Fishery Data Series No. 08-38

Takotna River Salmon Studies, 2007

Final Report for Study 05-304
USFWS Office of Subsistence Management
Fisheries Information Services Division

by

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

The Takotna River is a tributary of the upper Kuskokwim River that supports runs of Pacific salmon *Oncorhynchus spp*. A weir operated on the Takotna River 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 provides a means to track trends in escapement that should be monitored and considered in harvest management decisions. To this end, Takotna River weir has been operated annually since 2000 to determine daily and total salmon escapements; 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 1995, the Alaska Department of Fish and Game (ADF&G) established an escapement monitoring program on the Takotna River approximately 835 river kilometers (rkm) from the mouth of the Kuskokwim River. A counting tower was used to enumerate fish from 1995 to 1999 but success was limited and the project transitioned to a resistance board weir in 2000. Since its inception, the weir has been jointly operated by ADF&G Division of Commercial Fisheries and the Takotna Tribal Council (TTC). Historically, the Takotna River weir has maintained an excellent performance record, and in 2007 it suffered only one brief inoperative period from 6 to 8 August. Total annual escapement for the 2007 target operational period included 418 Chinook *O. tshawytscha*, 8,900 chum *O. keta*, 14 sockeye *O. nerka*, and 2,853 coho salmon *O. kisutch*. Age-sex-length (ASL) samples were obtained from 64.4% of the Chinook escapement, 10.6% of the chum escapement, and 15.5% of the coho escapement. The Chinook salmon escapement comprised 50.4% age-1.2 fish, 33.9% age-1.3 fish, 14.7% age-1.4 fish, 0.8% age-1.5 fish, 0.3% age-2.3 fish, and 12.9% females. The chum salmon escapement comprised 60.1% age-0.3 fish, 33.7% age-0.4 fish, 3.4% age-0.2 fish, 2.7% age-0.5 fish, and 47.8% females. The coho salmon escapement comprised 92.5% age-2.1 fish, 5.2% of age-3.1 fish, 2.2% of age-1.1 fish, and 52.3% females. In addition to enumerating escapement and estimating ASL composition the weir served as a platform for 2 other projects: *Kuskokwim River Chinook Salmon Run Reconstruction* and *Kuskokwim River Sockeye Salmon Investigations.* The Takotna River weir successfully contributed to each of these projects in 2007.

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

INTRODUCTION

Draining an area approximately 130,000 km^2 (11% of the total area of the state), the Kuskokwim River is the second largest river in Alaska (Figure 1; Brown 1983). Each year mature Pacific salmon *Oncorhynchus spp.* return to the river and its tributaries to spawn, supporting an annual average subsistence and commercial harvest of nearly 1 million salmon (Whitmore et al. 2008). The subsistence salmon fishery in the Kuskokwim Area is one of the largest in the state and remains a fundamental component of local culture (Coffing 1991; Coffing *Unpublished* a, b; Coffing et al. 2000; Smith et al. *In prep*; Whitmore et al. 2008). 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. 2008). Salmon contributing 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), though 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, numerous tribal groups are charged by their constituency to actively promote a healthy and sustainable subsistence salmon fishery. For years, these and other groups have combined their resources in an effort to achieve long-term sustainability of Kuskokwim River salmon.

Proper salmon management provides 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. For much of ADF&G management history escapement monitoring has been limited to aerial surveys and 2 ground-based escapement-monitoring projects. Of the dozens of tributaries known to support spawning populations of salmon, the operation of escapement-monitoring projects on only 2 is inadequate for assessing escapements for the entire Kuskokwim River basin. This situation was improved with the addition of several escapement monitoring projects in the mid to late 1990s, one of which was the Takotna River weir. The data provided by the current array of projects have much greater utility for fishery managers and have decreased their reliance on aerial stream surveys which are less reliable (Whitmore et al. 2008). Over time and with sufficient data, escapement goals can be developed as a means of gauging annual escapement. The Takotna River weir does not currently have escapement goals for any species, but that will probably change after a few more years of successful weir operation. Meanwhile, annual escapement monitoring in the Takotna River contributes to the escapement and abundance information required for effective management (Holmes and Burkett 1996; Mundy 1998).

Kuskokwim River Chinook *O. tshawytscha* and chum *O. keta* salmon have received considerable attention from the Alaska Board of Fisheries (BOF) due to erratic run abundance patterns in recent decades. In 2000, the BOF designated these as “stocks of yield concern” based on several years of poor returns and lower than expected harvest (Burkey et al. 2000a, b). This “stock of yield concern” designation was continued during the 2004 BOF meeting (Bergstrom and Whitmore 2004), but was rescinded during the 2007 BOF meeting at the recommendation of ADF&G following several years of increasing abundance (Molyneaux and Brannian 2006). Between 2001 and 2006 subsistence and commercial fisheries were managed conservatively and in accordance with 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 were implemented using the existing weir infrastructure for data collection. Such projects have since become deeply integrated components of Kuskokwim River salmon management.

Upper Kuskokwim River salmon stocks (e.g. Takotna River) may contribute a disproportionately high fraction of subsistence-harvested salmon, particularly Chinook salmon. Kuskokwim River subsistence fishers tend to harvest more heavily in the early part of yearly salmon migrations (Smith et al. *In prep*). Data from Kuskokwim River tagging studies indicate that early arriving salmon in the Kuskokwim River may be dominated by fish bound for the most distant tributaries like the Takotna River (Pawluk et al. 2006). Therefore, despite runs of modest size, Takotna River salmon stocks are considered an important contributor to overall annual production and genetic diversity of Kuskokwim River fisheries similar to smaller Bristol Bay systems described by Hilborn et al. (2003). More importantly, The Takotna River weir currently provides the only reliable tool for assessment of upper tributary abundance, and in light of these stocks’ contributions to area fisheries, the Takotna River weir is particularly important for maintaining long-term sustainability of the downriver fisheries (Burkey et al. 2000a).

The utility of weirs extends beyond providing annual escapement estimates. Escapement projects, such as the Takotna River weir, commonly serve as platforms for other research initiatives aimed at providing information useful for management. Collection of age, sex, and length (ASL) data are typically included in escapement monitoring projects such as the Takotna River weir (Molyneaux et al. *In prep*). Knowledge of ASL composition can improve understanding of fluctuations in salmon abundance and is essential for understanding spawner-recruit relationships, which are integral to formulating escapement goals (Molyneaux and Brannian 2006). The Takotna River weir also serves as a platform for collecting information on habitat variables including water temperature, water chemistry, and stream discharge (water level), which are fundamental variables of the stream environment that directly or indirectly influence salmon productivity and migration timing (Hauer and Hill 1996; Kruse 1998; Quinn 2005).

BACKGROUND

Takotna River weir salmon escapements have been low in recent years; however, historical evidence suggest that salmon abundance was once much higher. Up through the early 1900s, salmon were harvested from the Takotna River by small bands of Athabaskans such as those resident at Tagholjitdochak', a now abandoned village site located near the confluence of Fourth of July Creek. The Takotna River also hosted immigration of residents from the Vinasale and Tatlawiksuk Athabaskan bands who maintained small seasonal camps in the Takotna River drainage (Figure 2; Anderson 1977; BLM 1984; Hosley 1966; Stokes 1983, 1985). The numbers of salmon these groups harvested is unknown, but Nikolai elders suggest the existence of strong Chinook and chum salmon runs in the Takotna River into the early twentieth century (Stokes 1985).

The historical harvest method of choice for Native Athabaskans was a weir constructed of spruce poles and fitted with a fish. According to Nikolai elders, at least 4 such weirs were located on the Takotna River (Figure 2; Stokes 1983). One of these was located on the Nixon Fork of the Takotna River near the confluence of the West Fork River. Other locations included a site on the main river a short distance above the current community of Takotna; one near Big Creek (lower); and another near or within Fourth of July Creek. The site near Fourth of July Creek is believed to have been operated by residents of Tagholjitdochak' (Stokes 1983). These sites were all abandoned by the mid 1920s (Stokes 1983).

The discovery of gold in the Innoko mining district in 1906 was a catalyst for social change that may have been a significant factor in the near extirpation of salmon in the Takotna River. The community of Takotna developed as a staging area for miners who used the Takotna River as an access route to mining operations that were mostly located in the Yukon River drainage (Brown 1983). The thousands of miners and related support personnel that migrated into the area were dependent on dog teams for winter transportation. The community of Takotna served as a major summer kenneling area, and salmon was a common food source for the dogs.

Steamboats navigated as far upstream as the current community of Takotna and probably had an adverse effect on local salmon stocks. A Kusko Times article published in 1921 references the construction of small temporary dams on the Takotna River to facilitate steamboat passage (Kusko Times 1921). We have been unable to uncover any details about these dams, but they too may have contributed to salmon declines by altering stream habitat or creating obstructions to migration. Stokes (1985) conducted interviews with residents as part of a study of subsistence harvest activities in the upper Kuskokwim River, but residents were unclear about the cause and timing of declines in salmon harvest. Based on historical evidence, Stokes (1985) concluded that it was likely a combination of overfishing and habitat alteration associated with mining development.

Area residents and local biologists described the Takotna River as being nearly void of salmon during the 1960s and 1970s (Molyneaux et al. 2000). By the 1980s, however, Takotna residents began to notice adult salmon in the river again. Around 1990 rod and reel fishers began to catch coho salmon while fishing for northern pike *Esox lucius* (Dick Newton, local resident, Takotna; personal communication). During an aerial survey in 1994, an experienced ADF&G fishery biologist observed several thousand chum salmon and some Chinook salmon in Fourth of July Creek, but few salmon were observed elsewhere in the drainage (Burkey and Salomone 1999).

The perception of recovering salmon abundance inspired interest among ADF&G and local residents and prompted the development of a project designed to document the numbers of spawning salmon returning to the Takotna River. Initially, high school students built a salmon counting tower that they operated from 1995 to 1999, but success was limited because of poor water clarity, periodic high water levels, and organizational difficulties (Molyneaux et al. 2000). The monitoring project transitioned to a resistance board weir in 2000 (Schwanke et al. 2001) as one of several initiatives started in the late 1990s to improve salmon escapement monitoring in the Kuskokwim Area. The Takotna River weir has operated successfully every year since inception and is currently the farthest upstream ground-based salmon escapement-monitoring project in the Kuskokwim River drainage. As such, the project is integrated into drainage-wide initiatives to understand the dynamics of Kuskokwim River salmon.

The Takotna River weir is operated jointly by ADF&G Division of Commercial Fisheries and the Takotna Tribal Council (TTC). Staff from ADF&G help oversee inseason operations and serve as the principal agent for data management, data analysis, and report writing. The TTC provides most of the field crew and coordinates much of the preseason preparations and inseason operations.

OBJECTIVES

The annual objectives of the Takotna River escapement monitoring project (FIS 05-304) were to:

1. Determine daily and total annual escapements of male and female Chinook, chum, sockeye *O. nerka*, and coho salmon in the Takotna River upstream of the community of Takotna during the target operational period of 24 June to 20 September;
2. Estimate the age, sex, and length (ASL) composition of total annual Chinook, chum, and coho salmon escapements from a minimum of 3 pulse samples, 1 collected from each third of the run, such that 95% simultaneous confidence intervals for the age composition in each pulse are no wider than 0.20 ($\alpha = 0.05$ and $d = 0.10$);
3. Monitor environmental variables; and,
4. Integrate with other research initiatives in the Kuskokwim River drainage by:

a. Serve as a monitoring location for Chinook salmon equipped with radio transmitters and anchor tags deployed as part of *Kuskokwim River Chinook Salmon Run Reconstruction*; and,

b. Serve as a monitoring location for sockeye salmon equipped with radio transmitters deployed as part of *Kuskokwim River Sockeye Salmon Investigations*.

The primary goal of this report is to summarize results for the 2007 field season at the Takotna River weir. Secondarily, we intend to provide broader spatial and temporal context by comparing results from the 2007 season at Takotna River weir with historical data, findings from other related projects, and activities in the commercial and subsistence fisheries. 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 might change. Therefore, readers should consult the original documents prior to referencing results from other projects, especially those listed as "*In prep*". 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 view broader spatial and temporal trends with caution.

METHODS

STUDY AREA

The Takotna River originates in the central Kuskokwim Mountains of the upper Kuskokwim River basin (Figure 1). Formed by the confluence of Moore Creek and Little Waldren Fork, the river flows northeasterly and passes the community of Takotna at river kilometer (rkm) 80, before turning southeasterly near the confluence of the Nixon Fork at rkm 24 (Figure 2; Brown 1983). The Tatalina River joins at rkm 4.8, and then the Takotna River empties into the Kuskokwim River across from McGrath at rkm 752 of the Kuskokwim River.

The Takotna River is about 160 km in length and drains an area of 5,646 sq km (Brown 1983). The river is shallow with many meanders from its headwaters to the community of Takotna, but gradually becomes deeper downstream of that point, especially after the confluence of the Nixon Fork. In the lower reaches, the current is sluggish and the channel width averages 122 to 152 m. The river's average slope is about 89 cm per km (Brown 1983).

At normal flow the Takotna River has a nominal load of suspended materials; however, the water is stained due to organic leaching. The Nixon Fork and Tatalina rivers drain extensive bog flats and swampy lowlands, but the remainder of the basin is primarily upland spruce-hardwood forest (Brown 1983; Selkregg 1976). White spruce *Picea glauca*, birch *Betula spp.*, and aspen *Populus trenuloides* are common on moderate south-facing slopes, while black spruce *P. mariana* is more characteristic of northern exposures and poorly drained flat areas. The understory consists of spongy moss and low brush on the cool, moist slopes, grasses on the dry slopes, and willow *Salix spp.* and alder *Alnus spp* in the higher open forest near the timberline.

WEIR DESIGN

Installation Site

Each year the weir is installed approximately 185 m upstream of the Takotna River Bridge (Costello et al. 2007). The site is about 3 rkm upstream of the village of Takotna and 83 rkm from the confluence with the Kuskokwim River (Figure 2). The weir site is downstream from most known spawning areas.

At the weir site, the Takotna River is approximately 85 m wide and 4 m deep from bank level to the bottom of the channel. During normal summer operations, river depth is about 1 m in the thalweg. The weir is positioned in the center of a 1 km stretch of relatively straight channel, with a large floodplain to the south. Vegetation on the floodplain is mostly grasses with interspersed patches of alder and willow, which suggests an intermediate stage of succession.

Construction

The Takotna River weir is termed a "floating panel" resistance board weir. Tobin (1994) describes details of the design and construction and Schwanke et al. (2001) describes the changes implemented for the Takotna River weir. Each year the weir is installed across the entire 110 m channel following the techniques described by Stewart (2003). The substrate rail and resistance board panels cover the middle 79-m (260-ft) portion of the channel, and fixed weir materials extend the weir 3 m (10 ft) to each bank. The pickets are 3.33 cm (1-5/16 in) in diameter and spaced at intervals of 6.67 cm (2-5/8 in), leaving a gap of 3.33 cm (1-5/16 in) between each picket. Stewart (2002, 2003) describes details of panel construction and installation.

Most fish passage intentionally occurs through the fish trap, which is annually installed within the deeper portion of the stream channel. The fish trap is about 2.5 m long (parallel to channel) and 1.5 m wide (perpendicular to channel) and has 2 gates: 1 facing downstream and 1 facing upstream. After all the panels are installed across the river, 1 is removed where the trap is to be installed and modified weir panels are fastened to the side of each panel adjacent the gap. The trap is lowered into the river just upstream of the rail with its downstream gate centered on the gap. The modified panels are butted against the trap frame and maintain the weir's integrity. The trap can be easily configured to pass fish freely upstream or to capture individuals for sampling.

Installation of 2 skiff gates allows boats to pass with little or no involvement from the weir crew. Both skiff gates comprise the same modified weir panels described by Schwanke et al. (2001), but 1 gate is modified to accommodate propeller-driven boats. Boats with jet-drive engines are the most common and can pass up or downstream over the primary skiff gate after reducing speed to 5 miles per hr (8 km per hr) or less. Operators of propeller-driven boats can pass upstream and downstream over the modified boat gate described by Costello et al. (2005).

To accommodate downstream migration of longnose suckers *Catastomas catostomas* and other resident species, downstream passage chutes are incorporated into the weir once resident species are observed congregating upstream. At locations where downstream migrants are most concentrated, chutes are created by releasing the resistance boards on 1 or 2 adjacent weir panels so the distal ends dipped slightly below the stream surface. The chute's shallow profile guides downstream migrants, but prevents upstream salmon passage. The chutes are monitored and adjusted to ensure salmon are not passing upstream. Downstream salmon passage is not enumerated; however, few salmon have been observed passing downstream over these chutes and their numbers are not considered significant.

Maintenance

The weir is cleaned several times each day, typically at the end of a counting shift. To clean the weir, a technician walks along the floating end, which partially submerges each panel and allows the current to wash debris downstream. A rake is used to push larger debris off the weir. Each time the weir is cleaned panels and other weir components are inspected for damage. Periodically, a more thorough inspection is performed by snorkeling along the rail.

ESCAPEMENT MONITORING

The Takotna River weir operates according to a "target operational period" that encompasses virtually the entire runs of Chinook, chum, and coho salmon. Having a target operational period facilitates historical comparisons. The target operational period for the Takotna River weir has been established as 24 June to 20 September. Actual operational dates may vary due to stream conditions and anomalies in run timing and/or abundance. Reported daily and annual Chinook, chum, coho, and sockeye salmon escapements consist of observed plus any estimated passage. Counts of all other species, including pink salmon, are reported as observed passage; expected missed passage is not estimated.

Passage Counts

Passage counts are conducted periodically during daylight hours. Substantial delays in fish passage occur only at night or during ASL sampling. Crew members visually identify the species and sex of each salmon as it passes upstream and records it by species on a multiple tally counter. Counting continues for a minimum of 1 hour or until passage substantially decreases. Counting effort is 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 record 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 are copied to logbook forms. These counts are reported each morning to ADF&G staff in Bethel.

The live trap is used as the primary means of upstream fish passage. Fish are counted as they enter the downstream end of the trap. Proper identification is enhanced by use of a clear-bottom viewing box that reduces glare and water turbulence. In addition to aiding in species identification, this tool allows observers to see and thus trap tagged fish in support of tagging projects, such as *Kuskokwim River Chinook Salmon Run Reconstruction* and *Kuskokwim River Sockeye Salmon Investigations* in 2007. Other methods are occasionally used when salmon are reluctant to enter the fish trap, such as during periods of extreme low water. Costello et al. (2007) describes other methods.

Visual determination of sex is possible due to advanced sexual dimorphism. Females are obviously swollen and round behind the pectoral fins, have blunt (bullet-shaped) heads, and swim with steady, wide strokes. Males exhibit an exaggerated elongation of the kype, are streamlined and muscular in appearance, and swim with short, powerful strokes. Though some variation exists, these differences are applicable to all salmon species. Sex identification is aided by the combination of a “flash panel” on the river bottom, which improves color contrast, and a viewing window on the surface that reduces glare and turbulence.

Estimating Missed Passage

To better assess annual run size of each species of salmon and to facilitate comparison among years, upstream salmon passage is estimated for days when the weir is not operational within the target operational period. When historical data indicate that passage of a particular species on an inoperable day is probably negligible, passage is assumed to be zero without performing any calculations. However, when historical records indicate that passage of a particular species is probably considerable, 1 of the 3 formulas listed below are used to calculate potential missed passage. The method used depends on the duration and timing of the inoperable periods.

Single Day

When the weir is not operational for part or all of 1 day, an estimate for the inoperable day is calculated using the following formula:

$$\hat{n}_{d_i} = \left(\frac{(n_{d-2} + n_{d-1} + n_{d+1} + n_{d+2})}{4} \right) - n_{o_i} \qquad (1)$$

where

n_{d_I-1}, n_{d_I-2} = observed passage of 1, 2 days before the weir was washed out;

n_{d_I+1}, n_{d_I+2} = observed passage of 1, 2 days after the weir was reinstalled; and,

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

Linear Method

When the weir is not operational for 2 or more days and later becomes operational, passage estimates for the inoperable days are calculated using the following formula:

$$\hat{n}_{d_i} = (\alpha + \beta \cdot i) - n_{o_i} \qquad (2)$$

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

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

where

I = number of inoperative days ($I > 2$), and

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

Proportion Method

In circumstances when the weir does not first become operational until after the target start date (24 June) or when the weir ceases operating long before the target end date (20 September) daily passage for inoperable days is estimated using passage data from another year at the Takotna River weir or from the present year at a neighboring project. The dataset used to model escapement for a particular situation is selected because it exhibits similar passage patterns to the incomplete dataset. With this method, daily passage estimates are calculated using the following formula:

$$\hat{n}_{d_i} = \left(\frac{\left(n_{md_i} \times \sum n_{d_1} \right)}{\sum n_{md_1}} \right) - n_{o_i} \tag{3}$$

where

n_{md_i} = passage for the i^{th} day in the model data;

$\sum n_{d_1}$ = cumulative passage;

$\sum n_{md_1}$ = cumulative passage of the model data for the corresponding time period; and,

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

Estimates Required in 2007

Presented here in chronological order, the "linear method" was used to estimate missed Chinook, chum, coho, and sockeye salmon passage during the inoperable period that occurred between 6 and 8 August. Passage of Chinook, chum, and sockeye salmon potentially missed when the weir became inoperable on 20 September, the last day of the target operational period, was assumed to be zero without performing any calculations. Coho salmon passage on this day was extrapolated using daily passages on the 12 preceding days. The "proportion method" was not used in this case because the sources of error associated with using a model dataset were thought to outweigh the benefits.

Carcass Counts

In 2007 the weir was cleaned several times each day, typically at the beginning and end of counting shifts. Spawned out salmon and carcasses of dead salmon (both hereafter referred to as carcasses) that wash up on the weir were counted by species and sex and passed downstream. Daily and cumulative carcass counts were copied to logbook forms.

Age, Sex, and Length Composition

The ASL composition of the total Chinook, chum, and coho salmon escapements were estimated by sampling a fraction of the fish passage and applying the ASL composition of those samples to the total escapement as described in DuBois and Molyneaux (2000).

Sample Collection

The crew at the Takotna River weir employed standard sampling techniques as described by DuBois and Molyneaux (2000). For chum and coho salmon, a pulse sampling design was used in which moderate sampling was conducted for a few days followed by several days without sampling. The goal was to obtain a minimum of 3 pulse samples (one from each third of the run) to account for temporal dynamics in ASL composition. The intended pulse size was 200 for chum and 170 for coho salmon.

The pulse sample design commonly used at other locations for Chinook salmon was not strictly followed at Takotna River weir in 2007 due to low abundance. Optimally, crews would sample

210 Chinook salmon in 3 pulses, but Chinook salmon abundance in the Takotna River is too low for this to be feasible. Instead, limited sampling was conducted continuously between 30 June and 29 July. Sampling effort was greatest during periods of high Chinook salmon passage to maximize sample size without greatly hindering chum salmon passage.

Sample sizes were selected based on criteria suggested by Bromaghin (1993). Generally, sample sizes are selected so that the simultaneous 95% confidence interval for estimates of age and sex composition proportions would be no wider than 0.20 (Bromaghin 1993) per pulse. Sample sizes were chosen based on the assumed number of age/sex categories in the population and the number of samples needed to properly define each category. The assumed number of age/sex categories for each species is based on historical determination of age/sex structure within Kuskokwim River salmon populations. The number of age/sex categories assumed for Takotna River Chinook, chum, and coho salmon were 10, 8, and 6, respectively. Target sample sizes for all species were increased by about 10% from those 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, 1 sample period representing each third of the run, to account for temporal dynamics in the ASL composition. Sampling efforts often fell short of sampling goals; however, known population size as determined by weir counts allows for the application of a finite population correction, which allows intra-annual variations in age composition to be reasonably investigated despite relatively low sample sizes (Toshihide Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication).

To facilitate sampling, salmon were trapped by leaving the entrance gate open while leaving the exit gate shut. The entrance gate was “set” by securing the 2 doors of the gate such that they formed a V-shape, similar in principle to a fyke net. Fish could swim freely into the holding box but the V-shape positioning of the entrance gate prevented them from easily escaping. The holding box was allowed to fill with fish until a reasonable number was inside. Crew members used a dip net to capture fish within the holding box. To obtain length data and aid in scale collection, fish were removed from the dip net and placed into a partially submerged “fish cradle”. Three scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards (DuBois and Molyneaux 2000). Sex was determined through visual examination of the external morphology focusing on the prominence of a kype, roundness of the belly, and the presence or absence of an ovipositor. Length was measured to the nearest millimeter from mid-eye to tail-fork (METF) using a straight-edged meter stick. Sex and length data were recorded on standardized numbered data sheets that correspond with numbers on the gum cards on which the scales were placed. After sampling, each fish was released upstream of the weir and the procedure was repeated until the holding box was emptied to ensure no bias in selection.

Additional samples were collected for difficult species (i.e. Chinook and sockeye salmon) through the process of “active sampling”. Active sampling required that an observer be positioned above the downstream end of the trap to view fish passing upstream. In this method of obtaining samples, both the entrance and exit gates remained open, which allowed most species to pass unimpeded and increased current flow through the trap. Increased current flow appeared to encourage fish to enter. When the targeted species entered the trap, the observer would immediately close both the entrance and exit gates, thereby actively trapping the fish for sampling. This method was useful in isolating the relatively few Chinook salmon from larger volumes of chum passing at the same time.

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 Costello et al. (2007). 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. 2006a).

Estimating Age, Sex, and Length Composition of Escapement

ADF&G staff in Bethel and Anchorage aged scales and processed the ASL data. DuBois and Molyneaux (2000) describe details. For each sampled species, 2 types of summary tables were generated from this process: one described the age and sex composition and the other described length statistics. These summary tables illustrated 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, and then applying the ASL composition of individual temporal samples to the corresponding temporal stratum, and finally summing all strata to generate the estimated ASL composition for the season. This procedure ensured that the ASL composition of the total annual escapement was weighted by the abundance of fish in the escapement rather than the abundance of fish in the samples. For example, if 6 pulse samples of chum salmon had been collected, the season would have been partitioned into 6 temporal strata with dates selected such that each stratum encompassed 1 pulse sample. Hence, a hypothetical sample of 200 chum salmon collected from 3 to 4 July would be used to estimate the ASL composition of the hypothetical escapement of 2,000 chum salmon that passed the weir during the temporal stratum that might extend from 1 to 7 July. This procedure would be repeated for each temporal stratum, and the estimated age and sex composition for the total annual escapement would be calculated as the sum of chum salmon in all strata. In similar fashion, the estimated mean length composition for the total annual escapement would be calculated by weighting the mean lengths in each temporal stratum by the escapement of chum salmon that passed the weir during that stratum. Confidence intervals for estimates of length composition were constructed based on the method set forth by Thompson (1992, p.105).

Fish ages are mostly reported here using European notation. European notation is composed of 2 numerals separated by a decimal. The first numeral is the number of winters the juvenile has spent in freshwater and the second numeral is the number of winters it spent in the ocean as determined from scale annuli (Groot and Margolis 1991). Total age of a fish is equal to the sum of these 2 numerals, plus 1 year to account for the winter when the egg was incubating in gravel. For example, a Chinook salmon described as age-1.4 is actually 6 years of age. European notation will be used throughout this document to represent specific age classes and fish exhibiting 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.

Visual Sex Determination

Sex was determined for every salmon passing upstream of the weir through observation of sexually dimorphic characteristics. Sex compositions derived visually and through ASL were compared to assess possible biases in each method and to test the potential of visual sex determination in clear water tributaries. Each ASL stratum was considered independently, with the sex composition determined by ASL compared to the sex composition determined visually for the same time period.

WEATHER AND STREAM OBSERVATIONS

Weather and stream observations were taken twice daily at approximately 0800 and 1700 hours. Air and water temperatures (in °C) were measured using a calibrated thermometer. Air temperatures were obtained from a thermometer mounted semi-permanently in the shade near the weir site and stream temperature was determined by submerging the thermometer below the water's surface until the temperature reading stabilized. Temperature readings were recorded in the logbook, along with notations about cloud cover, wind direction, wind speed, and precipitation. Wind speed was estimated to the nearest 5 miles per hour, and daily precipitation was measured (in millimeters) using a calibrated rain gauge. Water temperature readings were also obtained from a thermograph installed midstream just upstream from the weir. The thermograph was programmed to record water temperature every hour (on the hour) during the weir operational period. Records were retrieved at the end of the season and archived for future comparisons.

Daily operations included monitoring river depth with a standardized staff gauge. The staff gauge consisted of a metal rod driven into the stream channel with a meter stick attached. The height of the water surface, as measured from the meter stick, represented the "stage" of the river above an established datum plane. The staff gauge was calibrated to the datum plane by a semi-permanent benchmark located about 6 m from the river bank and consisted of a nail driven into a tree. The height of the nail corresponded to stage measurements of 300 mm relative to the datum plane. River stage was measured at approximately 0800 and 1700 hours.

RELATED FISHERIES PROJECTS

Kuskokwim River Chinook Salmon Run Reconstruction

Objectives of the *Kuskokwim River Chinook Salmon Run Reconstruction* project (henceforth referred to as the "run reconstruction project") included investigating the relationship between drainage-wide abundance estimates and known tributary escapements to derive a statistical model that would compute historical annual abundance estimates based on known tributary escapements. The run reconstruction project utilized data obtained from the inriver abundance project and most of the methods used by the latter were implemented into the experimental design of the former. The former inriver abundance project provided abundance estimates for each year between 2002 and 2006. In an effort to increase the power of the model and since the infrastructure was already in place investigators decided to continue radio-tagging and anchor-tagging Chinook salmon in 2007 to achieve another annual abundance estimate. As with the in-river abundance project, radio transmitters were inserted into select Chinook salmon with lengths greater than 450 mm caught near Kalskag (rkm 270) following methods described by Stuby (2007). Radio-tagged fish were detected by several tracking stations spread throughout the drainage and every weir upstream of the tagging locations was accompanied by a tracking station (Figure 1). Radio-tags are not visible when fish are viewed from above, so every radio-tagged fish was fitted with an anchor tag that allowed weir crews to identify and trap radio-tagged fish for tag number recovery. Tag data recovered by weir crews supplemented, and sometimes verified, tracking station recovery information. This system of weirs and tracking stations allowed for: (1) the development of tagged-to-untagged ratios, (2) a means to test potential tagging bias, and (3) the development of annual abundance estimates for most of the drainage.

With the run reconstruction project, additional attention was given to the Aniak River drainage for which an annual abundance estimate had remained elusive. In 2006 and 2007, a weir and tracking station were installed together on an upper-river tributary of the Aniak River (specifically, the Salmon River) to generate a tagged-to-untagged ratio assumed to be representative of the entire Aniak River drainage. Consequently, Aniak River abundance estimates are available for 2006 and 2007.

The location of the tracking station relative to the weir differed slightly at each weir location. At the Takotna River weir site, the receiver station was placed about 300 m downstream of the weir. Due to the orientation of the receiver station to the weir, fish were detected passing the receiver station before they passed upstream of the weir. 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 Kalskag tagging site.

The overall cost to initiate run reconstruction project was relatively little because most of the infrastructure required to operate the project was already installed. The presence of weirs and other escapement monitoring projects was a critical component that satisfied the requirement for reliable escapement data. Nearly the entire network of stationary tracking stations and much of the tagging equipment was installed for previous and concurrent radiotelemetry-based projects, including *Inriver Abundance of Chinook Salmon in the Kuskokwim River* (Stuby 2007), *Kuskokwim River Sockeye Salmon Investigations* (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication), and *Assessment of Chinook, Chum, and Coho Salmon Escapements in the Holitna River Drainage Using Radiotelemetry* (Stroka and Brase 2004). Most of the tagging equipment was provided by these and a former project entitled *Kuskokwim River Salmon Mark-Recapture Project* (Pawluk et al. 2006). In subsequent text, these project names will be truncated to the following: “inriver abundance project”, “sockeye salmon investigations project”, “Holitna River telemetry project”, and “mark–recapture project”.

Kuskokwim River Sockeye Salmon Investigations

The Takotna River weir acted as a platform for the project entitled *Kuskokwim River Sockeye Salmon Investigations* in 2007. 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 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 Chinook salmon radio-tagging efforts, radio transmitters were inserted into sockeye salmon caught near Kalskag. Radio-tagged fish were also equipped with an anchor 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. In 2006, juvenile salmon were sampled from various habitat types throughout the Holitna River 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.

RESULTS

ESCAPEMENT MONITORING

Favorable water conditions motivated early weir installation in 2007, and installation was complete by 20 June. Complete weir removal was not achieved until early October because earlier removal efforts were impaired by unseasonably high water levels in September. Weir integrity was breached twice during the target operational period. The most consequential breach occurred between 6 and 8 August when water levels exceeded the operational limit for the weir. The second incidence is when the weir became inoperative on 20 September, the last day of the target operational period.

Chinook Salmon

A total of 419 Chinook salmon passed the weir between 20 June and 20 September (Table 1; Appendix A1). Of those, 418 passed during the target operational period that began on 24 June and ended on 20 September. Calculations were performed to estimate the Chinook salmon passage that occurred between 6 and 8 August. Chinook salmon passage was assumed to be zero on 20 September. These daily passage estimates amounted to 1.9% of the annual escapement in 2007. The first Chinook salmon was observed on 20 June and the last was observed on 15 September (Table 1). Daily passage peaked at 42 on 11 July. Based on total estimated escapement during the target operational period, the median passage date was 12 July and the central 50% of the run occurred between 9 and 20 July (Figure 3).

Chum Salmon

A total of 8,907 chum salmon passed the weir between 20 June and 20 September (Table 1; Appendix A2). Of those, 8,900 passed during the target operational period that began on 24 June and ended on 20 September. Calculations were performed to estimate the chum salmon passage that occurred between 6 and 8 August. Chum salmon passage was assumed to be zero on 20 September. These daily passage estimates amounted to 0.5% of the annual escapement in 2007. The first chum salmon was observed on 22 June and the last was observed on 19 September (Table 1). Daily passage peaked at 533 on 11 July. Based on total estimated escapement during the target operational period, the median passage date was 16 July and the central 50% of passage occurred between 11 and 22 July (Figure 3).

Coho Salmon

A total of 2,853 coho salmon passed the weir between 20 June and 20 September (Table 1; Appendix A3). None of these passed outside of the target operational period. Calculations were performed to estimate the coho salmon passage that occurred between 6 and 8 August and 20 September. Combined, daily passage estimates amounted to 2.0% of the annual escapement in 2007. Coho salmon were first observed on 23 July and nearly every day thereafter before weir operations ceased on 20 September (Table 1). Daily passage peaked at 232 on 29 August. Based on total estimated escapement during the target operational period, the median passage date was 25 August and the central 50% of passage occurred between 19 and 30 August (Figure 3).

Sockeye Salmon

A total of 14 sockeye salmon passed the weir between 20 June and 20 September (Table 1). None of these passed outside of the target operational period. Calculations were performed to estimate the sockeye salmon passage that occurred between 6 and 8 August. Sockeye salmon passage was assumed to be zero on 20 September. These daily passage estimates amounted to 14.3% of the annual escapement in 2007. The first sockeye salmon was observed on 27 July and the last was observed on 10 September (Table 1). Daily passage never exceeded 2 fish. Based on total estimated escapement during the target operational period, the median passage date was 10 August and the central 50% of passage occurred between 8 and 24 August (Table 1).

Other Species

Pink Salmon

Pink salmon *O. gorbuscha* are extremely rare in the Takotna River and none were observed in 2007.

Resident Species

Four resident fish species were observed passing upstream and downstream over the weir in 2007. Longnose suckers were the most abundant non-salmon species passing the weir and a total of 205 were observed passing during operational days within the target operational period (Appendix B1). Longnose suckers were first observed on 26 June and the last was observed on 12 September. Passage was not estimated for non operational days. Other fish that were observed passing upstream included 48 Arctic grayling *Thymallus arcticus*, 24 whitefish *Coregonus spp*, and 17 northern pike. Passage of resident species was not estimated for days when the weir was not operational.

Carcass Counts

A total of 511 salmon carcasses were recovered from the Takotna River weir in 2007 (Appendix C1). A total of 58 male and 4 female Chinook salmon carcasses were recovered (14.8% of annual escapement) from 19 July through 16 September. A total of 309 male and 114 female chum salmon carcasses were recovered (4.8% of annual escapement) from 12 July through 15 September. A total of 21 male and 4 female coho salmon carcasses were recovered (0.9% of annual escapement) from 13 August through 17 September. The 1 male sockeye salmon carcass that was recovered on 18 September represented 7.1% of annual escapement. No pink salmon carcasses were recovered.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Chinook salmon ASL sampling at the Takotna River weir was conducted every day between 30 June and 29 July, resulting in a total sample of 325 fish. Of those, age was determined for 269 fish (83% of the total sample), or 64.4% of the total Chinook salmon escapement (Table 2). The total sample size and temporal distribution was more than adequate to estimate annual age composition. The total annual escapement was partitioned into 3 temporal strata based on the temporal distribution of the sampling effort, with sample sizes of 99, 96, and 74 aged (i.e. age was determined) fish per stratum (Table 2). These sample sizes were considerably below the in-season goal of 210 fish per pulse derived via methods in Bromaghin (1993). However, the application of the finite population correction revealed that these sample sizes were large enough to satisfy the requirement that confidence intervals be no wider than 0.20. Thus, intra-annual variations in age composition could be reasonably investigated despite low sample sizes.

Age Composition

Most Chinook salmon age *groups* were comprised of only 1 age *class*; that is, all 4-year-old fish were of the 1.2 age class; all 5-year-old fish were of the 1.3 age class; and all 7-year-old fish were of the 1.5 age class (Table 2). Of the 6-year-old Chinook salmon, all but 1 fish were of the 1.4 age class. The 2007 Chinook salmon escapement was dominated by 3 age classes that when combined comprised 99% of the total annual escapement (Table 2). Age 1.2 was the most abundant age class (50.6%), followed by age 1.3 (33.5%), and age 1.4 (14.8%). Seven-year-old fish comprised only a tiny fraction of escapement in 2007 (0.8%) and no 3- or 8-year-old fish were found in the sample. The percentage of age-1.2 fish decreased as the run progressed while the proportion of age-1.3 fish increased (Table 2; Figure 4). The percentage of age-1.4 fish varied during the run and no consistent pattern was observed except that their proportional contribution increased considerably near the end of the run. Of the 3 dominant age classes (age 1.2, 1.3, and 1.4), the percentage of age-1.2 fish was highest and age-1.4 fish the lowest in the first 2 strata; however, during the last stratum both the percentage of age-1.4 and age-1.3 fish exceeded that of fish age 1.2 (Table 2; Figure 4). The greatest intra-seasonal variation occurred among age-1.2 fish whose contribution ranged from a minimum of 21.6% to a maximum of 67.7%.

Sex Composition

Based on ASL sampling, the ratio of males to females in the Chinook salmon escapement that passed the Takotna River weir was approximately 8:1 (Table 2). Female Chinook salmon comprised 12.9% of the total annual escapement based on weighted ASL samples. Sex composition consistently increased throughout the run; females represented only a small fraction of the total escapement in the first 2 sampling strata (3.0% and 7.3%, respectively), but their proportion increased to 31.1% in the last stratum with the arrival of more age-1.4 fish (Table 2; Figure 5). The female escapement was dominated (59.3%) by older, age-1.4, individuals. Conversely, the male escapement was largely comprised of younger age-1.2 and age-1.3 individuals, representing 50.6% and 29.2% of the total male escapement, respectively.

The visual method yielded a sex ratio similar to that derived from ASL sampling. Based on this method, female Chinook salmon comprised 12.9% of the total annual escapement. Stratification of male and female passage counts into the same temporal strata used in the process of estimating intra-annual trends in ASL composition revealed that percent females tended to increase over the course of the Chinook salmon run in 2007. Determined through regular passage counts, females comprised 3.0%, 7.3%, and 31.1% of total Chinook salmon escapement during the first, second, and third stratum, respectively.

Length Composition

Analysis of length composition suggested partitioning by sex and age class. The length of female Chinook salmon ranged from 687 to 934 mm, and males ranged from 433 to 982 mm (Table 3). In the 2 age classes that contained considerable numbers of both males and females (ages 1.3 and

1.4), female Chinook salmon were larger at age than males and average length increased with age for both females and males (Figure 6). Average length of age-1.3 females was 751 mm while the average length of age-1.4 females was 819 mm. Average lengths for male age-1.2, -1.3, and -1.4 Chinook salmon were 527 mm, 673 mm, and 772 mm, respectively. One male age-2.3 Chinook salmon was sampled with a length of 615 mm. Two females of the -1.5 age class were sampled with lengths of 721 and 934 mm. Considering the variation within an age class, average lengths-at-age varied little during the run for both male and female Chinook salmon (Table 3; Figure 7).

Chum Salmon

Sampling goals for chum salmon were achieved in 2007. Intensive sampling was conducted during 5 sampling pulses distributed evenly throughout the chum salmon run for a total of 1,050 fish. Of those, age was determined for 946 chum salmon (90% of the total sample), or 10.6% of the total annual chum salmon escapement in 2007 (Table 4). The chum salmon run was partitioned into 5 temporal strata based the temporal distribution of the sampling effort, with sample sizes ranging between 182 and 197 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 Takotna River weir in 2007.

Age Composition

The chum salmon escapement that passed the weir was largely represented by 4-year-old individuals, which comprised 60.1% of the total chum salmon escapement in 2007 (Table 4). Five-year-old individuals comprised 33.7% of the escapement, followed by 3-year-old individuals at 3.4% and 6-year-old individuals at 2.7% (Table 4). Since virtually all chum salmon out-migrate the first spring or summer after emergence, all 3-year-old individuals were of the 0.2 age class, all 4-year-old individuals were of the 0.3 age class, all 5-year-old individuals were of the 0.4 age class, and all 6-year-old individuals were of the 0.5 age class. Relative age composition changed little over the course of the run (Table 4; Figure 8). The proportion of age-0.3 chum salmon ranged from a minimum of 52.3% early in the run to a maximum of 66.1% near the end while the proportion of age-0.4 individuals ranged from a maximum of 40.0% early in the run to a minimum of 28.5% near the end. The relative age structure summarized for the entire run (i.e. age-0.3 fish being dominant followed by age-0.4, -0.2, and -0.5 fish) was generally maintained in each temporal strata (Table 4).

Sex Composition

Based on ASL sampling, the proportion of males and females in the chum salmon escapement that passed the Takotna River weir was about equal (Table 4). Female chum salmon comprised 47.8% of the total annual escapement based on weighted ASL samples and sex composition varied little during the run (Figure 5). The proportional contribution of females was considerably lower in the first strata, but in others the proportion of females remained constant and near 50%. Both the male and female escapement was dominated by age-0.3 individuals (57.0% for males, 63.5% for females).

The visual method yielded a sex ratio similar to that derived from ASL sampling (Figure 9). Based on this method, female chum salmon comprised 50.7% of the total annual escapement. Stratification of male and female passage counts into the same temporal strata used in the process of estimating intra-annual trends in ASL composition revealed that percent females remained relatively consistent over the course of the run in 2007 (Figure 9). The proportional contribution of females in strata 1–6 was 49.0%, 49.8%, 49.3%, 53.1%, and 52.4%.

Length Composition

Analysis of length composition suggested partitioning by sex and age class. The length of female chum salmon ranged from 477 to 608 mm, and males ranged from 433 to 667 mm (Table 5). Male chum salmon were generally larger at age than females, and average length increased with age for both males and females (Figure 6). Average lengths for female age-0.2, -0.3, -0.4 and -0.5 fish were 526, 532, 533, and 545 mm, respectively. Average lengths for male age-0.2, -0.3, -0.4, and -0.5 fish were 520, 554, 569, and 574 mm, respectively. For both males and females, average length at age varied little during the run (Table 5; Figure 10).

Coho Salmon

Coho salmon ASL sampling at the Takotna River weir was conducted in 3 sampling pulses distributed evenly throughout the coho salmon run, for a total of 522 fish. Of those, age was determined for 441 coho salmon (85% of the total sample), or 15.5% of the total annual coho salmon escapement (Table 6). The total sample size and temporal distribution was more than adequate to estimate annual age composition. The coho salmon run was partitioned into 3 temporal strata based on the temporal distribution of sampling effort, with sample sizes if 160, 141, and 140 aged fish per stratum (Table 6). These sample sizes were below the in-season goal of 170 fish per pulse derived via methods in Bromaghin (1993). However, the application of the finite population correction revealed that the sample sizes in the first and last strata (160 and 140) were large enough to satisfy the requirement that confidence intervals be no wider than 0.20. The sample collected during the middle strata was only slightly below that required given the moderate population size, so intra-annual variations in age composition can be reasonably investigated.

Age Composition

The coho salmon escapement that passed the weir was dominated by 4-year-old individuals, which comprised 92.5% of the total coho salmon escapement at the Takotna River weir. Three-year-old and 5-year-old fish comprised 2.2% and 5.2% of the escapement, respectively (Table 6). Since virtually all coho salmon spend only 1 winter at sea before returning to spawn, all 3-year-old fish were of the 1.1 age class, all 4-year-old fish were of the 2.1 age class, and all 5-year-old fish were of the 3.1 age class (Table 6). No individuals from other age classes were sampled. Some intra-annual variation in age composition was observed, but variations tended to be slight. For example, the percentage of age-2.1 fish increased continually during the run, but only from a minimum of 91.3% to a maximum of 95.0% (Figure 11). Conversely, the percentage of age-1.1 fish steadily decreased from 5.0% to 0.7%. The percentage of age-3.1 fish varied between 3.8% and 6.4%, the highest being in the middle stratum.

Sex Composition

Based on ASL sampling, the proportion of males and females in the coho salmon escapement that passed the Takotna River weir was about equal (Table 6). Female coho salmon comprised 52.3% of the total annual escapement based on weighted ASL samples. Sex composition varied considerably during the run (Table 6). The proportional contribution of females increased steadily over the course of the run, comprising 46.2%, 53.2%, and 57.9% of escapement during the first, second, and third strata, respectively (Table 6; Figure 9). Both the male and female escapement was dominated by age-2.1 individuals, representing 92.1% and 92.9% of the total male and female escapement, respectively.

The visual method yielded a sex ratio similar to that derived from ASL sampling (Figure 9). Based on this method, female coho salmon comprised 49.0% of the total annual escapement. Stratification of male and female passage counts into the same temporal strata used in the process of estimating intra-annual trends in ASL composition revealed that percent females tended to increase over the course of the coho salmon run in 2007, although not to the same extent as with the ASL sampling method (Figure 9). Percent female in the coho salmon escapement was 45.1% in the first stratum, 49.6% in the second, and 52.3% in the third.

Length Composition

Analysis of length composition suggested partitioning by sex and age class. The length of female coho salmon ranged from 463 to 614 mm, and males ranged from 371 to 627 (Table 7). Female coho salmon were generally larger at age than males, and average length increased with age for both males and females (Figure 6). Average lengths for female age-1.1, -2.1, and -3.1 were 532, 545, and 558, respectively. Average lengths for male age-1.1, -2.1, and -3.1 fish were 514, 532, and 536 mm, respectively. For both males and females average length at age varied little during the run (Figure 12).

WEATHER AND STREAM OBSERVATIONS

In 2007, water levels at the Takotna River weir ranged from 38.0 to 140.0 cm, with an average of 72.1 cm for the overall operational period (Appendix D1). During installation and for approximately 2 weeks afterwards daily water levels were below historical per-date minimums (Figure 13). Beginning on 11 July, however, daily water levels were above average for the duration of the season. In fact, historical daily maximum levels were exceeded several times during the season, the most severe of which forced weir operations to cease in early August.

Based on twice-daily thermometer observations, water temperature in the Takotna River ranged from 6.0 to 18.0°C and averaged 11.6°C for the overall operational period (Appendix D1). Based on hourly data logger readings, daily average water temperature ranged from 6.5 to 16.9°C and averaged 12.0°C for the overall operational period (Appendix D2). Investigated on a daily basis, differences between the 2 methods were not great (Figure 14). Daily water temperature fluctuated considerably throughout the 2007 operational period but remained within the historical range nearly the entire duration of the season (Figure 15). On a couple of occasions, daily water temperatures dropped below historical daily minimums or exceeded daily historical maximums. Overall, however, water temperatures observed in the Takotna River in 2007 were typical for this location (Figure 15).

Air temperature at the weir ranged from 3.0 to 28.5°C, with an average air temperature of 14.7°C for the operational period (Appendix D1). Air temperature is not thought to directly affect fish behavior around the Takotna River weir, so it will not be discussed in detail in this report.

RELATED FISHERIES PROJECTS

Kuskokwim River Chinook Salmon Run Reconstruction

A total of 4 radio-tagged Chinook salmon were detected by the receiver station located near the Takotna River weir in 2007. Telemetry data from the tracking station along with telemetry data from aerial tracking efforts and tag passage data through the weir revealed that none passed upstream of the weir site.

The 2007 estimates of Chinook salmon abundance provided by this study are preliminary at the time of writing; however, they are probably near the final values and sufficient for discussion here. Estimates resulting from this study indicate that 121,370 Chinook salmon greater than 450 mm in length (SE = 13,027; 95% CI = 95,837-146,904) migrated upstream of Kalskag and a total of 105,832 Chinook salmon greater than 450 mm in length (SE = 12,288; 95% CI = 81,747-129,916) migrated upstream of the Aniak River confluence (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). According to these estimates, the George River stock represented 4.0% of total abundance upstream of Kalskag and 4.6% of the abundance upstream of the Aniak River confluence.

Kuskokwim River Sockeye Salmon Investigations

No radio-tagged or anchor-tagged sockeye salmon were observed passing the Takotna River weir or detected passing the receiver station in 2007. Tagged sockeye salmon were tracked to tributaries throughout the Kuskokwim River basin using 18 ground-based tracking stations and aerial tracking surveys conducted in July and August. Of 488 tags deployed, 398 (81%) successfully resumed upstream migration and 378 (77%) were successfully tracked to tributary streams. Radio-tagged sockeye salmon were identified in most major drainages between Kalskag and the Stony River. Large aggregates were observed in the Aniak, Holitna, Hoholitna, and Stony river drainages, and 4 were observed in the Holokuk River. The highest concentrations were observed in the Holitna River. Complete results of this project can be obtained from Gilk (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

DISCUSSION

ESCAPEMENT MONITORING

The reported Chinook, chum, coho, and sockeye escapements in 2007 are considered accurate representations of annual escapements to the Takotna River. Daily passage trends indicated few, if any, Chinook, chum, coho, or sockeye salmon passed the weir site before or after the target operational period (Table 1). Additionally, the methods used to interpolate or extrapolate passage during inoperable periods, which are commonly used in the Kuskokwim River drainage, yielded estimates that represented only modest fractions of annual escapement by species (Table 1).

Chinook Salmon

Abundance

The early installation date and timing of inoperable periods confirms that annual Chinook salmon escapement to the Takotna River was reasonably determined in 2007, and the reported escapement of 418 fish is considered a reliable estimate of the annual Chinook salmon escapement upstream of the weir. Only 1 Chinook salmon was observed passing the weir before the target operational date and only 1 fish was observed after 24 August (Table 1). The 8 fish estimated to have passed the weir during the brief inoperable period in August constituted only a small fraction (1.9%) of the total escapement in 2007.

All weir-based Chinook salmon escapement values (2000–2007) are considered accurate and reliable, but direct comparisons between weir-derived escapement values and tower-derived escapement values from 1996 and 1997 (Molyneaux et al. 2000) are inadvisable. Differences in sources of error associated with the 2 gear types are considerable and preclude direct comparisons between data obtained from the 2 methods. For example, investigators suspect the 1997 escapement values may not accurately reflect true escapement because the extreme Chinook salmon escapement value determined for 1997 (Figure 16) has not been substantiated by more numerous and reliable weir-derived escapement values. This concern about 1997 also discredits the value determined for 1996. Thus, historical comparisons should only involve weir-derived escapement data.

Unfortunately, 2007 escapement cannot be measured against an escapement goal because one has not been formally adopted for Takotna River Chinook salmon. Though technically the time series of historical data is not sufficient for official escapement goal development, much of the prerequisite groundwork has already been completed and a preliminary escapement goal range has been suggested. In a recent report prepared just prior the 2007 BOF meeting (Molyneaux and Brannian 2006), authors investigated the potential of developing an SEG based on existing weir and tower escapement data, which at the time was 8 years between 1996–2005. Using weir- and tower-determined escapement data collected through 2005, the SEG derived from the Bue and Hasbrouck method would range between 350 and 710. Escapement in 2007 was well within this range.

The Bue and Hasbrouck (*Unpublished*) method for developing a sustainable escapement goal (SEG) range requires at least 10 years of reliable escapement data (one life cycle of returns). To date, this has been achieved for Takotna River Chinook salmon, but there have been no attempts to incorporate 2006 and 2007 data into the escapement goal that Molyneaux and Brannian (2006) suggested. Takotna River escapement goals probably will be reconsidered just before the next BOF meeting, which is scheduled to occur in 2010. Assuming the weir is successfully operated in 2008 and 2009, investigators will have the flexibility by that time to include or exclude tower-derived escapement data depending on which option provides more benefit. As with the goal suggested by Molyneaux and Brannian (2006), a goal developed with data through 2007 will still be reliant on tower-derived escapement counts from 1996 and 1997. Whether using data from 1996–2009 or 2000–2009, the goal eventually adopted by the BOF will probably be similar to that suggested by Molyneaux and Brannian (2006) unless escapements in 2008 and 2009 deviate dramatically from the historical range. The position of the 2007 escapement near the historical average increases the likelihood that it will fall within the escapement goal range eventually adopted.

Where escapement goals have been developed (Kogrukluk, George, and Kwethluk river weirs), Chinook salmon escapements in 2007 fell within or the current escapement goal ranges (Figure 16). While, in general, escapements in recent years have remained considerably higher than the relatively low escapements observed throughout the drainage between 1998 and 2000 (Figure 16; Bergstrom and Whitmore 2004; Molyneaux and Brannian 2006), most project escapements have been declining since 2005 and escapements in 2007 were generally less than those in 2006. The same trend is reflected in the Kuskokwim River Chinook salmon composite index; however, despite the recent decline, the index for 2007 is still the fourth highest on record (Figure 16). Only 2 projects reported escapements that contradicted this pattern: 1 was Tuluksak River weir where reported escapement was the lowest on record (Plumb and Harper 2008) and the other was George River weir where 2007 escapement exceeded escapements from 2005 and 2006 (Thalhauser et al. *In prep*). Regardless of how they differ between this year and last, Chinook salmon escapements in 2007 were higher than in 1999 and 2000, which were the years that prompted the BOF "stock of yield concern" designation in 2001 (Figure 16).

The decrease between the 2007 abundance estimate provided by *Kuskokwim River Chinook Salmon Run Reconstruction* (K. L. Schaberg, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication) and earlier estimates of abundance provided by *Inriver Abundance of Chinook Salmon in the Kuskokwim River* (Stuby 2007) is reflected by the escapement numbers at all of the weir projects with the exception of the George and Tatlawiksuk river weirs; each observed increased Chinook salmon escapement from 2006 to 2007 (Figure 16; Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*). The annual proportion of the total run above Aniak monitored by each upriver weir project has been fairly consistent over time. The Kogrukluk River weir represents the highest proportion (12%) followed by the George River weir (3%), Tatlawiksuk River weir (2%), and Takotna River weir (0.3%). Consistency in the proportional contribution of each weir project suggests the Kogrukluk, George, Tatlawiksuk, and Takotna river weirs, singly and in concert, provide a reasonable index of inriver abundance of Chinook salmon within the upper Kuskokwim drainage.

By limiting exploitation, the closure of the commercial fishery in District W-1 until 1 August probably increased 2007 escapements of Takotna River and other Kuskokwim River Chinook salmon stocks. Though no commercial fishing effort in the Kuskokwim River was directed at Chinook salmon, a modest level of incidental harvest did occur during coho salmon-directed openings in August (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication). The actual effect of the combined pressure of subsistence and commercial harvest on Takotna River Chinook salmon is unknown because stock-specific exploitation cannot be calculated. Furthermore, the total subsistence harvest for 2007 has not yet been estimated. Annual Chinook salmon harvest has remained relatively constant through history, despite varying abundance and escapement. Though the most recent 10-year average (1997–2006) of 72,277 (Smith et al. *In prep*) is still preliminary, it probably reasonably approximates the 2007 harvest. The subsistence harvest combined with the relatively small incidental commercial harvest of 179 fish (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication) adds to an approximate harvest of less than 73,000 in 2007. When compared to the estimated inriver abundance of 121,370 Chinook salmon above Kalskag and the 105,832 fish above the Aniak River (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication), it is obvious that, in terms of size, the subsistence harvest is a significant component of the total run. The region of the Kuskokwim River above Aniak experiences relatively limited harvest of Chinook salmon (Smith et al. *In prep*); consequently, estimations of abundance above this point are a reasonable estimate of total escapement to this portion of the Kuskokwim drainage. These comparisons suggest a reasonable harvestable surplus was available to Kuskokwim Area users, but this cannot be verified by escapement goals since they do not exist for most of the Kuskokwim River tributaries.

Spawning Locations

Due to budget shortfalls, aerial surveys were not flown in the Takotna River drainage in 2007. However, surveys flown in past years reveal that most Chinook salmon spawning occurs in

Fourth of July Creek (Clark and Molyneaux 2003; Costello et al. 2005; Costello et al. 2006; Gilk and Molyneaux 2004; Schwanke et al. 2001; Schwanke and Molyneaux 2002).

Run Timing at Weir

Based on median passage dates, the timing of the 2007 Chinook salmon run at the Takotna River was fairly close to the historical average (Figure 3). The central 50% passage occurred over a 12-day period and the central 80% occurred over a 23-day period, both of which are considered normal for the Takotna River weir. All other Kuskokwim River escapement monitoring projects exhibited relatively late run timing in 2007 (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*).

Index Value

The Takotna River weir is the only ground-based escapement monitoring project in the upper Kuskokwim River drainage and can be used as an index for this vast sub-basin. The only other escapement monitoring regularly conducted in the upper Kuskokwim River are aerial surveys of the Salmon River (Pitka Fork drainage), a formal escapement index stream (Whitmore et al. 2008). The Salmon River surveys, however, focus only on Chinook salmon and are not conducted every year. To date, there are 8 years of paired Chinook escapement measures for both the Takotna and the Salmon River, but they do not correlate ($R^2 = 0.0081$; Figure 17). To what extent this is attributable to differences in stock abundance or to error inherent in aerial surveys is uncertain; aerial surveys are notoriously unreliable measures of escapement. Survey date, time of day, weather, pilot, and, perhaps more importantly, experience and capability of the observer are all variables that can affect the outcome of a survey. Therefore, the aerial survey conducted annually on the Salmon River is probably not an adequate index for the entire upper Kuskokwim River drainage. This strongly supports the continued operation of the Takotna River weir as an index of salmon abundance for the upper Kuskokwim River.

Chum Salmon

Abundance

The early installation date and the timing of inoperable periods confirms that annual chum salmon escapement to the Takotna River was reasonably determined in 2007; the reported escapement of 8,900 fish is considered a reliable estimate of the total annual chum salmon escapement upstream of the weir. Only 7 chum salmon were observed passing the weir before the target operational date (Table 1). The last chum salmon was observed on 19 September, which was the last full day weir operation in 2007. The 43 fish estimated to have passed the weir during the brief inoperable period in August constituted only a small fraction (0.5%) of the total escapement in 2007.

All weir-based chum salmon escapement values (2000–2007) are considered accurate and reliable, but, as with Chinook salmon, direct comparisons between weir-derived escapement values and tower-derived escapement values from 1996 and 1997 (Molyneaux et al. 2000) are inadvisable. Though annual escapements in 1996 and 1997 are not anomalous (Figure 18), the concern about the accuracy of the 1997 Chinook salmon escapement value influences investigators' confidence in the escapement value for chum salmon. Thus, historical comparisons in this report will only involve weir-derived escapement data.

Unfortunately, 2007 escapement cannot be measured against an escapement goal because one has not been formally adopted for Takotna River chum salmon. Though technically the time series of historical data is not sufficient for official escapement goal development, much of the prerequisite groundwork has already been done and a preliminary escapement goal range has been suggested. In a recent report prepared just prior the 2007 BOF meeting (Molyneaux and Brannian 2006), authors investigated the potential of developing an SEG based on existing weir and tower escapement data, which at the time was 8 years between 1996 and 2005. Using weir- and tower-determined escapement data collected through 2005, the SEG derived from the Bue and Hasbrouck method would range between 1,700 and 5,400. Escapement in 2007 was well above this range.

The Bue and Hasbrouck (*Unpublished*) method for developing a sustainable escapement goal (SEG) range requires at least 10 years of reliable escapement data (one life cycle of returns). To date, this has been achieved for Takotna River chum salmon. Takotna River escapement goals will be reconsidered prior to the next BOF meeting, which is scheduled to occur in 2010. Assuming the weir is successfully operated in 2008 and 2009, investigators will have the flexibility by that time to include or exclude tower-derived escapement data depending on which option provides more benefit. As with the goal suggested by Molyneaux and Brannian (2006), a goal developed with data through 2007 will still be reliant on tower-derived escapement counts from 1996 and 1997. Whether using data from 1996–2009 or 2000–2009 the goal eventually adopted by the BOF will probably be similar to that suggested by Molyneaux and Brannian (2006) unless escapements in 2008 and 2009 deviate dramatically from the historical range. The position of the 2007 escapement well above the historical average increases the likelihood that it will fall within or above the escapement goal range that is eventually adopted (Figure 18).

Every monitoring project in the Kuskokwim River reported above average chum salmon escapements in 2007, but inter-annual trends in recent years have been highly variable (Figure 18). Chum salmon escapements in tributaries for which goals have been developed (Kogrukluk River weir and Aniak River sonar) exceeded current escapement goal ranges in 2007 (Figure 18; McEwen *In prep*; Williams et al. *In prep*). Three projects in addition to the Takotna River weir reported a decrease in annual escapement between 2006 and 2007 (McEwen *In prep*; Plumb and Harper 2008; Williams et al. *In prep*), but the Takotna River weir was unique in that escapement in 2006 exceeded both 2005 and 2007. At other projects where 2006 escapement exceeded 2007 escapement, the decrease from 2006 to 2007 was a continuation of a trend that originated in 2005; the locations where this occurred also reported record-high escapements in 2005 (Aniak River sonar, Kogrukluk River weir, and Tuluksak River weir). In contrast, 3 projects (George, Kwethluk, and Tatlawiksuk river weirs) witnessed a chum salmon escapement in 2007 that exceeded all previous years (Figure 18; Miller et al. *In prep*; Stewart et al. *In prep*; Thalhauser et al. *In prep*). Though the spatial variability in relative escapement may be unusually pronounced in 2007, it is not uncommon. Regardless of how they differ between this year and last, chum salmon escapements throughout the drainage in recent years have remained well above the relatively poor levels observed in 1999 and 2000.

Commercial harvest pressure on Kuskokwim River chum salmon has been low in the past few years, and the harvest of 10,763 chum salmon in 2007 (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication) probably had a negligible impact on individual chum salmon stocks. The commercial harvest of chum salmon represented a decrease of over 29,000 fish from 2006 and the recent 10-year average about 40,000 and a dramatic decrease from the pre-2001 10-year average of 216,406. The number of chum salmon harvested commercially was only a modest fraction of the total number counted upstream of tributary weirs (297,388) and the sonar project in the Aniak River (696,801; Figure 18). The relatively low exploitation in 2007 was due to a lack of commercial market and processor interest that resulted in the commercial fishery remaining closed throughout all of June and July, and was not a consequence of low abundance (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication). Another factor influencing the low harvests reported in recent years has been the timing of the commercial fishery (June and/or July), which maximizes the number of chum salmon harvested and reduces more valuable catches of Chinook and sockeye salmon, resulting in depressed ex-vessel prices driven by low market demand and processor transportation costs.

As with the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River chum salmon stocks was probably not significant. Estimates are not yet available for 2007, but the 1997–2006 average harvest was 52,439 fish (Smith et al. *In prep*). Since annual subsistence harvests have not varied greatly in the past 10 years of available data, the recent 10-year average reasonably approximates the total harvest in 2007. Compared to the number of chum salmon counted upstream of tributary weirs and into the Aniak River in 2007, a subsistence harvest near 60,000 chum salmon probably did 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 (Smith et al. *In prep*). 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 lower abundance of chum salmon at that time. A subsistence fishing schedule was not implemented in 2007 after data indicated that the schedules implemented in 2001–2006 were not effective at improving the temporal distribution of harvest effort (Toshihide Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication) and probably provided no benefit to upper river stocks such as that bound for the Takotna River.

Run Timing at Weir

Based on median passage dates, the timing of the 2007 chum salmon run at the Takotna River weir was equal to 2005 (Costello et al. 2006) and, as such, was slightly later than average (Figure 3). Historically, median passage dates at the Takotna River weir have occurred between 6 July (1996) and 18 July (2003; Gilk and Molyneaux 2004). With central 50% passage occurring over a 12-day period and central 80% occurring over a 21-day period, the chum salmon run in 2007 was similar in duration to previous years (Figure 3). All Kuskokwim River escapement monitoring projects observed later-than-average run timing based on median passage dates (McEwen *In prep*; Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*).

Coho Salmon

Abundance

The early installation date and timing of inoperable periods confirms that annual coho salmon escapement to the Takotna River was reasonably determined in 2007; the reported escapement of 2,853 fish is considered a reliable estimate of the annual coho salmon escapement upstream of the weir (Table 1). The 58 fish estimated to have passed the weir during the brief inoperable period in August constituted only a small fraction (2.0%) of the total escapement.

All weir-based coho salmon escapement values (2000–2007) are considered accurate and reliable. The counting tower project in the mid 1990s was not designed to enumerate coho salmon and annual project operation during these years terminated before most of the coho run had migrated into the Takotna River (Molyneaux et al. *In prep*). Thus, the coho salmon escapement information recorded in 1996 and 1997 is not valuable for historical comparisons. Coho escapement in 2007 was 30% below the 2000–2006 average and exceeded the escapements of only 2 other years: 2001 and 2005 (Figure 19; Costello et al. 2006; Schwanke and Molyneaux 2002). Though not available in 2007 (or 2006), inriver abundance estimates provided by the *Kuskokwim River Salmon Mark–Recapture Project* between 2001 and 2005 indicate that Takotna River coho salmon comprise about 0.7% of the total return of coho salmon upstream of Kalskag (Pawluk et al. 2006).

Unfortunately, 2007 escapement cannot be measured against an escapement goal because one has not been formally adopted for Takotna River coho salmon. In fact, the only project that currently bears an escapement goal for coho salmon is the Kogrukluk River weir (Brannian et al. 2000b). Though technically the time series of historical data is not sufficient for official escapement goal development, much of the prerequisite groundwork has already been conducted and a preliminary escapement goal range has been suggested. In a recent report prepared just prior the 2007 BOF meeting (Molyneaux and Brannian 2006), authors investigated the potential of developing an SEG based on existing weir and tower escapement data, which at the time was through 2005. Using weir- and tower-determined escapement data collected through 2005, the SEG derived from the Bue and Hasbrouck method would range between 2,600 and 7,200. Escapement in 2007 was within this range but near the lower boundary.

The Bue and Hasbrouck (*Unpublished*) method for developing a sustainable escapement goal (SEG) range usually requires at least 10 years of reliable escapement data (one life cycle of returns). To date, this has not been achieved for Takotna River coho salmon. Furthermore, there have been no attempts to incorporate 2006 and 2007 data into the escapement goal that Molyneaux and Brannian (2006) suggested. Takotna River escapement goals probably will be reconsidered just before the next BOF meeting, which is scheduled to occur in 2010. Assuming the weir is successfully operated in 2008 and 2009, data will be sufficient by that time to generate an escapement goal from 10 years of reliable escapement data. The goal eventually adopted by the BOF will probably be similar to that suggested by Molyneaux and Brannian (2006) unless escapements in 2008 and 2009 deviate dramatically from the historical range. The position of the 2007 escapement near the lower limit of the suggested SEG range makes it questionable whether this year's escapement will fall within or below the SEG range eventually adopted.

Generally, Kuskokwim River coho salmon escapement was considered average in 2007. Coho salmon escapement goals have not been developed for most Kuskokwim River tributaries, which limits investigators' ability to assess overall (whole Kuskokwim River) escapement adequacy. The position of the 2007 escapement value near the upper SEG boundary at the Kogrukluk River weir (Figure 19; Williams et al. *In prep*) substantiates investigators' judgment that overall escapement to the Kuskokwim River was probably adequate and sustainable. However, this conclusion is somewhat compromised by the high degree of variation among projects in 2007. For example, the Kwethluk and Tuluksak river weirs reported record-low annual escapement

(Miller and Harper *In prep*; Plumb and Harper 2008) whereas the George River weir reported an annual escapement near the record-high set in 2003 (Figure 19; Linderman et al. 2004; Thalhauser et al. *In prep*). Regardless of intra-annual inconsistencies in recent years, Kuskokwim River coho salmon did not exhibit the spatially-consistent low abundances in the late 1990s that chum and Chinook salmon did, and were not subjected to the conservative management practices imposed on Chinook and chum salmon in years following. Furthermore, coho salmon escapements in the Kuskokwim River have not exhibited periodic cycles of increase or decrease like what has been observed among Chinook salmon (Figure 16).

Commercial harvest pressure on Kuskokwim River coho salmon has always been considerable. Though the commercial harvest of 141,049 coho salmon in 2007 (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication) was probably sufficient to detract from observed escapements at tributary weirs, the harvest probably represents a relatively low exploitation rate considering the escapements observed. Total inriver abundance estimates are not available for 2007 (or 2006), but results from the *Kuskokwim River Salmon Mark–Recapture Project* indicated that between 2001 and 2005 abundance of coho salmon ranged from 386,743 (2004) to 928,075 (2003) fish (Pawluk et al. 2006). 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 were estimated at about 70,000 fish. Kuskokwim River coho salmon were not identified as a stock of concern by the Alaska BOF (Bergstrom and Whitmore 2004), and have not been the focus of conservation measures. 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 and most of the 1990s (Smith et al. *In prep*). In fact, the recent 10-year average of 194,851 coho salmon in the commercial harvest is lower than all annual harvests between 1977 and 1996. The small harvests in recent years may be partially attributable to relatively low permit utilization and depressed commercial markets for chum salmon.

Contrary to the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River coho salmon stocks was probably not significant. Estimates are not yet available for the 2007, but the preliminary 1997–2006 average harvest estimate of 30,472 fish (Smith et al. *In prep*) is probably a reasonable approximation because annual subsistence harvests have not varied greatly in the past 10 years of available data. Compared to the number of coho salmon captured in the commercial fishery, and recognizing that escapements near average to high, a subsistence harvest of approximately 30,000 coho salmon probably did not significantly affect escapements of individual stocks. Indeed, the exploitation rate of coho salmon for subsistence use is undoubtedly much lower than that for Chinook salmon. The subsistence fishing schedule that was implemented annually from 2001 to 2006 had no effect on coho salmon subsistence harvest practices because, in each year, the schedule was lifted for the season long before coho salmon were passing through the lower river in significant numbers.

Run Timing at Weir

Based on median passage dates, the timing of the coho salmon run at the Takotna River weir in 2007 was among the earliest on record (Figure 3). However, the profoundness of this conclusion is somewhat nullified by the extraordinary consistency in annual run timing observed at this project. Historically, annual median passage dates have varied little, ranging between 25 and 28 August (Figure 3).

With central 50% occurring over a 12-day period and central 80% occurring over a 23-day period, the coho salmon run in 2007 was similar in duration to previous years (Figure 3). Between 2000 and 2006 the central 50% has occurred over a period ranging from 9 to 16 days and the central 80% has occurred over a period ranged from 18 to 26 days. Still, the overall pattern of daily passage was markedly similar among the 8 years of enumeration data, and much less variable than at other weir projects (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*). The early run timing exhibited by Takotna River coho salmon was consistent with all other projects.

Sockeye Salmon

Abundance

Few sockeye salmon are observed in the Takotna River, and the reported escapement of 14 sockeye salmon is considered a reliable estimate of total annual escapement in 2007. An escapement of 14 fish may seem small, especially when compared to the average annual escapement of over 12,000 sockeye salmon reported for the Kogrukluk River weir (Williams et al. *In prep*), but for the Takotna River weir this number is relatively high (Figure 20). Though nowhere near the record escapement of 60 fish observed in 2006 (Costello et al. 2007), the escapement of 14 sockeye salmon in 2007 still exceeded the escapements observed at this location between 2000 and 2003 (Clark and Molyneaux 2003; Gilk and Molyneaux 2004; Schwanke et al. 2001; Schwanke and Molyneaux 2002). These low escapements, relative to other locations, are not surprising since the Takotna River is not a primary spawning tributary for sockeye salmon. Overall, sockeye salmon escapement was above average throughout the Kuskokwim River drainage in 2007 but generally below escapements in 2005 and 2006 (Figure 20).

Compared to other species, little is known about the distribution and abundance of Kuskokwim River sockeye salmon. Sockeye salmon have been observed in several tributaries throughout the drainage (Burkey and Salomone 1999), but only the Kogrukluk River has a historical record of large sockeye runs (Figure 20; Williams et al. *In prep*). A recent investigation aimed at improving understanding of the biology and ecology of Kuskokwim River sockeye salmon shows substantial and previously unknown spawning aggregates in several upper Kuskokwim tributaries. Of these, the largest concentrations of sockeye occur in the Holitna River system (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). These findings are significant in that they indicate sockeye salmon are utilizing a watershed that lacks the lake habitat most commonly used by sockeye salmon for spawning and rearing (Burgner 1991). Preliminary results of this study suggest the ecological contribution of these atypical "river type" sockeye salmon to the Kuskokwim drainage may be larger than previously believed.

Sockeye salmon in the Kuskokwim River have not been identified as a stock of concern, although escapements may have benefited from the conservation measures imposed on Chinook and chum salmon because of the concurrent run timing of these 3 species. The actual effect of the combined pressure of subsistence and commercial harvest on sockeye salmon bound for the Takotna River is unknown. There are currently no subsistence harvest estimates for sockeye salmon in the Kuskokwim River for 2007; however, the most recent and preliminary 10-year average (1997–2006) of 37,077 fish (Smith et al. *In prep*) is probably a reasonable estimate. This modest subsistence harvest combined with the low 2007 commercial harvest of 703 (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication) adds to a total harvest estimate of approximately 40,000. Considering that the total observed escapement (sum of all projects) was just over 22,000 fish (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*), a harvest of 40,000 is probably significant. The level of significance cannot be assessed without further investigation of other known sockeye salmon stocks that may be of significant size (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Run Timing at Weir

Historical run timing comparisons are limited by low overall abundance, but higher abundance between 2004 and 2007 make comparisons among these years possible. Though low abundances reduce the utility of such assessment, the timing of the sockeye salmon run in 2007 was considerably earlier than in previous years based on median passage dates (Costello et al. 2005; 2006; 2007). Other measures of run timing (i.e. central 50 and 80% of passage) were not compared because low run abundances artificially influence perceived run duration.

Other Species

Pink Salmon

Pink salmon are rarely observed in the Takotna River. In fact, only 2 have been observed in the Takotna River since monitoring began here in 1995; 1 was observed in 2002 (Clark and Molyneaux 2003) and the other in 2006 (Costello et al. 2007). The probability of finding stray pink salmon in the Takotna River was probably higher in 2002 and 2006 than in other years because both years were characterized by extraordinarily high escapements of pink salmon in tributaries where they are regularly found (e.g. Liller et al. 2008).

No tributary system in the middle to upper Kuskokwim River drainage has a history of enumerating large escapements of pink salmon. Generally, pink salmon make less extensive spawning migrations into freshwater than other Pacific salmon species (Heard 1991). Given the spatial orientation of the Takotna River and other upper river tributaries, the small escapements observed at these sites is not surprising. The reasons for the increased abundance in upper river tributaries are not known, but low exploitation rates, favorable oceanic conditions, and increased incidences of straying may have all been contributing factors either independently or in concert. Accurate enumeration of pink salmon using weirs is difficult due to the species' small size, which probably enables them to pass between weir pickets. However, it does appear that the contribution of pink salmon to this and other Kuskokwim River tributaries is either greater than previously believed, or is increasing over time. To date, the relatively few pink salmon that return to spawn in upper Kuskokwim River tributaries are among the farthest known migrating pink salmon in the world (Morrow 1980; Heard 1991). Continued monitoring is needed to improve understanding of pink salmon run dynamics and importance to the ecosystem.

Resident Species

Of the non-salmon species that occur in the Takotna River, longnose suckers are historically the most abundant. Annual longnose sucker passage during the target operational period has ranged from 145 in 2004 (Costello et al. 2005) to 11,272 in 2001 (Schwanke and Molyneaux 2002). The passage of 205 fish during the target operational period in 2007 (Appendix B1) was considerably less than the historical average of 2,454 fish, but that average is heavily influenced by extraordinarily high passages in 2000 and 2001 that have not been achieved since (Schwanke et al. 2001; Schwanke and Molyneaux 2002).

Unfortunately, annual enumeration of longnose suckers is incomplete because smaller individuals may be able to pass freely between the pickets, and it appears that upstream migration may start well before the target start date for weir operations. Three points suggest that upstream migration starts before the target operational period. First, in years when the weir was operational before 24 June (2005 and 2006), longnose sucker passage before the target start date was much greater than the passage observed during the target operational period (Costello et al. 2006, 2007). 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 14 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. For example, in 2006 most (55%) of the 1,161 longnose suckers counted upstream through the weir passed before 24 June, emphasizing that the target operational period is not adequate for estimating annual longnose sucker passage. Recorded longnose sucker abundance is more likely influenced by the start date of weir operations than by actual abundance.

Including the Takotna River weir, longnose suckers were a prominent species at only 4 monitored tributaries in 2007. Unlike in past years, their relative abundance was fairly consistent at each of the 4 projects; abundances tended to be lower than average. This pattern does not support the idea that the spatial variation in abundance is simply the consequence of a finite population distributing itself over multiple tributaries, perhaps preferentially selecting some tributaries instead of others. Still, this pattern does not necessarily indicate an overall decline in longnose sucker abundance because it is certainly possible that the decrease in numbers in monitored tributaries was accounted for by increases in others that are/were not monitored. The utility of using weirs to monitor longnose sucker abundance is further impaired 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.

Carcass Counts

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 C1). The “sucker chutes” that are installed to facilitate downstream passage of resident species provide a pathway for post-spawning salmon (post-spawners) to pass downstream. First, weak or dead salmon are commonly observed washing over the sucker chutes, and daily carcass counts noticeably decrease following chute installation (Appendix C1). Second, carcass deposition was not estimated for the period when the weir was not operational, so no carcass information is available for the inoperable period in August. Third, the weir was removed long before most of the coho salmon had completed spawning, so the number of coho salmon carcasses counted on the weir significantly underestimated the number of post-spawners that drifted downstream of 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 site 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).

Estimating the sex composition of upstream passage from carcass counts is not reliable. In 2007, the method of counting carcass by sex underestimated the percentage of females in the Chinook, chum, and coho salmon escapements. Generally, sexing the carcasses yields female salmon percentages that are considerably lower than the percentage determined from ASL sampling. Thus, this method does not adequately estimate the sex composition of upstream escapement.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Predetermined sample goals were not achieved in 2007 because of the modest abundance of Chinook salmon in the Takotna River that only totaled 418 fish. However, post-season analysis revealed that actual sample sizes were sufficient to estimate age-class proportion with the desired confidence interval width for the total season as well as in 3 individual pulses (Table 2). This was only the fourth year out of 8 operational years that the annual Chinook salmon ASL sample was considered adequate for describing the annual escapement composition, the other years being 2006, 2002, and 2000.

The current ASL sampling goal of 630 fish (three 210-fish pulse samples) is poorly suited for the Takotna River because total annual escapement here seldom exceeds 630 fish (Figure 16). This sample design is based on recommendation by Bromaghin (1993), which assumes the sample is being drawn from a population of unknown size. Toshihide Hamazaki, an ADF&G biometrician for this region of Alaska, has proposed alternative sampling goals that are better suited to the relatively small population being investigated (T. Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication). In future years (2008 and beyond) the annual sampling goal for Chinook salmon will probably be reduced to 170 individuals for the entire season. The pulse sample design will be cancelled, but measures will be implemented to ensure that the sample is well distributed.

Age Composition

The assortment of age classes seen at Takotna River in 2007 (age 1.2, 1.3, 1.4 and 1.5) are similar to past years, and similar to what has been observed elsewhere in the Kuskokwim Area (Molyneaux et al. *In prep*). Overall, Chinook salmon passing upstream of the weir were mostly age-1.2 (4 year-old) and -1.3 (5 year-old) fish, accounting for 50.6% and 33.5% of what was a moderate annual escapement in 2007 (Table 2; Figure 16). These percentages were comparable to 2006 but far higher than those observed in 2000 and 2002. With few exceptions, we observed a similar pattern of abundant age-1.2 and/or age-1.3 Chinook at other escapement monitoring projects in the Kuskokwim River drainage (Molyneaux et al. *In prep*) indicating that this was a widespread occurrence and suggests a relatively strong return in 2008 of the age-1.3 and -1.4 siblings. In contrast, the abundance of age-1.4 Chinook salmon was relatively low in the Takotna River (Figure 21), as it was at most other escapement monitoring projects in 2007. Appendix E1 is a brood table generated from the available Takotna River data, but the information is as of yet too incomplete for assessing sibling relationships and cohort strength, plus it does not account for the fraction of Takotna River fish taken in the harvest that occurs downstream of the weir.

Age composition of the Chinook salmon escapement changed as the 2007 run progressed upstream of the Takotna River weir (Table 2). In comparing the 3 temporal strata, the percentage of age-1.2 fish progressively decreased as the season advanced, which is common for the Takotna River weir (Figure 4). The percentage of age-1.3 and -1.4 fish generally increased over time. During most years, intra-annual trends in age class percentage are not nearly as clear as those observed in 2007 (Figure 4). The absence of a clear trend is consistent with other escapement monitoring projects in the Kuskokwim River drainage (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*).

Sex Composition

At 12.9% (Table 2), the percentage of female Chinook salmon at Takotna River weir was far below the historical range of 23.3% to 30.0% (Figure 22). The low abundance of females may be attributable to the low abundance of the female-dominated 1.4 age class, coupled with the relatively high abundance of the male-dominated 1.2 and 1.3 age classes (Table 2). The significance of the low female ratio is accentuated by the relatively low Chinook salmon escapement to the Takotna River in 2007. Elsewhere in the Kuskokwim River drainage, percentages and abundances of female Chinook salmon were generally low (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*).

Most of the female Chinook salmon passed upstream of the Takotna River weir during the final third of the run (Table 2; Figure 5). This trend is consistent with historical ASL data from Takotna River weir (Figure 5) and elsewhere in the Kuskokwim River drainage (Molyneaux et al. *In prep*).

Sex composition of the fish sampled for ASL information typically serves as the basis for characterizing the sex composition of the total annual escapement. However, concerns are sometimes raised that the physical process required to capture fish for ASL sampling could be selective for or against specific components of the population. In order to assess this potential bias, the crew at the Takotna River weir recorded the sex of nearly every Chinook salmon observed passing upstream of the weir. Crew initiated this procedure in 2005 (Costello et al. 2006) and continued it through 2007. The passage gate at the Takotna River weir is fitted with a viewing window and movable panel the crew use to selectively position fish near the surface where the secondary sexual characteristics of each fish are more closely inspected before the fish is allowed to pass upstream. The prominence of diagnostic secondary sexual characteristics tends to be advanced at Takotna weir because of the close proximity of spawning grounds. No indication of bias in either the ASL method or non-ASL method of determining sex composition was detected (z-test; $p = 0.141$; Figure 9).

Length Composition

Mean lengths for each age-sex category in 2007 were similar to past years (Figure 23), including the tendency for female Chinook salmon to be longer than males of the same age (Figure 6), which a common pattern throughout the Kuskokwim River drainage (Molyneaux et al. *In prep*). Mean length increased with age, and the length range of female age-1.3 and male age-1.4 fish overlapped broadly (Figure 6). The length of fish in each age-sex category did not change appreciably as the 2007 season progressed (Figure 7), which is typical for Chinook salmon at Takotna River weir and elsewhere in the Kuskokwim River drainage (Molyneaux et al. *In prep*).

Management Implications

Salmon are harvested in both subsistence and commercial fisheries that occur in the mainstem Kuskokwim River far downstream from Takotna River and other spawning areas (Whitmore et al. 2008). Most harvest is taken with gillnets that are size selective for discrete components of the returning salmon population. The potential impact of the size selective harvest is perhaps most consequential to Chinook salmon because of their wide range of sizes at maturity.

Subsistence fishers tend to favor using gillnets of large mesh web (e.g., 8-inch stretch mesh; Smith et al. *In prep*), so their harvest is selective for the larger and older Chinook salmon. This is the same segment of the population in which females are most common (Molyneaux et al. *In prep*). Timing of the subsistence harvest tends to be weighted towards the early part of the run, which is when stocks with the most distant spawning grounds, such as Takotna River fish, are likely to be the most concentrated, although the degree of overlap in stock-specific run timings tends to be broad for Chinook salmon (Pawluk et al. 2006; K. L. Schaberg, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). The exploitation rate of the subsistence fishery was estimated to range between 22 and 32% of the total Kuskokwim River Chinook salmon runs in the years 2002, 2003, 2004, and 2005 (Molyneaux and Brannian 2006).

In contrast, commercial fishers are limited to using 6-inch or smaller mesh sizes (Whitmore et al. 2008), so their harvest is selective for smaller Chinook salmon in a size range dominated more by males (Molyneaux et al. *In prep*). The timing of the commercial fishery tends to be more towards the second half of the Chinook salmon run; however, in recent years low market interest has resulted in very limited commercial harvest. Exploitation rate from the commercial fishery are estimated to have been no more than 1.6% in the 2002 to 2005 run reconstructions (Molyneaux and Brannian 2006).

The Chinook salmon seen at the Takotna River weir and spawning grounds elsewhere in the Kuskokwim River consist of the fraction of fish that escape harvest. The selectivity of that harvest influences the resulting age, sex, and length composition of the escapement (Figure 24). Nearly all the Chinook salmon harvest in 2007 occurred in the subsistence fishery. The size selectivity of the prevalent subsistence harvest practices, in concert with the relatively high exploitation rate of the subsistence fishery, increased both the prevalence of smaller male Chinook salmon, and the scarcity of larger fish and females in the escapement (Figure 24). Furthermore, this occurrence seemed more amplified in the Takotna River escapement where the younger and smaller male Chinook salmon were more prevalent that at other escapement monitoring projects. A similar pattern was seen at Takotna River weir in 2006 (Costello et al. 2007), but has not been investigated for years prior to 2006. If this pattern is consistent, it supports suspicions that Takotna River Chinook salmon, and perhaps other upper Kuskokwim River Chinook salmon stocks, are more strongly influenced by subsistence harvest practices in the lower Kuskokwim River than are Chinook salmon stocks farther downstream.

Chum Salmon

The ASL data collected from chum salmon in 2007 were adequate for describing annual age, sex, and length composition for the total escapement as well as in 5 individual temporal strata (Table 4). Sampling pulses were well distributed throughout the run and the total sample size met or exceeded the minimum goal for each pulse. ASL composition has been estimated in all 8 years the project has operated.

Age Composition

The assortment of age classes seen at the Takotna River weir in 2007 (age 0.2, 0.3, 0.4, and 0.5) were similar to past years and to what has been observed elsewhere in the Kuskokwim Area (Molyneaux et al. *In prep*). Overall, chum salmon passing upstream of the weir were mostly age-0.3 (4 year-old) and -0.4 (5 year-old), accounting for 60.1% and 33.7% of what was considered high total annual escapement abundance (Table 4; Figure 21). These percentages were nearly identical to 2006 (and 2000) and near the historical average, but they equated to relatively high abundances of both age classes. The unusually high abundance of age-0.3 and age-0.4 chum salmon that migrated through the Takotna River weir in 2007 was a trend common to all projects (Molyneaux et al. *In prep*). The high abundance of age-0.3 chum salmon suggests a relatively strong return in 2008 of the age-0.4 siblings. Likewise, the relatively high abundance of age-0.2 chum salmon in the Takotna River and most other projects in 2007 indicates the potential for a high return of age-0.3 fish in 2008. High abundances of age-0.3 and age-0.4 chum salmon in 2008 at Takotna River weir and other projects will probably equate to high overall escapement.

Age composition of the chum salmon escapement varied considerably as the 2007 run progressed upstream of the Takotna River weir, but no age class adhered to a consistent increasing or decreasing trend (Table 4; Figure 8). Furthermore, the relative contribution determined for the whole escapement (i.e. age-0.3 dominant, followed by age-0.4, -0.2, and -0.5) was reflected in nearly every sampling stratum. Though no age class exhibited a consistent intra-annual trend of increase or decrease, the percentage of the age-0.4 component was highest in the first stratum while the proportion of age-0.3 fish was highest in the last (Table 4). This occurrence corroborates the trend that commonly occurs in the Takotna River: that the percentage of age-0.3 fish tends to increase while the percentage of age-0.4 fish tends to decrease during the run (Figure 8). In 2007 this relationship between the percentage of age-0.3 and -0.4 chum salmon, common in some years, was not widely observed. Though distinct trends were not observed elsewhere, some projects reported patterns similar to Takotna River weir in that the proportion of age-0.3 was highest in the last stratum while age-0.4 was highest in the first.

Brood tables provide the tools to investigate potential cohort survival and the number of returns per spawner (Appendix E2). For chum salmon, total return is calculated as the sum of all age-3, -4, -5, and -6 fish from a specific brood year, so the most recent return number available for any given year is from the brood year 6 years prior (2001 in this case). As with other projects in the Kuskokwim River drainage, return data for the Takotna River do not include the fraction of Takotna River chum salmon harvested annually in downstream fisheries. For chum salmon, the number of fish harvested in the subsistence fishery may be large enough to noticeably detract from escapement, so the return values presented in Appendix E2 underestimate actual returns. However, since subsistence harvests of chum salmon tend to vary with abundance, the values presented in this report are probably reasonable indexes of total returns to the Takotna River, which makes historical comparisons possible. Consistent ASL sampling effort has allowed calculation of return for all brood years between 1997 and 2001; however, of these brood years, return-per-spawner can only be calculated for 1997, 2000, and 2001 because escapement in 1998 and 1999 is unknown (Molyneaux et al. 2000; Appendix E2). Return per spawner has ranged from 0.84 for the 2000 brood year to 3.56 for the 1997 brood year. The 1.99 returns per spawner determined for the 2001 brood year, the most recent for which it can be calculated, fits comfortably between these two others. Unfortunately, that there are only a few years available from which to draw comparisons limits the validity of conclusions and makes it difficult to determine with confidence whether total returns in subsequent years were higher or lower than expected; however, 1.99 returns-per-spawner meant that the total brood from the 2001 brood year amounted to nearly twice the escapement of their parents. This occurrence, especially when considered in conjunction with similar findings at other projects, suggests high survivability in recent years.

Sex Composition

At 47.8% (Table 4), the percentage of female chum salmon at the Takotna River weir was near average (Figure 22). Female percentage varied considerably between projects, but nearly every project reported percentages near their respective historical average (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*). Compared to Chinook salmon, sex composition among chum salmon tends to vary little spatially and historically (Molyneaux et al. *In prep*).

At the Takotna River weir stratified sampling revealed slight changes in sex composition during the run; however, temporal changes in 2007 did not adhere to a general increasing or decreasing trend, which was true for most projects (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*). In some past years, the percentage of female chum salmon has increased consistently during the run and, consequently, tended to be lowest during the first pulse and highest during the last (Figure 5). At Takotna River weir in 2007 the percentage of female chum salmon was lowest during the first stratum but it reached its seasonal maximum in the middle of the run rather than at the end. Though not always true, it is common throughout the Kuskokwim River drainage for the percentage of female chum salmon to increase during the run (Molyneaux et al. *In prep*).

Sex composition of the fish sampled for ASL information typically serves as the basis for characterizing the sex composition of the total annual escapement. However, concerns are sometimes raised that the physical process required to capture fish for ASL sampling could be selective for or against specific components of the population. In order to assess this potential bias, the crew at the Takotna River weir recorded the sex of nearly every chum salmon observed passing upstream of the weir. Crew initialized this procedure in 2005 (Costello et al. 2006) and continued it through 2007. The passage gate at the Takotna weir is fitted with a viewing window and a movable panel the crew use to selectively position fish near the surface where the secondary sexual characteristics of each fish are more closely inspected before the fish is allowed to pass upstream. The prominence of diagnostic secondary sexual characteristics tends to be advanced at the Takotna River weir because of its close proximity to spawning grounds; so the accuracy of sexual identification in this method is assumed to be equal to that of the ASL sampling method in which every sampled fish is handled. Figure 9 shows that the concern of bias was validated in 2007, both in regards to the season total (z-test; $p < 0.001$) and during 2 independent strata: the first ($p < 0.001$) and third ($p = 0.030$). Though statistically significant, the 3.7% difference between the season totals for the 2 methods has no practical significance. Furthermore, similar analysis conducted on 2005 and 2006 data revealed no bias during these years (z-test; $p = 0.189$ and 0.180, respectively). Perhaps present, the potential bias between the 2 methods is not great enough to concern investigators.

Length Composition

In 2007, length of chum salmon in each age and sex category was considered below average (Figure 25). The most extreme change occurred among the population of age-0.4 females who exhibited a mean length below every other year with adequate data for comparison (2000–2004 and 2006). Similarly, mean lengths of age-0.3 males and females and age-0.4 males were significantly less than most previous years (Figure 25). Data from 2007 perpetuate an indistinct trend that has become evident for all age and sex categories in recent years: mean lengths of chum salmon have been declining since 2002 or 2003 (depending on age) in all age-sex categories.

Takotna River chum salmon exhibited length partitioning by age and sex. In summary, older fish tended to be longer and males of an age class tended to be longer than females (Figure 6). However, this was not true for age-0.3 and -0.4 females; mean lengths of these 2 constituents were remarkably similar. One implication that length varies between sexes is that annual mean length of a certain age class will be influenced by the number of females in that more females will equate to lower mean lengths. The similarity between females of different ages (Figure 6) is a valuable conclusion as well and confirms that age can not be deduced from length.

Typically, length trends have exhibited a high degree of spatial variability in the Kuskokwim River drainage, but historical trends involving only recent years are notably consistent. Over the past few years, most other Kuskokwim Area escapement projects have reported declines in annual mean lengths in every age and sex category (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*). Regarding intra-annual length trends in 2007, mean lengths among males 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 2007. Such patterns tend to be common at the Takotna River weir and other locations where ASL samples have been collected (Molyneaux et al. *In prep*).

Coho Salmon

The ASL data collected from coho salmon in 2007 were adequate for describing annual age, sex, and length composition for the total annual escapement as well as in 3 individual temporal strata (Table 6). Sampling pulses were well distributed throughout the run and total sample size met or exceeded the minimum goal for each pulse. ASL composition has been estimated in all 8 years the project has operated.

Age Composition

Kuskokwim River coho salmon are predominantly age-2.1 (4 year-old) fish. At the Takotna River weir in 2007 age-2.1 coho salmon comprised 92.5% of the total run, whereas age-3.1 comprised 5.2% and age-1.1 comprised 2.2% (Table 6). In the Takotna River, as with other projects, age-2.1 coho salmon typically comprise about 90% of annual escapement. Other age classes have fluctuated historically in terms of relative contribution, but their percentages are always slight compared to age-2.1 fish. In 2007, escapement in all age classes was relatively low, which explains the normal percentages despite the low abundance of the predominant age-2.1 component (Figure 21). Since annual escapement abundance is largely driven by the abundance of the age-2.1 fish (Figure 20), the moderate abundance of this age class in 2007 equated to moderate overall escapement.

The idea that the abundance of 1 age-class 1 year can predict the abundance of siblings (one age-class older) the next has limited utility when applied to coho salmon. First, nearly all coho return at age-2.1 individuals, so deviations in the abundance of other age classes will have little effect on total annual escapement. Second, historical data do not show that such predictions are reliable (Figure 20). Applied to 2007 escapement data, the moderate abundance of age-2.1 coho salmon does not guarantee a high abundance of age-3.1 fish in 2008, nor does the relatively high abundance of age-1.1 fish predict an unusually high abundance of age-2.1 fish (it did not between 2006 and 2007). As always, such speculation is marred by unknown stock-specific harvest that occurs downstream of the weir.

Age composition of the coho salmon escapement varied little as the 2007 run progressed upstream of the Takotna River weir. A slight, but consistent, positive trend was observed of the age-2.1 fish while a slight, negative trend was observed among the age-1.1 fish (Table 6; Figure 11). No trend was observed among age-3.1 coho salmon (Figure 11). Despite these variations, the relative contribution determined for the whole escapement (i.e. age-2.1 dominant, followed by age-3.1 and -1.1) was reflected in all 3 sampling strata (Table 6). Coho salmon do not usually exhibit such consistent trends in the Takotna River or in other tributaries of the Kuskokwim River (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*).

Brood tables provide the tools to investigate potential cohort survival and the number of returns per spawner (Appendix E3). For coho salmon, total return is calculated as the sum of all age-3, -4, and -5 fish from a specified brood year, so the most recent return number available in any given year is from the brood year 5 years before (2002 in this case). As with other projects in the Kuskokwim River drainage, return data for the Takotna River do not include the fraction of Takotna River coho salmon harvested annually in downstream fisheries. For coho salmon, the number of fish harvested in the commercial and subsistence fisheries may be large enough to noticeably detract from escapement, so the return values presented in Appendix E3 underestimate actual returns. However, the values presented in this report are probably reasonable indexes of total returns to the Takotna River, which makes historical comparisons possible. Consistent ASL sampling effort has allowed calculation of return for all brood years between 1997 and 2002; however, of these brood years, return-per-spawner can only be calculated for 2000–2002 because coho salmon escapement was not monitored in years prior (Molyneaux et al. 2000). Return-per-spawner has ranged from 0.82 for the 2001 brood year to 1.34 for the 2002 brood year (Appendix E3). Unfortunately, there are only a couple years available from which to draw comparisons, which limits the validity of conclusions and makes it difficult to determine with confidence whether total returns in subsequent years were higher or lower than expected; however, the 1.34 returns-per-spawner indicated by brood tables strongly suggests that the total return from the 2002 brood year were 34% more abundant than their parents. This occurrence suggests high survival in recent years.

Sex Composition

At 52.3% (Table 6), the percentage of female coho salmon at the Takotna River weir was the highest on record by a fraction, but closely resembled 2000 (Schwanke et al. 2001) and 2003 (Gilk and Molyneaux 2004; Figure 22). Female percentage varied considerably among projects and no wide-spread trend was apparent. Half the projects reported an above-average percentage of female coho salmon and half the projects reported a below-average percentage (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*). Compared to Chinook salmon, sex composition among coho tends to vary little spatially and historically.

At the Takotna River weir stratified sampling revealed slight changes in sex composition during the coho salmon run. In 2007, the percentage of female coho salmon increased continually from the first stratum to the last (Figure 5), a trend that is historically consistent at the Takotna River weir and consistent with most other projects in 2007 (Molyneaux et al. *In prep*). However, this trend has not occurred often enough throughout the Kuskokwim River drainage to be considered common. More often than not the percentage of female coho salmon is higher in the last stratum than in the first, but percentages tend to vary widely.

Sex composition of the fish sampled for ASL information typically serves as the basis for characterizing the sex composition of the total annual escapement. However, concerns are sometimes raised that the physical process required to capture fish for ASL sampling could be selective for or against specific components of the population. In order to assess this potential bias, the crew at the Takotna River weir recorded the sex of nearly every coho salmon observed passing upstream of the weir. Crew initialized this procedure in 2005 (Costello et al. 2006) and continued it through 2007. The passage gate at the Takotna River weir is fitted with a viewing window and movable panel the crew use to selectively position fish near the surface where the secondary sexual characteristics of each fish are more closely inspected before the fish is allowed to pass upstream. The prominence of diagnostic secondary sexual characteristics tends to be advanced at the Takotna River weir because of its close proximity to spawning grounds. In 2007 no indication of bias was detected (z-test; $p = 0.075$; Figure 9).

Length Composition

Annual mean lengths of male and female age-2.1 coho salmon at the Takotna River weir have varied considerably from year to year (Figure 26). Mean lengths for both female and male coho salmon in 2007 were only slightly below their historical averages and, as such, well within the range reported in previous years (Figure 26). In 2007 females were significantly longer, on average, than males (Figure 6). In fact, in the Takotna River the mean length of female coho salmon has exceeded that of males every year that data have been collected, and differences have usually been significant. In 2007 the mean length of female age-2.1 coho salmon exceeded that of males at most projects, and for some projects the difference between them was significant. In relation to past years, most projects reported near average mean lengths relative to respective locations; along with a general increase from those recorded in 2006 (Miller and Harper *In prep*; Plumb and Harper 2008; Stewart et al. *In prep*; Thalhauser et al. *In prep*; Williams et al. *In prep*).

WEATHER AND STREAM OBSERVATIONS

Water level in the Takotna River was above average for nearly the entire operational period and the mean water level was the highest on record (Figure 13). Daily water levels remained above daily historical maximums for about 2 weeks in July, 2 weeks in August, and periodically throughout September. Daily water temperatures in the Takotna River varied considerably throughout the operational period (Figure 14), but in general remained below average from 24 June to 18 August (Figure 15). In contrast, water temperatures remained above average after 18 August.

Any relationship between water level and passage strength or timing, or water temperature and passage strength or timing, is not easily discernible by the available data. 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 these procedures were standardized by time of day and remained consistent, the effect of water level on salmon passage may be better revealed.

RELATED FISHERIES PROJECTS

Kuskokwim River Chinook Salmon Run Reconstruction

Tag deployment efforts were successful in 2007. The Chinook salmon abundance estimates generated as one component of the project mark the sixth year that an abundance estimate was determined for the Kuskokwim River drainage upstream of the Aniak River confluence, and the second year that an abundance estimate could be calculated that included the Aniak River (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication; Stuby 2007). The deployment of anchor tags in addition to radio tags provided a tag sample large enough to investigate travel speed and run timing, thereby providing an additional year for historical comparisons of these measures.

At the time of publication, development of the model required for a comprehensive run reconstruction was still ongoing. Until the model is completed, historical abundance estimates can not be computed. Results and discussion of success will be reported in a separate publication that will be written upon completion of historical run abundance estimates (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication).

Abundance Estimate

Project investigators in 2007 worked closely with investigators from the former *Inriver Abundance of Chinook Salmon in the Kuskokwim River* project to ensure that methods remained consistent (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication; Stuby 2007). Generally, the same limitations and assumptions of the former project persist in the current. For example, Chinook salmon smaller than 450 mm MEF were not radio-tagged, so abundance estimates generated then and now do not include the fraction of the Kuskokwim River Chinook salmon run below this threshold. The annual abundance estimates generated without this component likely do not greatly underestimate the total abundance inclusive of fish less than 450 mm MEF because such small Chinook salmon are uncommon in the Kuskokwim River (Molyneaux et al. *In prep*). At Takotna River weir, for example, these small Chinook salmon only comprise about 2% of total escapement annually. Other weirs have reported much lower percentages.

Run Timing and Travel Speed

The run timing information derived from pooling the radio-tag and anchor-tag samples from *Kuskokwim River Chinook Salmon Run Reconstruction* indicates slight variation in stock-specific run timing in 2007. In 2007, as in most past years, there was a noticeable inverse relationship between natal stream distance and time of passage past the Kalskag tagging sites. Based on median passage dates, stocks with the furthest to travel tended to arrive earlier than stocks bound for tributaries nearer the tagging sites (Figure 27). The earliest arriving stocks for which run timing was assessed were bound for the Takotna and Tatlawiksuk rivers; both had a median passage date (at the Kalskag tagging sites) of 24 June. Consistent with this pattern, George River and Salmon River fish tended to arrive later (29 and 30 June, respectively), but, contrary to this pattern, the median passage date for fish bound for the Kogrukluk River occurred after that for the Tatlawiksuk stock (28 June) despite the former being further from the tagging sites (Figure 27). Though sample sizes are small, the median passage dates for tagged Takotna River bound Chinook salmon past the tagging sites have been the earliest of any stock in 2 of the

5 years with comparable data (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). In the remaining years only the Tatlawiksuk stock arrived earlier.

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 is considered with respect to the stock-specific run timing evident through the tagging and tracking of Chinook salmon. Relatively low subsistence and Bethel Test Fishery catches during a period when Chinook salmon should have been abundant based on tagging data contributed to the 2007 management decision to keep the commercial fishery closed until 1 August after which time management strategy shifted to coho salmon (J. C. Linderman, Jr., Area Management Biologist, ADF&G, Anchorage; personal communication). In retrospect, what was interpreted as low abundance was actually the consequence of relatively late run timing. Regardless, very few Chinook salmon were harvested in the August coho-directed fishing openings and run timing and travel speed data obtained from tagging studies further ensure that virtually no Takotna River Chinook salmon were harvested in the commercial fishery. Though irrelevant in 2007, the commercial fishing periods that usually occur in late June probably miss stocks bound for the Takotna River weir anyway, because of their early run timing of Takotna and other upper river stocks relative to stocks from tributaries further downriver. Though in some years Takotna River Chinook salmon may comprise a minute fraction of the total commercial harvest, the impact of the Kuskokwim River commercial fishery on individual Chinook salmon stocks is negligible when considered with respect to the total abundance estimates developed as part of *Inriver Abundance of Chinook Salmon in the Kuskokwim River* and *Kuskokwim River Chinook Salmon Run Reconstruction.* Due to fewer restrictions and greater annual harvest, the subsistence fishery likely had a much greater impact on Takotna River Chinook salmon (Smith et al. *In prep*).

Kuskokwim River Sockeye Salmon Investigations

For the third consecutive year, sockeye salmon radio tag deployment and recovery efforts were successful. The deployment of anchor tags in addition to radio tags provided a tag sample large enough to investigate travel speed and run timing, thereby providing an additional year for historical comparisons of these measures.

Run Timing and Travel Speed

No tagged sockeye salmon were observed at the Takotna River weir in 2007, which precludes assessment of travel speed and run timing. This was not unexpected because sockeye salmon escapement beyond the Takotna River weir in 2007 was not substantial and observed escapement may not have been stock from the Takotna River. In the 6 years that mark–recapture has been conducted for sockeye salmon, only 4 tagged sockeye have reached the Takotna River weir: 1 in 2004, 2 in 2005, and 1 in 2006 (Pawluk et al. 2006; K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). The numbers of tags recaptured during these years were too few to formulate many conclusions about these fish. Also, the sockeye salmon observed in the Takotna River are not thought to be a unique stock but individuals of stocks from other locations, suggesting the early stages of the founding of a new stock of sockeye salmon.

Though data are lacking because no tags were recovered in 2007, data from past years and other measures of run timing suggest the sockeye salmon observed in the Takotna River are annually among the latest to migrate through the lower Kuskokwim River (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). Furthermore, the consistently late at-the-weir run timing exhibited by Takotna River weir sockeye salmon escapement implies a propensity for late run timing in general. This latter argument is supported by trends in travel speed revealed through recaptured tagged sockeye salmon at the Takotna River weir and elsewhere in the drainage.

Information obtained from tagged sockeye salmon throughout the Kuskokwim River drainage reveals a consistency in average travel speed (about 25 km/day) regardless of tributary location. Assuming that sockeye salmon bound for the Takotna River travel at about this speed, fish migrating from the Kalskag tagging site would require about 27 days to travel to the weir. In effect, the dates of median passage at the weir (17 August in 2004 and 2005, 15 August in 2006, and 10 August in 2007) should have occurred approximately 27 days after the median passage date of these populations past the tagging sites, on roughly 21 July in 2004 and 2005, 19 July in 2006, and 14 July in 2007. Plotting these points against datasets from tag recoveries at other weirs supports the conclusion that sockeye salmon bound for the Takotna River are among the latest to travel through the lower river. Though data are lacking, travel speeds of the few tagged sockeye salmon recaptured at the Takotna River weir over the years have generally exceeded this 25 km/day average, which is consistent with the observed trend that travel speed increases with later run timing, and ultimately would indicate a later lower-river run timing than speculated based on the average travel speed observed elsewhere.

From an area-wide perspective, the run timing information derived from pooling the tag samples from *Kuskokwim River Salmon Mark–Recapture Project* and *Sockeye Salmon Investigations* indicates some variation in stock-specific run timing in 2007. In each year between 2004 and 2006, the tagged sockeye observed in the Takotna 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 (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). 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. 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.

CONCLUSIONS

ESCAPEMENT MONITORING

- The weir was installed by 20 June and was operational until 19 September, encompassing nearly the entire target operational period of 24 June to 20 September.

- The effect of the 3-day inoperable period between 6 and 8 August on salmon escapement is not considered significant.
- The Chinook salmon escapement of 418 fish to the Takotna River in 2007 represented a decrease of about 23% from 2006 but was only slightly below the historical average for this location.
- The decrease in Chinook salmon escapement between 2006 and 2007 was observed in other tributaries and reflected both in the composite index and by annual inriver abundance estimates provided through the radio tagging effort.
- The commercial fishery probably had a negligible impact on Chinook salmon escapement, but the subsistence fishery likely had a considerable impact.
- At-the-weir run timing of Chinook salmon at the Takotna River weir was near average whereas most projects reported relatively late run timing.
- Comparison with aerial surveys of the Salmon River (Pitka Fork) reveals that the Takotna River weir is not a reasonable index of abundance in the Salmon River.
- The chum salmon escapement of 8,900 fish to the Takotna River in 2007 represented a decrease of about 29% from 2006 but was still considerably higher than average for this location.
- The decrease in chum salmon escapement between 2006 and 2007 at the Takotna River weir was not spatially consistent in that some projects reported record-high escapements in 2007; however, escapements throughout the drainage were still considered high.
- The commercial and subsistence fisheries probably had a negligible impact on the chum salmon escapement.
- At-the-weir run timing of chum salmon at the Takotna River weir was slightly later than average, which was a trend consistent with other escapement monitoring projects in the Kuskokwim River drainage.
- The coho salmon escapement of 2,853 fish to the Takotna River in 2007 represented a decrease of about 50% from 2006 and was considerably below average for this location.
- The commercial fishery probably had a considerable impact on coho salmon escapement, but the subsistence fishery probably had little impact.
- At-the-weir run timing of coho salmon at the Takotna River weir was among the earliest on record for this location, which was a trend consistent with all other escapement monitoring projects in the Kuskokwim River drainage.
- The sockeye salmon escapement of 14 fish to the Takotna River in 2007 was the lowest since 2003 and represented a decrease of about 77% from 2006; however, escapements each year between 2004 and 2007 have been considerably above those prior to 2004.
- Comparisons of sockeye salmon run timing at the Takotna River weir are limited by relatively low abundance throughout project history; however, sockeye salmon run timing in 2007 was earlier than in previous years.

- Pink salmon are rare in the Takotna River; only 2 have been observed in the history of the project.
- Historical escapement records are not sufficient to develop escapement goals for Chinook, chum, or coho salmon at this time; however, by 2010 escapement data should be sufficient for escapement goal development if the weir continues to operate successfully through 2009.
- The weir is not an effective way of enumerating carcass fall out nor is counting carcasses by sex an effective way of estimating sex composition of upstream escapement.

AGE, SEX, AND LENGTH COMPOSITION

- Post-season analysis revealed that ASL sample collections for Chinook, chum, and coho salmon were sufficient for estimating the age, sex, and length composition of total annual escapement.
- The abundances of age-4 and -5 Chinook salmon at Takotna River weir in 2007 were similar to 2006 and higher than most years; however, the abundance of age-6 fish was below average.
- Age-6 Chinook salmon were expected to be more abundant than what was observed in 2007 based on the abundance of their siblings in 2006.
- Chinook salmon escapement to the Takotna River weir is expected to be high in 2008 based on the high abundance of age-4 and age-5 fish in 2007.
- Chinook salmon escapement past the Takotna River weir continues to be dominated by males and the percentage of female Chinook salmon here in 2007 was far below the historical range. The recently employed method of visually identifying the sex of every passing fish corroborates the sex bias deduced from ASL sampling.
- Chinook salmon were similar in length to previous years in all age and sex categories and changed little throughout the duration of the run.
- Female Chinook salmon tended to be longer than males of the same age and generally length increased with age.
- The timing of the commercial fishery in 2007 coupled with the small harvest of Chinook salmon implies that the ASL composition of Takotna River Chinook salmon escapement was not affected by commercial fishing activity in 2007 despite the exclusive use of small-mesh gear. In contrast, the prevalence of large-mesh gear in the subsistence fishery coupled with the timing and size of the harvest makes it likely that subsistence fishing activity affected the ASL composition of tributary escapements, including that of the Takotna River.
- The abundances of age-3, age-4, and age-5 chum salmon were above average while the abundance of age-6 was record-high.
- The relatively high abundance of age-4, -age-5 and age-6 chum salmon was anticipated given the relatively high abundances of their siblings in 2006. However, the high returns of these age classes were not anticipated following the low escapements that occurred in the Takotna River during the 2001, 2002, and 2003 brood years.

- The male-to-female sex ratio of chum salmon at the Takotna River weir in 2007 was slightly below average but close to 1:1. There was no functionally significant difference between the 2 methods of determining sex composition employed 2007.
- Mean lengths of chum salmon in each age and sex category were exceptionally low in 2007 and differences were generally significant. On average, age-5 female chum salmon in 2007 were significantly shorter than in all previous years.
- Male chum salmon tended to be longer than females of the same age and length increased with age for males but not for females.
- The abundances of age-4, and -5 coho salmon at Takotna River weir in 2007 were below average, but the abundance of age-3 fish was above average.
- The low abundance of age-4 coho salmon in 2007 was not anticipated considering that escapement during the 2003 brood year was record-high. Likewise, the relatively high abundance of age-3 coho salmon in 2007 was not anticipated given that escapement during the 2004 brood year was below average. Unfortunately, these conclusions are of limited utility because the number and ages of Takotna River coho salmon harvested downstream in the commercial and subsistence harvests is unknown.
- The percentage of females in the total coho salmon escapement at the Takotna River weir in 2007 was the highest on record. Historically, male-to-female sex ratios tend to vary little and are generally near 1:1. The recently introduced method of visually identifying the sex of every passing fish corroborates the sex bias deduced from ASL sampling.
- Of annual coho salmon escapement, only age-2.1 fish return in sufficiently high abundance to compare historical mean lengths. Mean lengths in 2007 were significantly higher than in 2006 and comfortably within the historical range.
- Female coho salmon tended to be longer than males of the same age.

WEATHER AND STREAM OBSERVATIONS

- For most of the season, water levels were above historical per-date averages and even exceeded previous per-date maximums in mid July and mid August.
- Daily water temperatures at the Takotna River weir in 2007 were not consistently above or below historical per-date averages; however, compared to past years, water temperature was generally above average between 18 August and 20 September.
- No obvious relationship was observed between fish passage and water level or water temperature.

RECOMMENDATIONS

ESCAPEMENT MONITORING

- Annual operation of the Takotna River weir should continue indefinitely. This project represents the only effort to monitor chum and coho salmon escapements in the upper Kuskokwim River basin and, for Chinook salmon, it is the only ground-based monitoring project that operates upstream of the Tatlawiksuk River. Furthermore, salmon from the Takotna River have consistently had the earliest run timing through the subsistence and commercial fisheries of the lower Kuskokwim River (Kalskag and Aniak) as determined through drainage-wide tagging programs. The run timing exhibited by Takotna River salmon is probably representative of other Chinook, summer chum, and coho salmon spawning populations destined for other upper-river tributaries. These early-running populations are subject to intensive subsistence and commercial fisheries that occur far downstream and at a time when fisheries managers have relatively little information to assess run abundance. Consequently, these early running populations are at greatest risk of management error. Data from the Takotna River weir is thought to reasonably approximate the escapement dynamics occurring in other, unmonitored, tributaries and is valuable for investigating impacts of harvest patterns.

- The Takotna River weir should continue to be operated jointly by TTC and ADF&G. The TTC crew is fully capable of operating the weir with the guidance of an ADF&G crew leader but TTC lacks capacity for conducting postseason data analysis and report writing. Long-term formal collaboration has resulted in a frequent and comfortable communication between 2 agencies that otherwise would probably not consort. The resulting relationship is thought to benefit both agencies involved as well as residents of Takotna and other neighboring communities that have ties to the Takotna River (such as McGrath). Formal and informal discussions that have arisen from the presence of ADF&G staff in Takotna and McGrath have improved public awareness of salmon management and stock status. The interaction has also improved public trust in ADF&G, which is a consequence that should be recognized and encouraged.
- As opportunity allows, crew members should consider installing the substrate rail late in the spring to take advantage of low water levels in the Takotna River, thereby hopefully avoiding the delay in operation experienced in 2003. All members of the TTC crew are residents at Takotna, making an early installation practical.
- Establish SEG ranges as soon as adequate data are 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 Hasbrouck Model (Bue and Hasbrouck *Unpublished*) should be achieved by 2009 for Chinook, chum, and coho salmon. Assuming successful weir operation continues, ADF&G should propose SEG ranges to the Alaska BOF during the 2010 meeting.

AGE, SEX, AND LENGTH COMPOSITION

- Current pulse sampling goals represent only a 10% increase from those recommended by Bromaghin (1993) to account for illegible or lost scales (“scale loss”). History has proven that scale loss is usually higher. Instead, actual goals should represent a 20% increase over those Bromaghin recommended. Preliminary revised goals should be 230 for Chinook salmon, 220 for chum salmon, and 200 for coho salmon.
- Project leaders and collaborators should adjust sample size objectives for Chinook salmon. Current sample size goals are inappropriate for 3 reasons: (1) current in-season sample size goals usually exceed annual escapement at this location, and (2) the minimum sample size (n) required to achieve the desired confidence interval width as required in the current Objective 2 is greatly reduced when sample sizes are corrected for finite population size (N) (i.e. finite population correction: Toshihide Hamazaki,

Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication). The sample size of 690 (three 230-fish pulse samples) that is required to achieve the current sample size goal usually exceeds the annual escapement at the weir. New sampling goals should be developed that acknowledge the ability of the weir to ascertain population size. Toshihide Hamazaki, an ADF&G Division of Commercial Fisheries biometrician for this area, recommends applying a finite correction to Bromaghin's formula for calculating sample sizes. This correction can either be applied pre-season for establishing sampling goals or can be applied post-season to determine whether confidence interval width was achieved. Chinook salmon escapement to the Takotna River rarely exceeds 500 fish, so it is reasonable to assume that N equals 500. When this is finite population correction is applied, the minimum sample size required to achieve confidence intervals of 0.20 is reduced by about 27%. After adjusting for the finite population correction, and increasing the goal by 20% for scale loss, the sample size goal is about 170 fish.

- In addition to being impossible due to low abundance, sampling 510 Chinook salmon (three 170-fish pulse samples) is impractical at the Takotna River weir because chum salmon escapement greatly exceeds that of Chinook salmon. In such tributaries it is impossible to sample large groups of Chinook salmon in 3 distinct pulses without greatly inhibiting chum salmon passage. Therefore, sampling goals should be reduced such that the desired confidence interval width of 0.20 would apply to the entire annual escapement but not to individual strata. Consequently, instead of trying to sample a total of 510 fish over 3 pulse samples, investigators should sample a minimum of 170 fish for the entire season. Though one purpose of the pulse sampling design was to ensure fair distribution of the sampling effort, pulse sampling is not necessary to estimate total annual ASL composition as long as sampling effort is fairly well distributed and is conducted proportional to the run. The annual run can still be stratified and intra-annual changes can still be investigated, but confidence intervals for age composition per strata will generally be broader than what is required by the current Objective 2. Historically, the Chinook salmon confidence interval requirement of Objective 2 has rarely been achieved. Thus, if recommendations described in this section are implemented, it will have little effect on the comparability of historical data.
- Another recommendation would be to simplify the current Objective 2 to read: "Estimate the age, sex, and length composition of annual Chinook, chum, and coho salmon escapements to the George River weir such that simultaneous 95% confidence intervals of age composition are no wider than 0.20 ($\alpha = 0.05$, $d = 0.10$)." As it is currently written, there are 2 clauses that have proven nearly impossible to achieve. First, it is impractical to implement a pulse sampling design for Chinook salmon and this species should not be among those for which pulse sampling is recommended. Second, requirements for confidence interval width as it applies to pulse samples should be omitted from the objective; currently, this objective is not achieved when confidence interval width exceeds 0.20 for each pulse sample. Since confidence intervals depend on the size of the sample(s) after ages have been determined, which is a variable that cannot be controlled when sampling, it may not be appropriate to include as a condition of the objective. Desired confidence interval width should be one criterion on which to base sample size goals but it should not influence the success or failure at meeting the objective. In practice, chum and coho sampling can be conducted following the pulse sampling design and attempts can be made to collect samples large enough to achieve tight confidence

intervals; however, the wording of the objective should not be such that it is not achieved when sample sizes prove to be too small for the desired confidence interval width per pulse.

- Future project reports for the Takotna 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.

WEATHER AND STREAM OBSERVATIONS

- Continue monitoring environmental conditions indefinitely. It is clear that environmental stimuli can and do influence migration of Pacific salmon (Quinn 2005). Kuskokwim Area escapement monitoring projects are not specifically designed to evaluate environmental cues to upstream migration, but knowledge of environmental conditions and a commitment to long-term monitoring is valuable to understanding migration and survival of Pacific salmon (Quinn 2005). Even though annual relationships between environmental conditions and salmon migration and abundance are not always clear, long-term data sets may prove valuable to understanding the biology and ecology of these species. We cannot begin to assess the effects of changing environmental conditions on Kuskokwim River salmon without sufficient baseline data consisting of complete and accurate measures of environmental variables. 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.

- Investigators should consider installing a stream gauging station in the Takotna River near the weir site or the community of Takotna similar to that installed in the George River in 2006 (Hildebrand et al. 2007). Stream gauging stations provide critical baseline data about river flow that could be used to establish a water reservation on the Takotna 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, Alaskan 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.

- Cooperate with USFWS OSM in their effort to collect reliable, consistent, and scientifically-defensible baseline data on weather and stream conditions at weir sites. A thermograph was first installed in the Takotna River in 2007 and will continue to be installed annually until battery life expires. If the Takotna River weir crew is selected to assist in this effort, project managers' are willing to add this thermograph to a pool of equipment that is shared among all projects involved.

SPAWNER-RECRUIT ANALYSIS

- Continue to develop a spawner-recruit analysis for Takotna River salmon. One of the caveats in undertaking this initiative in the past was accounting for the unknown fraction of Takotna River fish harvested in the commercial and subsistence fisheries. Preliminary findings from the tagging projects operated between 2001 and 2007 may allow for assumptions regarding the temporal position of Takotna River fish within the overall Chinook, chum, and coho salmon runs as they migrate through areas where most fishing occurs. Isolating harvest during that time period and applying an estimated spawning stock apportionment to account for Takotna River fish may provide the resolution required for identifying a reasonable spawner-recruit relationship.

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TABLES AND FIGURES

Table 1.–Daily, cumulative, and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at the Takotna River weir, 2007.

Date	Chinook Salmon			Chum Salmon			Coho Salmon			Sockeye Salmon		
	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage
20-Jun [a]	1			0			0			0		
21-Jun [a]	0			0			0			0		
22-Jun [a]	0			2			0			0		
23-Jun [a]	0			5			0			0		
24-Jun	0	0	0	1	1	0	0	0	0	0	0	0
25-Jun	0	0	0	8	9	0	0	0	0	0	0	0
26-Jun	0	0	0	1	10	0	0	0	0	0	0	0
27-Jun	0	0	0	15	25	0	0	0	0	0	0	0
28-Jun	0	0	0	19	44	0	0	0	0	0	0	0
29-Jun	0	0	0	18	62	1	0	0	0	0	0	0
30-Jun	3	3	1	43	105	1	0	0	0	0	0	0
1-Jul	1	4	1	44	149	2	0	0	0	0	0	0
2-Jul	0	4	1	53	202	2	0	0	0	0	0	0
3-Jul	20	24	6	159	361	4	0	0	0	0	0	0
4-Jul	15	39	9	147	508	6	0	0	0	0	0	0
5-Jul	17	56	13	166	674	8	0	0	0	0	0	0
6-Jul	15	71	17	149	823	9	0	0	0	0	0	0
7-Jul	6	77	18	252	1,075	12	0	0	0	0	0	0
8-Jul	11	88	21	239	1,314	15	0	0	0	0	0	0
9-Jul	42	130	31	374	1,688	19	0	0	0	0	0	0
10-Jul	33	163	39	415	2,103	24	0	0	0	0	0	0
11-Jul	42	205	49	533	2,636	30	0	0	0	0	0	0
12-Jul	20	225	54	421	3,057	34	0	0	0	0	0	0
13-Jul	10	235	56	471	3,528	40	0	0	0	0	0	0
14-Jul	10	245	59	514	4,042	45	0	0	0	0	0	0
15-Jul	32	277	66	255	4,297	48	0	0	0	0	0	0
16-Jul	3	280	67	346	4,643	52	0	0	0	0	0	0
17-Jul	5	285	68	347	4,990	56	0	0	0	0	0	0
18-Jul	12	297	71	349	5,339	60	0	0	0	0	0	0
19-Jul	10	307	73	380	5,719	64	0	0	0	0	0	0
20-Jul	14	321	77	375	6,094	68	0	0	0	0	0	0
21-Jul	25	346	83	477	6,571	74	0	0	0	0	0	0
22-Jul	5	351	84	315	6,886	77	0	0	0	0	0	0
23-Jul	3	354	85	281	7,167	81	2	2	0	0	0	0
24-Jul	3	357	85	192	7,359	83	1	3	0	0	0	0
25-Jul	7	364	87	251	7,610	86	0	3	0	0	0	0
26-Jul	7	371	89	252	7,862	88	0	3	0	0	0	0
27-Jul	8	379	91	161	8,023	90	0	3	0	1	1	7
28-Jul	6	385	92	154	8,177	92	0	3	0	0	1	7
29-Jul	2	387	93	72	8,249	93	2	5	0	0	1	7
30-Jul	0	387	93	110	8,359	94	1	6	0	0	1	7
31-Jul	0	387	93	63	8,422	95	0	6	0	0	1	7
1-Aug	2	389	93	61	8,483	95	3	9	0	0	1	7
2-Aug	0	389	93	34	8,517	96	2	11	0	0	1	7

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Table 1.–Page 2 of 3.

	Chinook Salmon			Chum Salmon			Coho Salmon			Sockeye Salmon		
Date	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage
3-Aug	0	389	93	38	8,555	96	4	15	1	0	1	7
4-Aug	1	390	93	27	8,582	96	11	26	1	0	1	7
5-Aug	4	394	94	25	8,607	97	15	41	1	0	1	7
6-Aug [b]	3	397	95	28	8,635	97	17	58	2	1	2	11
7-Aug [b]	3	400	96	29	8,664	97	21	79	3	1	3	18
8-Aug [b]	3	403	96	31	8,694	98	25	105	4	2	4	29
9-Aug	2	405	97	44	8,738	98	38	143	5	2	6	43
10-Aug	5	410	98	20	8,758	98	21	164	6	2	8	57
11-Aug	1	411	98	28	8,786	99	24	188	7	0	8	57
12-Aug	1	412	99	21	8,807	99	30	218	8	0	8	57
13-Aug	2	414	99	18	8,825	99	76	294	10	1	9	64
14-Aug	0	414	99	10	8,835	99	58	352	12	0	9	64
15-Aug	0	414	99	22	8,857	100	56	408	14	0	9	64
16-Aug	0	414	99	6	8,863	100	81	489	17	0	9	64
17-Aug	0	414	99	7	8,870	100	79	568	20	0	9	64
18-Aug	0	414	99	3	8,873	100	49	617	22	0	9	64
19-Aug	0	414	99	4	8,877	100	147	764	27	0	9	64
20-Aug	1	415	99	4	8,881	100	136	900	32	0	9	64
21-Aug	0	415	99	0	8,881	100	115	1,015	36	0	9	64
22-Aug	1	416	100	5	8,886	100	73	1,088	38	0	9	64
23-Aug	0	416	100	2	8,888	100	135	1,223	43	1	10	71
24-Aug	1	417	100	0	8,888	100	167	1,390	49	1	11	79
25-Aug	0	417	100	0	8,888	100	47	1,437	50	0	11	79
26-Aug	0	417	100	1	8,889	100	43	1,480	52	0	11	79
27-Aug	0	417	100	0	8,889	100	96	1,576	55	1	12	86
28-Aug	0	417	100	2	8,891	100	155	1,731	61	0	12	86
29-Aug	0	417	100	0	8,891	100	232	1,963	69	0	12	86
30-Aug	0	417	100	0	8,891	100	167	2,130	75	0	12	86
31-Aug	0	417	100	0	8,891	100	119	2,249	79	0	12	86
1-Sep	0	417	100	1	8,892	100	144	2,393	84	0	12	86
2-Sep	0	417	100	0	8,892	100	86	2,479	87	0	12	86
3-Sep	0	417	100	0	8,892	100	57	2,536	89	1	13	93
4-Sep	0	417	100	0	8,892	100	30	2,566	90	0	13	93
5-Sep	0	417	100	1	8,893	100	43	2,609	91	0	13	93
6-Sep	0	417	100	0	8,893	100	5	2,614	92	0	13	93
7-Sep	0	417	100	0	8,893	100	14	2,628	92	0	13	93
8-Sep	0	417	100	0	8,893	100	30	2,658	93	0	13	93
9-Sep	0	417	100	0	8,893	100	30	2,688	94	0	13	93
10-Sep	0	417	100	3	8,896	100	22	2,710	95	1	14	100
11-Sep	0	417	100	0	8,896	100	18	2,728	96	0	14	100
12-Sep	0	417	100	0	8,896	100	26	2,754	97	0	14	100
13-Sep	0	417	100	1	8,897	100	16	2,770	97	0	14	100
14-Sep	0	417	100	0	8,897	100	11	2,781	97	0	14	100
15-Sep	1	418	100	1	8,898	100	17	2,798	98	0	14	100
16-Sep	0	418	100	1	8,899	100	15	2,813	99	0	14	100

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Table 1.–Page 3 of 3.

	Chinook Salmon			Chum Salmon			Coho Salmon			Sockeye Salmon		
Date	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**
17-Sep	0	418	100	0	8,899	100	9	2,822	99	0	14	100
18-Sep	0	418	100	0	8,899	100	10	2,832	99	0	14	100
19-Sep	0	418	100	1	8,900	100	14	2,846	100	0	14	100
20-Sep [c]	0	418	100	0	8,900	100	7	2,853	100	0	14	100

Note: The sum of daily passages may not equal the total cumulative passage due to rounding errors inherent in passage estimates. Cumulative passage values are accurate.

[a] Date outside of the target operational period; daily passage is not included in cumulative escapement.

[b] Weir was not operational; daily passage was estimated from linear interpolation.

[c] Weir was removed early due to anticipated flood conditions; passage was estimated based on the “proportion method” as defined in the methods.

Table 2.–Age and sex composition of Takotna River Chinook salmon in 2007 based on escapement samples collected at the weir.

Sample Dates	Sample		Age Class																	
			1.1		1.2		1.3		2.2		1.4		2.3		1.5		2.4		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
6/30-7/9	99	M	0	0.0	88	67.7	28	21.2	0	0.0	9	7.1	1	0.8	0	0.0	0	0.0	126	97.0
(6/24-7/9)		F	0	0.0	0	0.0	1	1.0	0	0.0	3	2.0	0	0.0	0	0.0	0	0.0	4	3.0
		Subtotal[a]	0	0.0	88	67.7	29	22.2	0	0.0	12	9.1	1	0.8	0	0.0	0	0.0	130	100.0
7/10-18	96	M	0	0.0	97	58.3	49	29.2	0	0.0	9	5.2	0	0.0	0	0.0	0	0.0	155	92.7
(7/10-18)		F	0	0.0	0	0.0	5	3.1	0	0.0	7	4.2	0	0.0	0	0.0	0	0.0	12	7.3
		Subtotal[a]	0	0.0	97	58.3	54	32.3	0	0.0	16	9.4	0	0.0	0	0.0	0	0.0	167	100.0
7/19-29	74	M	0	0.0	26	21.6	46	37.8	0	0.0	11	9.5	0	0.0	0	0.0	0	0.0	83	68.9
(7/19-9/20)		F	0	0.0	0	0.0	11	9.5	0	0.0	23	18.9	0	0.0	3	2.7	0	0.0	38	31.1
		Subtotal[a]	0	0.0	26	21.6	57	47.3	0	0.0	34	28.4	0	0.0	3	2.7	0	0.0	121	100.0
Season[b]	269	M	0	0.0	212	50.6	122	29.2	0	0.0	29	7.0	1	0.3	0	0.0	0	0.0	364	87.1
		F	0	0.0	0	0.0	18	4.3	0	0.0	33	7.8	0	0.0	3	0.8	0	0.0	54	12.9
		Total	0	0.0	212	50.6	140	33.5	0	0.0	62	14.8	1	0.3	3	0.8	0	0.0	418	100.0

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

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

Table 3.–Length composition of Takotna River Chinook salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4
6/30-7/9	M	Mean Length		522	665		800	615		
(6/24-7/9)		SE		5	15		42	-		
		Range		433- 592	555- 875		655- 928	615- 615		
		Sample Size	0	67	21	0	7	1	0	0
	F	Mean Length			687		823			
		SE			-		11			
		Range			687- 687		812- 834			
		Sample Size	0	0	1	0	2	0	0	0
7/10-18	M	Mean Length		522	669		758			
(7/10-18)		SE		6	12		43			
		Range		433- 635	520- 810		666- 890			
		Sample Size	0	56	28	0	5	0	0	0
	F	Mean Length			741		806			
		SE			28		27			
		Range			700- 794		738- 850			
		Sample Size	0	0	3	0	4	0	0	0
7/19-29	M	Mean Length		561	683		761			
(7/19-9/20)		SE		12	8		46			
		Range		494- 663	593- 765		628- 982			
		Sample Size	0	16	28	0	7	0	0	0
	F	Mean Length			762		823		828	
		SE			10		16		107	
		Range			704- 781		712- 920		721- 934	
		Sample Size	0	0	7	0	14	0	2	0
Season[a]	M	Mean Length		527	673		772	615		
		Range		433- 663	520- 875		628- 982	615- 615		
		Sample Size	0	139	77	0	19	1	0	0
	F	Mean Length			751		819		828	
		Range			687- 794		712- 920		721- 934	
		Sample Size	0	0	11	0	20	0	2	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 Takotna River chum salmon in 2007 based on escapement samples collected at the weir.

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 %
6/29-7/3	195	M	7	1.0	211	31.3	180	26.7	34	5.2	432	64.1
(6/24-7/5)		F	3	0.5	142	21.0	90	13.3	7	1.0	242	35.9
		Subtotal[a]	10	1.5	353	52.3	270	40.0	41	6.2	674	100.0
7/8-10	197	M	12	0.5	774	32.5	411	17.2	36	1.5	1,234	51.8
(7/6-12)		F	97	4.1	726	30.4	303	12.7	24	1.0	1,149	48.2
		Subtotal[a]	109	4.6	1,500	62.9	714	29.9	60	2.5	2,383	100.0
7/15-17	182	M	0	0.0	731	27.5	526	19.8	44	1.6	1,302	48.9
(7/13-19)		F	59	2.2	849	31.8	439	16.5	15	0.6	1,360	51.1
		Subtotal[a]	59	2.2	1,580	59.3	965	36.3	59	2.2	2,662	100.0
7/22-24	186	M	37	1.6	644	28.0	520	22.6	25	1.1	1,226	53.2
(7/20-27)		F	62	2.7	694	30.1	285	12.3	37	1.6	1,078	46.8
		Subtotal[a]	99	4.3	1,338	58.1	805	34.9	62	2.7	2,304	100.0
7/29-8/1	186	M	5	0.5	288	32.8	151	17.2	10	1.1	453	51.6
(7/28-9/20)		F	23	2.7	292	33.3	99	11.3	9	1.1	424	48.4
		Subtotal[a]	28	3.2	580	66.1	250	28.5	19	2.2	877	100.0
Season[b]	946	M	61	0.7	2,648	29.7	1,789	20.1	149	1.7	4,647	52.2
		F	244	2.7	2,702	30.4	1,215	13.6	92	1.0	4,253	47.8
		Total	305	3.4	5,350	60.1	3,004	33.7	241	2.7	8,900	100.0

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

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

Table 5.–Length composition of Takotna River chum salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
6/29-7/3 (6/24-7/5)	M	Mean Length	549	564	576	585
		SE	39	4	5	5
		Range	510- 588	504- 610	514- 653	565- 614
		Sample Size	2	61	52	10
	F	Mean Length	545	539	560	534
		SE	-	4	5	47
		Range	545- 545	488- 597	513- 608	487- 581
		Sample Size	1	41	26	2
7/8-10 (7/6-12)	M	Mean Length	504	561	569	552
		SE	-	3	5	16
		Range	504- 504	512- 610	504- 625	521- 568
		Sample Size	1	64	34	3
	F	Mean Length	543	531	540	560
		SE	8	4	6	16
		Range	514- 584	482- 596	476- 585	544- 575
		Sample Size	8	60	25	2
7/15-17 (7/13-19)	M	Mean Length		545	567	573
		SE		4	5	10
		Range		492- 618	494- 667	560- 592
		Sample Size	0	50	36	3
	F	Mean Length	501	530	528	585
		SE	10	3	4	-
		Range	480- 523	483- 580	488- 563	585- 585
		Sample Size	4	58	30	1
7/22-24 (7/20-27)	M	Mean Length	521	554	570	594
		SE	17	5	5	17
		Range	500- 554	433- 642	519- 652	577- 610
		Sample Size	3	52	42	2
	F	Mean Length	524	538	525	527
		SE	12	4	7	15
		Range	497- 553	482- 605	458- 587	502- 553
		Sample Size	5	56	23	3
7/29-8/1 (7/28-9/20)	M	Mean Length	510	555	560	576
		SE	-	4	5	22
		Range	510- 510	473- 633	503- 627	554- 598
		Sample Size	1	61	32	2
	F	Mean Length	526	525	531	523
		SE	7	3	7	12
		Range	509- 548	477- 567	482- 575	511- 534
		Sample Size	5	62	21	2
Season[a]	M	Mean Length	520	554	569	574
		Range	500- 588	433- 642	494- 667	521- 614
		Sample Size	7	288	196	20
	F	Mean Length	526	532	533	545
		Range	480- 584	477- 605	458- 608	487- 585
		Sample Size	23	277	125	10

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 4.

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

Table 6.–Age and sex composition of Takotna River coho salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 1.1 Esc.	1.1 %	2.1 Esc.	2.1 %	3.1 Esc.	3.1 %	Total Esc.	Total %
8/10-14	160	M	24	3.1	377	49.4	10	1.3	411	53.8
(6/24-8/19)		F	14	1.9	320	41.9	19	2.5	353	46.2
		Subtotal[a]	38	5.0	697	91.3	29	3.8	764	100.0
8/25-28	141	M	11	0.7	642	43.3	42	2.8	695	46.8
(8/20-31)		F	10	0.7	727	48.9	53	3.6	790	53.2
		Subtotal[a]	21	1.4	1,369	92.2	95	6.4	1,485	100.0
9/4-11	140	M	0	0.0	233	38.6	22	3.6	255	42.1
(9/1-20)		F	4	0.7	341	56.4	4	0.7	349	57.9
		Subtotal[a]	4	0.7	574	95.0	26	4.3	604	100.0
Season[b]	441	M	35	1.2	1,253	43.9	73	2.6	1,360	47.7
		F	29	1.0	1,387	48.6	76	2.6	1,493	52.3
		Total	64	2.2	2,640	92.5	149	5.2	2,853	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 the "Season" summary is the sum of all strata; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 7.–Length composition of Takotna River coho salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	3.1
8/10-14 (6/24-8/19)	M	Mean Length	516	533	583
		SE	27	5	35
		Range	443- 606	371- 609	548- 618
		Sample Size	5	79	2
	F	Mean Length	536	552	557
		SE	6	3	10
		Range	525- 546	477- 614	530- 573
		Sample Size	3	67	4
8/25-28 (8/20-31)	M	Mean Length	509	528	517
		SE	-	5	35
		Range	509- 509	417- 592	421- 579
		Sample Size	1	61	4
	F	Mean Length	522	534	557
		SE	-	4	16
		Range	522- 522	463- 594	504- 590
		Sample Size	1	69	5
9/4-11 (9/1-20)	M	Mean Length		542	552
		SE		6	6
		Range		444- 627	535- 567
		Sample Size	0	54	5
	F	Mean Length	544	559	577
		SE	-	3	-
		Range	544- 544	469- 603	577- 577
		Sample Size	1	79	1
Season[a]	M	Mean Length	514	532	536
		Range	443- 606	371- 627	421- 618
		Sample Size	6	194	11
	F	Mean Length	532	545	558
		Range	522- 546	463- 614	504- 590
		Sample Size	5	215	10

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 6.

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

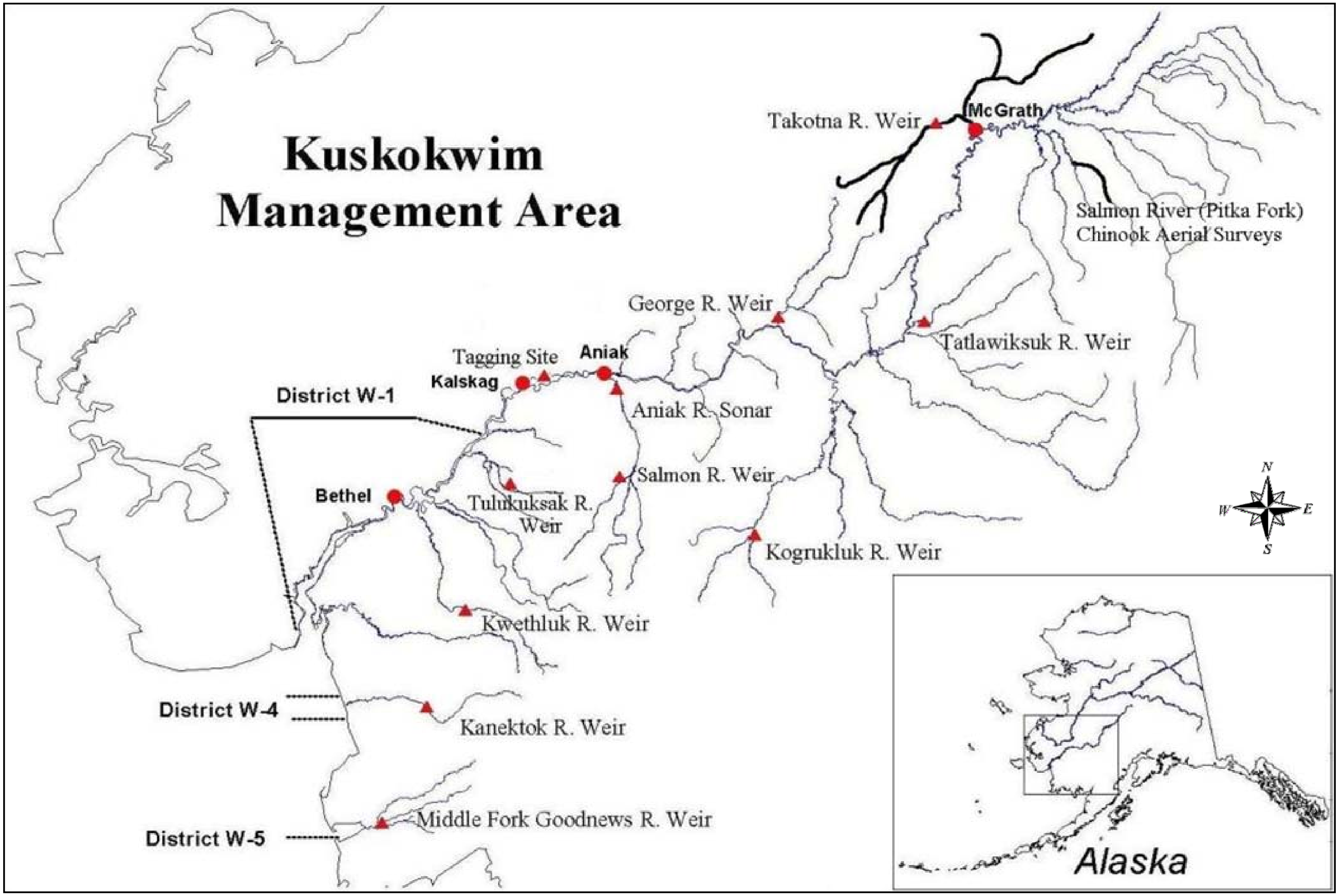


Figure 1.–Map depicting the location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Takotna River and Salmon River of the Pitka Fork.

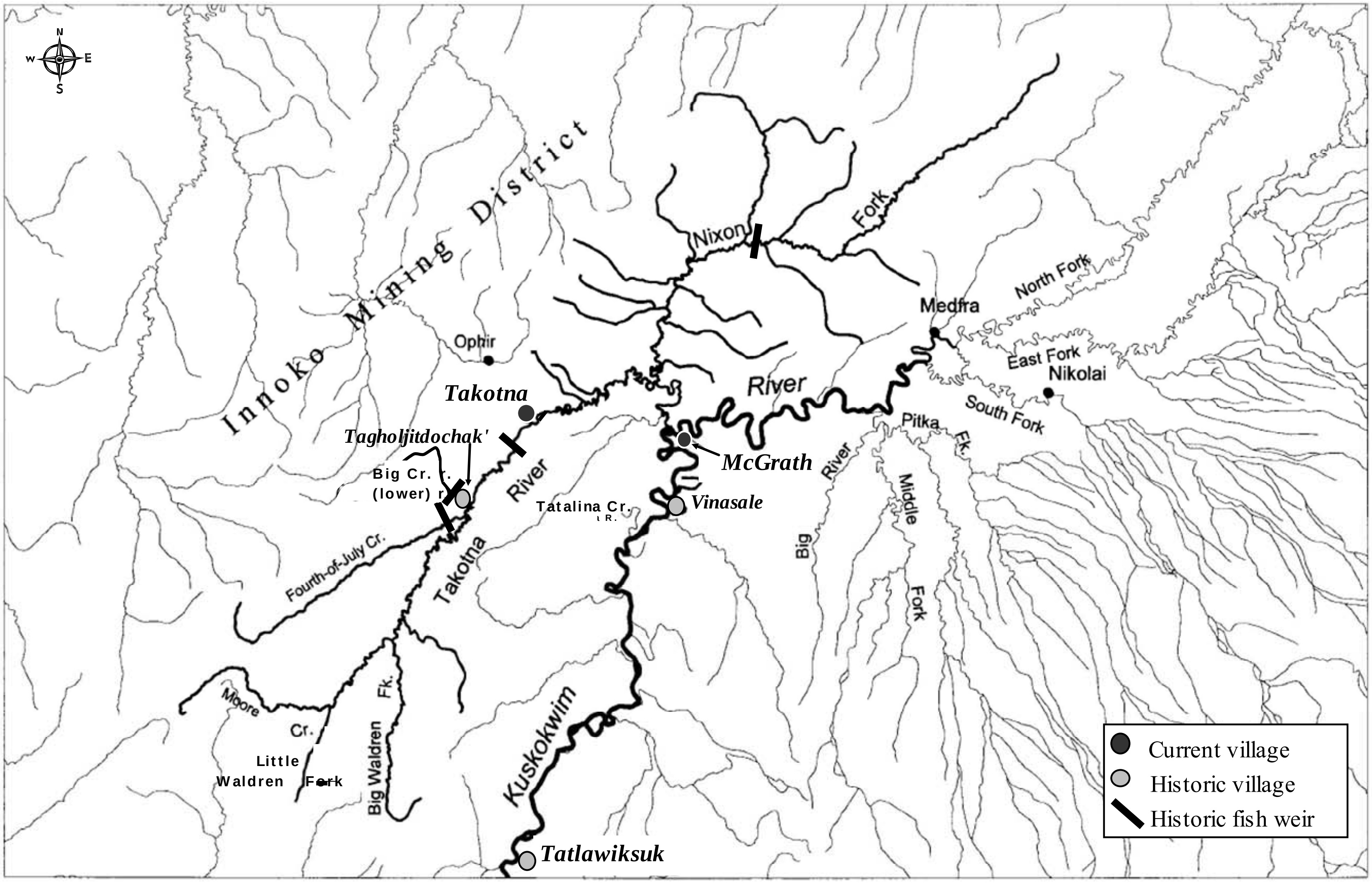
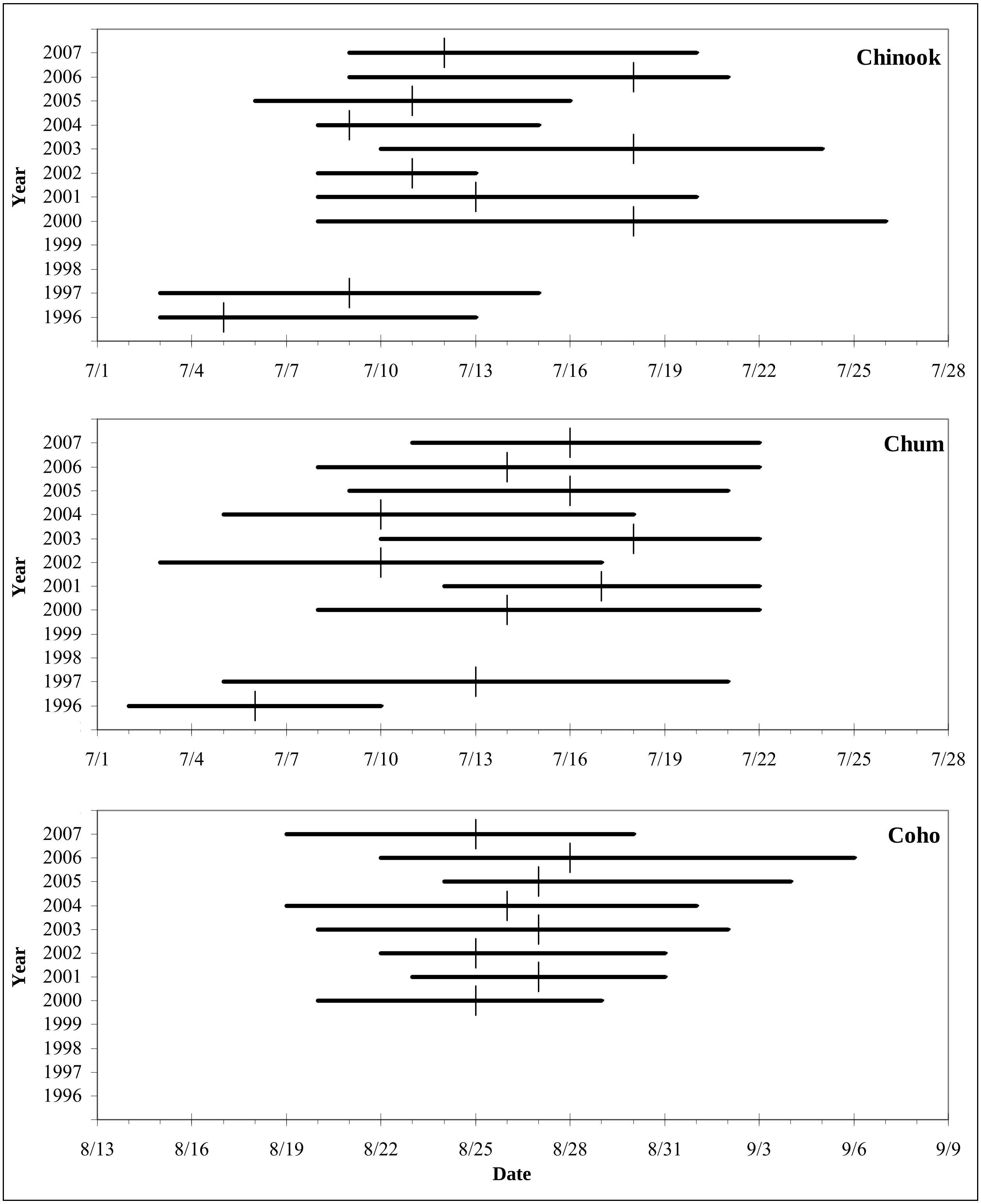


Figure 2.–Takotna River drainage and the location of historic native communities and fish weirs.



Note: Solid lines represent the dates when the central 50% of the run passed (elongated box in Table 1) and cross-bars represent the median passage date (bold box in Table 1).

Figure 3.–Annual run timing of Chinook, chum, and coho salmon through the Takotna River weir based on cumulative percent passage.

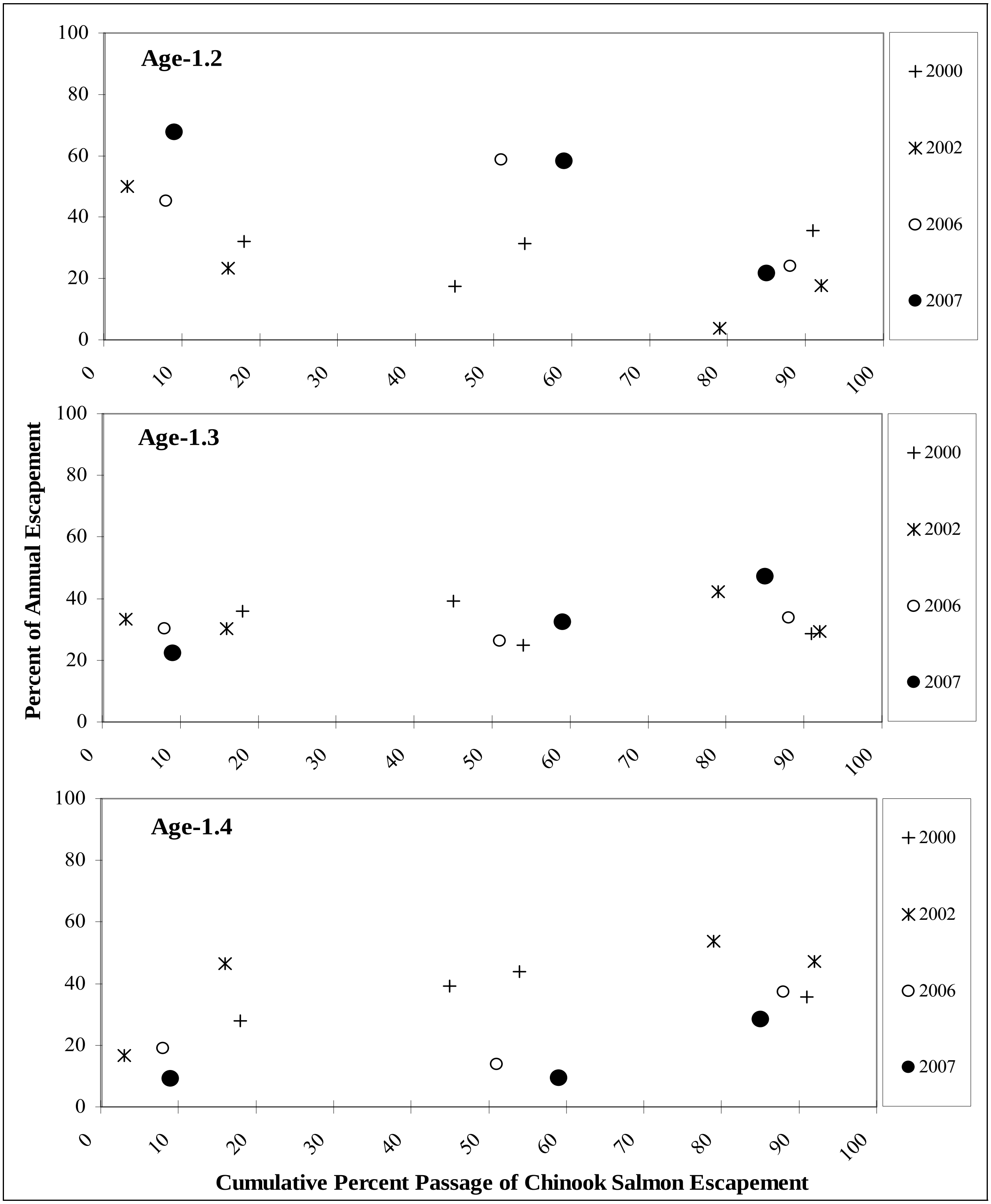


Figure 4.–Age composition of Takotna River Chinook salmon by cumulative percent passage through the weir, 2000–2007.

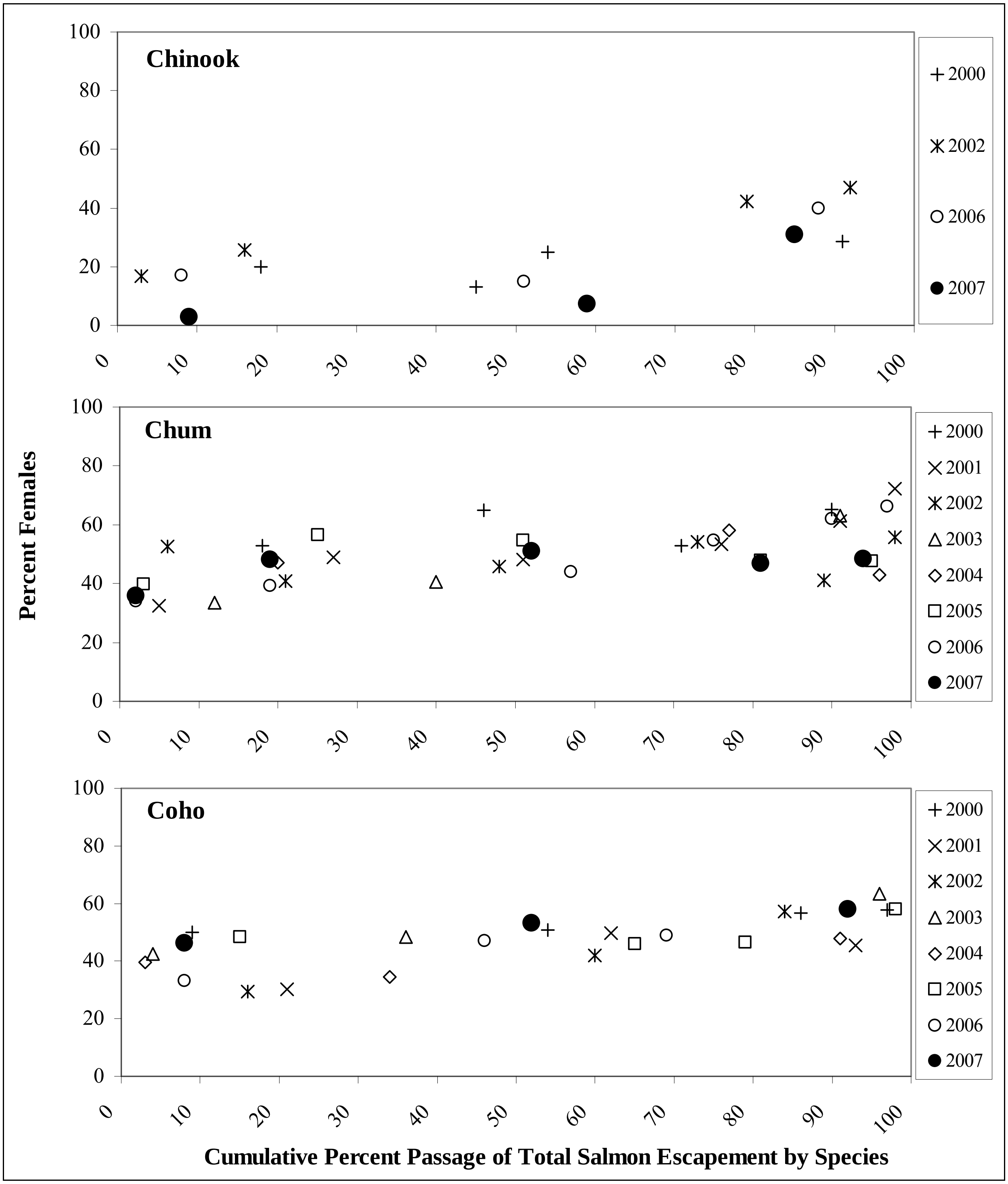


Figure 5.–Percentage of female Chinook, chum, and coho salmon by cumulative percent passage at the Takotna River weir, 2000–2007.

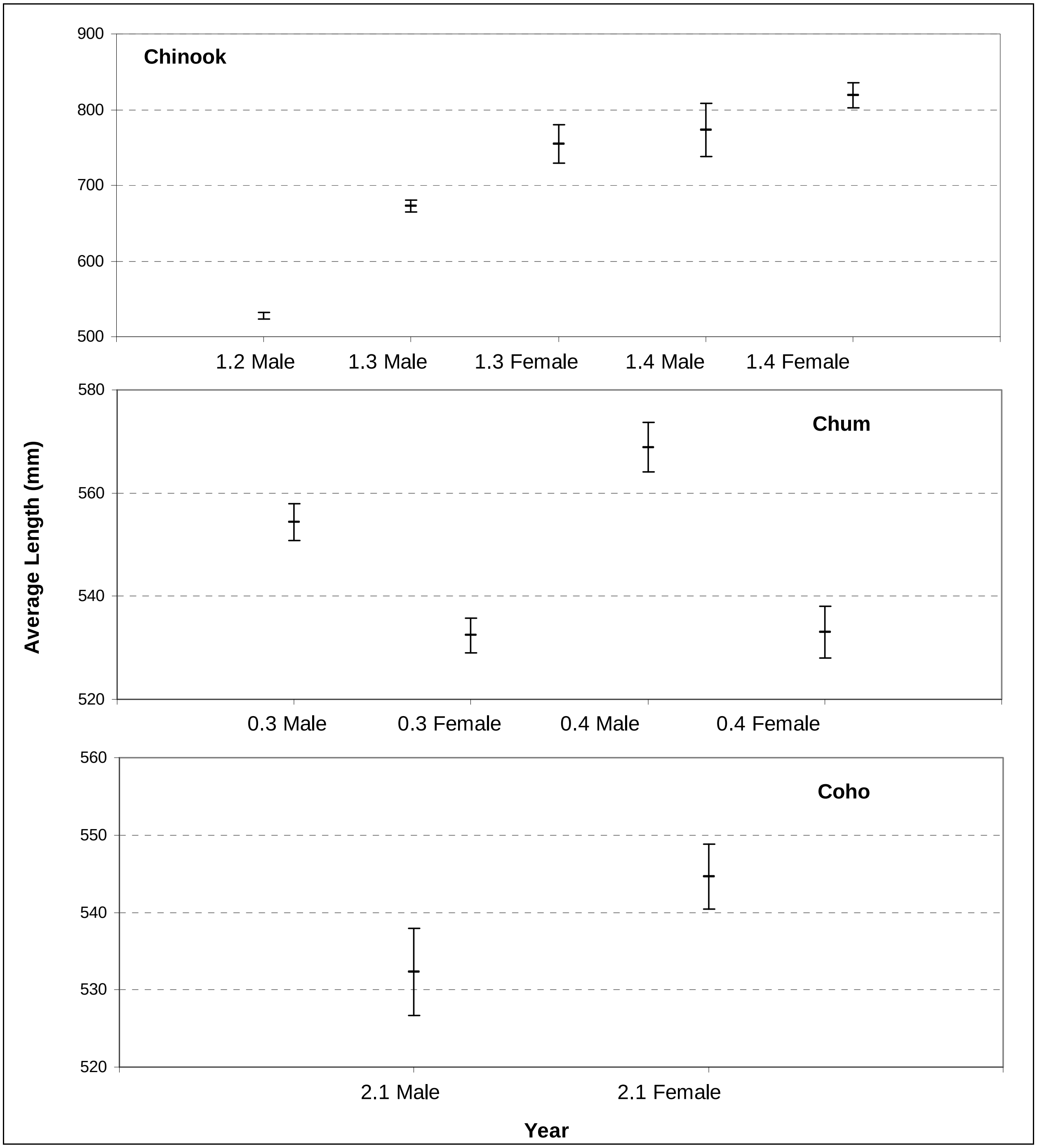
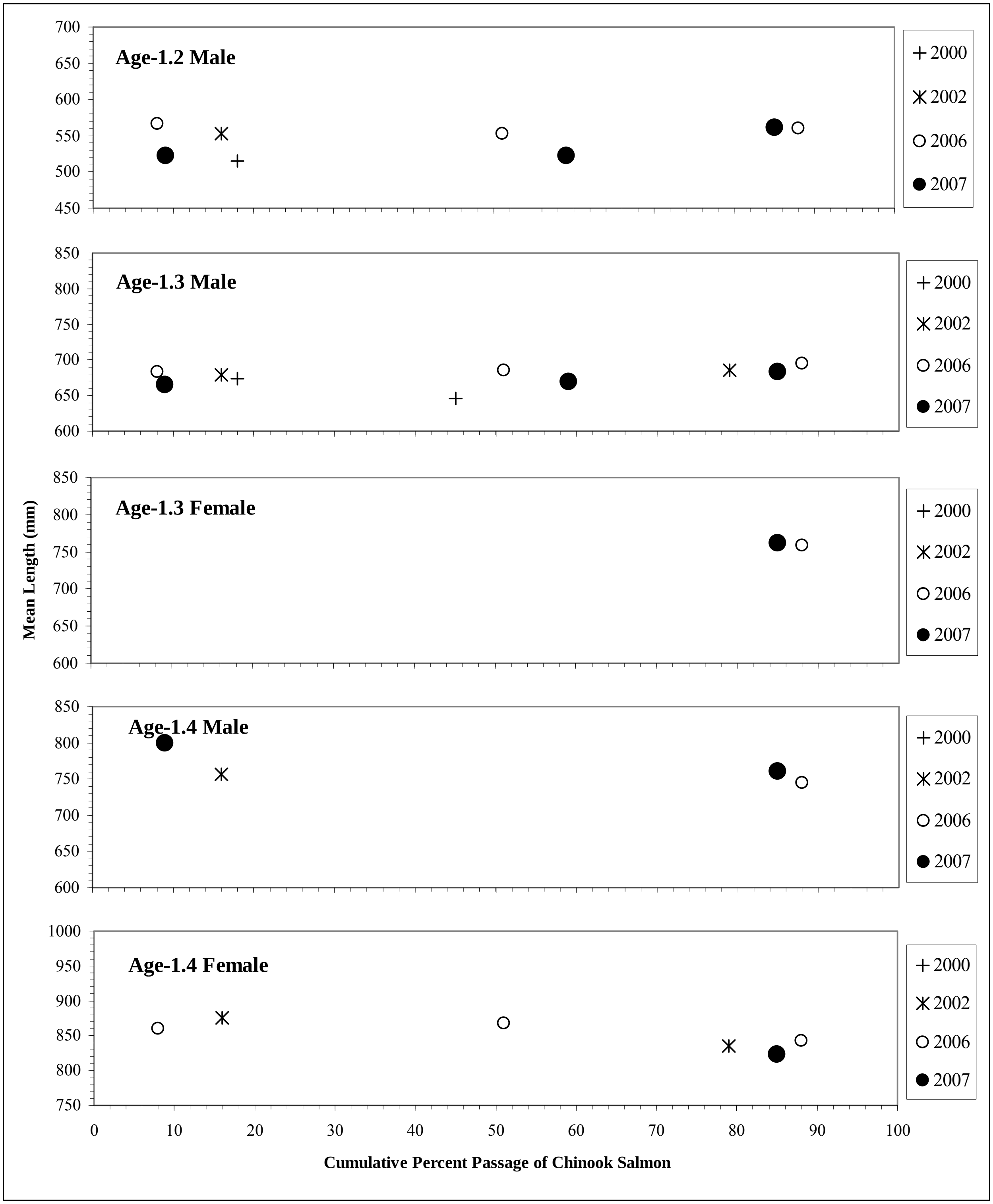


Figure 6.–Average length of Takotna River Chinook, chum, and coho salmon by age/sex category in 2007 with 95% confidence intervals.



Note: Only samples consisting of more than 6 fish are included in this figure.

Figure 7.–Average length of common Takotna River Chinook salmon age/sex categories by cumulative percent passage, 2000–2007.

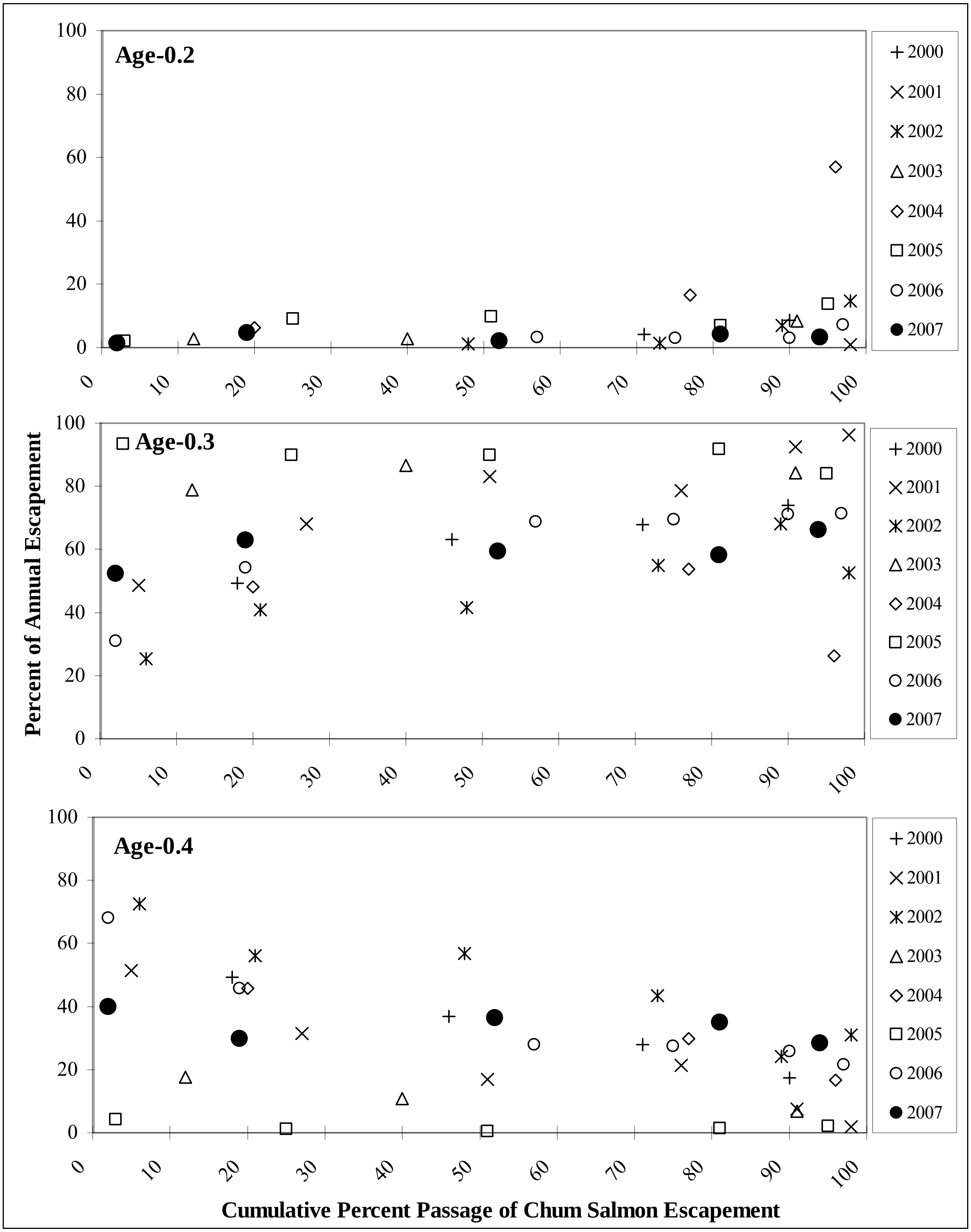
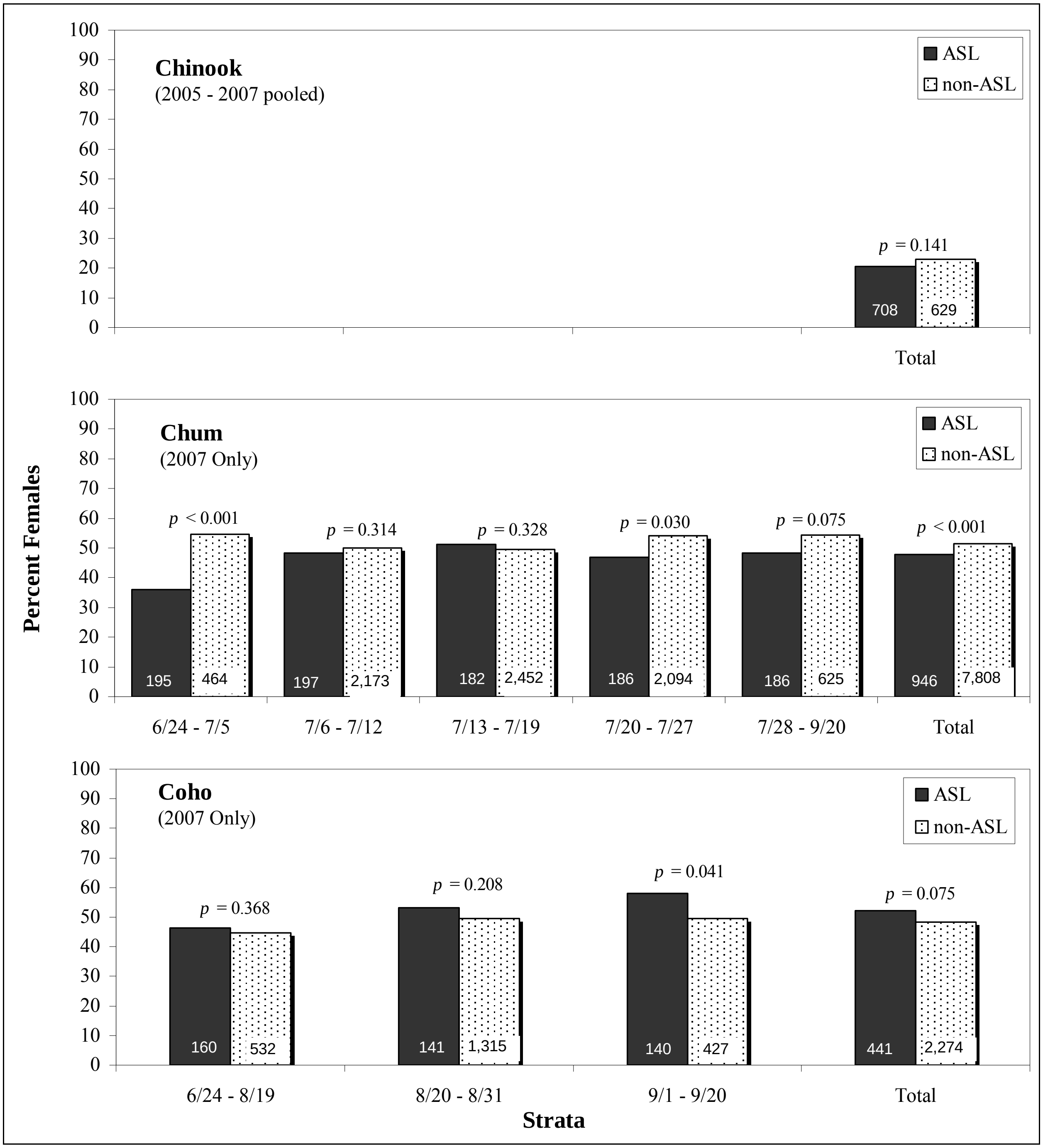
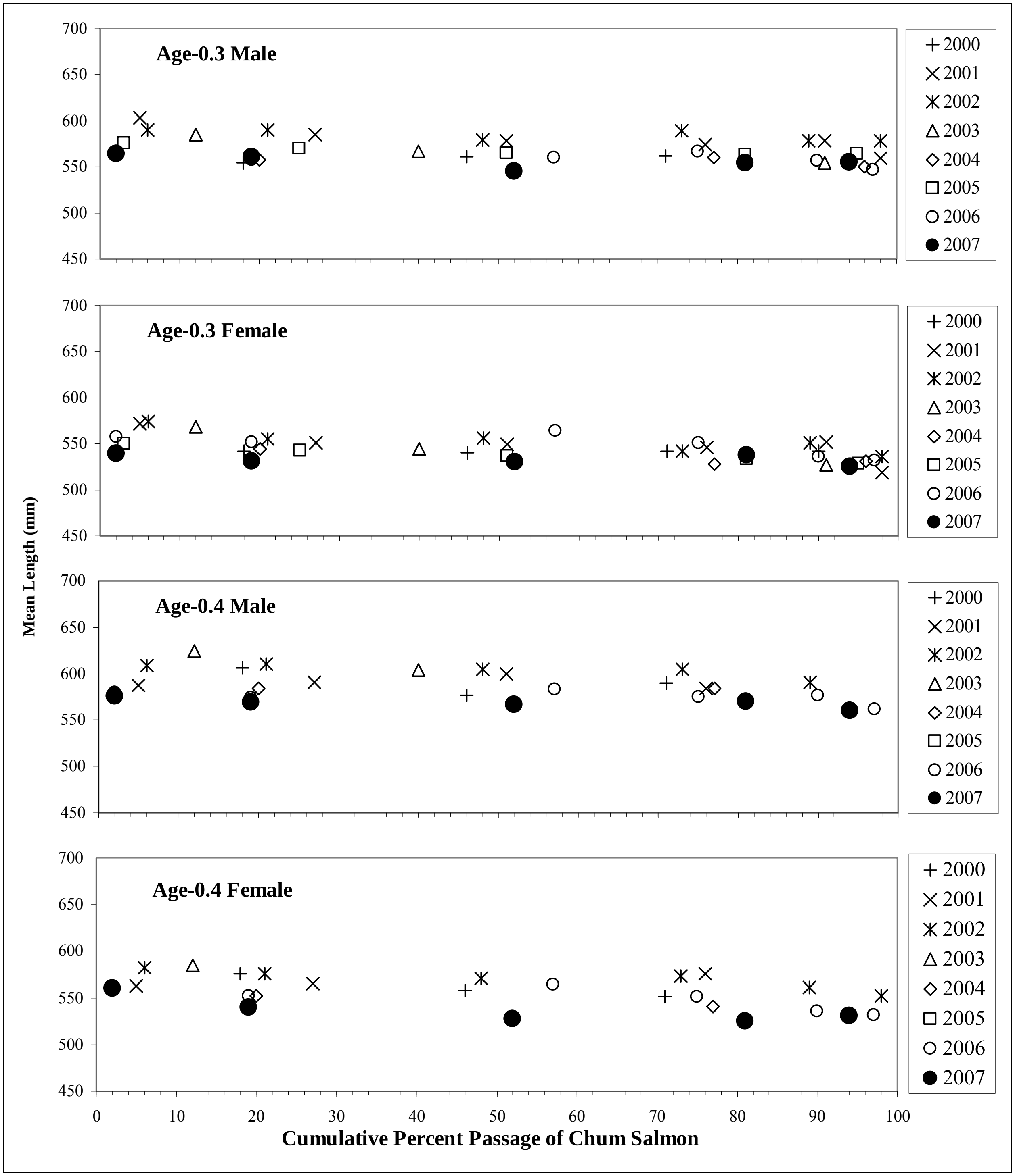


Figure 8.–Age composition of Takotna River chum salmon by cumulative percent passage through the weir, 2000–2007.



Note: The number above each pair of columns is a *z*-test derived *p*-value (*p*) and the number at the base of each column is the sample size (*n*).

Figure 9.–The percentage of female salmon passing upstream of the Takotna River weir as determined from standard ASL sampling using a fish trap compared to the method of determining the sex of every passing fish.



Note: Only samples consisting of more than 6 fish are included in this figure.

Figure 10.–Average length of common Takotna River chum salmon age/sex categories by cumulative percent passage, 2000–2007.

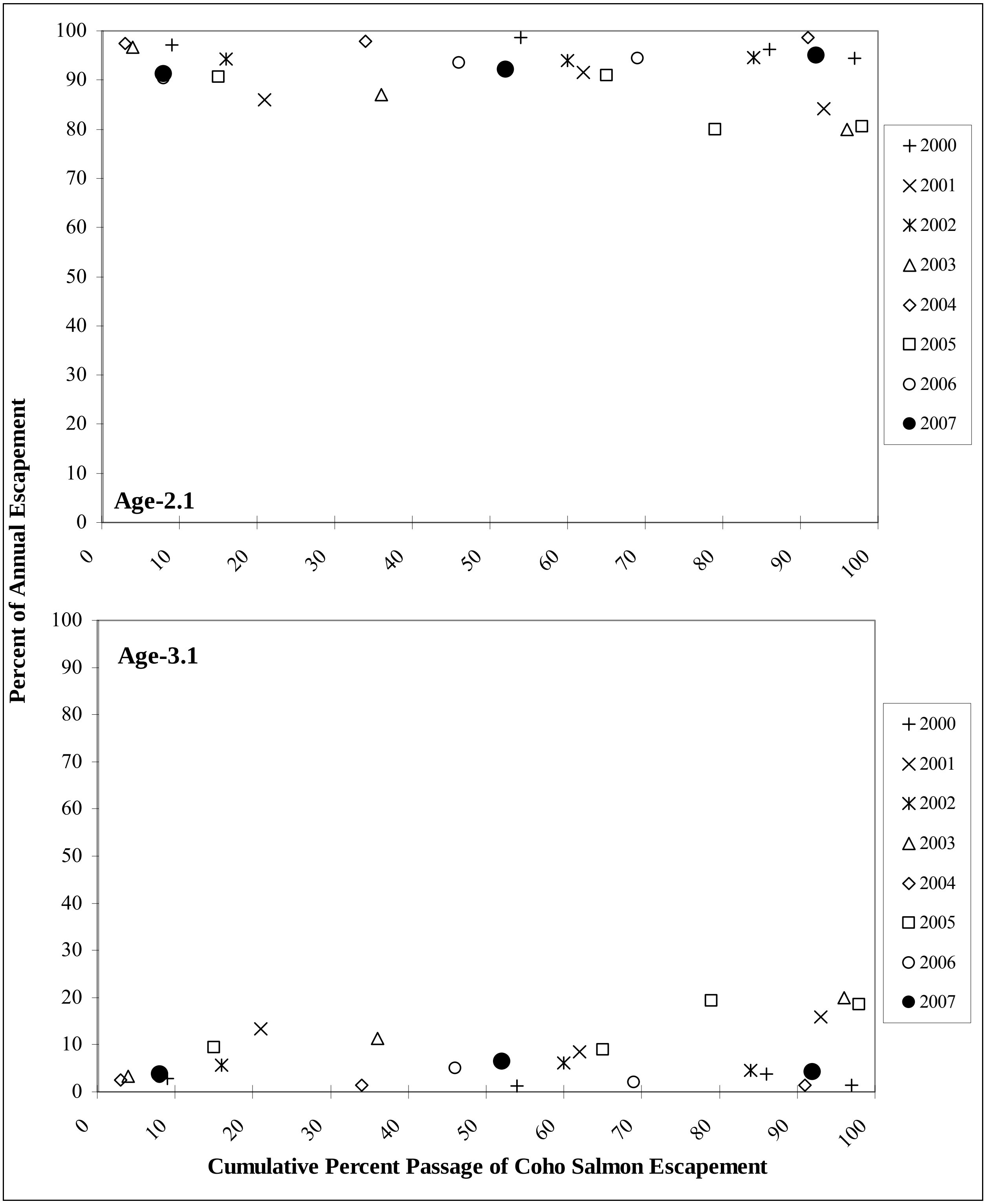
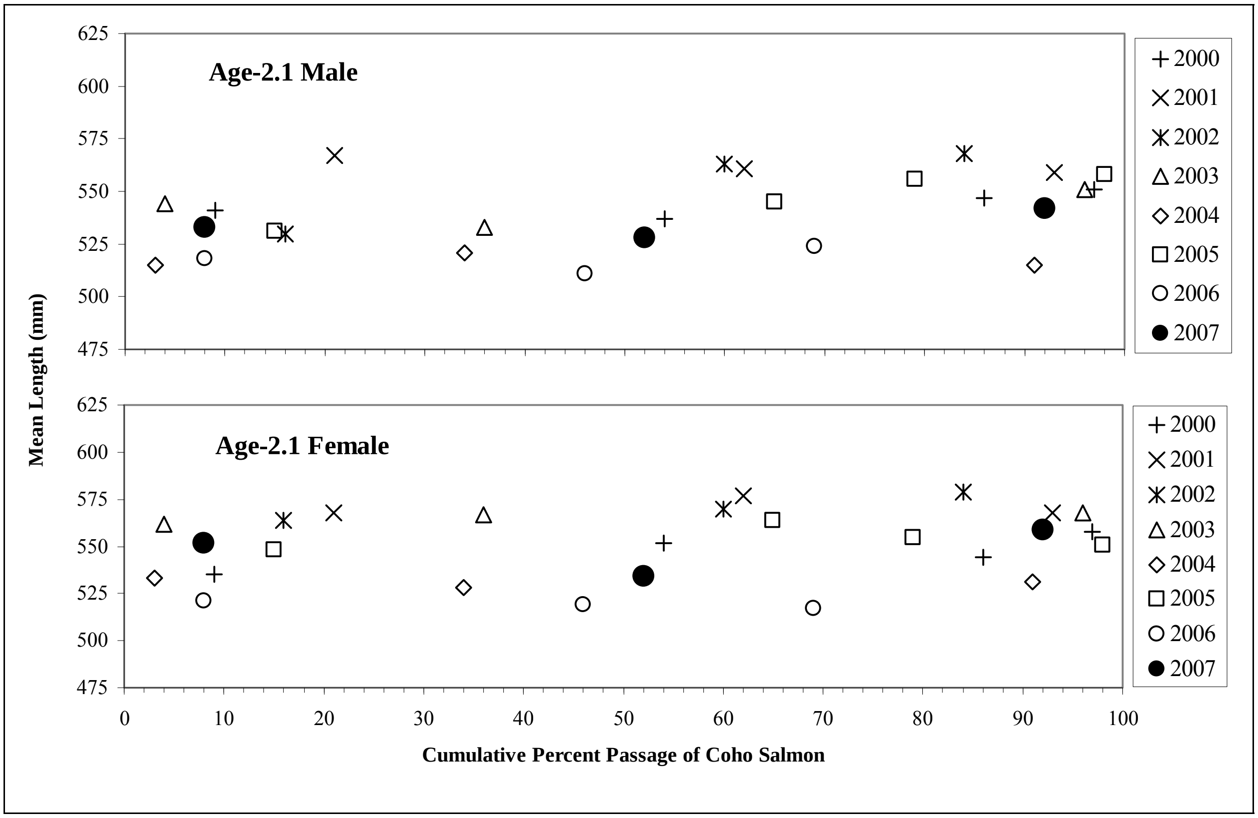


Figure 11.–Age composition of Takotna River coho salmon by cumulative percent passage through the weir, 2000–2007.



Note: Only samples consisting of more than 6 fish are included in this figure.

Figure 12.–Average length of common Takotna River coho salmon age/sex categories by cumulative percent passage, 2000–2007.

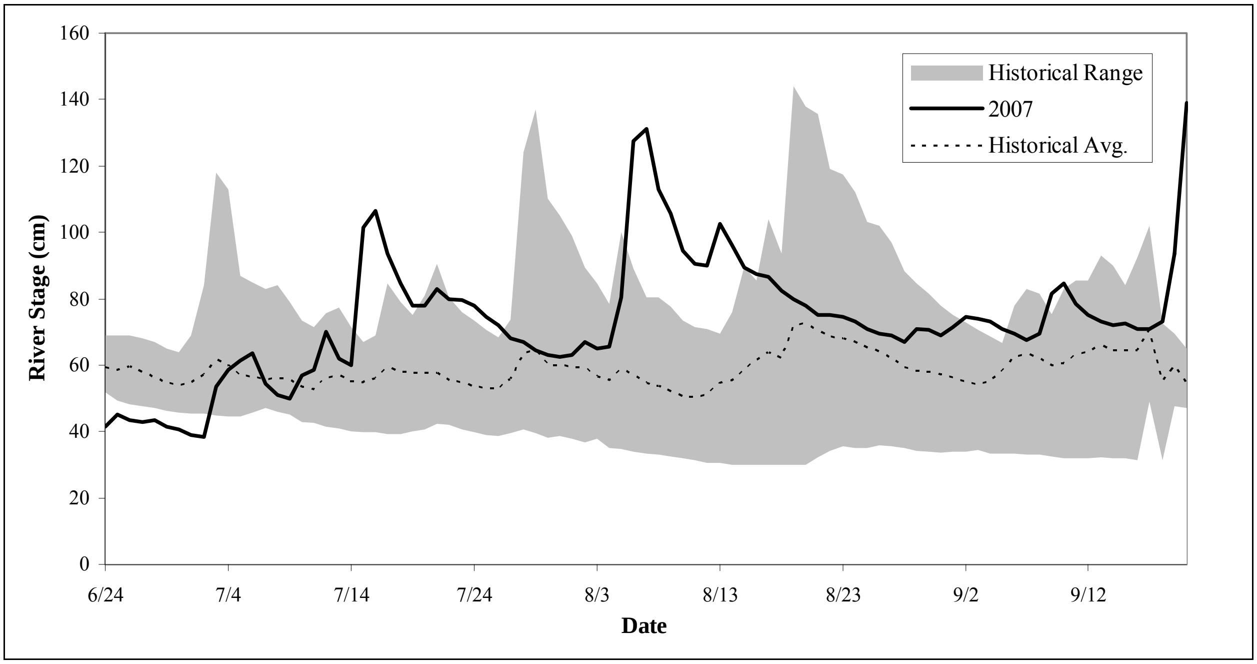


Figure 13.–Daily morning river stage at the Takotna River weir in 2007 (bold line) relative to the historical average (dotted line) and the historical (2000–2006) range.

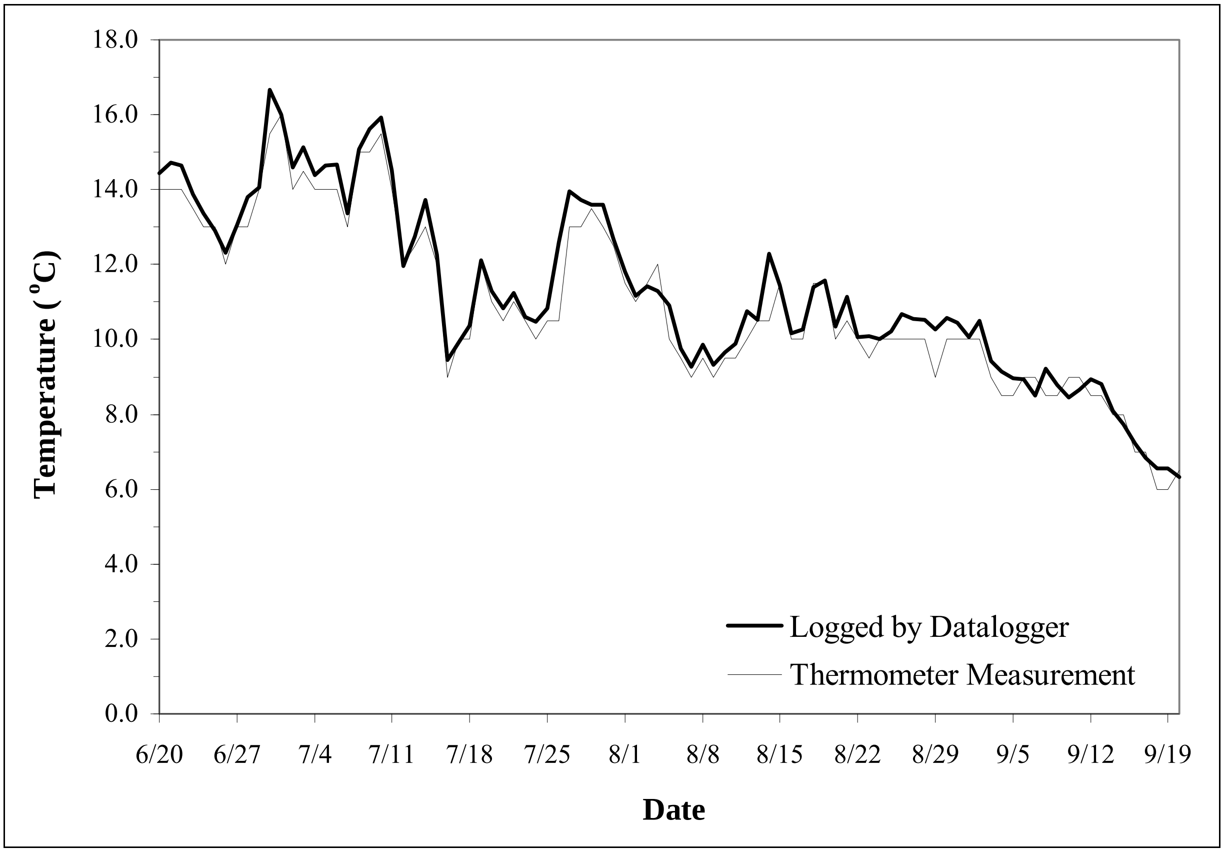


Figure 14.–Daily morning water temperature logged by the thermograph compared to daily morning water temperature determined using a thermometer at the Takotna River weir in 2007.

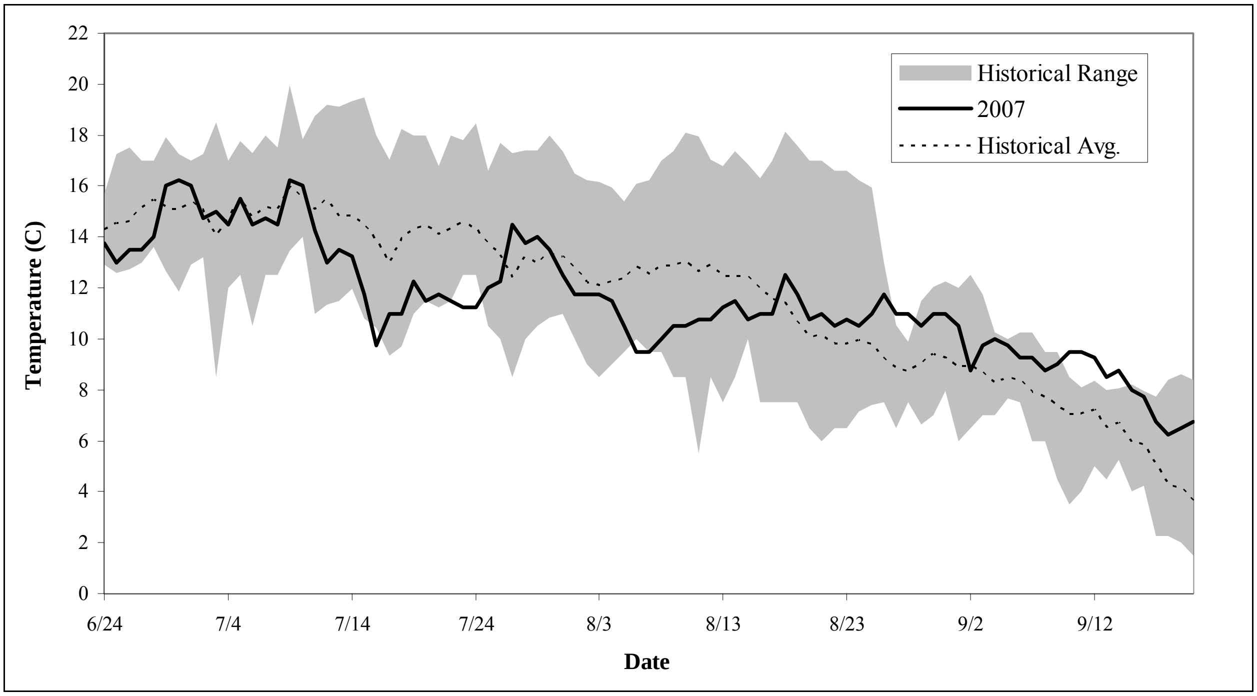


Figure 15.–Daily morning water temperature at the Takotna River weir in 2007 (bold line) relative to the historical average (dotted line) and the historical (2000–2006) range.

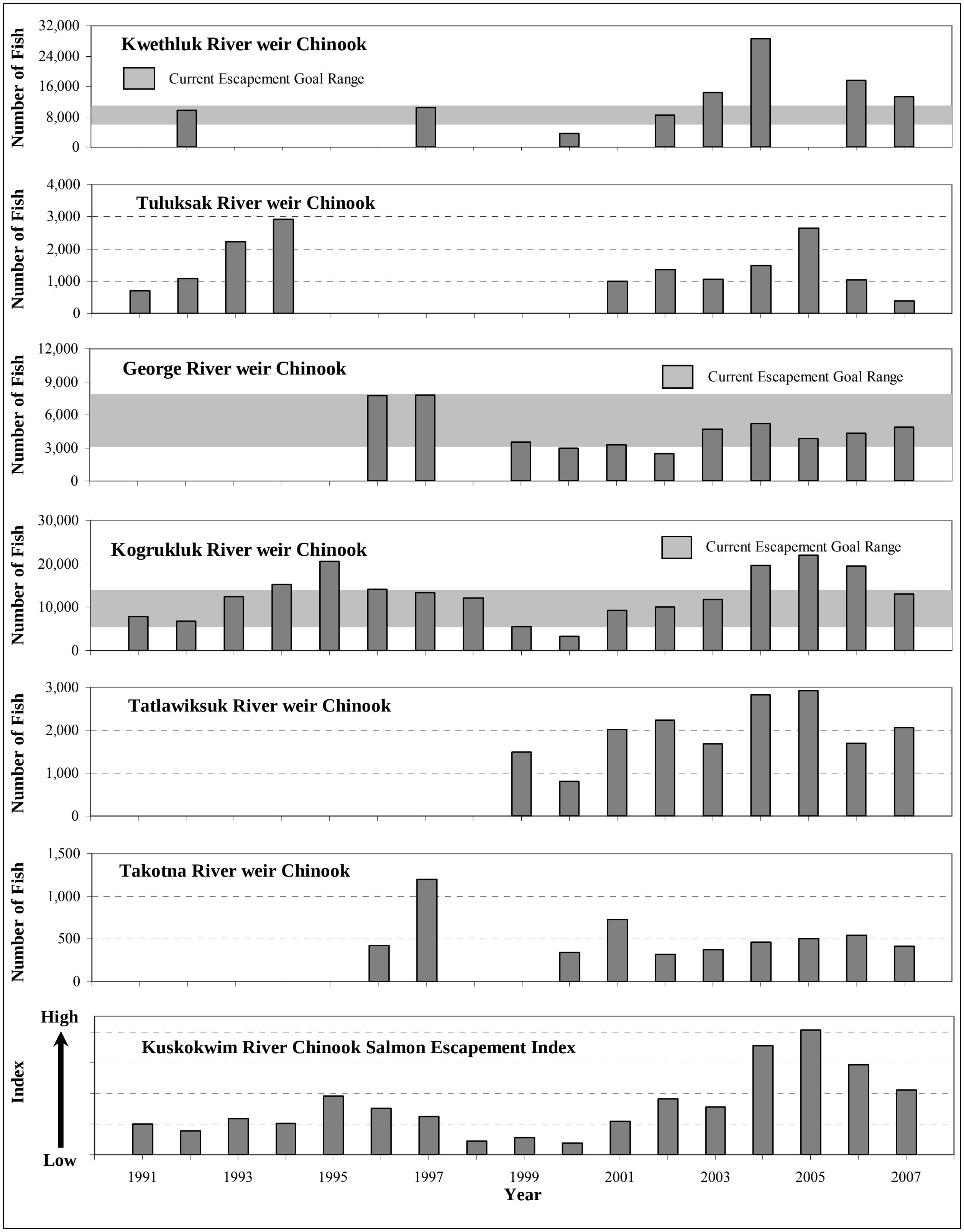
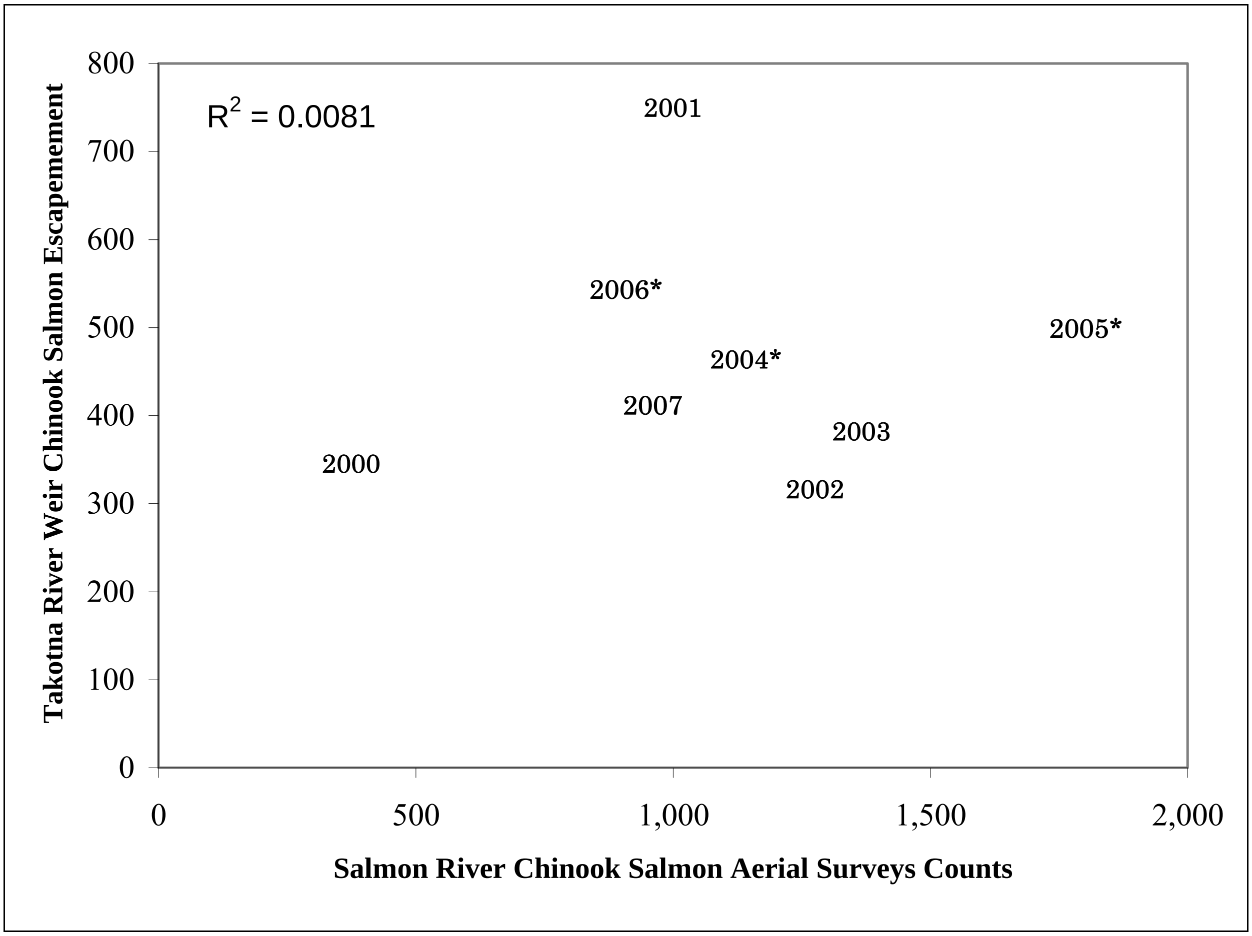


Figure 16.–Annual Chinook salmon escapements into 6 Kuskokwim River tributaries graphed in comparison to each other and to the drainage-wide Kuskokwim River Chinook Salmon Escapement Index.



Note: An asterisk (*) denotes an incomplete survey.

Figure 17.–Comparison of Salmon River (Pitka Fork) aerial survey counts and Takotna River escapement counts for Chinook salmon, 2000–2007.

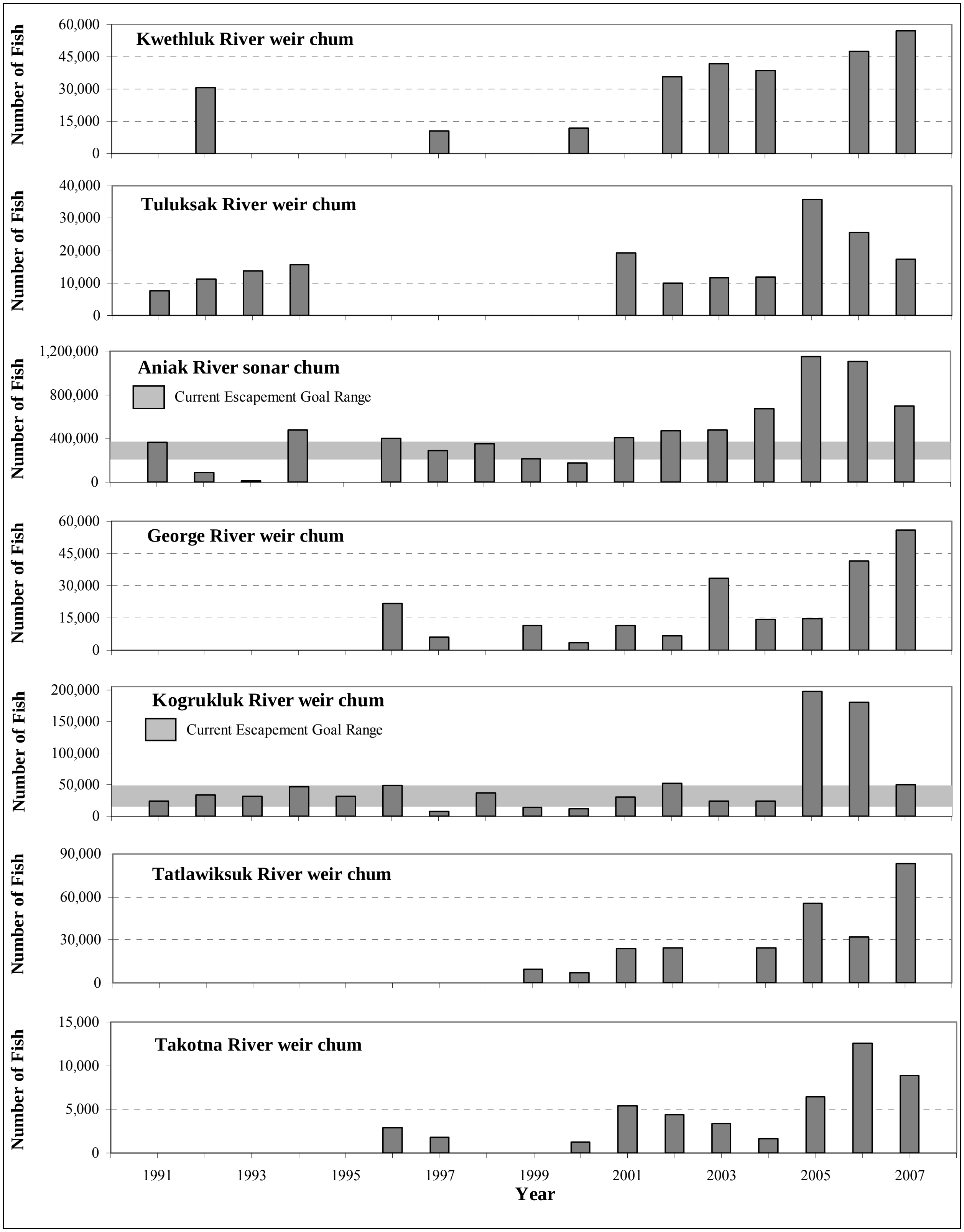


Figure 18.–Annual chum salmon escapement into 7 Kuskokwim River tributaries.

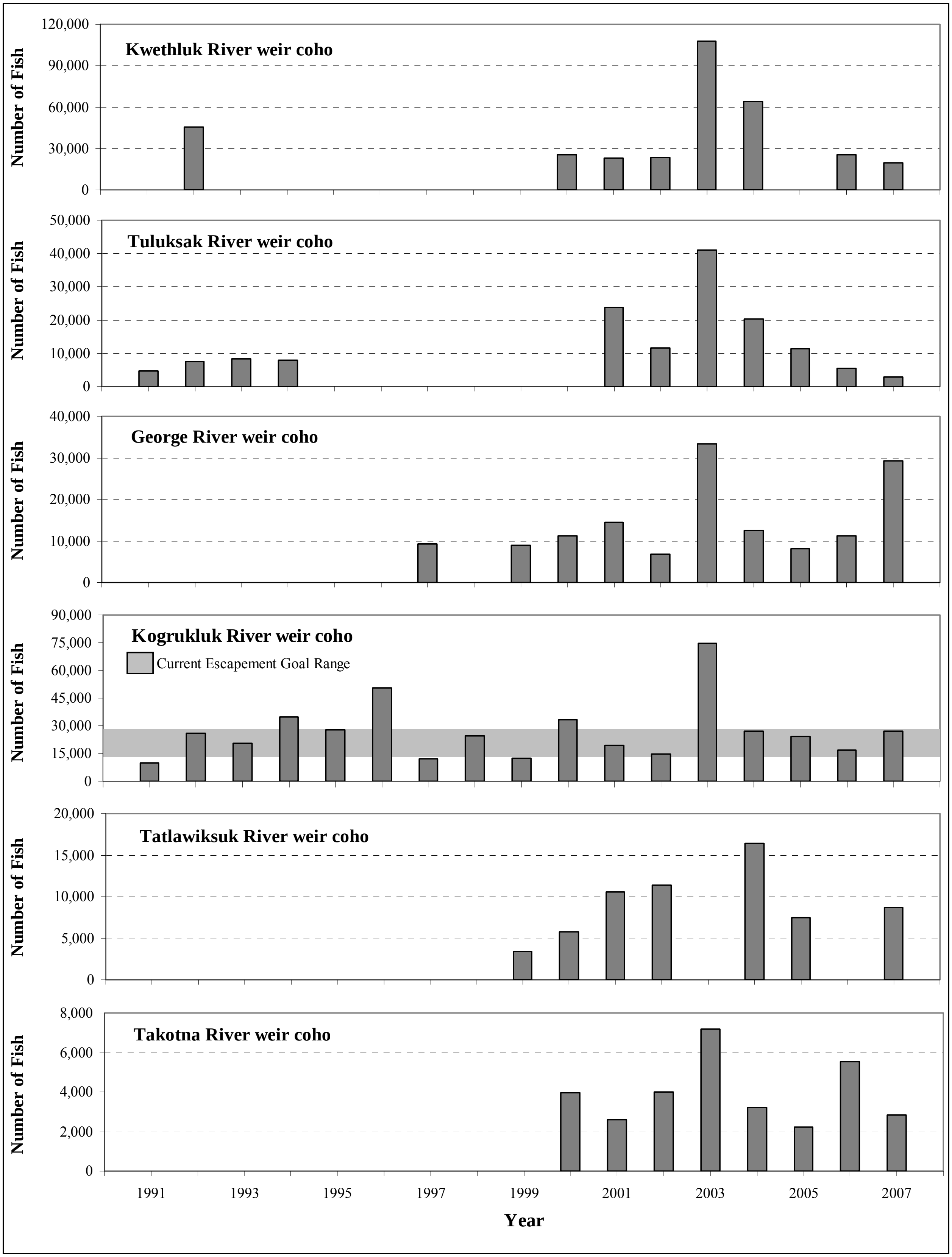
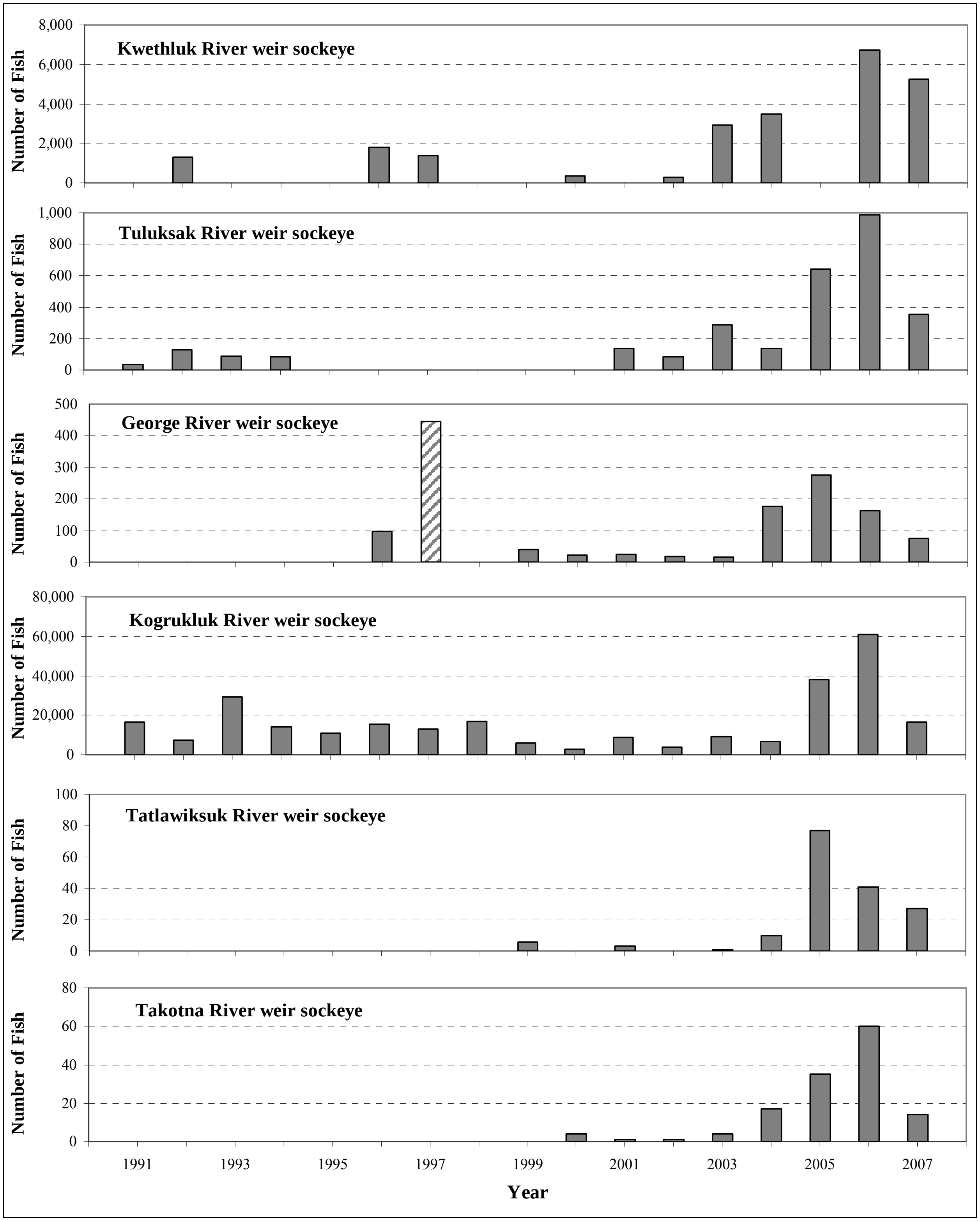
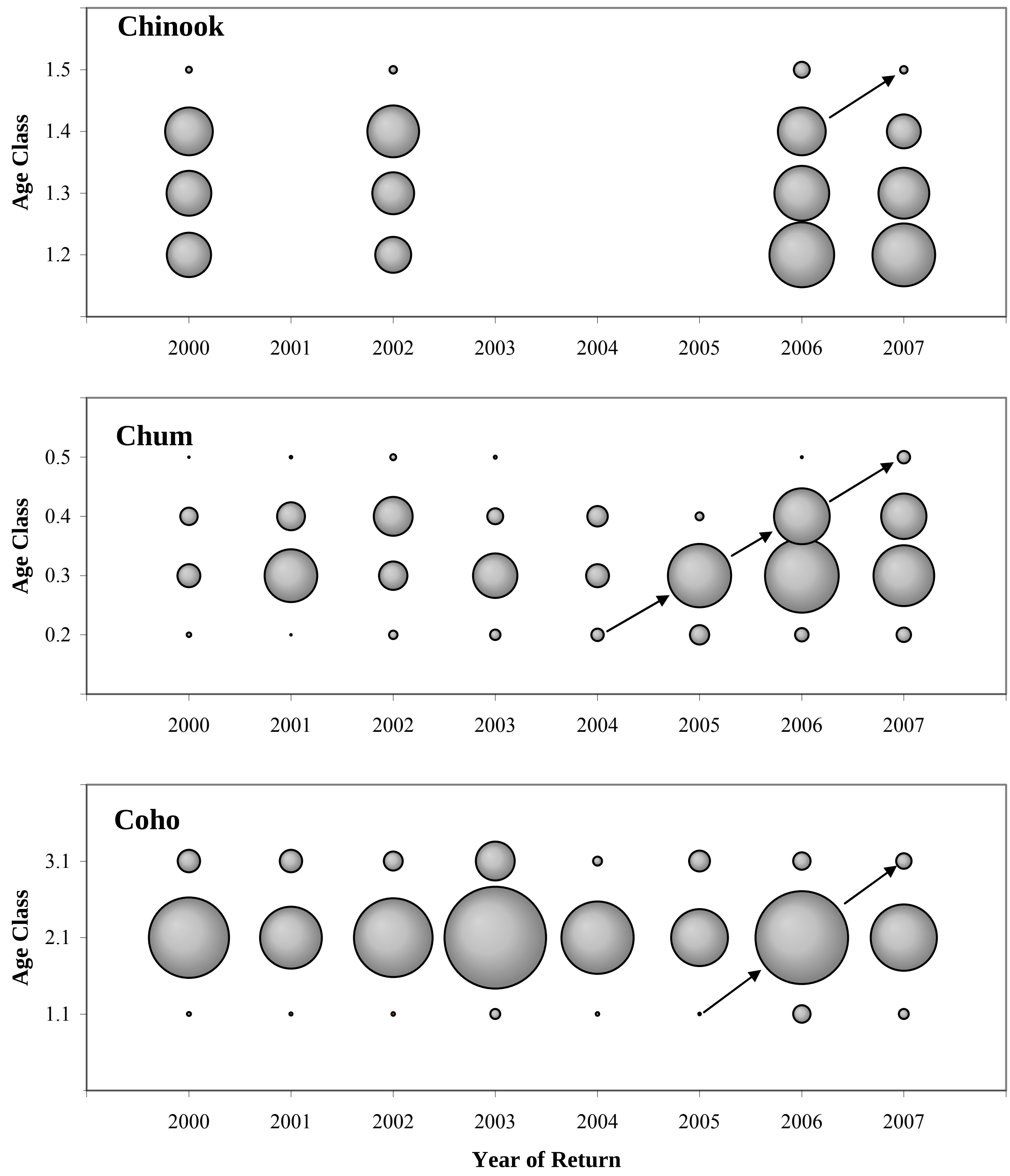


Figure 19.–Annual coho salmon escapement into 6 Kuskokwim River tributaries.



Note: 1997 escapement for George River is hatched because investigators suspect it may be incorrect. View with caution.

Figure 20.–Annual sockeye salmon escapements into 6 Kuskokwim River tributaries.



Note: Size of circles represents abundance and arrows illustrate a cohort group. Plots that appear empty correspond to years when greater than 20% of reported escapement was derived through calculations for missed passage. Years when sample objectives were not achieved contain no data plots.

Figure 21.–Relative age class abundance by return year of Chinook, chum, and coho salmon at the Takotna River weir.

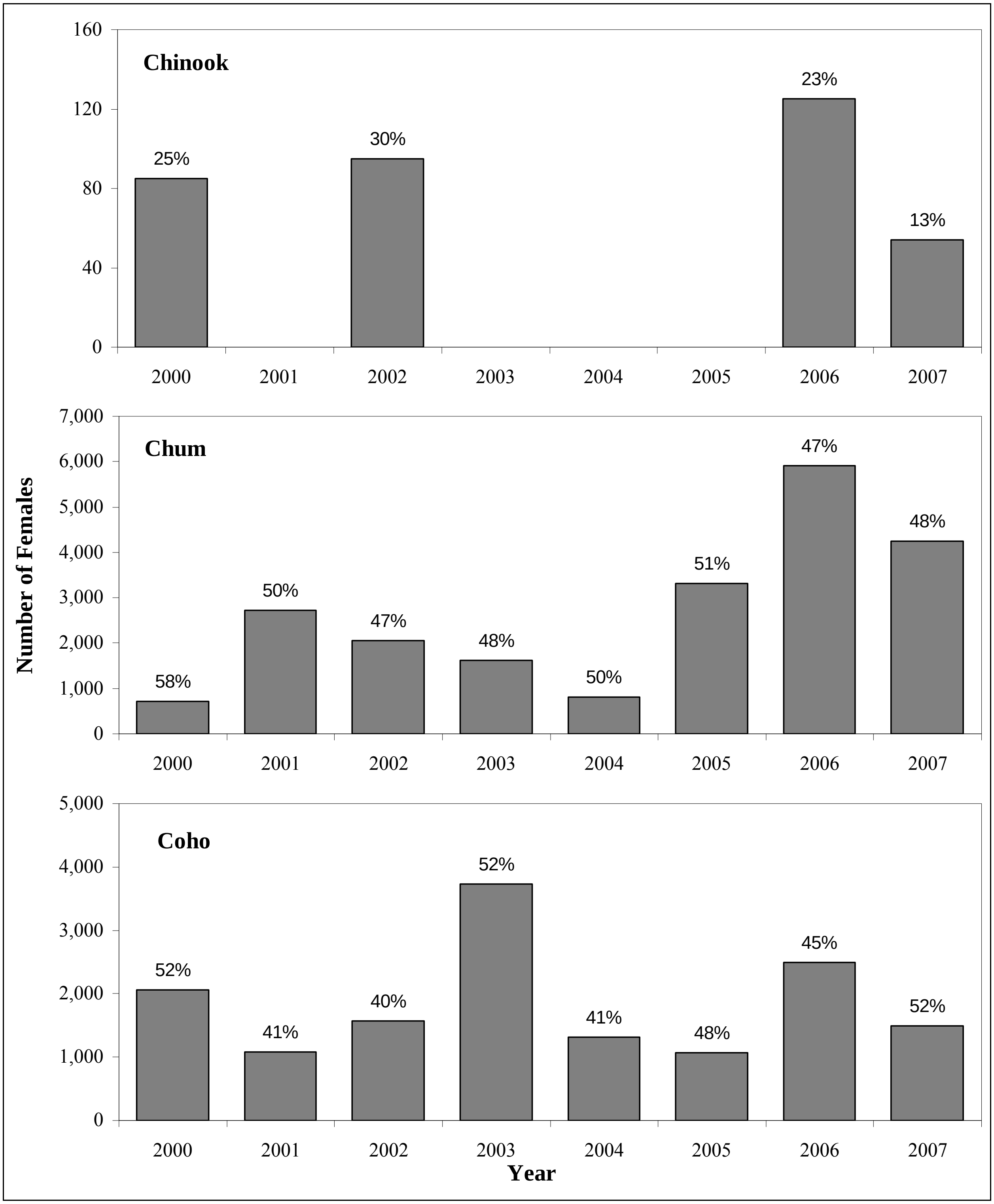
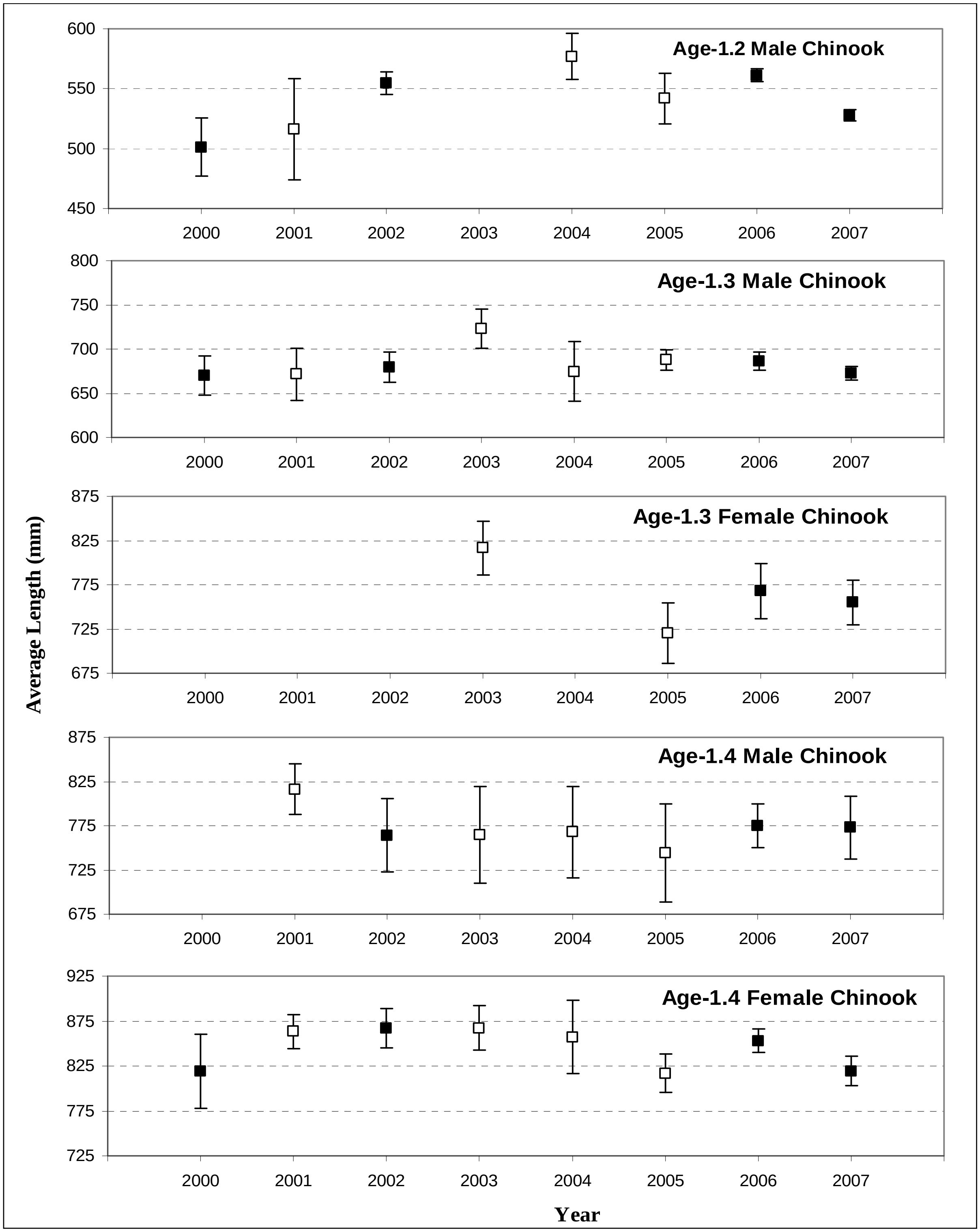
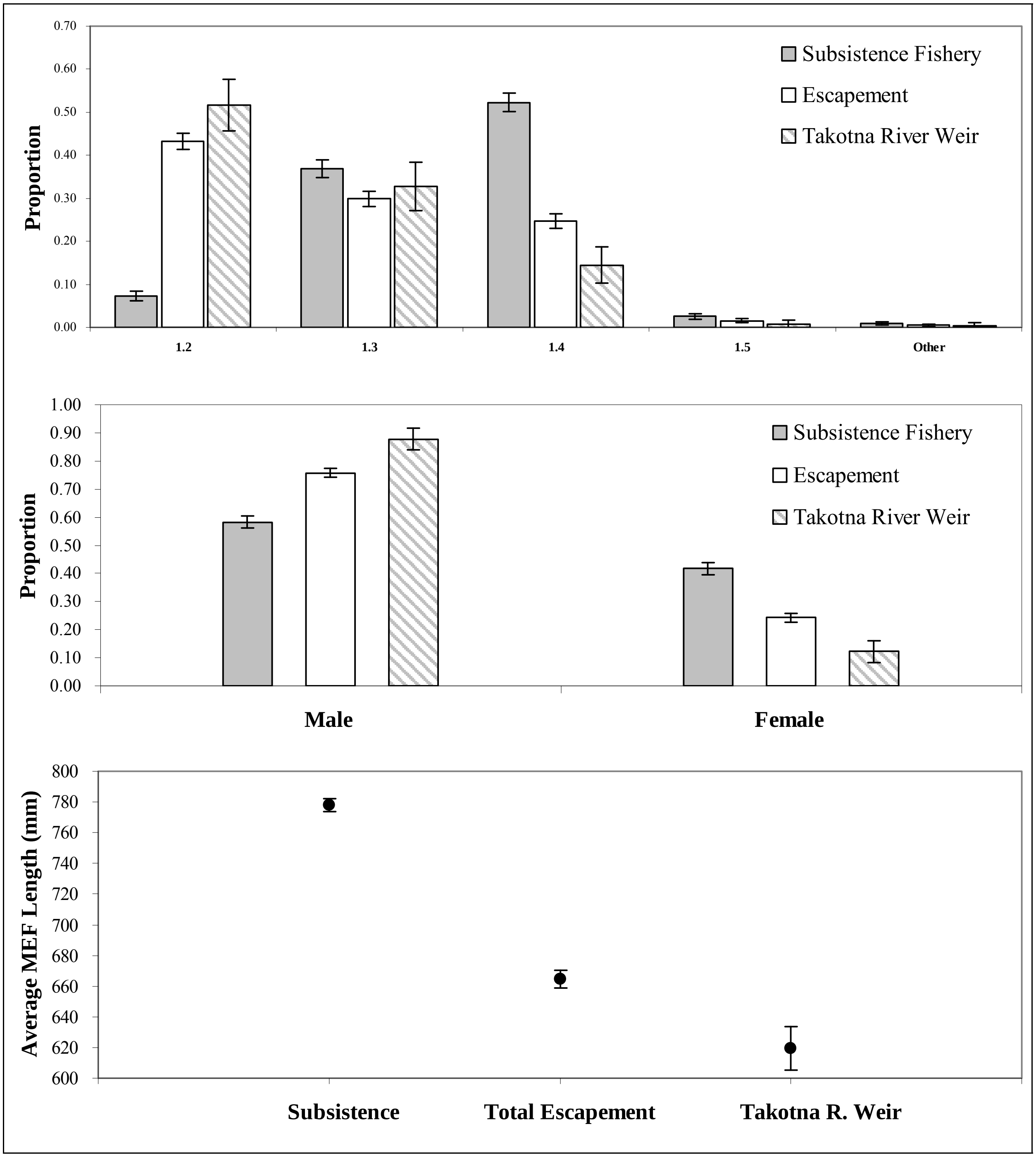


Figure 22.–Annual escapement of female Chinook, chum, and coho salmon at the Takotna River weir with labels indicating the percentage of total escapement consisting of females.



Note: Blank plots indicate that though sampling goals were not achieved mean lengths could be calculated from 1 or more sampling pulses. Years without plots indicate that either sampling was insufficient for ASL analysis or confidence intervals were so broad they would skew the scale of the vertical axis.

Figure 23.–Average annual length of common Chinook salmon age/sex categories at the Takotna River weir with 95% confidence intervals.



Note: Few Chinook salmon were harvested in the coho salmon-directed commercial fishery in 2007 and none of the incidental harvest was sampled for ASL analysis.

Figure 24.–ASL composition of the 2007 Kuskokwim River Chinook salmon subsistence harvest of Chinook salmon compared to total Kuskokwim River escapement and Takotna River escapement, with 95% confidence intervals.

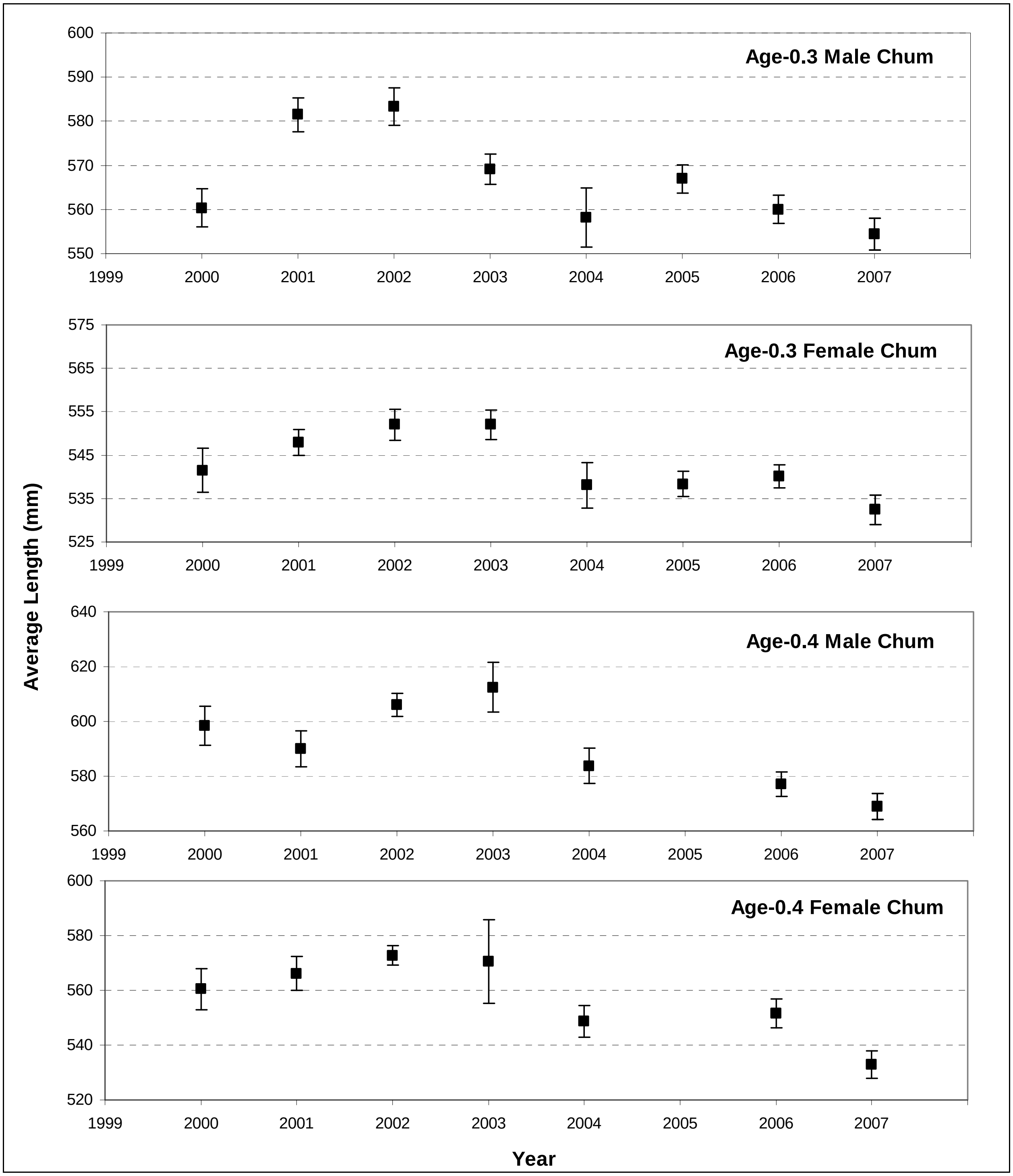


Figure 25.–Average annual length of common chum salmon age/sex categories at the Takotna River weir with 95% confidence intervals.

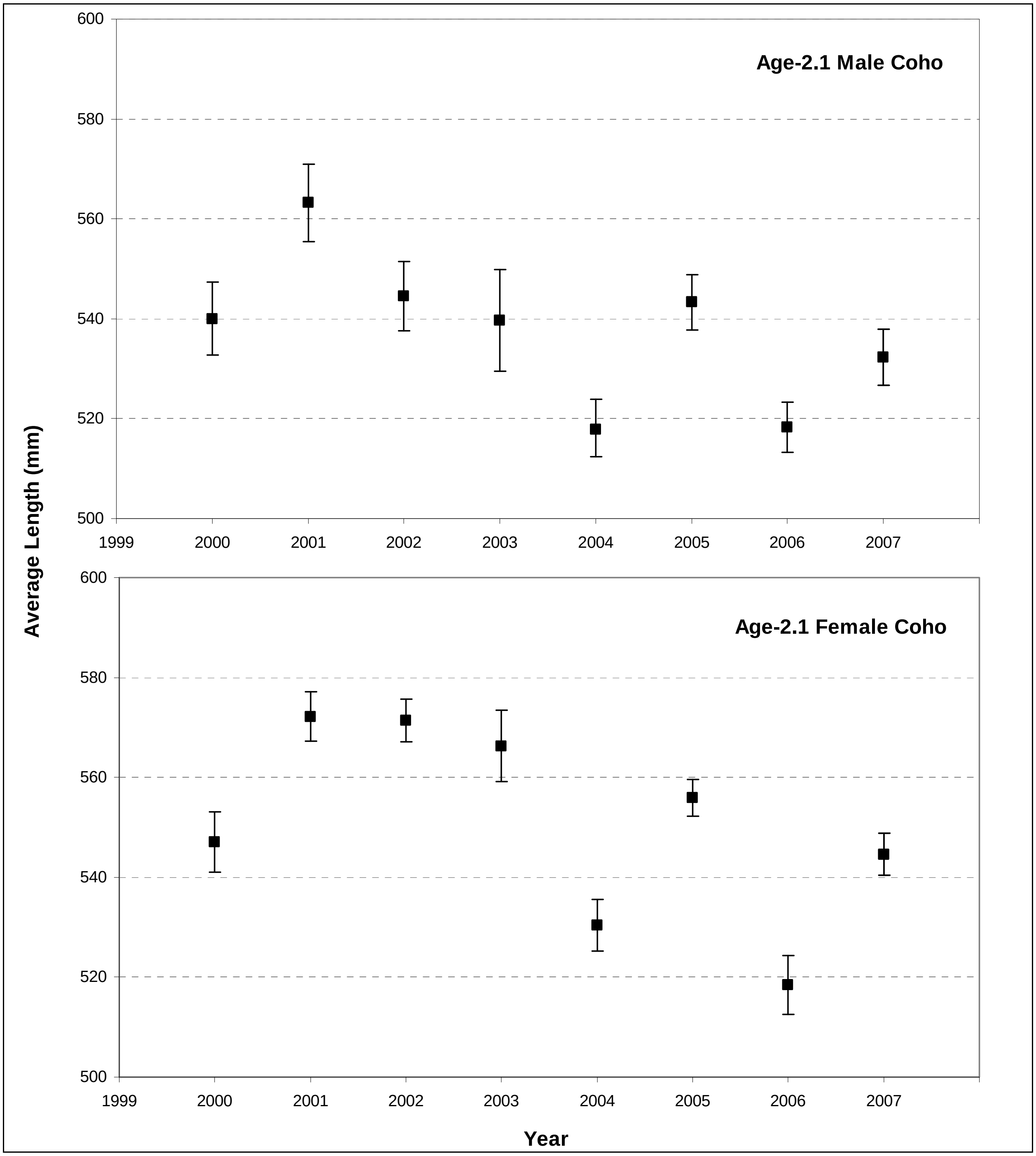
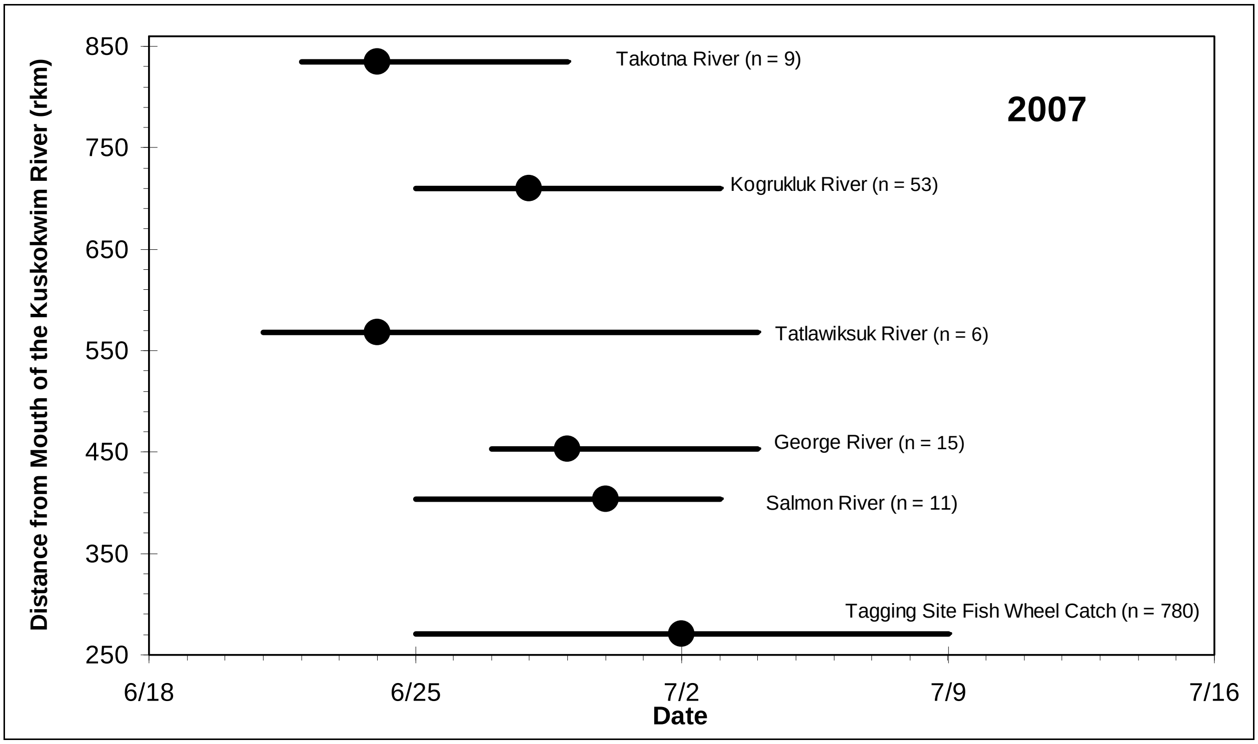


Figure 26.–Average annual length of common coho salmon age/sex categories at the Takotna River weir with 95% confidence intervals.



Note: Horizontal lines represent the central 50% and circles represent the median passage date. Results are confounded by inconsistent weir operational dates (resulting from high water levels) that affected tag recovery success.

Figure 27.–Date ranges when individual Chinook salmon stocks passed through the Kalskag tagging sites (rkm 271) in 2007 based on anchor- and radio-tagging efforts.

APPENDIX A. HISTORICAL SALMON ESCAPEMENT AT THE TAKOTNA RIVER WEIR (PASSAGE ESTIMATES INCLUDED)

Appendix A1.–Historical daily Chinook salmon escapement at the Takotna River tower (1995–1997) and weir (2000–2007) during the current target operational period.

Date	1995	1996	1997[a]	2000	2001	2002	2003	2004	2005	2006	2007
6/24	[b]	0	12	0	1	1	[b]	1	1	0	0
6/25	[b]	0	30	2	3	0	[b]	2	0	1	0
6/26	[b]	9	24	2	1	0	[b]	3	4	0	0
6/27	[b]	17	9	1	4	2	[b]	7	3	0	0
6/28	[b]	8	33	0	1	4	[b]	16	23	0	0
6/29	[b]	21	36	1	1	3	[b]	4	14	2	0
6/30	[b]	18	57	1	13	1	[b]	16	50	0	3
7/1	[b]	15	0	0	17	5	[b]	2	1	3	1
7/2	[b]	12	30	15	4	0	10 [c]	1	1	3	0
7/3	[b]	12	72	16	23	1	5 [c]	4	1	0	20
7/4	[b]	73	66	3	10	2	0 [c]	23	10	12	15
7/5	[b]	39	54	14	1	3	6	6	13	11	17
7/6	[b]	10	54	7	3	11	6	17	21	12	15
7/7	4	37	33	12	15	17	6	6	15	17	6
7/8	7	24	54	37	110	32	10	19	21	24	11
7/9	2	3	69	9	17	7	37	147	11	51	42
7/10	8	4	51	3	69	2	23	16	38	32	33
7/11	41	5	69	8	9	93	10	15	22	21	42
7/12	8	5	48	22	30	51	16	14	17	20	20
7/13	12	7	24	1	45	2	24	3	56	15	10
7/14	17	7	66	3	29	2	5	16	17	17	10
7/15	9	9	27	4	41	2	2	12	3	0	32
7/16	6	0	12	4	28	0	5	9	43	3	3
7/17	0	20	36	2	17	3	9	4	15	19	5
7/18	12	11	48	6	14	5	22	9	6	13	12
7/19	12	9	12	4	31	4	26	1	18	41	10
7/20	6	8	15	8	26	9	26	3	7	61	14
7/21	0	7	3	7	23	5	8	6	1	42	25
7/22	9	5	12	39	21	2	15	2	3	12	5
7/23	0	4	9	2	13	0	6	26	7	12	3
7/24	0	3	18	5	17	0	11	1	4	4	3
7/25	0	0	15	17	10	6	7	0	7	3	7
7/26	0	0 [d]	18	3	11	5	4	9	0	6	7
7/27	0	0 [d]	12	9	6	2	9	2	3	9	8
7/28	0	1 [d]	6	5	11	1	6 [d]	3	9	4	6
7/29	0	0 [d]	15	9	3	8	6 [d]	2	6	4	2
7/30	3	1 [d]	0	5	2	5	6 [d]	12	0	8	0
7/31	0	5 [d]	0	2	4	0	5 [d]	0	2	7	0
8/1	0	2 [d]	3	1	1	2	5 [e]	0	1	1	2
8/2	0	1 [d]	6	1	3	0	4	1	0	11	0
8/3	0	0 [d]	3	5	0	0	5	0	1	11	0
8/4	0	2 [d]	0	8	2	1	5	1	1	5	1
8/5	0 [d]	1 [d]	2 [d]	7	1	0	4	6	3	3	4
8/6	0 [d]	0 [d]	0 [d]	4	4	1	1	2	3	0	3 [d]
8/7	0	0 [d]	2 [d]	1	1	2	2	1	1	4	3 [d]
8/8	0 [d]	2 [d]	2 [d]	7	3	0	5	0	0	0	3 [d]
8/9	0 [d]	0 [d]	2 [d]	7	1	3	2	2	1	1	2
8/10	0	1 [d]	0 [d]	0	2	2	0	1	1	1	5
8/11	0 [d]	0 [d]	2 [d]	3	1	0	0	0	1	2	1
8/12	0	0 [d]	0 [d]	6	2	4	0	0	0	0	1
8/13	0 [d]	1 [d]	0 [d]	2	1	1	0	2	1	0	2
8/14	0 [d]	1 [d]	5 [d]	1	1	0	2	0	0	1	0

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Date	1995	1996	1997	2000	2001	2002	2003	2004	2005	2006	2007
8/15	0	1 [d]	0 [d]	0	0	1	0	1	0	4	0
8/16	0 [d]	0 [d]	0 [d]	0	1	0	0	0	2	0	0
8/17	0 [d]	0 [d]	0 [d]	0	0	0	1	0	0	1	0
8/18	0 [d]	0 [d]	0 [d]	2	1	0	2	1	0	0	0
8/19	0 [d]	1 [d]	0 [d]	0	0	0	1	1	0	1 [c]	0
8/20	0 [d]	0 [d]	0 [d]	0	1 [e]	0	1	1	0	0 [c]	1
8/21	0	1 [d]	0 [d]	0	1 [d]	0	1	0	0	0 [c]	0
8/22	0 [d]	0 [d]	5 [d]	0	1 [d]	0	0	0	0	1 [d]	1
8/23	0	0 [d]	2 [d]	0	1	0	2	0	0	1	0
8/24	0 [d]	0 [d]	2 [d]	0	0	0	0	1	2	0	1
8/25	0	0 [d]	2 [d]	0	0	1	1	0	1	0	0
8/26	0 [d]	0 [d]	2 [d]	0	1	0	1	1	1	1	0
8/27	0 [d]	0 [d]	2 [d]	1	1	0	1	0	1	0	0
8/28	0	0 [d]	0 [d]	0	1	0	0	0	1	0	0
8/29	0	0 [d]	0 [d]	0	1	0	0	0	1	0	0
8/30	0	0 [d]	0 [d]	0	1	0	0	0	0	0	0
8/31	0	0 [d]	0 [d]	0	1	0	0	0	0	1	0
9/1	0	0 [d]	0 [d]	0	0	0	1	0	0	0	0
9/2	[b]	0 [d]	2 [d]	0	0	0	0	0	0	0	0
9/3	[b]	0 [d]	0 [d]	0	1	0	0	0	0	0	0
9/4	[b]	0 [d]	0 [d]	0	1	0	0	0	1	0	0
9/5	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0
9/6	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0
9/7	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0
9/8	[b]	0 [d]	2 [d]	0	0	0	0	0	0	0	0
9/9	[b]	0 [d]	0 [d]	1	0	0	0	0	0	0	0
9/10	[b]	0 [d]	0 [d]	0	0	0	0	0	1	0	0
9/11	[b]	0 [d]	2 [d]	0	0	0	0	0	0	0	0
9/12	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0
9/13	[b]	0 [d]	0 [d]	0	0	1	0	0	1	0	0
9/14	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0
9/15	[b]	0 [d]	0 [d]	0	0 [d]	1	0	0	0	0	1
9/16	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0	0	0	0
9/17	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0	0	0	0
9/18	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0	0	0	0
9/19	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0 [d]	0	0	0
9/20	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0 [d]	0	0	0 [d]

Note: The tower was operated for only 8 days in 1998; hence, that year is excluded from the table. The sum of daily passages might differ from the cumulative passage due to rounding error.

[a] Revisions were made to the 1997 daily passage data; estimates were generated to span the remainder of the target operational period.

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

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

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

[e] Partial day count; passage was estimated.

Appendix A2.–Historical daily chum salmon escapement at the Takotna River tower (1995–1997) and weir (2000–2007) during the current target operational period.

Date	1995	1996	1997[a]	2000	2001	2002	2003	2004	2005	2006	2007
6/24	[b]	0	12	1	3	29	0 [c]	4	2	20	1
6/25	[b]	0	30	24	9	55	0 [c]	8	4	21	8
6/26	[b]	9	24	23	10	55	1 [c]	31	9	32	1
6/27	[b]	17	9	11	12	111	5 [c]	28	9	65	15
6/28	[b]	8	33	9	4	116	7 [c]	32	14	70	19
6/29	[b]	21	36	6	19	168	4 [c]	29	16	94	18
6/30	[b]	18	57	6	20	147	12 [c]	34	40	157	43
7/1	[b]	15	0	10	42	180	10 [c]	54	24	175	44
7/2	[b]	12	30	18	24	72	40 [d]	41	41	181	53
7/3	[b]	12	72	17	47	145	57 [d]	59	47	306	159
7/4	[b]	73	66	39	40	94	54 [d]	58	86	309	147
7/5	[b]	39	54	12	21	250	111	48	222	351	166
7/6	[b]	10	54	45	60	204	120	108	205	593	149
7/7	4	37	33	44	106	251	126	66	301	616	252
7/8	7	24	54	101	188	124	137	65	398	459	239
7/9	2	3	69	49	78	110	142	92	200	480	374
7/10	8	4	51	27	204	205	88	87	327	462	415
7/11	41	5	69	58	198	259	47	74	193	469	533
7/12	8	5	48	29	372	266	77	73	223	488	421
7/13	12	7	24	49	275	80	62	23	220	448	471
7/14	17	7	66	50	309	103	140	33	189	517	514
7/15	9	9	27	35	265	97 [c]	129	22	241	413	255
7/16	6	0	12	33	257	88	155	31	291	392	346
7/17	0	20	36	51	206	117	150	57	414	392	347
7/18	12	11	48	34	264	73	172	92	301	393	349
7/19	12	9	12	59	352	161	187	29	373	443	380
7/20	6	8	15	50	301	109	231	36	313	355	375
7/21	0	7	3	43	212	72	155	15	142	441	477
7/22	9	5	12	53	215	95	168	25	240	321	315
7/23	0	4	9	33	165	79	87	58	153	288	281
7/24	0	3	18	23	168	67	69	33	122	318	192
7/25	0	0	15	25	145	62	63	15	127	268	251
7/26	0	0 [c]	18	20	93	53	53	24	141	254	252
7/27	0	0 [c]	12	14	117	23	53	13	93	248	161
7/28	0	1 [c]	6	11	135	49	50 [c]	13	150	216	154
7/29	0	0 [c]	15	18	58	39	46 [c]	17	121	133	72
7/30	3	1 [c]	0	12	64	21	43 [c]	26	56	163	110
7/31	0	5 [c]	0	10	68	15	39 [c]	17	55	156	63
8/1	0	2 [c]	3	3	38	21	36 [d]	12	33	135	61
8/2	0	1 [c]	6	12	30	22	29	8	37	131	34
8/3	0	0 [c]	3	2	34	15	35	3	34	148	38
8/4	0	2 [c]	0	22	30	17	32	5	44	131	27
8/5	0 [c]	1 [c]	2 [b]	5	38	5	44	4	24	64	25
8/6	0 [c]	0 [c]	0 [b]	11	25	4	28	5	37	62	28 [c]
8/7	0	0 [c]	2 [b]	5	16	13	18	4	24	54	29 [c]
8/8	0 [c]	2 [c]	2 [b]	11	11	3	11	2	23	68	31 [c]
8/9	0 [c]	0 [c]	2 [b]	5	13	5	6	3	5	29	44
8/10	0	1 [c]	0 [b]	10	8	6	6	1	10	25	20
8/11	0 [c]	0 [c]	2 [b]	6	8	6	6	2	10	28	28
8/12	0	0 [c]	0 [b]	6	5	4	4	4	8	16	21
8/13	0 [c]	1 [c]	0 [b]	2	2	2	10	2	8	21	18
8/14	0 [c]	1 [c]	5 [b]	0	3	0	7	1	5	34	10

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Date	1995	1996	1997	2000	2001	2002	2003	2004	2005	2006	2007
8/15	0	1 [c]	0 [b]	0	2	0	6	0	5	19	22
8/16	0 [c]	0 [c]	0 [b]	0	1	3	5	0	3	22	6
8/17	0 [c]	0 [c]	0 [b]	0	0	1	0	1	2	16	7
8/18	0 [c]	0 [c]	0 [b]	0	7	0	2	1	3	10	3
8/19	0 [c]	1 [c]	0 [b]	0	4	0	0	1	5	12 [c]	4
8/20	0 [c]	0 [c]	0 [b]	1	3 [d]	1	4	0	0	10 [c]	4
8/21	0	1 [c]	0 [b]	0	3 [c]	0	2	0	7	9 [c]	0
8/22	0 [c]	0 [c]	5 [b]	0	3 [c]	0	0	0	0	7 [d]	5
8/23	0	0 [c]	2 [b]	0	0	1	5	0	1	3	2
8/24	0 [c]	0 [c]	2 [b]	0	1	1	0	0	6	8	0
8/25	0	0 [c]	2 [b]	0	2	2	1	0	0	2	0
8/26	0 [c]	0 [c]	2 [b]	0	0	0	0	0	0	4	1
8/27	0 [c]	0 [c]	2 [b]	0	0	0	0	0	2	4	0
8/28	0	0 [c]	0 [b]	0	1	0	1	0	2	5	2
8/29	0	0 [c]	0 [b]	1	0	0	0	0	0	4	0
8/30	0	0 [c]	0 [b]	0	0	0	0	0	1	4	0
8/31	0	0 [c]	0 [b]	0	0	1	1	0	1	2	0
9/1	0	0 [c]	0 [b]	0	0	0	0	0	1	0	1
9/2	[b]	0 [c]	2 [b]	0	0	0	0	0	0	0	0
9/3	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	0
9/4	[b]	0 [c]	0 [b]	0	0	0	0	1	1	3	0
9/5	[b]	0 [c]	0 [b]	0	0	0	0	0	2	0	1
9/6	[b]	0 [c]	0 [b]	0	0	0	1	0	2	0	0
9/7	[b]	0 [c]	0 [b]	0	0	0	1	0	2	0	0
9/8	[b]	0 [c]	2 [b]	0	0	0	1	0	1	0	0
9/9	[b]	0 [c]	0 [b]	0	0	0	1	0	1	0	0
9/10	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	3
9/11	[b]	0 [c]	2 [b]	0	0	0	0	0	0	1	0
9/12	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	0
9/13	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	1
9/14	[b]	0 [c]	0 [b]	0	0	0	0	0	2	0	0
9/15	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	2	0	1
9/16	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	1	1	1
9/17	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	0	0	0
9/18	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	0	0	0
9/19	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0 [c]	0	0	1
9/20	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0 [c]	0	0	0 [c]

Note: The tower was operated for only 8 days in 1998; hence, that year is excluded from the table. The sum of daily passages might differ from the cumulative passage due to rounding error.

[a] Revisions were made to the 1997 daily passage data; estimates were generated to span the remainder of the target operational period.

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

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

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

[e] Partial day count; passage was estimated.

Appendix A3.–Historical daily coho salmon escapement at the Takotna River weir during the current target operational period.

Date	2000	2001	2002	2003	2004	2005	2006	2007
6/24	0	0	0	[a]	0	0	0	0
6/25	0	0	0	[a]	0	0	0	0
6/26	0	0	0	[a]	0	0	0	0
6/27	0	0	0	[a]	0	0	0	0
6/28	0	0	0	[a]	0	0	0	0
6/29	0	0	0	[a]	0	0	0	0
6/30	0	0	0	[a]	0	0	0	0
7/1	0	0	0	[a]	0	0	0	0
7/2	0	0	0	0 [b]	0	0	0	0
7/3	0	0	0	0 [b]	0	0	0	0
7/4	0	0	0	0 [b]	0	0	0	0
7/5	0	0	0	0	0	0	0	0
7/6	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0
7/8	0	0	0	0	0	0	0	0
7/9	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	0	0
7/11	0	0	0	0	0	0	0	0
7/12	0	0	0	0	0	0	0	0
7/13	0	0	0	0	0	0	0	0
7/14	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	0	0
7/16	0	0	0	0	0	0	0	0
7/17	0	0	0	0	0	0	0	0
7/18	0	0	0	0	0	0	0	0
7/19	0	0	0	0	0	0	0	0
7/20	0	0	0	0	0	0	0	0
7/21	0	0	0	0	0	0	0	0
7/22	0	0	0	0	0	0	0	0
7/23	0	0	0	0	0	0	0	2
7/24	0	0	0	0	0	0	0	1
7/25	0	0	0	0	0	2	0	0
7/26	0	0	0	4	0	2	0	0
7/27	0	0	0	3	0	0	0	0
7/28	0	0	0	4 [c]	0	3	0	0
7/29	0	0	0	4 [c]	0	3	0	2
7/30	0	1	1	5 [c]	0	1	1	1
7/31	0	0	1	5 [c]	1	0	1	0
8/1	0	0	0	6 [d]	1	2	1	3
8/2	0	0	0	4	1	2	2	2
8/3	0	1	0	8	0	1	8	4
8/4	3	0	0	13	3	8	15	11
8/5	11	0	0	15	4	7	8	15
8/6	8	3	2	27	16	5	8	17 [c]
8/7	14	1	0	25	14	2	16	21 [c]
8/8	19	1	2	48	19	10	15	25 [c]
8/9	40	2	6	40	24	6	25	38
8/10	31	3	6	50	18	6	7	21
8/11	44	12	4	85	28	12	112	24
8/12	80	19	26	139	78	10	40	30
8/13	42	20	27	150	20	19	53	76
8/14	51	29	23	212	61	20	31	58

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Appendix A3.–Page 2 of 2.

Date	2000	2001	2002	2003	2004	2005	2006	2007
8/15	58	31	36	140	60	22	74	56
8/16	54	51	49	131	92	14	118	81
8/17	98	44	20	121	182	18	175	79
8/18	146	77	159	160	124	57	121	49
8/19	192	66	17	348	56	22	159 [c]	147
8/20	80	91 [d]	11	197	74	25	170 [c]	136
8/21	387	91 [c]	266	356	57	26	182 [c]	115
8/22	178	91 [c]	326	254	61	27	193 [d]	73
8/23	241	74	328	176	88	111	125	135
8/24	152	145	397	189	57	258	283	167
8/25	107	156	301	217	137	204	290	47
8/26	86	275	267	299	572	114	111	43
8/27	314	175	107	429	73	84	232	96
8/28	490	151	134	335	44	69	231	155
8/29	140	164	121	288	74	102	138	232
8/30	120	104	127	219	46	163	235	167
8/31	62	137	205	267	37	55	115	119
9/1	70	105	133	285	398	80	231	144
9/2	66	92	107	277	330	21	155	86
9/3	54	71	63	192	70	47	126	57
9/4	70	73	90	91	11	106	104	30
9/5	46	68	118	262	20	85	74	43
9/6	100	26	134	209	3	82	254	5
9/7	42	13	109	188	6	59	132	14
9/8	25	14	79	200	23	45	328	30
9/9	30	14	39	131	18	37	164	30
9/10	36	15	19	70	192	40	105	22
9/11	40	11	21	78	0	31	119	18
9/12	27	24	37	83	0	26	66	26
9/13	29	12	13	79	0	16	65	16
9/14	16	15	14	28	9	17	61	11
9/15	9	6 [c]	16	10	3	13	41	17
9/16	15	11 [c]	7	9	2	13	54	15
9/17	5	3 [c]	7	4	0	4	48	9
9/18	8	5 [c]	2	1	0	0	42	10
9/19	10	6 [c]	2	1	0 [c]	0	43	14
9/20	11	7 [c]	5	0	0 [c]	2	41	7 [c]

Note: The tower was not operated long enough in 1995–1998 to enumerate coho salmon; therefore, these years are excluded from the table. The sum of daily passages might differ from the cumulative passage due to rounding error.

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

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

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

[d] Partial day count; passage was estimated.

APPENDIX B. 2007 DAILY PASSAGE OF ALL OBSERVED SPECIES (PASSAGE ESTIMATES EXCLUDED)

Appendix B1.–Daily passage counts by species at the Takotna River weir in 2007 excluding estimates calculated for inoperable days.

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Coho Salmon		Longnose	White-	
Date	Male	Female	Male	Female	Male	Female	Male	Female	Suckers	fish	Other[a]
6/20	1	0	0	0	0	0	0	0	0	0	0
6/21	0	0	0	0	0	0	0	0	0	0	0
6/22	0	0	0	0	1	1	0	0	0	1	0
6/23	0	0	0	0	2	3	0	0	0	0	1 P
6/24	0	0	0	0	1	0	0	0	0	0	0
6/25	0	0	0	0	5	3	0	0	0	3	0
6/26	0	0	0	0	1	0	0	0	3	0	0
6/27	0	0	0	0	8	7	0	0	11	0	6 G
6/28	0	0	0	0	11	8	0	0	13	4	1 G
6/29	0	0	0	0	9	9	0	0	3	1	0
6/30	3	0	0	0	28	15	0	0	2	0	0
7/1	1	0	0	0	30	14	0	0	16	0	0
7/2	0	0	0	0	38	15	0	0	2	0	1 P
7/3	20	0	0	0	76	83	0	0	45	3	0
7/4	15	0	0	0	62	85	0	0	25	0	0
7/5	17	0	0	0	75	91	0	0	54	1	0
7/6	15	0	0	0	80	69	0	0	4	0	0
7/7	6	0	0	0	118	134	0	0	3	0	0
7/8	11	0	0	0	133	106	0	0	4	0	0
7/9	39	3	0	0	190	184	0	0	0	0	0
7/10	31	2	0	0	206	209	0	0	1	0	0
7/11	40	2	0	0	264	269	0	0	2	0	0
7/12	20	0	0	0	205	216	0	0	7	0	0
7/13	10	0	0	0	267	204	0	0	0	0	0
7/14	9	1	0	0	246	268	0	0	1	0	0
7/15	25	7	0	0	127	128	0	0	0	0	0
7/16	3	0	0	0	160	186	0	0	1	0	0
7/17	4	1	0	0	170	177	0	0	1	0	0
7/18	12	0	0	0	200	149	0	0	0	0	0
7/19	8	2	0	0	179	201	0	0	0	0	0
7/20	11	3	0	0	197	178	0	0	0	0	0
7/21	18	7	0	0	230	247	0	0	0	0	0
7/22	2	3	0	0	161	154	0	0	0	2	0
7/23	3	0	0	0	124	157	0	2	0	0	6 G
7/24	1	2	0	0	82	110	1	0	0	0	4 G
7/25	4	3	0	0	109	142	0	0	0	0	0
7/26	5	2	0	0	98	154	0	0	0	0	0
7/27	5	3	0	1	79	82	0	0	0	0	0
7/28	4	2	0	0	61	93	0	0	0	0	1 P
7/29	2	0	0	0	41	31	2	0	0	0	3 G
7/30	0	0	0	0	50	60	1	0	0	0	0
7/31	0	0	0	0	31	32	0	0	0	0	1 G
8/1	1	1	0	0	26	35	2	1	0	0	0
8/2	0	0	0	0	17	17	0	2	0	0	0
8/3	0	0	0	0	20	18	3	1	0	1	0
8/4	1	0	0	0	19	8	6	5	0	0	0
8/5	4	0	0	0	9	16	10	5	0	0	0
8/6 [b]	0	0	0	0	12	3	1	0	2	1	0
8/7 [c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/8 [b]	1	0	0	1	15	14	7	5	0	1	2 G
8/9	2	0	0	2	23	21	15	23	0	0	2 G

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Appendix B1.–Page 2 of 2.

Date	Chinook Salmon Male	Chinook Salmon Female	Sockeye Salmon Male	Sockeye Salmon Female	Chum Salmon Male	Chum Salmon Female	Coho Salmon Male	Coho Salmon Female	Longnose Suckers	White-fish	Other[a]
8/10	4	1	1	1	8	12	13	8	0	0	2 G
8/11	1	0	0	0	12	16	9	14	0	0	2 P
8/12	0	1	0	0	8	13	11	19	0	0	3 G
8/13	2	0	0	1	7	11	41	35	1	1	2 G
8/14	0	0	0	0	5	5	37	21	1	0	0
8/15	0	0	0	0	9	13	29	27	0	0	7 G
8/16	0	0	0	0	4	2	47	34	0	0	0
8/17	0	0	0	0	3	4	45	34	0	0	1 G
8/18	0	0	0	0	1	2	30	19	0	1	0
8/19	0	0	0	0	3	1	81	66	0	0	7 G
8/20	1	0	0	0	2	2	80	56	0	0	0
8/21	0	0	0	0	0	0	64	51	0	0	0
8/22	1	0	0	0	4	1	33	40	0	0	0
8/23	0	0	1	0	0	2	70	65	0	0	0
8/24	1	0	1	0	0	0	82	85	0	0	1 P
8/25	0	0	0	0	0	0	27	20	0	0	1 P
8/26	0	0	0	0	1	0	23	20	0	0	0
8/27	0	0	0	1	0	0	45	51	0	0	1 P
8/28	0	0	0	0	0	2	68	87	0	0	1 P
8/29	0	0	0	0	0	0	131	101	0	0	0
8/30	0	0	0	0	0	0	65	102	1	0	1 G
8/31	0	0	0	0	0	0	60	59	0	0	0
9/1	0	0	0	0	1	0	75	69	0	0	1 P
9/2	0	0	0	0	0	0	40	46	0	0	1 P
9/3	0	0	0	1	0	0	28	29	0	0	0
9/4	0	0	0	0	0	0	15	15	1	0	0
9/5	0	0	0	0	1	0	18	25	0	0	1 P
9/6	0	0	0	0	0	0	3	2	0	0	1 P
9/7	0	0	0	0	0	0	9	5	0	0	1 P
9/8	0	0	0	0	0	0	12	18	0	0	0
9/9	0	0	0	0	0	0	10	20	0	0	0
9/10	0	0	1	0	2	1	8	14	0	0	0
9/11	0	0	0	0	0	0	6	12	0	0	1 P
9/12	0	0	0	0	0	0	8	18	1	0	0
9/13	0	0	0	0	0	1	8	8	0	0	0
9/14	0	0	0	0	0	0	7	4	0	1	0
9/15	1	0	0	0	1	0	12	5	0	0	1 P
9/16	0	0	0	0	0	1	7	8	0	0	0
9/17	0	0	0	0	0	0	5	4	0	1	0
9/18	0	0	0	0	0	0	6	4	0	1	1 P
9/19	0	0	0	0	1	0	8	6	0	1	0
9/20 [d]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

[a] Letter designations are as follows: P = Northern pike, G = Arctic grayling. Count may not correspond to actual day observed.

[b] Counts on this day were incomplete because the weir was not operational for a portion of the day.

[c] Weir was not operational due to extreme water level.

[d] Seasonal weir operation was terminated early.

APPENDIX C. DAILY CARCASS COUNTS

Appendix C1.–Daily carcass counts at the Takotna River weir in 2007.

	Chinook Salmon			Sockeye Salmon			Chum Salmon			Pink Salmon			Coho Salmon			Longnose	White-	Northern
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	**Sucker**	**fish**	**Pike**
6/20	0	0	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	0	0
6/22	0	0	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	0	0
6/24	0	0	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	0	0
6/26	0	0	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	0	0
6/28	0	0	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	0	0
6/30	0	0	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	0	0
7/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/12	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	5	0	0
7/13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0
7/16	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
7/17	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0
7/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/19	4	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/21	1	0	1	0	0	0	5	3	8	0	0	0	0	0	0	1	0	0
7/22	0	0	0	0	0	0	4	1	5	0	0	0	0	0	0	1	0	0
7/23	0	0	0	0	0	0	14	3	17	0	0	0	0	0	0	1	0	0
7/24	0	0	0	0	0	0	8	3	11	0	0	0	0	0	0	0	0	0

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Appendix C1.–Page 2 of 3.

Date	Chinook Salmon			Sockeye Salmon			Chum Salmon			Pink Salmon			Coho Salmon			Longnose Sucker	White-fish	Northern Pike
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total			
7/25	0	0	0	0	0	0	9	1	10	0	0	0	0	0	0	**0**	**0**	**0**
7/26	0	0	0	0	0	0	6	3	9	0	0	0	0	0	0	**0**	**0**	**0**
7/27	1	1	2	0	0	0	14	5	19	0	0	0	0	0	0	1	0	0
7/28	1	0	1	0	0	0	7	2	9	0	0	0	0	0	0	0	0	0
7/29	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0
7/30	0	0	0	0	0	0	13	3	16	0	0	0	0	0	0	0	0	0
7/31	1	0	1	0	0	0	16	8	24	0	0	0	0	0	0	0	0	0
8/1	2	0	2	0	0	0	12	4	16	0	0	0	0	0	0	3	2	0
8/2	0	0	0	0	0	0	8	3	11	0	0	0	0	0	0	0	0	0
8/3	0	0	0	0	0	0	24	5	29	0	0	0	0	0	0	0	0	0
8/4	4	0	4	0	0	0	23	12	35	0	0	0	0	0	0	0	1	0
8/5	9	0	9	0	0	0	31	11	42	0	0	0	0	0	0	4	0	0
8/6[a]	0	0	0	0	0	0	6	1	7	0	0	0	0	0	0	1	0	0
8/7[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/8[a]	2	0	2	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
8/9	5	1	6	0	0	0	17	9	26	0	0	0	0	0	0	2	0	0
8/10	3	0	3	0	0	0	11	6	17	0	0	0	0	0	0	1	0	0
8/11	3	0	3	0	0	0	6	1	7	0	0	0	0	0	0	13	0	0
8/12	2	0	2	0	0	0	8	0	8	0	0	0	0	0	0	6	0	0
8/13	5	0	5	0	0	0	16	15	31	0	0	0	3	1	4	41	0	0
8/14	3	0	3	0	0	0	7	4	11	0	0	0	0	0	0	24	0	0
8/15	1	0	1	0	0	0	3	3	6	0	0	0	0	0	0	0	0	0
8/16	1	0	1	0	0	0	9	2	11	0	0	0	0	1	1	9	0	0
8/17	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18	2	0	2	0	0	0	9	1	10	0	0	0	1	0	1	8	0	0
8/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/21	3	1	4	0	0	0	10	2	12	0	0	0	0	0	0	1	1	0
8/22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix C1.–Page 3 of 3.

Date	Chinook Salmon			Sockeye Salmon			Chum Salmon			Pink Salmon			Coho Salmon			Longnose Sucker	White-fish	Northern Pike
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total			
8/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/29	1	0	1	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
8/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0	0
9/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/11	0	0	0	0	0	0	0	0	0	0	0	0	6	1	7	23	0	1
9/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0
9/14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
9/15	1	0	1	0	0	0	1	0	1	0	0	0	2	0	2	7	1	0
9/16	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	21	0	0
9/17	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	4	2	0
9/18	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	3	0	0
9/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/20[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Carcass deposition was influenced by the downstream passage chutes that were installed for part of the season.

[a] The weir was not operational for part or most of the day; carcasses were counted but count does not represent total daily deposition.

[b] The weir was not operational due to a high-water event and carcasses were not counted.

APPENDIX D. WEATHER AND STREAM OBSERVATIONS

Appendix D1.–Weather and stream conditions at the Takotna River weir in 2007.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
6/20	8:00	2	0.0	16.0	14.0	40	1
	17:00	3		24.0	17.0	40	1.0
6/21	8:30	5	6.2	11.5	14.0	40	1
	17:00	3		19.0	16.5	40	1
6/22	8:00	5	0.8	10.0	14.0	40	1
	17:00	3		16.0	14.5	40	1
6/23	8:00	4	2.5	10.5	13.5	40	1
	17:00	4		13.5	15.0	40	1
6/24	8:00	4	3.6	10.0	13.0	41	1
	17:00	4		16.0	14.5	42	1
6/25	8:00	3	0.3	10.0	13.0	45	1
	17:00	4		13.0	13.0	45	1
6/26	8:00	3	0.2	11.0	12.0	44	1
	17:00	4		17.0	15.0	43	1
6/27	8:00	3	0.3	14.0	13.0	43	1
	17:00	4		21.5	14.0	43	1
6/28	8:00	3	0.0	13.5	13.0	44	1
	17:00	4		19.5	15.0	43	1
6/29	8:00	3	0.0	14.0	14.0	42	1
	17:00	2		26.5	18.0	41	1
6/30	8:00	4	0.0	14.5	15.5	41	1
	17:00	3		23.5	17.0	40	1
7/1	8:00	4	0.6	15.0	16.0	39	1
	17:00	4		17.5	16.0	39	1
7/2	8:00	4	1.6	14.0	14.0	39	1
	17:00	4		19.0	15.5	38	1
7/3	8:00	2	0.6	15.0	14.5	47	1
	17:00	1		26.5	15.5	60	2
7/4	8:00	2	1.7	16.5	14.0	59	3
	17:00	4		22.0	15.0	58	3
7/5	8:00	2	0.0	15.0	14.0	61	2
	18:00	3		22.5	17.0	62	2
7/6	8:00	3	3.2	16.5	14.0	66	3
	18:00	4		16.5	15.0	61	3
7/7	8:00	4	0.0	15.5	13.0	55	2
	17:00	2		24.0	16.5	54	2
7/8	8:00	1	0.0	19.5	15.0	52	2
	17:00	1		24.5	14.0	50	2
7/9	8:00	4	0.5	13.0	15.0	50	2
	17:00	1		27.5	17.5	50	2
7/10	8:00	2	0.0	13.0	15.5	55	2
	17:00	3		22.5	16.5	59	2
7/11	8:00	4	6.0	13.0	14.0	57	3
	17:00	4		19.0	14.5	60	3
7/12	8:00	4	0.0	13.0	12.0	71	3
	17:00	3		21.0	14.0	69	3
7/13	8:00	3	0.0	12.0	12.5	63	3
	17:00	3		18.5	14.5	61	3
7/14	8:00	3	7.0	12.0	13.0	59	2
	17:00	4		12.5	13.5	61	2
7/15	8:00	4	5.4	12.0	12.0	91	3
	17:00	2		19.0	11.5	112	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[c]
7/16	8:00	3	0.0	9.5	9.0	108	3
	17:00	4		16.5	10.5	105	3
7/17	8:00	3	0.2	12.0	10.0	97	3
	17:00	3		18.0	12.0	90	3
7/18	8:00	3	0.0	12.0	10.0	85	3
	17:00	2		23.0	12.0	84	3
7/19	8:00	3	0.0	15.0	12.0	81	3
	17:00	4		15.0	12.5	75	3
7/20	8:00	5	2.0	13.0	11.0	80	2
	17:00	3		17.0	12.0	76	2
7/21	8:00	5	0.0	13.5	10.5	83	2
	17:00	3		15.0	13.0	83	2
7/22	8:00	4	7.0	10.0	11.0	80	2
	17:00	4		15.0	12.0	80	2
7/23	8:00	3	5.0	12.0	10.5	79	2
	17:00	3		16.5	12.0	80	2
7/24	8:00	3	1.8	13.5	10.0	78	2
	17:00	4		20.5	12.5	78	2
7/25	8:00	1	0.0	12.5	10.5	75	2
	17:00	1		28.5	13.5	74	2
7/26	8:00	4	0.0	13.5	10.5	73	1
	17:00	2		24.5	14.0	71	1
7/27	8:00	4	0.0	14.0	13.0	69	1
	17:00	1		23.0	16.0	67	1
7/28	8:00	2	0.0	13.5	13.0	67	1
	17:00	4		18.0	14.5	67	1
7/29	8:00	4	0.0	12.5	13.5	65	1
	17:00	4		20.5	14.5	64	1
7/30	8:00	4	0.3	12.5	13.0	63	1
	17:00	4		17.0	14.0	63	1
7/31	8:00	2	0.9	12.5	12.5	62	1
	17:00	4		13.5	12.5	63	1
8/1	8:00	4	2.7	12.0	11.5	63	1
	17:00	4		14.5	12.0	63	1
8/2	8:00	5	0.0	12.5	11.0	67	1
	17:00	4		18.0	12.5	67	1
8/3	8:00	4	1.2	12.0	11.5	66	1
	17:00	4		15.5	12.0	64	1
8/4	8:00	5	9.5	11.0	12.0	65	1
	17:00	4		14.0	11.0	66	1
8/5	8:00	5	17.0	13.0	10.0	74	1
	17:00	4		14.0	11.0	87	1
8/6	8:00	4	11.8	10.5	9.5	120	3
	17:00	4		14.0	9.5	135	3
8/7	8:00	4	0.0	12.0	9.0	136	3
	17:00	3		21.5	10.0	126	3
8/8	8:00	2	0.0	12.0	9.5	114	3
	17:00	3		15.0	10.5	112	3
8/9	8:00	5	0.0	9.0	9.0	108	3
	17:00	3		24.5	12.0	103	3
8/10	8:00	1	0.0	14.5	9.5	95	2
	17:00	1		22.5	11.5	94	2

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Appendix D1.–Page 3 of 4.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[c]
8/11	8:00	1	0.0	9.5	9.5	92	2
	17:00	4		18.0	12.0	89	2
8/12	8:00	4	13.0	13.0	10.0	89	2
	17:00	4		21.0	11.5	91	2
8/13	8:00	3	0.2	18.5	10.5	105	3
	17:00	2		21.0	12.0	100	3
8/14	8:00	4	0.7	11.5	10.5	100	3
	17:00	4		13.0	12.5	92	3
8/15	8:00	4	0.1	10.0	11.5	90	3
	17:00	4		12.0	10.0	89	2
8/16	8:00	5	9.6	12.0	10.0	88	2
	17:00	1		22.0	12.0	87	2
8/17	8:00	5	0.2	7.0	10.0	87	2
	17:00	1		25.0	12.0	86	2
8/18	8:00	2	0.0	13.0	11.5	83	1
	17:00	1		26.0	13.5	82	1
8/19	8:00	2	0.0	11.5	11.5	80	1
	17:00	3		19.0	12.0	80	1
8/20	8:00	3	0.0	9.5	10.0	78	1
	17:00	3		19.0	11.5	78	1
8/21	8:00	4	0.3	12.5	10.5	75	1
	17:00	2		19.0	11.5	75	1
8/22	8:00	4	0.1	9.0	10.0	75	1
	17:00	4		20.0	11.0	75	1
8/23	8:00	5	0.0	7.0	9.5	75	1
	17:00	3		20.0	12.0	74	1
8/24	8:00	3	0.3	7.0	10.0	73	1
	17:00	3		21.0	11.0	73	1
8/25	8:00	3	0.0	10.0	10.0	71	1
	17:00	3		23.0	12.0	71	1
8/26	8:00	2	0.0	6.5	10.0	70	1
	17:00	1		25.0	13.5	69	1
8/27	8:00	1	0.0	10.0	10.0	70	1
	17:00	4		19.5	12.0	68	1
8/28	8:30	2	0.0	11.0	10.0	68	1
	17:00	4		19.0	12.0	66	1
8/29	8:30	1	0.0	10.0	9.0	71	1
	17:00	2		21.5	12.0	71	1
8/30	8:00	2	2.0	9.5	10.0	71	1
	17:00	3		20.0	12.0	70	1
8/31	8:00	2	8.5	9.0	10.0	69	1
	17:00	3		20.5	12.0	69	1
9/1	8:00	5	0.1	8.0	10.0	70	1
	17:00	4		18.0	11.0	73	1
9/2	8:00	1	5.0	9.0	10.0	76	1
	17:00	4		15.0	7.5	73	2
9/3	8:00	5	2.4	8.5	9.0	74	2
	17:00	3		12.5	10.5	74	2
9/4	8:30	3	0.0	9.0	8.5	73	1
	17:00	3		22.5	11.5	73	1
9/5	8:30	1	0.0	3.0	8.5	71	1
	17:00	4		13.5	11.0	71	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[c]
9/6	8:00	5	0.0	8.0	9.0	70	1
	17:00	4		13.0	9.5	69	1
9/7	8:00	5	1.0	8.0	9.0	68	1
	20:00	5		14.0	9.5	67	1
9/8	8:00	4	15.5	10.0	8.5	68	1
	20:00	3		13.5	9.0	71	1
9/9	8:00	4	4.5	12.0	8.5	77	1
	20:00	3		12.0	9.5	86	1
9/10	8:30	3	1.8	8.0	9.0	86	2
	20:00	3		12.0	10.0	83	2
9/11	8:30	4	0.0	9.0	9.0	79	2
	20:00	4		15.5	10.0	78	2
9/12	8:30	5	4.0	9.0	8.5	75	2
	17:00	2		15.0	10.0	75	2
9/13	8:30	4	3.8	9.5	8.5	73	2
	17:00	4		10.5	8.5	73	2
9/14	9:00	4	0.7	7.5	8.0	72	2
	17:00	4		12.5	9.5	72	2
9/15	8:00	4	0.0	7.0	8.0	73	2
	17:00	3		13.0	8.0	72	2
9/16	8:00	4	0.0	4.5	7.0	71	2
	17:00	3		16.0	8.5	71	2
9/17	8:00	4	0.5	4.5	7.0	71	2
	17:00	4		9.5	6.5	71	2
9/18	8:00	4	7.0	6.5	6.0	72	1
	17:00	4		8.0	6.5	74	2
9/19	9:00	3	21.4	8.0	6.0	85	2
	17:00	4		9.5	7.0	102	2
9/20	9:00	4	6.4	9.5	6.5	138	1
	17:00	4		9.0	7.0	140	1

[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
5 = thick fog

[b] Represents the cumulative precipitation in the 24 hours prior to the daily morning observation.

[c] Water clarity codes:
1 = visibility greater than 1 meter
2 = visibility 0.5 to 1 meter
3 = visibility less than 0.5 meter

Appendix D2.–Daily stream temperature summary for the Takotna River weir from hourly readings logged by the Hobo® Water Temp Pro tethered to the stream bottom, 2007.

	Temperature (°C)				Temperature (°C)		
Date	Avg.	Min.	Max.	Date	Avg.	Min.	Max.
6/20	15.3	14.4	16.4	8/7	9.8	9.3	10.3
6/21	15.6	14.7	16.5	8/8	10.2	9.8	10.7
6/22	15.0	14.5	15.7	8/9	10.4	9.3	11.8
6/23	14.5	13.9	15.5	8/10	10.9	9.5	12.3
6/24	13.8	13.1	14.5	8/11	10.9	9.8	11.9
6/25	13.2	12.8	14.0	8/12	11.2	10.7	11.7
6/26	13.3	12.2	14.4	8/13	11.8	10.4	13.3
6/27	14.2	13.1	15.6	8/14	12.7	12.1	13.3
6/28	14.7	13.8	15.5	8/15	11.5	10.9	12.8
6/29	16.0	14.1	18.7	8/16	10.9	10.1	12.1
6/30	16.9	16.1	17.7	8/17	11.4	10.1	12.7
7/1	16.0	15.3	16.9	8/18	12.4	11.3	13.5
7/2	15.3	14.6	16.0	8/19	12.0	11.5	13.1
7/3	16.4	15.1	18.0	8/20	11.2	10.2	12.3
7/4	15.8	14.2	17.2	8/21	11.3	10.9	12.1
7/5	16.0	14.6	17.3	8/22	10.7	10.1	11.3
7/6	14.8	14.3	16.2	8/23	11.0	10.0	12.1
7/7	14.8	13.4	16.6	8/24	10.9	9.9	11.6
7/8	16.0	15.1	17.1	8/25	11.1	10.1	12.2
7/9	16.5	15.2	18.0	8/26	11.6	10.4	12.8
7/10	16.4	15.6	17.7	8/27	11.6	10.4	12.5
7/11	14.7	14.0	15.9	8/28	11.3	10.4	11.9
7/12	13.2	11.8	14.6	8/29	11.1	10.1	11.9
7/13	13.9	12.6	15.1	8/30	11.2	10.3	11.8
7/14	14.0	13.6	14.8	8/31	11.3	10.4	12.2
7/15	12.2	11.3	13.9	9/1	10.8	10.0	11.6
7/16	10.2	9.4	11.1	9/2	10.8	10.3	11.6
7/17	10.9	9.9	12.1	9/3	10.0	9.3	10.6
7/18	11.7	10.3	13.4	9/4	10.1	9.0	11.2
7/19	12.5	11.9	13.3	9/5	9.7	8.7	10.7
7/20	11.9	11.2	12.7	9/6	9.4	8.5	10.1
7/21	11.8	10.7	12.7	9/7	9.1	8.5	10.0
7/22	11.6	11.0	12.4	9/8	9.4	9.2	9.7
7/23	11.2	10.5	11.9	9/9	9.1	8.6	9.6
7/24	11.5	10.5	12.5	9/10	9.1	8.4	9.7
7/25	12.3	10.8	14.1	9/11	9.1	8.5	9.5
7/26	13.8	12.5	15.5	9/12	9.4	8.9	10.2
7/27	14.8	13.8	16.0	9/13	8.9	8.5	9.4
7/28	14.4	13.6	15.6	9/14	8.3	8.0	8.6
7/29	14.0	13.4	14.4	9/15	7.9	7.5	8.3
7/30	13.7	13.3	14.2	9/16	7.6	7.1	8.1
7/31	12.9	12.6	13.7	9/17	7.0	6.6	7.7
8/1	12.2	11.8	12.6	9/18	6.7	6.5	6.9
8/2	11.8	11.2	12.6	9/19	6.7	6.5	6.9
8/3	11.8	11.2	12.3	9/20	6.5	6.3	6.7
8/4	11.5	11.2	12.0	Average:	12.0	11.2	12.9
8/5	11.1	10.7	11.7	Minimum:	6.5	6.3	6.7
8/6	10.0	9.6	10.8	Maximum:	16.9	16.1	18.7

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APPENDIX E. TAKOTNA RIVER BROOD TABLES

Appendix E1.–Ad hoc brood table for Takotna River Chinook salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year					Returns[a]	Return per Spawner[a]
		3	4	5	6	7		
1993	ND	ND	ND	ND	ND	2	-	-
1994	ND	ND	ND	ND	123	-	-	-
1995	156 [bc]	ND	ND	109	-	3	-	-
1996	422 [b]	ND	106	-	145	-	-	-
1997	1,197 [b]	5	-	94	-	-	-	-
1998	21 [bc]	-	69	-	-	-	-	-
1999	ND [d]	0	-	-	-	14	-	-
2000	345	-	-	-	124	3	-	-
2001	721 [e]	-	-	163	62	ND	-	-
2002	316	-	228	140	ND	ND	-	-
2003	378 [e]	9	212	ND	ND	ND	-	-
2004	461 [e]	0	ND	ND	ND	ND	-	-
2005	499 [e]	ND	ND	ND	ND	ND	ND	ND
2006	539	ND	ND	ND	ND	ND	ND	ND
2007	418	ND	ND	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.
[b] Escapement is from tower counts. ASL sampling was not conducted.
[c] Incomplete escapement data.
[d] Project was not operated.
[e] Insufficient age data.

Appendix E2.–Ad hoc brood table for Takotna River chum salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year				Returns[a]	Return per Spawner[a]
		3	4	5	6		
1994	ND	ND	ND	ND	5	-	-
1995	1,685 [bc]	ND	ND	442	11	-	-
1996	2,872 [b]	ND	774	1,337	54	-	-
1997	1,839 [b]	33	4,068	2,221	17	6,339	3.45
1998	45 [bc]	4	1,994	370	0	2,368	-
1999	ND [d]	107	2,835	622	0	3,564	-
2000	1,254	171	775	95	8	1,049	0.84
2001	5,414	236	5,816	4,476	241	10,769	1.99
2002	4,377	556	7,837	3,004	ND	-	-
2003	3,393	276	5,350	ND	ND	-	-
2004	1,630	305	ND	ND	ND	-	-
2005	6,467	ND	ND	ND	ND	ND	ND
2006	12,598	ND	ND	ND	ND	ND	ND
2007	8,900	ND	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.
[b] Escapement is from tower counts. ASL sampling was not conducted.
[c] Incomplete escapement data.
[d] Project was not operated.

Appendix E3.–Ad hoc brood table for Takotna River coho salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year			Returns[a]	Return per Spawner[a]
		3	4	5		
1995	ND	ND	ND	80	-	-
1996	ND	ND	3,866	307	-	-
1997	ND	11	2,291	219	2,521	-
1998	ND	7	3,756	911	4,674	-
1999	ND	9	6,197	52	6,258	-
2000	3,957	62	3,146	267	3,475	0.88
2001	2,606	8	1,944	190	2,142	0.82
2002	3,984	5	5,171	149	5,325	1.34
2003	7,171	187	2,640	ND	-	-
2004	3,207	64	ND	ND	-	-
2005	2,216	ND	ND	ND	ND	ND
2006	5,548	ND	ND	ND	ND	ND
2007	2,853	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.