Jr., M. Coffing, D. B. Molyneaux and P. Salomone. 2000a. Kuskokwim River Chinook salmon stock status and development of management/action plan options, report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-40, Anchorage.

Burkey, C. Jr., M. Coffing, D. B. Molyneaux, and P. Salomone. 2000b. Kuskokwim River chum salmon stock status and development of management/action plan options, report to the Alaska board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-41, Anchorage.

Burkey, C. Jr., M. Coffing, J. Estensen, R. L. Fisher, and D. B. Molyneaux. 2002. Annual management report for the subsistence and commercial fisheries of the Kuskokwim area, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-53, Anchorage.

REFERENCES CITED (Continued)

Cederholm, C. J., M. D. Kunze, T. Murota and A. Sibatani. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24(10):6-15.

Cederholm, C. J., D. H. Johnson, R. E. Bilby, L. G. Dominguez, A. M. Garrett, W. H. Graeber, E. L. Greda, M. D. Kunze, B. G. Marcot, J. F. Palmisano, W. G. Pearcy, C. A. Simenstad, and P. C. Trotter. 2000. Pacific salmon and wildlife–ecological contexts, relationships, and implications for management. Special Edition Technical Report, Prepared for D.H. Johnson and T.A. O'Neil (Mang. Dirs.). Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia.

Coffing, M. 1991. Kwethluk subsistence: contemporary land use patterns, wild resource harvest and use, and the subsistence economy of a lower Kuskokwim River area community. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 157, Juneau.

Coffing, M. *Unpublished* a. Kuskokwim area subsistence salmon harvest summary, 1996; prepared for the Alaska Board of Fisheries, Fairbanks, Alaska, December 2, 1997. Alaska Department of Fish and Game, Division of Subsistence, Bethel.

Coffing, M. *Unpublished* b. Kuskokwim area subsistence salmon fishery; prepared for the Alaska Board of Fisheries, Fairbanks, Alaska, December 2, 1997. Alaska Department of Fish and Game, Division of Subsistence, Bethel.

Coffing, M., L. Brown, G. Jennings and C. Utermohle. 2001. The subsistence harvest and use of wild resources in Akiachak, Alaska, 1998. Alaska Department of Fish and Game, Division of Subsistence, Final Project Report to U.S. Fish and Wildlife Service, Office of Subsistence Management, FIS 00-009, Juneau.

Costello, D. J., D. B. Molyneaux, and C. Goods. *In prep*. Takotna River salmon studies, 2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Costello, D. J., R. Stewart, D. B. Molyneaux, and D. E. Orabutt. 2006. Tatlawiksuk River salmon studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-28, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-28.pdf

DuBois, L. and D. B. Molyneaux. 2000. Salmon age, sex, and length catalog for the Kuskokwim Area, 1999 Progress Report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-18, Anchorage.

Groot, C. and L. Margolis, editors. 1991. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, British Columbia.

Harper, K. C. and C. B. Watry. 2001. Abundance and run timing of adult salmon in the Kwethluk River, Yukon Delta National Wildlife Refuge, Alaska, 2000. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fishery Data Series Number 2001-4, Kenai, Alaska.

Hauer, F. R., and W. R. Hill. 1996. Temperature, light and oxygen. Pages 93-106 in F. R. Hauer and G. A. Lambert (editors) Methods in Stream Ecology. Academic Press, San Diego.

Hilborn, R., T. P. Quinn, D. E. Schindler, and D. E. Rogers. 2003. Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Sciences. 100(11):6564–6568.

Hildebrand, H. L., R. Stewart, D. J. Costello, and D. B. Molyneaux. *In prep*. George River Salmon Studies, 2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Holmes, R. A., and R. D. Burtkett. 1996. Salmon stewardship: Alaska's perspective. Fisheries 21(10):36-38.

INPFC (International North Pacific Fisheries Commission). 1963. Annual report, 1961. International North Pacific Fisheries Commission, Vancouver, British Columbia.

Keefer, M. L., C. A. Peery, M. A. Jepson, K. R. Tolotti, and T. C. Bjornn. 2004. Stock-specific migration timing of adult spring-summer Chinook salmon in the Columbia River basin. North American Journal of Fisheries Management 24:1145-1162.

REFERENCES CITED (Continued)

Kerkvliet, C. M., T. Hamazaki, K. E. Hyer, and D. Cannon. 2003. A mark–recapture experiment to estimate the abundance of Kuskokwim River chum, sockeye, and coho salmon, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-25, Anchorage.

Kerkvliet, C. M., J. Pawluk, T. Hamazaki, K. E. Hyer, and D. Cannon. 2004. A mark–recapture experiment to estimate the abundance of Kuskokwim River sockeye, chum and coho salmon, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-14, Anchorage.

Kruse, G. H. 1998. Salmon run failures in 1997-1998: a link to anomalous ocean conditions? Alaska Fishery Research Bulletin 5(1):55-63.

Liller, Z. W., D. J. Costello, and D. B. Molyneaux. *In prep*. Kogrukluk River weir salmon studies, 2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Linderman, J. C. Jr., D. B. Molyneaux, L. DuBois and W. Morgan. 2002. Tatlawiksuk River weir salmon studies, 1998–2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-11, Anchorage.

Linderman, J. C. Jr., D. J. Cannon, and D. B. Molyneaux. 2003. Tatlawiksuk River weir salmon studies, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-16, Anchorage.

Linderman, J. C. Jr., D. B. Molyneaux, D. L. Folletti, and D. J. Cannon. 2004. Tatlawiksuk River weir salmon studies, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-16, Anchorage.

Linderman, J. C., M. M. Martz, and D. G. Bue. *In prep* a. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2005. Alaska Department of Fish and Game, Fisheries Management Report, Anchorage.

Linderman J.C. Jr., J. Pawluk, P. Jones, C. A. Shelden, and D.G. Bue. *In pre*p b. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2006. Alaska Department of Fish and Game, Fishery Management Report, Anchorage.

Martz, M., and B. S. Dull. 2006. Lower Kuskokwim River inseason subsistence salmon catch monitoring, 2005. Alaska Department of Fish and Game, Fishery Management Report No. 06-44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr06-44.pdf

McEwen, M. S. *In prep*. Sonar estimation of chum salmon passage in the Aniak River, 2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Miller, S. and K. C. Harper. 2007. Abundance and run-timing of adult Pacific salmon in the Kwethluk River, Yukon Delta National Wildlife Refuge, Alaska, 2006. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office. Alaska Fisheries Data Series Number 2007-9, Kenai, Alaska.

Molyneaux, D. M., and L. K. Brannian. 2006. Review of escapement and abundance information for Kuskokwim area salmon stocks. Alaska Department of Fish and Game, Fishery Manuscript No. 06-08, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fms06-08.pdf

Molyneaux, D. B., D. L. Folletti, and C. A. Shelden. 2006. Salmon age, sex, and length catalog for the Kuskokwim Area, 2005. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A06-01, Anchorage.

Molyneaux, D. B. and D. Folletti. *In prep*. Salmon age, sex, and length catalog for the Kuskokwim Area, 2006. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, Anchorage.

Mundy, P. R. 1998. Principles and criteria for sustainable salmon management, a contribution to the development of a salmon fishery evaluation framework for the State of Alaska. Alaska Department of Fish and Game, Contract No. IHP-98-045, Anchorage.

REFERENCES CITED (Continued)

NRC (National Research Council). 1996. Upstream: salmon and society in the Pacific Northwest, Committee on the Protection and Management of Pacific Northwest Salmonids. National Academy Press, Washington, D.C.

Parken, C. K., R. E. McNicol, and J. R. Irvine. 2004. Habitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia. Fisheries and Oceans Canada, Pacific Scientific Advice Review Committee, Salmon Subcommittee Working Groups Paper S2004-05, Nanaimo, British Columbia.

Pawluk, J., J. Baumer, T. Hamazaki, and D. Orabutt. 2006a. A mark-recapture study of Kuskokwim River Chinook, sockeye, chum and coho salmon, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-54, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fds06-54.pdf

Pawluk, J., C. M. Kerkvliet, T. Hamazaki, K. E. Hyer, and D. Cannon. 2006b. A mark-recapture study of Kuskokwim River sockeye, chum, and coho salmon, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-52, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-52.pdf

Plumb M. P., K. C. Harper, and D. G. Spencer. 2007. Abundance and run-timing of adult Pacific salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 2006. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office. Alaska Fisheries Data Series Number 2007-4, Kenai, Alaska.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle.

Schaberg, K., J. Baumer, T. Hamazaki, D. E. Orabutt, J. Pawluk, and C. Shelden. *In prep*. A mark–recapture study of Kuskokwim River Chinook, sockeye, and coho salmon, 2001 to 2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Schneiderhan, D. J. *Unpublished*. Kuskokwim stream catalog, 1954-1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Schwanke, C. J., D. B. Molyneaux, L. DuBois, and C. Goods. 2001. Takotna River salmon studies and upper Kuskokwim River aerial surveys, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A01-02, Anchorage.

Stewart, R. 2002. Resistance board weir panel construction manual, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-21, Anchorage.

Stewart, R. 2003. Techniques for installing a resistance board fish weir. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-26, Anchorage.

Stewart, R., and D. B. Molyneaux. 2005. Tatlawiksuk River salmon studies, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-47, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-47.pdf

Stroka, S. M. and A. L. J. Brase. 2004. Assessment of Chinook, chum, and coho salmon escapements in the Holitna River drainage using radiotelemetry, 2001–2003. Final Report for Study 01-141 USFWS Office of Subsistence Management Fisheries Information Services Division. Alaska Department of Fish and Game, Fishery Data Series No. 04-07, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-07.pdf

Stuby, L. 2003. Inriver abundance of Chinook salmon in the Kuskokwim River, 2002. Annual Report for Study 02-015, USFWS Office of Subsistence Management, Fisheries Information Services Division. Alaska Department of Fish and Game, Fishery Data Series No. 03-22, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-22.pdf

Stuby, L. 2004. Inriver abundance of Chinook salmon in the Kuskokwim River, 2003. Alaska Department of Fish and Game, Fishery Data Series No. 04-30, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-30.pdf

Stuby, L. 2005. Inriver abundance of Chinook salmon in the Kuskokwim River, 2002-2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-39, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-39.pdf

Stuby, L. 2006. Inriver abundance of Chinook salmon in the Kuskokwim River, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-45, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-45.pdf

REFERENCES CITED (Continued)

Stuby, L. *In prep*. Inriver abundance of Chinook salmon in the Kuskokwim River, 2002–2006. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Thompson, S. K. 1992. Sampling. John Wiley and Sons, New York.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai, Alaska.

Ward, T. C., M. Coffing, J. L. Estensen, R. L. Fisher, and D. B. Molyneaux. 2003. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-27, Anchorage.

Whitmore, C., M. M. Martz, D. G. Bue, J. C. Linderman, and R. L. Fisher. 2005. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2003. Alaska Department of Fish and Game, Fishery Management Report No. 05-72, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr05-72.pdf

Whitmore, C., M. M. Martz, D. G. Bue, J. C. Linderman, and R. L. Fisher. *In prep*. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2004. Alaska Department of Fish and Game, Fisheries Management Report, Anchorage.

Wood, C. C., B. E. Riddell, and D. T. Rutherford. 1987. Alternative juvenile life histories of sockeye salmon (*Oncorhynchus nerka*) and their contribution to production in the Stikine River, Northern British Columbia. Pages 12-24 In: H. D. Smith, L. Margolis, and C. C. Woods (editors). Sockeye salmon (*Oncorhynchus nerka*) population biology and future management, Canadian Special Publication Fisheries and Aquatic Sciences. 96.

TABLES AND FIGURES

Table 1.–Actual daily and estimated counts of Chinook, chum, and coho salmon at the Tatlawiksuk River weir, 2006.

	Chinook Salmon			Chum Salmon			Coho Salmon	
Date	Daily	Cumulative	Percent Passage	Daily	Cumulative	Percent Passage	Daily	Cumulative
15-Jun	0	0	0	0	0	0	0	0
16-Jun	0	0	0	0	0	0	0	0
17-Jun	0	0	0	0	0	0	0	0
18-Jun	0	0	0	3	3	0	0	0
19-Jun[a]	0	0	0	0	3	0	0	0
20-Jun	0	0	0	0	3	0	0	0
21-Jun	0	0	0	3	6	0	0	0
22-Jun	0	0	0	12	18	0	0	0
23-Jun	0	0	0	58	76	0	0	0
24-Jun	0	0	0	115	191	1	0	0
25-Jun	1	1	0	234	425	1	0	0
26-Jun	3	4	0	265	690	2	0	0
27-Jun	22	26	2	441	1,131	4	0	0
28-Jun	3	29	2	267	1,398	4	0	0
29-Jun	4	33	2	464	1,862	6	0	0
30-Jun	42	75	4	1,369	3,231	10	0	0
1-Jul	23	98	6	458	3,689	11	0	0
2-Jul	21	119	7	208	3,897	12	0	0
3-Jul	5	124	7	764	4,661	14	0	0
4-Jul	128	252	15	2,190	6,851	21	0	0
5-Jul	47	299	18	347	7,198	22	0	0
6-Jul	187	486	29	1,109	8,307	26	0	0
7-Jul	35	521	31	745	9,052	28	0	0
8-Jul	78	599	35	845	9,897	31	0	0
9-Jul	228	827	49	2,141	12,038	37	0	0
10-Jul	146	973	57	1,791	13,829	43	0	0
11-Jul	46	1,019	60	1,018	14,847	46	0	0
12-Jul	111	1,130	66	1,365	16,212	50	0	0
13-Jul	59	1,189	70	1,003	17,215	53	0	0
14-Jul	52	1,241	73	504	17,719	55	0	0
15-Jul	41	1,282	75	491	18,210	56	0	0
16-Jul	36	1,318	78	929	19,139	59	1	1
17-Jul	23	1,341	79	979	20,118	62	0	1
18-Jul	65	1,406	83	799	20,917	65	0	1
19-Jul	52	1,458	86	1,059	21,976	68	1	2
20-Jul	29	1,487	87	1,106	23,082	71	9	11
21-Jul	24	1,511	89	1,215	24,297	75	17	28
22-Jul	15	1,526	90	924	25,221	78	14	42
23-Jul	29	1,555	91	962	26,183	81	4	46
24-Jul	21	1,576	93	755	26,938	83	9	55
25-Jul	10	1,586	93	734	27,672	86	2	57
26-Jul	5	1,591	94	612	28,284	88	2	59
27-Jul	20	1,611	95	503	28,787	89	7	66
28-Jul	8	1,619	95	543	29,330	91	16	82
29-Jul	17	1,636	96	597	29,927	93	26	108
30-Jul	11	1,647	97	578	30,505	94	30	138
31-Jul	10	1,657	97	378	30,883	96	57	195
1-Aug	11	1,668	98	232	31,115	96	52	247
2-Aug	8	1,676	99	216	31,331	97	50	297
3-Aug	5	1,681	99	124	31,455	97	39	336
4-Aug	3	1,684	99	104	31,559	98	55	391
5-Aug	2	1,686	99	72	31,631	98	47	438
6-Aug	6	1,692	100	115	31,746	98	152	590

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Table 1.–Page 2 of 2.

	Chinook Salmon			Chum Salmon			Coho Salmon	
Date	Daily	Cumulative	Percent Passage	Daily	Cumulative	Percent Passage	Daily	Cumulative
7-Aug	4	1,696	100	101	31,847	99	75	665
8-Aug	2	1,698	100	73	31,920	99	57	722
9-Aug	1	1,699	100	108	32,028	99	79	801
10-Aug	1	1,700	100	22	32,050	99	41	842
11-Aug	0	1,700	100	88	32,138	99	54	896
12-Aug	0	1,700	100	33	32,171	100	102	998
13-Aug	0	1,700	100	21	32,192	100	231	1,229
14-Aug	0	1,700	100	3	32,195	100	176	1,405
15-Aug	0	1,700	100	1	32,196	100	260	1,665
16-Aug	0	1,700	100	4	32,200	100	190	1,855
17-Aug	0	1,700	100	10	32,210	100	282	2,137
18-Aug	0	1,700	100	4	32,214	100	225	2,362
19-Aug	0[b]	1,700	100	17[b]	32,231	100	76[b]	2,438
20-Aug	0[b]	1,700	100	11[b]	32,242	100	73[b]	2,512
21-Aug	0[b]	1,700	100	11[b]	32,252	100	657[b]	3,169
22-Aug	0[b]	1,700	100	20[b]	32,272	100	251[b]	3,420
23-Aug	0[b]	1,700	100	1[b]	32,273	100	1,056[b]	4,475
24-Aug	0[b]	1,700	100	3[b]	32,276	100	957[b]	5,433
25-Aug	0[b]	1,700	100	1[b]	32,277	100	411[b]	5,843
26-Aug	0[b]	1,700	100	3[b]	32,280	100	476[b]	6,320
27-Aug	0[b]	1,700	100	0[b]	32,280	100	275[b]	6,595
28-Aug	0[b]	1,700	100	3[b]	32,282	100	262[b]	6,856
29-Aug	0[b]	1,700	100	3[b]	32,285	100	167[b]	7,023
30-Aug	0[b]	1,700	100	3[b]	32,288	100	107[b]	7,130
31-Aug	0[b]	1,700	100	0[b]	32,288	100	290[b]	7,421
1-Sep	0[b]	1,700	100	0[b]	32,288	100	241[b]	7,662
2-Sep	0[b]	1,700	100	3[b]	32,290	100	159[b]	7,821
3-Sep	0[b]	1,700	100	1[b]	32,292	100	72[b]	7,894
4-Sep	0[b]	1,700	100	3[b]	32,294	100	253[b]	8,147
5-Sep	0[b]	1,700	100	3[b]	32,297	100	233[b]	8,380
6-Sep	0[b]	1,700	100	1[b]	32,298	100	122[b]	8,502
7-Sep	0[b]	1,700	100	0[b]	32,298	100	181[b]	8,683
8-Sep	0[b]	1,700	100	0[b]	32,298	100	100[b]	8,783
9-Sep	0[b]	1,700	100	1[b]	32,300	100	77[b]	8,860
10-Sep	0[b]	1,700	100	0[b]	32,300	100	86[b]	8,946
11-Sep	0[b]	1,700	100	0[b]	32,300	100	81[b]	9,027
12-Sep	0[b]	1,700	100	0[b]	32,300	100	75[b]	9,102
13-Sep	0[b]	1,700	100	0[b]	32,300	100	68[b]	9,170
14-Sep	0[b]	1,700	100	0[b]	32,300	100	61[b]	9,231
15-Sep	0[b]	1,700	100	0[b]	32,300	100	54[b]	9,285
16-Sep	0[b]	1,700	100	1[b]	32,301	100	48[b]	9,333
17-Sep	0[b]	1,700	100	0[b]	32,301	100	41[b]	9,374
18-Sep	0[b]	1,700	100	0[b]	32,301	100	35[b]	9,409
19-Sep	0[b]	1,700	100	0[b]	32,301	100	28[b]	9,437
20-Sep	0[b]	1,700	100	0[b]	32,301	100	16[b]	9,453
Total Escapement		1,700			32,301			9,453
Observed Escapement		1,700			32,214			2,362
Percent Estimated		0.0%			0.3%			75.0%

Note: Discrepancies between the sum of the daily totals and the cumulative passage are attributed to rounding errors.

[a] The weir remained fish-tight but no counts were performed due to low visibility and relatively little suspected passage.

[b] The weir was not operational; daily passage was estimated.

Table 2.–Age and sex composition of Chinook salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap.

			Age Class															
Sample Dates	**Sample**		**1.1**		**1.2**		**1.3**		**2.2**		**1.4**		**1.5**		**2.4**		**Total**	
(Stratum Dates)	**Size**	**Sex**	**Esc.**	**%**	**Esc.**	**%**	**Esc.**	**%**	**Esc.**	**%**	**Esc.**	**%**	**Esc.**	**%**	**Esc.**	**%**	**Esc.**	**%**
6/28-7/12	90	M	0	0.0	251	21.1	304	25.5	0	0.0	106	8.9	40	3.4	0	0.0	700	58.9
(6/15-7/13)		F	0	0.0	0	0.0	211	17.8	0	0.0	251	21.1	26	2.2	0	0.0	489	41.1
		Subtotal[a]	0	0.0	251	21.1	515	43.3	0	0.0	357	30.0	66	5.6	0	0.0	1,189	100.0
7/14-17	44	M	0	0.0	59	27.3	93	43.2	0	0.0	10	4.6	0	0.0	0	0.0	163	75.0
(7/14-18)		F	0	0.0	0	0.0	20	9.1	0	0.0	29	13.6	5	2.3	0	0.0	54	25.0
		Subtotal[a]	0	0.0	59	27.3	113	52.3	0	0.0	39	18.2	5	2.3	0	0.0	217	100.0
7/19-8/7	44	M	0	0.0	47	15.9	60	20.5	0	0.0	27	9.1	0	0.0	0	0.0	134	45.5
(7/9-9/20)		F	0	0.0	0	0.0	60	20.5	0	0.0	93	31.8	7	2.3	0	0.0	160	54.5
		Subtotal[a]	0	0.0	47	15.9	120	40.9	0	0.0	120	40.9	7	2.3	0	0.0	294	100.0
Season[b]	178	M	0	0.0	357	21.0	458	26.9	0	0.0	142	8.4	40	2.3	0	0.0	997	58.6
		F	0	0.0	0	0.0	291	17.2	0	0.0	374	22.0	38	2.3	0	0.0	703	41.4
		Total	0	0.0	357	21.0	749	44.1	0	0.0	516	30.4	78	4.6	0	0.0	1,700	100.0

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in "Season" summaries are the strata sums; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 3.–Mean length (mm) of Chinook salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	1.2	1.3	2.2	1.4	1.5	2.4
6/28-7/12 (6/15-7/13)	M	Mean Length		584	682		779	820	
		SE		9	11		38	93	
		Range		515- 660	585- 780		625- 905	725-1,005	
		Sample Size	0	19	23	0	8	3	0
	F	Mean Length			721		816	795	
		SE			13		15	65	
		Range			670- 870		710- 935	730- 860	
		Sample Size	0	0	16	0	19	2	0
7/14-17 (7/14-18)	M	Mean Length		564	685		698		
		SE		8	13		18		
		Range		520- 605	540- 810		680- 715		
		Sample Size	0	12	19	0	2	0	0
	F	Mean Length			688		758	790	
		SE			17		10	-	
		Range			650- 730		730- 785	790- 790	
		Sample Size	0	0	4	0	6	1	0
7/19-8/7 (7/9-9/20)	M	Mean Length		544	677		740		
		SE		13	22		54		
		Range		495- 605	615- 805		610- 860		
		Sample Size	0	7	9	0	4	0	0
	F	Mean Length			746		808	850	
		SE			15		18	-	
		Range			670- 805		695- 905	850- 850	
		Sample Size	0	0	9	0	14	1	0
Season[a]	M	Mean Length		575	682		766	820	
		Range		495- 660	540- 810		610- 905	725-1,005	
		Sample Size	0	38	51	0	14	3	0
	F	Mean Length			724		810	804	
		Range			650- 870		695- 935	730- 860	
		Sample Size	0	0	29	0	39	4	0

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 2.

[a] "Season" mean lengths are weighted by the escapement passage in each stratum.

Table 4.–Age and sex composition of chum salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %
6/27-29	181	M	0	0.0	721	15.5	2,035	43.6	26	0.6	2,781	59.7
(6/15-7/3)		F	0	0.0	670	14.3	1,210	26.0	0	0.0	1,880	40.3
		Subtotal[a]	0	0.0	1,391	29.8	3,245	69.6	26	0.6	4,661	100.0
7/7-9	179	M	70	0.6	4,208	33.5	4,138	33.0	0	0.0	8,416	67.0
(7/4-13)		F	70	0.5	2,385	19.0	1,683	13.4	0	0.0	4,138	33.0
		Subtotal[a]	140	1.1	6,593	52.5	5,821	46.4	0	0.0	12,554	100.0
7/17-19	176	M	0	0.0	3,094	31.8	1,989	20.5	55	0.6	5,138	52.8
(7/14-24)		F	110	1.1	3,259	33.5	1,215	12.5	0	0.0	4,585	47.2
		Subtotal[a]	110	1.1	6,353	65.3	3,204	33.0	55	0.6	9,723	100.0
7/28-30	179	M	123	2.8	1,153	26.3	663	15.1	0	0.0	1,939	44.1
(7/25-8/2)		F	147	3.3	1,767	40.2	540	12.3	0	0.0	2,454	55.9
		Subtotal[a]	270	6.1	2,920	66.5	1,203	27.4	0	0.0	4,393	100.0
8/5- 9,11-12	220	M	13	1.4	318	32.7	93	9.5	4	0.5	428	44.1
(8/3-9/20)		F	62	6.3	370	38.2	110	11.4	0	0.0	542	55.9
		Subtotal[a]	75	7.7	688	70.9	203	20.9	4	0.5	970	100.0
Season[b]	935	M	206	0.6	9,494	29.4	8,916	27.6	85	0.3	18,701	57.9
		F	390	1.2	8,451	26.2	4,759	14.7	0	0.0	13,600	42.1
		Total	596	1.8	17,945	55.6	13,675	42.3	85	0.3	32,301	100.0

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in "Season" summaries are strata sums; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 5.–Mean length (mm) of chum salmon at the Tatlawiksuk River weir in 2006 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
6/27-29 (6/15-7/3)	M	Mean Length		571	589	615
		SE		4	3	-
		Range		535- 615	530- 665	615- 615
		Sample Size	0	28	79	1
	F	Mean Length		543	560	
		SE		5	4	
		Range		505- 605	510- 610	
		Sample Size	0	26	47	0
7/7-9 (7/4-13)	M	Mean Length	485	566	593	
		SE	-	3	4	
		Range	485- 485	525- 610	540- 690	
		Sample Size	1	60	59	0
	F	Mean Length	525	551	555	
		SE	-	5	5	
		Range	525- 525	515- 650	510- 615	
		Sample Size	1	34	24	0
7/17-19 (7/14-24)	M	Mean Length		572	579	560
		SE		4	5	-
		Range		500- 635	505- 635	560- 560
		Sample Size	0	56	36	1
	F	Mean Length	513	540	554	
		SE	23	3	7	
		Range	490- 535	475- 585	495- 610	
		Sample Size	2	59	22	0
7/28-30 (7/25-8/2)	M	Mean Length	505	553	579	
		SE	17	5	8	
		Range	440- 535	480- 660	500- 660	
		Sample Size	5	47	27	0
	F	Mean Length	511	531	546	
		SE	4	3	6	
		Range	500- 520	490- 590	490- 595	
		Sample Size	6	72	22	0
8/5- 9,11-12 (8/3-9/20)	M	Mean Length	500	550	582	550
		SE	23	3	8	-
		Range	460- 540	480- 610	510- 650	550- 550
		Sample Size	3	72	21	1
	F	Mean Length	508	524	549	
		SE	7	3	5	
		Range	465- 565	460- 600	490- 590	
		Sample Size	14	84	25	0
Season[a]	M	Mean Length	498	566	588	576
		Range	440- 540	480- 660	500- 690	550- 615
		Sample Size	9	263	222	3
	F	Mean Length	513	541	555	
		Range	465- 565	460- 650	490- 615	
		Sample Size	23	275	140	0

Table 6.–Age and sex composition of coho salmon sampled at the Tatlawiksuk River weir in 2006 that were captured using a live trap.

			Age Class			
Sample Dates	**Sample Size**	**Sex**	**1.1**	**2.1**	**3.1**	**Total**
8/7 - 9, 11 - 12	155	M	10.9	51.3	0.5	62.7
		F	4.0	28.9	4.4	37.3
		Total	14.9	80.2	4.9	100.0

Note: This table represents 1 pulse sample only and the percentages reported here can not be applied to the entire 2006 estimated escapement due to insufficient sample collection and escapement estimates.

Table 7.–Mean length (mm) of coho salmon at the Tatlawiksuk River weir in 2006 that were captured using a live trap.

			Age Class		
Sample Dates	**Sex**		**1.1**	**2.1**	**3.1**
8/7 - 9, 11 - 12	M	Mean Length	509	524	490
		SE	40	40	-
		Range	415 - 585	440 - 590	490 - 490
		Sample Size	17	77	1
	F	Mean Length	508	525	541
		SE	17	33	33
		Range	485 - 535	390 - 570	495 - 585
		Sample Size	6	47	7

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 6. This table represents 1 pulse sample only and the lengths reported here can not be assumed for the entire 2006 coho salmon escapement due to insufficient sample collection and escapement estimates.

Table 8.–Brood table for Tatlawiksuk River Chinook salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year						Returns[a]	Return per Spawner[a]
		3	4	5	6	7	8		
1990	ND	ND	ND	ND	ND	ND	-	-	-
1991	ND	ND	ND	ND	ND	-	-	-	-
1992	ND	ND	ND	ND	-	-	-	-	-
1993	ND	ND	ND	-	-	-	-	-	-
1994	ND	ND	-	-	-	-	0	-	-
1995	ND	-	-	-	-	81	-	-	-
1996	ND	-	-	-	1,183	-	0	-	-
1997	ND	-	-	450	-	0	0	-	-
1998	970[b,c]	-	517	-	932	42	0	-	-
1999	1,490[b]	0	-	1,150	1,040	78	ND	-	-
2000	817[b]	-	751	1,445	516	ND	ND	-	-
2001	2,010[b]	0	391	749	ND	ND	ND	-	-
2002	2,237	0	357	ND	ND	ND	ND	-	-
2003	1,683[b]	0	ND	ND	ND	ND	ND	-	-
2004	2,833	ND	ND	ND	ND	ND	ND	ND	ND
2005	2,918	ND	ND	ND	ND	ND	ND	ND	ND
2006	1,700	ND	ND	ND	ND	ND	ND	ND	ND

[a] Total returns and return per spawner can not be calculated due to insufficient data.

[b] ASL sampling was not adequate to determine age composition of the escapement; returns from brood year are not known.

[c] Incomplete escapement count.

Table 9.–Brood table for Tatlawiksuk River chum salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year				Returns[a]	Return per Spawner[a]
		3	4	5	6		
1992	ND	ND	ND	ND	-	-	-
1993	ND	ND	ND	-	29	-	-
1994	ND	ND	-	2,660	34	-	-
1995	ND	-	6,959	2,781	93	-	-
1996	ND	10	4,011	7,941	364	12,326	-
1997	ND	139	15,582	8,158	-	-	-
1998	5,726[b]	100	14,379	-	43	-	-
1999	9,559	1,641	-	9,150	0	-	-
2000	7,044	-	8,942	3,027	85	-	-
2001	23,718	3,110	49,802	13,675	ND	-	-
2002	24,542	2,893	17,945	ND	ND	-	-
2003	479[b]	596	ND	ND	ND	-	-
2004	24,201	ND	ND	ND	ND	ND	ND
2005	55,720	ND	ND	ND	ND	ND	ND
2006	32,301	ND	ND	ND	ND	ND	ND

[a] Total returns and return per spawner can not be calculated for most brood years due to insufficient data.

[b] Incomplete escapement count and ASL sampling; returns from brood year are not known.

Table 10.–Brood table for Tatlawiksuk River coho salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year			Returns[a]	Return per Spawner[a]
		3	4	5		
1994	ND	ND	ND	445	-	-
1995	ND	ND	2,740	-	-	-
1996	ND	278	-	691	-	-
1997	ND	-	9,580	1,087	-	-
1998	ND[b]	231	10,191	ND	-	-
1999	3,455	134	ND	416	-	-
2000	5,756[c]	ND	15,485	7,496	-	-
2001	10539[d]	510	6,727	-	-	-
2002	11,345	330	-	ND	-	-
2003	ND[e]	-	ND	ND	-	-
2004	16,410	ND	ND	ND	ND	ND
2005	7,495	ND	ND	ND	ND	ND
2006	9,453[f]	ND	ND	ND	ND	ND

[a] Total returns and return per spawner can not be calculated for most brood years due to insufficient data.

[b] Weir was intentionally not operated during the coho salmon run.

[c] Incomplete escapement estimate and insufficient ASL information. Return per spawner was not calculated.

[d] Reported escapement includes 46% passage estimates.

[e] Weir was not operational during the coho salmon run. Escapement was not determined.

[f] Reported escapement includes 75% passage estimates. ASL samples were not sufficient to estimate age composition of total escapement.

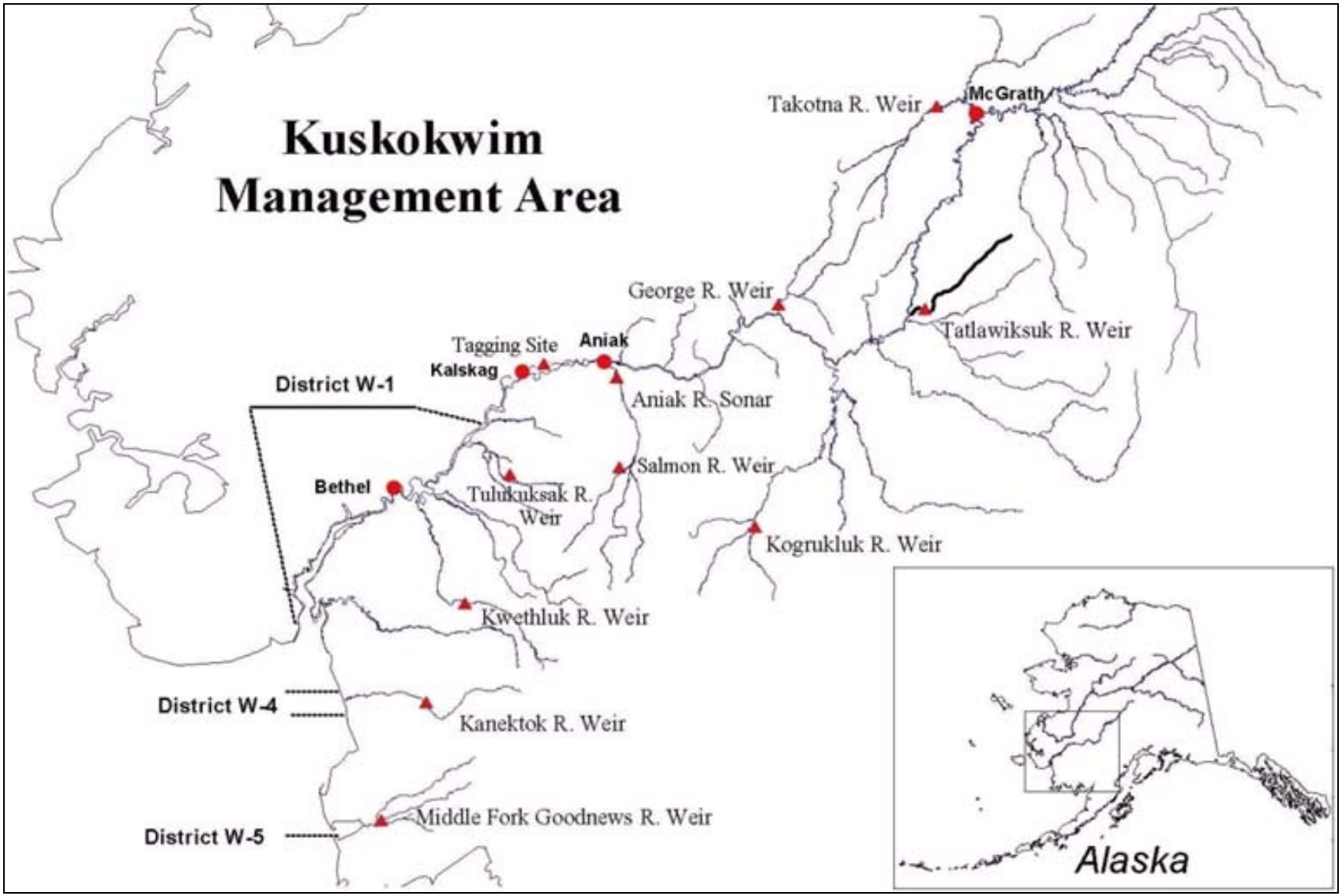


Figure 1.–Location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Tatlawiksuk River.

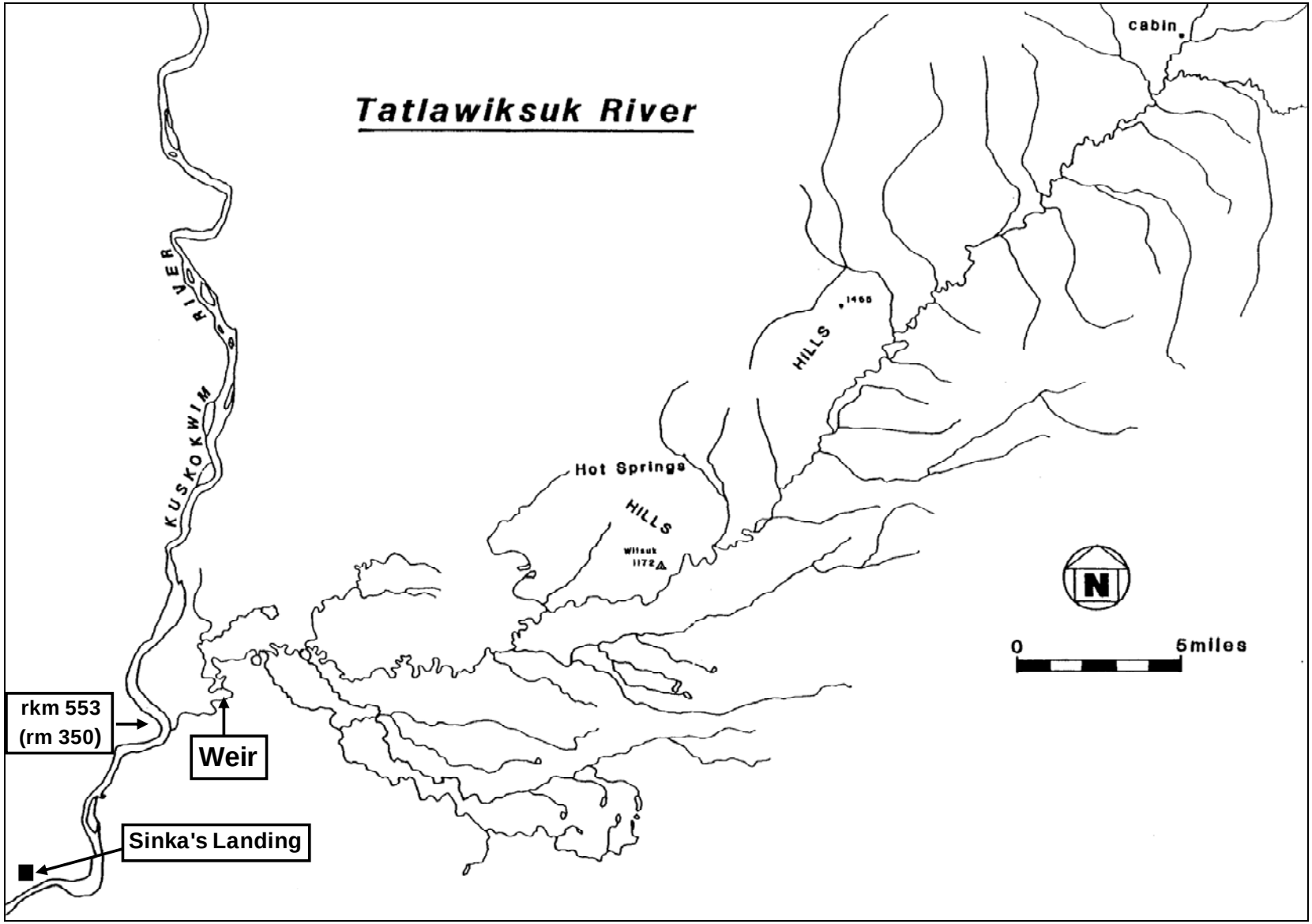
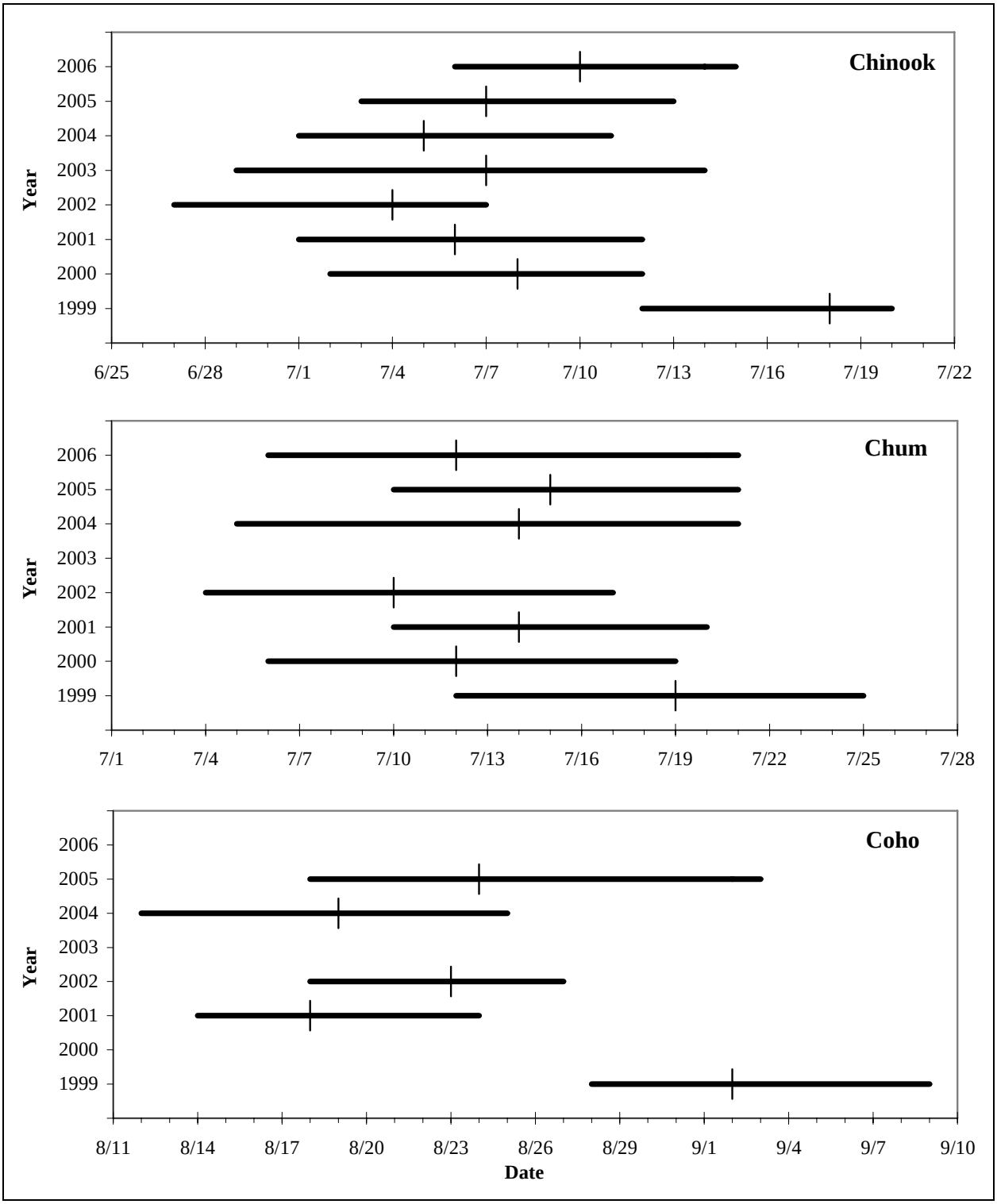


Figure 2.–Tatlawiksuk River drainage and the location of the weir.



Note: Solid lines represent the dates when the central 50% of the run passed and cross-bars represent the median passage date.

Figure 3.–Annual run timing of Chinook, chum, and coho salmon based on cumulative percent passage at the Tatlawiksuk River weir, 1999–2006.

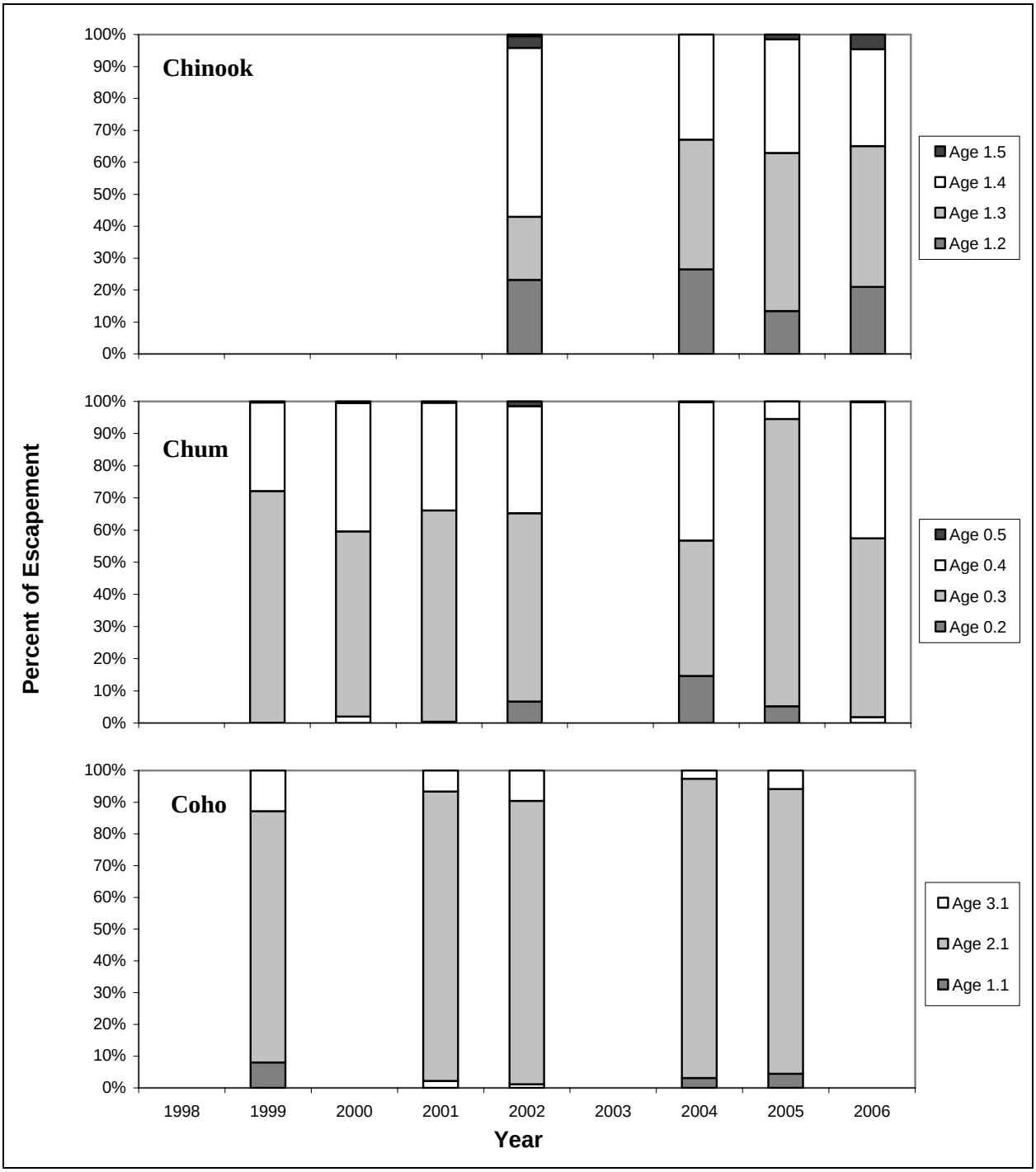


Figure 4.–Historical age composition of Chinook, chum, and coho salmon at the Tatlawiksuk River weir, 1998–2006.

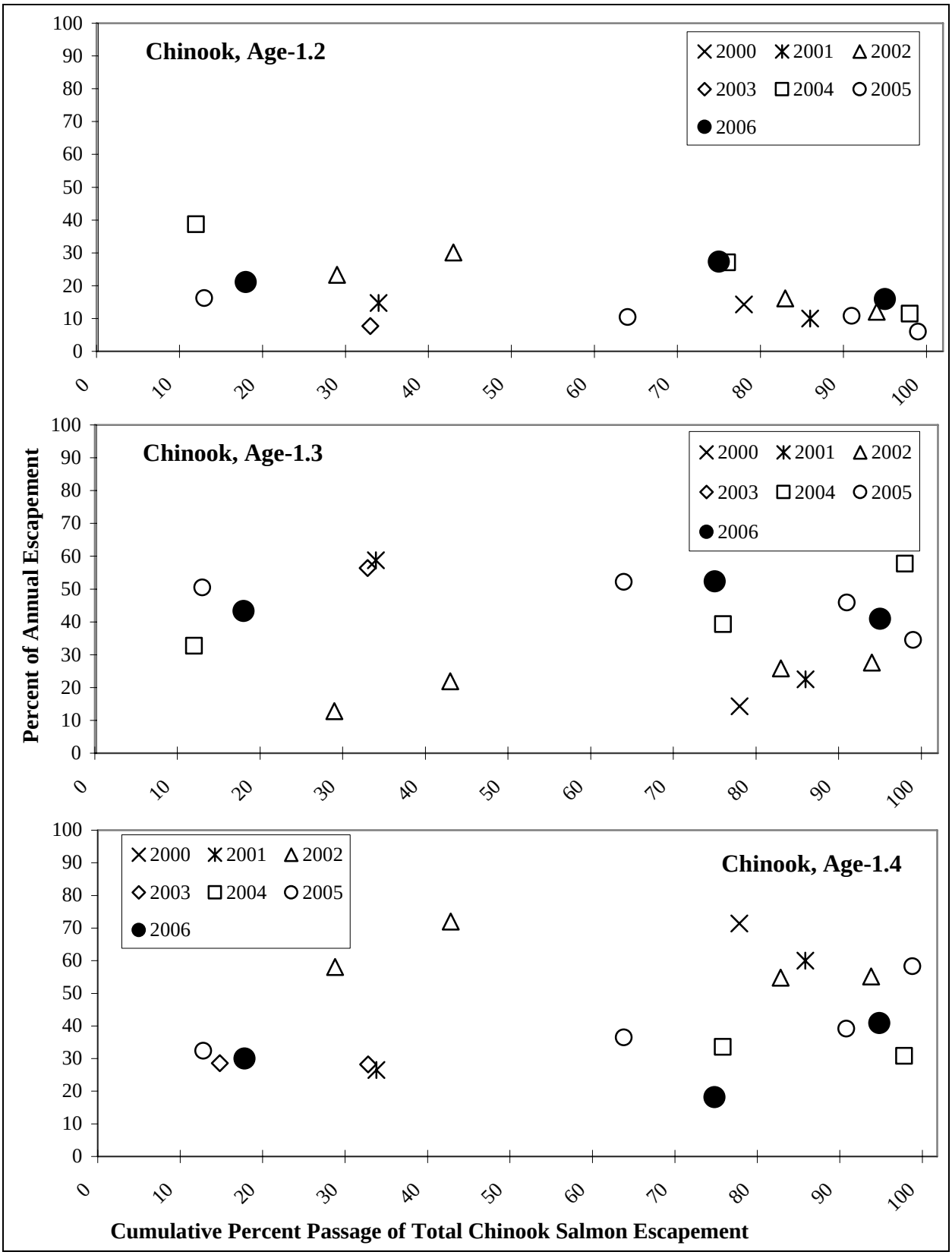


Figure 5.–Historical age composition by cumulative percent passage of Chinook salmon at the Tatlawiksuk River weir, 2000–2006.

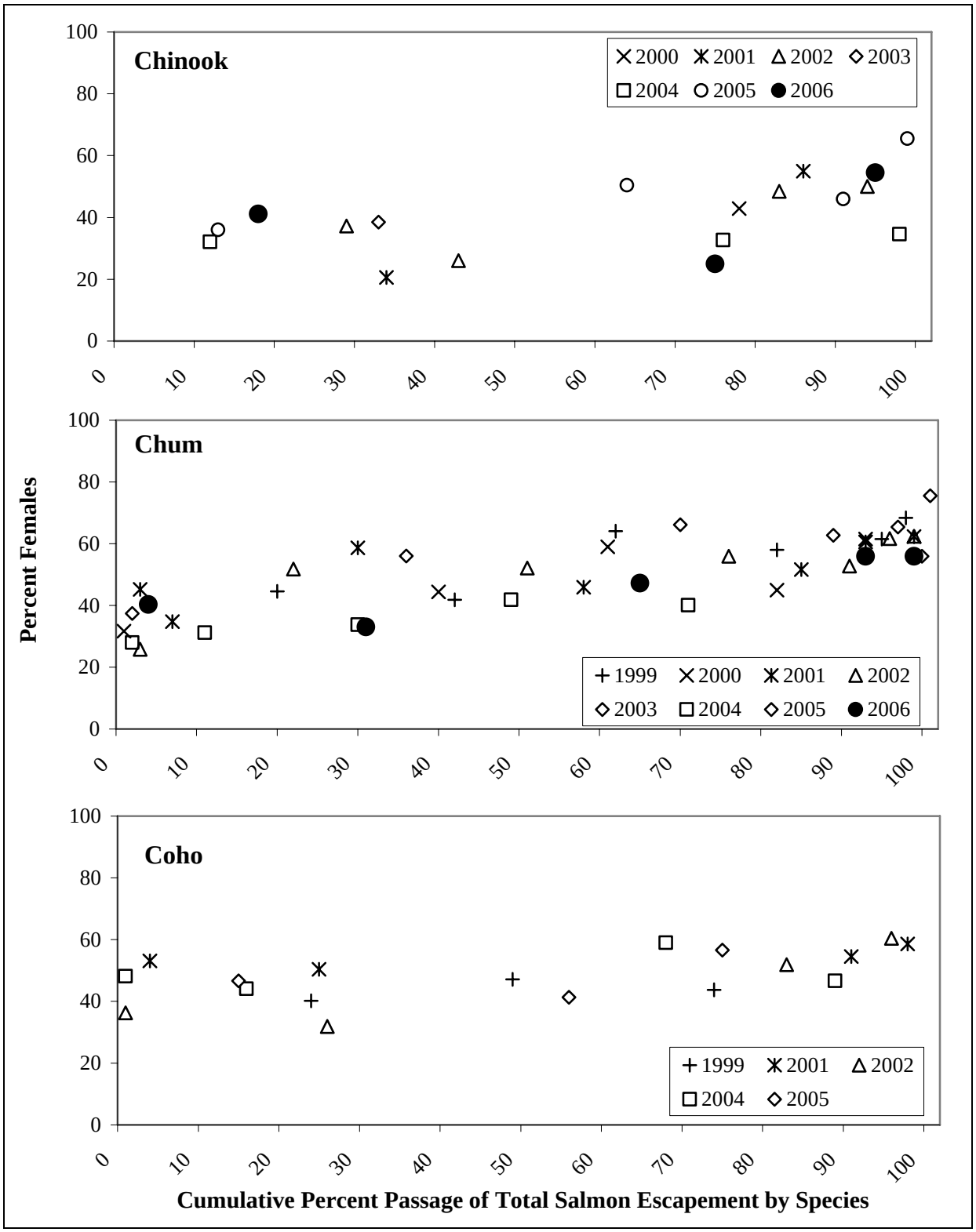
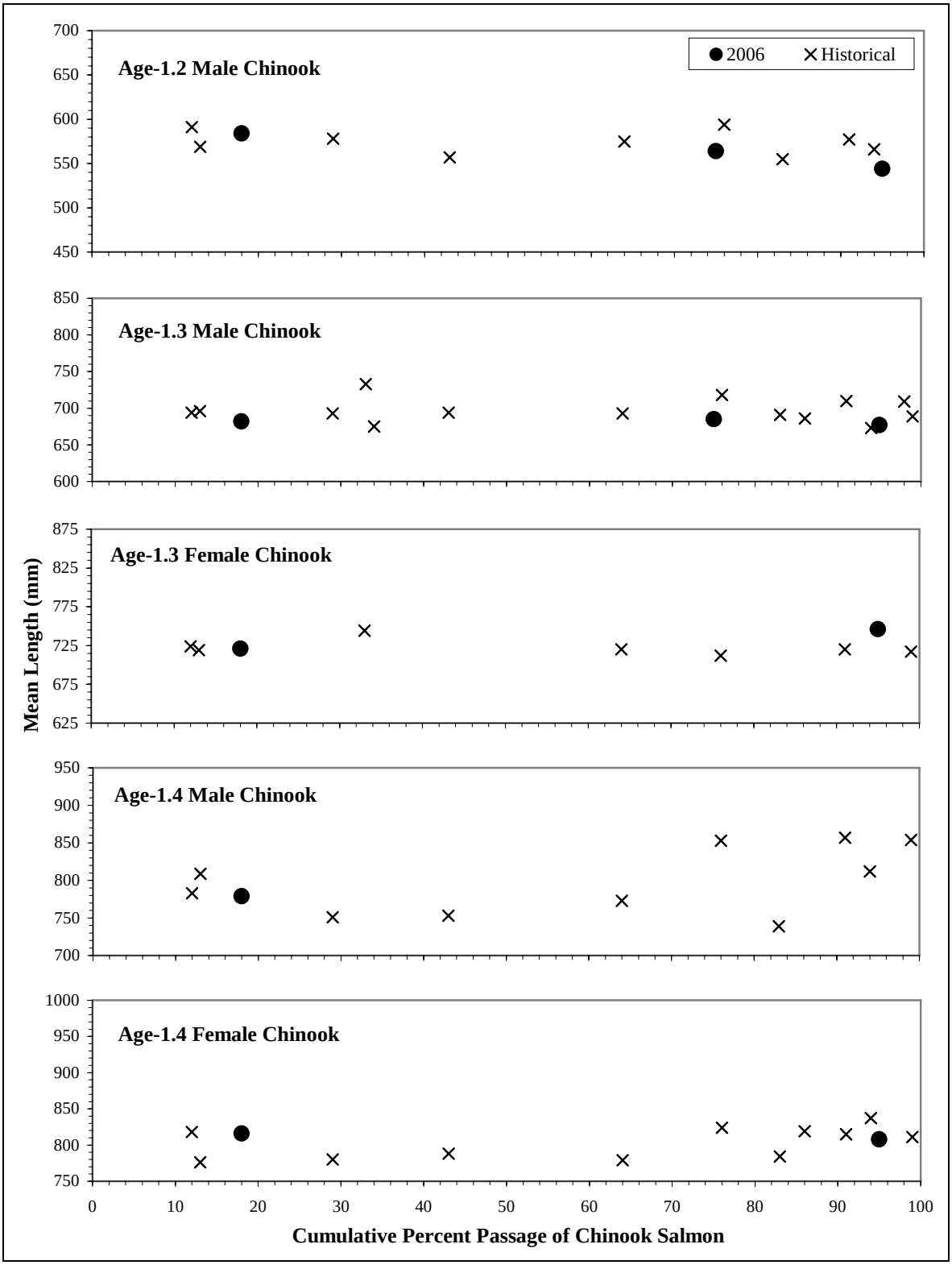


Figure 6.–Historical percentage of female Chinook, chum, and coho salmon by cumulative percent passage at the Tatlawiksuk River weir.



Note: Only samples greater than 6 fish were included in this figure.

Figure 7.–Historical intra-annual mean length-at-age of male and female Chinook salmon by cumulative percent passage at the Tatlawiksuk River weir.

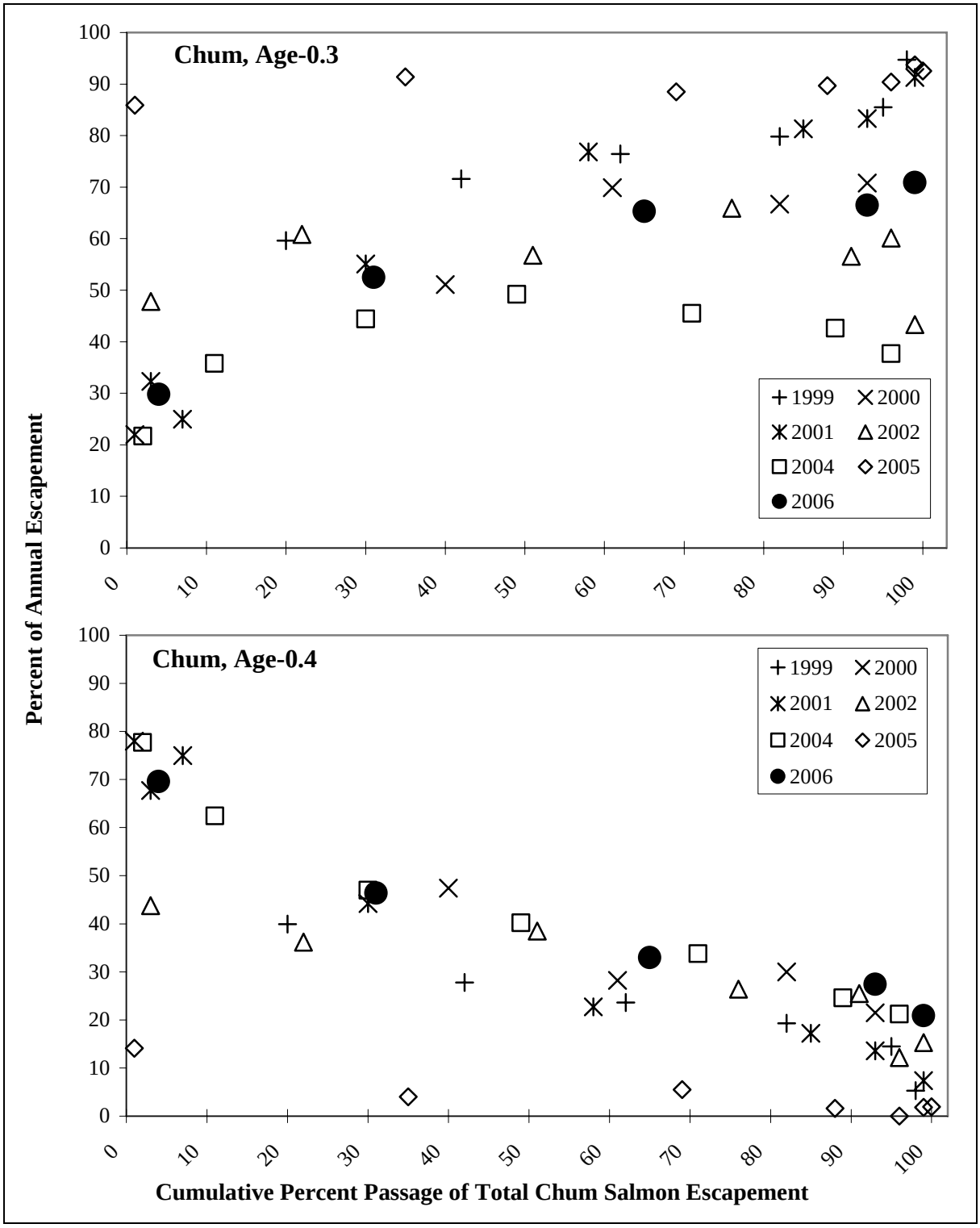


Figure 8.–Historical age composition by cumulative percent passage of chum salmon at the Tatlawiksuk River weir, 1999–2006.

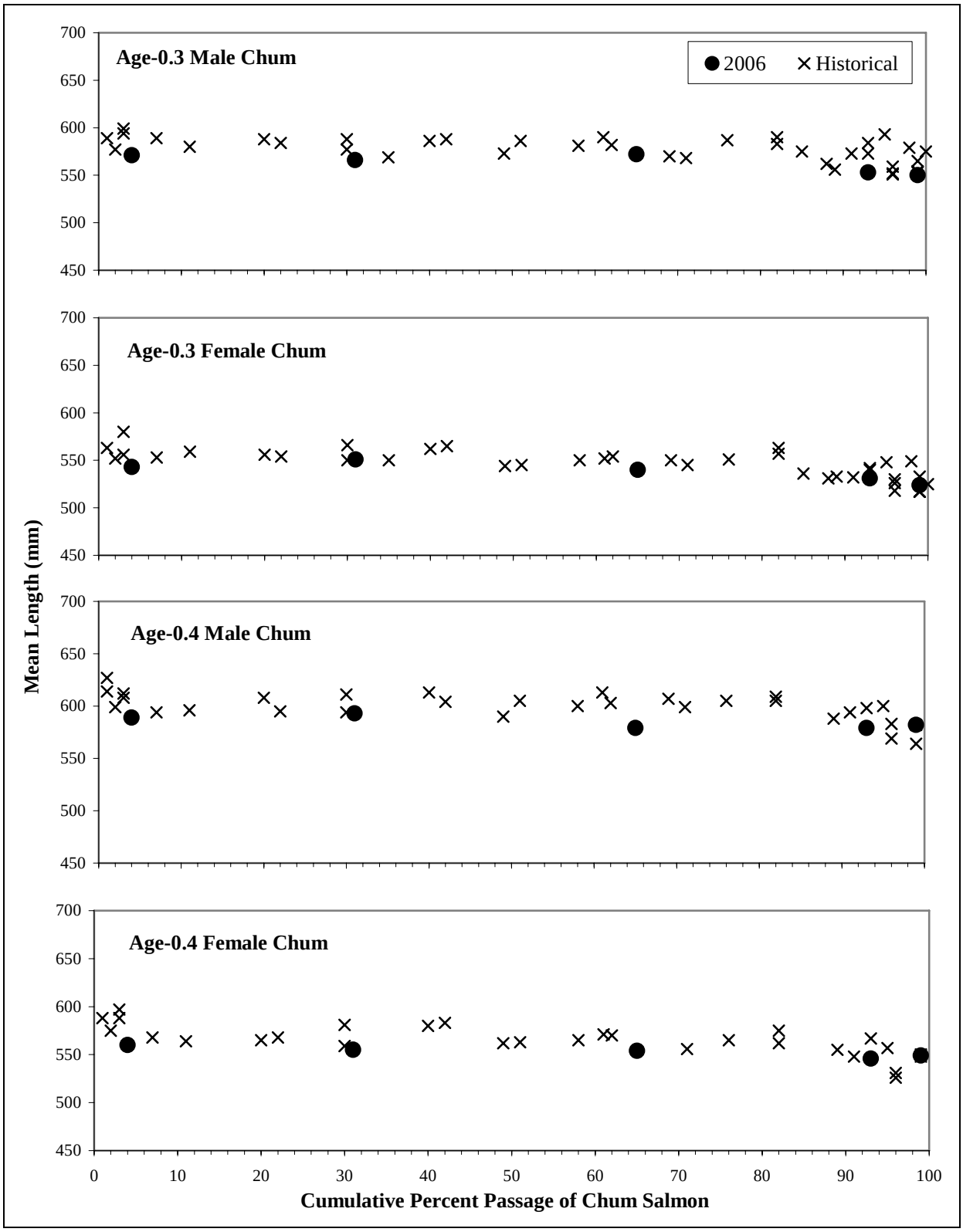


Figure 9.–Historical intra-annual mean length-at-age of chum salmon by cumulative percent passage at the Tatlawiksuk River weir.

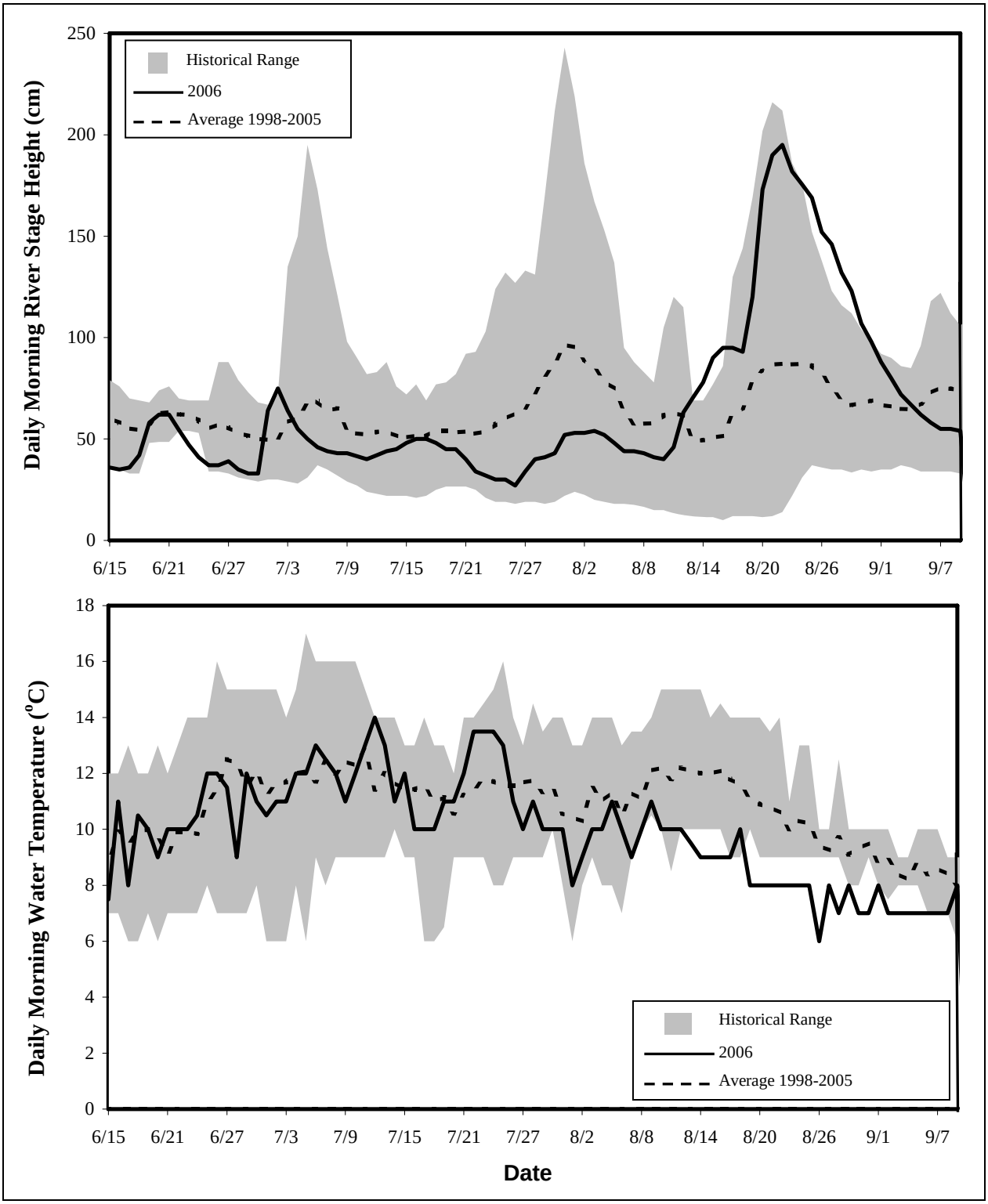


Figure 10.–Historical average, minimum, and maximum morning river stage and water temperature (observed thermometer measurements) at the Tatlawiksuk River weir from 1998 to 2005, compared to morning river stage and water temperature in 2006.

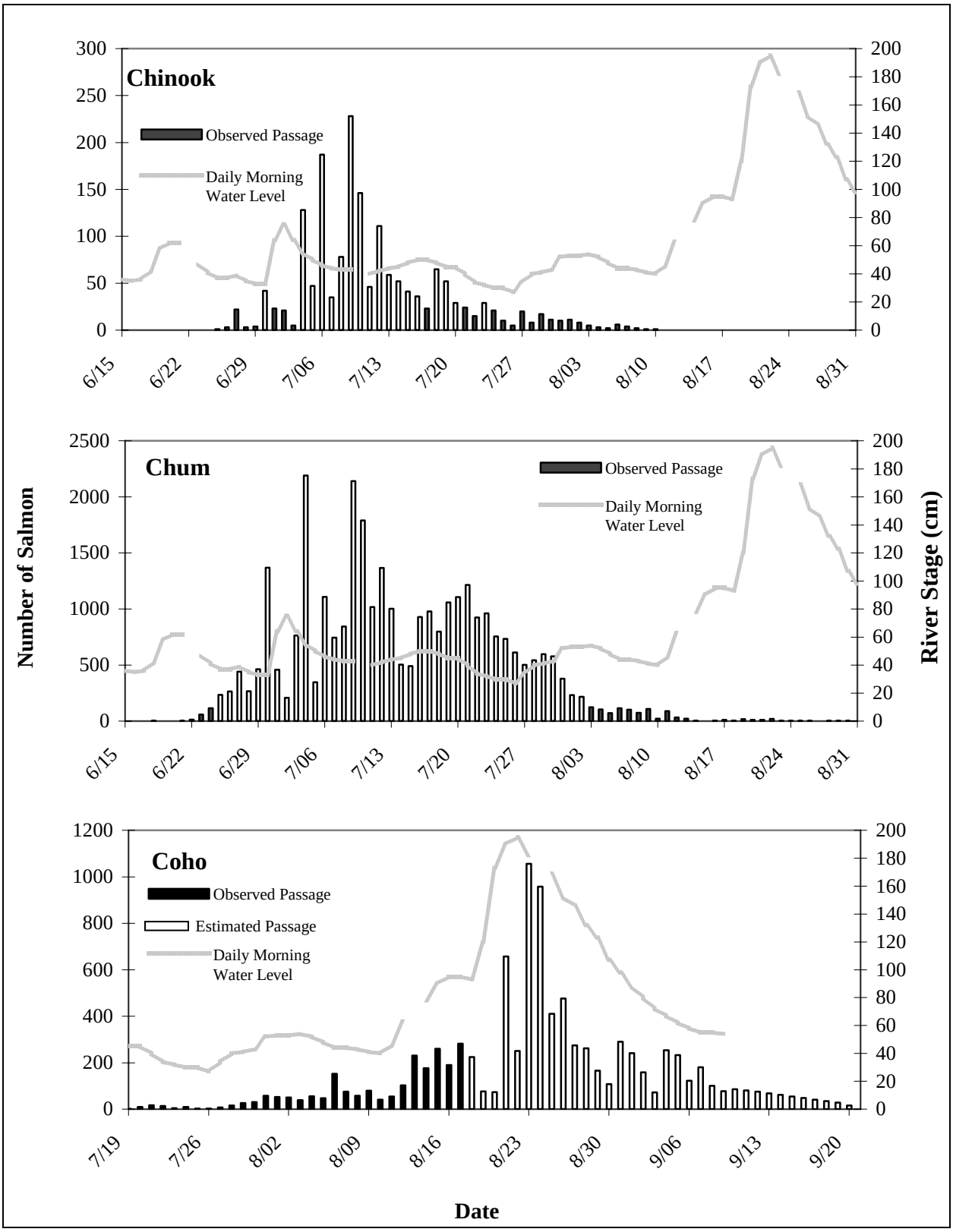


Figure 11.–Daily Chinook, chum, and coho salmon passage at the Tatlawiksuk River weir relative to daily average river stage height, 2006.

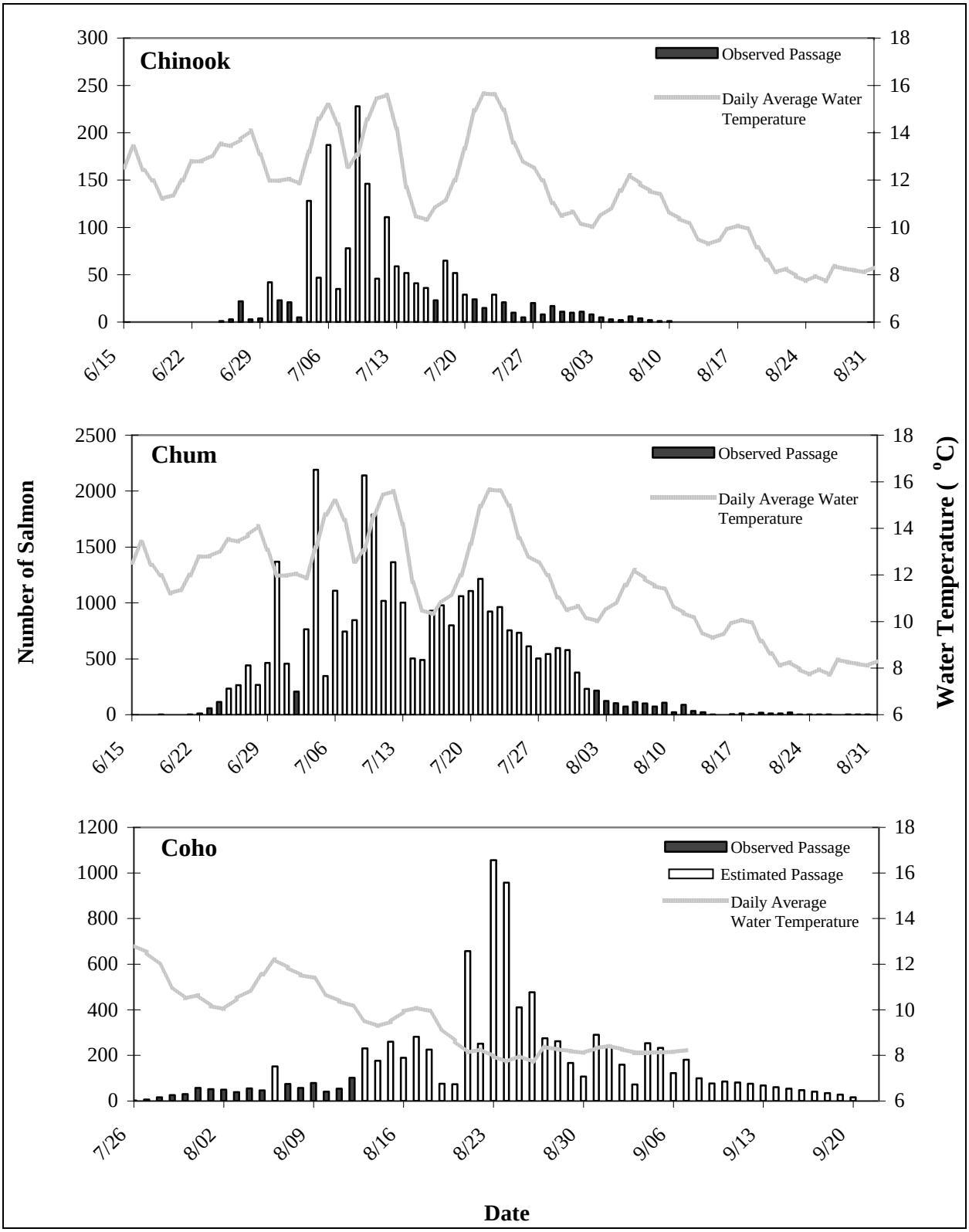


Figure 12.–Daily Chinook, chum, and coho salmon passage at the Tatlawiksuk River weir relative to daily average water temperature (data logger readings), 2006.

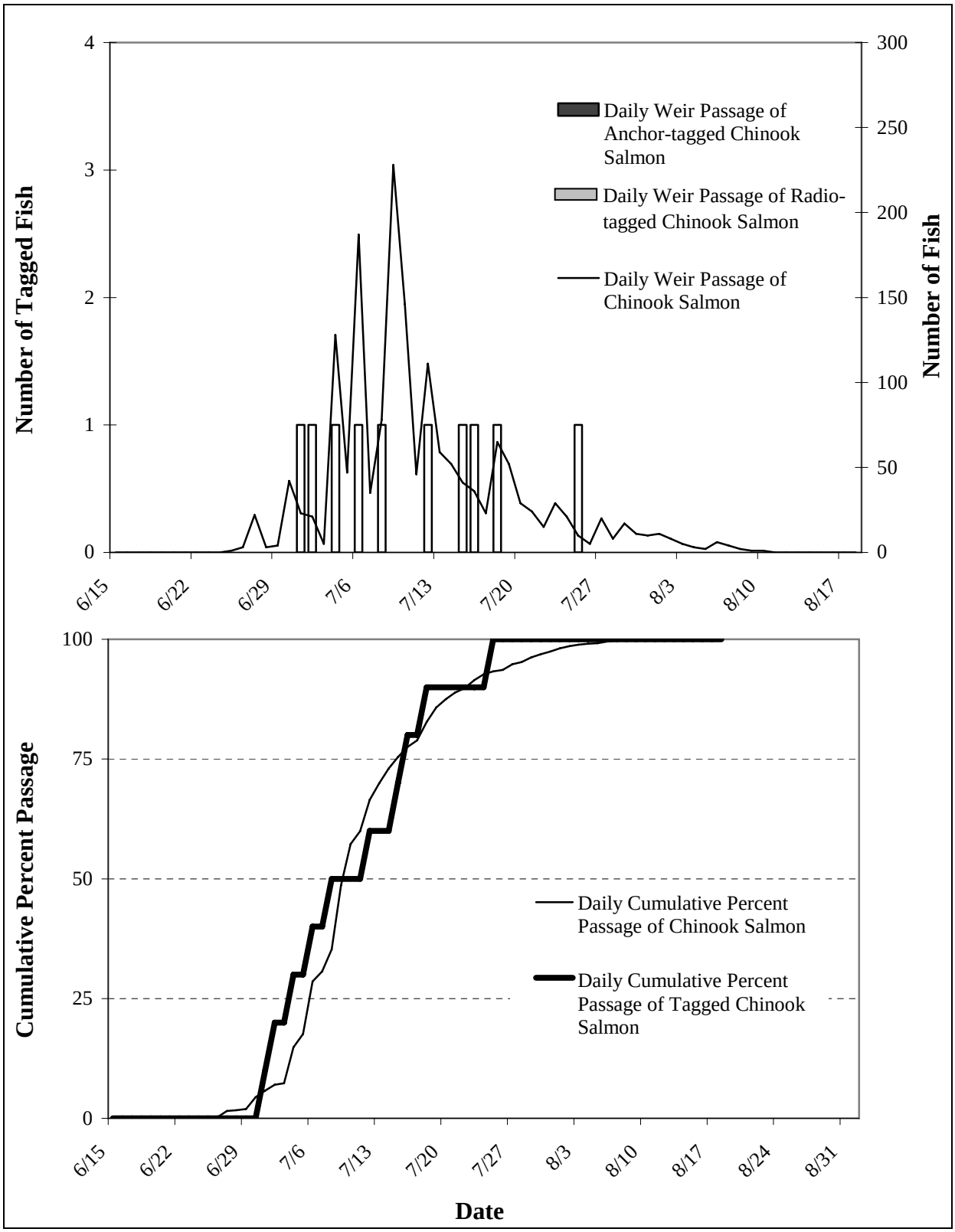
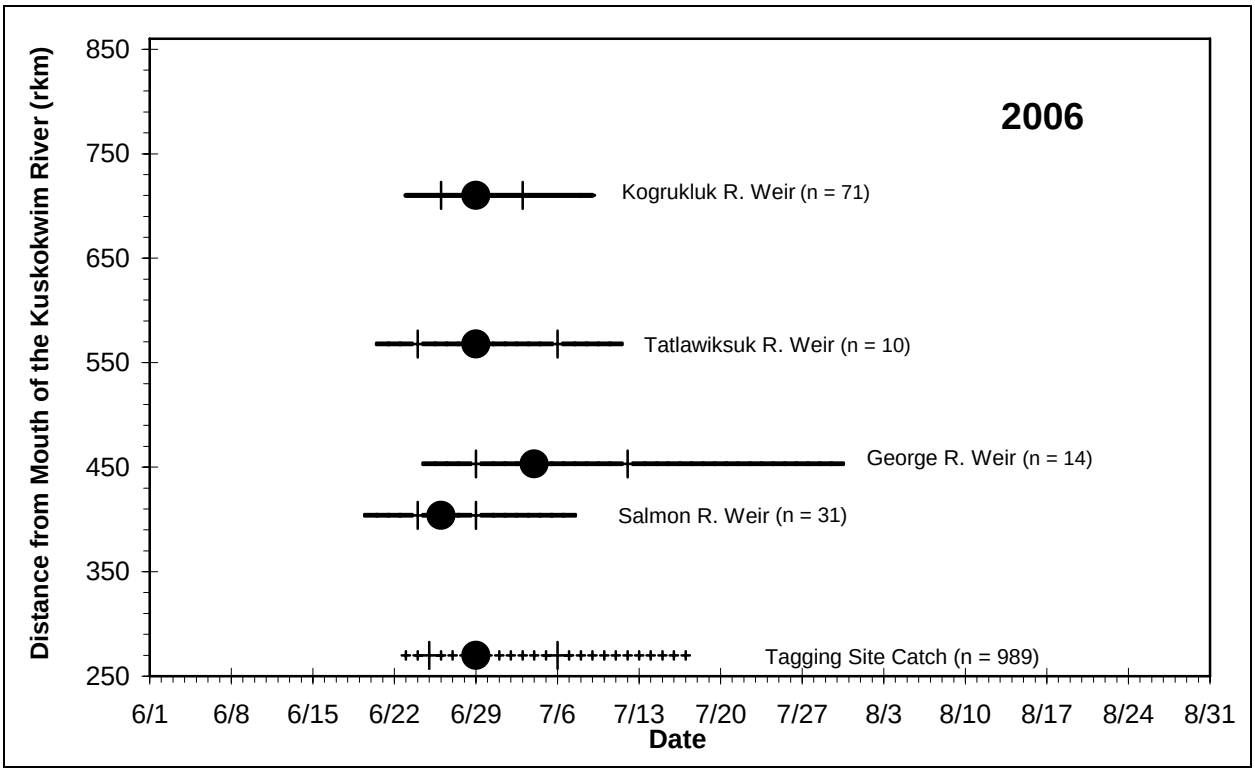


Figure 13.–Daily and cumulative percent passage of overall Chinook salmon passage compared to tagged Chinook salmon passage at the Tatlawiksuk River weir in 2006.



Source: Schaberg et al. *In prep*.

Note: Horizontal lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock.

Figure 14.–Dates when individual Chinook salmon stocks passed through the Kalskag tagging sites (rkm 271) based on anchor- and radio-tagging studies conducted in 2006.

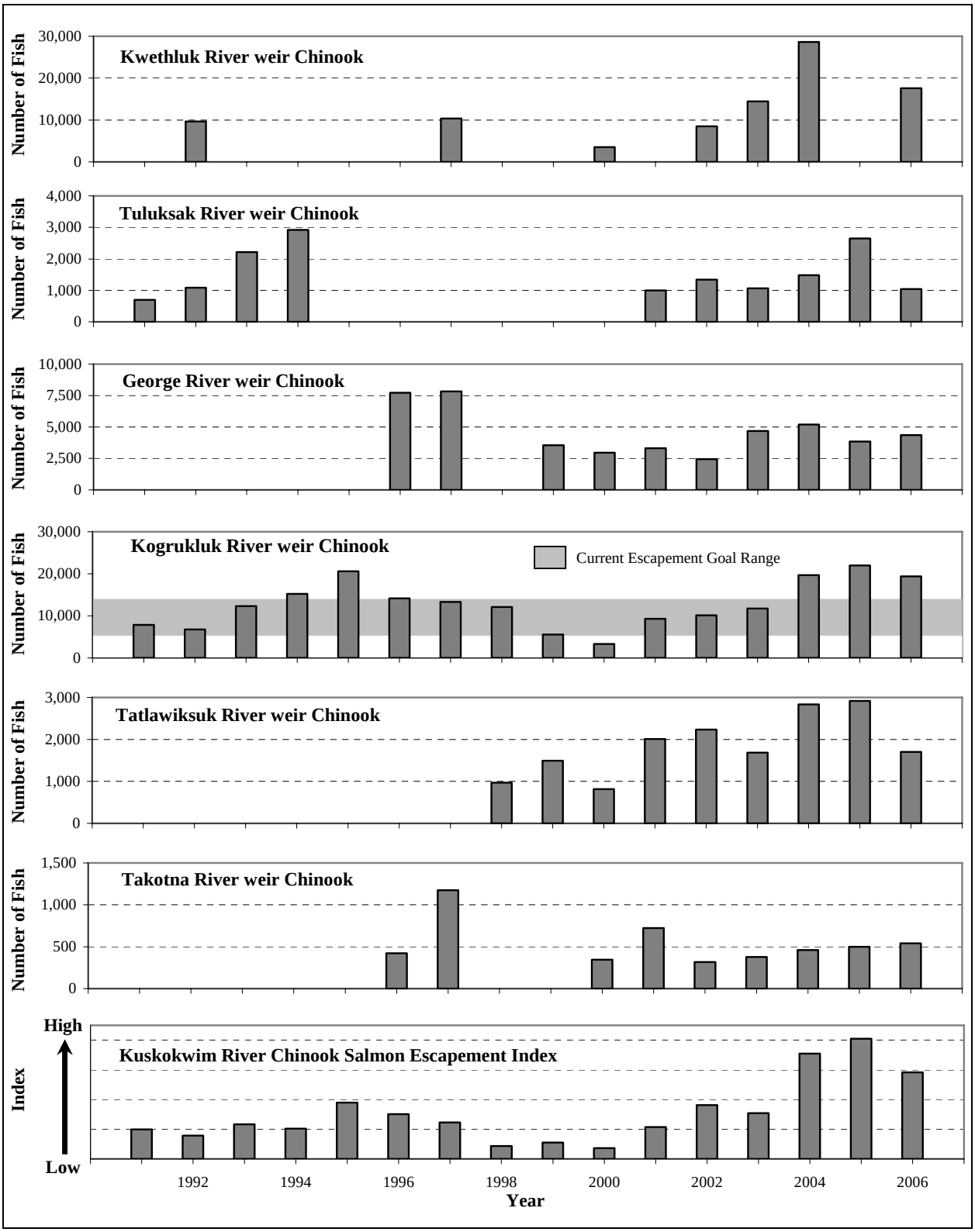


Figure 15.–Historical annual Chinook salmon escapement into 6 Kuskokwim River tributaries and annual Kuskokwim River Chinook salmon escapement indices, 1991–2006.

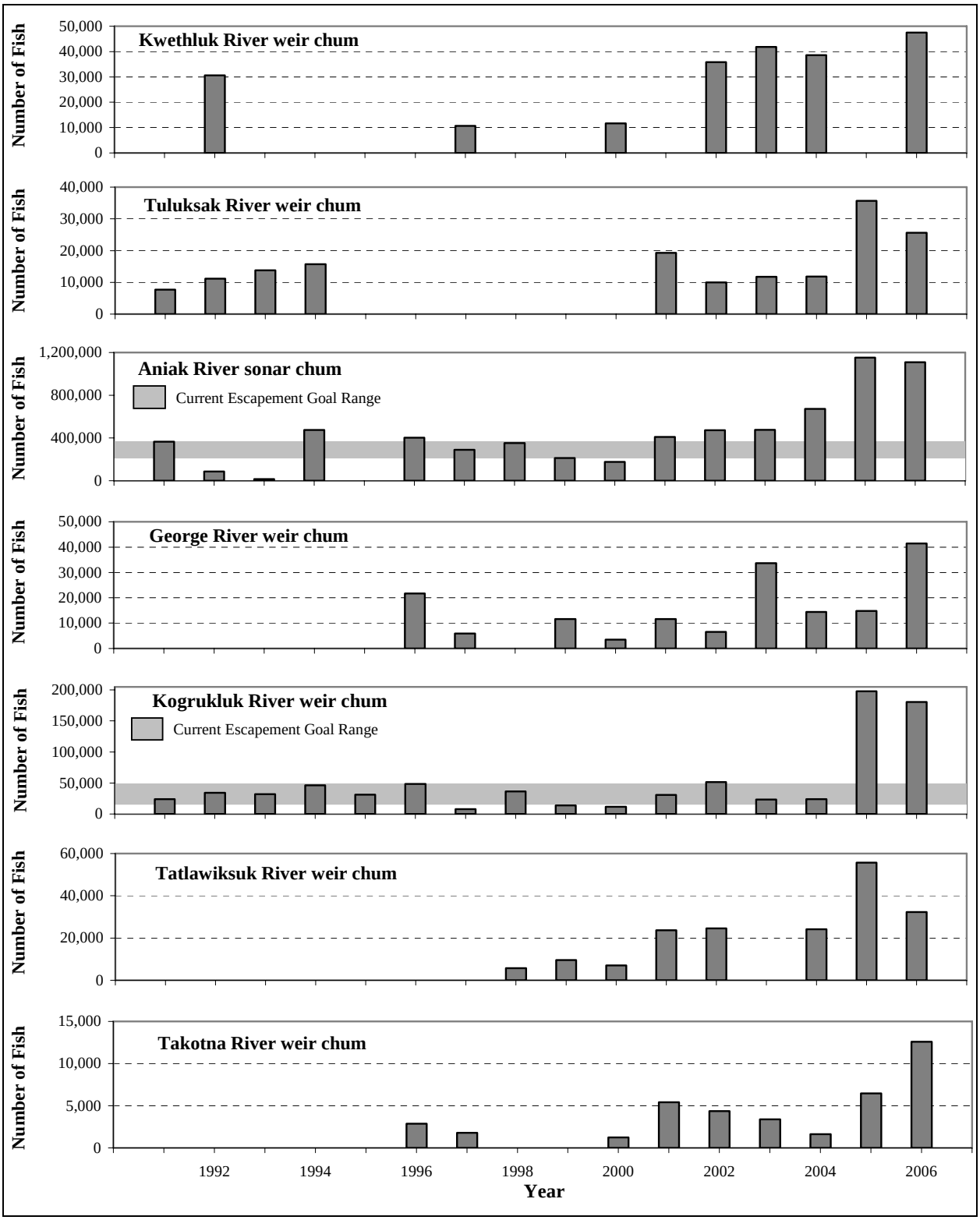
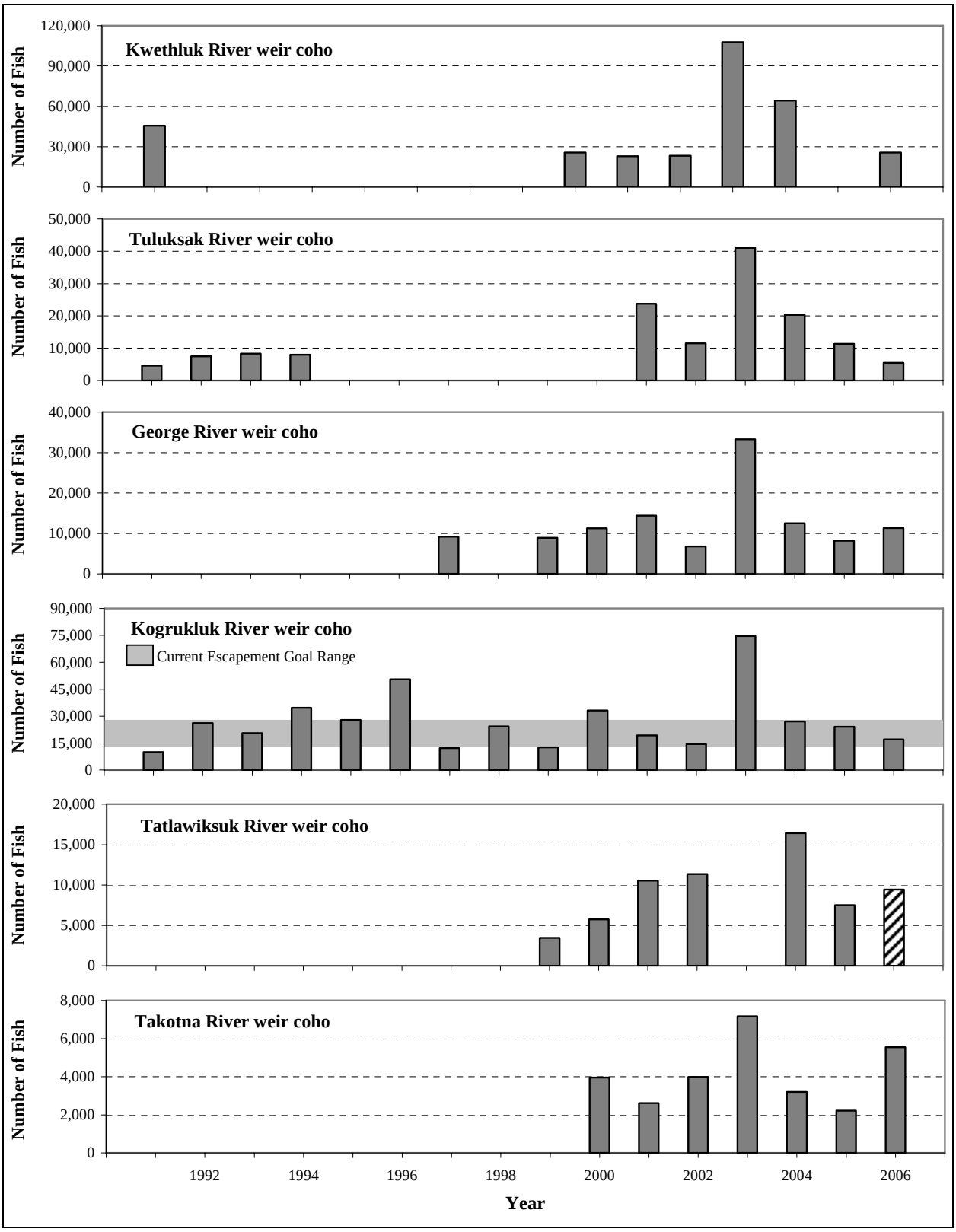
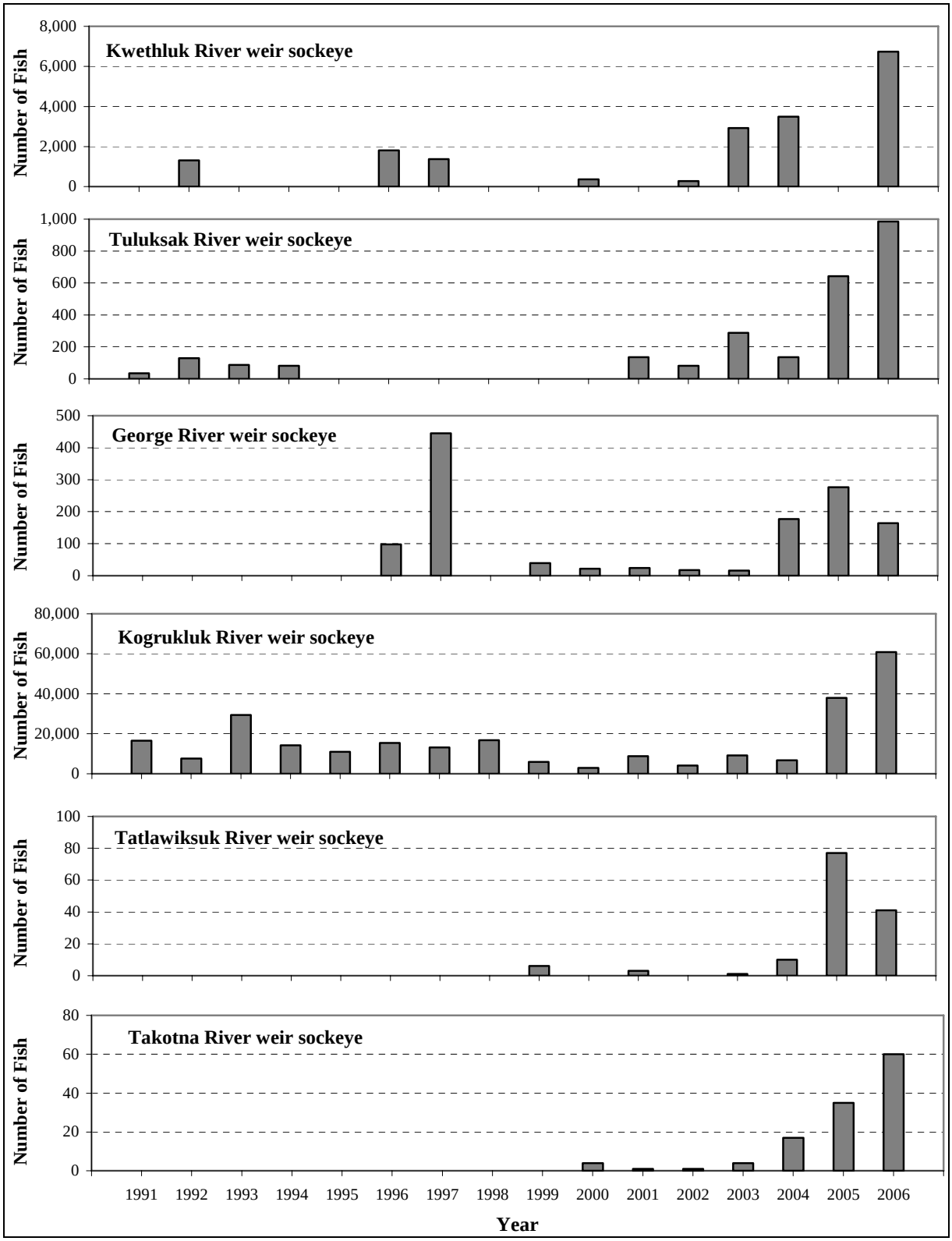


Figure 16.–Historical annual chum salmon escapement into 7 Kuskokwim River tributaries, 1991-2006.



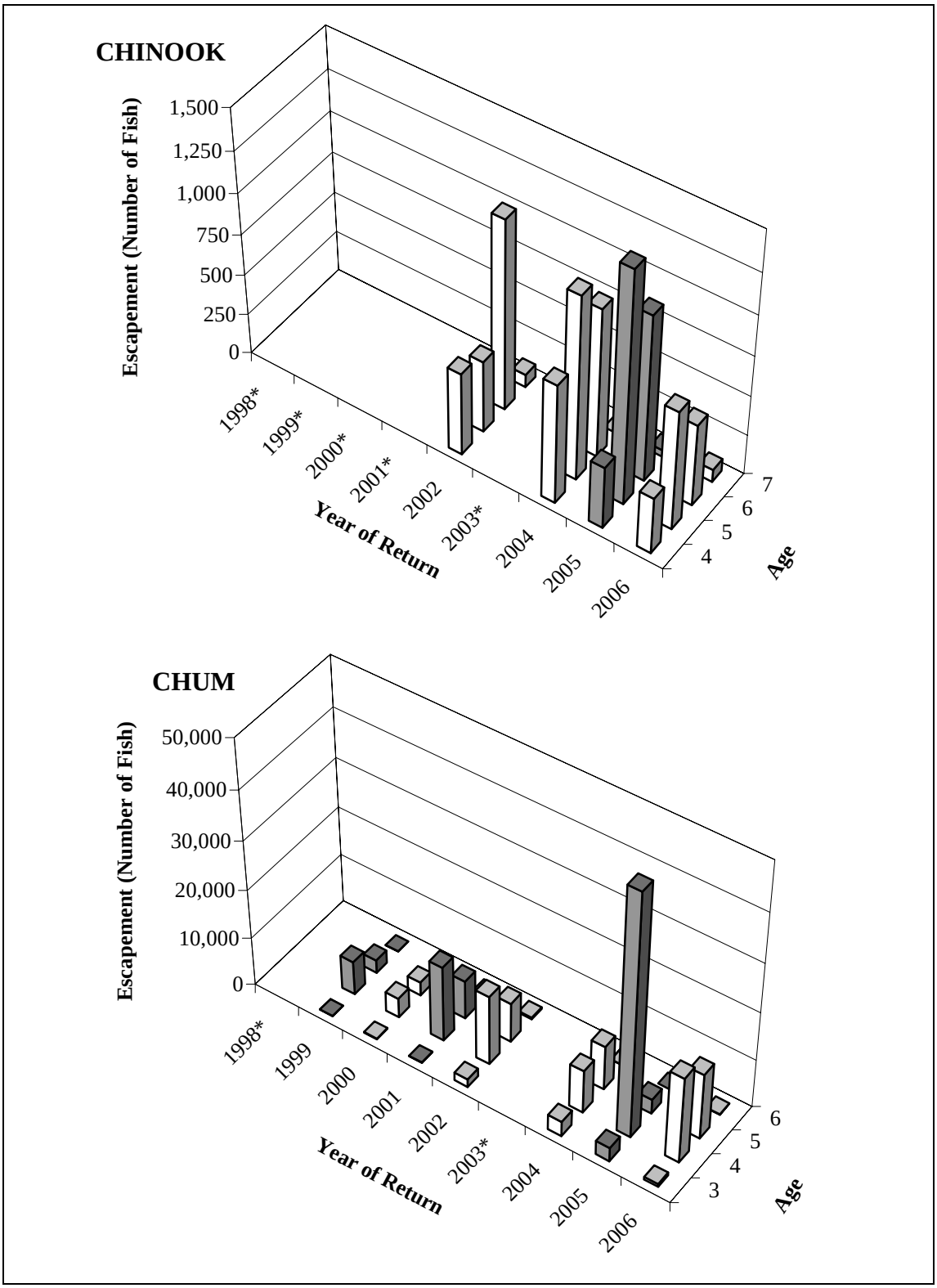
Note: The bar representing Tatlawiksuk River weir 2006 escapement is hatched because it includes 75% estimated escapement.

Figure 17.–Historical annual coho salmon escapement into 6 Kuskokwim River tributaries, 1991–2006.



Source: Linderman et al. *In prep*.

Figure 18.–Historical annual sockeye salmon escapement into 6 Kuskokwim River tributaries, 1991-2006.



Note: An asterisk (*) denotes incomplete sampling or escapement estimates.

Figure 19.–Historical Chinook and chum salmon age distribution for common ages at the Tatlawiksuk River weir.

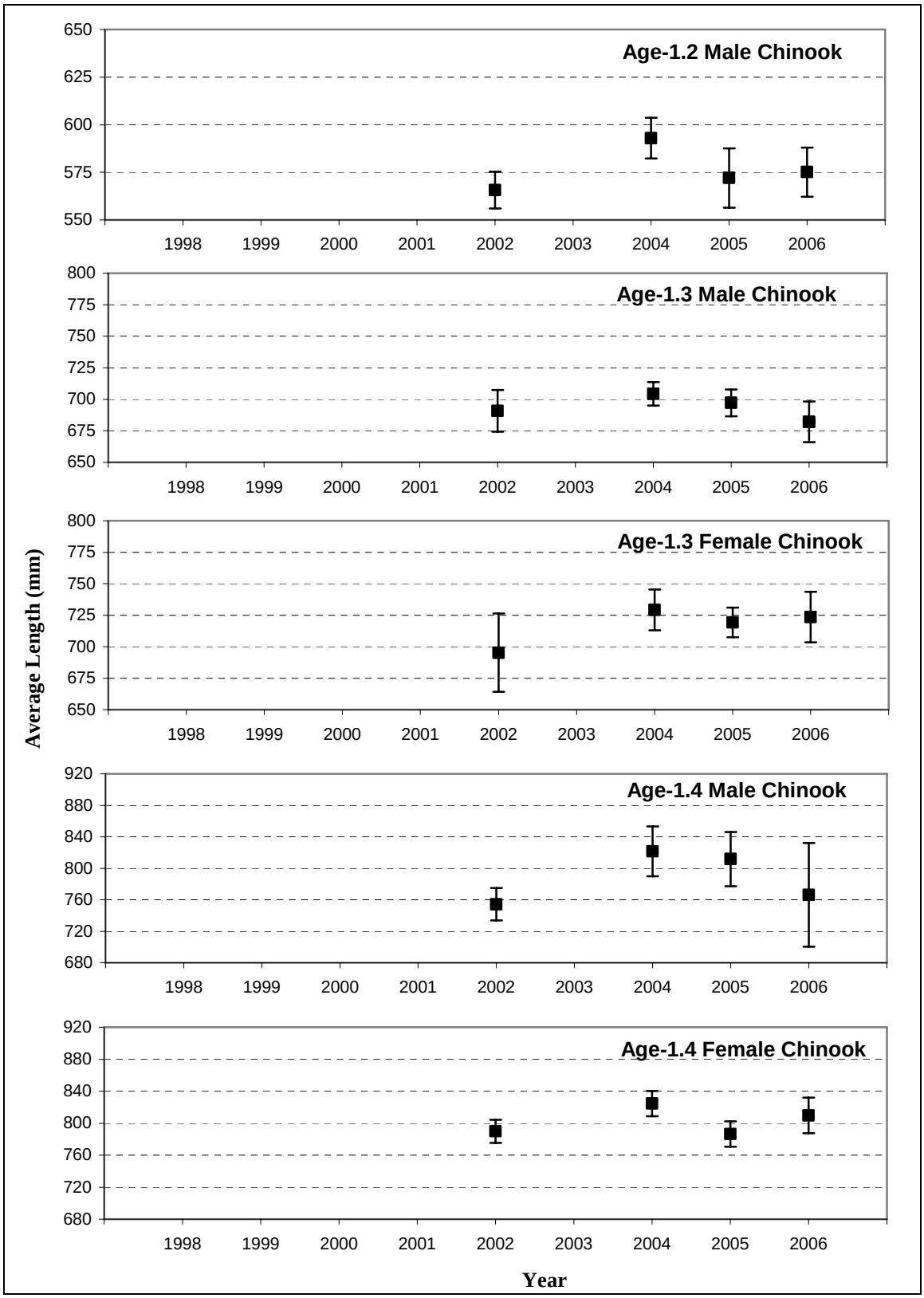


Figure 20.–Historical average annual length with 95% confidence intervals for Chinook salmon at the Tatlawiksuk River weir.

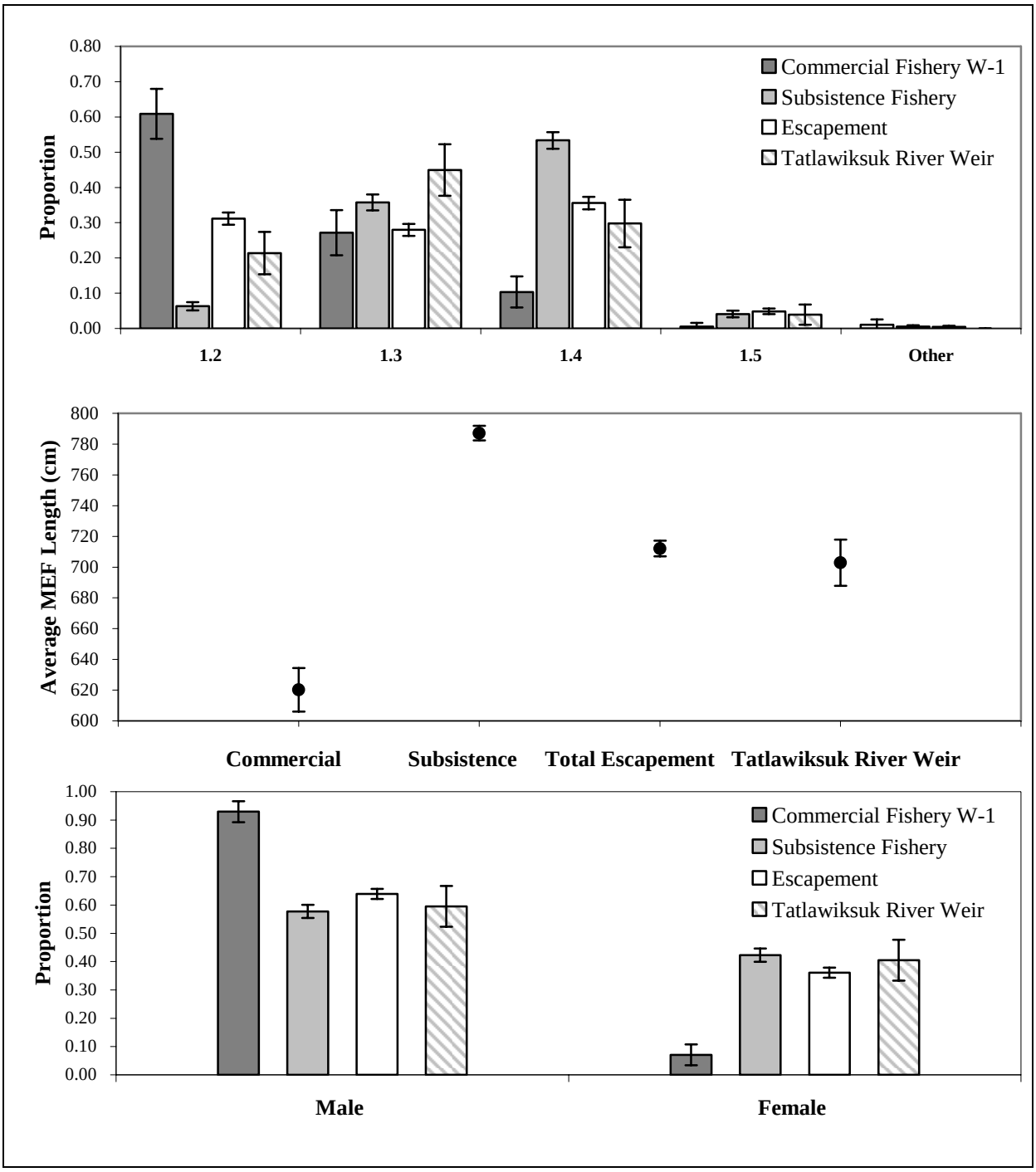


Figure 21.–ASL composition of the 2006 Kuskokwim River Chinook salmon commercial and subsistence harvests, total monitored escapement, and the Tatlawiksuk River weir (+/- 95% confidence interval).

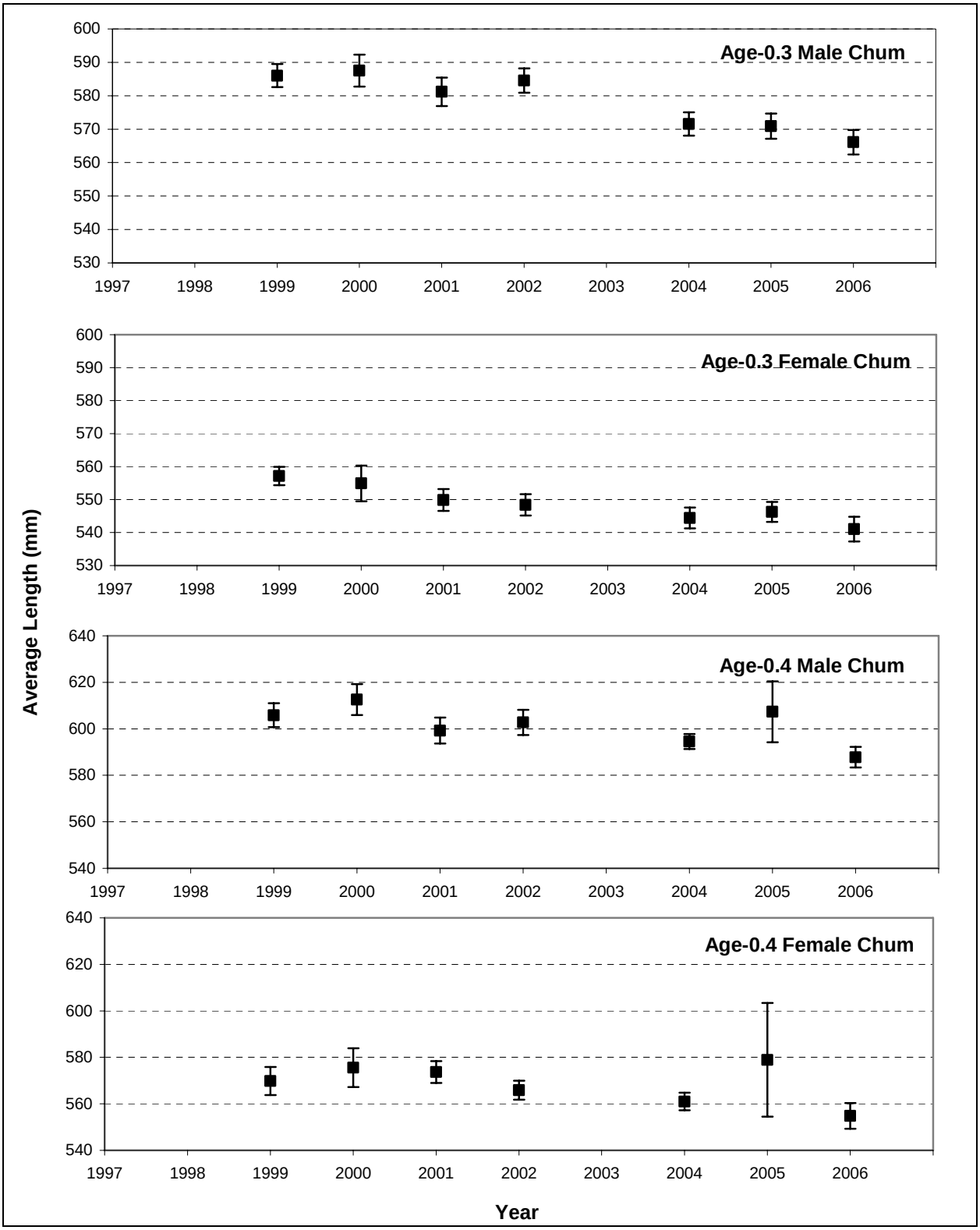
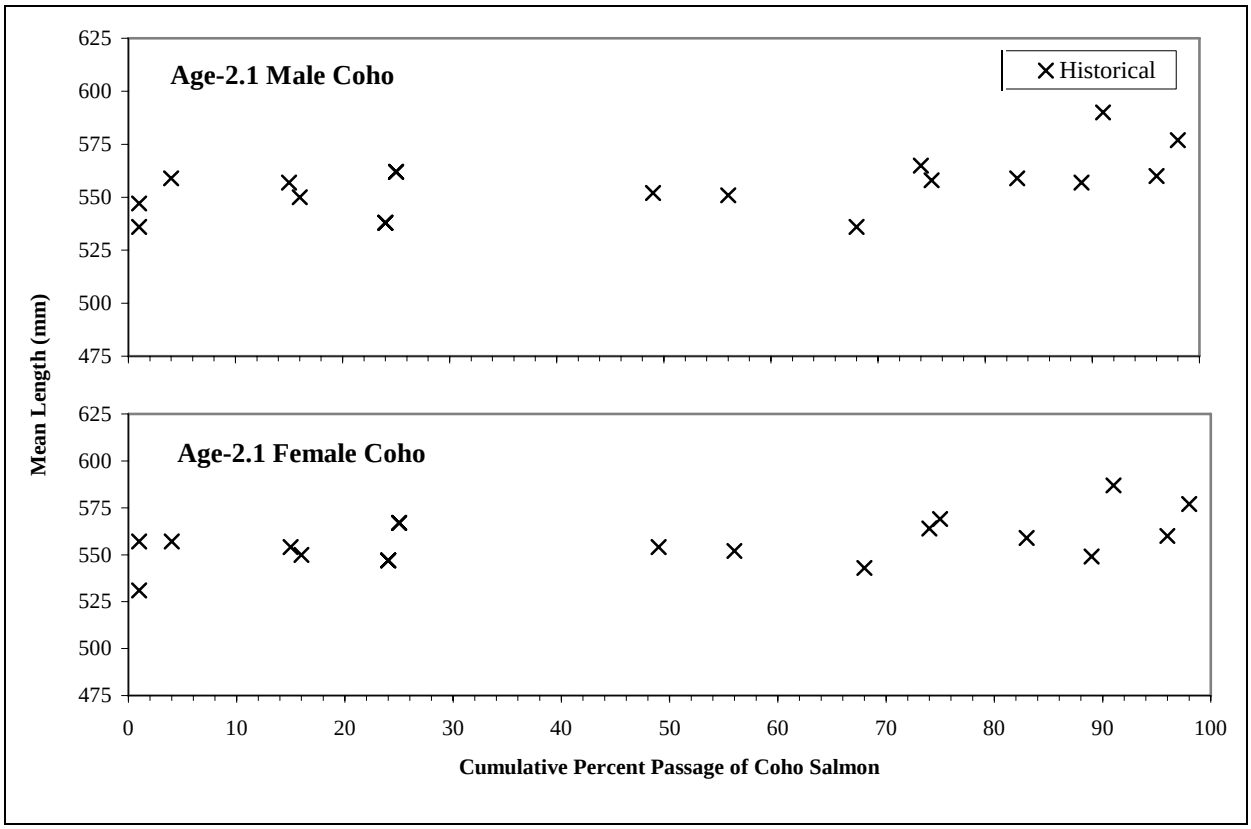
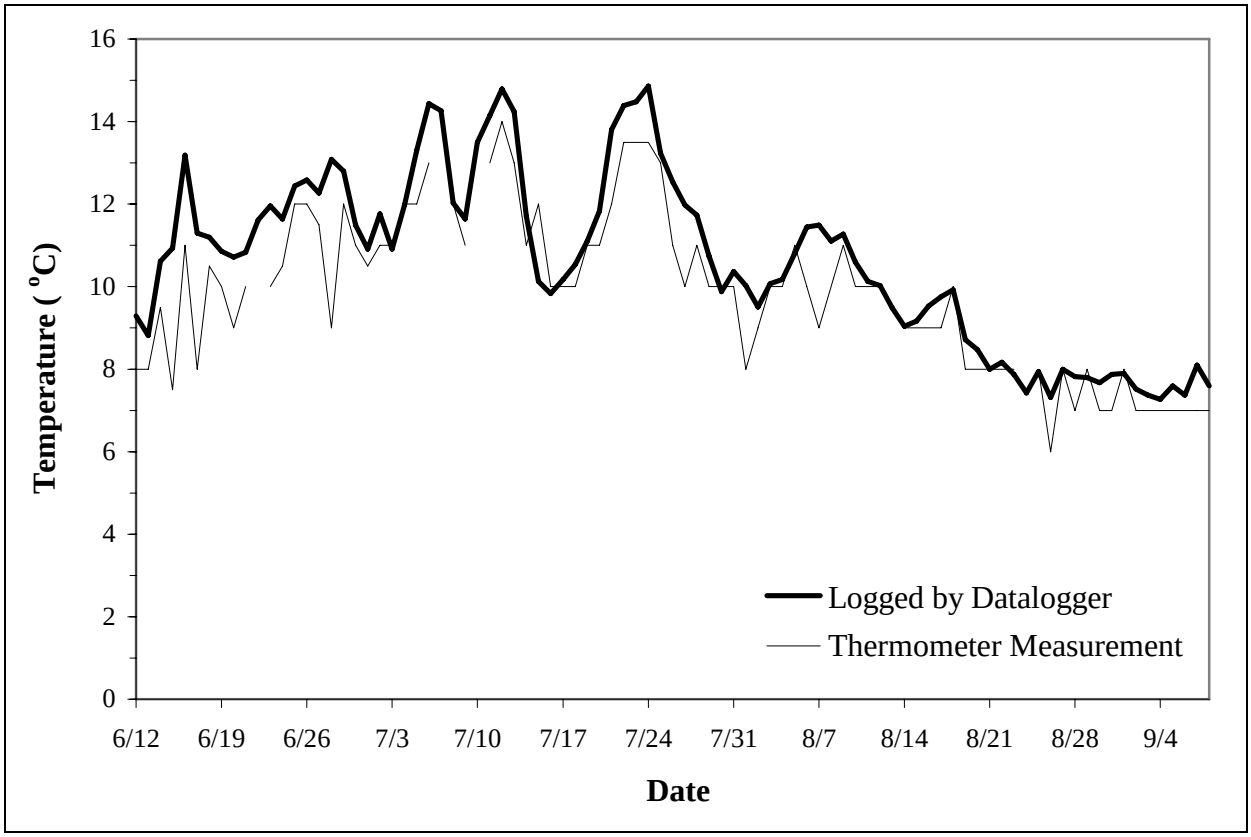


Figure 22.–Historical average annual length with 95% confidence intervals for chum salmon at the Tatlawiksuk River weir.



Note: Annual data from 2006 are not included because the ASL sample was not sufficient to estimate the length of coho salmon escapement.

Figure 23.–Historical intra-annual mean length-at-age of male and female coho salmon by cumulative percent passage at the Tatlawiksuk River weir.



Note: Observed water temperature measured using a thermometer was compared only with data logger readings from approximately the same time.

Figure 24.–Daily morning water temperature logged by the data logger compared to daily morning water temperature determined using a thermometer at the Tatlawiksuk River weir in 2006.

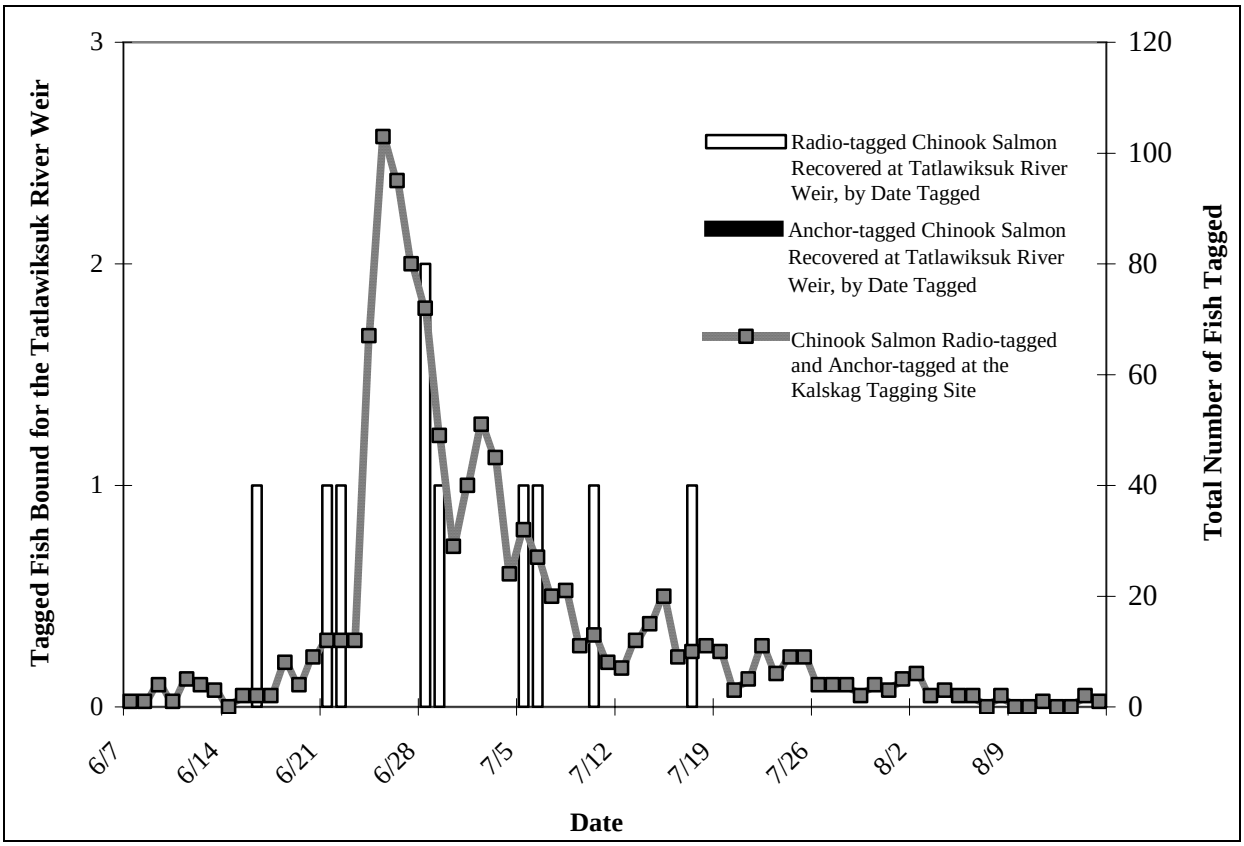
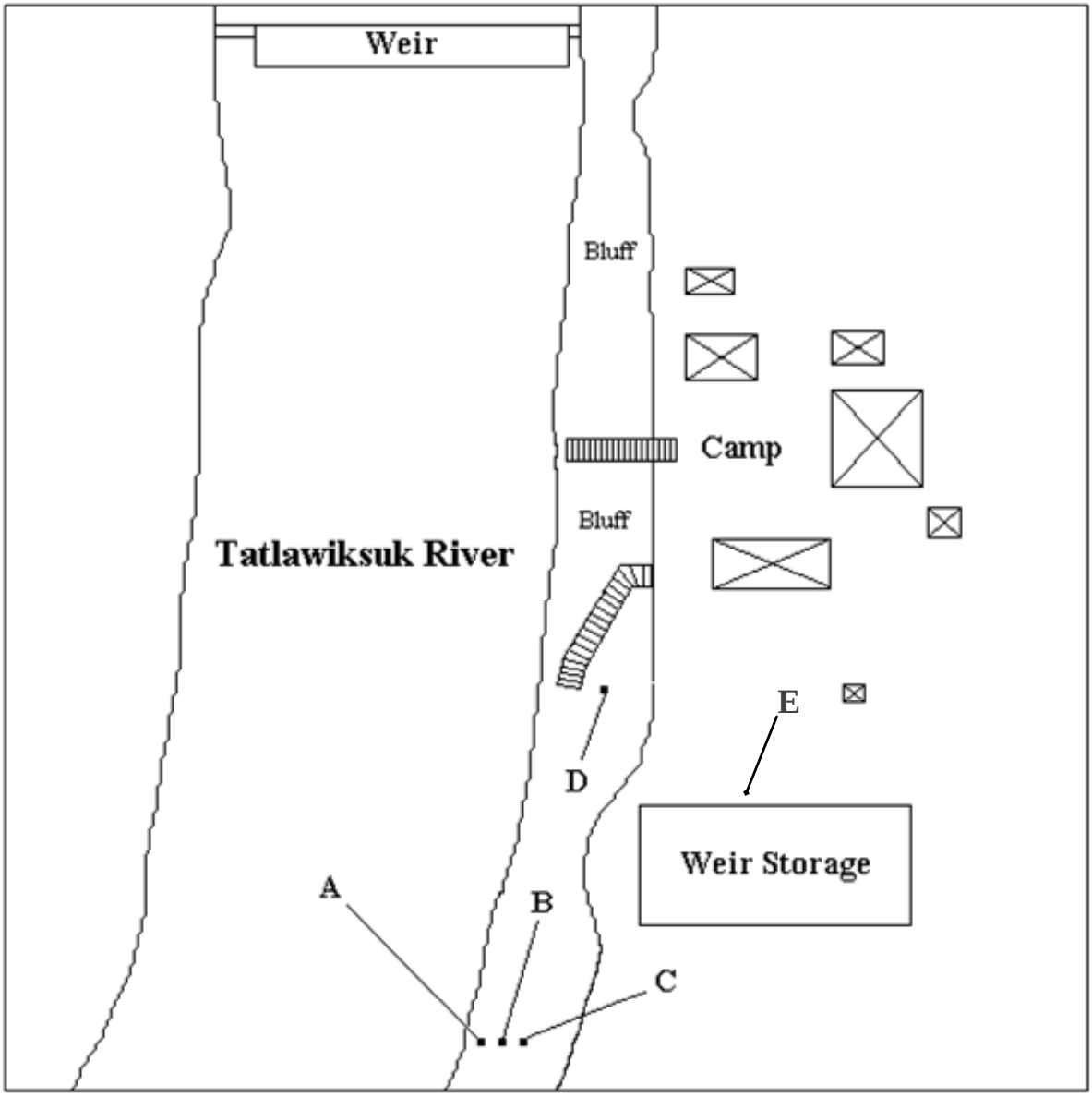


Figure 25.–Chinook salmon captured and tagged at the Kalskag tagging sites, by date, compared to Chinook salmon recovered at the Tatlawiksuk River weir, by date tagged, 2006.

APPENDIX A. STREAM HEIGHT BENCHMARK

Appendix A1.–Locations and descriptions of stream height benchmarks at the Tawiksuk River weir.



Descriptions:

A: Benchmark 1 – Set in 1999 and represented a stream height of 70 cm. This benchmark was washed out in September of 2000.

B: Benchmark 2 – Set in 1999 and represented a stream height of 115 cm. This benchmark was washed out in September of 2000.

C: Benchmark 3 – Set in 1999 and represents a stream height of 170 cm. This benchmark was in place as of 2005. It consists of two 4-ft long sections of ¾-in aluminum pipe, driven into the bank, one vertically and one horizontally, with the top few inches exposed.

D: Benchmark 4 – Set in 2001 and represents a stream height of 204 cm. This benchmark was not found in 2004.

E: Benchmark 5 – Set in 2005 and represents a stream height of 300 cm. This benchmark consists of a can lid nailed to the flat surface of a sawed-off stump. The can lid is inscribed with "BM 300 cm," and is located near the weir panel rack, on the upstream side.

Appendix A2.–Photograph illustrating the location of the stream height benchmark currently used.

APPENDIX B. HISTORICAL SALMON PASSAGE AT THE TATLAWIKSUK RIVER WEIR

Appendix B1.–Historical daily and cumulative Chinook salmon passage at the Tatlawiksuk River weir during the target operational period.

	Daily Passage									Cumulative Passage								
Date	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
6/15	0 [a]	0	0	0 [a]	0 [a]	0 [a]	2	0	0	0	0	0	0	0	0	2	0	0
6/16	0 [a]	0	0	0 [a]	0 [a]	0 [a]	2	0	0	0	0	0	0	0	0	4	0	0
6/17	0 [a]	0	0	0 [a]	0 [b]	0 [a]	0	0	0	0	0	0	0	0	0	4	0	0
6/18	0	0	2	0 [a]	0	0 [a]	4	1	0	0	0	2	0	0	0	8	1	0
6/19	0	0	2	0 [a]	0	0 [a]	8	1	0	0	0	4	0	0	0	16	2	0
6/20	1	0	0	0	0	0	3	1	0	1	0	4	0	0	0	19	3	0
6/21	0	0	0	1	1	0	2	6	0	1	0	4	1	1	0	21	9	0
6/22	0	0	1	2	19	6	1	7	0	1	0	5	3	20	6	22	16	0
6/23	8	4	0	1	67	0	0	3	0	9	4	5	4	87	6	22	19	0
6/24	12	2	10	3	3	5	11	6	0	21	6	15	7	90	11	33	25	0
6/25	7	2	0	5	2	13	74	5	1	28	8	15	12	92	24	107	30	1
6/26	12	6	20	71	8	19	241	27	3	40	14	35	83	100	43	348	57	4
6/27	37	4	2	18	517	3	21	10	22	77	18	37	101	617	46	369	67	26
6/28	31	14	5	38	21	152	84	5	3	108	32	42	139	638	198	453	72	29
6/29	23	5	2	15	195	297	75	5	4	131	37	44	154	833	495	528	77	33
6/30	5	2	22	105	25	57	43	192	42	136	39	66	259	858	552	571	269	75
7/1	99	16	26	364	15	41	315	24	23	235	55	92	623	873	593	886	293	98
7/2	182	5	149	24	84	8	131	74	21	417	60	241	647	957	601	1,017	367	119
7/3	171	13	47	27	108	96 [a]	86	481	5	588	73	288	674	1,065	697	1,103	848	124
7/4	224	26	30	13	135	29 [a]	165	248	128	812	99	318	687	1,200	726	1,268	1,096	252
7/5	74	14	42	111	338	59 [a]	243	239 [b]	47	886	113	360	798	1,538	786	1,511	1,335	299
7/6	62	15	17	428	64	42 [a]	7	87	187	948	128	377	1,226	1,602	827	1,518	1,422	486
7/7	22 [c]	14	18	170	145	13 [a]	84	140	35	970	142	395	1,396	1,747	841	1,602	1,562	521
7/8	[d]	13	13	21	10	27 [a]	106	98	78		155	408	1,417	1,757	868	1,708	1,660	599
7/9	[d]	21	73	29	24	129 [a]	229	112	228		176	481	1,446	1,781	997	1,937	1,772	827
7/10	[d]	40	51	29	27	35 [a]	165	95	146		216	532	1,475	1,808	1,033	2,102	1,867	973
7/11	[d]	79 [b]	45	14	48	35 [a]	43	143	46		295	577	1,489	1,856	1,068	2,145	2,010	1,019
7/12	[d]	118	50	48	19	34 [a]	16	101	111		413	627	1,537	1,875	1,102	2,161	2,111	1,130
7/13	[d]	54	9	150	20	88 [a]	98	86	59		467	636	1,687	1,895	1,190	2,259	2,197	1,189
7/14	[d]	64	0	48	21	65 [a]	29	123	52		531	636	1,735	1,916	1,255	2,288	2,320	1,241
7/15	[d]	24	8	47	103	38 [a]	31	35	41		555	644	1,782	2,019	1,293	2,319	2,355	1,282
7/16	[d]	65	20	12	10	28 [a]	47	96	36		620	664	1,794	2,029	1,321	2,366	2,451	1,318
7/17	[d]	6	47	19	15	18 [a]	161	70	23		626	711	1,813	2,044	1,339	2,527	2,521	1,341
7/18	[d]	146	5	31	3	22 [a]	53	65	65		772	716	1,844	2,047	1,361	2,580	2,586	1,406
7/19	[d]	20	8	36	15	30 [a]	17	80	52		792	724	1,880	2,062	1,390	2,597	2,666	1,458

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Appendix B1.–Page 2 of 3.

	Daily Passage									Cumulative Passage								
Date	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
7/20	[d]	381	10	17	8	72 [a]	12	52	29		1,173	734	1,897	2,070	1,462	2,609	2,718	1,487
7/21	[d]	18	2	8	14	9 [a]	22	36	24		1,191	736	1,905	2,084	1,471	2,631	2,754	1,511
7/22	[d]	9	16	21	29	15 [a]	21	24	15		1,200	752	1,926	2,113	1,486	2,652	2,778	1,526
7/23	[d]	86	7	11	13	17 [a]	26	10	29		1,286	759	1,937	2,126	1,503	2,678	2,788	1,555
7/24	[d]	46	5	13 [e]	7	25 [a]	19	15	21		1,332	764	1,950	2,133	1,528	2,697	2,803	1,576
7/25	[d]	33	8	9 [e]	18	16 [a]	13	11	10		1,365	772	1,959	2,151	1,544	2,710	2,814	1,586
7/26	[d]	18	2	6	4	14 [a]	14	11	5		1,383	774	1,965	2,155	1,558	2,724	2,825	1,591
7/27	[d]	14 [e]	3	5 [e]	24	14 [a]	26	5	20		1,397	777	1,970	2,179	1,572	2,750	2,830	1,611
7/28	[d]	10	1	2	20	16 [a]	19	12	8		1,407	778	1,972	2,199	1,588	2,769	2,842	1,619
7/29	[d]	22	1	8	10	13 [a]	9	14	17		1,429	779	1,980	2,209	1,602	2,778	2,856	1,636
7/30	[d]	15	6	3	5	8 [a]	2	12	11		1,444	785	1,983	2,214	1,610	2,780	2,868	1,647
7/31	[d]	6	1	5 [d]	6	16 [a]	15	8	10		1,450	786	1,988	2,220	1,627	2,795	2,876	1,657
8/1	[d]	6	2	4 [a]	1	6 [a]	0	3	11		1,456	788	1,992	2,221	1,632	2,795	2,879	1,668
8/2	[d]	1	3 [a]	3 [a]	5	8 [a]	1	7	8		1,457	791	1,995	2,226	1,640	2,796	2,886	1,676
8/3	[d]	4	8	2 [d]	0	6 [a]	2	5	5		1,461	799	1,997	2,226	1,646	2,798	2,891	1,681
8/4	[d]	3	2	2	1	2 [a]	4	0	3		1,464	801	1,999	2,227	1,648	2,802	2,891	1,684
8/5	[d]	5	0	1	0	2 [a]	6	7	2		1,469	801	2,000	2,227	1,650	2,808	2,898	1,686
8/6	[d]	3	1	1	0	4 [a]	5	2	6		1,472	802	2,001	2,227	1,653	2,813	2,900	1,692
8/7	[d]	2	1	2	1	2 [a]	3	3 [e]	4		1,474	803	2,003	2,228	1,656	2,816	2,903	1,696
8/8	[d]	4	3	2	0	2 [a]	4	2	2		1,478	806	2,005	2,228	1,658	2,820	2,905	1,698
8/9	[d]	0	1	0	1	2 [a]	0	0	1		1,478	807	2,005	2,229	1,660	2,820	2,905	1,699
8/10	[d]	1 [a]	1	1	0	2 [a]	2	0	1		1,479	808	2,006	2,229	1,661	2,822	2,905	1,700
8/11	[d]	1 [a]	1	0	0	1 [a]	3	0	0		1,480	809	2,006	2,229	1,662	2,825	2,905	1,700
8/12	[d]	1 [a]	0	2	1	3 [a]	0	0	0		1,481	809	2,008	2,230	1,665	2,825	2,905	1,700
8/13	[d]	1 [a]	1	1	0	3 [a]	1	1	0		1,482	810	2,009	2,230	1,668	2,826	2,906	1,700
8/14	[d]	1 [a]	2 [c]	0	0	2 [a]	0	1	0		1,483	812	2,009	2,230	1,670	2,826	2,907	1,700
8/15	[d]	1 [a]	1 [a]	0	2	1 [a]	0	2	0		1,484	814	2,009	2,232	1,671	2,826	2,909	1,700
8/16	[d]	1 [a]	1 [a]	0	0	1 [a]	1	1	0		1,485	814	2,009	2,232	1,673	2,827	2,910	1,700
8/17	[d]	1 [a]	0 [a]	0 [a]	0	1 [a]	0	0	0		1,486	814	2,009	2,232	1,674	2,827	2,910	1,700
8/18	[d]	1 [a]	0 [a]	0 [a]	0	1 [a]	0	1	0		1,487	815	2,009	2,232	1,675	2,827	2,911	1,700
8/19	[d]	1 [a]	1 [a]	0 [a]	1	1 [a]	0	0	0 [a]			815	2,009	2,233	1,676	2,827	2,911	1,700
8/20	[d]	0 [a]	0 [a]	0 [a]	0	2 [a]	0	1	0 [a]		1,488	815	2,009	2,233	1,678	2,827	2,912	1,700
8/21	[d]	0 [a]	0 [a]	0 [a]	1	1 [a]	3	0	0 [a]		1,488	815	2,009	2,234	1,679	2,830	2,912	1,700
8/22	[d]	0 [a]	1 [a]	0 [a]	0	1 [a]	1	0	0 [a]		1,488	816	2,009	2,234	1,680	2,831	2,914	1,700
8/23	[d]	0	0 [a]	0 [a]	0	1 [a]	0	1	0 [a]		1,488	816	2,009	2,234	1,681	2,831	2,915	1,700
											1,488							

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Appendix B1.–Page 3 of 3.

	Daily Passage									Cumulative Passage								
Date	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
8/24	[d]	1	0 [a]	0 [a]	0	0 [a]	0	1	0 [a]			816	2,009	2,234	1,681	2,831	2,916	1,700
8/25	[d]	0 [e]	1 [a]	0 [a]	0	0 [a]	0	1	0 [a]	1,489		817	2,009	2,234	1,682	2,831	2,917	1,700
8/26	[d]	0	0 [a]	1 [b]	0	0 [a]	0	1	0 [a]	1,489		817	2,010	2,234	1,682	2,831	2,918	1,700
8/27	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,489		817	2,010	2,234	1,682	2,831	2,918	1,700
8/28	[d]	0	0 [a]	0	0	0 [a]	1	0	0 [a]	1,489		817	2,010	2,234	1,682	2,832	2,918	1,700
8/29	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,489		817	2,010	2,234	1,682	2,832	2,918	1,700
8/30	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,489		817	2,010	2,234	1,682	2,832	2,918	1,700
8/31	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,489		817	2,010	2,234	1,682	2,832	2,918	1,700
9/1	[d]	1	0 [a]	0	0	0 [a]	1	0	0 [a]	1,489		817	2,010	2,234	1,682	2,833	2,918	1,700
9/2	[d]	0	0 [a]	0	1	0 [a]	0	0	0 [a]	1,490		817	2,010	2,235	1,682	2,833	2,918	1,700
9/3	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,490		817	2,010	2,235	1,683	2,833	2,918	1,700
9/4	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,490		817	2,010	2,235	1,683	2,833	2,918	1,700
9/5	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,490		817	2,010	2,235	1,683	2,833	2,918	1,700
9/6	[d]	0	0 [a]	0	1	0 [a]	0	0	0 [a]	1,490		817	2,010	2,236	1,683	2,833	2,918	1,700
9/7	[d]	0	0 [a]	0	0	0 [a]	0	0	0 [a]	1,490		817	2,010	2,236	1,683	2,833	2,918	1,700
9/8	[d]	0	0 [a]	0	1	0 [a]	0	0	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/9	[d]	0	0 [a]	0	0	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/10	[d]	0	0 [a]	0	0	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/11	[d]	0	0 [a]	0	0 [b]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/12	[d]	0	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/13	[d]	0	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/14	[d]	0	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/15	[d]	0	0 [a]	0 [a]	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/16	[d]	0	0 [a]	0 [a]	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/17	[d]	0	0 [a]	0 [a]	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/18	[d]	0	0 [a]	0 [a]	0 [a]	0 [a]	0	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/19	[d]	0	0 [a]	0 [a]	0 [a]	0 [a]	[d]	0 [a]	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
9/20	[d]	0	0 [a]	0 [a]	0 [b]	0 [a]	[d]	0	0 [a]	1,490		817	2,010	2,237	1,683	2,833	2,918	1,700
										1,490								

[a] The weir was not operational; daily passage was estimated.

[b] Partial day count; passage was estimated.

[c] Partial day count; passage was not estimated.

[d] The weir was not operational; daily passage was not estimated.

[e] Daily passage was estimated due to the occurrence of a hole in the weir.

Appendix B2.–Historical daily and cumulative chum salmon passage at the Tatlawiksuk River weir during the target operational period.

	Daily Passage									Cumulative Passage								
Date	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
6/15	0 [a]	0	1	0 [a]	1 [a]	[c]	9	0	0	0	0	1	0	1		9	0	0
6/16	0 [a]	0	1	0 [a]	2 [a]	[c]	15	3	0	0	0	2	0	3		24	3	0
6/17	0 [a]	0	0	0 [a]	4 [b]	[c]	7	0	0	0	0	2	0	7		31	3	0
6/18	0	0	2	0 [a]	2	[c]	22	2	3	0	0	4	0	9		53	5	3
6/19	0	0	0	0 [a]	6	[c]	75	10	0	0	0	4	0	15		128	15	3
6/20	0	0	0	0	3	0	105	4	0	0	0	4	0	18	0	233	19	3
6/21	5	0	2	3	42	0	53	9	3	5	0	6	3	60	0	286	28	6
6/22	4	0	7	4	168	1	81	13	12	9	0	13	7	228	1	367	41	18
6/23	12	0	1	30	262	5	71	7	58	21	0	14	37	490	6	438	48	76
6/24	25	18	18	22	28	6	169	32	115	46	18	32	59	518	12	607	80	191
6/25	26	7	30	61	103	4	594	15	234	72	25	62	120	621	16	1,201	95	425
6/26	65	18	97	131	483	12	450	36	265	137	43	159	251	1,104	28	1,651	131	690
6/27	197	25	7	69	392	20	175	43	441	334	68	166	320	1,496	48	1,826	174	1,131
6/28	275	67	10	143	574	106	176	56	267	609	135	176	463	2,070	154	2,002	230	1,398
6/29	195	67	3	133	834	71	266	130	464	804	202	179	596	2,904	225	2,268	360	1,862
6/30	146	58	88	368	634	135	378	366	1,369	950	260	267	964	3,538	360	2,646	726	3,231
7/1	464	91	176	440	424	78	462	213	458	1,414	351	443	1,404	3,962	438	3,108	939	3,689
7/2	529	86	492	143	1,037	41	690	1,605	208	1,943	437	935	1,547	4,999	479	3,798	2,544	3,897
7/3	556	101	280	171	501	[c]	660	2,380	764	2,499	538	1,215	1,718	5,500		4,458	4,924	4,661
7/4	1,005	110	147	162	759	[c]	525	1,110	2,190	3,504	648	1,362	1,880	6,259		4,983	6,034	6,851
7/5	1,011	94	325	488	1,278	[c]	482	1,387 [d]	347	4,515	742	1,687	2,368	7,537		5,465	7,421	7,198
7/6	757	141	155	618	1,762	[c]	235	993	1,109	5,272	883	1,842	2,986	9,299		5,700	8,414	8,307
7/7	454 [e]	171	175	778	809	[c]	638	1,063	745	5,726	1,054	2,017	3,764	10,108		6,338	9,477	9,052
7/8	[c]	158	109	900	666	[c]	811	1,439	845		1,212	2,126	4,664	10,774		7,149	10,916	9,897
7/9	[c]	324	462	1,061	840	[c]	836	1,748	2,141		1,536	2,588	5,725	11,614		7,985	12,664	12,038
7/10	[c]	391	247	1,399	828	[c]	627	1,546	1,791		1,927	2,835	7,124	12,442		8,612	14,210	13,829
7/11	[c]	404 [d]	391	596	1,238	[c]	425	2,741	1,018		2,331	3,226	7,720	13,680		9,037	16,951	14,847
7/12	[c]	416	611	1,179	869	[c]	502	2,775	1,365		2,747	3,837	8,899	14,549		9,539	19,726	16,212
7/13	[c]	280	169	1,199	702	[c]	967	2,610	1,003		3,027	4,006	10,098	15,251		10,506	22,336	17,215
7/14	[c]	361	33	1,301	707	[c]	759	3,095	504		3,388	4,039	11,399	15,958		11,265	25,431	17,719
7/15	[c]	268	266	1,330	1,123	[c]	642	2,780	491		3,656	4,305	12,729	17,081		11,907	28,211	18,210
7/16	[c]	377	367	1,092	677	[c]	829	3,283	929		4,033	4,672	13,821	17,758		12,736	31,494	19,139
7/17	[c]	339	257	1,201	959	[c]	863	2,370	979		4,372	4,929	15,022	18,717		13,599	33,864	20,118
7/18	[c]	404	183	1,607	880	[c]	800	2,260	799		4,776	5,112	16,629	19,597		14,399	36,124	20,917
7/19	[c]	160	144	859	707	[c]	655	2,115	1,059		4,936	5,256	17,488	20,304		15,054	38,239	21,976

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Appendix B2.–Page 2 of 3.

	Daily Passage									Cumulative Passage								
Date	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
7/20	[c]	663	88	699	468	[c]	573	2,156	1,106		5,599	5,344	18,187	20,772		15,627	40,395	23,082
7/21	[c]	306	176	761	504	[c]	557	2,196	1,215		5,905	5,520	18,948	21,276		16,184	42,591	24,297
7/22	[c]	275	238	650	515	[c]	495	1,422	924		6,180	5,758	19,598	21,791		16,679	44,013	25,221
7/23	[c]	628	158	614	409	[c]	513	1,491	962		6,808	5,916	20,212	22,200		17,192	45,504	26,183
7/24	[c]	322	152	511 [b]	251	[c]	463	1,152	755		7,130	6,068	20,723	22,451		17,655	46,656	26,938
7/25	[c]	338	114	391 [b]	206	[c]	474	1,138	734		7,468	6,182	21,114	22,657		18,129	47,794	27,672
7/26	[c]	205	85	270	195	[c]	359	1,144	612		7,673	6,267	21,384	22,852		18,488	48,938	28,284
7/27	[c]	214 [d]	122	206 [b]	301	[c]	421	794	503		7,886	6,389	21,590	23,153		18,909	49,732	28,787
7/28	[c]	222	93	169	224	[c]	344	807	543		8,108	6,482	21,759	23,377		19,253	50,539	29,330
7/29	[c]	130	94	178	159	[c]	304	732	597		8,238	6,576	21,937	23,536		19,557	51,271	29,927
7/30	[c]	285	141	230	144	[c]	123	680	578		8,523	6,717	22,167	23,680		19,680	51,951	30,505
7/31	[c]	141	72	190 [b]	119	[c]	322	587	378		8,664	6,789	22,357	23,799		20,002	52,538	30,883
8/1	[c]	171	41	176 [a]	99	[c]	151	344	232		8,835	6,830	22,533	23,898		20,153	52,882	31,115
8/2	[c]	125	37 [a]	163 [a]	59	[c]	124	440	216		8,960	6,867	22,696	23,957		20,277	53,322	31,331
8/3	[c]	141	18	149 [b]	54	[c]	85	486	124		9,101	6,885	22,845	24,011		20,362	53,808	31,455
8/4	[c]	60	15	131	64	[c]	93	266	104		9,161	6,900	22,976	24,075		20,455	54,074	31,559
8/5	[c]	57	8	139	98	[c]	117	265	72		9,218	6,908	23,115	24,173		20,572	54,339	31,631
8/6	[c]	35	9	96	44	[c]	87	227	115		9,253	6,917	23,211	24,217		20,659	54,566	31,746
8/7	[c]	43	12	95	55	[c]	99	196 [d]	101		9,296	6,929	23,306	24,272		20,758	54,761	31,847
8/8	[c]	24	5	62	72	[c]	134	122	73		9,320	6,934	23,368	24,344		20,892	54,883	31,920
8/9	[c]	42	2	69	30	[c]	43	168	108		9,362	6,936	23,437	24,374		20,935	55,051	32,028
8/10	[c]	30 [a]	5	36	37	[c]	44	105	22		9,392	6,941	23,473	24,411		20,979	55,156	32,050
8/11	[c]	28 [a]	7	38	22	[c]	45	62	88		9,420	6,948	23,511	24,433		21,024	55,218	32,138
8/12	[c]	26 [a]	8	38	25	[c]	26	93	33		9,446	6,956	23,549	24,458		21,050	55,311	32,171
8/13	[c]	24 [a]	9	27	13	[c]	13	63	21		9,470	6,965	23,576	24,471		21,063	55,374	32,192
8/14	[c]	22 [a]	10 [b]	19	5	[c]	22	59	3		9,492	6,975	23,595	24,476		21,085	55,433	32,195
8/15	[c]	20 [a]	4 [a]	23	13	[c]	19	55	1		9,512	6,979	23,618	24,489		21,104	55,488	32,196
8/16	[c]	17 [a]	4 [a]	8	8	[c]	14	44	4		9,529	6,983	23,626	24,497		21,118	55,532	32,200
8/17	[c]	15 [a]	4 [a]	14 [a]	8	[c]	7	16	10		9,544	6,987	23,640	24,505		21,125	55,548	32,210
8/18	[c]	13 [a]	2 [a]	13 [a]	15	[c]	5	28	4		9,557	6,989	23,653	24,520		21,130	55,576	32,214
8/19	[c]	11 [a]	6 [a]	12 [a]	1	[c]	14	19	17 [a]			6,995	23,665	24,521		21,144	55,595	32,231
8/20	[c]	9 [a]	14 [a]	11 [a]	2	[c]	20	6	11 [a]		9,568	7,009	23,675	24,523		21,164	55,601	32,242
8/21	[c]	7 [a]	8 [a]	9 [a]	1	[c]	9	12	11 [a]		9,577	7,017	23,684	24,524		21,173	55,613	32,252
8/22	[c]	4 [a]	0 [a]	8 [a]	2	[c]	12	33	20 [a]		9,584	7,017	23,692	24,526		21,185	55,646	32,272
8/23	[c]	1 [a]	2 [a]	7 [a]	0	[c]	9	17	1 [a]		9,588	7,019	23,699	24,526		21,194	55,663	32,273
											9,589							

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Appendix B2.–Page 3 of 3.

	Daily Passage									Cumulative Passage								
Date	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
8/24	[c]	1	0 [a]	6 [a]	2	[c]	4	13	3 [a]			7,019	23,705	24,528		21,198	55,676	32,276
8/25	[c]	0	6 [a]	4 [a]	2	[c]	7	1	1 [a]		9,590	7,025	23,709	24,530		21,205	55,677	32,277
8/26	[c]	2 [d]	2 [a]	3 [a]	2	[c]	5	5	3 [a]		9,590	7,027	23,712	24,532		21,210	55,682	32,280
8/27	[c]	2	2 [a]	2 [b]	0	[c]	4	5	0 [a]		9,592	7,029	23,714	24,532		21,214	55,687	32,280
8/28	[c]	0	2 [a]	1	0	[c]	3	5	3 [a]		9,594	7,031	23,715	24,532		21,217	55,692	32,282
8/29	[c]	0	2 [a]	0	2	[c]	3	4	3 [a]		9,594	7,033	23,715	24,534		21,220	55,696	32,285
8/30	[c]	0	2 [a]	0	1	[c]	0	3	3 [a]		9,594	7,035	23,715	24,535		21,220	55,699	32,288
8/31	[c]	1	0 [a]	0	2	[c]	1	2	0 [a]		9,594	7,035	23,715	24,537		21,221	55,701	32,288
9/1	[c]	0	4 [a]	0	2	[c]	6	0	0 [a]		9,595	7,039	23,715	24,539		21,227	55,701	32,288
9/2	[c]	1	0 [a]	2	1	[c]	0	1	3 [a]		9,595	7,039	23,717	24,540		21,227	55,702	32,290
9/3	[c]	0	2 [a]	1	0	[c]	2	1	1 [a]		9,596	7,041	23,718	24,540		21,229	55,703	32,292
9/4	[c]	0	0 [a]	0	0	[c]	2	2	3 [a]		9,596	7,041	23,718	24,540		21,231	55,705	32,294
9/5	[c]	1	2 [a]	0	1	[c]	1	3	3 [a]		9,596	7,044	23,718	24,541		21,232	55,708	32,297
9/6	[c]	2	0 [a]	0	0	[c]	2	1	1 [a]		9,597	7,044	23,718	24,541		21,234	55,709	32,298
9/7	[c]	0	0 [a]	0	0	[c]	3	1	0 [a]		9,599	7,044	23,718	24,541		21,237	55,710	32,298
9/8	[c]	0	0 [a]	0	0	[c]	0	2	0 [a]		9,599	7,044	23,718	24,541		21,237	55,712	32,298
9/9	[c]	0	0 [a]	0	0	[c]	0	0	1 [a]		9,599	7,044	23,718	24,541		21,237	55,712	32,300
9/10	[c]	0	0 [a]	0	0	[c]	0	1 [a]	0 [a]		9,599	7,044	23,718	24,541		21,237	55,713	32,300
9/11	[c]	0	0 [a]	0	0	[c]	2	1 [a]	0 [a]		9,599	7,044	23,718	24,541		21,239	55,714	32,300
9/12	[c]	0	0 [a]	0	1 [b]	[c]	1	1 [a]	0 [a]		9,599	7,044	23,718	24,542		21,240	55,715	32,300
9/13	[c]	0	0 [a]	0	0 [a]	[c]	1	1 [a]	0 [a]		9,599	7,044	23,718	24,542		21,241	55,716	32,300
9/14	[c]	0	0 [a]	0	0 [a]	[c]	1	1 [a]	0 [a]		9,599	7,044	23,718	24,542		21,242	55,716	32,300
9/15	[c]	0	0 [a]	0	0 [a]	[c]	2	1 [a]	0 [a]		9,599	7,044	23,718	24,542		21,244	55,717	32,300
9/16	[c]	0	0 [a]	0 [a]	0 [a]	[c]	1	1 [a]	1 [a]		9,599	7,044	23,718	24,542		21,245	55,718	32,301
9/17	[c]	0	0 [a]	0 [a]	0 [a]	[c]	0	1 [a]	0 [a]		9,599	7,044	23,718	24,542		21,245	55,718	32,301
9/18	[c]	0	0 [a]	0 [a]	0 [a]	[c]	0	1 [a]	0 [a]		9,599	7,044	23,718	24,542		21,245	55,719	32,301
9/19	[c]	0	0 [a]	0 [a]	0 [a]	[c]	[c]	1 [a]	0 [a]	9,599	9,599	7,044	23,718	24,542			55,720	32,301
9/20	[c]	0	0 [a]	0 [a]	0 [b]	[c]	[c]	0	0 [a]		9,599	7,044	23,718	24,542			55,720	32,301

[a] The weir was not operational; daily passage was estimated.

[b] Partial day count; passage was estimated.

[c] The weir was not operational; daily passage was not estimated.

[d] Daily passage was estimated due to the occurrence of a hole in the weir.

[e] Partial day count; passage was not estimated.

Appendix B3.–Historical daily and cumulative coho salmon passage at the Tatlawiksuk River weir during the target operational period.

	Daily Passage								Cumulative Passage							
Date	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
6/15	0	0	0 [a]	0 [a]	[b]	0	0	0	0	0	0	0		0	0	0
6/16	0	0	0 [a]	0 [a]	[b]	0	0	0	0	0	0	0		0	0	0
6/17	0	0	0 [a]	0 [c]	[b]	0	0	0	0	0	0	0		0	0	0
6/18	0	0	0 [a]	0	[b]	0	0	0	0	0	0	0		0	0	0
6/19	0	0	0 [a]	0	[b]	0	0	0	0	0	0	0		0	0	0
6/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/4	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/5	0	0	0	0	[b]	0	0 [d]	0	0	0	0	0		0	0	0
7/6	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/7	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/8	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/9	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/10	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/11	0 [d]	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/12	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/13	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/14	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/15	0	0	0	0	[b]	0	0	0	0	0	0	0		0	0	0
7/16	0	0	0	0	[b]	0	0	1	0	0	0	0			0	1
7/17	0	0	0	0	[b]	0	0	0	0	0	0	0			0	1
7/18	0	0	0	0	[b]	0	1	0	0	0	0	0			1	1
7/19	0	2	0	0	[b]	0	0	1	0	2	0	0	0		1	2

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Appendix B3.–Page 2 of 3.

	Daily Passage								Cumulative Passage							
Date	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
7/20	0	0	0	0	[b]	1	0	9	0	2	0	0			1	11
7/21	0	1	0	0	[b]	0	0	17	0	3	0	0			1	28
7/22	0	0	0	0	[b]	3	2	14	0	3	0	0			3	42
7/23	0	0	0	0	[b]	6	1	4	0	3	0	0	1	10	4	46
7/24	0	1	0 [d]	0	[b]	7	6	9	0	4	0	0	1	17	10	55
7/25	1	0	0 [d]	0	[b]	3	8	2	1	4	0	0	4	20	18	57
7/26	0	0	0	0	[b]	19	16	2	1	4	0	0		39	34	59
7/27	1 [d]	0	0 [d]	3	[b]	31	21	7	2	4	0	3		70	55	66
7/28	2	3	1	3	[b]	22	16	16	4	7	1	6		92	71	82
7/29	9	2	0	3	[b]	18	19	26	13	9	1	9		110	90	108
7/30	1	25	8	8	[b]	15	37	30	14	34	9	17		125	127	138
7/31	1	11	18 [d]	3	[b]	106	38	57	15	45	27	20		231	165	195
8/1	0	40	29 [a]	5	[b]	55	20	52	15	85	56	25		286	185	247
8/2	0	110 [a]	42 [a]	11	[b]	93	29	50	15	195	98	36		379	214	297
8/3	0	172	54 [d]	16	[b]	98	70	39	15	367	152	52		477	284	336
8/4	0	215	42	4	[b]	128	36	55	15	582	194	56		605	320	391
8/5	2	173	91	33	[b]	214	36	47	17	755	285	89		819	356	438
8/6	0	129	47	23	[b]	452	51	152	17	884	332	112		1,271	407	590
8/7	5	277	74	46	[b]	468	80 [d]	75	22	1,161	406	158		1,739	487	665
8/8	1	108	135	43	[b]	437	60	57	23	1,269	541	201		2,176	547	722
8/9	1	267	130	79	[b]	497	172	79	24	1,536	671	280		2,673	719	801
8/10	3 [a]	619	264	73	[b]	536	118	41	27	2,155	935	353		3,209	837	842
8/11	5 [a]	730	212	63	[b]	450	101	54	32	2,885	1,147	416		3,659	938	896
8/12	2 [a]	1,123	306	437	[b]	722	91	102	33	4,008	1,453	853		4,381	1,029	998
8/13	9 [a]	1,429	314	787	[b]	534	73	231	42	5,437	1,767	1,640		4,915	1,102	1,229
8/14	12 [a]	319 [c]	864	240	[b]	646	167	176	54	5,756	2,631	1,880		5,561	1,269	1,405
8/15	13 [a]	[b]	530	220	[b]	628	82	260	67		3,161	2,100		6,189	1,351	1,665
8/16	27 [a]	[b]	860	345	[b]	515	71	190	94		4,021	2,445		6,704	1,422	1,855
8/17	36 [a]	[b]	652 [a]	53	[b]	575	277	282	129		4,673	2,498		7,279	1,699	2,137
8/18	44 [a]	[b]	610 [a]	349	[b]	591	162	225	173		5,283	2,847		7,870	1,861	2,362
8/19	26 [a]	[b]	567 [a]	27	[b]	716	125	76 [a]	199		5,850	2,874		8,586	1,986	2,438
8/20	71 [a]	[b]	525 [a]	28	[b]	395	118	73 [a]	270		6,375	2,902		8,981	2,104	2,512
8/21	73 [a]	[b]	482 [a]	1,199	[b]	708	111	657 [a]	343		6,856	4,101		9,689	2,215	3,169
8/22	32 [a]	[b]	439 [a]	420	[b]	825	80	251 [a]	375		7,296	4,521		10,514	2,295	3,420
8/23	71 [a]	[b]	397 [a]	1,347	[b]	679	757	1,056 [a]	446		7,692	5,868		11,193	3,052	4,475

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Appendix B3.–Page 3 of 3.

	Daily Passage								Cumulative Passage							
Date	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
8/24	103	[b]	354 [a]	1,027	[b]	473	881	957 [a]	549		8,046	6,895		11,666	3,933	5,433
8/25	88	[b]	311 [a]	542	[b]	638	277	411 [a]	637		8,358	7,437		12,304	4,210	5,843
8/26	93 [d]	[b]	269 [a]	750	[b]	266	199	476 [a]	730		8,626	8,187		12,570	4,409	6,320
8/27	97	[b]	226 [c]	354	[b]	304	194	275 [a]	827		8,853	8,541		12,874	4,603	6,595
8/28	181	[b]	185	345	[b]	259	177	262 [a]	1,008		9,038	8,886		13,133	4,780	6,856
8/29	171	[b]	182	106	[b]	246	226	167 [a]	1,179		9,220	8,992		13,379	5,006	7,023
8/30	93	[b]	204	52	[b]	238	162	107 [a]	1,272		9,424	9,044		13,617	5,168	7,130
8/31	184	[b]	176	368	[b]	284	211	290 [a]	1,456		9,600	9,412		13,901	5,379	7,421
9/1	239	[b]	64	409	[b]	507	72	241 [a]	1,695		9,664	9,821		14,408	5,451	7,662
9/2	170	[b]	87	225	[b]	260	92	159 [a]	1,865		9,751	10,046		14,668	5,543	7,821
9/3	140	[b]	107	92	[b]	281	52	72 [a]	2,005		9,858	10,138		14,949	5,595	7,894
9/4	190	[b]	88	182	[b]	183	323	253 [a]	2,195		9,946	10,320		15,132	5,918	8,147
9/5	193	[b]	80	201	[b]	88	264	233 [a]	2,388		10,026	10,521		15,220	6,182	8,380
9/6	103	[b]	33	79	[b]	137	164	122 [a]	2,491		10,059	10,600		15,357	6,346	8,502
9/7	30	[b]	43	253	[b]	117	108	181 [a]	2,521		10,102	10,853		15,474	6,454	8,683
9/8	35	[b]	55	40	[b]	134	159	100 [a]	2,556		10,157	10,893		15,608	6,613	8,783
9/9	53	[b]	38	62	[b]	119	92	77 [a]	2,609		10,195	10,955		15,727	6,705	8,860
9/10	303	[b]	13	54	[b]	123	117 [a]	86 [a]	2,912		10,208	11,009		15,850	6,821	8,946
9/11	81	[b]	61	53	[b]	149	108 [a]	81 [a]	2,993		10,269	11,062		15,999	6,929	9,027
9/12	81	[b]	29	51 [c]	[b]	95	99 [a]	75 [a]	3,074		10,298	11,113		16,094	7,029	9,102
9/13	99	[b]	30	45 [a]	[b]	114	90 [a]	68 [a]	3,173		10,328	11,158		16,208	7,119	9,170
9/14	82	[b]	38	40 [a]	[b]	85	82 [a]	61 [a]	3,255		10,366	11,198		16,293	7,201	9,231
9/15	51	[b]	56	36 [a]	[b]	68	73 [a]	54 [a]	3,306		10,422	11,234		16,361	7,274	9,285
9/16	26	[b]	39 [a]	31 [a]	[b]	19	64 [a]	48 [a]	3,332		10,461	11,265		16,380	7,338	9,333
9/17	32	[b]	31 [a]	27 [a]	[b]	23	55 [a]	41 [a]	3,364		10,492	11,292		16,403	7,393	9,374
9/18	18	[b]	24 [a]	22 [a]	[b]	7	47 [a]	35 [a]	3,382		10,516	11,314		16,410	7,439	9,409
9/19	56	[b]	16 [a]	18 [a]	[b]	0 [a]	38 [a]	8 [a]	3,438		10,531	11,332		16,410	7,477	9,437
9/20	17	[b]	8 [a]	13 [c]	[b]	0 [a]	18	16 [a]	3,455		10,539	11,345		16,410	7,495	9,453

[a] The weir was not operational; daily passage was estimated.
[b] The weir was not operational; daily passage was not estimated.
[c] Partial day count; passage was estimated.
[d] Daily passage was estimated due to the occurrence of a hole in the weir.

APPENDIX C. PASSAGE OF OTHER SPECIES

Appendix C1.–Daily passage of sockeye and pink salmon and non-salmon species observed at the Tatlawiksuk River weir, 2006.

Date	Sockeye Salmon	Pink Salmon	Longnose Sucker	Whitefish	Arctic Grayling	Northern Pike	Dolly Varden
6/15	0	0	47	1	0	0	0
6/16	0	0	270	3	0	0	0
6/17	0	0	176	6	0	0	0
6/18	0	0	144	0	0	0	0
6/19 [a]	0	0	0	0	0	0	0
6/20	0	0	2	0	0	0	0
6/21	0	0	136	0	0	0	1
6/22	0	0	152	0	0	0	0
6/23	0	0	171	1	0	0	0
6/24	0	0	26	7	0	0	3
6/25	0	0	21	8	0	0	0
6/26	0	0	30	5	0	0	0
6/27	0	0	17	16	0	0	0
6/28	0	0	6	2	1	2	0
6/29	0	0	24	2	0	0	0
6/30	0	0	7	1	0	0	0
7/1	0	0	3	0	0	0	0
7/2	0	0	7	0	0	0	0
7/3	0	0	1	1	0	0	0
7/4	0	0	2	1	2	0	0
7/5	0	0	0	0	0	0	0
7/6	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0
7/8	0	0	0	0	1	0	0
7/9	0	0	3	2	0	0	0
7/10	0	0	6	1	0	0	0
7/11	0	0	2	3	0	0	0
7/12	0	0	6	0	1	0	0
7/13	0	0	3	0	0	0	0
7/14	0	0	1	0	0	0	0
7/15	1	0	0	0	0	0	0
7/16	2	0	0	0	1	0	0
7/17	0	1	0	0	0	0	0
7/18	0	1	0	0	0	0	0
7/19	0	1	0	0	0	0	0
7/20	0	1	1	1	0	0	0
7/21	2	1	0	5	0	0	0
7/22	2	3	1	1	0	0	0
7/23	0	1	10	0	0	0	0
7/24	0	3	1	1	1	0	0
7/25	0	2	1	1	0	0	0
7/26	2	2	1	0	0	0	0
7/27	0	1	1	0	0	0	0
7/28	0	0	5	3	0	0	0
7/29	3	1	0	3	0	0	0
7/30	1	0	0	1	0	0	0
7/31	0	1	0	0	0	0	0
8/1	2	0	0	0	0	0	0
8/2	2	0	1	0	0	0	0
8/3	0	0	0	0	0	0	0
8/4	2	0	0	0	0	0	0
8/5	0	0	0	0	0	0	0
8/6	4	1	0	0	0	0	0
8/7	0	0	0	0	0	0	0
8/8	1	0	0	0	0	0	1
8/9	2	0	0	0	1	0	0

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Appendix C1.–Page 2 of 2.

Date	Sockeye Salmon	Pink Salmon	Longnose Sucker	Whitefish	Arctic Grayling	Northern Pike	Dolly Varden
8/10	0	0	0	0	0	0	0
8/11	0	0	0	0	0	0	0
8/12	2	0	2	0	0	0	0
8/13	1	0	3	0	0	0	0
8/14	7	0	0	0	0	1	0
8/15	0	0	1	0	0	0	0
8/16	1	0	2	0	0	0	0
8/17	0	0	0	0	0	0	0
8/18	1	0	0	0	0	1	0
8/19 [b]	1	0	--	--	--	--	--
8/20 [b]	0	0	--	--	--	--	--
8/21 [b]	0	0	--	--	--	--	--
8/22 [b]	0	0	--	--	--	--	--
8/23 [b]	0	0	--	--	--	--	--
8/24 [b]	0	0	--	--	--	--	--
8/25 [b]	0	0	--	--	--	--	--
8/26 [b]	0	0	--	--	--	--	--
8/27 [b]	0	0	--	--	--	--	--
8/28 [b]	0	0	--	--	--	--	--
8/29 [b]	1	0	--	--	--	--	--
8/30 [b]	1	0	--	--	--	--	--
8/31 [b]	0	0	--	--	--	--	--
9/1 [b]	1	0	--	--	--	--	--
9/2 [b]	0	0	--	--	--	--	--
9/3 [b]	1	0	--	--	--	--	--
9/4 [b]	0	0	--	--	--	--	--
9/5 [b]	0	0	--	--	--	--	--
9/6 [b]	0	0	--	--	--	--	--
9/7 [b]	0	0	--	--	--	--	--
9/8 [b]	0	0	--	--	--	--	--
9/9 [b]	0	0	--	--	--	--	--
9/10 [b]	0	0	--	--	--	--	--
9/11 [b]	0	0	--	--	--	--	--
9/12 [b]	0	0	--	--	--	--	--
9/13 [b]	0	0	--	--	--	--	--
9/14 [b]	0	0	--	--	--	--	--
9/15 [b]	0	0	--	--	--	--	--
9/16 [b]	0	0	--	--	--	--	--
9/17 [b]	0	0	--	--	--	--	--
9/18 [b]	0	0	--	--	--	--	--
9/19 [b]	0	0	--	--	--	--	--
9/20 [b]	0	0	--	--	--	--	--
Total	41[c]	20	1293	76	8	4	5

[a] The weir remained fish-tight but no counts were performed due to poor visibility.

[b] The weir was not operational; daily passage was estimated for sockeye and pink salmon but not for the other listed species.

[c] Due to rounding error associated with estimates, the values in the "total" column are not necessarily the sum of the daily passages from the column above.

APPENDIX D. DAILY CARCASS COUNTS

Appendix D1.–Daily salmon carcass counts at the Tatlawiksuk River weir, 2006.

	Chinook			Sockeye			Chum			Coho			Pink		
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
6/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
6/30	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0
7/1	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0
7/2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0
7/3	0	0	0	0	0	0	4	2	6	0	0	0	0	0	0
7/4	0	0	0	0	0	0	4	3	7	0	0	0	0	0	0
7/5	0	0	0	0	0	0	13	7	20	0	0	0	0	0	0
7/6	0	0	0	0	0	0	12	5	17	0	0	0	0	0	0
7/7	0	0	0	0	0	0	8	4	12	0	0	0	0	0	0
7/8	0	0	0	0	0	0	15	3	18	0	0	0	0	0	0
7/9	0	0	0	0	0	0	19	7	26	0	0	0	0	0	0
7/10	0	0	0	0	0	0	25	8	33	0	0	0	0	0	0
7/11	0	0	0	0	0	0	19	8	27	0	0	0	0	0	0
7/12	0	0	0	0	0	0	31	15	46	0	0	0	0	0	0
7/13	0	0	0	0	0	0	39	11	50	0	0	0	0	0	0
7/14	0	0	0	0	0	0	44	12	56	0	0	0	0	0	0
7/15	0	0	0	0	0	0	30	2	32	0	0	0	0	0	0
7/16	0	0	0	0	0	0	30	4	34	0	0	0	0	0	0
7/17	0	0	0	0	0	0	16	3	19	0	0	0	0	0	0
7/18	0	0	0	0	0	0	35	8	43	0	0	0	0	0	0
7/19	0	0	0	0	0	0	32	8	40	0	0	0	0	0	0
7/20	0	0	0	0	0	0	31	10	41	0	0	0	0	0	0
7/21	1	0	1	0	0	0	31	16	47	0	0	0	1	0	1
7/22	1	0	1	0	0	0	46	32	78	0	0	0	0	0	0
7/23	0	0	0	1	1	2	42	26	68	0	0	0	0	0	0
7/24	1	0	1	0	0	0	48	36	84	0	0	0	0	0	0
7/25	0	1	1	0	0	0	39	30	69	0	0	0	0	0	0
7/26	3	0	3	0	0	0	63	20	83	0	0	0	0	0	0
7/27	0	0	0	0	0	0	58	25	83	0	0	0	0	0	0
7/28	1	0	1	0	0	0	45	40	85	0	0	0	0	0	0
7/29	1	0	1	0	0	0	19	16	35	0	0	0	0	0	0
7/30	1	0	1	0	0	0	17	8	25	0	0	0	0	0	0
7/31	2	0	2	0	0	0	16	14	30	0	1	1	0	0	0
8/1	0	1	1	0	0	0	22	15	37	0	0	0	0	0	0
8/2	0	1	1	0	0	0	17	9	26	0	0	0	0	0	0
8/3	0	0	0	0	0	0	8	4	12	0	0	0	0	0	0
8/4	0	0	0	0	0	0	8	2	10	0	1	1	0	0	0
8/5	1	0	1	0	0	0	14	3	17	0	0	0	0	0	0
8/6	1	0	1	0	0	0	18	6	24	0	0	0	0	0	0
8/7	0	0	0	0	0	0	27	12	39	0	0	0	0	0	0
8/8	1	1	2	0	0	0	30	10	40	0	0	0	0	0	0
8/9	0	0	0	0	0	0	13	12	25	0	0	0	0	0	0
8/10	0	0	0	0	0	0	4	1	5	0	0	0	0	0	0
8/11	0	0	0	0	0	0	17	11	28	0	1	1	0	0	0
8/12	1	0	1	0	0	0	17	11	28	0	0	0	0	0	0
8/13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/14	0	0	0	0	0	0	11	6	17	0	0	0	0	0	0
8/15	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0
8/16	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0
8/17	0	0	0	0	0	0	3	3	6	0	0	0	0	0	0
8/18	1	0	1	0	0	0	3	2	5	0	0	0	0	0	0
Totals:	17	5	22	1	1	2	1,052	498	1,550	0	3	3	1	0	1
Percent Female:			22.7%			50.0%			32.1%			100.0%			0.0%

Note: Downstream passage chutes for resident species were installed in late July. Carcass counts from late July through the end of weir operations are incomplete.

APPENDIX E. WEATHER AND STREAM OBSERVATIONS

Appendix E1.–Daily weather and stream observations at the Tatlawiksuk River weir site, 2006.

		Observations by Hour				Daily Totals
		Sky	Temperature		River	Precipitation
Date	Time	Code[a]	Air	Water	Stage (cm)	(mm)[b]
6/11	10:00	4	9.0	9.0	40.0	1.1
6/12	7:30	4	9.0	8.0	38.0	1.0
6/13	7:30	4	15.5	8.0	37.0	2.0
6/14	7:30	3	12.5	9.5	37.0	0.0
6/15	7:30	2	12.5	7.5	36.0	0.0
	17:00	3	26.0	14.0	35.0	
6/16	7:30	4	15.5	11.0	35.0	0.0
	17:00	4	16.5	11.0	35.0	
6/17	8:30	1	11.5	8.0	36.0	9.5
	17:00	3	14.5	10.0	38.0	
6/18	8:30	4	11.5	10.5	42.0	3.1
	17:00	4	14.5	12.0	43.0	
6/19	7:30	5	8.0	10.0	58.0	2.0
	17:00	3	18.0	14.0	67.0	
6/20	7:30	1	10.0	9.0	62.0	0.5
6/21	7:30	1	8.0	10.0	62.0	1.0
6/22	17:00	2	22.0	12.0	50.0	
6/23	7:30	2	8.0	10.0	47.0	0.0
	17:00	3	19.0	13.0	45.0	
6/24	7:30	2	9.0	10.5	41.0	0.0
6/25	9:00	2	14.0	12.0	37.0	0.0
	19:00	4	16.0	12.0	37.0	
6/26	9:00	3	16.0	12.0	37.0	1.0
	17:00	4	ND	ND	37.0	
6/27	7:00	1	9.5	11.5	39.0	3.5
	17:00	2	21.0	12.0	35.0	
6/28	7:30	3	11.0	9.0	35.0	0.0
	17:00	2	16.0	12.0	35.0	
6/29	7:30	3	12.0	12.0	33.0	0.0
	17:00	4	13.0	12.0	31.0	
6/30	7:30	4	10.0	11.0	33.0	28.0
	17:00	3	16.5	12.0	38.0	
	23:00	1	ND	ND	45.0	
7/1	9:00	1	13.0	10.5	64.0	2.5
	17:00	1	21.0	12.0	75.0	
7/2	10:00	4	13.0	11.0	75.0	0.0
	17:00	4	18.0	12.0	70.0	
7/3	7:00	4	10.0	11.0	64.0	0.0
	17:00	1	22.0	13.0	58.0	
7/4	7:00	4	16.0	12.0	55.0	0.0
7/5	7:00	1	16.0	12.0	50.0	0.0
	17:00	2	28.0	9.0	48.0	
7/6	7:00	2	15.0	13.0	46.0	0.3
	17:00	4	19.0	ND	46.0	
7/7	7:00	3	15.0	ND	44.0	1.0
	17:00	4	17.0	14.0	44.0	
7/8	10:00	4	13.0	12.0	43.0	4.0
	17:00	4	17.0	13.0	45.0	
	23:30	3	15.0	13.0	45.0	
7/9	10:00	1	16.0	11.0	43.0	2.7
	17:00	2	25.0	14.0	43.0	
7/10	17:00	1	25.0	15.0	40.0	0.0
7/11	0:00	2	19.0	16.0	40.0	
	10:00	2	14.0	13.0	40.0	4.0
7/12	7:30	2	10.0	14.0	42.0	0.0
	17:00	3	20.0	15.0	44.0	
7/13	7:30	4	11.0	13.0	44.0	2.4
7/14	7:30	4	10.0	11.0	45.0	6.2
	17:00	4	10.0	11.0	47.0	
7/15	10:00	4	10.0	12.0	48.0	8.5
7/16	10:00	4	11.0	10.0	50.0	4.0
	17:00	3	15.0	11.0	49.0	

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Appendix E1.–Page 2 of 3.

		Observations by Hour				Daily Totals
		Sky	Temperature		River	Precipitation
Date	Time	Code[a]	Air	Water	Stage (cm)	(mm)[v]
7/17	7:00	4	10.0	10.0	50.0	0.7
	17:00	3	19.0	11.0	50.0	
7/18	7:00	4	10.0	10.0	48.0	0.0
7/19	7:00	4	10.0	11.0	45.0	3.6
	17:00	3	19.0	13.0	45.0	
7/20	7:00	1	8.0	11.0	45.0	0.5
	17:00	1	26.0	14.0	44.0	
7/21	7:00	3	13.0	12.0	40.0	0.0
	17:00	1	23.0	16.0	38.0	
7/22	10:00	3	15.5	13.5	34.0	0.0
	17:00	2	24.0	16.5	33.0	
7/23	10:00	2	12.0	13.5	32.0	5.2
	17:00	3	23.0	16.0	31.0	
7/24	7:00	4	13.5	13.5	30.0	0.0
	16:30	3	18.0	14.0	30.0	
7/25	7:00	4	11.5	13.0	30.0	1.3
7/26	7:30	4	11.0	11.0	27.0	1.9
	17:00	3	15.0	10.0	28.0	
7/27	7:30	4	12.0	10.0	34.0	9.8
	17:00	3	17.0	12.0	38.0	
7/28	7:00	3	6.0	11.0	40.0	0.0
	16:30	4	15.0	12.0	42.0	
7/29	10:00	4	10.0	10.0	41.0	1.5
	17:00	4	13.0	ND	40.0	
7/30	10:00	4	10.0	10.0	43.0	2.0
	17:00	4	14.0	11.0	46.0	
7/31	9:00	4	10.0	10.0	52.0	1.5
	17:00	4	11.0	11.0	53.0	
8/1	7:00	4	7.0	8.0	53.0	1.5
	17:00	4	14.0	ND	53.0	
8/2	7:00	4	9.0	9.0	53.0	8.0
	17:00	4	14.0	10.5	53.0	
8/3	7:00	4	10.0	10.0	54.0	2.1
8/4	7:00	4	9.0	10.0	52.0	1.0
8/5	9:30	5	11.0	11.0	48.0	1.0
	17:00	3	15.5	12.0	46.0	
8/6	10:00	1	12.0	10.0	44.0	0.5
	17:00	4	17.0	12.0	44.0	
8/7	7:15	3	7.0	9.0	44.0	0.0
	17:00	3	18.0	12.0	44.0	
8/8	7:00	4	10.0	10.0	43.0	0.0
	17:00	4	14.0	12.0	42.0	
8/9	7:00	4	11.0	11.0	41.0	0.0
	17:00	4	ND	11.0	40.0	
8/10	7:00	4	11.0	10.0	40.0	9.0
	17:00	4	13.0	ND	-	
8/11	7:00	4	11.0	10.0	46.0	12.5
	17:00	4	14.0	10.0	53.0	
8/12	10:00	4	13.0	10.0	63.0	6.5
	17:00	4	11.0	10.0	66.0	
8/13	17:00	4	13.0	9.0	76.0	
8/14	7:00	4	10.0	9.0	78.0	15.0
8/15	7:00	4	10.0	9.0	90.0	12.5
	17:00	3	15.0	11.0	92.0	
8/16	7:00	3	9.0	9.0	95.0	3.0
	17:00	3	17.0	12.0	96.0	
8/17	7:00	3	9.0	9.0	95.0	2.0
	17:00	3	15.0	10.0	92.0	
8/18	7:00	4	10.0	10.0	93.0	30.0
	17:00	4	12.0	10.0	101.0	
8/19	10:00	2	6.0	8.0	120.0	15.0
	17:00	3	12.0	10.0	145.0	
8/20	7:00	1	5.0	8.0	173.0	0.0
	17:00	4	13.0	8.0	182.0	
8/21	7:00	4	-1.0	8.0	190.0	0.0
8/22	7:00	3	10.0	8.0	195.0	13.0
	17:00	4	12.0	8.0	192.0	

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Appendix E1.–Page 3 of 3.

		Observations by Hour				Daily Totals
		Sky	Temperature		River	Precipitation
Date	Time	Code[a]	Air	Water	Stage (cm)	(mm)[b]
8/23	7:00	4	6.0	8.0	182.0	7.0
	17:00	4	13.0	ND	178.0	
8/25	7:30	4	7.0	8.0	169.0	5.0
	17:00	3	12.0	8.0	157.0	
8/26	10:00	3	7.0	6.0	152.0	3.0
	17:00	4	15.0	8.0	152.0	
8/27	10:00	5	8.0	8.0	146.0	0.7
8/28	7:30	3	2.0	7.0	132.0	0.0
	17:00	3	15.0	8.0	128.0	
8/29	7:30	3	5.0	8.0	123.0	0.0
8/30	7:30	3	2.0	7.0	107.0	
	17:00	3	17.0	8.0	105.0	
8/31	7:30	2	8.0	7.0	98.0	0.0
	17:00	4	14.0	9.0	94.0	
9/1	10:00	4	8.0	8.0	88.0	0.0
9/2	10:00	3	5.0	7.0	80.0	0.0
	17:00	3	16.0	8.0	78.0	
9/3	10:00	1	8.0	7.0	72.0	0.0
	17:00	1	19.0	8.0	71.0	
9/4	10:00	1	4.0	7.0	67.0	0.0
	17:00	1	20.0	9.0	65.0	
9/5	10:00	2	6.0	7.0	62.0	0.0
	17:00	4	12.0	8.0	60.0	
9/6	10:00	1	4.0	7.0	58.0	2.5
	17:00	1	17.0	9.0	57.0	
9/7	10:00	4	10.0	7.0	55.0	0.0
	17:00	4	11.0	8.0	55.0	
9/8	10:00	4	9.0	7.0	55.0	10.0
	17:00	4	17.0	9.0	55.0	
9/9	10:00	5	7.0	8.0	54.0	0.5
		Minimum:	-1.0	6.0	27.0	0.0
		Maximum:	28.0	16.5	195.0	30.0
		Average:[c]	13.2	10.5	64.0	3.2

Note: ND = no data.

[a] Sky Codes: 0 = no observation
1 = clear or mostly clear (<10% cloud cover)
2 = cloud cover less than 50% of the sky
3 = cloud cover more than 50% of the sky
4 = complete overcast

[b] Represents cumulative precipitation in the previous 24 hours.

[c] Includes only days with a morning observation between 0700 and 1000 hrs and an afternoon observation between 1630 and 2000 hours. On the rare occasion that two observations were made during the afternoon range of time, the observation closest to 1700 hours was used.

Appendix E2.–Daily stream temperature summary from the data logger at the Tatlawiksuk River weir, 2006.

	Temperature (^{o}C)		
Date	**Avg.**	**Min.**	**Max.**
6/12	9.6	9.2	10.1
6/13	9.8	8.8	11.2
6/14	11.5	10.6	12.6
6/15	12.5	10.9	14.5
6/16	13.4	13.0	14.3
6/17	12.4	11.2	13.3
6/18	12.0	11.1	12.8
6/19	11.2	10.6	12.3
6/20	11.4	10.7	12.4
6/21	12.0	10.8	13.4
6/22	12.8	11.6	14.2
6/23	12.8	11.9	13.6
6/24	13.0	11.6	14.7
6/25	13.5	12.4	14.8
6/26	13.4	12.6	14.2
6/27	13.7	12.2	15.5
6/28	14.1	13.0	15.1
6/29	13.1	12.5	14.4
6/30	12.0	11.4	12.7
7/1	12.0	10.9	12.9
7/2	12.1	11.7	12.5
7/3	11.9	10.8	13.4
7/4	13.2	11.9	14.9
7/5	14.6	13.2	16.3
7/6	15.2	14.3	15.9
7/7	14.4	13.8	15.5
7/8	12.6	12.0	13.6
7/9	13.1	11.5	15.1
7/10	14.6	13.4	16.0
7/11	15.4	14.1	17.1
7/12	15.6	14.8	16.6
7/13	14.2	13.2	15.8
7/14	11.7	11.1	13.0
7/15	10.5	10.1	11.0
7/16	10.3	9.8	11.2
7/17	10.8	10.1	11.7
7/18	11.2	10.5	12.0
7/19	12.0	11.1	13.1
7/20	13.3	11.8	15.4
7/21	15.0	13.7	16.6
7/22	15.7	14.4	17.1
7/23	15.6	14.5	16.7
7/24	15.0	14.5	16.0
7/25	13.6	12.8	14.4
7/26	12.8	12.1	13.7
7/27	12.5	11.9	13.1
7/28	12.0	11.5	12.7
7/29	11.0	10.6	11.8
7/30	10.5	9.9	11.2
7/31	10.7	10.3	11.0
8/1	10.2	9.8	10.7
8/2	10.0	9.4	10.9
8/3	10.5	10.0	10.9
8/4	10.8	10.1	11.9

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	Temperature (^{o}C)		
Date	**Avg.**	**Min.**	**Max.**
8/5	11.6	10.8	12.7
8/6	12.2	11.4	13.2
8/7	11.8	11.3	12.5
8/8	11.5	10.9	12.2
8/9	11.4	11.2	11.9
8/10	10.7	10.4	11.1
8/11	10.4	10.1	10.7
8/12	10.2	10.0	10.5
8/13	9.5	9.3	10.0
8/14	9.3	9.0	9.7
8/15	9.5	9.1	10.0
8/16	9.9	9.5	10.5
8/17	10.1	9.7	10.4
8/18	9.9	9.8	10.1
8/19	9.2	8.7	9.7
8/20	8.6	8.3	9.1
8/21	8.1	7.7	8.6
8/22	8.3	8.1	8.4
8/23	8.0	7.7	8.3
8/24	7.7	7.2	8.2
8/25	8.0	7.8	8.2
8/26	7.7	7.3	8.3
8/27	8.4	8.0	8.9
8/28	8.3	7.7	8.9
8/29	8.2	7.7	8.8
8/30	8.1	7.6	8.6
8/31	8.3	7.8	8.8
9/1	8.4	7.9	9.0
9/2	8.3	7.5	9.1
9/3	8.1	7.4	9.0
9/4	8.1	7.3	9.0
9/5	8.1	7.6	8.5
9/6	8.2	7.4	9.1
9/7	8.2	8.1	8.6
Average:	11.3	10.6	12.1
Minimum:	7.7	7.2	8.2
Maximum:	15.7	14.8	17.1

Appendix E3.–Worksheet used to calculate river discharge at the Tatlawiksuk River weir site on 9 September, 2006.

Location: Tatlawiksuk River weir **Date:** 9/9/2006

Description: Approx. 50 m downstream of weir **Gauge Height:** 54

Crew: Rob Stewart, Jay Baumer, Phillip Duffy

Comments: Water level was near the seasonal average and within normal operating limits for the weir. **Meter Type:** AA

Station **Dist.** (m)	Stream **Depth** (m)	Meter **Height** (m)	Substrate Description	**Velocity** (m/sec)			Cell			
				Point	Mean Vert.	Mean Cell	Depth (m)	Width (m)	Area (m^2)	Flow (m^3/sec)
0			river left, gravel bar	0.00		-	-	-	-	-
3.0	0.30	0.12	gravels and sand	0.76		0.38	0.30	2.97	0.89	0.34
5.9	0.40	0.16	gravels and sand	0.92		0.84	0.35	2.97	1.04	0.88
8.9	0.56	0.22	gravels and sand	1.08		1.00	0.48	2.97	1.43	1.43
11.9	0.64	0.26	gravels and sand	1.08		1.08	0.60	2.97	1.78	1.93
14.9	0.72	0.29	gravels and sand	1.12		1.10	0.68	2.97	2.02	2.22
17.8	0.82	0.33	gravels and sand	1.09		1.11	0.77	2.97	2.29	2.53
20.8	0.92	0.37	gravels and sand	1.09		1.09	0.87	2.97	2.58	2.82
23.8	0.98	0.39	gravels and sand	1.14		1.12	0.95	2.97	2.82	3.15
26.7	1.05	0.42	gravels and sand	1.26		1.20	1.02	2.97	3.02	3.62
29.7	1.00	0.40	gravels and sand	1.28		1.27	1.03	2.97	3.05	3.87
32.7	0.92	0.37	gravels and sand	1.34		1.31	0.96	2.97	2.85	3.74
35.6	0.84	0.34	gravels and sand	1.25		1.30	0.88	2.97	2.61	3.39
38.6	0.72	0.29	gravels and sand	1.03		1.14	0.78	2.97	2.32	2.64
41.6	0.56	0.22	gravels and sand	1.05		1.04	0.64	2.97	1.90	1.98
44.6	0.42	0.17	gravels and sand	0.79		0.92	0.49	2.97	1.46	1.34
47.5	0.34	0.14	gravels and sand	0.51		0.65	0.38	2.97	1.13	0.74
50.5	0.24	0.10	gravels and sand	0.45		0.48	0.29	2.97	0.86	0.41
54.7	0.00	0.00	river right, gravel bar	0.00		0.22	0.12	4.16	0.50	0.11

Avg. Depth: 0.64 m Avg. Velocity: 0.91 m/sec

Max. Depth: 1.05 m Max.Velocity: 1.34 m/sec

Total Discharge: 37.1 m^3/sec

APPENDIX F. HISTORICAL CUMULATIVE PERCENT SALMON PASSAGE

Appendix F1.–Historical daily cumulative percent passage of coho salmon at the Tatlawiksuk River weir.

Date	1998[a]	1999	2000	2001[a]	2002	2003[a]	2004	2005	2006[b]
6/15		0		0	0		0	0	
6/16		0		0	0		0	0	
6/17		0		0	0		0	0	
6/18		0		0	0		0	0	
6/19		0		0	0		0	0	
6/20		0		0	0		0	0	
6/21		0		0	0		0	0	
6/22		0		0	0		0	0	
6/23		0		0	0		0	0	
6/24		0		0	0		0	0	
6/25		0		0	0		0	0	
6/26		0		0	0		0	0	
6/27		0		0	0		0	0	
6/28		0		0	0		0	0	
6/29		0		0	0		0	0	
6/30		0		0	0		0	0	
7/01		0		0	0		0	0	
7/02		0		0	0		0	0	
7/03		0		0	0		0	0	
7/04		0		0	0		0	0	
7/05		0		0	0		0	0	
7/06		0		0	0		0	0	
7/07		0		0	0		0	0	
7/08		0		0	0		0	0	
7/09		0		0	0		0	0	
7/10		0		0	0		0	0	
7/11		0		0	0		0	0	
7/12		0		0	0		0	0	
7/13		0		0	0		0	0	
7/14		0		0	0		0	0	
7/15		0		0	0		0	0	
7/16		0		0	0		0	0	
7/17		0		0	0		0	0	
7/18		0		0	0		0	0	
7/19		0		0	0		0	0	
7/20		0		0	0		0	0	
7/21		0		0	0		0	0	
7/22		0		0	0		0	0	
7/23		0		0	0		0	0	
7/24		0		0	0		0	0	
7/25		0		0	0		0	0	
7/26		0		0	0		0	0	
7/27		0		0	0		0	1	
7/28		0		0	0		1	1	
7/29		0		0	0		1	1	
7/30		0		0	0		1	2	
7/31		0		0	0		1	2	
8/01		0		1	0		2	2	
8/02		0		1	0		2	3	
8/03		0		1	0		3	4	
8/04		0		2	0		4	4	

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Appendix F1.–Page 2 of 2.

Date	1998[a]	1999	2000	2001[a]	2002	2003[a]	2004	2005	2006[b]
8/05		0		3	1		5	5	
8/06		0		3	1		8	5	
8/07		1		4	1		11	6	
8/08		1		5	2		13	7	
8/09		1		6	2		16	10	
8/10		1		9	3		20	11	
8/11		1		11	4		22	13	
8/12		1		14	8		27	14	
8/13		1		17	14		30	15	
8/14		2		25	17		34	17	
8/15		2		30	19		38	18	
8/16		3		38	22		41	19	
8/17		4		44	22		44	23	
8/18		5		50	25		48	25	
8/19		6		56	25		52	26	
8/20		8		60	26		55	28	
8/21		10		65	36		59	30	
8/22		11		69	40		64	31	
8/23		13		73	52		68	41	
8/24		16		76	61		71	52	
8/25		18		79	66		75	56	
8/26		21		82	72		77	59	
8/27		24		84	75		78	61	
8/28		29		86	78		80	64	
8/29		34		87	79		82	67	
8/30		37		89	80		83	69	
8/31		42		91	83		85	72	
9/01		49		92	87		88	73	
9/02		54		93	89		89	74	
9/03		58		94	89		91	75	
9/04		64		94	91		92	79	
9/05		69		95	93		93	82	
9/06		72		95	93		94	85	
9/07		73		96	96		94	86	
9/08		74		96	96		95	88	
9/09		76		97	97		96	89	
9/10		84		97	97		97	91	
9/11		87		97	98		97	92	
9/12		89		98	98		98	94	
9/13		92		98	98		99	95	
9/14		94		98	99		99	96	
9/15		96		99	99		100	97	
9/16		96		99	99		100	98	
9/17		97		100	100		100	99	
9/18		98		100	100		100	99	
9/19		100		100	100		100	100	
9/20		100		100	100		100	100	

Note: The boxes represent the median passage date and central 50% of the run.

[a] The weir was not operational for most of the coho salmon run; passage was not estimated.

[b] The weir was not operational for most of the coho salmon run; cumulative percent passage was not determined.

Appendix F2.–Historical daily cumulative percent passage of Chinook salmon at the Tatlawiksuk River weir.

Date	1998	1999	2000	2001	2002	2003	2004	2005	2006
6/15		0	0	0	0	0	0	0	0
6/16		0	0	0	0	0	0	0	0
6/17		0	0	0	0	0	0	0	0
6/18		0	0	0	0	0	0	0	0
6/19		0	0	0	0	0	1	0	0
6/20		0	0	0	0	0	1	0	0
6/21		0	0	0	0	0	1	0	0
6/22		0	1	0	1	0	1	1	0
6/23		0	1	0	4	0	1	1	0
6/24		0	2	0	4	1	1	1	0
6/25		1	2	1	4	1	4	1	0
6/26		1	4	4	4	3	12	2	0
6/27		1	5	5	28	3	13	2	2
6/28		2	5	7	29	12	16	2	2
6/29		2	5	8	37	29	19	3	2
6/30		3	8	13	38	33	20	9	4
7/01		4	11	31	39	35	31	10	6
7/02		4	29	32	43	36	36	13	7
7/03		5	35	34	48	41	39	29	7
7/04		7	39	34	54	43	45	38	15
7/05		8	44	40	69	47	53	46	18
7/06		9	46	61	72	49	54	49	29
7/07		10	48	69	78	50	57	54	31
7/08		10	50	70	79	52	60	57	35
7/09		12	59	72	80	59	68	61	49
7/10		14	65	73	81	61	74	64	57
7/11		20	71	74	83	63	76	69	60
7/12		28	77	76	84	65	76	72	66
7/13		31	78	84	85	71	80	75	70
7/14		36	78	86	86	75	81	80	73
7/15		37	79	89	90	77	82	81	75
7/16		42	81	89	91	78	84	84	78
7/17		42	87	90	91	80	89	86	79
7/18		52	88	92	92	81	91	89	83
7/19		53	89	94	92	83	92	91	86
7/20		79	90	94	93	87	92	93	87
7/21		80	90	95	93	87	93	94	89
7/22		81	92	96	94	88	94	95	90
7/23		86	93	96	95	89	95	96	91
7/24		89	93	97	95	91	95	96	93
7/25		92	94	97	96	92	96	96	93
7/26		93	95	98	96	93	96	97	94
7/27		94	95	98	97	93	97	97	95
7/28		94	95	98	98	94	98	97	95
7/29		96	95	99	99	95	98	98	96
7/30		97	96	99	99	96	98	98	97
7/31		97	96	99	99	97	99	99	97
8/01		98	96	99	99	97	99	99	98
8/02		98	97	99	100	97	99	99	99

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Appendix F2.–Page 2 of 2.

Date	1998	1999	2000	2001	2002	2003	2004	2005	2006
8/03		98	98	99	100	98	99	99	99
8/04		98	98	99	100	98	99	99	99
8/05		99	98	100	100	98	99	99	99
8/06		99	98	100	100	98	99	99	100
8/07		99	98	100	100	98	99	99	100
8/08		99	99	100	100	99	100	100	100
8/09		99	99	100	100	99	100	100	100
8/10		99	99	100	100	99	100	100	100
8/11		99	99	100	100	99	100	100	100
8/12		99	99	100	100	99	100	100	100
8/13		99	99	100	100	99	100	100	100
8/14		100	99	100	100	99	100	100	100
8/15		100	100	100	100	99	100	100	100
8/16		100	100	100	100	99	100	100	100
8/17		100	100	100	100	99	100	100	100
8/18		100	100	100	100	100	100	100	100
8/19		100	100	100	100	100	100	100	100
8/20		100	100	100	100	100	100	100	100
8/21		100	100	100	100	100	100	100	100
8/22		100	100	100	100	100	100	100	100
8/23		100	100	100	100	100	100	100	100
8/24		100	100	100	100	100	100	100	100
8/25		100	100	100	100	100	100	100	100
8/26		100	100	100	100	100	100	100	100
8/27		100	100	100	100	100	100	100	100
8/28		100	100	100	100	100	100	100	100
8/29		100	100	100	100	100	100	100	100
8/30		100	100	100	100	100	100	100	100
8/31		100	100	100	100	100	100	100	100
9/01		100	100	100	100	100	100	100	100
9/02		100	100	100	100	100	100	100	100
9/03		100	100	100	100	100	100	100	100
9/04		100	100	100	100	100	100	100	100
9/05		100	100	100	100	100	100	100	100
9/06		100	100	100	100	100	100	100	100
9/07		100	100	100	100	100	100	100	100
9/08		100	100	100	100	100	100	100	100
9/09		100	100	100	100	100	100	100	100
9/10		100	100	100	100	100	100	100	100
9/11		100	100	100	100	100	100	100	100
9/12		100	100	100	100	100	100	100	100
9/13		100	100	100	100	100	100	100	100
9/14		100	100	100	100	100	100	100	100
9/15		100	100	100	100	100	100	100	100
9/16		100	100	100	100	100	100	100	100
9/17		100	100	100	100	100	100	100	100
9/18		100	100	100	100	100	100	100	100
9/19		100	100	100	100	100	100	100	100
9/20		100	100	100	100	100	100	100	100

Note: The boxes represent the median passage date and central 50% of the run. The weir was not operational for most of 1998 and 2003; estimates were made for 2003.

Appendix F3.–Historical daily cumulative percent passage of chum salmon at the Tatlawiksuk River weir.

Date	1998	1999	2000	2001	2002	2003	2004	2005	2006
6/15		0	0	0	0		0	0	0
6/16		0	0	0	0		0	0	0
6/17		0	0	0	0		0	0	0
6/18		0	0	0	0		0	0	0
6/19		0	0	0	0		1	0	0
6/20		0	0	0	0		1	0	0
6/21		0	0	0	0		1	0	0
6/22		0	0	0	1		2	0	0
6/23		0	0	0	2		2	0	0
6/24		0	0	0	2		3	0	1
6/25		0	1	1	3		6	0	1
6/26		0	2	1	4		8	0	2
6/27		1	2	1	6		9	0	4
6/28		1	2	2	8		9	0	4
6/29		2	3	3	12		11	1	6
6/30		3	4	4	14		12	1	10
7/01		4	6	6	16		15	2	11
7/02		5	13	7	20		18	5	12
7/03		6	17	7	22		21	9	14
7/04		7	19	8	26		23	11	21
7/05		8	24	10	31		26	13	22
7/06		9	26	13	38		27	15	26
7/07		11	29	16	41		30	17	28
7/08		13	30	20	44		34	20	31
7/09		16	37	24	47		38	23	37
7/10		20	40	30	51		41	26	43
7/11		24	46	33	56		43	30	46
7/12		29	54	38	59		45	35	50
7/13		32	57	43	62		49	40	53
7/14		35	57	48	65		53	46	55
7/15		38	61	54	70		56	51	56
7/16		42	66	58	72		60	57	59
7/17		46	70	63	76		64	61	62
7/18		50	73	70	80		68	65	65
7/19		51	75	74	83		71	69	68
7/20		58	76	77	85		74	72	71
7/21		62	78	80	87		76	76	75
7/22		64	82	83	89		79	79	78
7/23		71	84	85	90		81	82	81
7/24		74	86	87	91		83	84	83
7/25		78	88	89	92		85	86	86
7/26		80	89	90	93		87	88	88
7/27		82	91	91	94		89	89	89
7/28		84	92	92	95		91	91	91
7/29		86	93	92	96		92	92	93
7/30		89	95	93	96		93	93	94
7/31		90	96	94	97		94	94	96
8/01		92	97	95	97		95	95	96
8/02		93	97	96	98		95	96	97

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Appendix F3.–Page 2 of 2.

Date	1998	1999	2000	2001	2002	2003	2004	2005	2006
8/03		95	98	96	98		96	97	97
8/04		95	98	97	98		96	97	98
8/05		96	98	97	98		97	98	98
8/06		96	98	98	99		97	98	98
8/07		97	98	98	99		98	98	99
8/08		97	98	99	99		98	98	99
8/09		98	98	99	99		99	99	99
8/10		98	99	99	99		99	99	99
8/11		98	99	99	100		99	99	99
8/12		98	99	99	100		99	99	100
8/13		99	99	99	100		99	99	100
8/14		99	99	99	100		99	99	100
8/15		99	99	100	100		99	100	100
8/16		99	99	100	100		99	100	100
8/17		99	99	100	100		99	100	100
8/18		100	99	100	100		99	100	100
8/19		100	99	100	100		100	100	100
8/20		100	100	100	100		100	100	100
8/21		100	100	100	100		100	100	100
8/22		100	100	100	100		100	100	100
8/23		100	100	100	100		100	100	100
8/24		100	100	100	100		100	100	100
8/25		100	100	100	100		100	100	100
8/26		100	100	100	100		100	100	100
8/27		100	100	100	100		100	100	100
8/28		100	100	100	100		100	100	100
8/29		100	100	100	100		100	100	100
8/30		100	100	100	100		100	100	100
8/31		100	100	100	100		100	100	100
9/01		100	100	100	100		100	100	100
9/02		100	100	100	100		100	100	100
9/03		100	100	100	100		100	100	100
9/04		100	100	100	100		100	100	100
9/05		100	100	100	100		100	100	100
9/06		100	100	100	100		100	100	100
9/07		100	100	100	100		100	100	100
9/08		100	100	100	100		100	100	100
9/09		100	100	100	100		100	100	100
9/10		100	100	100	100		100	100	100
9/11		100	100	100	100		100	100	100
9/12		100	100	100	100		100	100	100
9/13		100	100	100	100		100	100	100
9/14		100	100	100	100		100	100	100
9/15		100	100	100	100		100	100	100
9/16		100	100	100	100		100	100	100
9/17		100	100	100	100		100	100	100
9/18		100	100	100	100		100	100	100
9/19		100	100	100	100			100	100
9/20		100	100	100	100			100	100

Note: The boxes represent the median passage date and central 50% of the run. The weir was not operational for most of 1998 and 2003; estimates were not made.