Fishery Data Series No. 09-75

Takotna River Salmon Studies, 2008

Final Report for Study 08-304
USFWS Office of Subsistence Management
Fisheries Resource Monitoring Program

by

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

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ABSTRACT

The Takotna River weir has operated since 2000 to estimate the abundance and age-sex-length compositions of salmon escapements, monitor environmental variables, and facilitate other Kuskokwim Area fisheries projects. In 2008, a resistance-board weir was operated in the Takotna River from 20 June through 23 September to estimate escapements of 4 species of pacific salmon *Oncorhynchus* spp. The total annual escapements of Chinook salmon *O. tshawytscha (*413 fish), coho salmon *O. kisutch* (2,817 fish), and sockeye salmon *O. nerka* (13 fish) were slightly below average. The total escapement of chum salmon *O. keta* (5,691 fish) was average. Age-sex-length samples taken from fish caught in a live trap were used to describe the age-sex structure of the Chinook, chum, and coho salmon escapements. Females comprised 24.6% of Chinook salmon escapement, 49.7% of the chum salmon escapement, and 51.4% of coho salmon escapement. The Chinook salmon escapement was comprised of 5 age classes dominated by age-1.3 fish (52.2%). Chum salmon escapement was comprised of 3 age classes, dominated by age-0.4 fish (61.3%). Coho salmon escapement was comprised of 3 age classes, dominated by age-2.1 fish (76.8%).

Takotna River weir is one of several components that form an integrated array of escapement monitoring projects in the Kuskokwim Area. This array of projects provides a means to monitor and assess escapement trends that must be considered in harvest management decisions in accordance with the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222).

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, 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[1];Coffing et al. 2000; Smith and Dull 2008; Whitmore et al. 2008). The commercial salmon fishery 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 other agencies contribute to the decision making process. 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 such as the Takotna Tribal Association (TTC) are charged by their constituency to actively promote a healthy and sustainable subsistence salmon fishery. These and other groups have combined their resources in an effort to achieve sustainable Kuskokwim River salmon fisheries.

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

In the State of Alaska, the goal of salmon management is to provide for 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, which influence management decisions. Over time and with sufficient data, escapement goals can be developed as a means to gauge escapement adequacy, but current spawner-recruit models for escapement goal development require many years of data. For much of ADF&G management history, escapement monitoring has been limited to aerial surveys and 2 ground-based escapement monitoring projects.

With salmon spawning on dozens of tributaries, several ground-based monitoring projects were needed to adequately evaluate escapement in 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 known to be imprecise (Holmes and Burtkett 1996; Molyneaux and Brannian 2006; Mundy 1998). The Takotna River weir does not currently have escapement goals for any species; however, annual escapement monitoring in the Takotna River contributes to the escapement and abundance information required for effective management (Holmes and Burkett 1996; Mundy 1998).

In recent years, 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 sizes. 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 increased 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 integrated components of Kuskokwim River salmon management.

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). 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 fishermen tend to harvest more heavily in the early part of yearly salmon migrations (Smith and Dull 2008). Therefore, despite average escapements only approximately 400 Chinook, 5,000 chum, and 4,000 coho salmon, these Takotna River salmon stocks are considered an important contributors to the overall annual production of Kuskokwim River fisheries. These Kuskokwim River tributaries are 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 sustainability of the downriver fisheries (Burkey et al. 2000a).

The utility of weirs extends beyond providing annual escapement estimates. Collection of age, sex, and length (ASL) data is typically included in escapement monitoring projects such as Takotna River weir (Molyneaux et al. 2008). Knowledge of ASL composition can improve understanding of fluctuations in salmon abundance and are 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 may directly or indirectly influence salmon productivity and timing of salmon migrations (Hauer and Hill 1996; Kruse 1998; Quinn 2005). These variables can be affected by human activities (i.e., mining, timber harvesting, man-made impoundments, etc.; NRC 1996) or broader climatic variability (e.g., El Nino and La Nina events, climate change).

BACKGROUND

Takotna River salmon escapements have been small since escapement monitoring began; however, historical accounts suggest that salmon abundance was once much higher. In the early 1900s, salmon were harvested from the Takotna River by small bands of Athabaskans including residents of 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; Stokes 1985). The numbers of salmon these groups harvested are unknown, but Nikolai elders suggest that there were strong Chinook and chum salmon runs in the Takotna River into the early twentieth century (Stokes 1985).

The historical harvest method of choice for Athabaskans was a weir constructed of spruce poles and fitted with a fish trap. 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 and may have been a significant factor in the near extirpation of salmon in Takotna River. The community of Takotna developed as a staging area for miners who used Takotna River as an access route to mining operations that were mostly located in the Yukon River drainage (Brown 1983). 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 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 fishermen began to catch coho salmon *O. kisutch* 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 staff 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 drainagewide 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 pre-season preparations and inseason operations.

OBJECTIVES

The annual objectives of the Takotna River escapement monitoring project (FIS 08-304) 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 composition of annual Chinook, chum, and coho salmon escapements to the Takotna River such that 95% confidence intervals for the age composition are no wider than ±10% (α= 0.05 and d= 0.10);
3. Mentor high school students through the TTC high school internship program; and,
4. Serve as a platform to facilitate other fisheries research projects by:
    a. Serving as a monitoring location for coho salmon equipped with radio transmitters and anchor tags deployed as part of a Kuskokwim River coho salmon study;
    b. Serving as a monitoring location for a temperature monitoring project;

c. Serving as a collection location for a study investigating the productivity of Kuskokwim juvenile coho salmon;
d. Serving as a collection location for a study investigating the use of stable isotope and otolith elemental analyses as tools for salmon stock assessment.

The primary goal of this report is to summarize results for the 2008 field season at Takotna River weir. Secondary to this, we intend to provide a more holistic perspective of Kuskokwim Area fisheries by placing the 2008 findings into broader spatial and temporal context. To do this we draw heavily on data from past years to highlight temporal trends and we draw on data from other escapement monitoring projects, related research projects, and commercial and subsistence fisheries to highlight spatial trends. These goals are intended to enhance the utility of this report beyond simply archiving data. It is important to note that some of the data used to make these broader comparisons are preliminary. 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. Therefore, readers should consult the original documents prior to referencing results from other projects. Furthermore, unless stated, the statistical significance of the trends discussed for this and other escapement monitoring projects have not been determined. Many of these trends are subjective and based on low sample sizes with high variance. It is important to remember that sampling methodologies often differ across projects and over time leading to difficulty in comparisons. Throughout this document every effort was made to ensure sound comparisons; however, the reader should be aware of these potential issues and 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, Takotna 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 Nixon Fork. In lower reaches, the current is sluggish and channel width averages 122 to 152 m. Takotna 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 tremuloides* 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. The site is about 3 rkm upstream of Takotna village and 83 rkm from the confluence with Kuskokwim River (Figure 2). The weir site is downstream from most known spawning areas.

At the weir site, 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.

Construction

The Takotna River weir is termed a “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 channel and fixed weir materials extend the weir 3 m (10 ft) to each bank. 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 occurs through the live trap, which is annually installed within the deeper portion of the stream channel. The live trap is about 2.5 m long (parallel to channel) and 1.5 m wide (perpendicular to channel) and has 2 gates: an entrance gate facing downstream and an exit gate facing upstream. After all the panels are installed across the river, one 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 consist of the same modified weir panels described by Schwanke et al. (2001), but one 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 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 dip 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 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, sockeye and coho salmon and provides for consistent comparisons among years. 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 missed 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. Counts are recorded 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 zero 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 window 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 the coho salmon project in 2008.

The sex of passing salmon is determined by identifying characteristics shaped from 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 as mentioned above.

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 methods 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 one day, an estimate for the inoperable day is calculated using the following formula:

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

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:

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

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

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

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 well into the one or more salmon runs, or when the weir ceases operating before data suggest salmon runs are nearing completion, daily passage for inoperable days is estimated using passage data from another year at the Kogrukluk River weir or from 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:

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

where:

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

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

$\sum n_{md_i}$ = 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.

Exponential Method

When model data sets are not adequate to use the “proportion method” the “exponential method” can be used. This method uses non-linear regression to fit an exponential function to existing data. For estimating the beginning of a run, use the rising limb of the run curve to fit an exponential trend line. For estimating the end of a run, use the falling limb of the run curve to fit an exponential trend line. Using this method the trendline is fitted to the data using the exponential function:

$$\hat{n}_{d_i} = ae^{bi} \tag{4}$$

where:

a = y-intercept of the fitted line

b = slope of the fitted line

i = day of the estimated portion of the run

Carcass Counts

In 2008, the weir was typically cleaned once each day, usually at the end of a counting shift. Spawned out salmon and carcasses of dead salmon (both hereafter referred to as carcasses) that wash up on the weir were identified by species and sex based on external morphological characteristics and passed downstream. Daily and cumulative carcass counts were copied to logbook forms.

AGE, SEX, AND LENGTH COMPOSITION

To estimate the age, sex, and length composition of annual Chinook, chum, and coho salmon escapements, live sampling was conducted as fish migrated upstream through the weir. Samples were collected throughout the season to account for temporal dynamics in ASL characteristics. Samples were stratified postseason to develop weighted estimates.

Sample Size and Distribution

A minimum sample size was determined for each species following conventions described by Bromaghin (1993) to achieve 95% confidence intervals of age-sex composition no wider than ±10% of each age-sex category (α=0.05 and d=0.10), assuming 10 age-sex categories for Chinook salmon (n=190), 8 age-sex categories for chum salmon (n=180), and 6 age-sex categories for coho salmon (n=168), and unknown population size. Because the Takotna River

Chinook population is small, the sample size of 190 was corrected for a population of 500 fish using the finite population correction:

$$n' = \frac{n}{1 + \left(\frac{n-1}{N} \right)} \tag{5}$$

where:

$n =$ sample size of unknown population size;

$N =$ population size; and,

$n' =$ sample size corrected for a known population size.

Minimum sample sizes for each species were then increased by about 20% to account for unreadable scales or collection errors. This yielded a minimum collection goal for each sample of 165 Chinook, 220 chum, and 200 coho salmon.

The abundance of chum and coho salmon at Takotna River weir is generally high enough to collect a large sample size in a short period of time. A pulse sampling strategy was therefore employed to ensure adequate temporal distribution of chum and coho samples. The term "pulse" is used to describe an instantaneous sample, though in practice a pulse sample is typically collected over the period of a few days. Well spaced pulse samples are thought to have greater power for detecting temporal changes in ASL composition than other sampling methods (Geiger and Wilbur 1990). Pulse sampling was conducted approximately every 7–10 days. The goal was to collect a minimum of one pulse sample from each third of the run.

The relatively low abundance of Chinook salmon at Takotna River weir makes pulse sampling impractical. Instead, the sample was collected continuously over the run following a daily collection schedule based on historical run timing information. Daily sample sizes were proportional to average historical escapements by day to ensure a good distribution across the run. The overall sample size was selected to exceed the minimum necessary to meet precision and accuracy criteria for this location and was similar to average historical sampling success.

Sample Collection Procedures

Salmon were sampled using the live trap installed in the weir. Salmon were trapped by opening the entrance gate while the exit gate remained closed. Fish were allowed to swim freely into the live trap, but the V-shape positioning of the entrance gate prevented them from easily escaping. The live trap was allowed to fill with fish until a reasonable number was inside. Crew members used a short-handled dip net to capture fish within the live trap. To obtain length data and aid in scale collection, fish were removed from the dip net and placed into a partially submerged fish "cradle." Scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards as described in Molyneaux et al. (2008). 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. Mideye to fork (MEF) length was measured to the nearest millimeter 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 used for scale preservation. After sampling, each fish was released upstream of the weir. The procedure was repeated until the live trap was emptied.

After sampling was completed, relevant information such as sex, length, sampling date, and sampling location was copied to computer mark–sense forms that correspond to numbered gum cards. The completed gum cards and mark–sense forms were sent to the Bethel and/or 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. 2006).

Data Processing and Reporting

Samples were aged and processed by ADF&G staff in Bethel and Anchorage following procedures describe by Molyneaux et al. (2008). Samples were partitioned into a minimum of 3 temporal strata, based on overall distribution within the run. The escapement in each stratum was divided into age-sex classes proportionately with strata sample composition. Mean length by age-sex class was determined for each stratum as well. Annual estimates were calculated as strata sums, weighted by the abundance in each stratum. When sample size or distribution was not considered adequate to estimate annual ASL composition, results were reported, but not applied to annual escapements.

Sex compositions derived from passage counts and through ASL sampling 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.

Two summary tables were generated for each species. The first table provides the escapement and percentage of each age-sex class by stratum, with season totals weighted by escapement in each stratum. The second table provides a summary of mean length-at-age by sex for each stratum, with season totals weighted by escapement in each stratum. Sample sizes and dates are included for each stratum. Age is reported in the European notation, composed of 2 numerals separated by a decimal. The first numeral represents the number of winters the juvenile spent in freshwater excluding the first winter spent incubating in the gravel, and the second numeral is the number of winters it spent in the ocean (Groot and Margolis 1991). The total age is therefore 1 year greater than the sum of these 2 numerals.

TTC High School Internship Program

Five local area high school students were recruited to spend 1 to 2 weeks at the Takotna River weir. Students participated in passage counts, ASL sample collections, and weather and stream measurements under the supervision of project crew members. In addition, the crew administered a curriculum of daily educational assignments and field activities. The curriculum was developed by consulting Iditarod Area School District teachers and is a melding of the Alaska state high school science and math standards with lessons about fish biology and ecology, fisheries research, subsistence living, and fisheries management. All students were paid $250 per week for successfully completing their internships.

Weather and Stream Observations

Weather and stream observations were taken twice each day 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 Hobo® Water Temp Pro V1[2] data logger 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 gage. The staff gage 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 gage 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 cm relative to the datum plane. River stage was measured at approximately 0800 and 1700 hours.

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Investigations

The Takotna River weir served as a recovery site for the first season of a two-season basin-wide mark–recapture and radio telemetry study entitled *Kuskokwim River Coho Salmon Investigations* funded by the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative. The project was designed to estimate coho salmon abundance, distribution, and run timing above the upper Kalskag tagging site (rkm 270), as well as produce a statistical model that would compute historical annual abundance estimates from known escapement data. Coho salmon were captured at upper Kalskag and tagged using individually numbered Floy® anchor tags. A subset of tagged coho received an individually coded radio tag. Adipose fin clips were used as a secondary mark. Tagging methods are described by Stuby (2007).

Whenever possible, tagged coho salmon observed passing through the weir's live trap were captured to recover tag information. Recorded data for "recovered" fish included the tag number, tag color, condition, presence of secondary mark, and recovery date. When a tagged fish was not captured it was recorded as "observed" along with the tag color and passage date. Tag loss was assessed at the weir by inspecting for secondary marks during routine ASL sampling.

This project built on an established network of telemetry tracking stations set up in support of Stuby (2007), with additional stations to increase the resolution of coho salmon distribution. The Takotna River weir crew helped set-up and maintain the Takotna River weir station. All data collected by the crew was transferred to the principal investigator on an opportunistic basis.

Temperature Monitoring

The Takotna River weir serves as a monitoring site for a temperature monitoring project funded by Office of Subsistence Management (FIS 08-701). The contractor provided monitoring

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

equipment to the principal investigator for installation at the weir site. Two Hobo® Water Temp Pro V2 data loggers and two Hobo® Air Temperature R/H data loggers were installed at the beginning of the field season. The water temperature loggers were anchored to the bottom near mid-channel and the air temperature loggers were installed using a solar shield attached to a pole. At the end of the field season one water temperature logger and one air temperature logger were removed and the remaining temperature loggers were downloaded using the provided data shuttle and left to continue monitoring temperature. The removed temperature loggers and data shuttle were returned to the contractor for data management and reporting and logger maintenance and storage.

Juvenile Coho Salmon Collection

Juvenile coho salmon were collected throughout the Kuskokwim River watershed in support of a study investigating the productivity of Kuskokwim juvenile coho salmon, funded by the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative, in an effort to develop scale radius-fish length relationships. Baited minnow traps were used to collect juvenile coho salmon. Traps were baited with cured salmon eggs and soaked for variable lengths of time (typically 0.5 to 1 hour) to maximize trapping efficiency. Traps were placed in pools, backwater areas, and along river and creek banks. Captured coho salmon juveniles were measured to determine size class. Fish of a given size class were placed in Whirlpacks® with buffered 10% formalin. A log book was used to record soak time, number of each species captured, and approximate size of juvenile coho salmon collected. Fish were collected throughout the summer or until a sample size of 100 juvenile coho salmon was collected with fish evenly distributed across the range of available size classes. Collected samples were sent to the principle investigator at the end of the season (G. Ruggerone, Natural Resources Consultants, Inc, Seattle WA).

Otolith Collection

Otoliths were collected from chum and Chinook salmon carcasses in support of 2 pilot investigations looking into the utility of microchemical analysis for stock identification. Crews collected carcasses from the weir on an opportunistic basis. Carcasses were examined to ensure that the fish had spawned above the weir, and these were assumed to belong to Takotna River stocks. A goal was set to collect otoliths from 20 male and 20 female chum and Chinook salmon carcasses. Carcasses were rated 1 to 4 based on gill color, with red gills rated 1 and no color rated 4. Saggital otoliths were collected only from fish with a rating of 1 or 2 because fresh carcasses are needed for microchemical analysis. Plastic forceps were used to extract the samples to prevent contamination from foreign metals. Fresh forceps were used on each sample and then discarded to prevent contamination between samples. Otoliths from each fish were placed in separate envelopes with location, length, and sex information recorded on the outside. The envelopes were sent to the USFWS (F. Harris, Principle Investigator, USFWS, Kenai Fisheries Resource Office, Kenai) and the University of Alaska Fairbanks (T. Sutton, Principle Investigator, UAF, Fairbanks).

RESULTS

ESCAPEMENT MONITORING

Favorable water conditions allowed for an early weir installation in 2008, which was completed by 20 June. Weir removal began on 23 September; low water conditions allowed for weir operation to continue several days after the target operational period to ensure any passage occurring beyond this period was nominal. The weir remained fully operational throughout the above mentioned operation period and thus no escapement estimates were necessary.

Chinook Salmon

In 2008, a total of 413 Chinook salmon passed the weir, of which, all passage occurred during the target operational period (Table 1; Appendix A1). The first Chinook salmon was observed on 25 June and the last was observed on 7 September (Table 1). Daily passage peaked at 40 on 22 July. Based on total escapement during the target operational period, the median passage date was 22 July and the central 50% of the run occurred between 16 and 26 July (Figure 3).

Chum Salmon

A total of 5,691 chum salmon passed the weir between 20 June and 23 September. Of those, 5,691 passed during the target operational period (Table 1). The first chum salmon was observed on 24 June and the last was observed on 21 September (Appendix A1). Daily passage peaked at 289 on 16 July. Based on total 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 2,841 coho salmon passed the weir between 31 July and 23 September. Of those, 2,817 passed during the target operational period (Table 1). Coho salmon were first observed on 31 July and nearly every day thereafter until weir operations ceased on 23 September (Appendix A1). Daily passage peaked at 207 on 27 August. Based on total escapement during the target operational period, the median passage date was 28 August and the central 50% of passage occurred between 22 August and 5 September (Figure 3).

Sockeye Salmon

A total of 14 sockeye salmon passed the weir between 21 July and 23 September. Only 1 of these passed outside of the target operational period, on 23 September. The first sockeye salmon was observed on 21 July and the last was observed on 23 September (Appendix A1). Daily passage never exceeded 2 fish. Based on total escapement during the target operational period, the median passage date was 19 August and the central 50% of passage occurred between 1 and 25 August (Table 1).

Other Species

Pink Salmon

Pink salmon *O. gorbuscha* are extremely rare in the Takotna River and none were observed in 2008.

Non-Salmon Species

Four non-salmon fish species were observed passing the weir in 2008. Longnose suckers were the most abundant with 1,633 observed passing upstream in 2008; of those, 675 were observed passing within the target operational period. Longnose suckers were first observed on 20 June and the last was observed on 21 September (Appendix A1). Other species observed passing upstream included 6 Arctic grayling *Thymallus arcticus*, 18 whitefish *Coregonus* spp, 18 northern pike, and 1 Sheefish *Stenodus Leucichthys*.

Carcass Counts

A total of 578 salmon carcasses were recovered from the Takotna River weir in 2008 (Appendix B1). A total of 25 male and 5 female Chinook salmon carcasses were recovered (7.3% of annual escapement) from 24 July through 16 September. A total of 357 male and 189 female chum salmon carcasses were recovered (9.6% of annual escapement) from 1 July through 31 August. A total of 2 male and 0 female coho salmon carcasses were recovered (0.1% of annual escapement) on 7 September. No sockeye or pink salmon carcasses were recovered.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Chinook salmon ASL sampling at the Takotna River weir was conducted nearly every day between 30 June and 5 August, resulting in a total sample of 178 fish. Of those, age was determined for 154 fish (86.5% of the total sample), or 37.3% of the total Chinook salmon escapement. The total annual escapement was partitioned into 3 temporal strata based on the temporal distribution of the sampling effort, with sample sizes of 83, 47, and 24 aged (i.e. age was determined) fish per stratum (Table 2). The 3 sampling events were well distributed over the course of the run taking place at 16%, 50%, and 87% of the run, respectively. The total sample size and temporal distribution was more than adequate to estimate annual age composition given that 95% confidence intervals for age composition ranged no wider than ±7.7% in 2008.

Age Composition

The 2008 Chinook salmon escapement was dominated by 3 age classes that when combined comprised 99% of the total annual escapement (Table 2). Age-1.3 was the most abundant age class (52.2%), followed by age-1.4 (25.2%), and age-1.2 (21.8%). Age-1.5 and age-2.3 fish each comprised only a tiny fraction of escapement in 2008 (0.8% combined); no age-1.1, -2.2, or -2.4 fish were found in the sample. With the exception of age-1.4 fish, there were no consistent intra-seasonal trends in the age composition. The percentage of age-1.4 fish continually increased from a minimum of 9.6% to a maximum of 37.5% as the run progressed, while the percentage of age-1.3 fish was near 57% in the first 2 strata and decreased to 41.7% in the third. The percentage of age-1.2 fish was highest in the first strata at 30.1% and lowest in the middle strata at 14.9% (Table 2; Figure 4).

Sex Composition

Female Chinook salmon comprised 24.6% of the total annual escapement based on weighted ASL samples. Female sex composition generally increased throughout the run; females represented a maximum 31.9% during the second stratum. The final stratum was similar consisting of 29.2% females, while the lowest female percentage (12%) was in the first stratum (Table 2; Figure 5). The female escapement was dominated (69.6%) by older, age-1.4, individuals. Conversely, the male escapement was largely comprised of younger age-1.2 and age-1.3 individuals, representing 28.9% and 60.1% of the total male escapement, respectively.

Visual sex determination of each passing fish yielded a sex ratio similar to that derived from ASL sampling. Based on this method, female Chinook salmon comprised 28.2% 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 2008 (Figure 6).

As indicated by daily passage counts, females comprised 6.0%, 22.8%, and 41.9% of total Chinook salmon escapement during the first, second, and third stratum, respectively.

Length Composition

Length analysis was partitioned by sex and age class. The length of female Chinook salmon ranged from 690 to 950 mm and males ranged from 475 to 833 mm (Table 3). In the age-1.4 class, females were larger than males (Figure 7). Sample sizes of females in other age classes were too small to compare male versus female length-at-age. Average length of age-1.4 females was 857 mm and average length of age-1.3 females was 753 mm. Average lengths for male age-1.2, -1.3, and -1.4 were 538 mm, 695 mm, and 739 mm, respectively. Considering the variability of length within an age class, average lengths-at-age varied little during the run for both male and female Chinook salmon (Table 3; Figure 8).

Chum Salmon

Sampling goals for chum salmon were achieved in 2008. Pulse sampling was conducted from 30 June to 1 August and was distributed evenly throughout the chum salmon run for a total of 651 fish. Of those, age was determined for 601 chum salmon (92.3% of the total sample), or 10.5% of the total annual chum salmon escapement in 2008 (Table 4). The chum salmon run was partitioned into 4 temporal strata based on the temporal distribution of the sampling effort, with sample sizes ranging between 99 and 199 aged fish per stratum, (Table 4). Sample size was adequate for estimating total annual age composition of chum salmon escapement to the Takotna River weir given that the 95% confidence intervals ranged no wider than ±3.8%.

Age Composition

The chum salmon escapement that passed the weir was largely represented by age-0.4 individuals, which comprised 61.3% of the total chum salmon escapement in 2008 (Table 4). Age-0.3 individuals comprised 32.4% of the escapement, followed by age-0.5 individuals at 6.3%; no age-0.2 individuals were sampled in 2008 (Table 4). Age composition did shift over the course of the run, age-0.4 fish decreased as the run progressed while age-0.3 fish increased (Table 4; Figure 9). The percentage of age-0.3 chum salmon ranged from a minimum of 11.2% early in the run to a maximum of 43.8% at the end, while the percentage of age-0.4 fish ranged from a maximum of 83.2% early in the run to a minimum of 51.1% at the end. The relative age structure summarized for the entire run was sustained in each temporal stratum (Table 4).

Sex Composition

The percentage of males and females in the chum salmon escapement that passed the Takotna River weir was essentially equal. Female chum salmon comprised 49.7% of the total annual escapement based on weighted ASL samples (Table 4). Aside from the first stratum, the sex composition varied little during the run (Figure 5). The percent contribution of females was considerably lower in the first stratum (32.8%), but in others the percentage of females remained constant and near 50%. Both the male and female escapement was dominated by age-0.4 individuals (65.9% for males, 56.6% for females).

Visual sex determination of each passing fish yielded a sex ratio similar to that derived from ASL sampling (Figure 6). Based on this method, female chum salmon comprised 48.7% 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 2008 (Figure 6). As indicated through daily passage counts the percent contribution of females in strata 1-4 was 41.8%, 45.4%, 48.7%, and 52.4%, respectively.

Length Composition

Length analysis was partitioned by sex and age class. The length of female chum salmon ranged from 457 to 626 mm and males ranged from 478 to 689 mm (Table 5). Male chum salmon were longer at age than females (Figure 7). Average lengths for female age-0.3, -0.4 and -0.5 fish were 527, 544, 547 mm, respectively. Average lengths for male age-0.3, -0.4, and -0.5 fish were 554, 568, and 577 mm, respectively. For both males and females, there was little intra-annual variation in average length-at-age (Table 5; Figure 10).

Coho Salmon

Pulse sampling for coho salmon was conducted from 18 August to 7 December and was distributed evenly throughout the run, for a total of 567 fish. Of those, age was determined for 440 coho salmon (77.6% of the total sample), or 15.6% of the total annual coho salmon escapement (Table 6). The coho salmon run was partitioned into three temporal strata based the temporal distribution of the sampling effort, with sample sizes ranging between 113 and 181 aged fish per stratum (Table 6). Sample size was adequate for estimating total annual age composition of coho salmon escapement to the Takotna River weir given that the 95% confidence intervals ranged no wider than ±4.4% in 2008.

Age Composition

The coho salmon escapement that passed the weir was dominated by age-2.1 individuals, which comprised 76.8% of the total coho salmon escapement at the Takotna River weir. Age-1.1 and age-3.1 fish comprised 2.2% and 21.0% of the escapement, respectively (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 and trends were not apparent. Age-2.1 fish composed 82.9% of the first stratum then fell to 68.1% in the second stratum and rose back to 78.1% in the third stratum. Conversely, the percentage of age-3.1 fish rose to a high of 30.1% in the second stratum compared to 15.5% in the first and 19.2% in the third (Figure 11). Age-1.1 fish remained a small percentage of the run and ranged from 1.7% to 2.7% in all 3 strata.

Sex Composition

The percentage of males and females in the coho salmon escapement that passed the Takotna River weir was about equal. Female coho salmon comprised 51.4% of the total annual escapement based on weighted ASL samples. Sex composition varied considerably during the run (Table 6). The percent contribution of females increased steadily over the course of the run, comprising 45.9%, 46.9%, and 57.5% of escapement during the first, second, and third stratum, respectively (Table 6; Figure 5). Both the male and female escapement was dominated by age-2.1 individuals, representing 75.5% and 78.0% of the total male and female escapement, respectively.

Visual sex determination of each passing fish yielded a sex ratio similar to that derived from ASL sampling (Figure 6). Based on this method, female coho salmon comprised 50.2% 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 2008, although not to the same extent as indicated by the ASL sampling method (Figure 6). Based on the visual method, percent female in the coho salmon escapement was 49.4% in the first stratum, 50.2% in the second, and 51.4% in the third.

Length Composition

Length analysis was partitioned by sex and age class. The length of female coho salmon ranged from 419 to 609 mm and males ranged from 432 to 628 mm (Table 7). Female coho salmon were generally larger at age-2.1 than males (Figure 7), although average length did not increase with age for either males or females (Table 7). Average lengths for female age-1.1, -2.1, and -3.1 were 547, 539, and 540 mm, respectively. Average lengths for male age-1.1, -2.1, and -3.1 fish were 523, 529, and 523 mm, respectively. For both males and females, average length-at-age varied little during the run (Figure 12).

WEATHER AND STREAM OBSERVATIONS

In 2008, water levels at the Takotna River weir ranged from 48.0 to 121.0 cm, with an average of 63.6 cm for the overall operational period (Appendix C1). During installation, and for approximately a week afterwards, daily water levels were above historical per-date maximums (Figure 13). On 1 July the water level peaked from a rain event. Water levels began to decline after the peak and by 4 August water levels remained below average for the duration of the season.

Air temperature at the weir ranged from 2.0 to 27.5°C, with an average air temperature of 12.4°C for the operational period (Appendix C1). Based on twice-daily thermometer observations, water temperature in the Takotna River ranged from 6.0 to 17.0°C and averaged 11.4°C for the overall operational period (Appendix C1). Based on hourly data logger readings, daily average water temperature ranged from 5.9 to 16.7°C and averaged 11.8°C for the overall operational period (Appendix C2). Investigated on a daily basis, differences between the two methods were not great (Figure 14). Daily water temperature fluctuated considerably throughout the 2008 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 2008 were typical for this location (Figure 15).

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Investigations

From 18 July to 8 September 3,324 coho salmon were caught at the Kalskag fish wheels. Of those, 2,517 received anchor tags and 308 received radio tags. The Takotna River weir crew observed and recovered 11 tagged fish (0.4%) of the 2,825 fish tagged at Kalskag. Of those, 10 fish had anchor tags and 1 had a radio tag. The fixed tracking station at Takotna River weir detected 1 coho salmon. 571 coho salmon were examined for a cut adipose fin. None of those fish were observed to have the adipose fin cut and the tag missing.

Temperature Monitoring

Hobo® air and water temperature loggers were deployed on 22 July and pulled and/or downloaded on 9 October.

Juvenile Coho Salmon Collection

Approximately 50 juvenile coho salmon samples were collected at Takotna River in 2008. Information regarding collection, processing, and result can be obtained from Ruggerone (G. Ruggerone, Natural Resources Consultants, Inc., Seattle, WA).

Otolith Collection

A total of 24 chum salmon and 13 Chinook salmon otoliths were collected from the Takotna River weir in 2008. Information regarding the collection, processing and results can be obtained from Sutton and Harris (T. Sutton, UAF, Fairbanks; F. Harris, USFWS, Kenai).

DISCUSSION

ESCAPEMENT MONITORING

The reported Chinook, chum, coho, and sockeye salmon escapements in 2008 are considered accurate representations of annual escapements upstream of the Takotna River weir. Daily passage trends indicated few Chinook, chum, coho, or sockeye salmon passed the weir site before or after the target operational period, 24 June to 20 September (Table 1). Additionally, weir integrity was retained throughout the operational period.

Chinook Salmon

Abundance

The reported escapement of 413 fish is considered a reliable estimate of the annual Chinook salmon escapement upstream of the weir based on the early installation date and continuous weir operations in 2008. There were no Chinook salmon observed passing the weir for the 4 days prior to the target operational start date and the last fish was observed on 7 September (Appendix A1).

Although weir-based Chinook salmon escapement estimates (2000–2008) are considered accurate, direct comparisons between weir-derived escapement estimates and tower-derived escapement estimates from 1996 and 1997 are inadvisable. Molyneaux et al. (2000) recommended viewing the tower derived salmon passage estimates in 1996 and 1997 with a "healthy level of professional skepticism." This was a new project that was mostly staffed by high school students and had little oversight from a fishery professional. Furthermore, the extreme Chinook salmon escapement value determined for 1997 (Figure 16; Appendix D1) was not substantiated by more numerous and reliable weir-derived escapement values or other Kuskokwim River escapement monitoring projects. This concern about 1997 also discredits the value determined for 1996. Thus, historical comparisons in this report only involve weir-derived escapement data.

The reported escapement of 413 Chinook salmon at Takotna River weir in 2008 is within the historical range of weir-based escapements (316–723 fish) and is slightly below the historical average of 460 fish (Figure 16). In 2008, only 5 fewer fish were observed than in 2007. Takotna River weir was the only Kuskokwim River drainage ground-based escapement project that had similar escapements in 2007 and 2008. All others, except Tuluksak River weir reported a decline from 2007 to 2008 (Figure 16).

Escapement patterns at Takotna River weir have generally followed similar patterns of the entire Kuskokwim River drainage since weir operations began in 2000. Of the 4 tributaries in the Kuskokwim River drainage with established ground-based escapement goals, only Kogrukluk

River weir met its minimum goal (Williams et al. *In prep*). The Kuskokwim River Chinook salmon escapement index was lower than in 2002–2007, but it was higher than the low years in 1998–2000 (Figure 16). Overall the 2008 Kuskokwim River Chinook salmon escapement was characterized as average to below average (J. C. Linderman, Jr., Division of Commercial Fisheries Biologist, ADF&G, personal communication).

The commercial fishery harvest in 2008 likely had little impact on Takotna River or on other Kuskokwim River Chinook salmon stocks. When compared to the recent 10-year average (3,287 fish), the 2008 harvest (8,865 fish) seems large. However, in the past 10 years there have been very few commercial openings prior to the beginning of August, when coho salmon-directed commercial openings typically begin. The 2008 Chinook salmon harvest is considerably lower than the historical average of 25,058 fish (1960–2007). This difference in harvest sizes is an issue of processor capacity rather than abundance (J. C. Linderman, Jr., Division of Commercial Fisheries Biologist, ADF&G, personal communication).

In contrast with the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River Chinook salmon stocks was considerable. The total subsistence harvest for 2008 was not estimated at the time of this report. However, the annual subsistence harvest of Chinook salmon has remained relatively constant through history, despite varying abundance, so the most recent 10-year average (1997–2006) of 72,277 fish probably reasonably approximates the 2008 harvest (Smith and Dull 2008), although this estimate is preliminary. The subsistence harvest and the commercial harvest add to an approximate harvest of 80,000 in 2008.

Run Timing at Weir

Based on median passage dates, the timing of the 2008 Chinook salmon run at the Takotna River was the latest on record (Figure 3). Additionally, the first 25% of the run occurred approximately a week later than average. The central 50% passage occurred over an 11-day period and the central 80% occurred over a 26-day period, both of which are considered normal for the Takotna River weir. All other Kuskokwim River escapement monitoring projects exhibited late to record late run timing in 2008 (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; 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 is 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 9 years of paired Chinook escapement measures for both the Takotna and the Salmon River, but no correlation has been detected (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 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, as well as the weir remaining fish tight for the duration of its target operational period, indicated that annual chum salmon escapement to the Takotna River was accurately determined in 2008. Of salmon stocks that return to the Takotna River, none were observed passing the weir during the 4 days of operation prior to the target operational period (Appendix A1). The last chum salmon was observed on 21 September, followed by 2 full days of weir operation in which no chum salmon were observed.

All weir-based chum salmon escapement values (2000–2008) are considered accurate and reliable, however, 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; Appendix D2) the concern about tower operations and 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.

The reported escapement of 5,691 chum salmon is near the historical average of weir-derived escapements, which have ranged from a low of 1,254 in 2000 to a high of 12,598 in 2006 (Figure 18). Because formal escapement goals have not been established at the Takotna River weir, it is difficult to assess the adequacy of escapement. However, chum salmon escapements at Kogrukluk River weir were within the upper range of the escapement goal for that system (Williams et al. *In prep*) and exceeded the escapement goal range at Aniak River sonar (Figure 18; McEwen *In prep*).

Similar to Takotna River weir escapements, overall chum salmon escapements to Kuskokwim River tributaries have recovered from low levels in 2000 to record high levels in 2005–2007 and average to above average levels in 2008 (Figure 18). Prior to the poor chum salmon runs in 1999 and 2000, the 10-year average commercial harvest was 334,029 fish. Closure of the chum directed commercial fishery in 2001–2003 presumably helped restore runs to healthy levels, but poor market demand for Kuskokwim River chum salmon since the fishery was re-opened in 2004 has resulted in little harvest activity. The 2008 commercial harvest of 30,516 chum salmon was 27% below the most recent 10-year average (1998–2007) of 39,274 (Smith and Dull 2008). This level of harvest probably had little impact on Takotna River and Kuskokwim River stocks and is likely negligible when compared to the historical average of 197,285 fish (1960–2007) (J. C. Linderman Jr., Division of Commercial Fisheries Biologist, ADF&G, personal communication).

The total subsistence harvest for 2008 has not yet been estimated; however, the most recent 10-year average (1998–2007) of 53,823 fish (Smith and Dull 2008) probably reasonably approximates the 2008 harvest. This subsistence harvest and the relatively below average commercial harvest add to a combined harvest of less than 85,000 in 2008. Compared to the escapement of 144,107 fish observed across all Kuskokwim River weir projects combined (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*) and the 427,911 estimated in the Aniak River via sonar, (McEwen in prep) the total harvest of chum salmon probably did not negatively affect chum salmon stocks. These occurrences, combined with the fact that escapements were healthy in every monitored tributary, indicate there was a harvestable surplus of chum salmon in 2008. However, processing interest waned and subsistence users' needs were reduced at this time in the year (J. C. Linderman Jr., Division of Commercial Fisheries Biologist, ADF&G, personal communication).

Run Timing at Weir

Run timing of chum salmon in 2008 was slightly later than average, with a median passage date of 16 July (Figure 3). Historically, median passage dates at the Takotna River weir have occurred between 6 July (1996) and 18 July (2003; Costello et al. 2008) with the central 50% passage occurring over a 12-day period and central 80% occurring over a 21-day period. The chum salmon run in 2008 was similar in duration to previous years (Figure 3). All other Kuskokwim River ground-based escapement monitoring projects observed later than average median passage dates (Elison et al. *In prep*; McEwen *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

Coho Salmon

Abundance

The early installation date and absence of inoperable periods indicated that annual coho salmon escapement to the Takotna River was accurately determined in 2008. Only 24 fish were observed passing the weir over 3 days immediately following end of the target operational period, indicating that coho salmon passage after the target operational period was nominal.

All weir-based coho salmon escapement values for the Takotna River (2000–2008) 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. 2000). Thus, the coho salmon escapement information recorded in 1996 and 1997 is not valuable for historical comparisons.

The coho salmon escapement of 2,817 fish in 2008 was 29% below the 2000–2007 average of 3,943. Escapements have ranged from a low of 2,216 in 2005 to a high of 7,171 in 2003 (Figure 19). Escapement in 2008 cannot be measured against an escapement goal because one has not been formally adopted for Takotna River coho salmon.

Generally, Kuskokwim River coho salmon escapement was considered above average in 2008. The 2008 escapement at the Kogrukluk River weir was above the upper SEG boundary (Figure 19; Williams et al. *In prep*). However, there was considerable variation among projects in 2008. Four of the Kuskokwim River escapement projects reported escapements near their upper historical range (Elison et al *In prep*; Miller and Harper *In prep* a; Stewart et al. 2009; Williams et al. *In prep*), but Takotna and Tuluksak River weirs reported escapements near their lower historical range (Figure 19; Miller and Harper *In prep*). Regardless of spatial 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 was not subjected to the conservative management practices imposed on Chinook and chum salmon in the years following these low returns. Furthermore, coho salmon escapements in the Kuskokwim River have not exhibited periodic cycles of increase or decrease as have been observed with Chinook salmon (Figure 16).

The commercial harvest of 142,862 coho salmon in 2008 was 22% below the most recent 10-year average harvests of 195,875 (J. C. Linderman, Jr., Division of Commercial Fisheries Biologist, ADF&G, personal communication). Total inriver abundance estimates are not available for 2008, but results from a mark–recapture project indicated that, between 2001 and 2005, inriver abundance of coho salmon ranged from 386,743 (2004) to 928,075 (2003) fish (Pawluk et al. 2006). However, investigators are not confident in these abundance estimates and a study entitled *Kuskokwim River Coho Salmon Investigation* (2007–2008) will be addressing that concern through annual inriver abundance estimates (Toshihide Hamazaki, Division of Commercial Fisheries Biometrician, ADF&G, personal communication).

Estimates are not yet available for the 2008 harvest, but the preliminary 1998–2007 average harvest estimate of 30,894 fish (Smith and Dull 2008) is probably a reasonable approximation because annual subsistence harvests have not varied greatly in the past 10 years of available data. Compared to the commercial harvest, the subsistence harvest likely had a much smaller impact on tributary escapements.

Run Timing at Weir

Based on median passage dates, the timing of the coho salmon run at the Takotna River weir in 2008 (16 July) was among the latest on record (Figure 3). However, the run timing and overall pattern of daily passage has been markedly similar among the 8 years of enumeration data and much less variable than at other weir projects. Overall, Kuskokwim River coho salmon run timing was near average in 2008. Kogrukluk and Kwethluk River weirs had near average median passage dates, while Tuluksak, George, and Tatlawiksuk River weirs had earlier than average median passage dates (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

Sockeye Salmon

Abundance

Few sockeye salmon are observed in the Takotna River, and the reported escapement of 13 sockeye salmon is considered a reliable estimate of daily and total annual escapement in 2008. Although it is well below the record escapement of 60 fish observed in 2006 (Costello et al. 2007), the escapement of 13 sockeye salmon in 2008 still exceeded the escapements observed at this location between 2000 and 2003 and was only 1 less fish than observed in 2007 (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.

In 2008, escapements observed at Kwethluk and Kogrukluk River weirs were above average, but below the record escapements of 2005 and 2006 (Figure 20; Miller and Harper *In prep*; Williams et al. *In prep*). Sockeye salmon are not generally abundant in the Kuskokwim River and sockeye salmon are not prominent in subsistence and commercial harvests. Comparatively little is known about sockeye salmon in the Kuskokwim River. As a result, escapement goals do not exist for this species.

Sockeye salmon harvests correlate to Chinook and chum salmon harvests because they share similar run timing. Like Chinook salmon, the 2008 commercial sockeye harvest of 15,601 fish is an increase from the recent 10-year average of 13,318 fish (J. C. Linderman Jr., Division of Commercial Fisheries Biologist, ADF&G, personal communication). The actual effect of the combined pressure of subsistence and incidental commercial harvest on Kuskokwim River sockeye salmon is unknown. At time of writing, there are no subsistence harvest estimates for sockeye salmon in the Kuskokwim River for 2008; however, the recent 10-year average (1997–2006) of 37,077 fish is a reasonable estimate (Smith and Dull 2008). The combined harvest results in an estimate of approximately 49,000 harvested Kuskokwim River sockeye salmon. These harvest estimates can not be properly compared to weir abundance estimates because most monitored tributaries do not see large escapements of sockeye salmon (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

Run Timing at Weir

Historical run timing comparisons are limited by low overall abundance, but higher abundance between 2004 and 2008 make comparisons among these years possible. The timing of the sockeye salmon run in 2008 was later than in previous years based on median passage dates (Costello et al. 2008). 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

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). Pink salmon are rarely observed in the Takotna River. Only 2 have been observed since monitoring began here in 1995; one was observed in 2002 (Clark and Molyneaux 2003) and the other in 2006 (Costello et al. 2007).

Non-Salmon Species

Similar to previous years, small numbers of sheefish, Northern pike, and Arctic Grayling passed upstream sporadically throughout the season (Appendix A1). 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 675 fish during the target operational period in 2008 (Appendix A1) was considerably less than the historical average of 2,173 fish.

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 provide evidence for this: first, in years when the weir was operational before 24 June (2005, 2006, and 2008) longnose sucker passage before the target start date was much greater than the passage observed during the target operational period (Costello et al. 2006; Costello et al. 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.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

In 2008, the Takotna River weir crew sampled Chinook salmon opportunistically throughout the run and did not adhere to a strict pulse-sample protocol. The crew's intent to sample a fraction of escapement every day was very successful; sampling events and sample sizes mirrored the escapement curve quite well. As a result, the sample meets the objective confidence interval widths, indicating that our estimate was a good representation of the run.

Age Composition

In the limited number of years in which adequate ASL data has been gathered the dominate age class has been variable with no distinct pattern emerging. The pattern of age-1.3 Chinook salmon dominating the 2008 escapement was observed at all other escapement monitoring projects in the Kuskokwim River drainage (Molyneaux et al. *In prep*) indicating that this was a widespread occurrence. The 2007 escapement was dominated by age-1.2 fish (Costello et al. 2007) and sibling relationships suggest a relatively strong return of the age-1.4 siblings in 2009. The abundance of age-1.2 Chinook salmon was relatively low compared to 2006 and 2007 (Costello et al. 2007; Costello et al. 2008) in the Takotna River (Figure 21), as it was at most other escapement monitoring projects in 2008 (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

Brood tables provide the tools to investigate potential cohort survival and the number of returns-per-spawners. The lack of harvest data on Takotna River salmon prevent the ability to estimate the true R/S values and are therefore considered relative. Appendix E1 is a brood table for Chinook salmon generated from the available Takotna River data. Preliminary relative returns-per-spawner (R/S) can be determined for the 2001 and 2002 brood years, although 2001 does not account for 3-year-old fish and 2002 does not account for 7-year-old fish because data are unavailable. These 2 age classes typically constitute a negligible proportion of the run so the estimated 0.45 relative R/S from 2001 and 1.49 relative R/S from 2002 can be considered reasonable indices. With more years of escapement data and the possible analysis of the stock composition of the harvest, we may be able to complete this analysis and draw meaningful conclusions on stock specific exploitation and spawner-recruit relationships.

Intra-annual trends in age class percentages tend to be variable and observed trends are typically unclear; although age composition of the Chinook salmon escapement changed as the 2008 run progressed upstream of the Takotna River weir (Table 2). In comparing the 3 temporal strata, there was no clear trend in the percentage of age-1.2 and age-1.3 fish as the season advanced, but the percentage of age-1.4 fish continually increased over time.

Sex Composition

At 24.6%, the percentage of female Chinook salmon at Takotna River weir was about average and nearly double the percent contribution and abundance of females observed in 2007 (Table 2; Figure 22). Elsewhere in the Kuskokwim River drainage in 2008, while abundances tended to be below average, percentages of female Chinook salmon were generally above average with the exception of Kogrukluk and George River weirs (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*). Most of the female Chinook salmon passed upstream of the Takotna River weir during the final two thirds 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. 2008).

Sex composition of 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 every Chinook salmon observed passing upstream of the weir during passage counts using methods described above. The crew initiated this procedure in 2005 (Costello et al. 2006) and have continued it through 2008. The percent female as determined visually was only 3.6% higher than determined through ASL sampling, furthermore the value determined visually falls within the 95% confidence interval bounds of the percent females determined through ASL sampling (Figure 6).

Length Composition

Mean lengths for each age-sex category in 2008 were similar to past years (Figure 23) including the tendency for female Chinook salmon to be longer than males of the same age (Figure 7) a common pattern throughout the Kuskokwim River drainage (Molyneaux et al. 2008). A low sample size of age-1.3 females and age-1.4 males limits trend analysis; however mean length tended to increase with age (Figure 7). The length of fish in each age-sex category did not change appreciably as the 2008 season progressed (Figure 8), which is typical for Chinook salmon at Takotna River weir and elsewhere in the Kuskokwim River drainage (Molyneaux et al. 2008).

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 size selective harvest is perhaps most consequential to Chinook salmon because of their wide range of sizes at maturity.

Subsistence fishermen tend to favor using gillnets of large mesh web (e.g., 8-inch stretch mesh; Smith and Dull 2008), so their harvest is selective for larger and older Chinook salmon. This is the same segment of the population in which females are most common (Molyneaux et al. 2008). Timing of 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 timing tends to be broad for Chinook salmon (Pawluk et al. 2006; K. L. Schaberg, Commercial Fishery Biologist, ADF&G, 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 2002–2005 (Molyneaux and Brannian 2006).

In contrast, commercial fishermen are usually 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. 2008). 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 rates 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 selectivity of harvest influences the resulting age, sex, and length composition in the escapement. Most of the Chinook salmon harvest in 2008 occurred in the subsistence fishery. The size selection of the prevalent subsistence harvest practices, in concert with the relatively high exploitation rate of the subsistence fishery, may have increased both the prevalence of smaller male Chinook salmon and the scarcity of larger fish and females in the escapement. This may have amplified the high proportion of young male to older female Chinook salmon observed in the Kuskokwim River drainage. While this trend was not apparent at Takotna River it was apparent at Kogrukluk River, which is likely a better indicator of overall Chinook salmon escapement in the Kuskokwim River drainage (J. C. Linderman Jr., Kuskokwim Division of Commercial Fisheries Biologist, ADF&G, personal communication).

Chum Salmon

The ASL data collected from chum salmon in 2008 were adequate for describing annual age, sex, and length composition for the total escapement within the desired confidence interval widths. 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 9 years the weir project has operated.

Age Composition

Chum salmon passing upstream of the weir were mostly age-0.3 and -0.4 accounting for 32.4% and 61.3%, respectively of the total escapement past the weir (Table 4). These percentages were the inverse the historical average where age-0.3 fish comprised nearly 60% of total escapement (Figure 9). The abundance of age-0.3 fish was below average while the abundance of age-0.4 fish was three times greater than average (Figure 21). This pattern was common to all projects in 2008, but has historically been uncommon within the Kuskokwim drainage (Molyneaux et al. *In prep*).

Age composition of the chum salmon escapement varied considerably as the 2008 run progressed upstream of the Takotna River weir. Age-0.3 fish continually increased throughout the run while age-0.4 fish continually decreased, which is a consistent trend that commonly occurs in the Takotna River (Table 4; Figure 9) and elsewhere in the Kuskokwim drainage (Molyneaux et al. 2008). However, age-0.4 remained the dominant component, even at their lowest abundance (Table 4).

Appendix E2 is a brood table for chum salmon generated from the available Takotna River data. Consistent ASL sampling effort has allowed calculation of return for all brood years between 1997 and 2002. However, as discussed above, escapements from 1997 are questionable, so the relative R/S can only be reliably calculated for 2000–2002 (Molyneaux et al. 2000; Appendix E2). The relative R/S has ranged from 0.84 for the 2000 brood year to 2.69 for the 2002 brood year. Unfortunately, it difficult to determine with confidence whether total returns in subsequent years were higher or lower than expected.

Sex Composition

At 49.7% (Table 4), the percentage of female chum salmon at the Takotna River weir was near average (Figure 22). Female contribution varied considerably between projects, but nearly every project reported percentages near their respective historical average (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*). Compared to Chinook salmon, sex composition among chum salmon tends to vary little spatially and historically (Molyneaux et al. 2008).

At the Takotna River weir, stratified sampling revealed temporal changes in sex composition during the run with a continual increase of percent female from 32.8% in the first stratum to 53.4% in the final stratum. This trend was common at other Kuskokwim River monitoring projects, however it did not hold true at the Kogrukluk and Kwethluk River weirs (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*). In some past years at the Takotna River, as well as other Kuskokwim River projects, the percentage of female chum salmon has increased consistently during the run; though observed throughout the Kuskokwim River drainage, this trend does not appear frequently enough to be considered the norm (Molyneaux et al. *In prep*).

Similar to Chinook salmon, sex of all chum salmon passing the Takotna River weir during passage counts were visually determined in order to assess potential biases in ASL sampling methods. The percent female as determined visually was only 1% lower than determined through ASL sampling. Furthermore the value determined visually falls within the 95% confidence interval bounds of the percent females determined through ASL sampling (Figure 6).

Length Composition

Chum salmon lengths within each age-sex class widely overlapped, but sample sizes of the age-sex classes were large enough to distinguish trends (Table 5). Mean length of males was longer than females in all age classes, which is a common trend in the Kuskokwim Area (Figure 7; Molyneaux et al. 2008). Mean length in all age-sex classes were below the historical average at Takotna River weir (Figure 24). This has been a general trend at all escapement projects since 2002 or 2003 (depending on age) and continued in 2008 (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

Coho Salmon

The ASL data collected from coho salmon in 2008 were adequate for describing age, sex, and length composition for the total annual escapement within the desired confidence interval widths. Sampling pulses were well distributed over the course of the run. ASL composition has been estimated in all 9 years the weir project has operated.

Age Composition

Kuskokwim River coho salmon are predominantly age-2.1 fish. At the Takotna River weir in 2008 age-2.1 coho salmon comprised 76.8% of the total run, whereas age-3.1 comprised 21.0% 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. The abundance of age-2.1 fish in 2008 was below average, but well within the historical range (Figure 21), while their percent contribution was the lowest on record for this project (Figure 11). Age-3.1 fish on the other hand exhibited above average abundance and their percent contribution in 2008 was higher than any other year on record (Figure 11). Since total annual escapement is largely comprised of age-2.1 fish (Figure 21), the moderate abundance of this age class in 2008 equated to moderate overall escapement. The trend of lower than average contribution of age-2.1 coho salmon and higher than average contribution of age-3.1 fish was consistent throughout the Kuskokwim River drainage (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

Sibling relationships have limited utility when applied to coho salmon. First, most coho salmon return as 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 21).

Appendix E3 is a brood table for coho salmon generated from the available Takotna River data. Consistent ASL sampling effort has allowed calculation of return for all brood years between 1997 and 2003. However, of these brood years, relative R/S can only be calculated for 2000–2003 because coho salmon escapement was not monitored in years prior (Molyneaux et al. 2000). The relative R/S has ranged from 0.48 for the 2003 brood year to 1.34 for the 2002 brood year (Appendix E3).

Sex Composition

At 51.4% (Table 6), the percentage of female coho salmon at the Takotna River weir was the fourth highest on record and only slightly below 2007 (Figure 21; Costello et al. 2008). Female percentages varied among projects, but all projects except the Tuluksak River weir had above average percentages of females (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*). Compared to Chinook salmon, sex composition among coho salmon tends to vary little spatially and historically.

Stratified sampling revealed slight changes in sex composition during the coho salmon run at the Takotna River weir. In 2008, the percentage of female coho salmon increased continually from 45.9% in the first stratum to 57.5% in the last (Figure 5), a trend that is historically consistent at this location and with most other projects in 2008 (Molyneaux et al. *In prep*). However, this trend has not occurred often enough throughout the Kuskokwim River drainage to be considered common. The percentage of female coho salmon is usually higher in the last stratum than in the first, but percentages tend to vary widely.

The percent female as determined visually was less than 1% lower than determined through ASL sampling. Furthermore, the value determined visually falls within the 95% confidence interval bounds of the percent females determined through ASL sampling (Figure 6).

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 25). Mean lengths for both female and male coho salmon in 2008 were only slightly below their historical averages and well within the range reported in previous years (Figure 25). In 2008 females were longer, on average, than males (Figure 7). Among Takotna River coho salmon, the mean length of females has exceeded that of males every year that data have been collected. 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 (Elison et al. *In prep*; Miller and Harper *In prep* a; Miller and Harper *In prep* b; Stewart et al. 2009; Williams et al. *In prep*).

TTC High School Internship Program

These internships benefit both students and the project that host them. Interns gain exposure to fisheries monitoring projects and the employment opportunities associated with them. The projects gain a much needed level of community involvement, which the authors believe contributes to continued local support of the research and management structure that they support.

WEATHER AND STREAM OBSERVATIONS

Water level at Takotna River was high during the first month of operation and average to below average for the last two months. The water level was at a record high during the start of the target operational period. About one week later a rain event caused the river to rise dramatically to the season peak of 121 cm on 1 July. The water level then followed a general decline to below average levels late in the season (Figure 13).

Water temperature was inversely related to water level and varied greatly early in the season. Temperatures started out below the historical average and dropped to the early season minimum of 9° C on 1 July, the same day as the peak high water level. With decreasing water levels and season high air temperatures, the water temperature rose to a season maximum of 15.5° C on 7 July (Figure 15). Temperatures were then average through late July and early August. Although they decreased through late August and into September, they were above the historical maximum for much of that period. This period corresponded to seasonally low water levels.

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Investigations

At the time of publication, the mark–recapture study is still in progress and the development of the model required for a comprehensive run reconstruction is ongoing. Results and discussion of success will be reported upon completion (K. L. Schaberg, Commercial Fishery Biologist, ADF&G, personal communication).

CONCLUSIONS

CHINOOK SALMON

- The escapement of 413 Chinook salmon in 2008 was slightly below the historical average at Takotna River weir.
- The dominate age class in the Chinook salmon escapement at Takotna River weir has varied historically. In 2008 the Chinook salmon escapement was dominated by age-1.3 fish (52%), followed by age-1.4 (25%) and age-1.2 fish (22%).
- Females comprised only 25% of the total Chinook salmon escapement in 2008, which is typical for Takotna River weir escapements.
- The Chinook salmon run in 2008 was later than all previous years.

CHUM SALMON

- The escapement of 5,691 chum salmon in 2008 is near the historical average at Takotna River weir.
- The chum salmon run timing in 2008 was slightly later than average.
- The abundance of age-0.4 chum salmon was almost three times higher than average, while the abundance of age-0.3 fish was near average.

COHO SALMON

- The escapement of 2,817 coho salmon in 2008 was below the historical average at Takotna River weir.
- Age-3.1 fish exhibited above average abundance and their percent contribution in 2008 was higher than any other year on record.

ACKNOWLEDGMENTS

The Takotna River salmon escapement monitoring program is a cooperative project operated jointly by TTC and ADF&G Division of Commercial Fisheries. The USFWS Office of Subsistence Management (OSM) provided funding support for this project, through the Fisheries Resource Monitoring Program under FWS Agreement Number 701818J690. Matching support for this grant was provided by the State of Alaska and Coastal Villages Region Fund. USFWS OSM Resource Monitoring Program under FWS Agreement Number 701817J646 funded project FIS 07-303, which supported salmon age, sex, and length data analysis for this project among others.

Many individuals have contributed to the development and operation of the Takotna River weir. Carole Absher assisted with administrative needs and we thank her for her support and participation. We would also like to thank McGrath Native Village Council for providing assistance during weir installation and dismantling. Our greatest appreciation goes to ADF&G crew leader Clinton Goods, TTC crew leader Amanda Goods, to TTC assistant crew leader Charlie Vanborg, and to TTC crew member Emanual Martinez (temporary) for their continued diligence and dedication to the project. We would also like to thank student interns Alfred Perkins, Robert Perkins, Rosalie Perkins, Tyler Goods, and Adam Mckee for their assistance throughout the 2008 field season. This project would not be possible without these members of the Takotna community.

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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, 2008.

	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
6/20 [a]	0			0			0			0		
6/21 [a]	0			0			0			0		
6/22 [a]	0			0			0			0		
6/23 [a]	0			0			0			0		
6/24	0	0	0	9	9	0	0	0	0	0	0	0
6/25	1	1	0	12	21	0	0	0	0	0	0	0
6/26	0	1	0	7	28	0	0	0	0	0	0	0
6/27	1	2	0	26	54	1	0	0	0	0	0	0
6/28	1	3	1	19	73	1	0	0	0	0	0	0
6/29	0	3	1	20	93	2	0	0	0	0	0	0
6/30	7	10	2	32	125	2	0	0	0	0	0	0
7/01	5	15	4	36	161	3	0	0	0	0	0	0
7/02	3	18	4	41	202	4	0	0	0	0	0	0
7/03	5	23	6	104	306	5	0	0	0	0	0	0
7/04	5	28	7	109	415	7	0	0	0	0	0	0
7/05	5	33	8	111	526	9	0	0	0	0	0	0
7/06	2	35	8	179	705	12	0	0	0	0	0	0
7/07	11	46	11	155	860	15	0	0	0	0	0	0
7/08	10	56	14	191	1,051	18	0	0	0	0	0	0
7/09	7	63	15	175	1,226	22	0	0	0	0	0	0
7/10	4	67	16	160	1,386	24	0	0	0	0	0	0
7/11	3	70	17	182	1,568	28	0	0	0	0	0	0
7/12	3	73	18	279	1,847	32	0	0	0	0	0	0
7/13	10	83	20	210	2,057	36	0	0	0	0	0	0
7/14	3	86	21	221	2,278	40	0	0	0	0	0	0
7/15	10	96	23	266	2,544	45	0	0	0	0	0	0
7/16	10	106	26	289	2,833	50	0	0	0	0	0	0
7/17	12	118	29	242	3,075	54	0	0	0	0	0	0
7/18	10	128	31	277	3,352	59	0	0	0	0	0	0
7/19	5	133	32	229	3,581	63	0	0	0	0	0	0
7/20	14	147	36	193	3,774	66	0	0	0	0	0	0
7/21	23	170	41	276	4,050	71	0	0	0	1	1	8
7/22	40	210	51	232	4,282	75	0	0	0	0	1	8
7/23	30	240	58	190	4,472	79	0	0	0	0	1	8
7/24	32	272	66	110	4,582	81	0	0	0	0	1	8
7/25	35	307	74	125	4,707	83	0	0	0	0	1	8
7/26	9	316	77	121	4,828	85	0	0	0	1	2	15
7/27	4	320	77	96	4,924	87	0	0	0	0	2	15
7/28	18	338	82	123	5,047	89	0	0	0	0	2	15
7/29	11	349	85	95	5,142	90	0	0	0	0	2	15
7/30	10	359	87	63	5,205	91	0	0	0	1	3	23
7/31	4	363	88	54	5,259	92	1	1	0	0	3	23

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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
8/01	8	371	90	51	5,310	93	1	2	0	1	4	31
8/02	6	377	91	62	5,372	94	1	3	0	0	4	31
8/03	7	384	93	36	5,408	95	3	6	0	0	4	31
8/04	4	388	94	45	5,453	96	3	9	0	0	4	31
8/05	2	390	94	40	5,493	97	2	11	0	0	4	31
8/06	4	394	95	37	5,530	97	3	14	0	1	5	38
8/07	5	399	97	28	5,558	98	4	18	1	0	5	38
8/08	1	400	97	20	5,578	98	15	33	1	1	6	46
8/09	2	402	97	18	5,596	98	7	40	1	0	6	46
8/10	1	403	98	15	5,611	99	11	51	2	0	6	46
8/11	2	405	98	4	5,615	99	14	65	2	0	6	46
8/12	2	407	99	7	5,622	99	12	77	3	0	6	46
8/13	1	408	99	6	5,628	99	16	93	3	0	6	46
8/14	0	408	99	8	5,636	99	23	116	4	0	6	46
8/15	1	409	99	5	5,641	99	23	139	5	0	6	46
8/16	0	409	99	5	5,646	99	42	181	6	0	6	46
8/17	0	409	99	6	5,652	99	74	255	9	0	6	46
8/18	1	410	99	5	5,657	99	69	324	12	0	6	46
8/19	0	410	99	6	5,663	100	120	444	16	1	7	54
8/20	1	411	100	3	5,666	100	58	502	18	1	8	62
8/21	1	412	100	5	5,671	100	95	597	21	0	8	62
8/22	0	412	100	9	5,680	100	147	744	26	0	8	62
8/23	0	412	100	1	5,681	100	52	796	28	0	8	62
8/24	0	412	100	3	5,684	100	84	880	31	1	9	69
8/25	0	412	100	2	5,686	100	82	962	34	1	10	77
8/26	0	412	100	0	5,686	100	102	1,064	38	0	10	77
8/27	0	412	100	0	5,686	100	207	1,271	45	0	10	77
8/28	0	412	100	0	5,686	100	149	1,420	50	0	10	77
8/29	0	412	100	0	5,686	100	82	1,502	53	1	11	85
8/30	0	412	100	0	5,686	100	46	1,548	55	0	11	85
8/31	0	412	100	0	5,686	100	147	1,695	60	0	11	85
9/01	0	412	100	0	5,686	100	52	1,747	62	0	11	85
9/02	0	412	100	0	5,686	100	98	1,845	65	0	11	85
9/03	0	412	100	1	5,687	100	128	1,973	70	0	11	85
9/04	0	412	100	0	5,687	100	88	2,061	73	0	11	85
9/05	0	412	100	1	5,688	100	93	2,154	76	2	13	100
9/06	0	412	100	0	5,688	100	56	2,210	78	0	13	100
9/07	1	413	100	0	5,688	100	66	2,276	81	0	13	100
9/08	0	413	100	0	5,688	100	71	2,347	83	0	13	100
9/09	0	413	100	0	5,688	100	51	2,398	85	0	13	100
9/10	0	413	100	1	5,689	100	28	2,426	86	0	13	100
9/11	0	413	100	0	5,689	100	46	2,472	88	0	13	100
9/12	0	413	100	0	5,689	100	37	2,509	89	0	13	100
9/13	0	413	100	0	5,689	100	40	2,549	90	0	13	100
9/14	0	413	100	0	5,689	100	69	2,618	93	0	13	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
9/15	0	413	100	0	5,689	100	46	2,664	95	0	13	100
9/16	0	413	100	1	5,690	100	23	2,687	95	0	13	100
9/17	0	413	100	0	5,690	100	23	2,710	96	0	13	100
9/18	0	413	100	0	5,690	100	37	2,747	98	0	13	100
9/19	0	413	100	0	5,690	100	48	2,795	99	0	13	100
9/20	0	413	100	1	5,691	100	22	2,817	100	0	13	100

Note: Outside boxes indicate the estimated central 50% of passage. Inside boxes indicate the date that the estimated cumulative 50% passage occurred.

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

Table 2.–Age and sex composition of Takotna River Chinook salmon in 2008 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sample Size	Sex	1.1 Esc.	1.1 %	1.2 Esc.	1.2 %	1.3 Esc.	1.3 %	2.2 Esc.	2.2 %	1.4 Esc.	1.4 %	2.3 Esc.	2.3 %	1.5 Esc.	1.5 %	2.4 Esc.	2.4 %	Total Esc.	Total %
6/30-7/19	83	M	0	0.0	40	30.1	72	54.2	0	0.0	3	2.4	0	0.0	2	1.2	0	0.0	117	88.0
(6/24-7/19)		F	0	0.0	0	0.0	5	3.6	0	0.0	10	7.2	2	1.2	0	0.0	0	0.0	16	12.0
		Subtotal[a]	0	0.0	40	30.1	77	57.8	0	0.0	13	9.6	2	1.2	2	1.2	0	0.0	133	100.0
7/20-24	47	M	0	0.0	21	14.9	62	44.7	0	0.0	12	8.5	0	0.0	0	0.0	0	0.0	95	68.1
(7/20-24)		F	0	0.0	0	0.0	18	12.7	0	0.0	26	19.2	0	0.0	0	0.0	0	0.0	44	31.9
		Subtotal[a]	0	0.0	21	14.9	80	57.4	0	0.0	38	27.7	0	0.0	0	0.0	0	0.0	139	100.0
7/25-8/3	24	M	0	0.0	29	20.8	53	37.5	0	0.0	18	12.5	0	0.0	0	0.0	0	0.0	100	70.8
(7/25-9/20)		F	0	0.0	0	0.0	6	4.2	0	0.0	35	25.0	0	0.0	0	0.0	0	0.0	41	29.2
		Subtotal[a]	0	0.0	29	20.8	59	41.7	0	0.0	53	37.5	0	0.0	0	0.0	0	0.0	141	100.0
Season[b]	154	M	0	0.0	90	21.8	187	45.3	0	0.0	33	7.9	0	0.0	2	0.4	0	0.0	311	75.4
		F	0	0.0	0	0.0	29	6.9	0	0.0	71	17.3	2	0.4	0	0.0	0	0.0	102	24.6
		Total	0	0.0	90	21.8	216	52.2	0	0.0	104	25.2	2	0.4	2	0.4	0	0.0	413	100.0
		95% C. I.				(±6.2)		(±7.7)				(±7.2)		(±0.4)		(±0.4)				

Note: Sample sizes for each age-sex class are provided in Table 3.

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

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

Table 3.–Mean length (mm) of Chinook salmon at the Takotna River weir in 2008 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.2	1.3	2.2	1.4	2.3	1.5
6/30-7/19	M	Mean Length	533	668		739		677
(6/24-7/19)		SE	7	8		5		
		Range	475-635	560-788		734-744		677-677
		Sample Size	25	45	0	2	0	1
	F	Mean Length		761		874	731	
		SE		36		17		
		Range		690-810		822-922	731-731	
		Sample Size	0	3	0	6	1	0
7/20-24	M	Mean Length	587	714		795		
(7/20-24)		SE	17	13		9		
		Range	533-652	589-833		773-812		
		Sample Size	7	21	0	4	0	0
	F	Mean Length		756		856		
		SE		22		24		
		Range		712-859		705-927		
		Sample Size	0	6	0	9	0	0
7/25-8/3	M	Mean Length	508	707		702		
(7/25-9/20)		SE	9	28		33		
		Range	484-534	510-798		643-758		
		Sample Size	5	9	0	3	0	0
	F	Mean Length		736		853		
		SE		-		28		
		Range		736-736		765-950		
		Sample Size	0	1	0	6	0	0
Season[a]	M	Mean Length	537	694		739		677
		SE[b]	5	8		17		
		Range	475-652	510-833		643-812		677-677
		Sample Size	37	75	0	9	0	1
	F	Mean Length		753		857	731	
		SE[b]				15		
		Range		690-859		705-950	731-731	
		Sample Size	0	10	0	21	1	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.

[b] Standard error was not calculated for small samples.

Table 4.–Age and sex composition of Takotna River chum salmon in 2008 based on escapement samples collected at the weir.

			Age Class									
			0.2		0.3		0.4		0.5		Total	
Sample Dates (Stratum Dates)	Sample Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
6/30-7/4	125	M	0	0.0	68	9.6	384	54.5	22	3.2	474	67.2
(6/15-7/6)		F	0	0.0	11	1.6	203	28.8	17	2.4	231	32.8
		Subtotal[a]	0	0.0	79	11.2	587	83.2	39	5.6	705	100.0
7/7-11	99	M	0	0.0	87	10.1	340	39.4	26	3.0	453	52.5
(7/7-11)		F	0	0.0	87	10.1	288	33.3	35	4.1	410	47.5
		Subtotal[a]	0	0.0	174	20.2	628	72.7	61	7.1	863	100.0
7/13-18	199	M	0	0.0	243	12.1	617	30.7	91	4.5	951	47.2
(7/12-19)		F	0	0.0	425	21.1	577	28.6	61	3.0	1,062	52.8
		Subtotal[a]	0	0.0	668	33.2	1,194	59.3	152	7.5	2,013	100.0
7/20-24,26,28-8/1	178	M	0	0.0	415	19.7	545	25.8	24	1.1	984	46.6
(7/20-9/20)		F	0	0.0	510	24.1	534	25.3	83	4.0	1,126	53.4
		Subtotal[a]	0	0.0	925	43.8	1,079	51.1	107	5.1	2,110	100.0
Season[b]	601	M	0	0.0	813	14.3	1,886	33.2	163	2.9	2,862	50.3
		F	0	0.0	1,033	18.1	1,601	28.1	196	3.4	2,829	49.7
		Total	0	0.0	1,846	32.4	3,487	61.3	359	6.3	5,691	100.0
		95% C. I.				(±3.6)		(±3.8)		(±1.9)		

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

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

Table 5.–Length summary for: Takotna River chum salmon, 2008

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
6/30-7/4	M	Mean Length		561	576	584
(6/15-7/6)		SE		9	4	13
		Range		497-609	478-674	559-609
		Sample Size	0	12	68	4
	F	Mean Length		519	555	554
		SE		19	4	15
		Range		500-537	490-600	525-577
		Sample Size	0	2	36	3
7/7-11	M	Mean Length		569	579	592
(7/7-11)		SE		6	5	9
		Range		525-587	504-689	574-603
		Sample Size	0	10	39	3
	F	Mean Length		551	555	583
		SE		7	4	8
		Range		519-590	514-592	562-596
		Sample Size	0	10	33	4
7/13-18	M	Mean Length		556	567	565
(7/12-19)		SE		7	4	9
		Range		480-614	490-635	510-604
		Sample Size	0	24	61	9
	F	Mean Length		535	541	546
		SE		3	3	11
		Range		493-590	472-626	507-587
		Sample Size	0	42	57	6
7/20-24,26,28-8/1	M	Mean Length		548	557	599
(7/20-9/20)		SE		4	4	17
		Range		493-618	495-609	582-615
		Sample Size	0	35	46	2
	F	Mean Length		517	536	530
		SE		4	4	10
		Range		457-557	490-597	490-556
		Sample Size	0	43	45	7
Season[a]	M	Mean Length		554	568	577
		SE		3	2	6
		Range		480-618	478-689	510-615
		Sample Size	0	81	214	18
	F	Mean Length		527	544	547
		SE		2	2	6
		Range		457-590	472-626	490-596
		Sample Size	0	97	171	20

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 coho salmon at the Takotna River weir in 2008 based on escapement samples collected with a live trap.

			Age Class							
			1.1		2.1		3.1		Total	
Sample Dates (Stratum Dates)	Sample Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%
8/15-22	181	M	9	1.1	352	44.2	70	8.9	431	54.1
(6/24-8/23)		F	4	0.6	308	38.7	53	6.6	365	45.9
		Subtotal[a]	13	1.7	660	82.9	123	15.5	796	100.0
8/25-30	113	M	7	0.9	246	32.7	146	19.5	399	53.1
(8/24-30)		F	6	0.9	266	35.4	80	10.6	353	46.9
		Subtotal[a]	13	1.8	512	68.1	226	30.1	752	100.0
8/31-9/3,5-7	146	M	18	1.4	435	34.3	87	6.9	539	42.5
(8/31-9/20)		F	17	1.3	556	43.8	156	12.3	730	57.5
		Subtotal[a]	35	2.7	991	78.1	243	19.2	1,269	100.0
Season[b]	440	M	33	1.2	1,033	36.7	304	10.8	1,369	48.6
		F	28	1.0	1,130	40.1	289	10.2	1,448	51.4
		Total	61	2.2	2,163	76.8	593	21.0	2,817	100.0
		95% C. I.		(±1.4)		(±3.8)		(±3.7)		

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

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

Table 7.–Mean length (mm) of coho salmon at the Takotna River weir in 2008 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	3.1
8/15-22 (6/24-8/23)	M	Mean Length	507	527	522
		SE	55	4	11
		Range	452- 561	444- 610	439- 575
		Sample Size	2	80	16
	F	Mean Length	532	533	530
		SE	-	3	7
		Range	532- 532	419- 584	475- 562
		Sample Size	1	70	12
8/25-30 (8/24-30)	M	Mean Length	432	533	529
		SE	-	7	9
		Range	432- 432	429- 628	456- 609
		Sample Size	1	37	22
	F	Mean Length	492	541	537
		SE	-	5	8
		Range	492- 492	490- 609	496- 570
		Sample Size	1	40	12
8/31-9/3,5-7 (8/31-9/20)	M	Mean Length	567	528	513
		SE	31	5	11
		Range	536- 598	445- 599	465- 563
		Sample Size	2	50	10
	F	Mean Length	573	540	545
		SE	12	3	5
		Range	561- 584	455- 597	503- 579
		Sample Size	2	64	18
Season[a]	M	Mean Length	523	529	523
		SE[b]		3	5
		Range	432- 598	429- 628	439- 609
		Sample Size	5	167	48
	F	Mean Length	547	539	540
		SE[b]		2	3
		Range	492- 584	419- 609	475- 579
		Sample Size	4	174	42

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.

[b] Standard error not calculated for small samples.

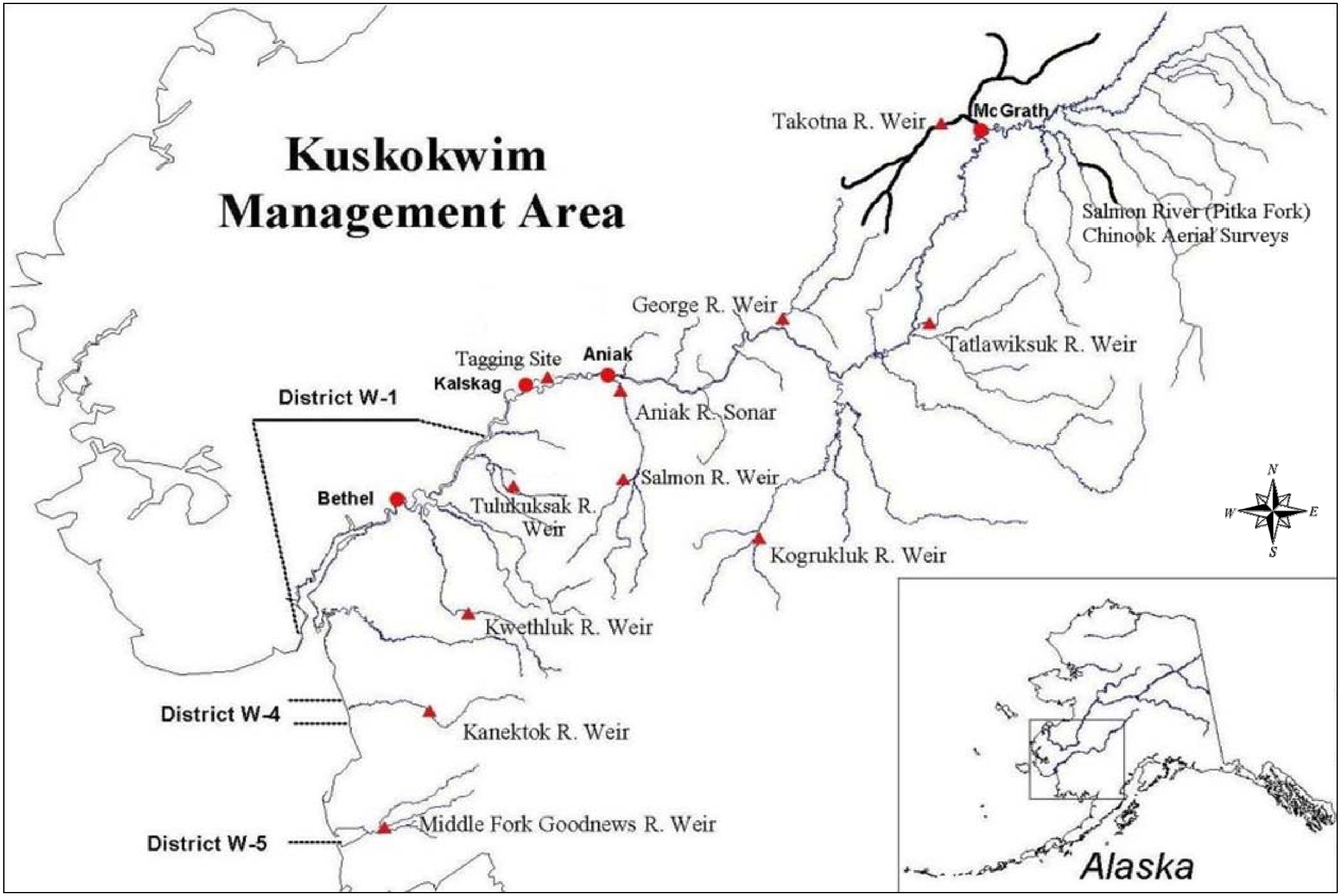


Figure 1.–Map depicting the location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Takotna River and Salmon River of the Pitka Fork.

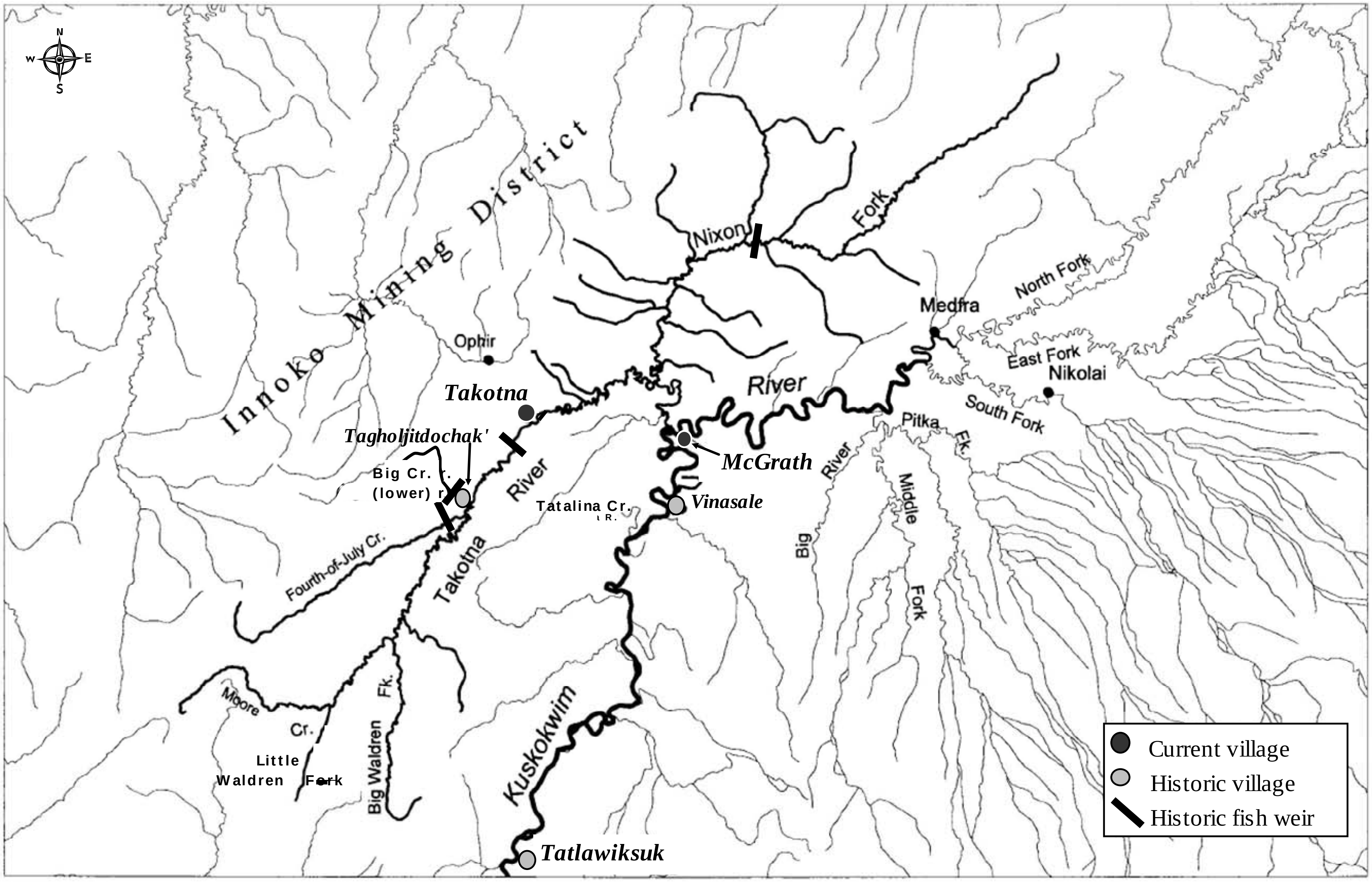
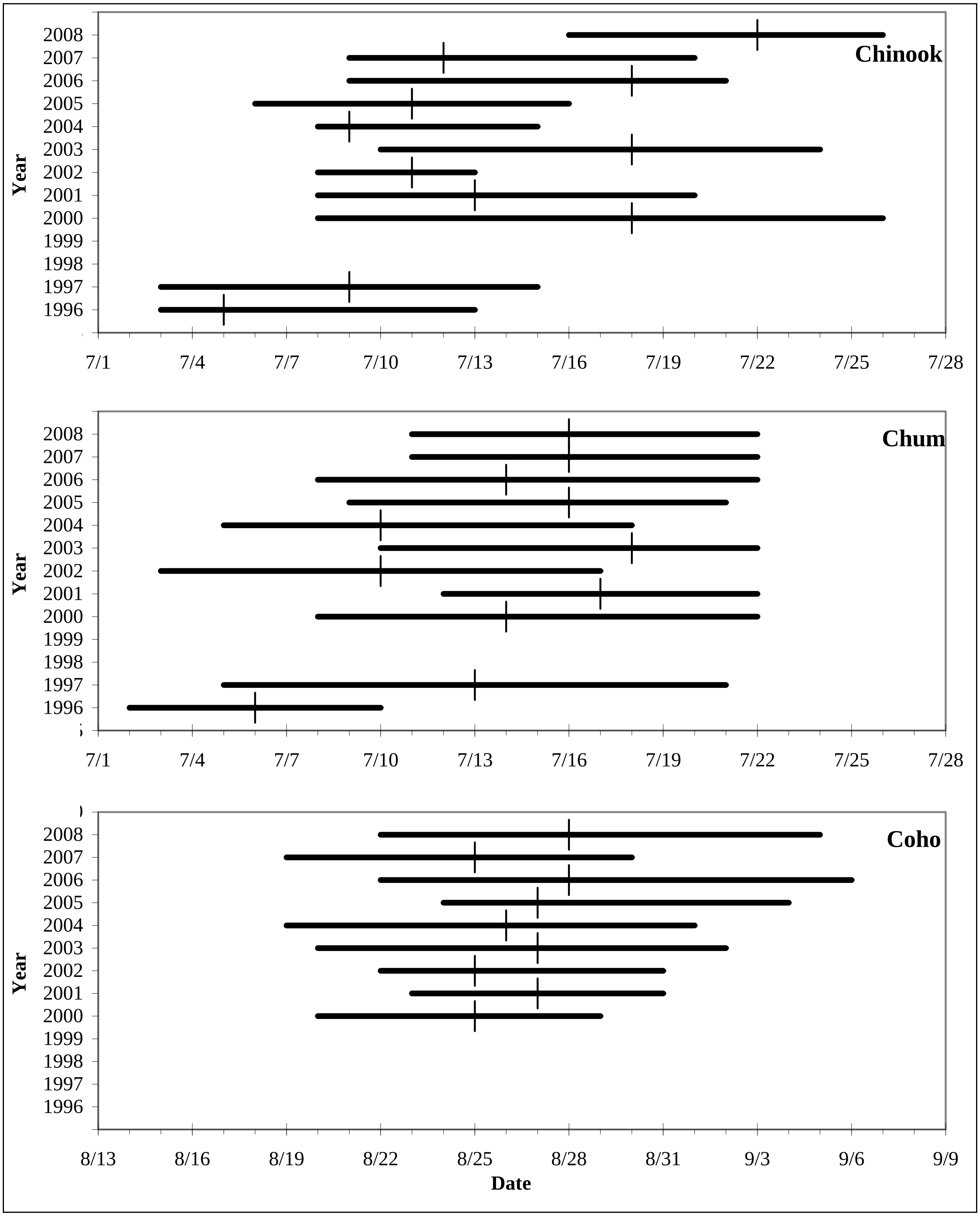


Figure 2.–Takotna River drainage and the location of historic native communities and fish weirs.



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.

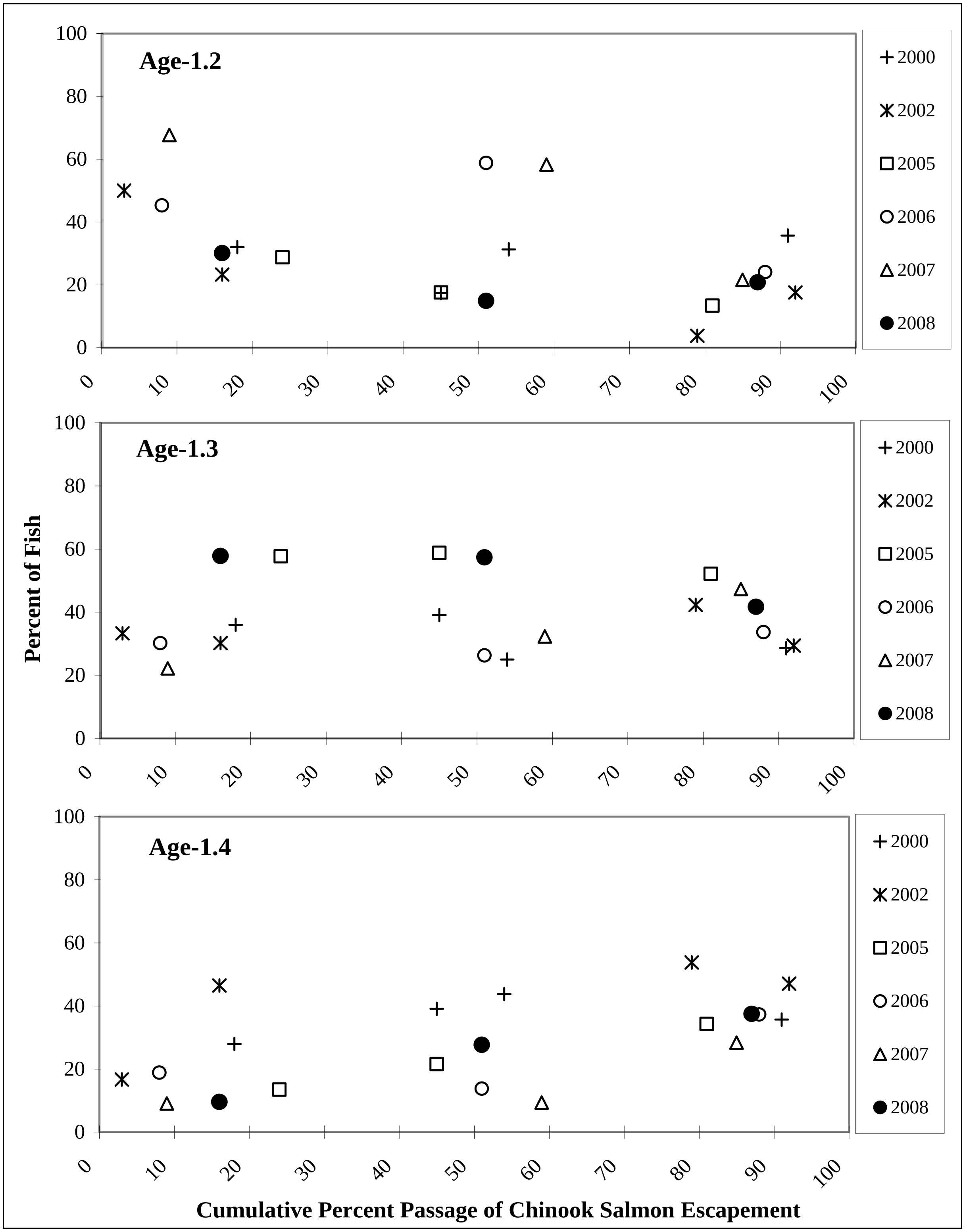


Figure 4.–Age composition of Takotna River Chinook salmon by cumulative percent passage through the weir, 2000–2008.

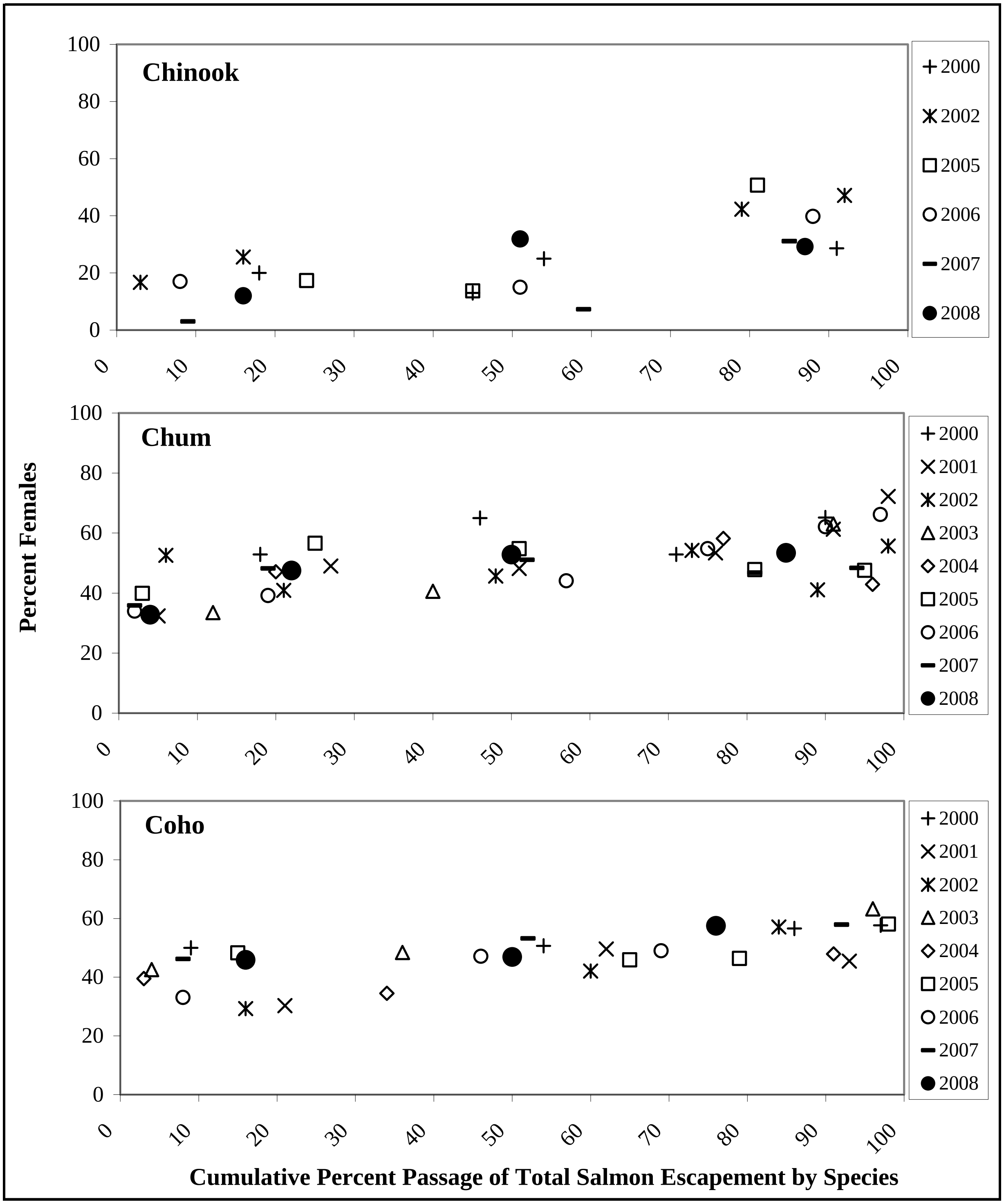
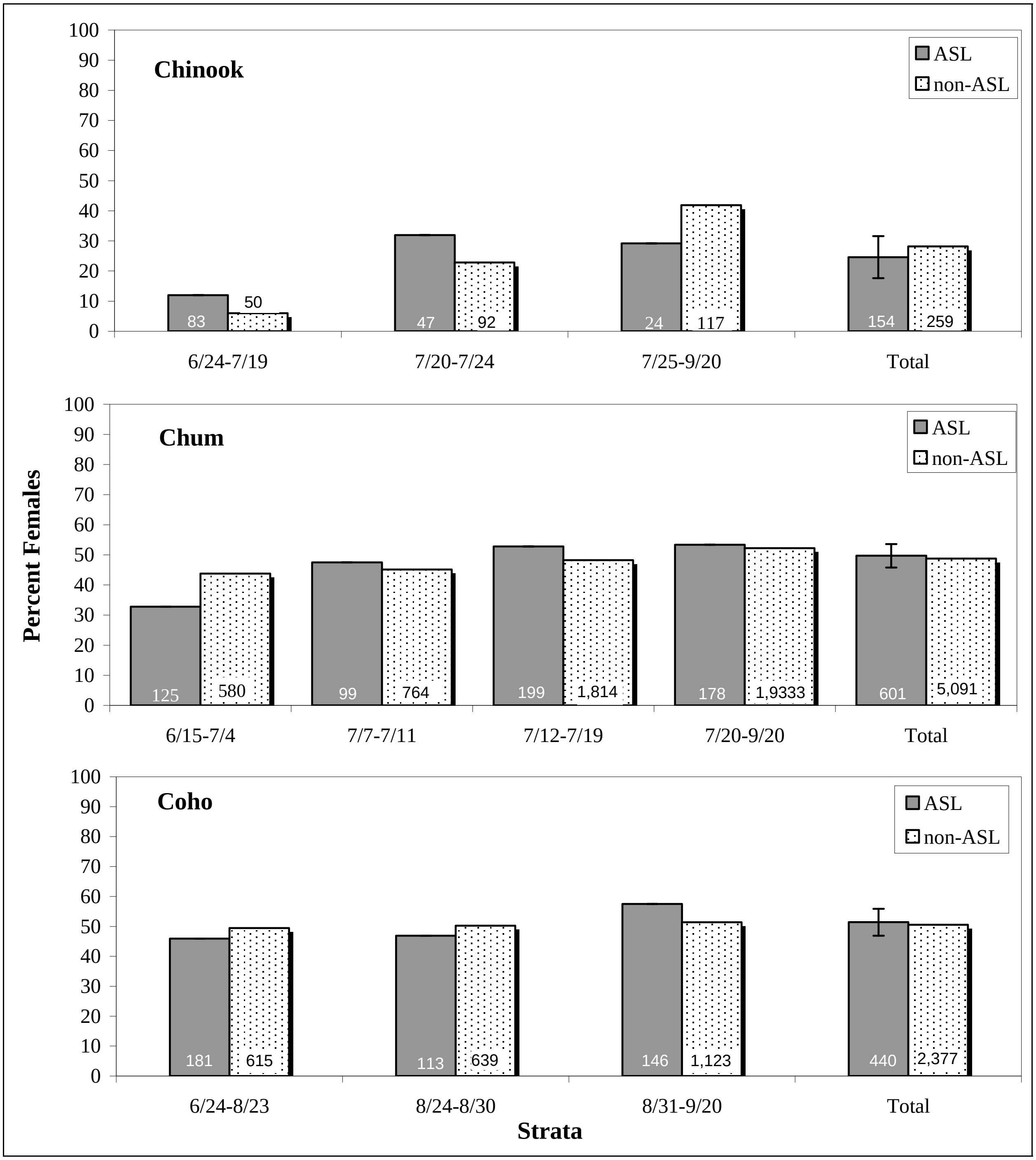


Figure 5.–Percentage of female Chinook, chum, and coho salmon by cumulative percent passage at the Takotna River weir, 2000–2008.



Note: The number in each column is the sample size.

Figure 6.–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 visually determining the sex of every passing fish.

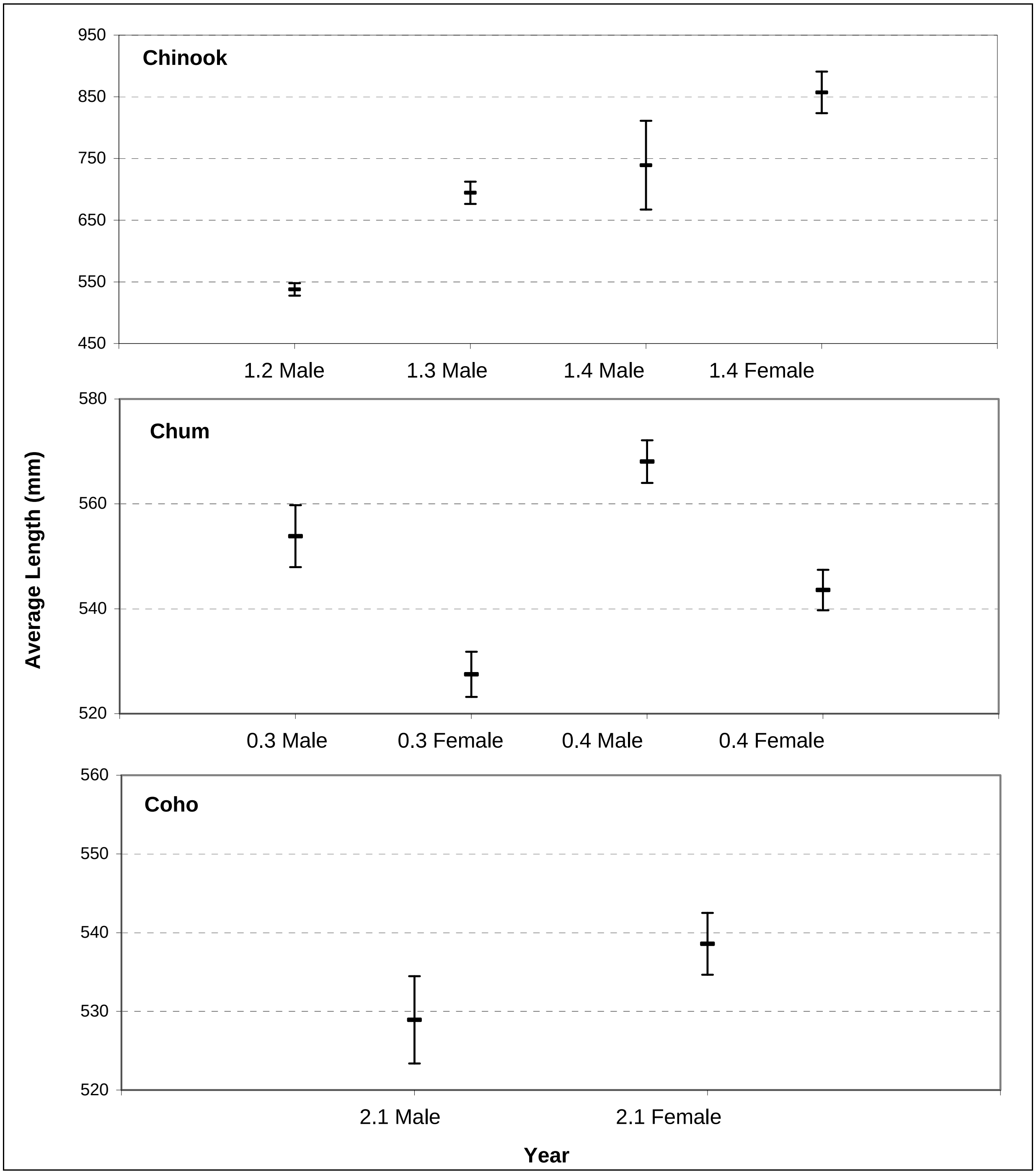


Figure 7.–Average length of Chinook, chum, and coho salmon age-sex class in 2008 at the Takotna River weir, with 95% confidence intervals.

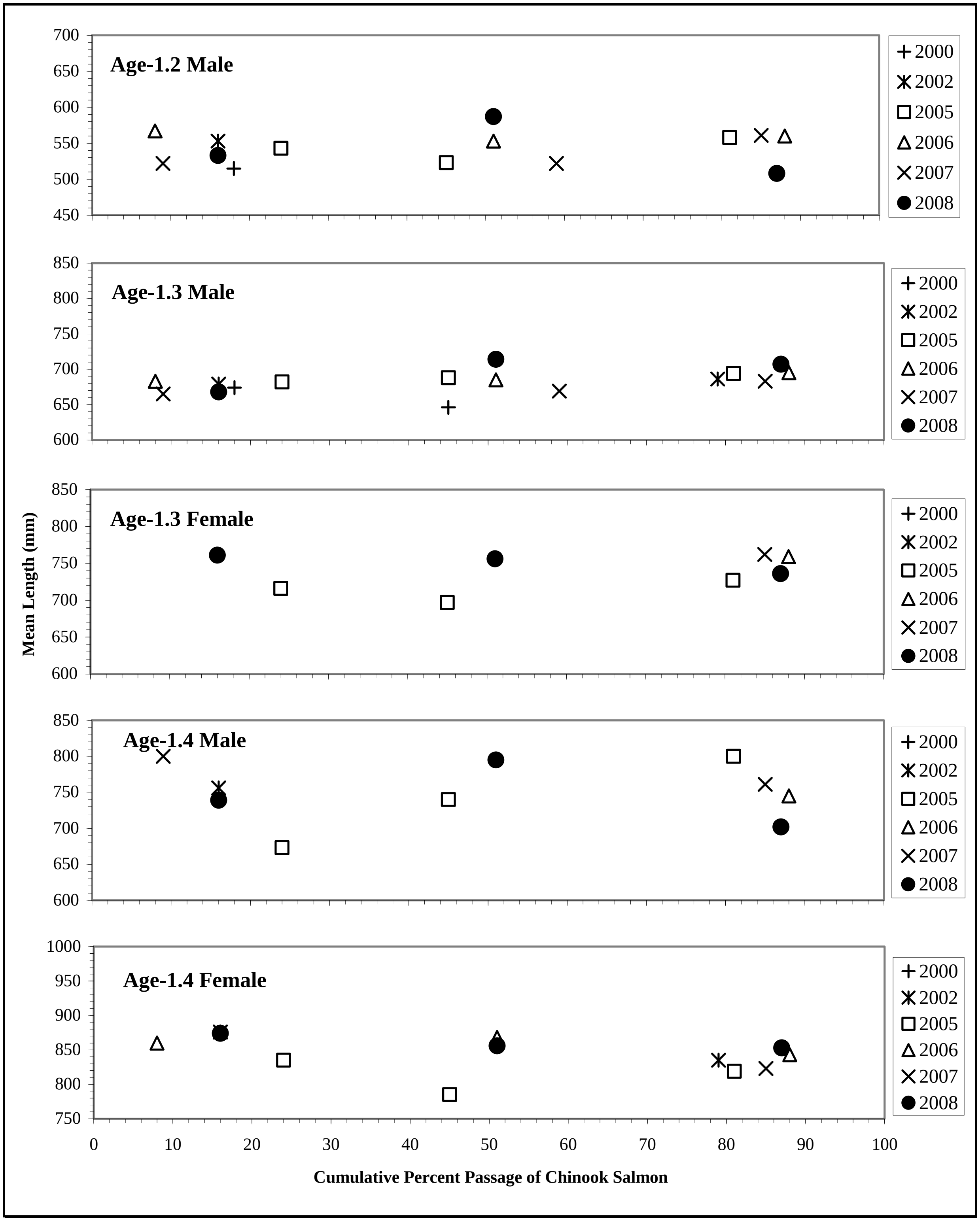


Figure 8.–Intra-annual mean length-at-age of male and female Chinook salmon by cumulative percent passage at Takotna River weir, 2000–2008.

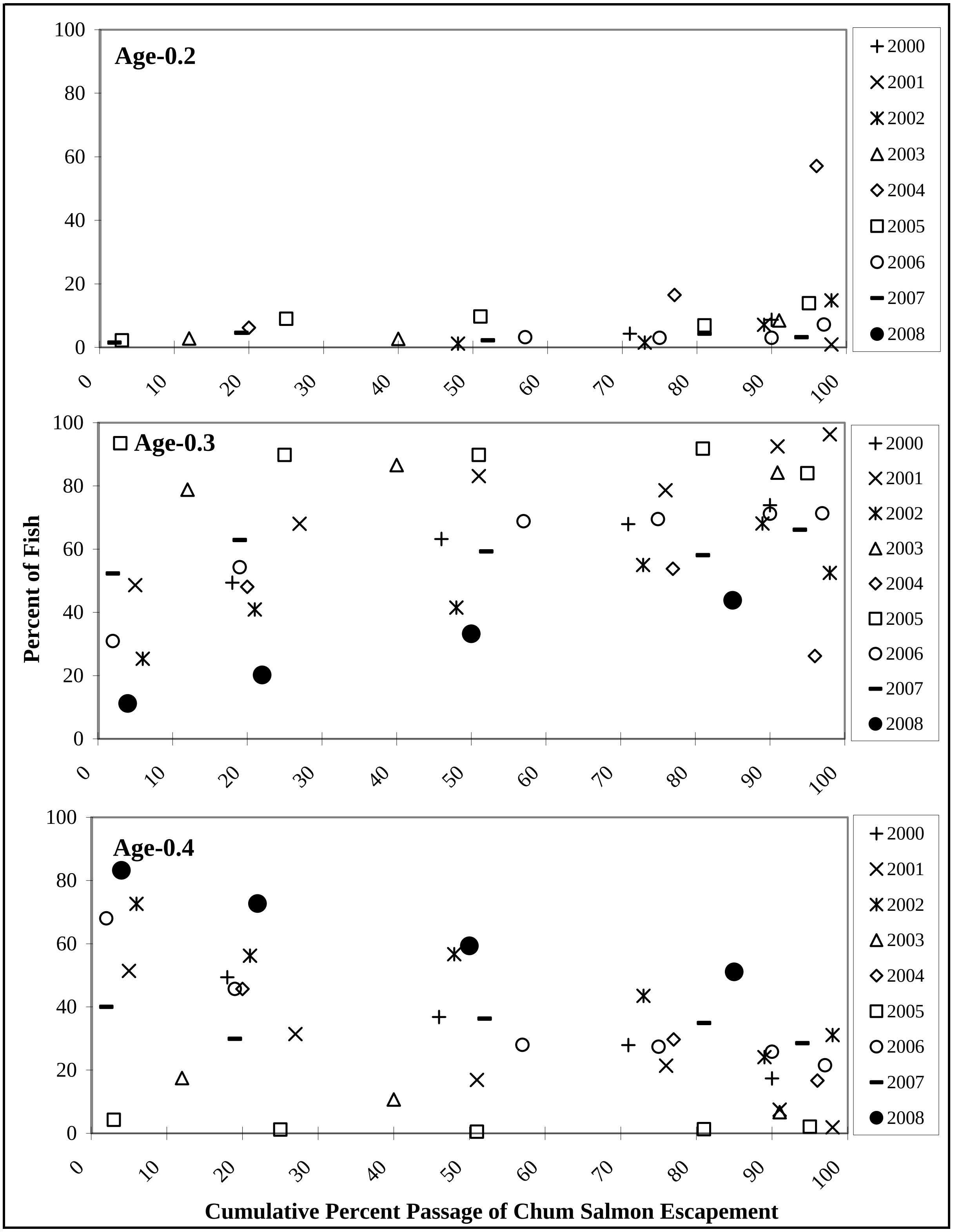


Figure 9.–Intra-annual age composition by cumulative percent passage for chum salmon at the Takotna River weir, 2000–2008.

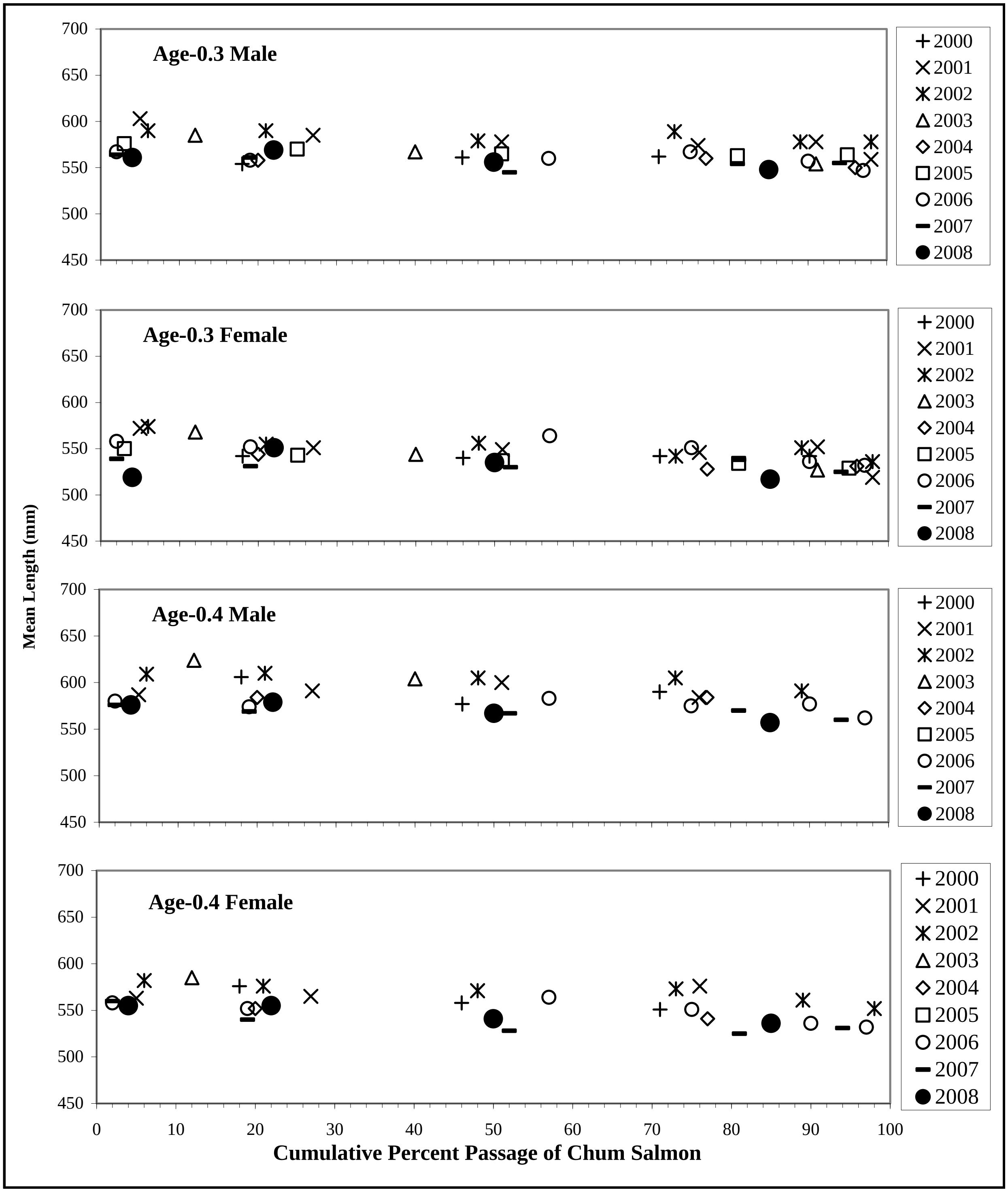


Figure 10.–Average length of Takotna River chum salmon age-sex categories by cumulative percent passage, 2000–2008.

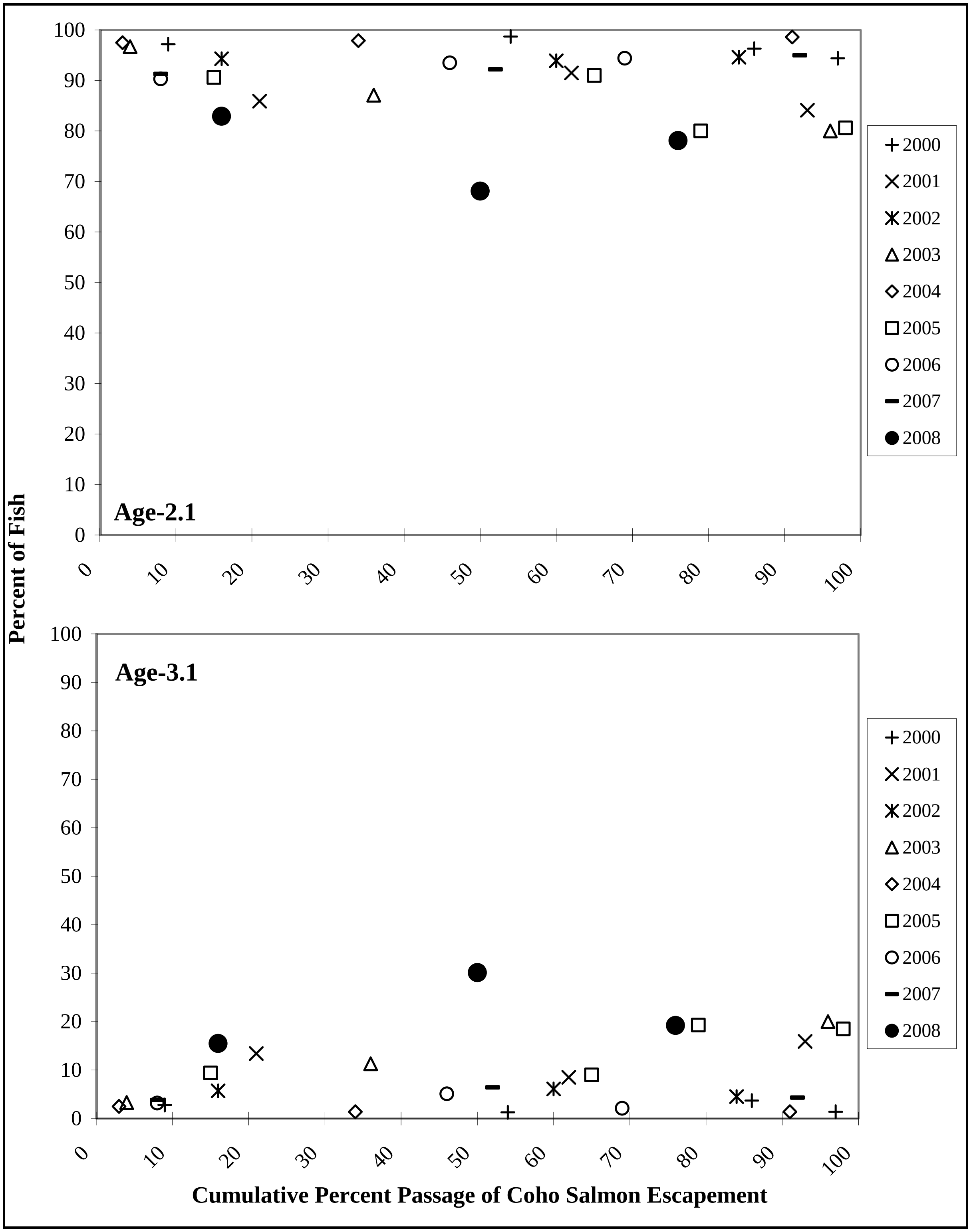


Figure 11.–Intra-annual age composition by cumulative percent passage for coho salmon at the Takotna River weir, 2000–2008.

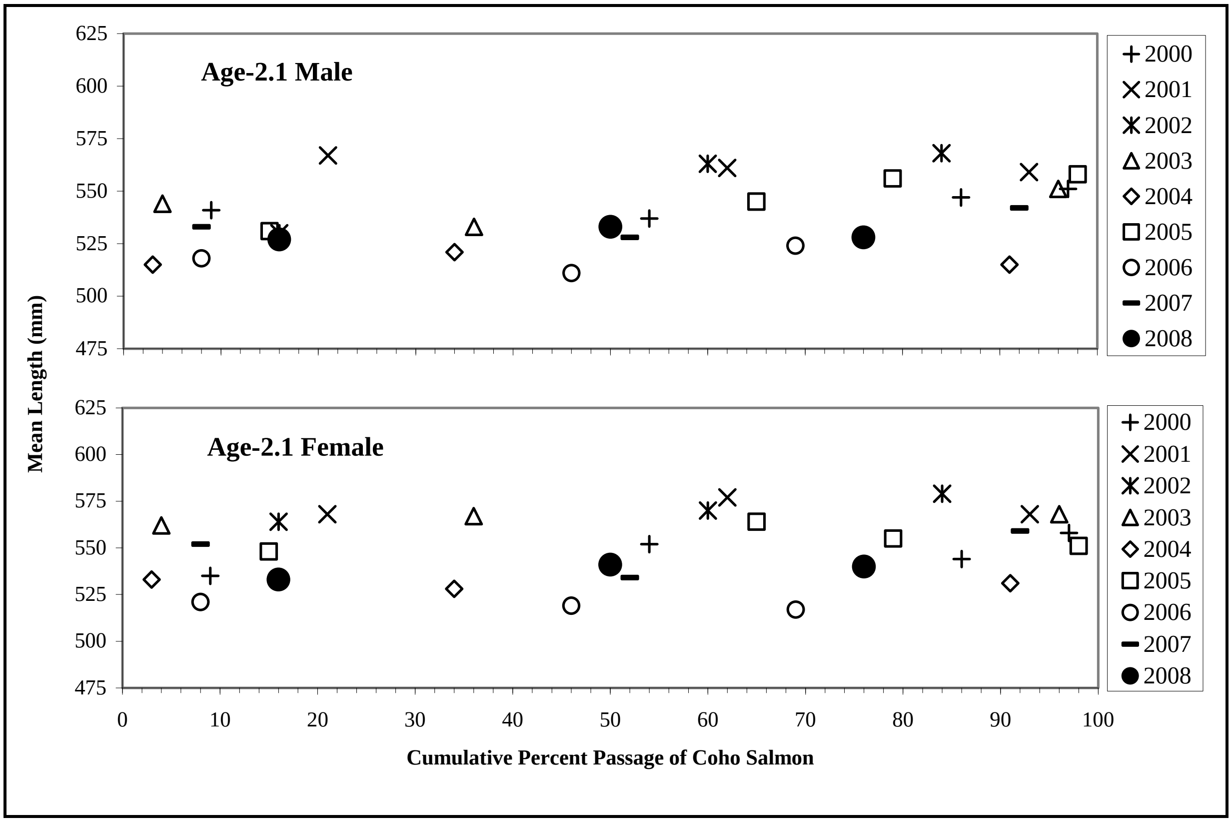


Figure 12.–Average length of common Takotna River coho salmon age-sex categories by cumulative percent passage, 2000–2008.

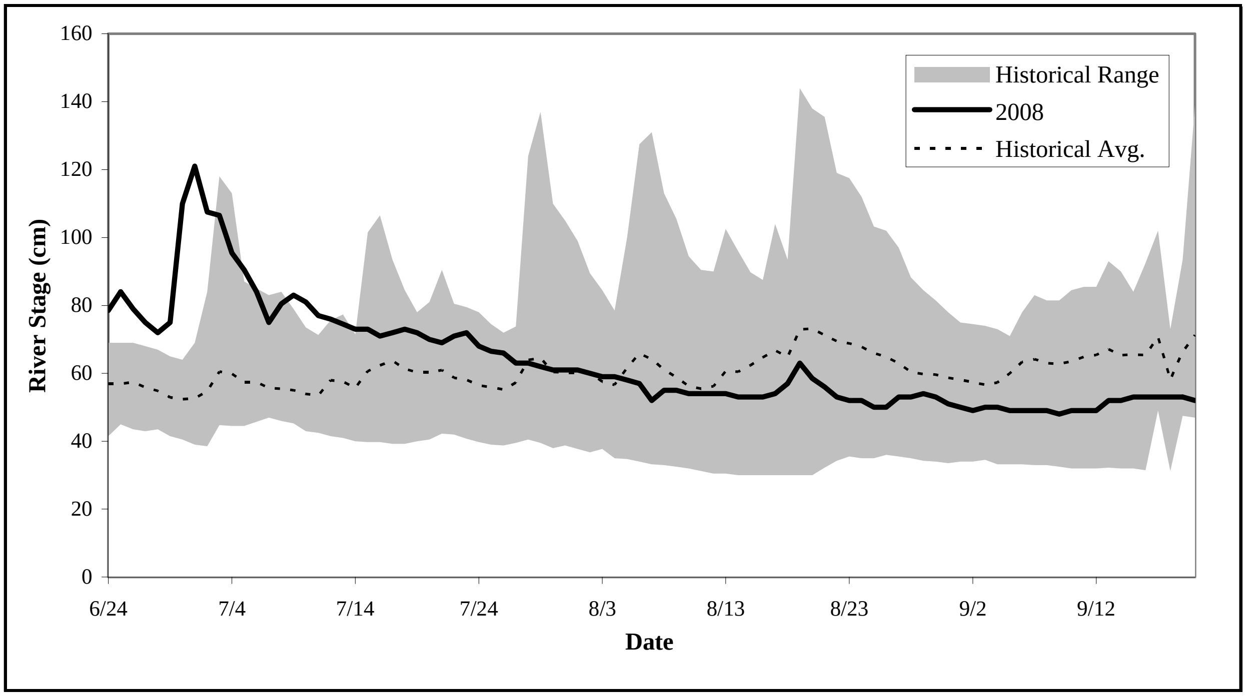


Figure 13.–Daily morning river stage at the Takotna River weir in 2008 (bold line) relative to the historical average (dotted line) and the historical (2000–2007) range.

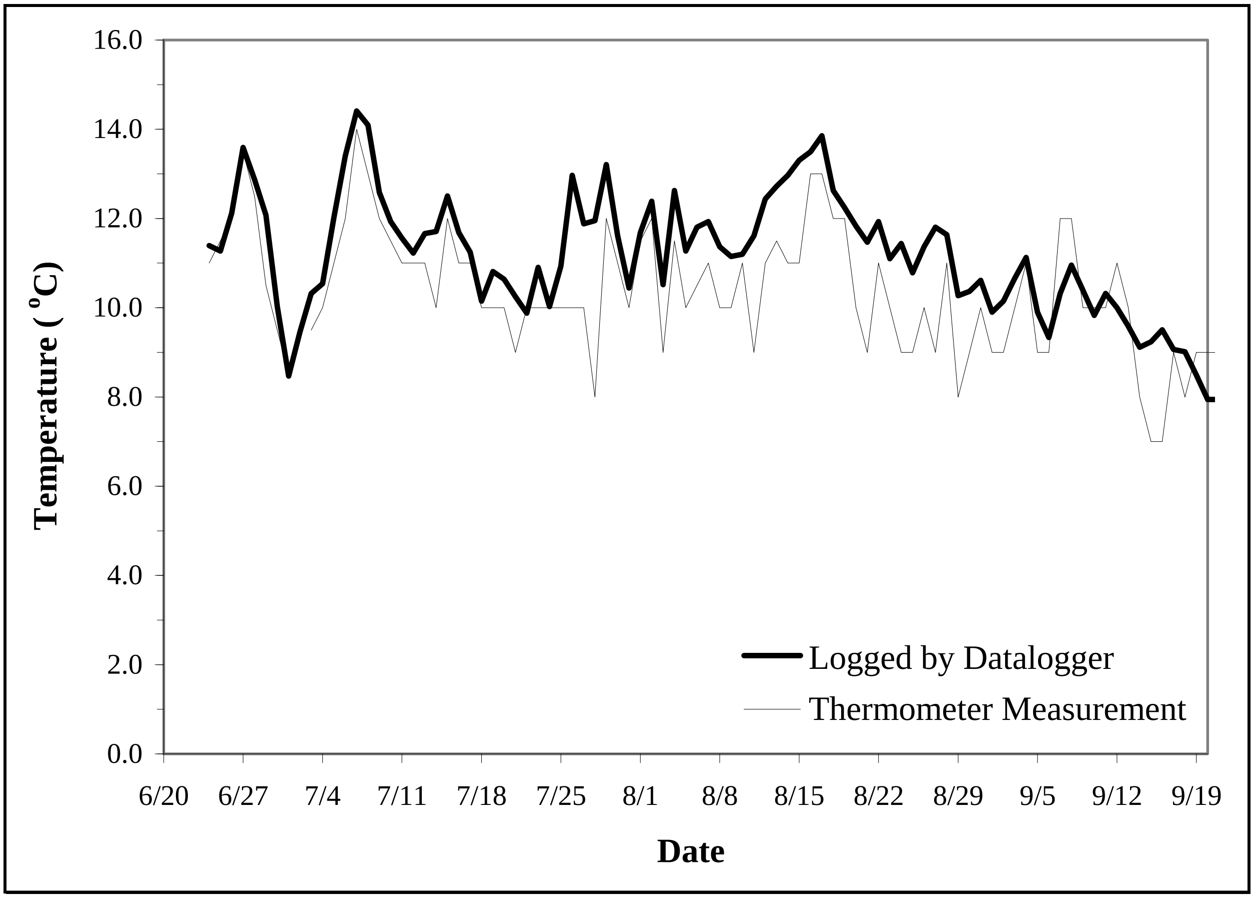


Figure 14.–Daily morning water temperature logged by the thermograph compared to daily morning water temperature determined using a thermometer at the Takotna River weir in 2008.

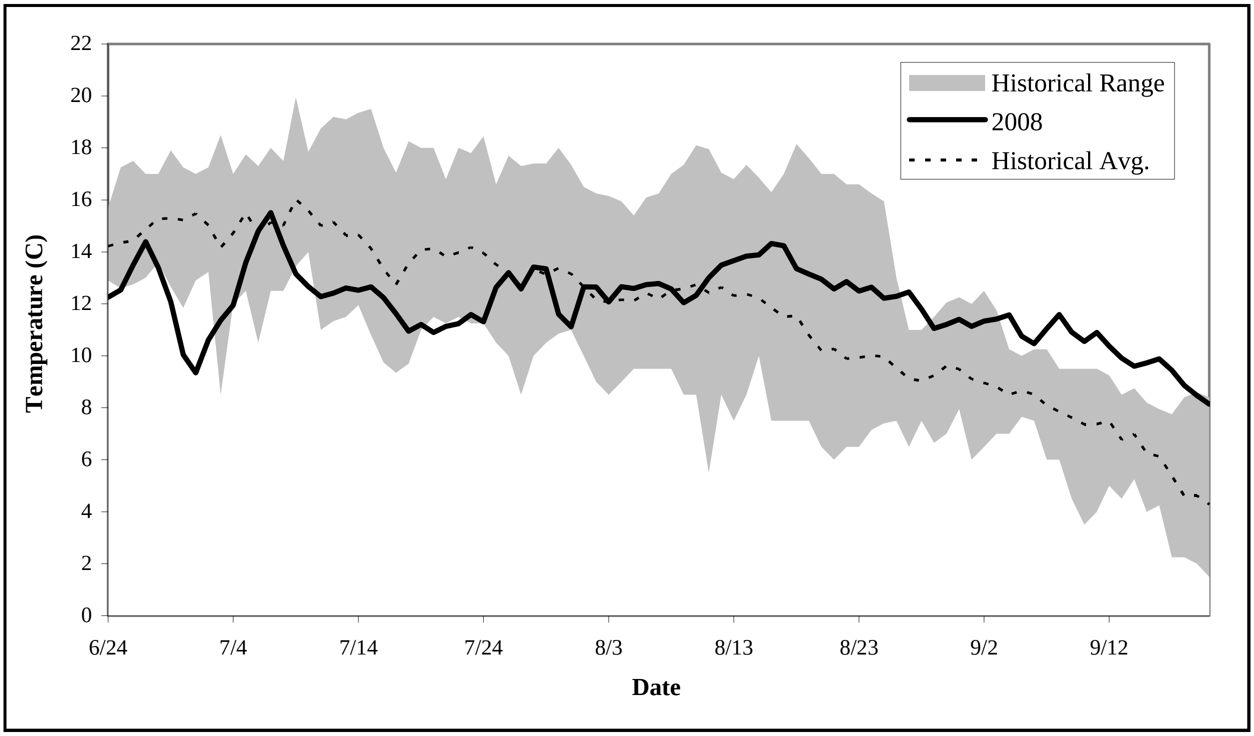


Figure 15.–Daily morning water temperature at the Takotna River weir in 2008 (bold line) relative to the historical average (dotted line) and the historical (2000–2007) range.

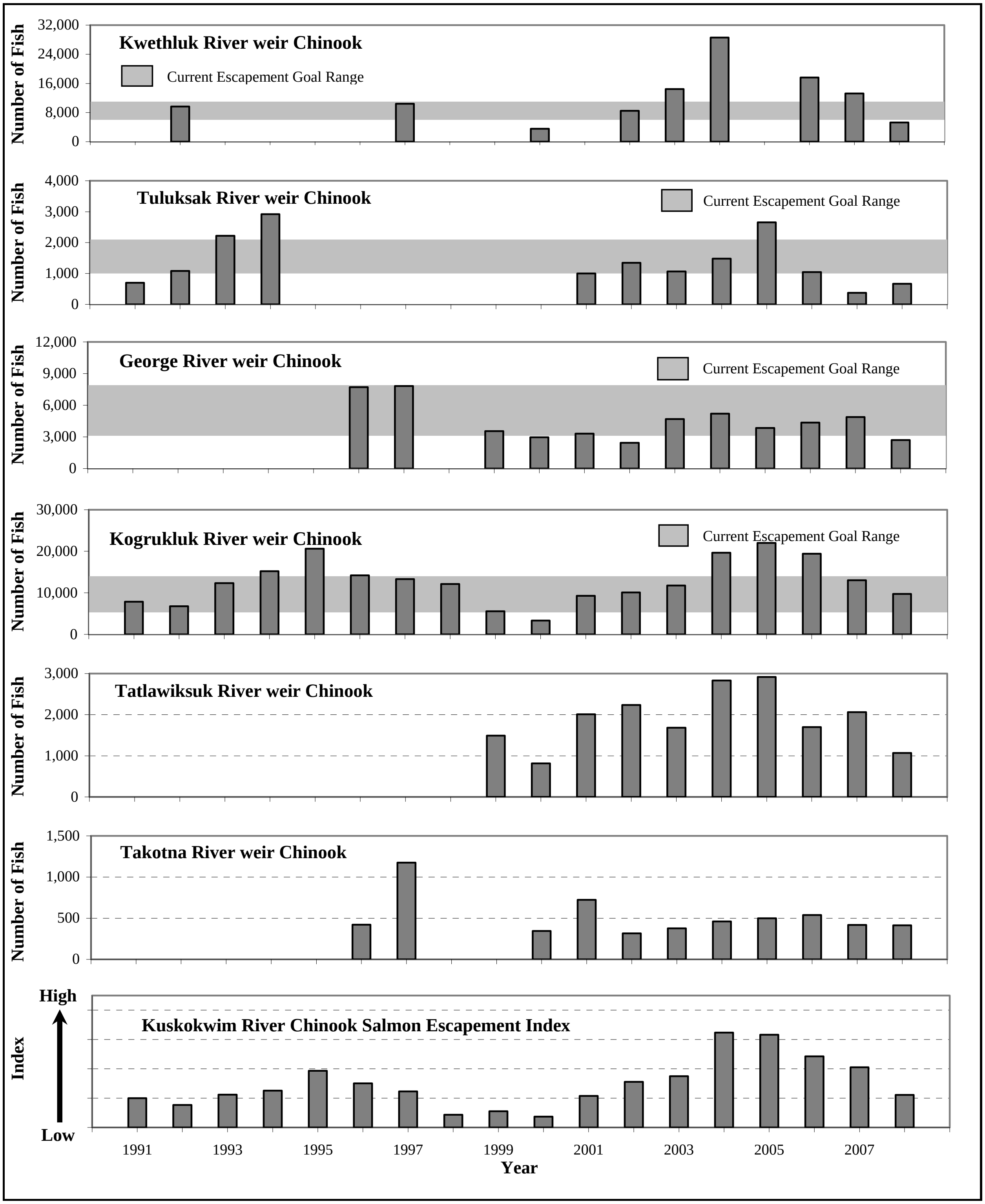
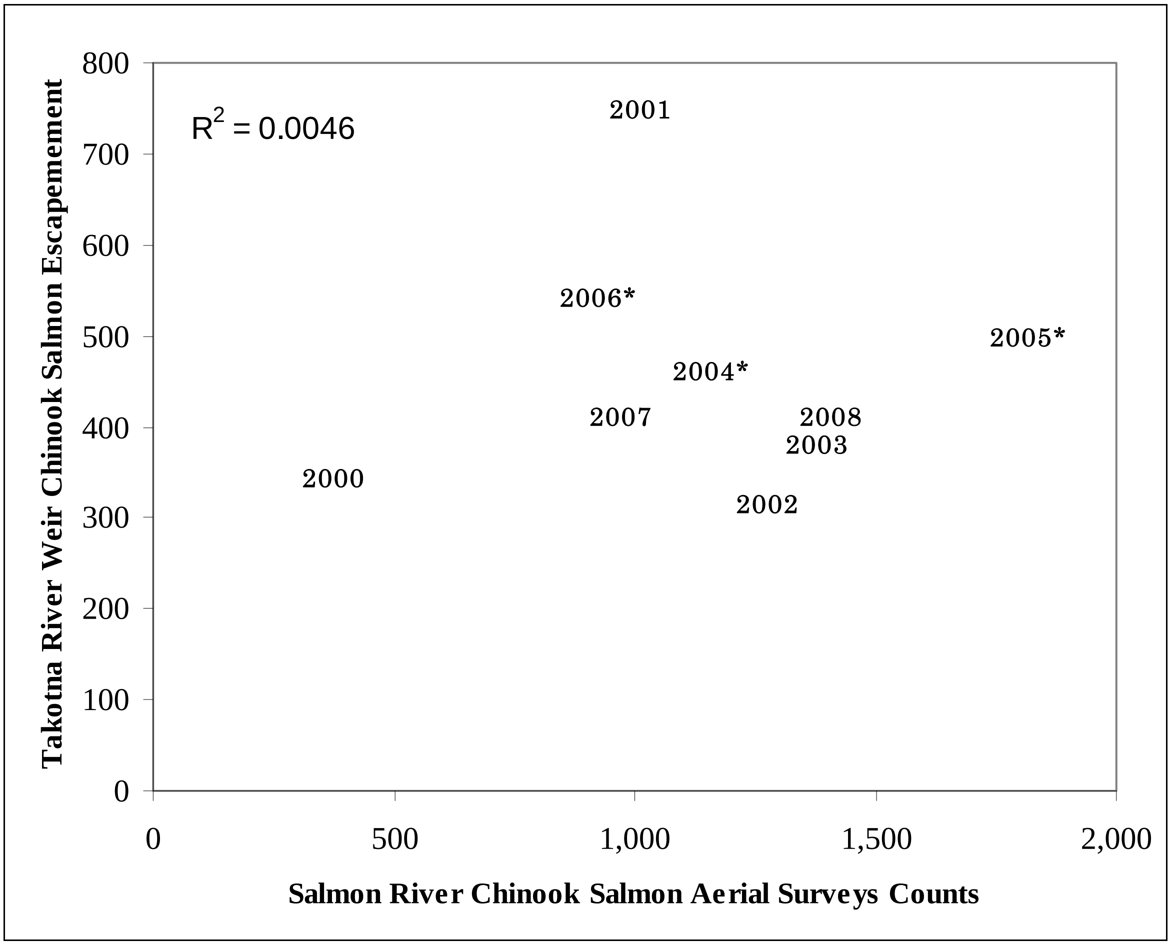


Figure 16.–Historical annual Chinook salmon escapement into 6 Kuskokwim River tributaries and annual Kuskokwim River Chinook salmon escapement indices, 1991–2008.



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, 2000–2008.

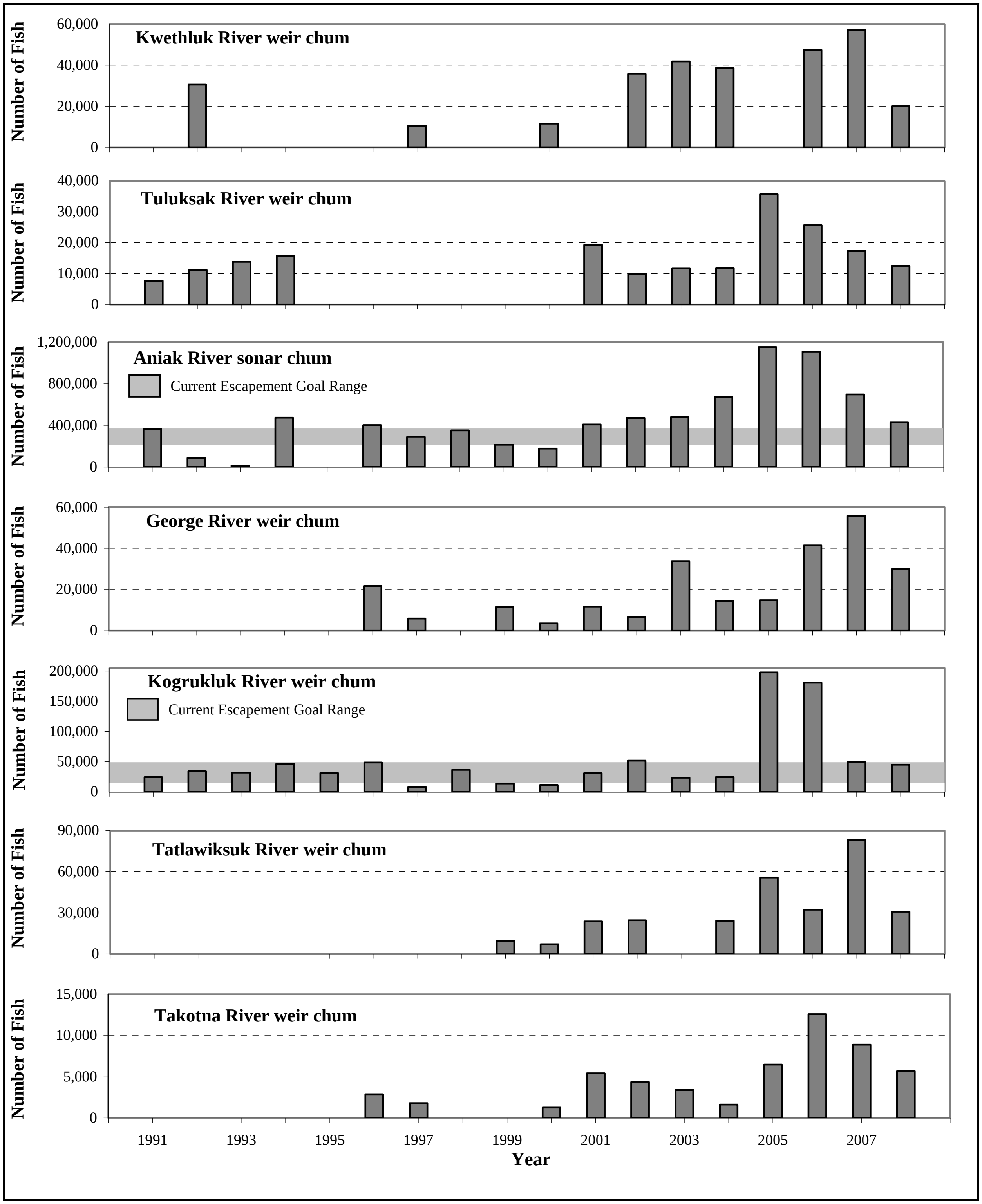


Figure 18.–Annual chum salmon escapement into 7 Kuskokwim River tributaries, 1991–2008.

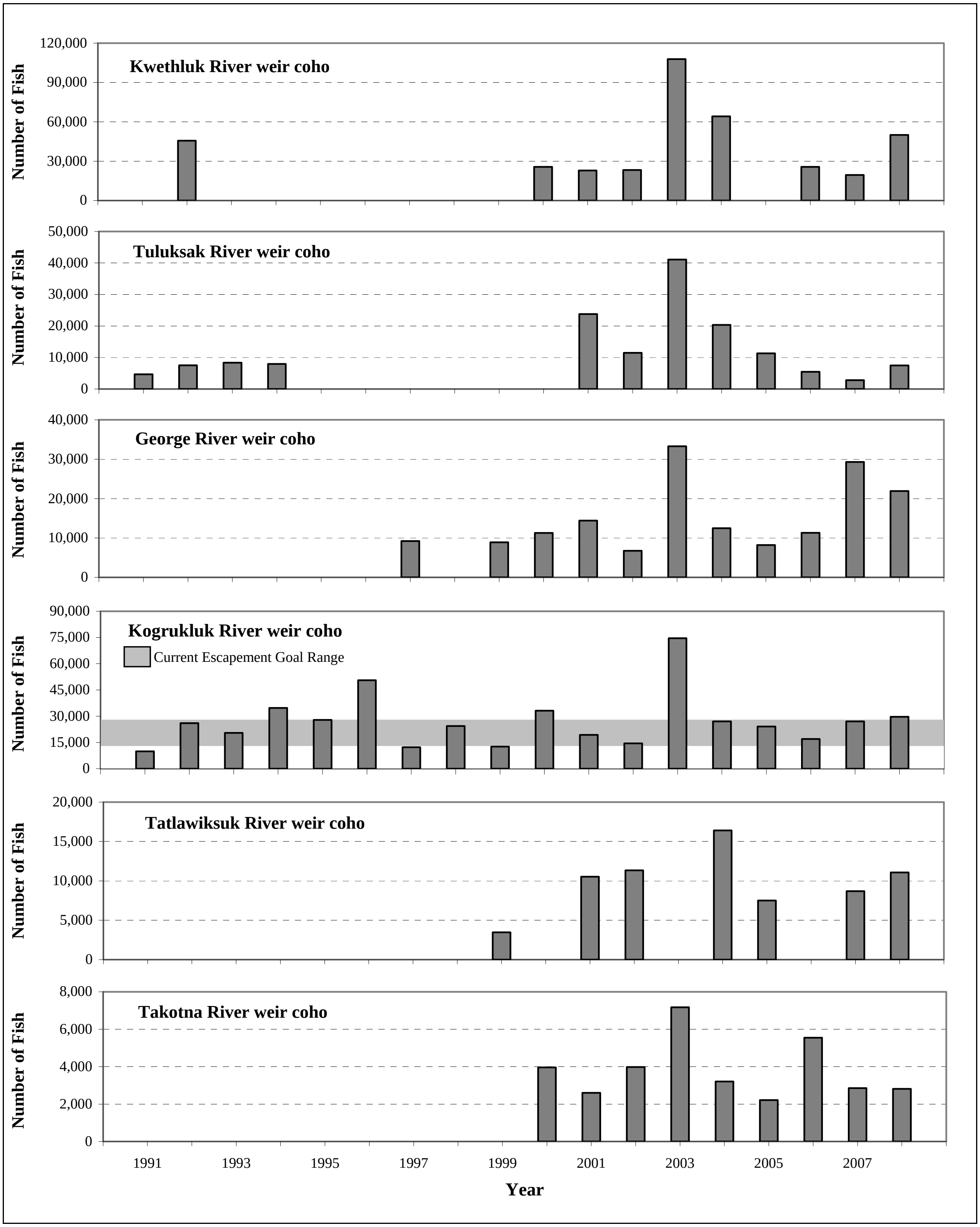
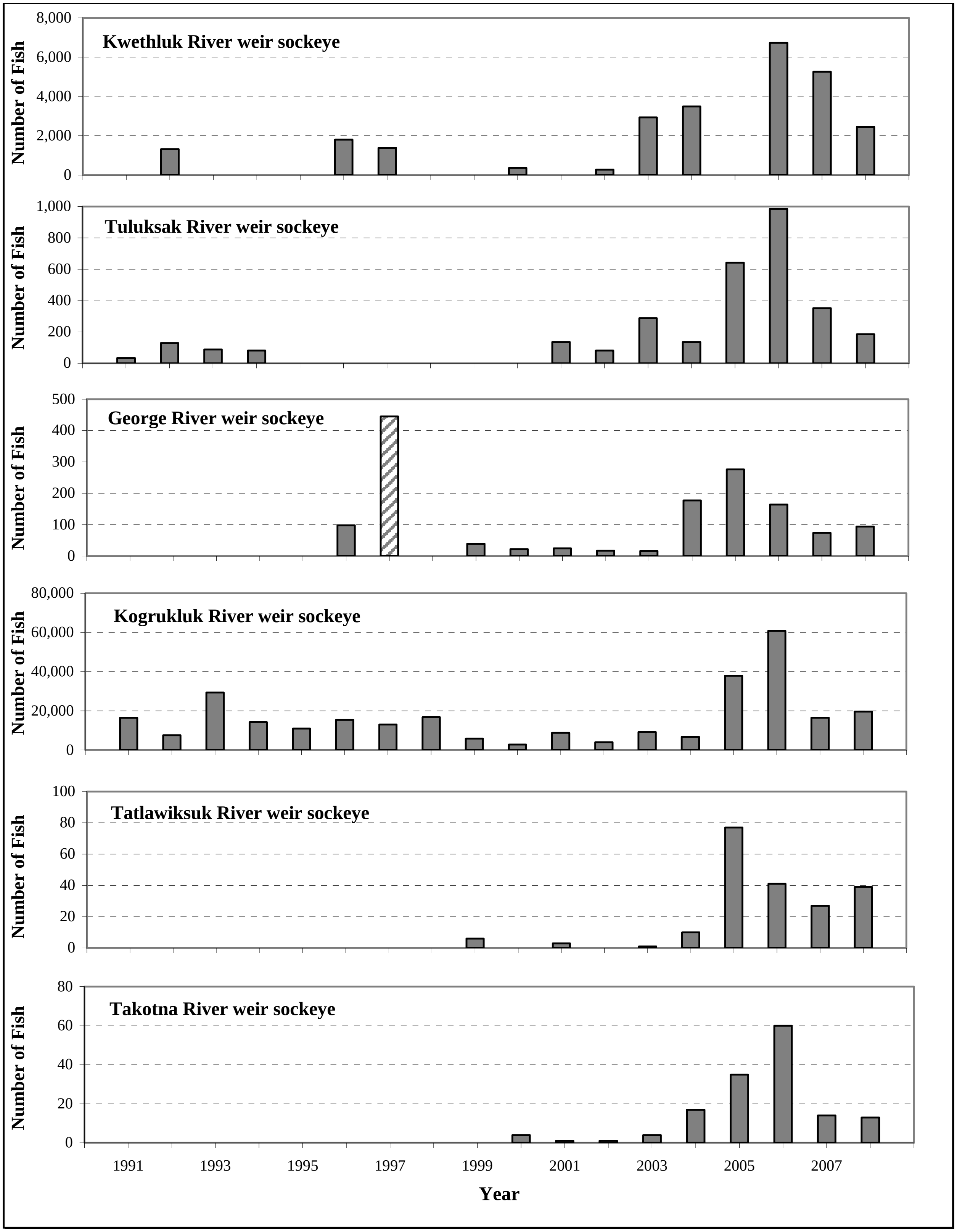
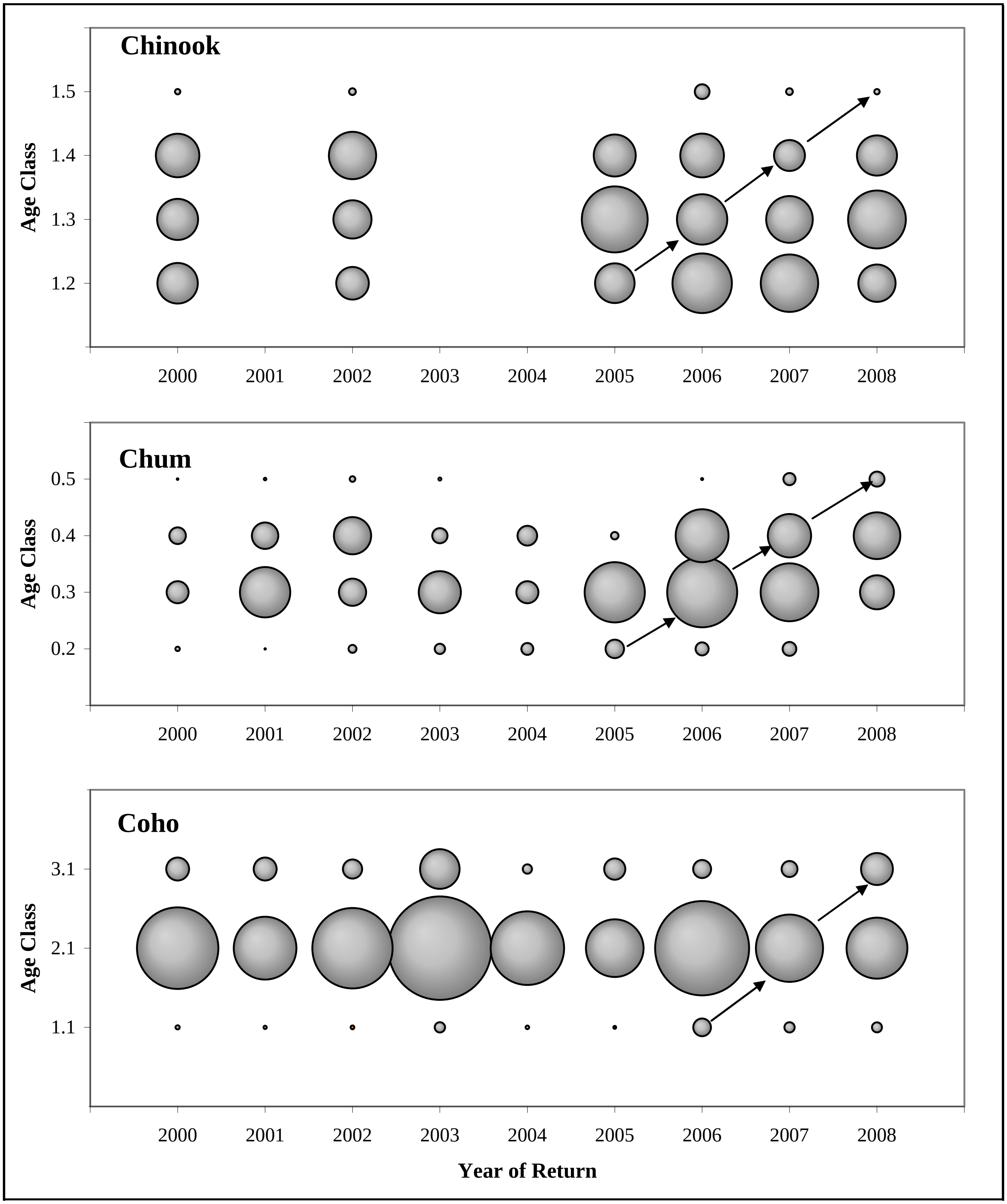


Figure 19.–Historical annual coho salmon escapement into 6 Kuskokwim River tributaries, 1991–2008.



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

Figure 20.–Historical annual sockeye salmon escapement into 6 Kuskokwim River tributaries, 1991–2008.



Note: Size of circles represents abundance and arrows illustrate a cohort group. 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.

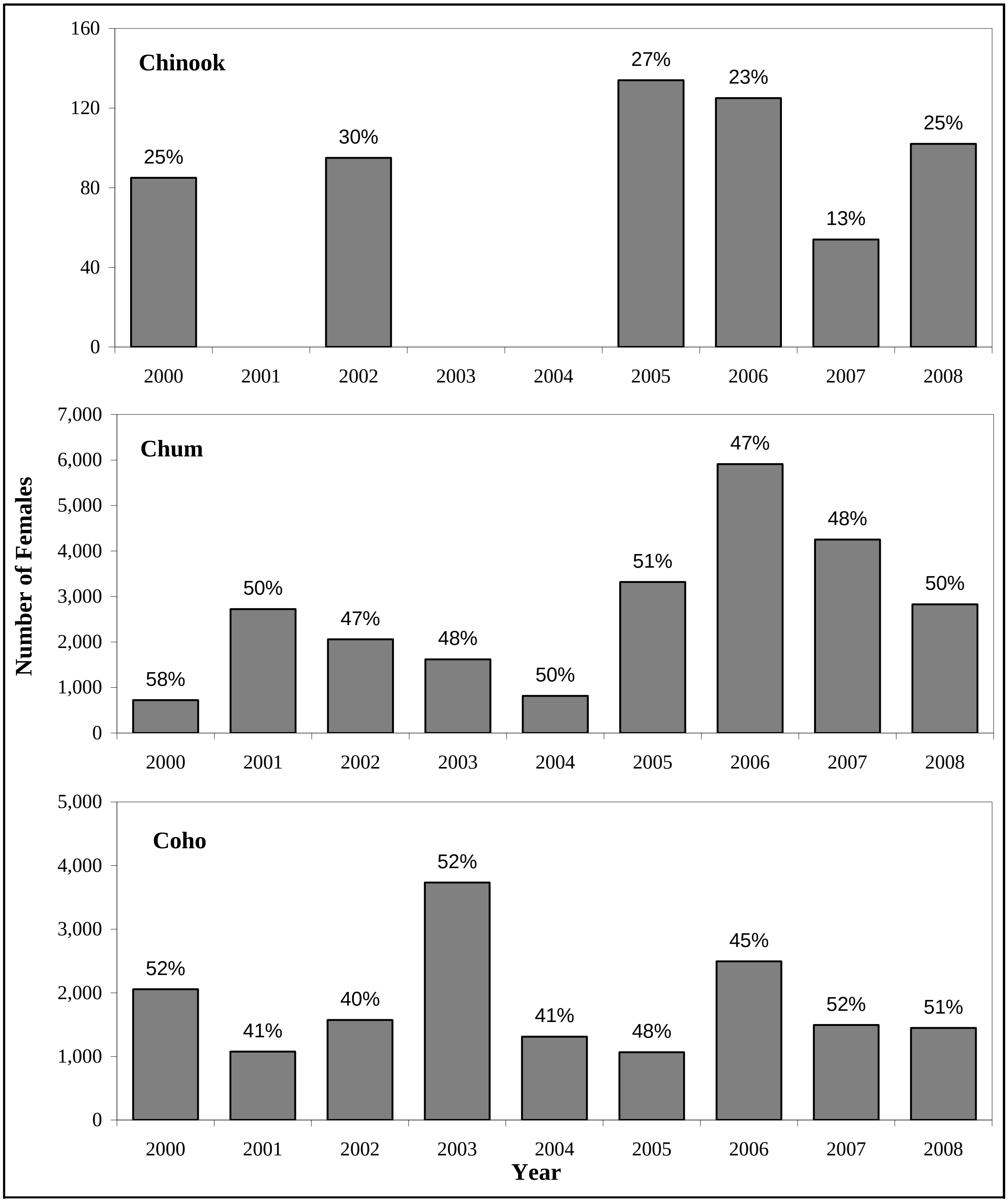
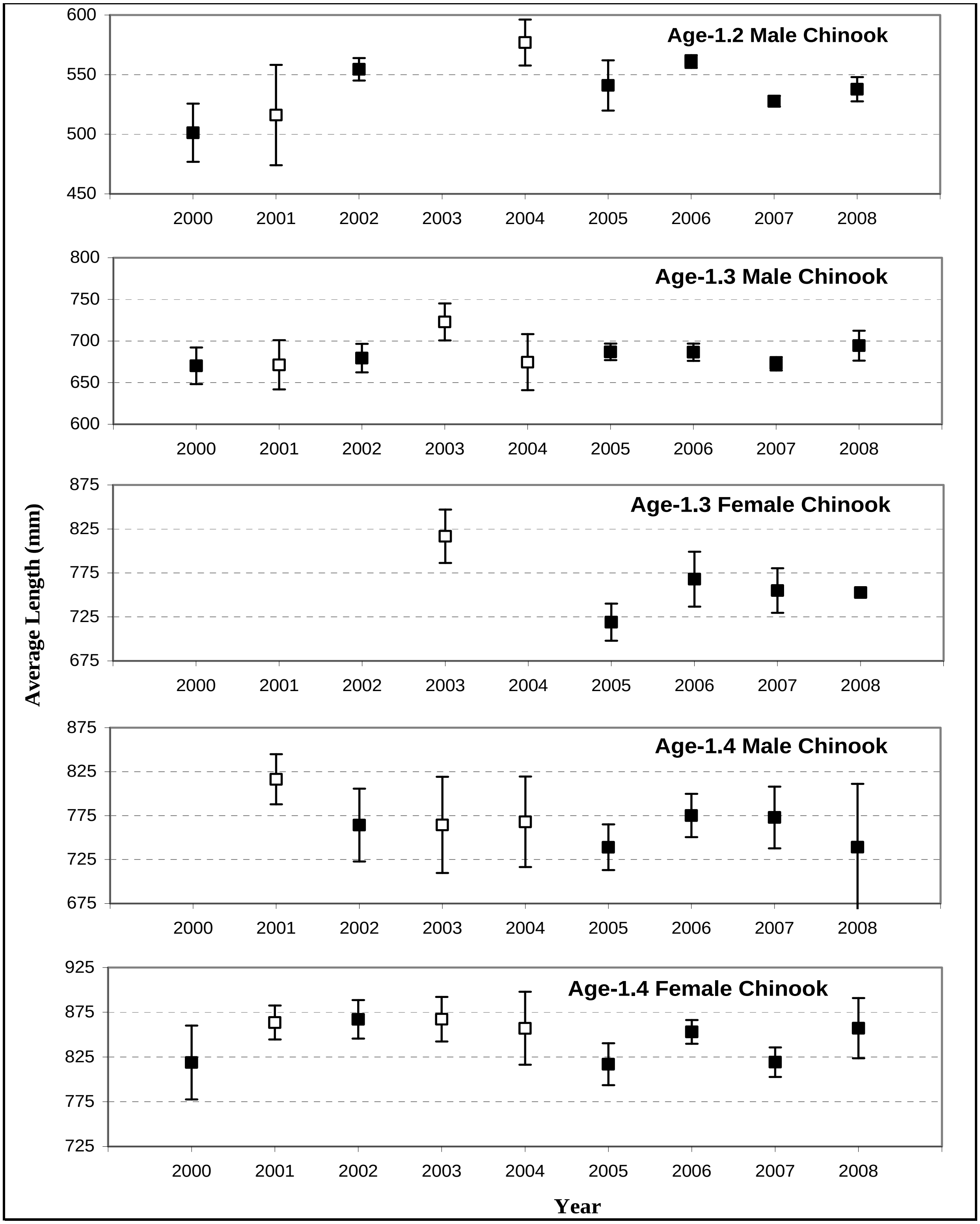


Figure 22.–Annual escapement of female Chinook, chum, and coho salmon at the Takotna River weir with labels indicating the percentage of total escapement consisting of females.



Note: Blank plots indicate that though sampling goals were not achieved mean lengths could be calculated from one 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.

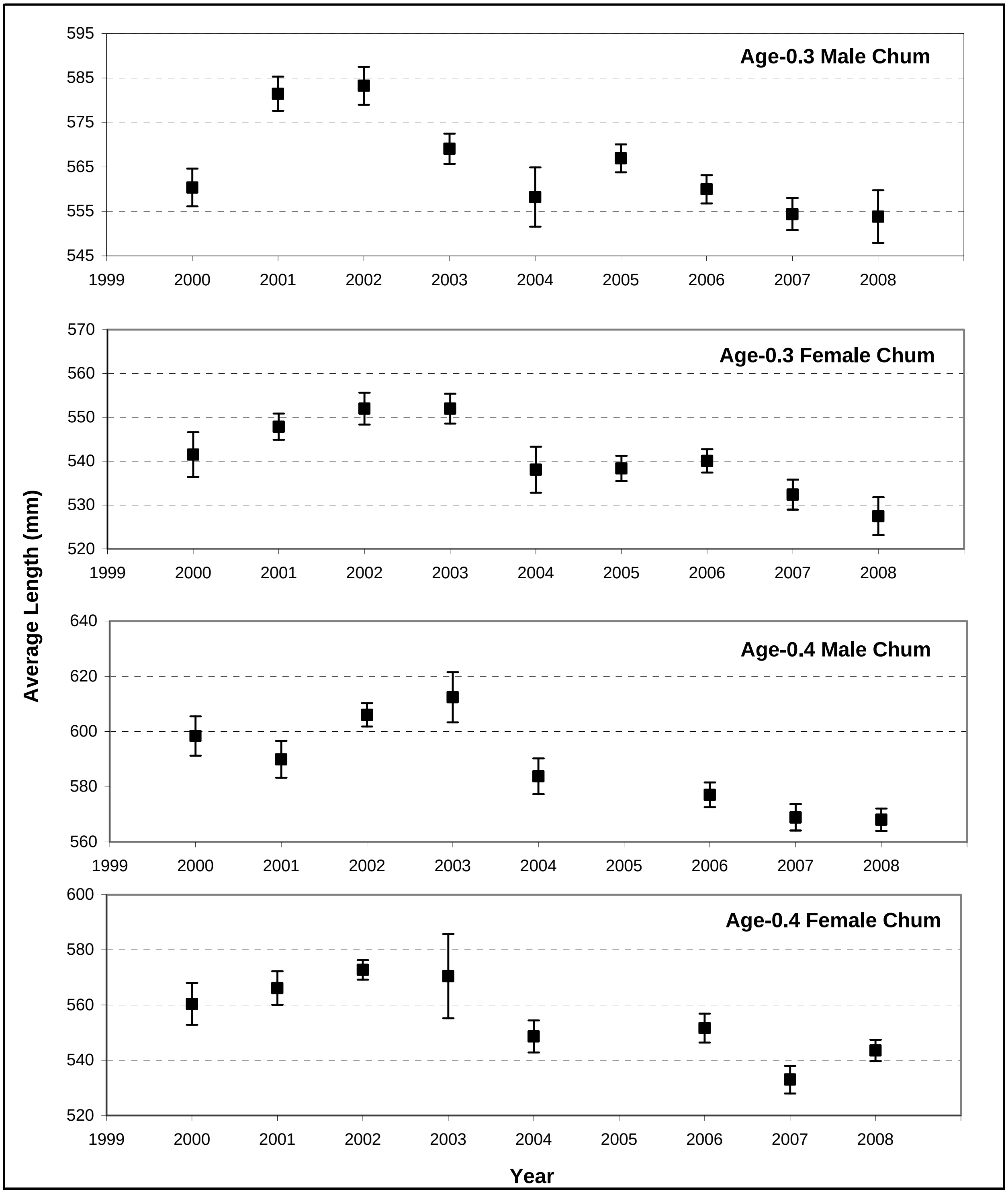


Figure 24.–Average annual length of common chum salmon age-sex categories at the Takotna River weir with 95% confidence intervals.

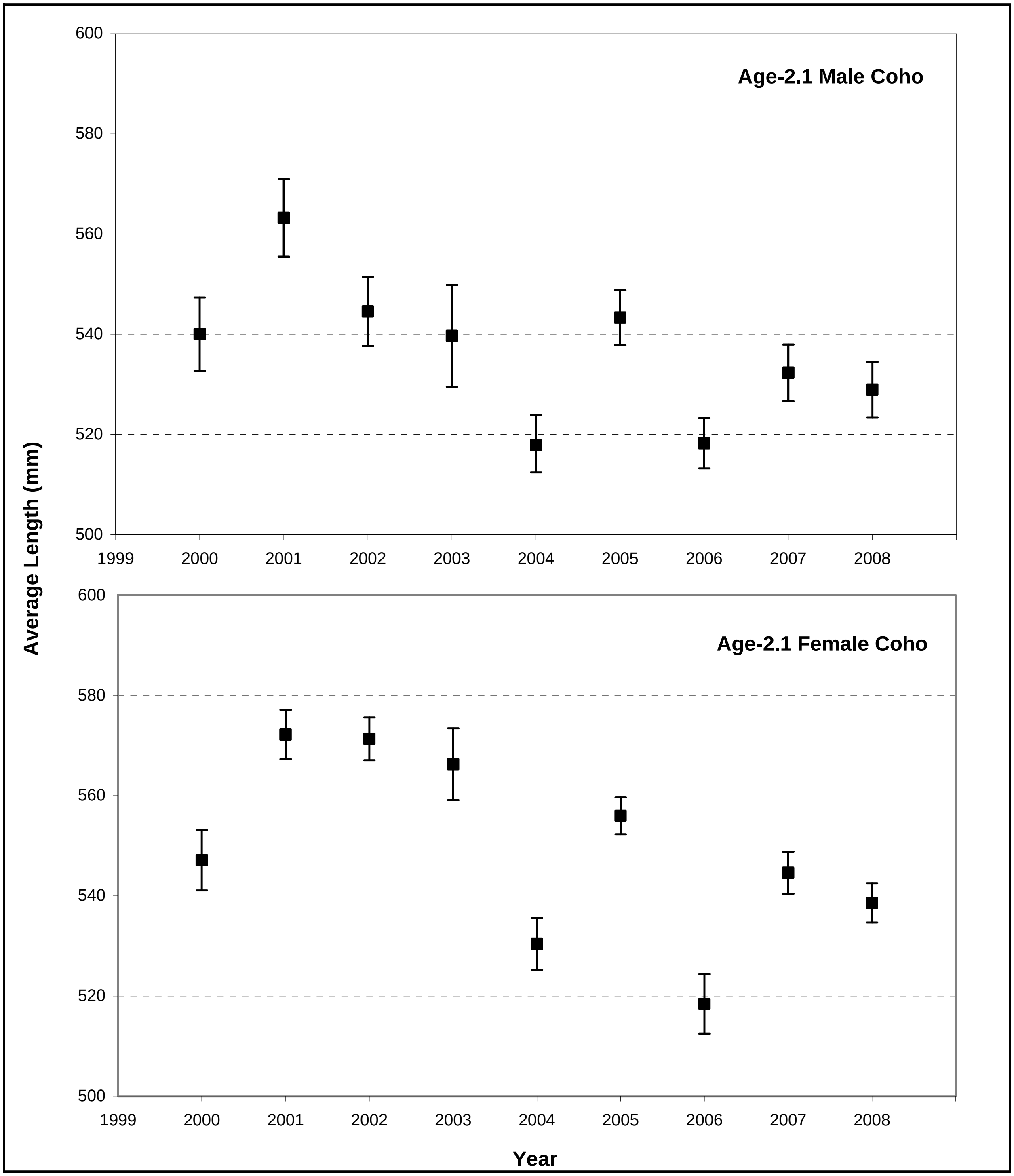


Figure 25.–Average annual length of common coho salmon age-sex categories at the Takotna River weir with 95% confidence intervals.

APPENDIX A

Appendix A1.–Daily passage excluding estimates at the Takotna River weir, 2008.

	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	0	0	0	0	0	0	0	0	366	0	0
6/21	0	0	0	0	0	0	0	0	387	0	0
6/22	0	0	0	0	0	0	0	0	157	0	0
6/23	0	0	0	0	0	0	0	0	48	0	0
6/24	0	0	0	0	7	2	0	0	143	1	0
6/25	1	0	0	0	8	4	0	0	121	2	0
6/26	0	0	0	0	5	2	0	0	163	4	0
6/27	1	0	0	0	14	12	0	0	23	1	0
6/28	0	1	0	0	11	8	0	0	12	0	0
6/29	0	0	0	0	11	9	0	0	23	1	0
6/30	7	0	0	0	24	8	0	0	30	1	0
7/01	5	0	0	0	19	17	0	0	3	1	0
7/02	3	0	0	0	28	13	0	0	5	0	0
7/03	5	0	0	0	73	31	0	0	15	1	0
7/04	5	0	0	0	56	53	0	0	2	0	0
7/05	4	1	0	0	65	46	0	0	16	0	0
7/06	2	0	0	0	89	90	0	0	8	0	0
7/07	9	2	0	0	80	75	0	0	10	0	2 G
7/08	10	0	0	0	110	81	0	0	3	0	0
7/09	7	0	0	0	106	69	0	0	2	0	0
7/10	4	0	0	0	82	78	0	0	6	0	0
7/11	3	0	0	0	93	89	0	0	0	0	0
7/12	3	0	0	0	150	129	0	0	1	0	1 P
7/13	9	1	0	0	123	87	0	0	36	0	0
7/14	2	1	0	0	106	115	0	0	1	0	0
7/15	9	1	0	0	143	123	0	0	14	0	2 P
7/16	9	1	0	0	140	149	0	0	4	0	0
7/17	10	2	0	0	124	118	0	0	1	0	1 G
7/18	8	2	0	0	128	149	0	0	0	0	0
7/19	4	1	0	0	119	110	0	0	3	0	0
7/20	12	2	0	0	97	96	0	0	0	0	1;1 P;G
7/21	19	4	1	0	130	146	0	0	3	0	0
7/22	28	12	0	0	92	140	0	0	1	0	0
7/23	25	5	0	0	97	93	0	0	1	0	0
7/24	19	13	0	0	45	65	0	0	2	0	0
7/25	16	19	0	0	60	65	0	0	0	0	0
7/26	4	5	0	1	70	51	0	0	2	0	0
7/27	2	2	0	0	50	46	0	0	0	0	0
7/28	14	4	0	0	55	68	0	0	0	0	0
7/29	11	0	0	0	48	47	0	0	2	1	0
7/30	9	1	1	0	33	30	0	0	0	0	0
7/31	1	3	0	0	28	26	1	0	0	0	0
8/01	4	4	1	0	25	26	1	0	0	0	0
8/02	3	3	0	0	25	37	0	1	0	1	0
8/03	4	3	0	0	16	20	2	1	0	0	0
8/04	1	3	0	0	17	28	1	2	2	0	1 P
8/05	1	1	0	0	18	22	1	1	0	0	0
8/06	3	1	0	1	16	21	2	1	0	0	0
8/07	3	2	0	0	14	14	3	1	1	0	0
8/08	1	0	0	1	7	13	7	8	0	0	0
8/09	2	0	0	0	13	5	4	3	3	0	1 P
8/10	1	0	0	0	8	7	6	5	0	0	0
8/11	1	1	0	0	2	2	6	8	0	1	1 P

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Appendix A1.–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]
8/12	1	1	0	0	2	5	8	4	3	0	1 P
8/13	1	0	0	0	1	5	7	9	0	0	1 P
8/14	0	0	0	0	5	3	11	12	3	0	1 P
8/15	0	1	0	0	2	3	14	9	1	0	0
8/16	0	0	0	0	1	4	18	24	0	0	1 P
8/17	0	0	0	0	3	3	37	37	0	0	1 G
8/18	0	1	0	0	3	2	31	38	0	0	0
8/19	0	0	0	1	1	5	67	53	2	0	0
8/20	1	0	1	0	2	1	36	22	1	0	0
8/21	1	0	0	0	5	0	58	37	0	0	1 P
8/22	0	0	0	0	6	3	66	81	0	1	0
8/23	0	0	0	0	1	0	22	30	0	0	0
8/24	0	0	0	1	2	1	43	41	0	0	1 P
8/25	0	0	0	1	2	0	45	37	0	0	0
8/26	0	0	0	0	0	0	56	46	0	0	0
8/27	0	0	0	0	0	0	92	115	0	0	0
8/28	0	0	0	0	0	0	83	66	0	0	0
8/29	0	0	0	1	0	0	39	43	0	0	0
8/30	0	0	0	0	0	0	20	26	0	0	1 P
8/31	0	0	0	0	0	0	68	79	0	0	0
9/01	0	0	0	0	0	0	18	34	0	0	0
9/02	0	0	0	0	0	0	69	29	0	0	0
9/03	0	0	0	0	1	0	59	69	0	0	0
9/04	0	0	0	0	0	0	43	45	0	0	2;1 P;G
9/05	0	0	0	2	0	1	53	40	0	0	0
9/06	0	0	0	0	0	0	21	35	0	0	1 S
9/07	0	1	0	0	0	0	23	43	0	0	0
9/08	0	0	0	0	0	0	32	39	0	0	2 P
9/09	0	0	0	0	0	0	20	31	0	0	0
9/10	0	0	0	0	1	0	7	21	1	0	0
9/11	0	0	0	0	0	0	19	27	0	0	0
9/12	0	0	0	0	0	0	24	13	0	0	0
9/13	0	0	0	0	0	0	21	19	0	0	0
9/14	0	0	0	0	0	0	30	39	0	0	0
9/15	0	0	0	0	0	0	30	16	0	0	0
9/16	0	0	0	0	0	1	10	13	0	2	0
9/17	0	0	0	0	0	0	6	17	0	0	0
9/18	0	0	0	0	0	0	25	12	1	0	0
9/19	0	0	0	0	0	0	19	29	0	0	0
9/20	0	0	0	0	1	0	11	11	0	0	0
9/21	0	0	0	0	1	0	6	6	1	0	0
9/22	0	0	0	0	0	0	2	4	0	0	0
9/23 [b]	0	0	1	0	0	0	1	5	0	0	0

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

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

APPENDIX B

Appendix B1.–Daily carcass counts at the Takotna River weir, 2008.

	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	7	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	20	0	0
7/01	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	7	0	0
7/02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
7/04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/09	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	9	4	13	0	0	0	0	0	0	2	0	1
7/11	0	0	0	0	0	0	5	3	8	0	0	0	0	0	0	0	0	0
7/12	0	0	0	0	0	0	6	0	6	0	0	0	0	0	0	0	0	1
7/13	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0
7/14	0	0	0	0	0	0	4	3	7	0	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	9	2	11	0	0	0	0	0	0	0	0	0
7/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/17	0	0	0	0	0	0	14	3	17	0	0	0	0	0	0	0	0	0
7/18	0	0	0	0	0	0	5	4	9	0	0	0	0	0	0	0	0	0
7/19	0	0	0	0	0	0	20	7	27	0	0	0	0	0	0	0	0	0
7/20	0	0	0	0	0	0	4	3	7	0	0	0	0	0	0	0	0	0
7/21	0	0	0	0	0	0	20	18	38	0	0	0	0	0	0	0	0	0
7/22	0	0	0	0	0	0	11	16	27	0	0	0	0	0	0	0	1	0
7/23	0	0	0	0	0	0	7	2	9	0	0	0	0	0	0	0	0	0
7/24	0	1	1	0	0	0	15	19	34	0	0	0	0	0	0	0	0	0
7/25	0	0	0	0	0	0	7	4	11	0	0	0	0	0	0	0	0	0
7/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Appendix B1.–Page 2 of 3.

	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
7/27	2	0	2	0	0	0	15	7	22	0	0	0	0	0	0	0	0	0
7/28	1	0	1	0	0	0	40	19	59	0	0	0	0	0	0	0	0	0
7/29	2	0	2	0	0	0	18	9	27	0	0	0	0	0	0	0	0	0
7/30	0	0	0	0	0	0	23	10	33	0	0	0	0	0	0	0	0	0
7/31	0	0	0	0	0	0	12	2	14	0	0	0	0	0	0	0	0	0
8/01	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/03	1	0	1	0	0	0	5	4	9	0	0	0	0	0	0	0	0	0
8/04	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/05	1	0	1	0	0	0	14	10	24	0	0	0	0	0	0	0	0	0
8/06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/10	6	3	9	0	0	0	35	21	56	0	0	0	0	0	0	0	0	0
8/11	3	0	3	0	0	0	18	4	22	0	0	0	0	0	0	0	0	0
8/12	0	0	0	0	0	0	6	3	9	0	0	0	0	0	0	0	1	0
8/13	4	1	5	0	0	0	4	3	7	0	0	0	0	0	0	0	0	0
8/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/15	0	0	0	0	0	0	12	5	17	0	0	0	0	0	0	0	0	0
8/16	1	0	1	0	0	0	2	1	3	0	0	0	0	0	0	0	0	0
8/17	0	0	0	0	0	0	9	3	12	0	0	0	0	0	0	0	0	0
8/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	0
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
8/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/29	0	0	0	0	0	0	0	0	0	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	2	0	2	0	0	0	0	0	0	0	0	0

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Appendix B1.–Page 3 of 3.

Date	Chinook Salmon			Sockeye Salmon			Chum Salmon			Pink Salmon			Coho Salmon			Longnose	White-	Northern
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Pike
9/01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/07	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0
9/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0
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	0	0	0	0	0	0
9/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

APPENDIX C

Appendix C1.–Daily weather and stream observations at the Takotna River weir site, 2008.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
6/24	8:00	3	5.4	11.0	11.0	78.5	1
	17:00	2	0.0	18.5	12.5	78.5	1
6/25	8:00	3	0.0	14.0	11.5	84	3
	17:00	3	0.0	27.5	13.5	85	3
6/26	8:00	1	0.0	12.5	12.0	79	2
	17:00	2	0.0	24.0	15.0	76	2
6/27	8:00	1	0.0	13.5	13.5	75	2
	17:00	4	0.0	21.5	14.5	73	2
6/28	8:00	4	5.8	13.0	12.5	72	1
	17:00	4	0.3	13.0	13.0	72	1
6/29	8:00	4	4.3	10.0	10.5	75	2
	17:00	4	3.8	11.5	12.5	85	2
6/30	8:00	4	4.6	11.0	9.5	110	3
	17:00	4	1.6	11.0	9.0	119.5	3
7/01	8:00	4	0.0	12.5	8.5	121	3
	17:00	3	0.0	22.0	10.0	119.5	3
7/02	8:00	3	0.0	ND	ND	107.5	3
	17:00	2	0.0	22.0	15.0	107	3
7/03	8:00	1	0.0	8.5	9.5	106.5	3
	17:00	4	0.0	22.0	11.0	100	3
7/04	8:00	1	0.0	13.0	10.0	95.5	3
	17:00	1	0.0	27.0	13.0	91	3
7/05	8:00	2	0.0	22.0	11.0	90.5	2
	17:00	1	0.0	26.0	15.0	90	2
7/06	8:00	2	0.0	13.0	12.0	84	2
	17:00	2	0.0	26.0	16.0	82	2
7/07	8:00	1	0.0	16.0	14.0	75	2
	17:00	3	0.0	22.0	16.5	75	2
7/08	8:00	4	0.5	13.5	13.0	80.5	2
	17:00	4	0.0	14.0	13.5	85	1
7/09	8:00	4	0.3	14.0	12.0	83	2
	17:00	3	0.0	20.0	14.0	82	1
7/10	8:00	2	0.0	13.0	11.5	81	1
	17:00	3	0.0	14.0	13.0	79	1
7/11	8:00	4	0.0	10.0	11.0	77	1
	17:00	4	0.0	16.0	13.0	77.5	1
7/12	8:00	2	0.0	12.0	11.0	76	1
	17:00	3	0.0	21.5	14.0	75	1
7/13	8:00	4	0.5	10.0	11.0	74.5	1
	17:00	3	0.0	16.0	14.0	74	1
7/14	8:00	4	0.1	9.0	10.0	73	1
	17:00	3	0.0	20.5	13.5	73	1
7/15	8:00	4	0.0	8.0	12.0	73	1
	17:00	4	0.0	14.0	12.0	72	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
7/16	8:00	4	1.0	13.0	11.0	71	1
	17:00	4	0.4	11.0	12.0	71	1
7/17	8:00	4	10.0	9.0	11.0	72	1
	17:00	4	0.4	11.0	12.0	73	1
7/18	8:00	4	0.0	8.0	10.0	73	1
	17:00	4	0.0	15.0	11.0	73	1
7/19	8:00	4	0.6	10.0	10.0	72	1
	17:00	4	1.2	15.0	12.0	71.5	1
7/20	8:00	4	0.2	10.0	10.0	70	1
	17:00	4	0.1	12.0	11.0	69	1
7/21	8:00	4	6.0	8.0	9.0	69	1
	17:00	2	0.3	15.0	14.0	69	1
7/22	8:00	1	0.0	5.0	10.0	71	1
	17:00	4	0.0	11.0	12.0	73	1
7/23	8:00	4	0.5	7.0	10.0	72	1
	17:00	3	0.2	16.0	11.0	70	1
7/24	8:00	4	0.0	7.0	10.0	68	1
	17:00	3	0.0	18.0	13.0	67	1
7/25	8:00	1	0.0	7.0	10.0	66.5	1
	17:00	3	0.0	23.0	11.0	66	1
7/26	8:00	1	0.0	7.0	10.0	66	1
	17:00	3	0.0	20.0	10.0	64	1
7/27	8:00	4	0.0	11.0	10.0	63	1
	17:00	4	0.8	13.0	13.0	63	1
7/28	8:00	3	0.0	10.0	8.0	63	1
	17:00	4	0.0	15.0	14.0	63	1
7/29	8:00	3	0.0	10.0	12.0	62	1
	17:00	2	0.0	20.0	13.0	62	1
7/30	8:00	4	0.3	10.0	11.0	61	1
	17:00	4	0.2	10.0	11.0	61	1
7/31	8:00	4	0.1	9.0	10.0	61	1
	17:00	4	0.0	10.0	11.5	61	1
8/01	8:00	3	0.0	10.0	11.5	61	1
	17:00	3	0.0	13.0	15.0	60	1
8/02	8:00	4	0.0	12.0	12.0	60	1
	17:00	4	0.0	19.0	12.0	60	1
8/03	8:00	1	0.0	11.0	9.0	59	1
	17:00	1	0.0	12.0	17.0	59	1
8/04	8:00	4	0.0	3.0	11.5	59	1
	17:00	4	0.0	13.0	13.5	58.5	1
8/05	8:00	1	0.0	11.0	10.0	58	1
	17:00	1	0.0	13.0	15.5	58	1
8/06	8:00	1	0.0	8.0	10.5	57	1
	17:00	3	0.0	15.0	14.0	57	1
8/07	8:00	2	0.0	4.0	11.0	52	1
	17:00	2	0.0	15.0	12.0	52	1
8/08	8:00	1	0.0	8.0	10.0	55	1
	17:00	2	0.1	16.0	14.5	55	1
8/09	8:00	3	0.0	4.0	10.0	55	1
	17:00	3	0.2	18.0	14.0	54	1
8/10	8:00	4	0.0	4.0	11.0	54	1
	17:00	3	12.5	17.0	11.0	54	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
8/11	8:00	5	0.4	6.0	9.0	54	1
	17:00	2	0.0	15.0	12.0	54	1
8/12	8:00	1	0.0	5.0	11.0	54	1
	17:00	3	0.0	20.0	16.0	54	1
8/13	8:00	1	0.5	8.0	11.5	54	1
	17:00	2	0.0	20.0	11.0	54	1
8/14	8:00	4	0.0	9.0	11.0	53	1
	17:00	4	0.0	18.0	15.0	53	1
8/15	8:00	4	0.0	11.0	11.0	53	1
	17:00	3	0.0	17.0	13.0	53	1
8/16	8:00	5	1.0	10.0	13.0	53	1
	17:00	2	0.0	20.0	15.0	54	1
8/17	8:00	5	19.0	12.0	13.0	54	1
	17:00	2	0.9	16.0	14.0	55	1
8/18	8:00	3	0.5	9.0	12.0	57	1
	17:00	2	4.0	15.0	15.0	61	1
8/19	8:00	2	0.0	8.0	12.0	63	1
	17:00	3	0.0	18.0	15.0	63	1
8/20	8:00	1	0.0	6.0	10.0	58.5	1
	17:00	3	0.0	13.0	9.0	58	1
8/21	8:00	1	0.0	4.0	9.0	56	1
	17:00	3	0.0	12.0	10.0	55	1
8/22	8:00	3	0.0	7.0	11.0	53	1
	17:00	3	0.0	18.0	13.0	53	1
8/23	8:00	1	0.0	4.0	10.0	52	1
	17:00	1	0.0	20.0	12.0	52	1
8/24	8:00	1	0.0	5.0	9.0	52	1
	17:00	1	0.0	19.0	14.0	52	1
8/25	8:00	2	0.0	3.0	9.0	50	1
	17:00	1	0.0	18.0	13.0	50	1
8/26	8:00	3	0.0	7.0	10.0	50	1
	17:00	4	0.0	17.0	12.0	50	1
8/27	8:00	4	13.0	8.0	9.0	53	1
	17:00	4	2.0	12.0	11.0	52	1
8/28	8:00	4	2.0	9.0	11.0	53	1
	17:00	4	0.5	11.0	14.0	53	1
8/29	8:00	1	0.0	4.0	8.0	54	1
	17:00	3	0.0	15.0	11.0	53.5	1
8/30	8:00	2	0.0	5.0	9.0	53	1
	17:00	2	0.0	18.0	14.0	52	1
8/31	8:00	4	0.0	5.0	10.0	51	1
	17:00	3	0.0	18.0	13.0	51	1
9/01	8:00	1	0.0	4.0	9.0	50	1
	17:00	2	0.0	22.0	10.0	50	1
9/02	8:00	2	0.0	3.0	9.0	49	1
	17:00	1	0.0	19.0	13.0	49	1
9/03	8:00	4	0.9	7.0	10.0	50	1
	17:00	4	0.5	15.0	13.0	50	1
9/04	8:00	4	0.7	9.0	11.0	50	1
	17:00	3	0.4	14.0	12.0	49	1
9/05	8:00	4	0.0	4.0	9.0	49	1
	17:00	3	0.0	15.0	10.0	49	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[c]
9/06	8:00	5	0.0	2.0	9.0	49	1
	17:00	4	0.0	17.0	13.0	49	1
9/07	8:00	3	1.0	9.0	12.0	49	1
	17:00	3	0.0	14.0	12.0	48	1
9/08	8:00	4	0.5	9.0	12.0	49	1
	17:00	4	0.0	15.0	13.0	48	1
9/09	8:00	4	0.0	10.0	10.0	48	1
	17:00	4	0.0	15.0	13.0	48	1
9/10	8:00	3	0.0	8.0	10.0	49	1
	17:00	4	0.0	13.0	13.0	48	1
9/11	8:00	5	8.0	9.0	10.0	49	1
	17:00	4	5.0	10.0	11.0	49	1
9/12	8:00	4	0.0	10.0	11.0	49	1
	17:00	4	7.0	12.0	11.0	49	1
9/13	8:00	5	2.3	9.0	10.0	52	1
	17:00	4	3.0	10.0	13.0	52	1
9/14	8:00	4	0.1	6.0	8.0	52	1
	17:00	3	0.4	14.0	8.0	52	1
9/15	8:00	3	0.6	9.0	7.0	53	1
	17:00	3	0.0	14.0	9.0	53	1
9/16	8:00	4	0.0	10.0	7.0	53	1
	17:00	4	0.0	12.0	7.0	53	1
9/17	8:00	3	1.0	8.0	9.0	53	1
	17:00	2	0.0	11.0	12.0	53	1
9/18	9:00	4	0.8	9.0	8.0	53	1
	17:00	4	0.0	10.5	8.5	54	1
9/19	9:00	5	0.0	9.0	9.0	53	1
	17:00	4	0.0	11.0	12.0	53	1
9/20	9:00	4	0.9	11.0	9.0	52	1
	17:00	2	0.0	9.0	6.0	52	1
9/21	9:00	4	0.5	4.0	8.0	51	1
	17:00	4	0.5	7.0	9.0	51	1
9/22	9:00						1
	17:00	4	1.5	13.0	9.0	51	1
9/23	9:00	4	6.4	10.0	9.0	52	1

[a] Sky condition codes:
0 = no observation
1 = clear or mostly clear; < 10% cloud cover
2 = partly cloudy; < 50% cloud cover
3 = mostly cloudy; > 50% cloud cover
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 between 0.5 and 1 meter
3 = visibility less than 0.5 meter

Appendix C2.–Daily stream temperature summary from Hobo® data logger at the Takotna River weir, 2008.

	Temperature (°C)		
Date	Avg.	Min.	Max.
6/24	12.2	11.4	13.4
6/25	12.5	11.3	14.0
6/26	13.5	12.1	15.4
6/27	14.4	13.6	15.2
6/28	13.4	12.8	14.4
6/29	12.1	11.5	13.4
6/30	10.0	9.3	11.3
7/01	9.4	8.5	10.7
7/02	10.6	9.4	12.2
7/03	11.4	10.3	12.4
7/04	11.9	10.5	13.8
7/05	13.6	12.0	15.5
7/06	14.8	13.4	16.4
7/07	15.5	14.4	16.7
7/08	14.2	13.6	15.9
7/09	13.2	12.5	14.1
7/10	12.7	11.9	13.4
7/11	12.3	11.5	13.1
7/12	12.4	11.2	13.7
7/13	12.6	11.6	13.7
7/14	12.5	11.6	14.0
7/15	12.6	12.4	13.1
7/16	12.2	11.6	12.8
7/17	11.6	11.0	12.5
7/18	10.9	10.1	11.7
7/19	11.2	10.7	11.7
7/20	10.9	10.5	11.4
7/21	11.1	10.1	12.5
7/22	11.2	9.8	12.5
7/23	11.6	10.8	12.4
7/24	11.3	10.0	12.5
7/25	12.6	10.9	14.9
7/26	13.2	12.6	14.3
7/27	12.6	11.8	13.3
7/28	13.4	11.9	15.5
7/29	13.3	12.7	14.8
7/30	11.6	11.1	12.6
7/31	11.1	10.4	12.4
8/01	12.7	11.7	14.6
8/02	12.6	12.2	13.8
8/03	12.1	10.5	13.9
8/04	12.7	12.3	13.5
8/05	12.6	11.3	14.7
8/06	12.7	11.8	13.4
8/07	12.8	11.8	14.0
8/08	12.6	11.2	13.9
8/09	12.0	11.0	13.0
8/10	12.3	11.2	13.9

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	Temperature (°C)		
Date	Avg.	Min.	Max.
8/11	13.0	11.5	14.8
8/12	13.5	12.2	14.6
8/13	13.7	12.7	14.5
8/14	13.8	12.9	14.8
8/15	13.9	13.3	14.7
8/16	14.3	13.5	16.0
8/17	14.2	13.7	15.3
8/18	13.4	12.3	14.4
8/19	13.1	12.2	14.2
8/20	12.9	11.6	14.2
8/21	12.6	11.2	13.5
8/22	12.9	11.9	13.8
8/23	12.5	11.0	14.1
8/24	12.6	11.3	14.0
8/25	12.2	10.6	14.0
8/26	12.3	11.3	13.3
8/27	12.5	11.8	13.1
8/28	11.8	11.4	12.5
8/29	11.1	10.1	11.9
8/30	11.2	10.2	12.2
8/31	11.4	10.6	12.3
9/01	11.1	9.8	12.7
9/02	11.3	10.0	12.8
9/03	11.4	10.6	12.2
9/04	11.6	11.1	12.2
9/05	10.8	9.7	12.1
9/06	10.5	9.1	11.7
9/07	11.0	10.2	12.0
9/08	11.6	10.9	12.6
9/09	10.9	10.3	11.7
9/10	10.5	9.8	11.2
9/11	10.9	10.2	11.6
9/12	10.4	9.9	10.8
9/13	9.9	9.6	10.2
9/14	9.6	9.1	10.1
9/15	9.7	9.2	10.5
9/16	9.9	9.4	10.3
9/17	9.4	9.0	9.9
9/18	8.9	8.4	9.3
9/19	8.5	7.9	9.3
9/20	8.1	7.5	8.9
9/21	7.8	7.1	8.5
9/22	6.9	6.2	7.9
9/23	6.3	6.0	6.6
9/24	6.3	5.9	6.8
Average:	11.8	10.9	12.9
Minimum:	6.3	5.9	6.6
Maximum:	15.5	14.4	16.7

APPENDIX D

Appendix D1.–Historical daily Chinook salmon passage at Takotna River weir during the target operational period.

Date	1995	1996	1997[a]	2000	2001	2002	2003	2004	2005	2006	2007	2008
6/24	[b]	0	12	0	1	1	[b]	1	1	0	0	0
6/25	[b]	0	30	2	3	0	[b]	2	0	1	0	1
6/26	[b]	9	24	2	1	0	[b]	3	4	0	0	0
6/27	[b]	17	9	1	4	2	[b]	7	3	0	0	1
6/28	[b]	8	33	0	1	4	[b]	16	23	0	0	1
6/29	[b]	21	36	1	1	3	[b]	4	14	2	0	0
6/30	[b]	18	57	1	13	1	[b]	16	50	0	3	7
7/01	[b]	15	0	0	17	5	[b]	2	1	3	1	5
7/02	[b]	12	30	15	4	0	10 [c]	1	1	3	0	3
7/03	[b]	12	72	16	23	1	5 [c]	4	1	0	20	5
7/04	[b]	73	66	3	10	2	0 [c]	23	10	12	15	5
7/05	[b]	39	54	14	1	3	6	6	13	11	17	5
7/06	[b]	10	54	7	3	11	6	17	21	12	15	2
7/07	4	37	33	12	15	17	6	6	15	17	6	11
7/08	7	24	54	37	110	32	10	19	21	24	11	10
7/09	2	3	69	9	17	7	37	147	11	51	42	7
7/10	8	4	51	3	69	2	23	16	38	32	33	4
7/11	41	5	69	8	9	93	10	15	22	21	42	3
7/12	8	5	48	22	30	51	16	14	17	20	20	3
7/13	12	7	24	1	45	2	24	3	56	15	10	10
7/14	17	7	66	3	29	2	5	16	17	17	10	3
7/15	9	9	27	4	41	2	2	12	3	0	32	10
7/16	6	0	12	4	28	0	5	9	43	3	3	10
7/17	0	20	36	2	17	3	9	4	15	19	5	12
7/18	12	11	48	6	14	5	22	9	6	13	12	10
7/19	12	9	12	4	31	4	26	1	18	41	10	5
7/20	6	8	15	8	26	9	26	3	7	61	14	14
7/21	0	7	3	7	23	5	8	6	1	42	25	23
7/22	9	5	12	39	21	2	15	2	3	12	5	40
7/23	0	4	9	2	13	0	6	26	7	12	3	30
7/24	0	3	18	5	17	0	11	1	4	4	3	32
7/25	0	0	15	17	10	6	7	0	7	3	7	35
7/26	0	0 [d]	18	3	11	5	4	9	0	6	7	9
7/27	0	0 [d]	12	9	6	2	9	2	3	9	8	4
7/28	0	1 [d]	6	5	11	1	6 [d]	3	9	4	6	18
7/29	0	0 [d]	15	9	3	8	6 [d]	2	6	4	2	11
7/30	3	1 [d]	0	5	2	5	6 [d]	12	0	8	0	10
7/31	0	5 [d]	0	2	4	0	5 [d]	0	2	7	0	4
8/01	0	2 [d]	3	1	1	2	5 [e]	0	1	1	2	8
8/02	0	1 [d]	6	1	3	0	4	1	0	11	0	6
8/03	0	0 [d]	3	5	0	0	5	0	1	11	0	7
8/04	0	2 [d]	0	8	2	1	5	1	1	5	1	4
8/05	0 [d]	1 [d]	2 [d]	7	1	0	4	6	3	3	4	2
8/06	0 [d]	0 [d]	0 [d]	4	4	1	1	2	3	0	3 [d]	4
8/07	0	0 [d]	2 [d]	1	1	2	2	1	1	4	3 [d]	5
8/08	0 [d]	2 [d]	2 [d]	7	3	0	5	0	0	0	3 [d]	1
8/09	0 [d]	0 [d]	2 [d]	7	1	3	2	2	1	1	2	2
8/10	0	1 [d]	0 [d]	0	2	2	0	1	1	1	5	1
8/11	0 [d]	0 [d]	2 [d]	3	1	0	0	0	1	2	1	2
8/12	0	0 [d]	0 [d]	6	2	4	0	0	0	0	1	2
8/13	0 [d]	1 [d]	0 [d]	2	1	1	0	2	1	0	2	1
8/14	0 [d]	1 [d]	5 [d]	1	1	0	2	0	0	1	0	0

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Appendix D1.–Page 2 of 2.

Date	1995	1996	1997	2000	2001	2002	2003	2004	2005	2006	2007	2008
8/15	0	1 [d]	0 [d]	0	0	1	0	1	0	4	0	1
8/16	0 [d]	0 [d]	0 [d]	0	1	0	0	0	2	0	0	0
8/17	0 [d]	0 [d]	0 [d]	0	0	0	1	0	0	1	0	0
8/18	0 [d]	0 [d]	0 [d]	2	1	0	2	1	0	0	0	1
8/19	0 [d]	1 [d]	0 [d]	0	0	0	1	1	0	1 [c]	0	0
8/20	0 [d]	0 [d]	0 [d]	0	1 [e]	0	1	1	0	0 [c]	1	1
8/21	0	1 [d]	0 [d]	0	1 [d]	0	1	0	0	0 [c]	0	1
8/22	0 [d]	0 [d]	5 [d]	0	1 [d]	0	0	0	0	1 [d]	1	0
8/23	0	0 [d]	2 [d]	0	1	0	2	0	0	1	0	0
8/24	0 [d]	0 [d]	2 [d]	0	0	0	0	1	2	0	1	0
8/25	0	0 [d]	2 [d]	0	0	1	1	0	1	0	0	0
8/26	0 [d]	0 [d]	2 [d]	0	1	0	1	1	1	1	0	0
8/27	0 [d]	0 [d]	2 [d]	1	1	0	1	0	1	0	0	0
8/28	0	0 [d]	0 [d]	0	1	0	0	0	1	0	0	0
8/29	0	0 [d]	0 [d]	0	1	0	0	0	1	0	0	0
8/30	0	0 [d]	0 [d]	0	1	0	0	0	0	0	0	0
8/31	0	0 [d]	0 [d]	0	1	0	0	0	0	1	0	0
9/01	0	0 [d]	0 [d]	0	0	0	1	0	0	0	0	0
9/02	[b]	0 [d]	2 [d]	0	0	0	0	0	0	0	0	0
9/03	[b]	0 [d]	0 [d]	0	1	0	0	0	0	0	0	0
9/04	[b]	0 [d]	0 [d]	0	1	0	0	0	1	0	0	0
9/05	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0	0
9/06	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0	0
9/07	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0	1
9/08	[b]	0 [d]	2 [d]	0	0	0	0	0	0	0	0	0
9/09	[b]	0 [d]	0 [d]	1	0	0	0	0	0	0	0	0
9/10	[b]	0 [d]	0 [d]	0	0	0	0	0	1	0	0	0
9/11	[b]	0 [d]	2 [d]	0	0	0	0	0	0	0	0	0
9/12	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0	0
9/13	[b]	0 [d]	0 [d]	0	0	1	0	0	1	0	0	0
9/14	[b]	0 [d]	0 [d]	0	0	0	0	0	0	0	0	0
9/15	[b]	0 [d]	0 [d]	0	0 [d]	1	0	0	0	0	1	0
9/16	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0	0	0	0	0
9/17	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0	0	0	0	0
9/18	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0	0	0	0	0
9/19	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0 [d]	0	0	0	0
9/20	[b]	0 [d]	0 [d]	0	0 [d]	0	0	0 [d]	0	0	0 [d]	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 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 D2.–Historical daily chum salmon passage at Takotna River weir during the target operational period.

Date	1995	1996	1997[a]	2000	2001	2002	2003	2004	2005	2006	2007	2008
6/24	[b]	0	12	1	3	29	0 [c]	4	2	20	1	9
6/25	[b]	0	30	24	9	55	0 [c]	8	4	21	8	12
6/26	[b]	9	24	23	10	55	1 [c]	31	9	32	1	7
6/27	[b]	17	9	11	12	111	5 [c]	28	9	65	15	26
6/28	[b]	8	33	9	4	116	7 [c]	32	14	70	19	19
6/29	[b]	21	36	6	19	168	4 [c]	29	16	94	18	20
6/30	[b]	18	57	6	20	147	12 [c]	34	40	157	43	32
7/01	[b]	15	0	10	42	180	10 [c]	54	24	175	44	36
7/02	[b]	12	30	18	24	72	40 [d]	41	41	181	53	41
7/03	[b]	12	72	17	47	145	57 [d]	59	47	306	159	104
7/04	[b]	73	66	39	40	94	54 [d]	58	86	309	147	109
7/05	[b]	39	54	12	21	250	111	48	222	351	166	111
7/06	[b]	10	54	45	60	204	120	108	205	593	149	179
7/07	4	37	33	44	106	251	126	66	301	616	252	155
7/08	7	24	54	101	188	124	137	65	398	459	239	191
7/09	2	3	69	49	78	110	142	92	200	480	374	175
7/10	8	4	51	27	204	205	88	87	327	462	415	160
7/11	41	5	69	58	198	259	47	74	193	469	533	182
7/12	8	5	48	29	372	266	77	73	223	488	421	279
7/13	12	7	24	49	275	80	62	23	220	448	471	210
7/14	17	7	66	50	309	103	140	33	189	517	514	221
7/15	9	9	27	35	265	97 [c]	129	22	241	413	255	266
7/16	6	0	12	33	257	88	155	31	291	392	346	289
7/17	0	20	36	51	206	117	150	57	414	392	347	242
7/18	12	11	48	34	264	73	172	92	301	393	349	277
7/19	12	9	12	59	352	161	187	29	373	443	380	229
7/20	6	8	15	50	301	109	231	36	313	355	375	193
7/21	0	7	3	43	212	72	155	15	142	441	477	276
7/22	9	5	12	53	215	95	168	25	240	321	315	232
7/23	0	4	9	33	165	79	87	58	153	288	281	190
7/24	0	3	18	23	168	67	69	33	122	318	192	110
7/25	0	0	15	25	145	62	63	15	127	268	251	125
7/26	0	0 [c]	18	20	93	53	53	24	141	254	252	121
7/27	0	0 [c]	12	14	117	23	53	13	93	248	161	96
7/28	0	1 [c]	6	11	135	49	50 [c]	13	150	216	154	123
7/29	0	0 [c]	15	18	58	39	46 [c]	17	121	133	72	95
7/30	3	1 [c]	0	12	64	21	43 [c]	26	56	163	110	63
7/31	0	5 [c]	0	10	68	15	39 [c]	17	55	156	63	54
8/01	0	2 [c]	3	3	38	21	36 [d]	12	33	135	61	51
8/02	0	1 [c]	6	12	30	22	29	8	37	131	34	62
8/03	0	0 [c]	3	2	34	15	35	3	34	148	38	36
8/04	0	2 [c]	0	22	30	17	32	5	44	131	27	45
8/05	0 [c]	1 [c]	2 [b]	5	38	5	44	4	24	64	25	40
8/06	0 [c]	0 [c]	0 [b]	11	25	4	28	5	37	62	28 [c]	37
8/07	0	0 [c]	2 [b]	5	16	13	18	4	24	54	29 [c]	28
8/08	0 [c]	2 [c]	2 [b]	11	11	3	11	2	23	68	31 [c]	20
8/09	0 [c]	0 [c]	2 [b]	5	13	5	6	3	5	29	44	18
8/10	0	1 [c]	0 [b]	10	8	6	6	1	10	25	20	15
8/11	0 [c]	0 [c]	2 [b]	6	8	6	6	2	10	28	28	4
8/12	0	0 [c]	0 [b]	6	5	4	4	4	8	16	21	7
8/13	0 [c]	1 [c]	0 [b]	2	2	2	10	2	8	21	18	6
8/14	0 [c]	1 [c]	5 [b]	0	3	0	7	1	5	34	10	8

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Date	1995	1996	1997	2000	2001	2002	2003	2004	2005	2006	2007	2008
8/15	0	1 [c]	0 [b]	0	2	0	6	0	5	19	22	5
8/16	0 [c]	0 [c]	0 [b]	0	1	3	5	0	3	22	6	5
8/17	0 [c]	0 [c]	0 [b]	0	0	1	0	1	2	16	7	6
8/18	0 [c]	0 [c]	0 [b]	0	7	0	2	1	3	10	3	5
8/19	0 [c]	1 [c]	0 [b]	0	4	0	0	1	5	12 [c]	4	6
8/20	0 [c]	0 [c]	0 [b]	1	3 [d]	1	4	0	0	10 [c]	4	3
8/21	0	1 [c]	0 [b]	0	3 [c]	0	2	0	7	9 [c]	0	5
8/22	0 [c]	0 [c]	5 [b]	0	3 [c]	0	0	0	0	7 [d]	5	9
8/23	0	0 [c]	2 [b]	0	0	1	5	0	1	3	2	1
8/24	0 [c]	0 [c]	2 [b]	0	1	1	0	0	6	8	0	3
8/25	0	0 [c]	2 [b]	0	2	2	1	0	0	2	0	2
8/26	0 [c]	0 [c]	2 [b]	0	0	0	0	0	0	4	1	0
8/27	0 [c]	0 [c]	2 [b]	0	0	0	0	0	2	4	0	0
8/28	0	0 [c]	0 [b]	0	1	0	1	0	2	5	2	0
8/29	0	0 [c]	0 [b]	1	0	0	0	0	0	4	0	0
8/30	0	0 [c]	0 [b]	0	0	0	0	0	1	4	0	0
8/31	0	0 [c]	0 [b]	0	0	1	1	0	1	2	0	0
9/01	0	0 [c]	0 [b]	0	0	0	0	0	1	0	1	0
9/02	[b]	0 [c]	2 [b]	0	0	0	0	0	0	0	0	0
9/03	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	0	1
9/04	[b]	0 [c]	0 [b]	0	0	0	0	1	1	3	0	0
9/05	[b]	0 [c]	0 [b]	0	0	0	0	0	2	0	1	1
9/06	[b]	0 [c]	0 [b]	0	0	0	1	0	2	0	0	0
9/07	[b]	0 [c]	0 [b]	0	0	0	1	0	2	0	0	0
9/08	[b]	0 [c]	2 [b]	0	0	0	1	0	1	0	0	0
9/09	[b]	0 [c]	0 [b]	0	0	0	1	0	1	0	0	0
9/10	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	3	1
9/11	[b]	0 [c]	2 [b]	0	0	0	0	0	0	1	0	0
9/12	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	0	0
9/13	[b]	0 [c]	0 [b]	0	0	0	0	0	0	0	1	0
9/14	[b]	0 [c]	0 [b]	0	0	0	0	0	2	0	0	0
9/15	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	2	0	1	0
9/16	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	1	1	1	1
9/17	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	0	0	0	0
9/18	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0	0	0	0	0
9/19	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0 [c]	0	0	1	0
9/20	[b]	0 [c]	0 [b]	0	0 [c]	0	0	0 [c]	0	0	0 [c]	1 [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 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] The weir or tower was not operational; daily passage was estimated.

[d] Partial day count; passage was estimated.

Appendix D3.–Historical daily coho salmon passage at Takotna River weir during the target operational period.

Date	2000	2001	2002	2003	2004	2005	2006	2007	2008
6/24	0	0	0	[a]	0	0	0	0	0
6/25	0	0	0	[a]	0	0	0	0	0
6/26	0	0	0	[a]	0	0	0	0	0
6/27	0	0	0	[a]	0	0	0	0	0
6/28	0	0	0	[a]	0	0	0	0	0
6/29	0	0	0	[a]	0	0	0	0	0
6/30	0	0	0	[a]	0	0	0	0	0
7/01	0	0	0	[a]	0	0	0	0	0
7/02	0	0	0	0 [b]	0	0	0	0	0
7/03	0	0	0	0 [b]	0	0	0	0	0
7/04	0	0	0	0 [b]	0	0	0	0	0
7/05	0	0	0	0	0	0	0	0	0
7/06	0	0	0	0	0	0	0	0	0
7/07	0	0	0	0	0	0	0	0	0
7/08	0	0	0	0	0	0	0	0	0
7/09	0	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	0	0	0
7/11	0	0	0	0	0	0	0	0	0
7/12	0	0	0	0	0	0	0	0	0
7/13	0	0	0	0	0	0	0	0	0
7/14	0	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	0	0	0
7/16	0	0	0	0	0	0	0	0	0
7/17	0	0	0	0	0	0	0	0	0
7/18	0	0	0	0	0	0	0	0	0
7/19	0	0	0	0	0	0	0	0	0
7/20	0	0	0	0	0	0	0	0	0
7/21	0	0	0	0	0	0	0	0	0
7/22	0	0	0	0	0	0	0	0	0
7/23	0	0	0	0	0	0	0	2	0
7/24	0	0	0	0	0	0	0	1	0
7/25	0	0	0	0	0	2	0	0	0
7/26	0	0	0	4	0	2	0	0	0
7/27	0	0	0	3	0	0	0	0	0
7/28	0	0	0	4 [c]	0	3	0	0	0
7/29	0	0	0	4 [c]	0	3	0	2	0
7/30	0	1	1	5 [c]	0	1	1	1	0
7/31	0	0	1	5 [c]	1	0	1	0	1
8/01	0	0	0	6 [d]	1	2	1	3	1
8/02	0	0	0	4	1	2	2	2	1
8/03	0	1	0	8	0	1	8	4	3
8/04	3	0	0	13	3	8	15	11	3
8/05	11	0	0	15	4	7	8	15	2
8/06	8	3	2	27	16	5	8	17 [c]	3
8/07	14	1	0	25	14	2	16	21 [c]	4
8/08	19	1	2	48	19	10	15	25 [c]	15
8/09	40	2	6	40	24	6	25	38	7
8/10	31	3	6	50	18	6	7	21	11
8/11	44	12	4	85	28	12	112	24	14
8/12	80	19	26	139	78	10	40	30	12
8/13	42	20	27	150	20	19	53	76	16
8/14	51	29	23	212	61	20	31	58	23

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Date	2000	2001	2002	2003	2004	2005	2006	2007	2008
8/15	58	31	36	140	60	22	74	56	23
8/16	54	51	49	131	92	14	118	81	42
8/17	98	44	20	121	182	18	175	79	74
8/18	146	77	159	160	124	57	121	49	69
8/19	192	66	17	348	56	22	159 [c]	147	120
8/20	80	91 [d]	11	197	74	25	170 [c]	136	58
8/21	387	91 [c]	266	356	57	26	182 [c]	115	95
8/22	178	91 [c]	326	254	61	27	193 [d]	73	147
8/23	241	74	328	176	88	111	125	135	52
8/24	152	145	397	189	57	258	283	167	84
8/25	107	156	301	217	137	204	290	47	82
8/26	86	275	267	299	572	114	111	43	102
8/27	314	175	107	429	73	84	232	96	207
8/28	490	151	134	335	44	69	231	155	149
8/29	140	164	121	288	74	102	138	232	82
8/30	120	104	127	219	46	163	235	167	46
8/31	62	137	205	267	37	55	115	119	147
9/01	70	105	133	285	398	80	231	144	52
9/02	66	92	107	277	330	21	155	86	98
9/03	54	71	63	192	70	47	126	57	128
9/04	70	73	90	91	11	106	104	30	88
9/05	46	68	118	262	20	85	74	43	93
9/06	100	26	134	209	3	82	254	5	56
9/07	42	13	109	188	6	59	132	14	66
9/08	25	14	79	200	23	45	328	30	71
9/09	30	14	39	131	18	37	164	30	51
9/10	36	15	19	70	192	40	105	22	28
9/11	40	11	21	78	0	31	119	18	46
9/12	27	24	37	83	0	26	66	26	37
9/13	29	12	13	79	0	16	65	16	40
9/14	16	15	14	28	9	17	61	11	69
9/15	9	6 [c]	16	10	3	13	41	17	46
9/16	15	11 [c]	7	9	2	13	54	15	23
9/17	5	3 [c]	7	4	0	4	48	9	23
9/18	8	5 [c]	2	1	0	0	42	10	37
9/19	10	6 [c]	2	1	0 [c]	0	43	14	48
9/20	11	7 [c]	5	0	0 [c]	2	41	7 [c]	22

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 E

Appendix E1.–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	-	-	0	-	-
1999	ND [d]	0	-	-	114	14	-	-
2000	345	-	-	281	124	3	-	-
2001	721 [e]	-	101	163	62	2	326 [f]	0.45
2002	316	0	228	140	104	ND	472 [g]	1.49
2003	378 [e]	9	212	216	ND	ND	-	-
2004	461 [e]	0	90	ND	ND	ND	-	-
2005	499 [e]	0	ND	ND	ND	ND	ND	ND
2006	539	ND	ND	ND	ND	ND	ND	ND
2007	418	ND	ND	ND	ND	ND	ND	ND
2008	413	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.
[f] Does not include possible 3-year-old fish.
[g] Does not include possible 7-year-old fish.

Appendix E2.–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	359	11,756	2.69
2003	3,393		276	5,350	3,487	ND	-	-
2004	1,630		305	1,846	ND	ND	-	-
2005	6,467		0	ND	ND	ND	ND	ND
2006	12,598		ND	ND	ND	ND	ND	ND
2007	8,900		ND	ND	ND	ND	ND	ND
2008	5,691		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.–Brood table for Takotna River coho salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year 3	4	5	Returns[a]	Return per Spawner[a]
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	593	3,420	0.48
2004	3,207	64	2,163	ND	-	-
2005	2,216	61	ND	ND	ND	ND
2006	5,548	ND	ND	ND	ND	ND
2007	2,853	ND	ND	ND	ND	ND
2008	2,817	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.