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Kogrukluk River Salmon Studies, 2005

by

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and

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March 2007

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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KOGRUKLUK RIVER SALMON STUDIES, 2005

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ABSTRACT

The Kogrukluk River is located in the upper Holitna River basin, which is a major tributary of the Kuskokwim River, and produces Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, sockeye salmon *O. nerka*, and coho salmon *O. kisutch* that contribute to intensive subsistence and commercial salmon fisheries downstream. The Kogrukluk River weir is one of several projects operated in the Kuskokwim Area that form an integrated geographic array of escapement monitoring projects. Collectively, and in accordance with the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222), this array of projects is a tool to ensure appropriate geographic and temporal distribution of spawners, and provide a means to assess trends in escapement that should be monitored and considered in harvest management decisions. Towards this end, the Kogrukluk River weir has been operated annually since 1976 to determine daily and total salmon escapements; to estimate age, sex, and length compositions of Chinook, chum, and coho salmon escapement; to monitor environmental variables that influence salmon productivity; and to provide part of an integrated platform in support of other Kuskokwim Area fisheries projects.

In 2005, a fixed-picket weir was successfully operated on the Kogrukluk River from 22 June through 22 September, with a total of 6 inoperable days. The total annual Chinook salmon escapement of 22,000 fish was above the sustainable escapement goal (SEG) range of 5,300 to 14,000 fish. Total annual chum salmon escapement was 197,723, which was above the SEG range of 15,000 to 49,000 fish. Total annual sockeye salmon escapement was 37,939, above the recent 10-year average of about 12,067 fish. The total annual coho salmon escapement of 24,116 was within the SEG range of 13,000 to 28,000 fish. Age, sex, and length (ASL) samples were taken from 3.3% of the Chinook escapement, 0.6% of the chum escapement, and 1.9% of the coho escapement. The Chinook sample composition included 46.5% age-1.3 fish, 28.1% age-1.4 fish, 24.3% age-1.2 fish, and 34.7% females. The chum salmon escapement was comprised of 90.5% age-0.3 fish, 5.6% age-0.4 fish, 4.0% age-0.2 fish, and 45.1% females. The coho salmon escapement was comprised of 84.9% age-2.1 fish, 9.1% age-3.1 fish, 6.0% age-1.1 fish, and 49.7% females. In addition to enumerating escapement and estimating ASL composition, the weir served as a platform for several other projects such as *Kuskokwim River Chinook Salmon Stock Assessment Project* (radiotelemetry), *Kuskokwim River Sockeye Salmon Radiotelemetry Pilot Project*, *Kuskokwim River salmon tagging project*, and *Kuskokwim River Chinook Salmon Genetic Diversity Project*. The objectives relating to these projects were fully achieved in 2005.

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

INTRODUCTION

The Kuskokwim River is the second largest river in Alaska, draining an area approximately 130,000 km^2 (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 over one million salmon (Whitmore et al. 2005). The subsistence salmon fishery in the Kuskokwim Area is one of the largest in the state, and remains a fundamental component of local culture (ADF&G 2004; Coffing 1991, *Unpublished* a, b; Coffing et al. 2000; Whitmore et al. 2005). The commercial salmon fishery, though modest in value compared to other areas of Alaska, has been an important component of the market economy of lower Kuskokwim River communities (Buklis 1999; Whitmore et al. 2005).

The Kogrukluk River is located in the upper Holitna River basin, which is one of the largest salmon-producing tributaries of the Kuskokwim River drainage. Salmon escapements in the Holitna River basin have been documented since 1961, when the first aerial survey was flown (Burkey 1994; Schneiderhan *Unpublished*). The importance of the Holitna River as a salmon producer and the necessity to closely monitor salmon escapement motivated the Alaska

Department of Fish and Game (ADF&G) to establish a weir on the Kogrukluk River in 1976 (Figures 1 and 2; Baxter *Unpublished* a). Kogrukluk River salmon escapements are a relatively small percentage of overall salmon escapements in the Kuskokwim River drainage; however, this tributary appears to support an above average number of spawning Chinook *O. tshawytscha*, chum *O. keta*, sockeye *O. nerka*, and coho *O. kisutch* salmon when compared to other Kuskokwim River tributaries of similar size (Burkey et al. 1999). According to results from recent radiotelemetry projects conducted in the mainstem Kuskokwim River (Stuby 2003, 2004, 2005) and the Holitna River (Chythlook and Evenson 2003; Stroka and Brase 2004; Stroka and Reed 2005; Wuttig and Evenson 2002), Chinook salmon escapement at the Kogrukluk River weir constitutes about 25% of the total Chinook salmon escapement to the Holitna River, and about 10% of the total Chinook salmon run upstream of the Aniak River confluence. Furthermore, results from the Holitna River radiotelemetry project indicate that total chum salmon escapement to the Kogrukluk River weir comprises 5–10% of the total chum salmon escapement to the Holitna River system (Chythlook and Evenson 2003; Stroka and Brase 2004; Stroka and Reed 2005; Wuttig and Evenson 2002). Neither radiotelemetry project provides useful insight about the abundance of coho salmon in the Kogrukluk River system relative to other tributaries because the proportions of radio-tagged coho salmon passing the Kogrukluk River weir were highly variable in the few years of the Holitna radiotelemetry project (Chythlook and Evenson 2003; Stroka and Brase 2004; Stroka and Reed 2005; Wuttig and Evenson 2002).

Managing for sustainable salmon fisheries in the Kuskokwim River is challenging due in part to the lack of abundance and run-timing information, both for total run and constituent stocks. Historically, few salmon spawning streams within the Kuskokwim River basin have been the focus of rigorous salmon escapement monitoring, which has limited the ability of managers to assess the adequacy of escapements and the effects of management decisions. The need for long-term escapement monitoring projects such as the Kogrukluk River weir became more evident in September 2000, when the Alaska Board of Fisheries (BOF) classified both Kuskokwim River Chinook and chum salmon as “yield concerns” (5 AAC 39.222, 2001) due to the chronic inability of those stocks to maintain expected harvest levels despite the use of specific management measures (Burkey et al. 2000 a, b).

In response to the yield concern finding, ADF&G has annually initiated three conservation measures: 1) subsistence fishers were required to follow a fishing schedule in June and July that included 3 consecutive days each week when the fishery was closed, 2) commercial fishing was closed in Districts W-1 and W-2 in June and July or until managers had sufficient evidence that escapement goals would be achieved, and 3) the northern boundary of District W-4 was moved south by about 5 km to make it more distant from the Kuskokwim River (Whitmore et al. 2005). The yield concern finding was continued following the January 2004 BOF meeting (Bergstrom and Whitmore 2004), although the original northern boundary of District W-4 was reinstated. In practice, however, the conservation measures were largely rescinded in 2005 because most run assessment tools indicated strong runs of Chinook and chum salmon.

In the early 1980s, fisheries management shifted from a strategy emphasizing guideline harvest levels to a strategy emphasizing escapement. ADF&G established species-specific escapement goals for streams such as the Kogrukluk River that had sufficient historical baseline information (Buklis 1993). These escapement goals were later termed biological escapement goals (BEGs) and more recently sustainable escapement goals (SEGs). SEGs are levels of escapement, indicated by an index or an escapement estimate, which are known to provide for sustained yield over a 5–10 year period (ADF&G 2004). The first formal escapement goals were established at the Kogrukluk River weir in 1983 for Chinook (10,000), chum (20,000), sockeye (2,000), and coho salmon (20,000). In 1984, escapement goals were increased to 30,000 for chum and 25,000 for coho salmon. Escapement goals for the Kogrukluk River weir were revised again in January 2004 and were in effect for the 2005 season (ADF&G 2004). These most recent escapement goals, expressed as ranges, are 5,300 to 14,000 Chinook salmon, 15,000 to 49,000 chum salmon, and 13,000 to 28,000 coho salmon. The escapement goal of 2,000 sockeye salmon was discontinued around 1995 because sockeye enumeration was considered ancillary and sockeye catch considered incidental (Burkey et al. 1997).

The Kogrukluk River weir continues to be the only project in the Kuskokwim River drainage with a formal escapement goal for coho salmon, the only ground-based project in the drainage with a formal escapement goal for Chinook salmon, and one of only two with an escapement goal for chum salmon, the other being a sonar project located in the Aniak River (Figure 1; Whitmore et al. 2005). The Aniak River chum salmon escapement goal is derived from sonar counts of unapportioned fish passage and is used as an index of chum salmon escapement. All other escapement goals in the Kuskokwim River drainage are based on peak aerial survey counts and are for Chinook salmon.

BACKGROUND

The Kogrukluk River, along with the Chukowan River and Shotgun Creek, forms the headwaters of the Holitna River. In the dialect of the upper Kuskokwim River Yup'ik people, Kogrukluk means "middle fork" (Evan Ignatti, elder, Kashegelok; personal communication). In the early 1800s, the Holitna River was an important route for the Russian fur-trading link to Bristol Bay and the Kuskokwim River (Oswalt 1990). Twice yearly, Russian explorers and traders traveled north and south along the Holitna and Nushagak Rivers, making a 5-day portage between Shotgun Creek and the Chichitnok River to complete the passage (Brown 1983; Oswalt 1990). Until 1845, this served as the primary supply route to the first Russian station on the Kuskokwim River, which was located at the mouth of the Holitna River. To service this trade route, a number of communities were established along the Holitna River including Kashegelok, Nogamut, and Itulilik. Residents of Holitna River communities made their living from subsistence hunting and fishing, relying heavily on the abundant Holitna River salmon runs and supplementing their livelihoods through the fur trade (Brown 1983; Oswalt 1990; Evan Ignatti, elder, Kashegelok; personal communication). In the 1930s the Red Devil mercury mine opened, creating jobs and luring Holitna villagers into the communities of Red Devil and Sleetmute. As the fur trade declined and other opportunities arose, the Holitna River villages were slowly abandoned. The last 2 residents (Evan Ignatti and Ignatti Ignatti) of the village of Kashegelok relocated to Red Devil in 2003. Today, there are a number of lodges and homesteads mostly on the lower Holitna River. The Holitna River drainage continues to draw users from throughout the Kuskokwim River drainage and beyond, and remains an important area for subsistence fishing, sport fishing, and hunting.

The importance of the Holitna River and its tributaries as a key salmon spawning system in the Kuskokwim River drainage has been recognized by state managers since at least 1961 (Schneiderhan *Unpublished*). In 1969, a salmon counting tower project was initiated on the Kogrukluk River upstream of the confluence of Shotgun Creek (Figure 2; Yanagawa 1972). The tower was relocated twice between 1970 and 1978 because of shifting river channels, but always remained upstream of the mouth of Shotgun Creek. In order to more accurately assess salmon escapements, installation of a counting weir was attempted in 1971 near the counting tower site, but the weir was destroyed by high water early in the season (Yanagawa 1973). Both tower and weir operations in this section of the Kogrukluk River were hindered by log jams and shifting channels. Inadequacies of the existing tower sites and the absence of more suitable tower sites resulted in a transition from a counting tower to a weir between 1976 and 1978 (Baxter 1979). Because the weir was located below the confluence of Shotgun Creek, both tower and weir projects were operated concurrently from 1976 to 1978 to compare escapement estimates between projects. Beginning in 1981, weir operational periods were extended to include coho salmon (Baxter 1982). Since the BOF yield concern findings in 2000, several mainstem and regional projects have depended on the Kogrukluk River weir as a platform for studies to determine stock-specific run timing through tag recoveries (Kerkvliet et al. 2004), to determine marked-to-unmarked ratios for abundance estimates (Stuby 2004), and to collect stock-specific baseline samples for genetic stock identification studies (Templin et al. 2004), among others. The Kogrukluk River weir (also known as the Ignatti weir or Holitna River weir) has the longest operational history of any ground-based escapement monitoring project in the Kuskokwim Area.

OBJECTIVES

The objectives of the Kogrukluk River escapement monitoring project in 2005 were to:

1. Determine the daily and total annual escapement of Chinook, chum, sockeye, and coho salmon to the Kogrukluk River,
2. Estimate the age, sex, and length (ASL) composition of total annual Chinook, chum, and coho salmon escapements from a minimum of 3 pulse samples, one collected from each third of the run, such that 95% simultaneous confidence intervals for the age composition in each pulse are no wider than 0.20 (α = 0.05 and d = 0.10),
3. Monitor habitat variables and determine possible effects of water level and water temperature on salmon migration past the weir, and
4. Provide for collaborative, efficient research in the Kuskokwim River system by:
    a. Serving as a monitoring location for Chinook salmon equipped with radio transmitters deployed as part of the *Inriver Abundance of Chinook Salmon in the Kuskokwim River Project*,
    b. Serving as a monitoring location for sockeye salmon equipped with radio transmitters deployed as part of *Kuskokwim River Sockeye Salmon Radiotelemetry Feasibility Study*,
    c. Serving as a recovery location for tagged Chinook, sockeye, chum, and coho salmon in support of *Kuskokwim River Salmon Mark–Recapture Project*, and
    d. Serving as a collection site for salmon genetic samples for the *Genetic Diversity of Chinook Salmon from the Kuskokwim River Project.*

METHODS

Study Area

The Kogrukluk River is formed by surface runoff from the north side of a low plateau dividing the Tikchik Lakes and Nushagak River basins from the Holitna and Kuskokwim River basins. From its headwaters near Nishlik Lake, the Kogrukluk River flows northerly for approximately 80 river kilometers (rkm). The Kogrukluk River joins the Chukowan River and Shotgun Creek near the abandoned village site of Kashegelok to form the headwaters of the Holitna River (Figure 2).

The Kogrukluk River descends approximately 250 m with an average drop of 3.2 m per km across a 1 to 5 km wide flood plain (Figure 3; Collazzi 1989). The flood plain is composed of soft sediments that erode easily, allowing the river to change coarse quickly and to form oxbows and sloughs favored by sockeye salmon as spawning habitat (Baxter *Unpublished* b). Sometime between 1940 and 1960, the Holitna River below the confluence of the Kogrukluk and the Chukowan rivers shifted to the east, effectively destroying the village of Kashegelok (Evan Ignatti, elder, Kashegelok; personal communication). During the spring flood of 2003, the Chukowan River cut a second mouth at its confluence with the Holitna River, building a gravel bar across the channel in an area traditionally favored as a floatplane landing site. At normal flow, the Kogrukluk River has a nominal load of suspended materials, making the water clear except at periods of high flow when it may be stained due to organic leaching.

The flood plain is poorly drained. Low-lying mixed spruce and cottonwood forest are interspersed with wet tundra. Large log jams are common, creating ideal rearing habitats for juvenile Chinook and coho salmon (Healy 1991). Riparian areas consist of mixed spruce and cottonwood forest, and colonial willows and alders on banks and gravel bars. Uplands are typically rolling spruce-hardwood forest, with alpine tundra above 200 m. White spruce, birch, and aspen are common on moderate south-facing slopes and black spruce are common on north-facing slopes, poorly drained areas, and pockets of permafrost. The understory consists of spongy moss and low brush on cool moist slopes, grasses on dry slopes, and willow, alder, and dwarf birch near timberline.

Weir Design

Installation Site

Located approximately 220 rkm from the village of Sleetmute and 212 km by air from the city of Bethel, the Kogrukluk River weir is the most remote ground-based escapement project in the Kuskokwim Area (Figure 1). Personnel and supplies are transported to and from the weir by floatplane.

The weir is located approximately 710 rkm from the mouth of the Kuskokwim River, about 1 rkm upstream from the confluence with the Chukowan River, and about 3 rkm downstream of the Shotgun Creek confluence (Figure 2). The weir has been at this location since 1976 (Baxter *Unpublished* a). Areas further downstream were considered unsuitable due to excessive water depth, channel width, and the occurrence of braided channels.

At the weir site, the Kogrukluk River is approximately 67 m wide and 4 m deep from bank level to the bottom of the channel. During normal summer operations, river depth is about 1.3 m in the deepest section. The weir is positioned in the center of a 2 km stretch of relatively straight channel. Banks are composed of soft sediment and bottom material is primarily composed of gravel and cobbles. The weir site is at the base of a southwest-facing hillside.

Construction

The design and materials used to construct the Kogrukluk River weir in 2005 were the same as those described by Baxter (1981), with the exception of an improved fish trap and a tighter picket spacing. The fish trap was modeled after the trap used at the George River and was first used in 2001 (Linderman et al. 2002). The picket spacing was narrowed in 2005 after investigators observed small chum salmon passing through the pickets in 2004, a year that was characterized by an unusually high abundance of small, 3 year old chum salmon. Improvements to the weir included reducing the picket intervals from 76.2 mm to 63.5 mm, which narrowed the gap from 49.0 to 36.5 mm. As in past years, the fixed-picket weir spanned a 70-m channel, with a fish trap located 30–50 m from the east bank.

Boat traffic at the weir was rare, but when necessary, boats were passed by removing weir pickets and pulling the boat through the opening (Baxter 1981). Fish that passed upstream during this process were counted and added to the daily passage.

Maintenance

The weir was cleaned and inspected daily. Smaller debris that accumulated around the weir pickets, such as sticks, leaves, fibrous root mats, algae, and fish carcasses, was removed and passed downstream. Larger debris such as logs and large root clumps was typically removed using chainsaws, axes, and ropes, and sometimes required partial dismantling of the weir.

The daily cleaning routine included a visual inspection of the weir for signs of substrate scouring, damaged pickets, or other conditions that could compromise operations. Periodically the crew conducted a more thorough inspection by snorkeling along the leading edge of the weir. Problems were addressed immediately. Areas showing signs of substrate scouring were addressed with sandbags or comparable means.

ESCAPEMENT MONITORING

Passage Counts

Salmon passing upstream through the weir were counted and recorded by species and sex, excluding fish that were small enough to pass freely between the weir pickets. Fish were enumerated 4–8 times a day between 0730 and 2400 hours, though frequency and duration of counting periods varied depending on fish behavior and abundance. The daily passage was tallied by species and sex and recorded in a logbook.

Fish passage generally occurred through the fish trap to facilitate recapture of tagged fish. An observer positioned on the trap viewed fish entering from the downstream side through a clear-bottom viewing box that reduced glare and water turbulence. In addition to clear identification of fish, this allowed observers to anticipate and effectively trap tagged fish. When salmon were reluctant to enter the fish trap, such as during periods of extreme low water, it was necessary to employ an alternative counting method in which the observer removed a few weir pickets and counted fish while positioned on the boardwalk above the weir. A “flash-panel” composed of light colored material, such as an aluminum weir panel or a painted board, was used to increase contrast and visibility. On occasion, fish that had previously passed upstream of the weir would move back downstream through this temporary gap. Such fish were subtracted from daily counts unless it was obvious that the fish had already spawned.

Visual determination of sex was possible due to advanced sexual dimorphism. For example, females became obviously swollen and round behind the pectoral fins, had blunt, bullet-shaped heads, and swam with steady, wide strokes. Males exhibited an exaggerated elongation of the kype, were streamlined and muscular in appearance, and swam with short, powerful strokes. Though some variation exists, these differences were applicable to all salmon species observed. The abovementioned viewing box greatly improved identification, although the presence of a flash-panel on the river bottom was usually sufficient for making these determinations.

Estimating Missed Passage

Total annual escapement was determined by combining total observed passage with any passage estimates made for inoperable periods. The passage estimate for a single inoperable day was calculated as the average of the observed passage for 2 days before and 2 days after the inoperable period, minus any observed passage from the inoperable day. Daily passage estimates for inoperable periods lasting 2 or more days were calculated by a linear interpolation of the average observed passage for 2 days before and after the inoperable period using the following formula:

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

where,

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

$$\beta = \frac{\left(n_{d_I+1} + n_{d_I+2}\right) - \left(n_{d_1-1} + n_{d_1-2}\right)}{2(I+1)}, \tag{3}$$

for (1, 2, …, *i*, …*I*)

where

$\hat{n}_{d_i}$ = passage estimate for the i^{th} day (1, 2, …, *i*, …*I*) of a multiple day breach event;

n_{d_I+1} = observed passage the first day after the inoperable period (d_I);

n_{d_I+2} = observed passage the second day after the inoperable period (d_I);

n_{d_1-1} = observed passage 1 day before the inoperable period;

n_{d_1-2} = observed passage 2 days before the inoperable period;

I = number of days the inoperable period lasted.

This method was used in 2003, 2004, and 2005, but varied from previous years. Clark and Salomone (2002) described details about past practices for estimating missed daily passages.

Carcasses

Spent and dead salmon (hereafter referred to as carcasses) that accumulated on the weir were counted by species before being passed downstream. The daily carcass count was tallied by species and recorded in the logbook.

Age, Sex, and Length Composition

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

Sample Collection

The crew at the weir employed standard ASL sampling techniques as described by DuBois and Molyneaux (2000). A pulse sampling design was used, in which intensive sampling was conducted for 1–4 days followed by a few days without sampling. The goal of each pulse was to collect samples from 210 Chinook, 210 chum, and 170 coho salmon. These sample sizes were selected so that the simultaneous 95% confidence interval estimates of age and sex composition proportions would be no wider than 0.20 (Bromaghin 1993) per pulse for Chinook salmon assuming 10 age/sex categories, for chum salmon assuming 8 age/sex categories, and for coho salmon assuming 6 age/sex categories. Sample sizes for coho salmon were increased from 70 to 170 fish per pulse in 2005, which allowed the characterization of each third of the run. Samples sizes were increased by about 10% from that recommended by Bromaghin (1993) to account for scales that could not be aged. The minimum acceptable number of pulse samples was 3 per species, 1 pulse sample from each third of the run, to account for temporal dynamics in the ASL composition. The need for achieving the pulse sample objectives, however, was weighed against the need to collect the samples over a brief period of time, the abundance of the species at the time of collection, and the need to avoid undue delay to the salmon migration.

Salmon were sampled from the fish trap, which included an entrance gate, holding box, and exit gate. On days when sampling was conducted, the entrance gate was opened while the exit gate remained closed, allowing fish to accumulate inside the 1.5 by 2.5 m holding box. The holding box was allowed to fill with fish and sampling was done during scheduled counting periods.

Crew members used a dip net to remove fish from the holding pen. Fish were removed from the dip net and placed into a partially submerged fish cradle. Three scales were taken from the preferred area as described in standard procedures, and used at a later date to determine the age of the fish (DuBois and Molyneaux 2000). Sex was determined through visual examination of the external morphology, keying on the development of the kype, roundness of the belly, and the presence or absence of an ovipositor. Length was measured to the nearest millimeter from mideye to tail fork using a straight-edged meter stick. After sampling, each fish was released upstream of the weir. Scales were placed on gum cards and sampling information was recorded. This information was later transferred to computer mark-sense data forms. The procedure was repeated until the holding pen was emptied. Completed gum cards and data forms were sent to the Bethel or Anchorage ADF&G office for aging and processing.

Additional Chinook and coho salmon samples were collected through active sampling. Active sampling required that a crew member be positioned on the platform above the downstream end of the trap to observe fish entering the holding pen. Both the entrance and exit gates would remain open, which allowed most species to pass unimpeded, and increased current flow through the structure. Fish were more likely to enter the trap with both gates open. When a Chinook or coho salmon entered the holding pen, the crew member would immediately close both the entrance and exit gates, thereby actively trapping the fish inside the holding box for sampling. This method was useful in isolating the relatively few Chinook salmon from larger volumes of chum and sockeye passing at the same time and improved ASL sampling success.

Estimating Age, Sex, and Length Composition

ADF&G staff in Bethel and Anchorage aged scales, processed the ASL data, and generated data summaries. DuBois and Molyneaux (2000) describe details of the processing and summarizing procedures. These procedures generated two types of summary tables for each species; one described the age and sex composition and the other described length statistics. These summaries accounted for changes in the ASL composition throughout the season by first partitioning the season into temporal strata based on pulse sample dates, then applying the ASL composition of individual pulse samples to the corresponding temporal stratum, and finally summing the strata to generate the estimated ASL composition for the season. This procedure ensured that the ASL composition of the total annual escapement was weighted by the abundance of fish in the escapement rather than the abundance of fish in the samples. For example, if samples of chum salmon were collected in 6 pulses, then the season was partitioned into 6 temporal strata with 1 pulse sample occurring in each stratum. A sample of 168 chum salmon collected from 7 to 8 July was used to estimate the ASL composition of the 4,305 chum salmon that passed the weir during the temporal stratum that extended from 6 to 13 July. This procedure was repeated for each stratum, and the estimated age and sex composition for the total annual escapement was calculated as the sum of chum salmon in each stratum. In similar fashion, the estimated mean length composition for the total annual escapement would be calculated by weighting the mean lengths in each stratum by the escapement of chum salmon that passed the weir during that stratum. Confidence intervals were constructed for the estimated mean lengths according to Thompson (1992, p.105).

Ages are reported using European notation, which is composed of 2 numerals separated by a decimal. The first numeral indicates the number of winters the juvenile has spent in freshwater and the second numeral indicates the number of winters spent in the ocean (Groot and Margolis 1991). Total age of a fish is equal to the sum of these 2 numerals, plus 1 year to account for the winter when the egg was incubating in gravel. For example, a Chinook salmon described as an age-1.4 fish is actually 6 years of age.

WEATHER AND STREAM OBSERVATIONS

Water and air temperatures were measured each day at approximately 0730 and 1700 hours. Water temperature was determined by submerging a calibrated thermometer below the water surface until the temperature reading stabilized. Air temperature was obtained from a thermometer attached to an outside wall of the cabin in a shaded location. Temperature readings were recorded in the logbook, along with notations about wind direction, estimated wind speed, cloud cover, and precipitation. Daily precipitation was measured using a rain gauge.

Daily operations included monitoring river depth with a standardized staff gauge. The staff gauge consisted of a metal rod driven into the stream channel with a meter stick attached. The height of the water surface, as measured from the meter stick, represented the “stage” of the river above an established datum plane. The staff gauge was calibrated to the datum plane by a semi-permanent benchmark to provide for consistent stage measurements between years. The benchmark consisted of a nail driven into the second step of a wooden staircase leading from the riverbank to the utility shed, which represents a measurement of 5 m above baseline and corresponds to the highest water level observed at the Kogrukluk River weir. Water stage was measured at approximately 0730 and 1700 hours.

RELATED FISHERIES PROJECTS

Inriver Abundance of Chinook Salmon in the Kuskokwim River Project

The Kogrukluk River weir was used as a platform for the project entitled *Inriver Abundance of Chinook Salmon in the Kuskokwim River*. For this study, radio transmitters were inserted into Chinook salmon caught near Kalskag, and radio receiver stations placed throughout the Kuskokwim River drainage monitored the movement of tagged Chinook salmon (Stuby *In prep*). Four receiver stations were placed in the Holitna River drainage: one near the confluence with the mainstem Kuskokwim River, one in the lower Holitna River, one in the lower Hoholitna River, and one just upstream of the Kogrukluk River weir. Each Chinook salmon captured at the Kalskag tagging site for radio-tagging was fitted with a blue spaghetti tag that allowed the weir crew to observe and recapture radio-tagged fish in the fish trap. For each recaptured fish, the crew recorded date of recapture, tag number, tag color, and the general condition of the fish. The known Chinook salmon passage at the weir, coupled with data collected from receiver stations, was used with similar data collected at other weir projects to develop estimates of the total Chinook salmon abundance upstream of the Aniak River (Stuby *In prep*).

Kuskokwim River Sockeye Salmon Radiotelemetry Feasibility Study

The Kogrukluk River weir was also used as a platform for the project entitled *Kuskokwim River Sockeye Radiotelemetry Feasibility Study*. For this project, radio transmitters were inserted into sockeye salmon caught at the Kalskag tagging site and receiver stations throughout the Kuskokwim River drainage monitored the movement of tagged sockeye salmon (Gilk *Unpublished*). Similar to the Chinook project, each salmon was equipped with a radio transmitter and a white spaghetti tag that allowed the weir crew to observe and recapture radio-tagged fish in the fish trap. Both radiotelemetry projects shared the same receiver stations in the Kuskokwim River system. The study was designed to examine the feasibility of a sockeye salmon radiotelemetry project in the Kuskokwim River.

Kuskokwim River Salmon Mark–Recapture Project

Chinook, chum, sockeye, and coho salmon were marked using Floy®[1] anchor tags at fish wheels located near Kalskag in an effort to estimate stock-specific run timing and travel speed, and to estimate total abundance for coho salmon in the Kuskokwim River (Pawluk, Baumer et al. 2006). The Kogrukluk River weir served as one of several tag recovery locations for the project entitled *Kuskokwim River Salmon Mark–Recapture Project*.

The weir crew recaptured tagged fish in the fish trap and recorded the date of recapture, species, tag color, and tag number (when recovered). The tagged fish were recaptured in the same manner as the active sampling technique described for the ASL sampling of Chinook and coho salmon. Visibility was enhanced through the use of clear-bottom viewing boxes that reduced glare and water turbulence. After recording the tag number, fish were released upstream of the

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

weir. The crew summarized the number of tagged and untagged fish daily, so that tagged fish not recaptured were recorded by tag color and added to the daily tallies. The crew also examined ASL-sampled salmon for a secondary mark (in this case, a severed adipose fin) in order to assess the incidence of tag loss.

Genetic Diversity of Chinook Salmon from the Kuskokwim River Project

Tissue samples were collected from 50 Chinook salmon to profile the Kogrukluk River spawning population as part of a genetic stock identification study entitled *Genetic Diversity of Chinook Salmon from the Kuskokwim River.* Genetic samples were gathered during each of the 5 ASL sampling pulses. After ASL sampling, a thumbnail size piece of axillary process was cut from the fish with scissors, wiped clean, and placed in a vial of isopropyl alcohol. Care was taken to prevent cross contamination by cleaning the sampling instruments. Vials were numbered, and the corresponding length, sex, location, and sampling date were recorded. The tissue samples were sent to the ADF&G Gene Conservation Laboratory for analysis. Templin et al. (2004) provides details.

RESULTS

ESCAPEMENT MONITORING

Installation of the Kogrukluk River weir began on 20 June, and the weir was operational from 2300 hours on 21 June, until 1000 hours on 23 September. Three inoperable periods occurred; the first was on 22 July when a hole developed under the weir due to an excessive build-up of carcasses on the weir. This hole was present for less than 12 hours. A second hole occurred on 26 July that was also the result of carcass build-up and was present for less than 12 hours. The third inoperable period occurred on 16 September when high water prompted the crew to remove pickets to allow debris to pass. Normal water levels resumed after 4 days and the weir was restored. Passage was estimated during these inoperable periods.

Low water levels in August appeared to have an adverse affect on fish passage. In response, the crew employed the alternate counting method described above to pass fish seen holding behind the weir. On 19 August, the fish trap was moved to deeper water and counting through the trap was resumed.

Chinook Salmon

Total annual Chinook salmon escapement upstream of the Kogrukluk River weir in 2005 was 22,000 fish, which includes an estimated 269 fish (1.2% of the total run) that passed during inoperable periods (Table 1). Chinook salmon were observed passing the weir from 22 June to 15 September. Peak daily passage of 1,309 Chinook salmon occurred on 10 July, and the median passage date was 13 July. The central 50% of the passage occurred between 7 and 20 July (Appendix A1).

Chum Salmon

Total annual chum salmon escapement upstream of the weir in 2005 was 197,723 fish, which includes an estimated 6,135 fish (3.1% of the total run) that passed during inoperable periods (Table 1). Chum salmon were observed passing upstream of the weir from 22 June to 22 September. Peak daily passage of 10,174 chum salmon occurred on 16 July, and the median passage date was 20 July. The central 50% of the passage occurred between 14 and 26 July (Appendix A1).

Sockeye Salmon

Total annual sockeye salmon escapement upstream of the weir in 2005 was 37,939 fish, which includes an estimated 474 sockeye (1.2% of the total run) that passed when the weir was inoperable (Table 1). Sockeye salmon were observed passing upstream of the weir from 25 June to 12 September. Peak daily passage of 2,655 fish occurred on 8 July, median passage date was 15 July, and the central 50% passage occurred between 10 and 21 July (Appendix A1).

Coho Salmon

Total annual coho salmon escapement upstream of the weir in 2005 was 24,116 fish, which includes an estimated 1,014 fish (4.2% of the total run) that passed during inoperable periods (Table 1). Coho salmon were observed passing upstream of the weir from 22 July to 22 September when the weir was dismantled. Peak daily passage of 2,122 coho salmon occurred on 4 September, and the median passage date was 3 September. The central 50% of passage occurred between 24 August and 7 September (Appendix A1).

Pink Salmon and Other Species

Pink salmon are not abundant in the Kogrukluk River; however, they were observed passing upstream of the weir in 2005. In 2005, 109 pink salmon were observed passing upstream through the weir, but complete enumeration is not possible because pink salmon can pass upstream through the spacing between weir pickets. Records were not kept of fish that were observed passing between the weir pickets.

Other species observed at the Kogrukluk River weir include Arctic grayling *Thymallus arcticus*, char *Salvelinus spp.*, and occasionally northern pike *Esox lucius*, whitefish *Coregonus sp.*, and burbot *Lota lota*. For a complete listing of fish species in the area, see Baxter (*Unpublished* c).

Carcasses

Carcasses recovered at the Kogrukluk River weir in 2005 included 2,797 Chinook, 36,745 chum, 3,005 sockeye, 35 coho, and 31 pink salmon (Appendix B1). Chinook carcasses were recovered between 12 July and 11 September, with 50% cumulative recovery on 5 August. Chum carcasses were recovered between 22 June and 14 September, with 50% cumulative recovery on 29 July. Sockeye carcasses were recovered between 8 July and 21 September, with 50% cumulative recovery on 14 August. Coho carcasses were first recovered 29 August. Pink salmon carcasses were recovered between 11 July and 1 September.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Age, sex, and length were determined for 734 of 835 sampled Chinook salmon, or 3.3% of the total annual Chinook escapement (Tables 2 and 3). The samples were collected in 5 pulses that ranged in size from 115 to 184 aged fish per pulse, and the run was partitioned into 5 temporal strata based on the temporal distribution of the sampling effort. As applied to the total Chinook escapement, age-1.3 was the most abundant age class (46.5%), followed by age-1.4 (28.1%), age-1.2 (24.3%), and age-1.5 (0.9%). Female Chinook salmon comprised 34.7% of the total annual escapement based on weighted ASL samples, and 29.9% of the run based on visual sex determination by crew members during daily enumeration routine (Tables 1 and 2).

The length of female Chinook salmon ranged from 560 to 976 mm, and males ranged from 413 to 973 mm (Table 3). The average length of sampled fish showed partitioning by age class. Average lengths for female age-1.2, -1.3, -1.4 and -1.5 Chinook salmon were 621, 782, 837, and 897 mm, respectively, and average lengths for male age-1.2, -1.3, -1.4 and -1.5 Chinook salmon were 554, 712, 803, and 740 mm, respectively.

Chum Salmon

Age, sex, and length were determined for 1,198 of 1,422 sampled chum salmon, or 0.6% of the total annual chum salmon escapement in 2005 (Tables 4 and 5). The samples were collected in 7 pulses that ranged in size from 141 to 194 aged fish per pulse, and the run was partitioned into 7 temporal strata based on the temporal distribution of the sampling effort. As applied to the total chum escapement, age-0.3 was the most abundant age class (90.5%), followed by age-0.4 (5.6%), and age-0.2 (4.0%). Female chum salmon comprised 45.1% of the total annual escapement based on weighted ASL samples, and 36.6% of the run based on visual sex determination by crew members during daily enumeration routine (Tables 1 and 4).

The length of female chum salmon ranged from 425 to 645 mm, and males ranged from 459 to 668 mm (Table 5). The average length of sampled fish showed partitioning by age class. Average lengths for female age-0.2, -0.3, and -0.4 chum salmon were 492, 530, and 563 mm, respectively, and average lengths for male age-0.2, -0.3, and -0.4 chum salmon were 529, 557, and 573 mm, respectively.

Coho Salmon

Age, sex, and length were determined for 447 of 550 sampled coho salmon, or 1.9% of the total annual coho salmon escapement in 2005 (Tables 6 and 7). The samples were collected in 3 pulses with sample sizes of 167, 142, and 138 aged fish, and the coho run was partitioned into 3 temporal strata based on sampling dates. As in 2003 and 2004, samples from all 3 temporal strata were pooled into a single sample for use in characterizing the entire run. This change was made from previous years because historical records show that Kuskokwim River coho salmon stocks show little variability in ASL composition within a given year.. As applied to the total coho escapement, age-2.1 was the most abundant age class (84.9%), followed by age-3.1 (9.1%), and age-1.1 (6.0%). Based on weighted ASL samples, female coho salmon comprised 49.7% of the total annual escapement, and 48.1% based on visual sex identification by crew during daily enumeration (Tables 1 and 6).

The length of female coho salmon ranged from 390 to 625 mm, and males ranged from 409 to 638 mm (Table 7). The average length of the sampled fish showed partitioning by age class. Average length for female age-2.1 and -3.1 coho salmon were 540 and 564 mm, respectively, and average length for male age-2.1 and -3.1 coho salmon were 543 and 553 mm, respectively.

WEATHER AND STREAM OBSERVATIONS

Water temperature at the weir ranged from 7.0° to 16.0°C, with an average water temperature of 11.6°C (Appendix C1). River stages ranged from 2,495 to 3,205 mm, with an average of 2,717 mm for the overall operational period. Air temperature at the weir ranged from 0° to 29°C, with an average air temperature of 13.4°C for the operational period.

Related Fisheries Projects

Inriver Abundance of Chinook Salmon in the Kuskokwim River Project

Of the 51 radio-tagged Chinook salmon that were detected by radiotelemetry in the Kogrukluk River in 2005, 49 crossed the weir and were considered recaptures (Stuby *In prep*). A total of 19 radio-tagged Chinook salmon were observed passing the weir, of which, spaghetti-tag numbers were recovered from 15 fish (Appendix D1).

Kuskokwim River Sockeye Salmon Radiotelemetry Feasibility Study

A total of 16 radio-tagged sockeye salmon were detected by radiotelemetry in the Kogrukluk River in 2005. Spaghetti-tag numbers were recovered from 8 of these fish (Appendix D1).

Kuskokwim River Salmon Mark–Recapture Project

In 2005, 56 anchor-tagged Chinook salmon (0.34% of the total observed passage) were observed passing the Kogrukluk River weir. Tag information was recovered from 51 of these fish (Appendix D1). Of 852 fish examined for secondary marks (3.87% of the observed passage), no untagged Chinook salmon had a secondary mark that would have indicated tag loss.

A total of 187 anchor-tagged chum salmon (0.09% of the total observed passage) were observed passing the Kogrukluk River weir in 2005. Tag information was recovered from 178 of these fish (Appendix D1). Of 1,893 fish examined for secondary marks (0.96% of the observed passage), 1 untagged chum salmon (0.05% of examined fish) had a secondary mark that indicated tag loss.

A total of 209 anchor-tagged coho salmon (0.87% of the total observed passage) were seen passing the weir in 2005, and tag information was recovered from 201 of these fish (Appendix D1). Of 840 fish examined for secondary marks (3.48% of the total passage), no untagged coho salmon had a secondary mark.

A total of 232 anchor-tagged sockeye salmon (0.61% of the total observed passage) were seen passing the weir in 2005 (Appendix D1). Tag information was recovered from 216 of these fish. Since sockeye salmon were not ASL-sampled, none were examined for a secondary mark that may indicate tag loss.

Genetic Diversity of Chinook Salmon from the Kuskokwim River Project

Fin clips were collected and preserved from 50 Chinook salmon sampled from the fish trap. Detailed results from the Chinook genetic sampling can be found in Templin et al. (2004).

DISCUSSION

Escapement Monitoring

Favorable river conditions during weir installation, operation, and removal led to a successful field season in 2005. The weir was operational from 21 June to 23 September. Water levels were moderate for most of the season. However, the weir did become inoperable on 16 September for 4 days due to high water. Holes were discovered and repaired on 22 July and 26 July. These holes were caused by excessive build-up of carcasses on the weir and subsequent scouring of the substrate under the weir. It is believed that these holes developed during the night when carcasses were allowed to build up. These 6 inoperable days were much less than the average, however, and the early start date and few inoperable days provided for reliable estimates of the 2005 salmon escapements to the Kogrukluk River weir. These estimates will provide an important reference for constructing future estimates and models.

Midway through the 2005 season, low water levels presented challenges to weir operations. At low water, coho salmon showed a reluctance to enter the fish trap creating difficulties with passing fish, tag recovery, and sampling. Crew members removed weir pickets to facilitate fish passage, but this impeded tag recovery and sampling. On 19 August, the fish trap was moved to deeper water and the crew resumed counting through the trap. Fish passage improved, and tags were recovered with greater frequency.

In most years, high water levels prevented weir installation at the Kogrukluk River until late June or early July, but moderate water levels in June 2005 allowed for early installation. The 2005 operational date for Kogrukluk River weir was the fourth earliest on record (Figure 4). Salmon passage was low for several days following weir installation, suggesting that few fish, if any, passed upstream of the weir site before the weir was installed (Table 1). This conclusion is reinforced by the results from the Chinook radiotelemetry study; the nearby receiver station detected no radio tags before the weir was installed, even though the receiver station was operational on 15 June and tagging began on 1 June. The last day of escapement enumeration in 2005 was similar to past years (Figure 4). Moderate water levels contributed to a quick and uncomplicated weir removal.

Chinook Salmon

Abundance

The early installation date and the limited number of inoperable days of the Kogrukluk River weir in 2005 provided a more complete picture of the total annual Chinook salmon escapement than most previous years (Appendix E1). Only 2 Chinook salmon were observed during the first 3 days of operation and passage increased steadily thereafter before peaking in July and decreasing gradually through early September to about 1 Chinook salmon per day. In addition, no radio-tagged Chinook salmon were detected by the nearby receiver station prior to weir installation. Consequently, the reported escapement of 22,000 Chinook salmon past the Kogrukluk River weir in 2005 is considered a reliable estimate of the total annual Chinook escapement upstream of the weir.

The total annual escapement of 22,000 Chinook salmon in 2005 was the highest escapement on record for the Kogrukluk River weir, and exceeded the SEG range of 5,300 to 14,000 fish (Figure 5). This SEG range was established by ADF&G in January 2004, replacing the pre-2004 goal of 10,000 Chinook salmon. The 2005 escapement was markedly higher than that of 1999 and 2000, which were years that contributed to the BOF classifying Kuskokwim River Chinook salmon as a stock of concern (Figure 5) (5 AAC 39.222, 2001; Burkey et al. 2000a). The elevated Chinook salmon escapement seen at Kogrukluk River weir in 2005 was similar to most other escapement monitoring projects in the Kuskokwim River basin (Figure 6) (Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; Stewart et al. 2006; Zabkar et al. *In prep*).

The subsistence fishing schedule implemented in response to the stock of concern classifications was rescinded on 19 June before it had gone into effect for the entire drainage because most run assessment tools indicated that the measure was no longer needed; thereafter, subsistence fishing was allowed 7 days a week. Kuskokwim River tributaries likely benefited from the schedule because June closures provided windows when fish could pass through the lower Kuskokwim River where the subsistence fishery is most intense.

For the second time since 2000, ADF&G permitted commercial fishing in District W-1 during late June and early July. District W-2 remained closed, however, due to the lack of a commercial market. Four chum- and sockeye-directed commercial openings occurred between 24 June and 1 July, after most run assessment tools indicated strong returns of Chinook and chum salmon to the Kuskokwim River (Linderman et al. *In prep*). The effect of the 4 commercial fishing openings on Kogrukluk River and other upper Kuskokwim River Chinook salmon escapement was likely negligible because of the relatively small harvest of 4,784 fish in comparison to the total run estimated at 145,373 Chinook salmon upstream of the Aniak River (Stuby *In prep*).

Run Timing at Weir

Chinook salmon run timing at the Kogrukluk River weir in 2005 was average (Figure 7). The 2005 median passage date of 13 July was similar to the historical average of 12 July. The central 50% passage in 2005 occurred from 7 to 20 July, compared to the historical average that occurs from 7 to 17 July. The earliest median passage date at the project is 7 July (1981 and 1996), and the latest date is 20 July (1999).

Chum Salmon

Abundance

The early installation date of Kogrukluk River weir in 2005 and the limited number of inoperable days provided a more complete picture of the total annual chum salmon escapement than most previous years (Appendix E1). Daily chum salmon passage during the first 5 days of operation averaged 7 fish per day. Passage increased rapidly, peaked in July, and then decreased through mid September when reported daily passage was less than 5 chum salmon per day. Consequently, the reported escapement of 197,723 chum salmon past the Kogrukluk River weir in 2005 is considered a reliable estimate of the total annual chum salmon escapement upstream of the weir.

The total annual escapement of 197,723 chum salmon in 2005 was the highest escapement on record for Kogrukluk River weir, and greatly exceeded the SEG range of 15,000 to 49,000 fish (Figure 5). This SEG range was established by ADF&G in January 2004, replacing the pre-2004 goal of 30,000 chum salmon. The 2005 escapement was also markedly better than the low escapements of 1997, 1999, and 2000, which were years that contributed to the BOF classifying Kuskokwim River chum salmon as a stock of concern (Figure 5) (5 AAC 39.222, 2001; Burkey et al. 2000b). The exceptional chum salmon escapement in 2005 was similar to most other escapement monitoring projects throughout the Kuskokwim River basin (Figure 8) (Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; Stewart et al. 2006; Zabkar et al. *In prep*).

For the second time since 2000, ADF&G permitted commercial fishing in District W-1 during late June and early July. District W-2 remained closed, however, due to the lack of a commercial market. Four chum- and sockeye-directed commercial openings occurred between 24 June and 1 July, after most run assessment tools indicated strong runs of Chinook and chum salmon to the Kuskokwim River (Linderman et al. *In prep*). The effect of the 4 commercial fishing openings on the Kogrukluk River and other upper Kuskokwim River salmon escapements was likely modest. The total harvest of 69,139 chum salmon in 2005 was well below the recent 10-year average of 107,572 chum salmon.

Run Timing at Weir

Chum salmon run timing at the weir in 2005 was the latest on record (Figure 7). The median passage date was 20 July in 2005, 7 days later than the historical average. The central 50% passage in 2005 occurred from 14 to 26 July. Historically, the earliest median passage date occurred on 9 July (1981, 1988, and 1996), while the latest date was on 19 July (1991).

Sockeye Salmon

Abundance

The early installation date and the limited number of inoperable days provided a more complete picture of the total annual sockeye salmon escapement at the Kogrukluk River weir than most years (Appendix E1). The first sockeye salmon was seen on 25 June, and daily passage increased rapidly thereafter until peaking in July. Daily passage decreased steadily during August and early September, and the last sockeye salmon was counted on 12 September. Consequently, the reported escapement of 37,939 sockeye salmon past the Kogrukluk River weir is considered a reliable estimate of the total annual sockeye escapement upstream of the weir in 2005.

No escapement goal is associated with sockeye salmon in the Kogrukluk River. Escapement in 2005 was the highest on record (Figure 9). The strong sockeye salmon escapement in 2005 was similar to most other escapement monitoring projects throughout the Kuskokwim area. In Kuskokwim Bay, Goodnews and Kanektok river weirs saw record numbers of sockeye salmon (Jones and Linderman 2006a, b); and in the Kuskokwim River, Tuluksak, George, Tatlawiksuk, and Takotna rivers, while not considered sockeye systems, all saw higher than usual numbers of sockeye salmon (Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; Stewart et al. 2006; Zabkar et al. *In prep*).

The Kogrukluk River weir is currently the only site in the Kuskokwim River drainage with a history of enumerating large numbers of sockeye salmon. Large lakes typical of sockeye salmon rearing habitat are absent from the Holitna River drainage, although sockeye salmon have been observed spawning in a number of backwater sloughs in Shotgun Creek and in the Holitna, Kogrukluk, Chuckowan, and Hoholitna rivers (Baxter *Unpublished* b; Baxter 1979). Sockeye salmon have been documented in several other tributaries in the Kuskokwim River basin (Burkey and Salomone 1999), but little is known about these populations. Rearing ecology of these "river-type" sockeye salmon is not well known in the Kuskokwim Area, though river-spawning behavior among sockeye salmon is documented in other areas of both Asia and North America (Burgner 1991). Wood et al. (1987) found that "river-type" sockeye salmon contributed from 39% to 48% of total sockeye salmon returns to the Stikine River in 1984 and 1985. The contribution of these "river-type" sockeye salmon to the overall Kuskokwim River sockeye salmon production could be substantial.

During the 2005 season, 4 chum- and sockeye-directed commercial openings were conducted in the Kuskokwim River in late June and early July (Linderman et al. *In prep*). These openings represented the second consecutive sockeye-directed commercial fishery in the Kuskokwim River drainage (Linderman et al. *In prep*). In response to growing interest in developing a sockeye salmon fishery, in 2004 the BOF established conservative guideline harvest levels for sockeye salmon on the Kuskokwim River, which range from 0 to 50,000 fish (5 AAC 07.365, 2004). Sockeye salmon in the Kuskokwim River have not been identified as a stock of concern, although escapements have likely benefited from the conservation measures discussed above for Chinook and chum salmon because of the concurrent run timing of these 3 species in June and early July. The total sockeye salmon harvest in 2005 was 27,645 fish, compared to the 1991 through 2000 average of 50,792 fish, and the recent 10-year average of 23,763 (Linderman et al. *In prep*).

Run Timing at Weir

Sockeye salmon run timing at the Kogrukluk River weir in 2005 was slightly later than past years (Figure 10). The median passage date was 15 July in 2005, 1 day later than average. The central 50% passage in 2005 occurred from 10 to 21 July. Historically, the earliest median passage date for Kogrukluk River sockeye salmon is 9 July (1981), and the latest date is 22 July (1999).

Coho Salmon

Abundance

The limited number of inoperable days and the late end date at the Kogrukluk River weir in 2005 provided a more complete picture of the total annual coho salmon escapement than most years (Appendix E1). The first coho salmon was observed on 23 July, but it is estimated that the first coho passed on 22 July through a hole in the weir. Passage increased thereafter and peaked on 4 September. After 4 September daily coho salmon passage decreased gradually to only a few hundred fish per day until the end of operations on 22 September. The number of coho salmon that passed upstream of the weir site after 22 September is unknown; however, the reported escapement of 24,116 coho salmon is considered a reliable estimate of the total annual coho escapement through that date in 2005 (Table 1).

The total annual escapement of 24,116 coho salmon in 2005 was within the SEG range of 13,000 to 28,000 fish (Figure 9). This SEG range was established by ADF&G in January 2004, replacing the pre-2004 goal of 25,000 coho salmon. The Kogrukluk River is the only tributary in the Kuskokwim basin with an established escapement goal for coho salmon, and it is the only tributary in the Kuskokwim Area with a long-term history of coho salmon escapement monitoring.

The abundance of coho salmon returning to the Kuskokwim River decreased dramatically after 1996, as evidenced by both escapements and harvest (Whitmore et al. 2005). Run abundance remained depressed until 2003 when record escapements were recorded (Figure 11). After several years of depressed runs, the commercial market was not positioned to fully exploit the unexpectedly strong coho salmon run in 2003. This problem was counteracted in 2004 when processing capacity was increased. Despite these changes, commercial harvest in 2005 remained low at 142,319 coho, well below the recent 10-year average of 300,280 fish. The commercial harvest of coho salmon in 2005 was lower than average because of a lower than expected abundance (Linderman *In prep*).

Run Timing at Weir

Coho salmon run timing at the weir in 2005 was near average (Figure 10). The median passage date was 3 September, 2 days later than the historical average. The central 50% of the 2005 passage occurred from 24 August to 7 September, slightly earlier than historical averages. Historically, the earliest median passage date occurred on 25 August (1996), and the latest date was on 10 September (1983 and 1990).

Pink Salmon

Similar to past years, the number of pink salmon observed passing the Kogrukluk River weir was low in 2005. However, the observed passage in 2005 was more than 4 times greater than any other year in which pink salmon were reported. This relatively high passage may be the result of the tighter picket spacing that allows fewer fish to pass between the pickets. However, the total annual escapement remains unknown because it is believed that many pink salmon are able to swim between the weir pickets. A total of 109 pink salmon were observed passing the weir in 2005, between 7 July and 13 August (Table 1). A total of 31 pink salmon carcasses were recovered on the weir between 11 July and 1 September. The Kogrukluk River is approximately 710 km from the mouth of the Kuskokwim River, making the few pink salmon that pass the weir among the farthest migrating pink salmon in the world (Morrow 1980; Heard 1991).

Carcasses

Approximately 13% of the 2005 Kogrukluk River Chinook salmon escapement was later observed as carcasses at the weir (Figure 12), which was higher than the historical average of 11% (Appendix F1). Approximately 19% of the observed 2005 Kogrukluk River chum salmon escapement was later observed as carcasses at the weir (Figure 12), which was slightly lower than the historical average of 23% (Appendix F1). Approximately 8% of the 2005 Kogrukluk River sockeye salmon escapement was later observed as carcasses at the weir (Figure 12), which is similar to the historical average (Appendix F1). The remainder of the spawned-out fish was likely retained in or near the river upstream of the weir for a protracted period of time, thereby contributing to the productivity of the system through the introduction of marine derived nutrients as described by Cederholm et al. (1999).

Few coho salmon carcasses were observed at the weir (Appendix B1). Most post-spawning mortality likely occurs after the weir is removed for the season, so no conclusions can be made about the occurrence of coho salmon carcasses.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Chinook ASL samples were below the objective sample size for 3 of the 5 pulse samples. However, pulses were well distributed throughout the run and the collective samples from 2005 were considered adequate for describing the ASL composition of the total annual Chinook salmon escapement.

Age-1.3 Chinook salmon dominated the 2005 age composition. Because Chinook salmon tend to have a strong sibling relationship, the prominence of age-1.3 fish in 2005 was anticipated since age-1.2 Chinook salmon were dominant in the 2004 age composition (Figure 13). Likewise, the abundance of age-1.3 fish in 2005 may forecast an abundant return of age-1.4 fish in 2006 assuming consistency in ocean survival. The abundance of age-1.3 Chinook salmon was similar to nearly every ASL data set collected in the Kuskokwim River in 2005 (Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; Stewart et al. 2006; Zabkar et al. *In prep*). Escapement in 2000 was the third lowest on record, which is the brood year for the age-1.3 Chinook salmon.

That such a low escapement in 2000 produced a high abundance of age-1.2 fish in 2004 and age-1.3 fish in 2005 may indicate that ocean conditions have been favorable for Chinook salmon in the past few years.

The proportion of age-1.2 Chinook salmon increased towards the end of the season in 2005 (Table 2). This is the opposite pattern as that observed in previous years and at the other weir projects throughout the Kuskokwim River (Molyneaux and Folletti, 2005). This divergent pattern may be the result of not achieving objective sample sizes in all 5 sample pulses. While the collective samples may be considered adequate to describe the total annual Chinook salmon escapement, they may not be adequate for describing intra-annual patterns. This emphasizes the importance of achieving objective sample sizes.

The 34.7% female Chinook salmon estimated from weighted ASL samples was comparable to the 29.9% visual estimate of the field crew during daily fish passage in 2005 (Figure 14). Both percentages are near the historical average. Similar to past years, the percent female in the escapement at Kogrukluk River weir was lower than that estimated in the subsistence catch (36.7%) but higher than that in the commercial catch in District W1 (16.0%; Molyneaux et al. *In prep* a; b). Disparities between the sex ratios at the weirs and in the commercial and subsistence catches are most likely due to the size selectivity of the different mesh sizes used in the commercial and subsistence fisheries (Molyneaux et al. *In prep* b).

Historical length composition data shows a general increase in length at age between 1984 and 1991, and then a general decrease until 2005 (Figure 15). One possible cause of this general decrease in length could be the use of large mesh gillnets by subsistence fishers. Most subsistence fishers use gillnets with a stretched mesh size of 8 inches or larger, which tends to select for larger Chinook salmon (Molyneaux et al. 2005). The population of Chinook salmon that escapes the gauntlet of subsistence nets likely has a mean length that is less than if most subsistence fishers were not using large mesh gillnets. This artificial selection pressure may effect the population at the genetic level; stocks originating from tributaries upstream from the areas of greatest subsistence fishing effort may be pressured to grow more slowly or return at a younger age (smaller size). Such conclusions are speculative, however, and are presented in this report simply as a possible mechanism for the trends seen at the Kogrukluk River weir.

Chum Salmon

Chum salmon ASL samples were below the objective sample size in 1 of the 7 pulse samples, which compromises the utility of that pulse towards determining intra-seasonal patterns in the ASL composition. Otherwise, pulses were well distributed throughout the run and provided a reasonable basis for characterizing both intra-seasonal patterns and the overall ASL composition for the total annual chum salmon escapement.

The age composition for chum salmon in 2005 showed a high proportion (90%) of age-0.3 fish (Table 4). This abundance of age-0.3 chum salmon was expected from the unusually high abundance of age-0.2 fish in the 2004 age composition (Figure 13). Likewise, age-0.3 fish were dominant in nearly every other ASL data set collected in the Kuskokwim River (Costello, Molyneaux et al. 2006; Costello. Stewart et al. 2006; Stewart et al. 2006; Zabkar et al. *In prep*). This abundance may foretell a strong return of age-0.4 chum salmon in 2006, and there may be another strong return of age-0.3 chum salmon in 2006 since the abundance of age-0.2 fish in 2005 exceeded the abundance of age-0.2 fish in 2004 in terms of total numbers (Figure 13). Sibling relationships for chum salmon, however, are not as reliable as with Chinook salmon at

Kogrukluk River weir, even with the relatively low and stable harvest that has occurred since 1999 (Linderman et al. *In prep*). Escapement in 2001 was average, which is the parent year for age-0.3 chum salmon in 2005, and escapement in 2002 was the fourth highest on record, which is the brood year for age-0.2 fish (Figure 5).

In 2005, the proportion of younger age classes increased as the season progressed (Table 4), which is typical of chum salmon in the Kuskokwim River drainage. This progression is most commonly evident in comparing the inverse proportions between age-0.3 and -0.4 chum salmon, which typically dominate the run.

The percentage of female chum salmon based on weighted ASL samples (45.1%) was similar to the estimate derived from visual observation during daily counting periods (36.6%), but the disparity between the estimates was slightly higher than the historical average (Figure 14). This difference may be due in part to the high abundance of chum salmon in 2005. With such a high rate of passage, visual sex identification was more difficult.

The percentage of female chum salmon is typically near 50% in most Kuskokwim Area data sets (Molyneaux and Folletti 2005). Although the percentage of females was near 50% in 2005, since 1990 the percentage at Kogrukluk River has generally been low, with a record low of 4.1% in 1997 (Figure 14). The increase in the percentage of female chum salmon in 2005 coincided with the use of a tighter picket spacing, which led to concerns that in the past, perhaps the leakage of smaller fish through the weir has led to erroneous sex ratios. However, examination of length frequency histograms in past years (Figure 16) does not show that smaller fish have been underrepresented to such a degree as to account for the anomalous sex ratios that were observed.

The historically low female percentages may have been caused by differences in the spawning behavior between females and males, coupled with the weir being located upstream of a large segment of spawning area in the mainstem Holitna River. When in spawning condition, male salmon tend to continue upstream a considerable distance, while females tend to remain near their redds (Schroder 1982). In 2005, the percentage of females may have been elevated to nearly 50% because of the large abundance of chum salmon in the Holitna River. As spawning habitat below the weir became saturated, more females may have moved upstream in order to find suitable redd sites. However, a strong correlation between chum salmon abundance and the percentage of females is not apparent.

Compared to past years, the mean length of Kogrukluk River chum salmon in 2005 was smaller for all age-sex categories than the historical averages (Table 5). Furthermore, the average length of age-0.3 male and female chum salmon and age-0.4 male chum salmon has progressively decreased since 1996 (Figure 17). Average lengths of female age-0.4 chum salmon have been more variable in recent years, and small sample sizes obscure any possible trends. Of particular interest is the sharp decline in the length of age-0.3 fish in 2005. Both male and female age-0.3 chum salmon were the smallest on record for Kogrukluk River. This drop in length is corroborated by the fact that 2005 saw the latest run timing on record for chum salmon at Kogrukluk River weir (Figure 7). Since the average length of chum salmon decreases as the season progresses (Figure 18; Molyneaux and Folletti 2005), later runs tend to have a larger proportion of smaller fish, thereby creating a negative correlation between average fish length and median passage date (Figure 19). A decrease in the length of female chum salmon may indicate that in years of high abundance the saturation of spawning habitat downstream of the weir drives females further upstream. As the larger females entered the river and use the lower habitat they pushed the smaller females, who came later, upstream in search of unoccupied spawning habitat.

The degree to which the new picket spacing contributed to the drop in chum salmon length in 2005 is unknown. Examination of the length frequency histograms in Figure 16 shows that the distribution of length has been shifting towards smaller fish for the years preceding 2005 as far back as 1996 (Figure 17). However, leakage of smaller fish through the pre-2005 weir design has been observed on many occasions, whereas it was not observed in 2005. Therefore, it is likely that the decrease in length is due to a combination of a naturally occurring shift in length and the tighter picket spacing.

Sockeye Salmon

The practice of collecting complete ASL data from sockeye salmon was discontinued at Kogrukluk River weir in 1995 because of scale absorption that confounds reliable aging (Burkey 1995; Cappiello and Burkey 1997), but crews continue to estimate sex composition as the fish are passed upstream of the weir. During the 1970s and 1980s the percentage of females was typically near 50% (Figure 14). Throughout the 1990s, however, there was a progressive decrease in the percentage of reported females in the annual escapement, with the lowest percentage (16%) reported in 1998 (Molyneaux and Folletti 2005). Thereafter the percentage was variable ranging from 40% in 2000 and 2001 to 23% in 2004. In 2005, the percentage of females increased to 55%.

The cause of the decline in females during the 1990s is unknown, but does not appear to be correlated to abundance. The phenomenon may be linked to differences in the spawning behavior of females and males, similar to what was described for chum salmon. Unlike chum salmon, however, the degree to which sockeye salmon spawn downstream of Kogrukluk River weir is unknown. This information gap may be addressed through a proposed sockeye radiotelemetry project scheduled to begin in 2006 (S. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Coho Salmon

The targeted ASL sample size per pulse was increased for coho salmon in 2005 with the intent of using the samples to characterize both the total annual escapement and intra-annual patterns. This goal was achieved in 2005 and the samples were well distributed throughout the run, providing a reasonable basis for characterizing the overall ASL composition for the total annual coho salmon escapement (Table 6).

No irregularities were observed in the estimated ASL composition of coho salmon at Kogrukluk River weir in 2005. Similar to past years, the coho salmon run was dominated by age-2.1 fish, which is typical of Kuskokwim Area coho runs (Table 6; Molyneaux and Folletti 2005). Females constituted 49.7% of the run based on ASL samples and 48.1% based on visual estimates, both of which are above the long-term average of 37.9%. Unlike chum and sockeye salmon, the historical sex composition of coho salmon at Kogrukluk River has been relatively stable (Figure 14). Mean lengths for coho salmon in 2005 were smaller than historical averages for both sexes and across age classes, but were comparable to the mean lengths in 2004 (Figure 20). Historical length trends for coho salmon seem to mimic those for chum salmon in that there is a general decrease in length since 1996. The lower average length of coho salmon in 2005 may be partially attributable to the tighter picket spacing.

In past years, there have been questions about the crew misidentifying the sex of fish. DuBois and Molyneaux (2000) identified erroneous sex identification as being a persistent problem with coho salmon, and this necessitates continued diligence in sexing fish at the Kogrukluk River weir.

WEATHER AND STREAM OBSERVATIONS

The Kogrukluk River is influenced by both coastal and interior weather systems which results in a local climate that is often different from the rest of the Kuskokwim Basin. Heavy thundershowers occur often between mid July and mid August. Heavy rain tends to wash out large quantities of debris and sediment, causing the Kogrukluk River to become stained and murky, though reduced water clarity usually improves quickly.

Moderate water levels predominated throughout the 2005 season at the Kogrukluk River weir. Low water level in August of 2005 appeared to affect the migration of coho salmon. Increases in water level on 24 August and 4 September resulted in increased coho salmon passage (Figure 21). This behavior has been observed in other stocks of coho salmon throughout their range (Sandercock 1991). Low passage numbers, presumably due to low water levels in August, necessitated use of alternate counting methods and relocation of the fish trap to deeper water in 2005. Each action independently showed increases in daily counts. In both cases, fish were counted through sections of the weir where depth and current were greatest.

Water temperature records for the Kogrukluk River in 2005 ranged from 7°C to 15°C during project operations (Appendix C1). The 2005 average water temperature of 11.6°C was slightly higher than the historical average of 11°C. It is unclear whether water temperature affected salmon passage because changes in water temperature at Kogrukluk River weir usually occur concurrently with fluctuations in water level, which has greater influence on salmon behavior and passage. The decrease in water temperature in September 2005 seemed to trigger increased salmon passage, but water level also increased rapidly during the same time and it was more likely that water level, not temperature, activated the coho salmon (Figures 21 and 22).

RELATED FISHERIES PROJECTS

Inriver Abundance of Chinook Salmon in the Kuskokwim River Project Details about the 2005 Kuskokwim River radiotelemetry project will be discussed by Stuby (*In prep*). One of the findings of this study was that the run timing of Kogrukluk River Chinook salmon past the Kalskag tagging site in 2005 was relatively late compared to stocks heading for other tributaries, which is similar to what was found in 2004 and 2003, but different from the early run timing observed in 2002 (Figures 23 and 24). The pattern of upper river populations passing the tagging site earlier than lower river populations was less evident for the Kogrukluk River in 2005, but the pattern persisted for Takotna, Tatlawiksuk, and Stony rivers stocks. In addition, the overall distribution of timings between represented stocks was more protracted in 2005 compared to 2003, but similar to 2004 and 2002.

Kuskokwim River Sockeye Salmon Radiotelemetry Feasibility Study

Details about the Kuskokwim River sockeye radiotelemetry pilot project are discussed by Gilk (*Unpublished*). Preliminary results from the pilot project suggest that the Holitna River is an important contributor to the Kuskokwim River sockeye salmon run, and the Kogrukluk River contributes a major portion of sockeye salmon to the Holitna River. This project was a pilot study and a more extensive project proposed for the summer of 2006 will yield more solid conclusions.

Kuskokwim River Salmon Mark–Recapture Project

Details about the 2005 mark–recapture project will be discussed by Pawluk, Baumer et al. (2006).

Chinook Salmon

Tags were recovered from 51 of the 56 anchor-tagged Chinook salmon that were observed passing the Kogrukluk River weir in 2005 (Appendix D1). Run timing of tagged fish was similar to the run timing of the overall escapement (Figure 25), suggesting that recovery time following handling did not affect overall migration rates.

Similar to the findings of the Chinook salmon radiotelemetry project, the pattern of upper river populations passing the tagging site earlier than lower river populations was less evident for the Kogrukluk River, but the pattern persisted for Tatlawiksuk and George rivers stocks. (Figure 26; Pawluk, Baumer et al. 2006). Kogrukluk River Chinook salmon were tagged throughout the Chinook run at the Kalskag tagging site (Figure 27).

The travel time for tagged fish from the Kalskag tagging site to the weir ranged from 10 to 39 days with an average travel time of 23.3 days. The migration speed from the tagging site to the Kogrukluk River weir ranged from 11 to 44 km per day with an average speed of 20.8 km per day, which was comparable to the average speed of Chinook salmon at George and Tatlawiksuk rivers (Pawluk, Baumer et al. 2006).

Kogrukluk River Chinook salmon traveling at an average speed of 20.8 km per day would have passed by Bethel (604 km downstream) approximately 29 days prior to arriving at the weir. Since the median passage date at the weir was 13 July, the median passage date at Bethel would have been 13 June. Therefore, Kogrukluk River Chinook salmon likely benefited from the subsistence fishing schedule because June closures provided windows when fish could pass through the lower Kuskokwim River.

In 2005, the percentage of tagged fish in the total annual Chinook salmon escapement past the Kogrukluk River weir (0.3%) was similar to that reported at the George, Tatlawiksuk and Takotna River weirs (Pawluk, Baumer et al. 2006). This indicates that Kogrukluk River Chinook salmon had a similar probability of capture at the tagging site as did Chinook salmon bound for other tributaries.

Chum Salmon

Tag numbers were recovered from 178 of the 187 anchor-tagged chum salmon that were observed passing the Kogrukluk River weir in 2005 (Appendix D1). Run timing of tagged fish was similar to the run timing of the overall escapement (Figure 28), indicating that recovery time following handling did not affect overall migration rates. Tag recoveries from various Kuskokwim River escapement projects suggest a difference in run timing between spawning populations as they pass the Kalskag tagging sites, with Kogrukluk River chum salmon typically passing during the earlier part of the run and before populations with spawning locations downstream of the Holitna River drainage (Figures 27, 29, 30) (Kerkvliet et al. 2003; 2004; Pawluk, Kerkvliet et al. 2006; Pawluk, Baumer et al. 2006).

Migration time between the Kalskag tagging site and the weir ranged from 7 to 25 days, with an average travel time of 13.4 days. Travel speed ranged from 18 to 63 km per day, with an average migration speed of 33.8 km per day, which was comparable to the average speed of chum salmon at George and Tatlawiksuk rivers (Pawluk, Baumer et al. 2006).

Kogrukluk River chum salmon traveling at an average speed of 33.8 km per day would have passed by Bethel (604 km downstream) approximately 18 days prior to arriving at the weir. Since the median passage date at the weir was 20 July, the median passage date at Bethel would have been 2 July, 13 days after the subsistence fishing schedule was rescinded. Therefore, Kogrukluk River chum salmon would not have received as much benefit from the June closures as did Chinook salmon.

In 2005, the percentage of tagged fish in the total annual chum salmon escapement past the Kogrukluk River weir (0.1%) was similar to that reported at the Tatlawiksuk and Takotna River weirs, but relatively small compared to the percentage observed at the George River weir (Pawluk, Baumer et al. 2006). The lower incidence of tagged chum salmon indicates that Kogrukluk River chum salmon had a lower probability of capture at the tagging site than did chum salmon bound for some other tributaries such as George River.

Sockeye Salmon

Tag numbers were recovered from 208 of the 224 anchor-tagged sockeye salmon observed passing the Kogrukluk River weir in 2005 (Appendix D1). Kogrukluk River weir is the only escapement project in the Kuskokwim River drainage where appreciable numbers of sockeye are observed; consequently, the Kogrukluk River recaptures constituted the majority of sockeye salmon recapture data in 2005. Kogrukluk River sockeye salmon were distributed within the early part of the sockeye salmon run past the Kalskag tagging site (Figure 31); however, run timing of tagged fish at the weir was about 6 days later than the timing of the overall escapement (Figure 32), which may be associated with recovery time following handling at the Kalskag tagging site. Kogrukluk River sockeye salmon tended to pass through the Kalskag tagging site earlier than George River fish whose spawning stream was less distant than Kogrukluk River (Figures 33 and 34).

The transit time for tagged fish from the Kalskag tagging site to the weir ranged from 5 to 38 days with an average travel time of 18.2 days. The migration speed from the tagging site to the Kogrukluk River weir ranged from 12 to 88 km per day with an average speed of 26.2 km per day, which was slightly higher than the average speed for sockeye salmon at George and Tatlawiksuk river weirs (Pawluk, Baumer et al. 2006).

Kogrukluk River sockeye salmon traveling at an average speed of 26.2 km per day would have passed by Bethel (604 km downstream) approximately 23 days prior to arriving at the weir. Since the median passage date at the weir was 15 July, the median passage date at Bethel would have been 21 June, 2 days after the subsistence fishing schedule was rescinded. Therefore, Kogrukluk River sockeye salmon would not have received as much benefit from the June closures as did Chinook salmon, but likely received more benefit than did chum salmon.

In 2005, the percentage of tagged fish in the total annual sockeye salmon escapement past the Kogrukluk River weir (0.6%) was relatively small compared to the percentage observed at the George, Tatlawiksuk, and Takotna river weirs (Pawluk, Baumer et al. 2006). The lower incidence of tagged sockeye salmon indicates that Kogrukluk River sockeye salmon had a lower probability of capture at the tagging site than did sockeye salmon bound for other tributaries.

Coho Salmon

In 2005, tag numbers were recovered from 201 of the 209 anchor-tagged coho salmon observed passing the Kogrukluk River weir (Appendix D1). Run timing of tagged fish was about 4 days later than the run timing of the overall escapement (Figure 35), which may be associated with recovery time following handling at the Kalskag tagging site. This lag in run timing of tagged fish was also observed in 2002, 2003 and 2004 (Kerkvliet et al. 2003; 2004; Pawluk, Kerkvliet et al. 2006).

Tag recoveries suggest that Kogrukluk River coho salmon tended to pass through the Kalskag tagging site later than coho salmon bound for tributaries further upstream, but earlier than coho salmon bound for downstream tributaries (Figures 36 and 37; Pawluk, Baumer et al. 2006). Though not as distinct as was seen in chum salmon (Figures 29 and 30), consideration of the differences in stock-specific run timing is an important element for sustainable management of Kuskokwim River coho salmon, which are the most heavily targeted species in the District W-1 commercial fishery.

Travel time between the lower Kalskag tagging site and the weir ranged from 11 to 42 days, with an average travel time of 20.1 days. Migration speed ranged from 10 to 40 km per day, with an average migration speed of 23.7 km per day, which is comparable to the average speed of coho salmon at Tatlawiksuk River and slightly higher than the average speed of coho salmon at George River (Pawluk, Baumer et al. 2006).

In 2005, the percentage of tagged fish in the total annual coho salmon escapement past the Kogrukluk River weir (0.9%) was similar to that reported at the George, Tatlawiksuk and Takotna River weirs (Pawluk, Baumer et al. 2006). This indicates that Kogrukluk River coho salmon had a similar probability of capture at the tagging site as did coho salmon bound for other tributaries.

CONCLUSIONS

ESCAPEMENT MONITORING

- The weir was installed by 21 June and was operational until 23 September.
- The weir developed holes twice that lasted for less than 12 hours and allowed salmon to pass undetected.
- The weir was inoperable for 4 days due to high water and heavy debris.
- Total annual escapement of 22,000 Chinook salmon in 2005 was the highest on record, exceeded the SEG range, and was similar to escapement trends observed elsewhere in the Kuskokwim River drainage. Run timing at the weir was near average.
- Total annual escapement of 197,723 chum salmon in 2005 was the highest on record, greatly exceeded the SEG range, and was similar to escapement trends observed elsewhere in the Kuskokwim River drainage. Run timing at the weir was later than average.
- Total annual escapement of 37,939 sockeye salmon in 2005 was the highest on record. Run timing at the weir was near average.

- Total annual escapement of 24,116 coho salmon in 2005 was within the SEG range, and was similar to escapement trends observed elsewhere in the Kuskokwim River drainage. Run timing at the weir was near average.

Age, Sex, and Length Composition

- The high abundance of age-1.3 Chinook salmon at the Kogrukluk River weir is consistent with findings at most other Kuskokwim Area projects and suggests a strong return of age-1.4 cohorts to the Kuskokwim River in 2006.
- The unusually high number of age-0.3 chum salmon in the Kogrukluk River in 2005 was consistent with most other Kuskokwim River projects, and suggests an abundant return of age-0.4 chum salmon to the Kuskokwim River in 2006.
- Despite relatively low parent year escapement, the prevalence of younger age classes in Chinook salmon in 2005 suggests continued favorable ocean survivability over the conditions that led to the low runs to the Kuskokwim River in 1998, 1999, and 2000.
- The percentage of females in the chum salmon escapement increased dramatically in 2005, reversing the downward trend since about 1990.
- The percentage of females in the coho salmon escapement in 2005 was the highest it has been since 1994.

Weather and Stream Observations

- For the 2005 season, daily water levels were moderate at Kogrukluk River weir. Low water occurred in August and high water occurred in September.
- Daily water temperatures at Kogrukluk River weir in 2005 were slightly higher than historical averages.

RECOMMENDATIONS

Weir Operations

- Adopt a standardized target operational period for describing the annual escapement. Variability in start and stop dates for the Kogrukluk River weir confound between-year comparisons of summary statistics such as the total annual escapement. Circumstances that dictate start and stop dates are often beyond the control of project leaders or crews, but comparability can be enhanced by adopting a standardized target operational period across all years. The span of dates selected for the target operational period would need to balance between what has been proven historically to be practical start and stop dates, while still providing a reasonable assessment of the total escapement estimate for each species. Project leaders would be required to estimate fish passage for inoperable periods that occurred within the target operational dates. Furthermore, counts made before or after the target operational period would be excluded from the reported cumulative passage and percent passage.
- Develop a method for estimating the amount of fish leakage through the pre-2005 weir design to correct previous years' counts. As stringers have been replaced over the years, the picket spacing has changed resulting in a design that incorporated panels of up to three different picket widths. The estimation method would require: 1) quantifying the

amount of fish leakage through each type of panel, and 2) quantifying the amount of each type of panel in every year's weir design. The former would entail installing older panels into the new weir design and enumerating fish passage through the pickets. The latter may be difficult since the occurrence of stringer changes has been poorly documented. An alternative method may be to examine length frequency histograms for each year to determine the extent to which smaller fish have been excluded from the ASL data. If smaller fish were passing through the pickets to a large degree, one would expect to see a positive skewness in the length frequency histograms.

FISH PASSAGE

- Incorporate counting tower escapement data into future project reports. Estimates of total annual escapement currently date to 1976, but extension of that timeline back to 1969 may be possible using the counting tower data. Some paired data exist for years when both the tower and weir operated concurrently that may allow for estimates of total annual Chinook and chum salmon escapement back to 1969.

SALMON AGE, SEX, AND LENGTH COMPOSITION

- Future project reports for the Kogrukluk River weir should continue and enhance inclusion of detailed Figures depicting trends in age, sex, and length composition. Kogrukluk River has the longest history of salmon escapement monitoring in the Kuskokwim Area, but inquiry into the rich history of data collected at this project is elusive because of the limited historical perspective provided by the standard project report. Future project reports for the Kogrukluk River weir should continue to include historical perspectives such as the following:
    - Brood Tables and three-dimensional graphics that illustrate the number of fish by age class for the recent past,
    - Inter-seasonal differences in sex composition as determined from weighted ASL samples and visual crew counts (both percent and total number),
    - Inter-seasonal trends in the number and percent of females in the escapement,
    - Inter-seasonal trends in average length at age and sex.
- Examine the variability in sex determination from the ASL samples compared to visual weir crew estimates derived from the daily counting routine. It may be valuable to design a method to test the accuracy of visual speciation and sex determination by field crews. If a level of error could be determined for visual differentiation, counts and sex ratios could be better compared to ASL data. This, along with documentation of observed salmon behavior with emphasis on patterns of migration through the weir, could lend insight into the discrepancies between ASL and visually derived sex ratios.

CLIMATOLOGICAL MONITORING

- Install a remote logging station to record climatological data on the Kogrukluk River through the winter. Information could be correlated against future runs to help discern favorable or unfavorable brood conditions for Kogrukluk River salmon stocks. Comparable climatic data loggers could be developed at other weir projects.

SPAWNER-RECRUIT ANALYSIS

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

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TABLES AND FIGURES

Table 1.–Daily and estimated counts of Chinook, chum, sockeye, coho, and pink salmon at Kogrukluk River weir, 2005.

	Chinook				Chum			Sockeye			Coho			Pink
Date	Male	Jacks [a]	Female	Totals	Male	Female	Totals	Male	Female	Totals	Male	Female	Totals	Totals
6/22	0	1	0	1	0	1	1	0	0	0	0	0	0	0
6/23	1	0	0	1	2	0	2	0	0	0	0	0	0	0
6/24	0	0	0	0	1	0	1	0	0	0	0	0	0	0
6/25	35	1	22	58	13	2	15	1	0	1	0	0	0	0
6/26	43	2	13	58	12	4	16	1	0	1	0	0	0	0
6/27	24	3	9	36	16	9	25	3	3	6	0	0	0	0
6/28	41	3	12	56	34	11	45	4	5	9	0	0	0	0
6/29	49	14	18	81	74	31	105	3	3	6	0	0	0	0
6/30	47	11	13	71	104	56	160	0	2	2	0	0	0	0
7/01	243	45	91	379	292	106	398	21	11	32	0	0	0	0
7/02	374	82	87	543	227	89	316	44	36	80	0	0	0	0
7/03	580	77	194	851	442	213	655	65	68	133	0	0	0	0
7/04	73	23	21	117	690	259	949	26	37	63	0	0	0	0
7/05	706	92	277	1,075	1982	760	2,742	337	482	819	0	0	0	0
7/06	661	76	239	976	3467	1669	5,136	627	825	1,452	0	0	0	0
7/07	798	116	305	1,219	3366	1650	5,016	773	934	1,707	0	0	0	1
7/08	609	141	207	957	4083	2175	6,258	1276	1379	2,655	0	0	0	4
7/09	754	109	355	1,218	4446	2300	6,746	683	833	1,516	0	0	0	1
7/10	768	158	383	1,309	3461	2139	5,600	976	1087	2,063	0	0	0	2
7/11	591	118	298	1,007	2904	2095	4,999	684	847	1,531	0	0	0	8
7/12	386	113	175	674	2203	1677	3,880	643	815	1,458	0	0	0	6
7/13	272	55	151	478	2506	1428	3,934	616	806	1,422	0	0	0	4
7/14	481	94	259	834	5301	2756	8,057	992	1167	2,159	0	0	0	14
7/15	404	80	202	686	5511	2634	8,145	872	921	1,793	0	0	0	1
7/16	473	79	277	829	6791	3383	10,174	1084	1163	2,247	0	0	0	6
7/17	658	122	356	1,136	5040	3087	8,127	1133	1288	2,421	0	0	0	3
7/18	456	104	308	868	3940	2213	6,153	895	1214	2,109	0	0	0	2
7/19	280	58	179	517	5694	3040	8,734	425	663	1,088	0	0	0	4
7/20	274	74	203	551	6105	3136	9,241	453	663	1,116	0	0	0	4
7/21	451	101	341	893	6481	3403	9,884	832	1292	2,124	0	0	0	10
7/22 [b]	252	99	185	634	3900	2091	8,579	463	605	1,314	0	0	1	5
7/23	315	88	233	636	5049	2820	7,869	576	663	1,239	3	0	3	4
7/24	228	72	156	456	4553	2770	7,323	351	425	776	1	1	2	1
7/25	173	65	147	385	4181	2520	6,701	274	323	597	0	0	0	8

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Table 1.–Page 2 of 3.

Date	Chinook				Chum			Sockeye			Coho			Pink
	Male	Jacks [a]	Female	Totals	Male	Female	Totals	Male	Female	Totals	Male	Female	Totals	Totals
7/26[b]	94	27	68	359	2086	1091	6,711	179	238	645	2	0	2	4
7/27	128	37	108	273	3587	2076	5,663	252	300	552	0	0	0	5
7/28	127	51	142	320	4415	2742	7,157	322	334	656	2	5	7	3
7/29	86	54	95	235	3208	2228	5,436	113	134	247	15	6	21	4
7/30	59	31	77	167	2134	1587	3,721	139	139	278	14	3	17	3
7/31	70	15	47	132	1792	1408	3,200	81	51	132	4	4	8	3
8/01	41	15	25	81	1612	1065	2,677	93	66	159	10	11	21	0
8/02	50	33	48	131	1637	912	2,549	102	88	190	23	6	29	1
8/03	48	26	30	104	1117	706	1,823	43	58	101	30	13	43	1
8/04	50	27	21	98	1126	613	1,739	70	37	107	20	14	34	0
8/05	31	14	19	64	857	553	1,410	49	58	107	11	6	17	0
8/06	37	12	8	57	881	637	1,518	37	36	73	18	12	30	0
8/07	21	13	11	45	698	497	1,195	32	19	51	24	13	37	0
8/08	23	13	15	51	727	542	1,269	49	45	94	50	28	78	0
8/09	14	11	5	30	577	561	1,138	26	45	71	26	21	47	1
8/10	16	13	3	32	424	435	859	12	18	30	37	28	65	0
8/11	8	4	2	14	339	327	666	27	36	63	34	36	70	0
8/12	12	11	3	26	233	258	491	12	20	32	87	79	166	0
8/13	13	9	11	33	208	224	432	17	31	48	110	97	207	1
8/14	6	9	1	16	170	172	342	10	22	32	114	105	219	0
8/15	4	6	3	13	131	152	283	10	16	26	117	93	210	0
8/16	3	3	1	7	83	121	204	16	13	29	142	106	248	0
8/17	1	5	3	9	84	104	188	12	18	30	66	50	116	0
8/18	14	4	5	23	78	83	161	28	21	49	497	463	960	0
8/19	6	8	2	16	68	83	151	14	21	35	412	306	718	0
8/20	3	5	1	9	40	72	112	6	13	19	179	155	334	0
8/21	2	4	2	8	40	58	98	11	12	23	338	308	646	0
8/22	2	1	0	3	22	38	60	4	8	12	15	8	23	0
8/23	1	1	2	4	23	40	63	5	12	17	574	373	947	0
8/24	1	3	8	12	42	58	100	12	21	33	1,237	833	2,070	0
8/25	7	1	0	8	29	36	65	6	10	16	445	389	834	0
8/26	3	2	0	5	9	20	29	2	2	4	47	42	89	0
8/27	3	1	0	4	7	15	22	0	1	1	12	11	23	0

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Table 1.–Page 3 of 3.

Date	Chinook				Chum			Sockeye			Coho			Pink
	Male	Jacks [a]	Female	Totals	Male	Female	Totals	Male	Female	Totals	Male	Female	Totals	Totals
8/28	3	0	1	4	9	16	25	1	5	6	384	279	663	0
8/29	1	1	1	3	12	14	26	2	5	7	387	407	794	0
8/30	1	0	1	2	6	14	20	1	4	5	481	396	877	0
8/31	1	0	1	2	4	8	12	0	1	1	387	323	710	0
9/01	0	0	0	0	5	4	9	1	0	1	89	99	188	0
9/02	0	0	0	0	1	4	5	0	0	0	13	11	24	0
9/03	0	0	0	0	1	4	5	1	0	1	372	276	648	0
9/04	0	0	1	1	7	4	11	1	1	2	1,177	945	2,122	0
9/05	1	0	0	1	2	8	10	1	1	2	693	671	1,364	0
9/06	0	0	1	1	5	4	9	2	2	4	535	494	1,029	0
9/07	0	1	0	1	5	5	10	0	0	0	805	802	1,607	0
9/08	0	0	0	0	4	6	10	0	2	2	303	401	704	0
9/09	0	1	0	1	0	4	4	0	2	2	182	237	419	0
9/10	0	0	0	0	4	5	9	0	1	1	378	488	866	0
9/11	0	0	0	0	5	4	9	0	2	2	222	347	569	0
9/12	0	0	0	0	2	2	4	0	2	2	268	369	637	0
9/13	2	0	1	3	0	0	0	0	0	0	138	263	401	0
9/14	0	0	0	0	3	0	3	0	0	0	134	197	331	0
9/15	1	0	0	1	3	4	7	0	0	0	175	289	464	0
9/16[c]	ND	ND	ND	0	ND	ND	4	ND	ND	0	ND	ND	340	0
9/17[c]	ND	ND	ND	0	ND	ND	4	ND	ND	0	ND	ND	282	0
9/18[c]	ND	ND	ND	0	ND	ND	3	ND	ND	0	ND	ND	224	0
9/19[c]	ND	ND	ND	0	ND	ND	2	ND	ND	0	ND	ND	166	0
9/20	0	0	0	0	2	1	3	0	0	0	45	77	122	0
9/21	0	0	0	0	0	0	0	0	0	0	45	50	95	0
9/22	0	0	0	0	1	0	1	0	0	0	50	77	127	0
Total Estimated Escapement	12,494	2,748	6,489	22,000	121,436	70,152	197,723	16,934	20,531	37,939	11,979	11,123	24,116	114
Observed Escapement				21,731			191,588			37,465			23,102	109
% Estimated				1.2%			3.1%			1.2%			4.2%	4.4%

Note: ND = no data.

[a] Jacks represent males less than approximately 600 mm.

[b] Estimated salmon passage (partial day).

[c] Estimated salmon passage (weir inoperable).

Table 2.–Age and sex of Chinook salmon at Kogrukluk River weir based on escapement samples collected with a live trap, 2005.

			Age Class																									
Sample Dates	Sample		0.2		1.1		1.2		2.1		1.3		2.2		1.4		2.3		1.5		2.4		1.6		2.5		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
6/27 – 7/1	115	M	0	0.0	19	0.9	464	21.7	0	0.0	1,021	47.8	0	0.0	241	11.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1,745	81.7
(6/22 – 7/3)		F	0	0.0	0	0.0	19	0.9	0	0.0	167	7.9	0	0.0	186	8.7	0	0.0	19	0.9	0	0.0	0	0.0	0	0.0	390	18.3
	Subtotal[a]		0	0.0	19	0.9	483	22.6	0	0.0	1,188	55.7	0	0.0	427	20.0	0	0.0	19	0.9	0	0.0	0	0.0	0	0.0	2,135	100.0
7/4 – 9	181	M	0	0.0	0	0.0	1,598	28.7	0	0.0	1,813	32.6	0	0.0	399	7.2	0	0.0	31	0.6	0	0.0	0	0.0	0	0.0	3,841	69.1
(7/4 – 9)		F	0	0.0	0	0.0	31	0.6	0	0.0	830	14.9	0	0.0	799	14.3	0	0.0	61	1.1	0	0.0	0	0.0	0	0.0	1,721	30.9
	Subtotal[a]		0	0.0	0	0.0	1,629	29.3	0	0.0	2,643	47.5	0	0.0	1,198	21.5	0	0.0	92	1.7	0	0.0	0	0.0	0	0.0	5,562	100.0
7/11 – 16	184	M	0	0.0	38	0.5	1,171	16.8	0	0.0	2,267	32.6	0	0.0	831	12.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4,308	62.0
(7/10 – 17)		F	0	0.0	0	0.0	0	0.0	0	0.0	945	13.6	0	0.0	1,663	23.9	0	0.0	38	0.5	0	0.0	0	0.0	0	0.0	2,645	38.0
	Subtotal[a]		0	0.0	38	0.5	1,171	16.8	0	0.0	3,212	46.2	0	0.0	2,494	35.9	0	0.0	38	0.5	0	0.0	0	0.0	0	0.0	6,953	100.0
7/18 – 22	125	M	0	0.0	0	0.0	820	20.0	0	0.0	1,377	33.6	0	0.0	426	10.4	0	0.0	33	0.8	0	0.0	0	0.0	0	0.0	2,656	64.8
(7/18 – 23)		F	0	0.0	0	0.0	0	0.0	0	0.0	623	15.2	0	0.0	820	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1,443	35.2
	Subtotal[a]		0	0.0	0	0.0	820	20.0	0	0.0	2,000	48.8	0	0.0	1,246	30.4	0	0.0	33	0.8	0	0.0	0	0.0	0	0.0	4,099	100.0
7/25,27 – 30	129	M	0	0.0	0	0.0	1,235	38.0	0	0.0	479	14.7	0	0.0	75	2.3	0	0.0	25	0.8	0	0.0	0	0.0	0	0.0	1,815	55.8
(7/24 – 9/22)		F	0	0.0	0	0.0	0	0.0	0	0.0	705	21.7	0	0.0	731	22.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1,436	44.2
	Subtotal[a]		0	0.0	0	0.0	1,235	38.0	0	0.0	1,184	36.4	0	0.0	806	24.8	0	0.0	25	0.8	0	0.0	0	0.0	0	0.0	3,251	100.0
Season [b]	734	M	0	0.0	56	0.3	5,288	24.1	0	0.0	6,958	31.6	0	0.0	1,974	9.0	0	0.0	89	0.4	0	0.0	0	0.0	0	0.0	14,365	65.3
		F	0	0.0	0	0.0	49	0.2	0	0.0	3,270	14.9	0	0.0	4,198	19.1	0	0.0	118	0.5	0	0.0	0	0.0	0	0.0	7,635	34.7
	Total		0	0.0	56	0.3	5,337	24.3	0	0.0	10,228	46.5	0	0.0	6,172	28.1	0	0.0	207	0.9	0	0.0	0	0.0	0	0.0	22,000	100.0

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

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

Table 3.–Mean length (mm) of Chinook salmon at Kogrukluk River weir based on escapement samples collected with a live trap, 2005.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5
6/27 – 7/1	M	Mean Length		415	560		695		796					
(6/22 – 7/3)		SE		-	7		7		14					
		Range		415-415	478-616		584-824		747-905					
		Sample Size	0	1	25	0	55	0	13	0	0	0	0	0
	F	Mean Length			618		785		818		906			
		SE			-		13		25		-			
		Range			618-618		735-841		642-934		906-906			
		Sample Size	0	0	1	0	9	0	10	0	1	0	0	0
7/4 – 9	M	Mean Length			546		714		800		753			
(7/4 – 9)		SE			7		8		23		-			
		Range			428-661		575-888		686-941		753-753			
		Sample Size	0	0	52	0	59	0	13	0	1	0	0	0
	F	Mean Length			623		762		822		874			
		SE			-		12		11		12			
		Range			623-623		560-862		687-918		862-886			
		Sample Size	0	0	1	0	27	0	26	0	2	0	0	0
7/11 – 16	M	Mean Length		490	558		721		808					
(7/10 – 17)		SE		-	11		7		15					
		Range		490-490	413-742		599-862		685-973					
		Sample Size	0	1	31	0	60	0	22	0	0	0	0	0
	F	Mean Length					791		835		930			
		SE					7		9		-			
		Range					725-851		697- 945		930-930			
		Sample Size	0	0	0	0	25	0	44	0	1	0	0	0
7/18 – 22	M	Mean Length			569		714		791		764			
(7/18 – 23)		SE			9		7		22		-			
		Range			499-660		608-820		619-924		764-764			
		Sample Size	0	0	25	0	42	0	13	0	1	0	0	0
	F	Mean Length					790		856					
		SE					11		9					
		Range					665-859		779-976					
		Sample Size	0	0	0	0	19	0	25	0	0	0	0	0
7/25,27 – 30	M	Mean Length			549		690		845		693			
(7/24 – 9/22)		SE			8		11		54		-			
		Range			445-680		557-762		737-903		693-693			
		Sample Size	0	0	49	0	19	0	3	0	1	0	0	0
	F	Mean Length					787		838					
		SE					7		9					
		Range					704-857		744-920					
		Sample Size	0	0	0	0	28	0	29	0	0	0	0	0
Season [a]	M	Mean Length		465	554		712		803		740			
		Range		415-490	413-742		557-888		619-973		693-764			
		Sample Size	0	2	182	0	235	0	64	0	3	0	0	0
	F	Mean Length			621		782		837		897			
		Range			618-623		560-862		642-976		862-930			
		Sample Size	0	0	2	0	108	0	134	0	4	0	0	0

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

Table 4.–Age and sex of chum salmon at Kogrukluk River weir based on escapement samples collected with a live trap, 2005.

Sample Dates (Stratum Dates)	Sample Size	Sex	0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %
6/28 – 7/1	141	M	0	0.0	1,011	58.2	222	12.7	0	0.0	1,233	70.9
(6/22 – 7/3)		F	0	0.0	395	22.7	111	6.4	0	0.0	506	29.1
		Subtotal[a]	0	0.0	1,406	80.9	333	19.1	0	0.0	1,739	100.0
7/4 – 7	194	M	0	0.0	13,147	48.9	2,353	8.8	0	0.0	15,499	57.7
(7/4 – 9)		F	0	0.0	10,517	39.2	830	3.1	0	0.0	11,348	42.3
		Subtotal[a]	0	0.0	23,664	88.1	3,183	11.9	0	0.0	26,847	100.0
7/11 – 13	173	M	0	0.0	14,406	41.6	801	2.3	0	0.0	15,207	43.9
(7/10 – 15)		F	2,001	5.8	16,607	48.0	800	2.3	0	0.0	19,408	56.1
		Subtotal[a]	2,001	5.8	31,013	89.6	1,601	4.6	0	0.0	34,615	100.0
7/18 – 20	179	M	292	0.6	28,349	54.2	1,754	3.3	0	0.0	30,394	58.1
(7/16 – 21)		F	1,462	2.8	18,996	36.3	1,461	2.8	0	0.0	21,919	41.9
		Subtotal[a]	1,754	3.4	47,345	90.5	3,215	6.1	0	0.0	52,313	100.0
7/25, 27 – 28	168	M	330	0.6	29,699	53.6	1,980	3.6	0	0.0	32,009	57.7
(7/22 – 29)		F	1,650	3.0	21,450	38.7	330	0.6	0	0.0	23,430	42.3
		Subtotal[a]	1,980	3.6	51,149	92.3	2,310	4.2	0	0.0	55,439	100.0
8/1 – 3	169	M	331	1.8	9,484	50.9	221	1.2	0	0.0	10,035	53.8
(7/30 – 8/6)		F	1,213	6.5	7,389	39.6	0	0.0	0	0.0	8,602	46.2
		Subtotal[a]	1,544	8.3	16,873	90.5	221	1.2	0	0.0	18,637	100.0
8/9 – 11	174	M	140	1.7	3,973	48.9	93	1.1	0	0.0	4,207	51.7
(8/7 – 9/23)		F	421	5.2	3,459	42.5	47	0.6	0	0.0	3,926	48.3
		Subtotal[a]	561	6.9	7,432	91.4	140	1.7	0	0.0	8,133	100.0
Season[b]	1,198	M	1,093	0.6	100,069	50.6	7,422	3.8	0	0.0	108,585	54.9
		F	6,746	3.4	78,813	39.9	3,580	1.8	0	0.0	89,138	45.1
		Total	7,839	4.0	178,882	90.5	11,002	5.6	0	0.0	197,723	100.0

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

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

Table 5.–Mean length (mm) of chum salmon at Kogrukluk River weir based on escapement samples collected with a live trap, 2005.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
6/28 – 7/1 (6/22 – 7/3)	M	Mean Length		573	604	
		SE		3	7	
		Range		511-639	540-658	
		Sample Size	0	82	18	0
	F	Mean Length		546	557	
		SE		4	9	
		Range		506-585	505-583	
		Sample Size	0	32	9	0
7/4 – 7 (7/4 – 9)	M	Mean Length		571	584	
		SE		3	10	
		Range		502-668	497-648	
		Sample Size	0	95	17	0
	F	Mean Length		541	576	
		SE		3	15	
		Range		448-592	546-645	
		Sample Size	0	76	6	0
7/11 – 13 (7/10 – 15)	M	Mean Length		565	568	
		SE		4	13	
		Range		505-648	542-603	
		Sample Size	0	72	4	0
	F	Mean Length	493	535	574	
		SE	10	3	7	
		Range	425-545	453-603	557-589	
		Sample Size	10	83	4	0
7/18 – 20 (7/16 – 21)	M	Mean Length	543	558	567	
		SE	-	3	7	
		Range	543-543	497-633	549-590	
		Sample Size	1	97	6	0
	F	Mean Length	497	533	567	
		SE	8	3	7	
		Range	471-513	488-598	540-579	
		Sample Size	5	65	5	0
7/25, 27 – 28 (7/22 – 29)	M	Mean Length	564	555	567	
		SE	-	3	17	
		Range	564-564	472-635	502-623	
		Sample Size	1	90	6	0
	F	Mean Length	498	528	505	
		SE	11	4	-	
		Range	460-525	447-627	505-505	
		Sample Size	5	65	1	0

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Table 5.–Page 2 of 2.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
8/1 – 3 (7/30 – 8/6)	M	Mean Length	489	540	580	
		SE	16	3	35	
		Range	466-520	459-622	545-615	
		Sample Size	3	86	2	0
	F	Mean Length	479	513		
		SE	6	8		
		Range	445-504	452-587		
		Sample Size	11	67	0	0
8/9 – 11 (8/7 – 9/23)	M	Mean Length	515	533	550	
		SE	11	3	38	
		Range	500-536	462-627	512-587	
		Sample Size	3	85	2	0
	F	Mean Length	487	511	462	
		SE	5	3	-	
		Range	462-507	436-586	462-462	
		Sample Size	9	74	1	0
Season [a]	M	Mean Length	529	557	573	
		Range	466-564	459-668	497-658	
		Sample Size	8	607	55	0
	F	Mean Length	492	530	563	
		Range	425-545	500-627	462-645	
		Sample Size	40	462	26	0

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

Table 6.–Age and sex of coho salmon at Kogrukluk River weir based on escapement samples collected with a live trap, 2005.

			Age Class									
Sample Dates	Sample		1.1		2.1		2.2		3.1		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
8/20–21,23–24,26,28–29	167	M	411	4.2	4,225	43.1	0	0.0	646	6.6	5,281	53.9
(6/22–8/29)		F	117	1.2	3,873	39.5	0	0.0	528	5.4	4,519	46.1
		Subtotal [a]	528	5.4	8,098	82.6	0	0.0	1,174	12.0	9,800	100.0
9/1–5	142	M	294	4.2	3,334	47.9	0	0.0	245	3.5	3,873	55.6
(8/30–9/6)		F	196	2.8	2,696	38.7	0	0.0	196	2.8	3,089	44.4
		Subtotal [a]	490	7.0	6,030	86.6	0	0.0	441	6.3	6,962	100.0
9/8–11	138	M	53	0.7	2,771	37.7	0	0.0	160	2.2	2,984	40.6
(9/7–22)		F	373	5.1	3,570	48.5	0	0.0	426	5.8	4,370	59.4
		Subtotal [a]	426	5.8	6,341	86.2	0	0.0	586	8.0	7,354	100.0
Season [b]	447	M	758	3.1	10,330	42.8	0	0.0	1,050	4.3	12,139	50.3
		F	687	2.9	10,140	42.1	0	0.0	1,151	4.8	11,977	49.7
		Total	1,445	6.0	20,470	84.9	0	0.0	2,201	9.1	24,116	100.0

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

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

Table 7.–Mean length (mm) of coho salmon at Kogrukluk River weir based on escapement samples collected with a live trap, 2005.

Year	Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	2.2	3.1
2005	8/20–21,23–24,26,28–29 (6/22–8/29)	M	Mean Length	516	554		555
			SE	18	5		13
			Range	448-579	449-638		489-634
			Sample Size	7	72	0	11
		F	Mean Length	531	540		564
			SE	84	7		15
			Range	447-614	390-609		471-607
			Sample Size	2	66	0	9
	9/1–5 (8/30–9/6)	M	Mean Length	514	539		554
			SE	18	5		14
			Range	430-549	439- 630		508-591
			Sample Size	6	68	0	5
		F	Mean Length	550	533		552
			SE	3	6		25
			Range	544-559	416-625		484-601
			Sample Size	4	55	0	4
	9/8–11 (9/7–22)	M	Mean Length	566	532		542
			SE	-	6		30
			Range	566-566	409-610		495-597
			Sample Size	1	52	0	3
		F	Mean Length	550	544		570
			SE	8	4		9
			Range	512-579	456-619		538-600
			Sample Size	7	67	0	8
	Season [a]	M	Mean Length	519	543		553
			Range	430-579	409-638		489-634
			Sample Size	14	192	0	19
		F	Mean Length	547	540		564
			Range	447-614	390-625		471-607
			Sample Size	13	188	0	21

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

Figure 1.–Locations of Kuskokwim Area salmon management districts and escapement monitoring projects.

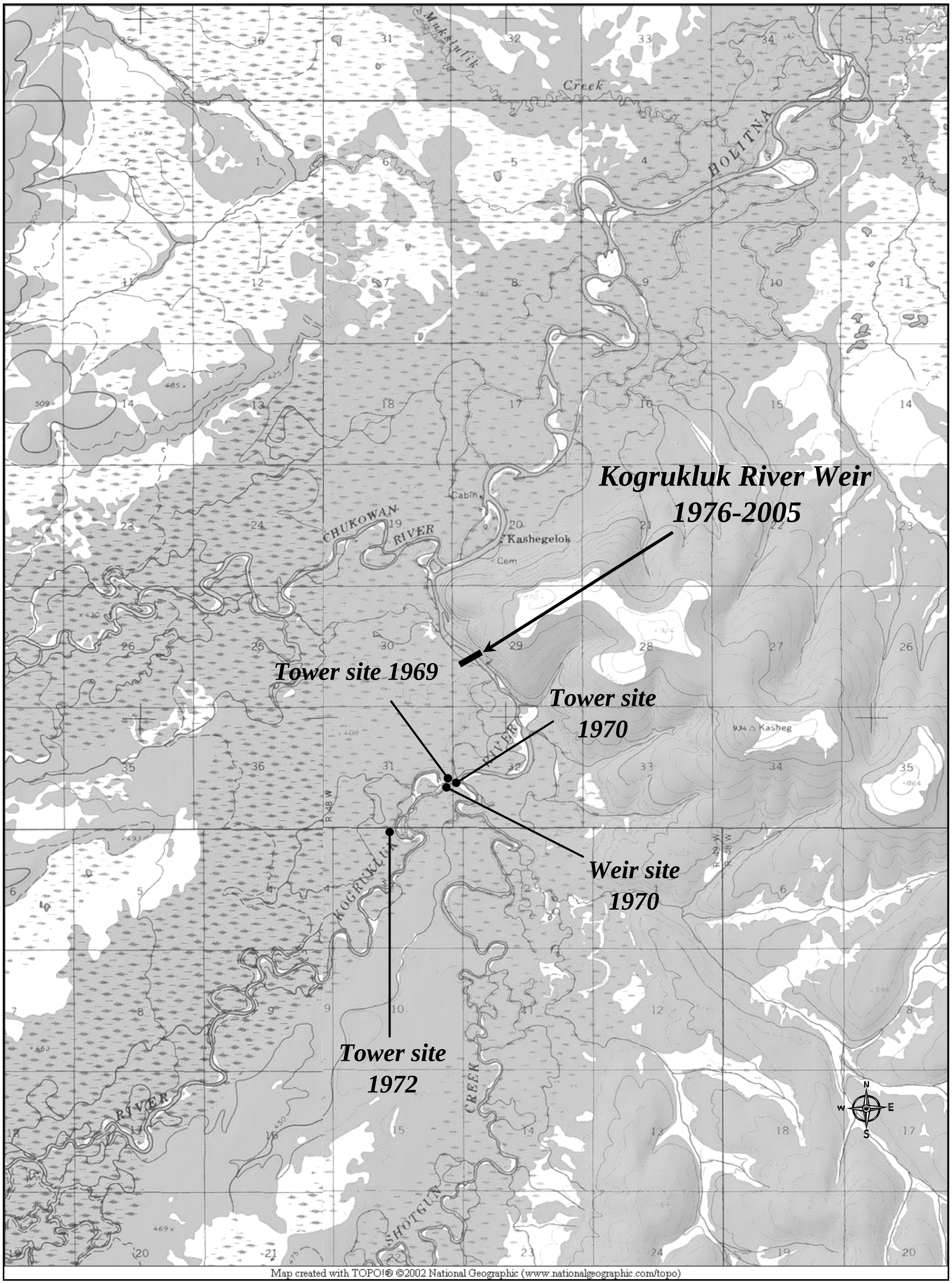
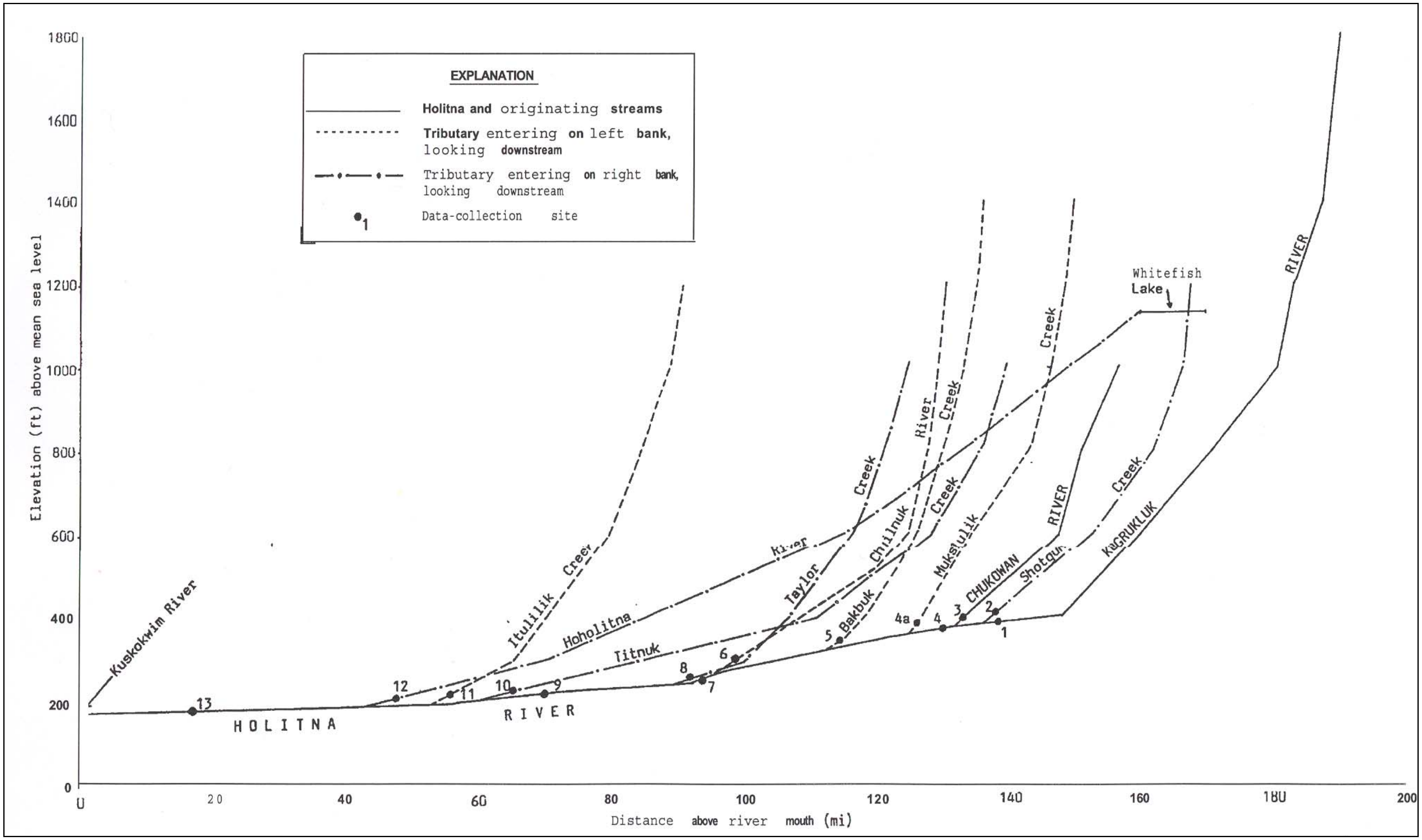


Figure 2.–Kogrukluk River study area and locations of historical escapement projects.



Source: Collazzi 1989.

Figure 3.–Profile of the Holitna River and major tributaries, Alaska.

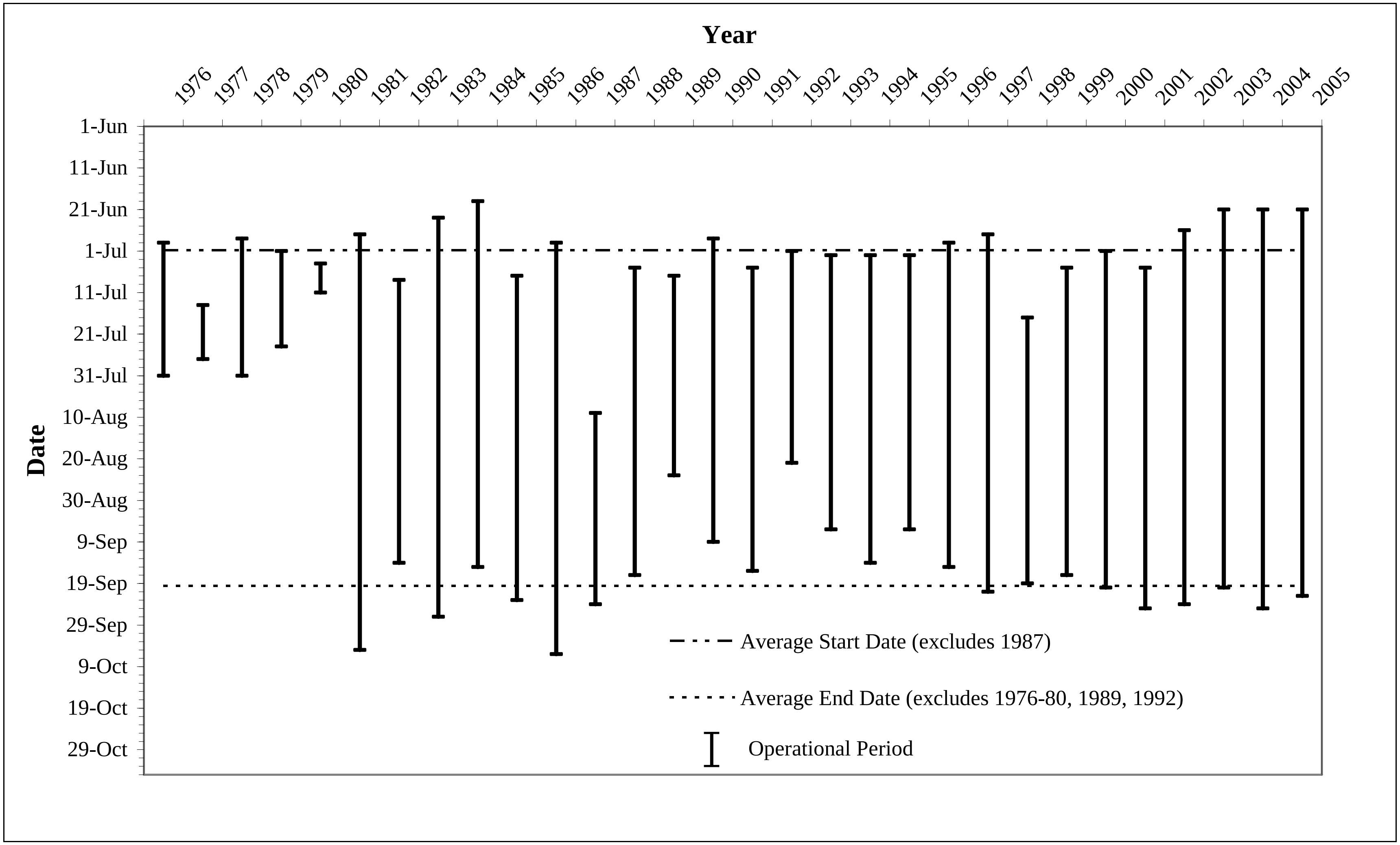
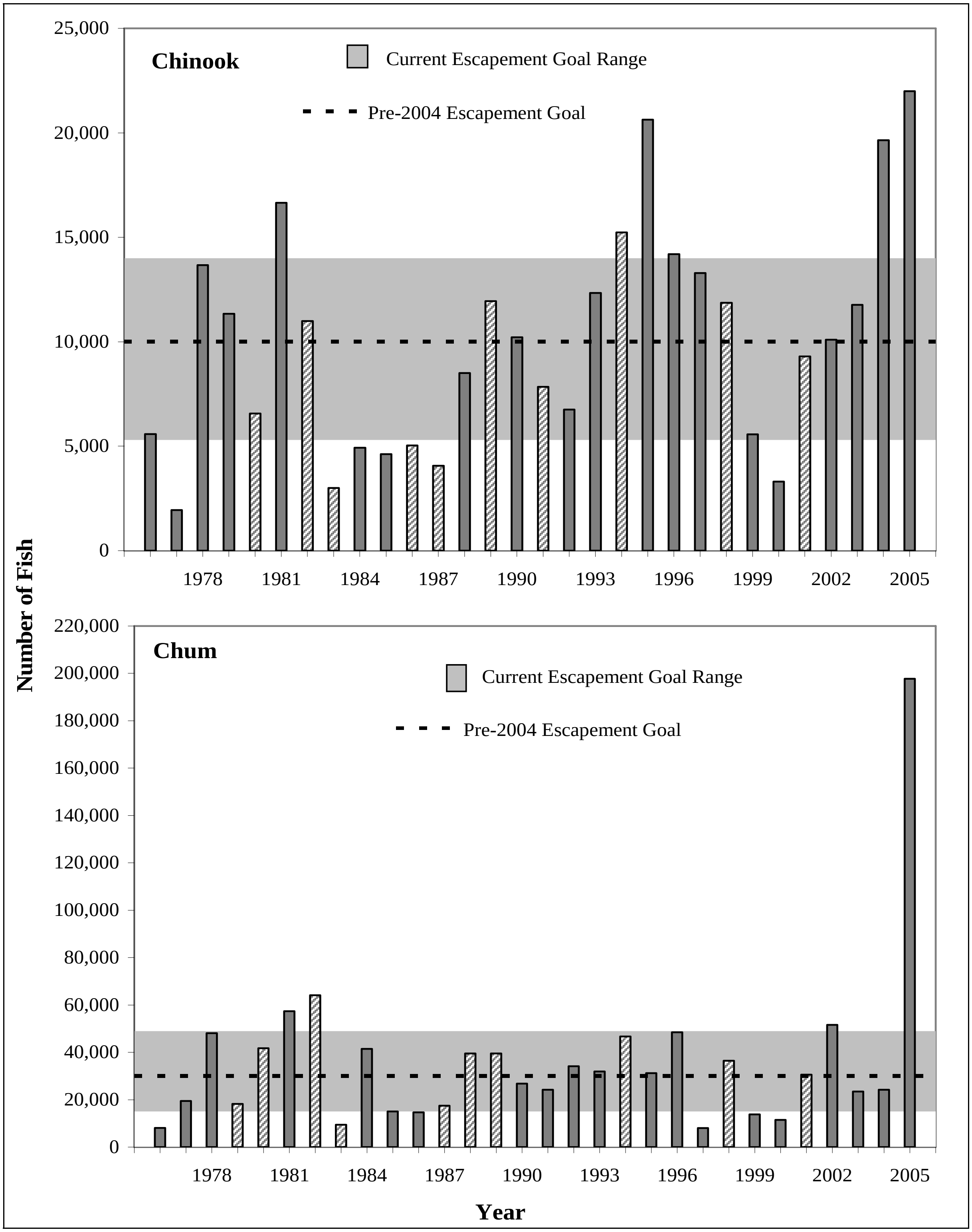
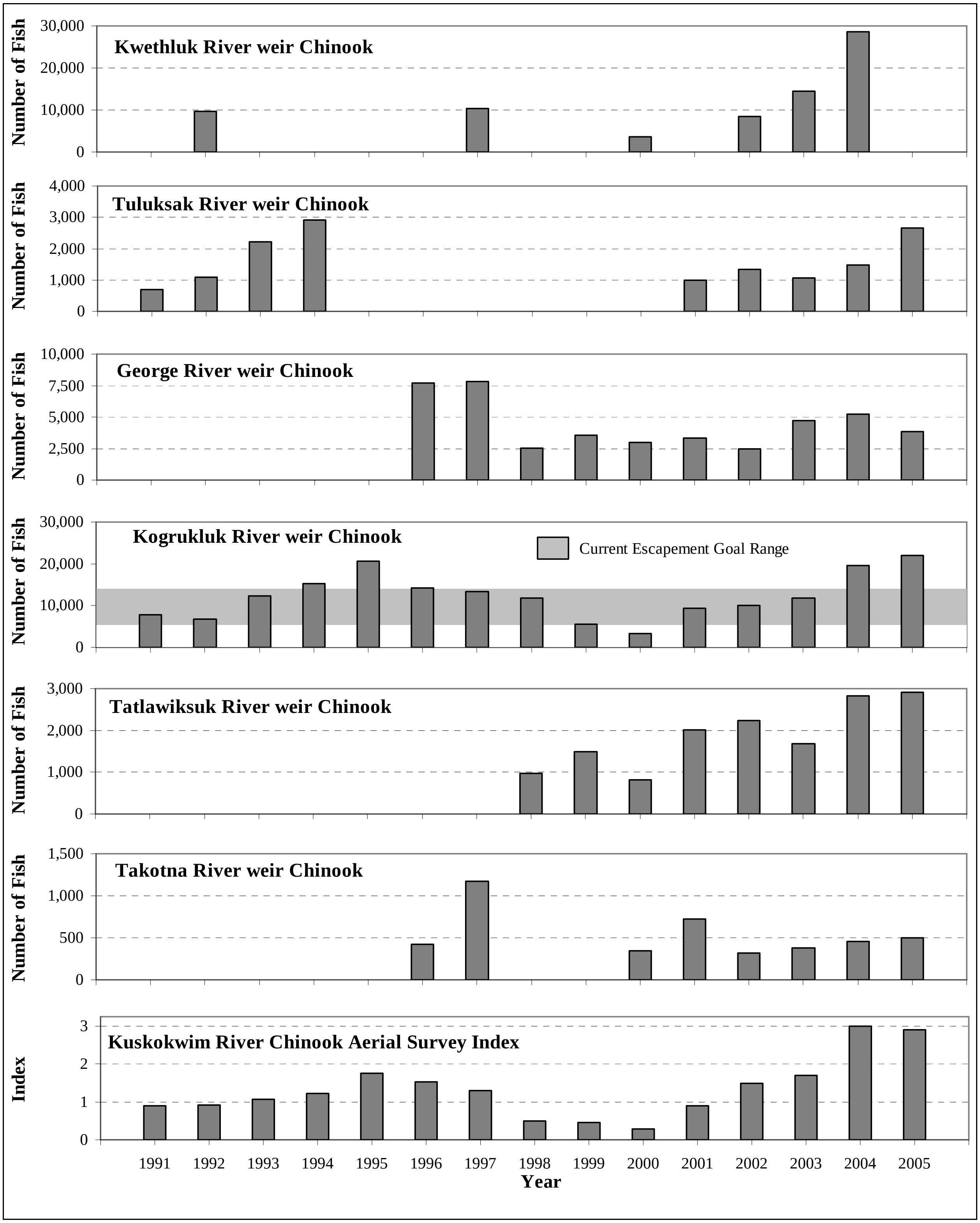


Figure 4.–Historical operational dates at the Kogrukluk River weir.



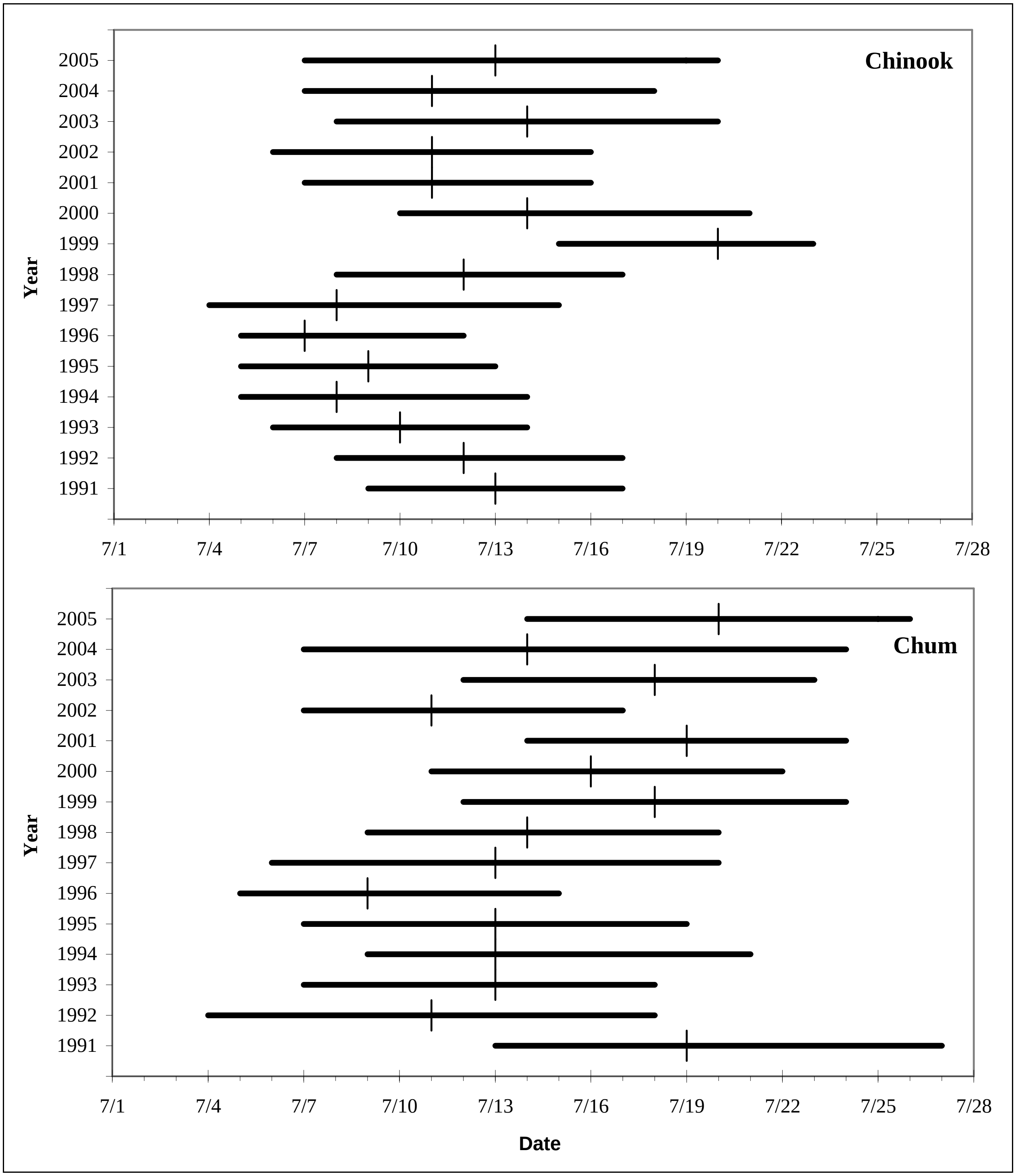
Note: Diagonally-hatched bars are years when more than 20% of the escapement was estimated.

Figure 5.–Historical Chinook and chum salmon escapement with the pre-2004 minimum escapement goal and current escapement goal range at Kogrukluk River weir.



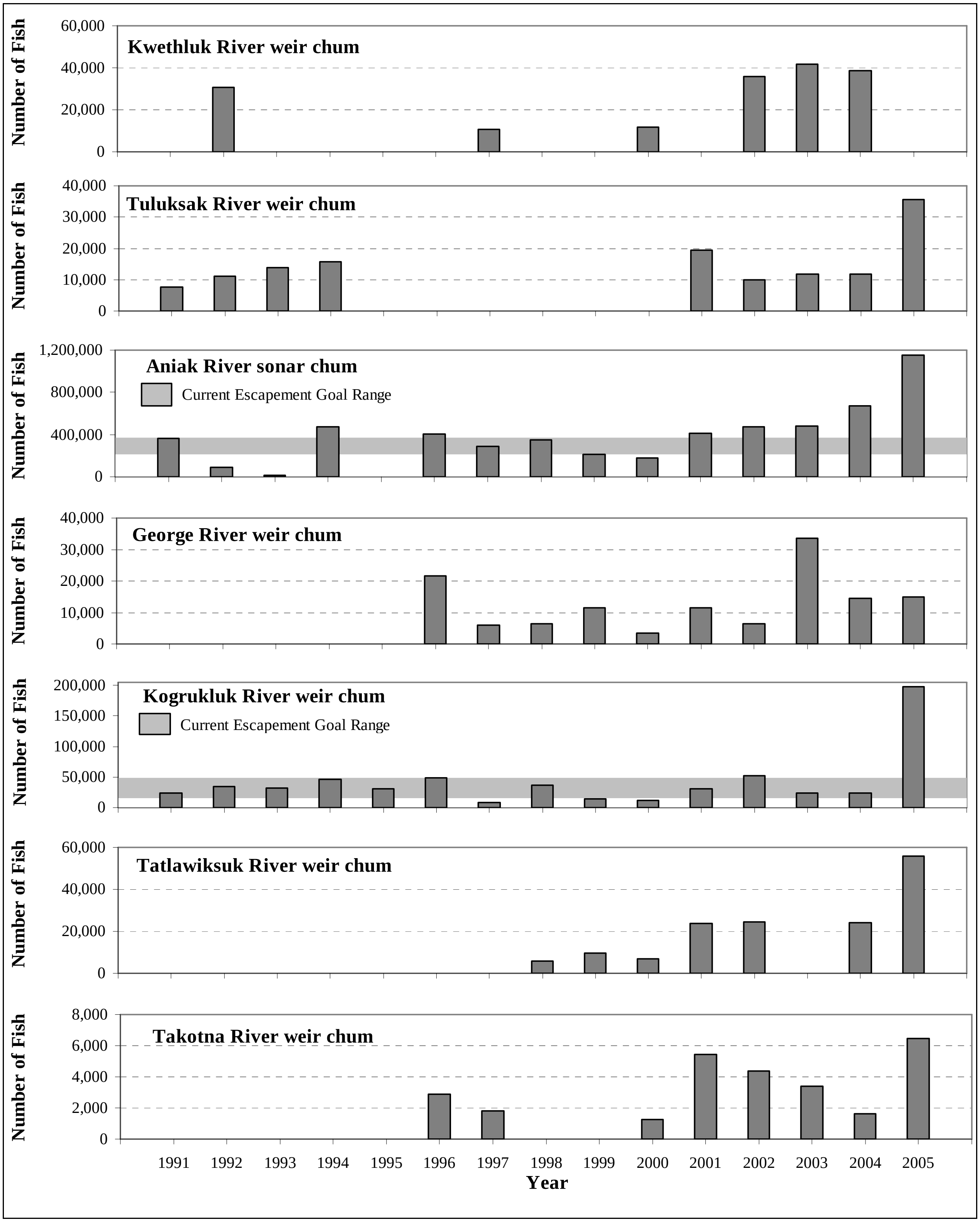
Sources: Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; Linderman *personal communication*; Roettiger et al. 2005; Stewart et al. 2006; Zabkar et al. *In prep.*

Figure 6.–Chinook salmon escapement into 6 Kuskokwim River tributaries, and Kuskokwim River Chinook salmon aerial survey indices, 1991–2005.



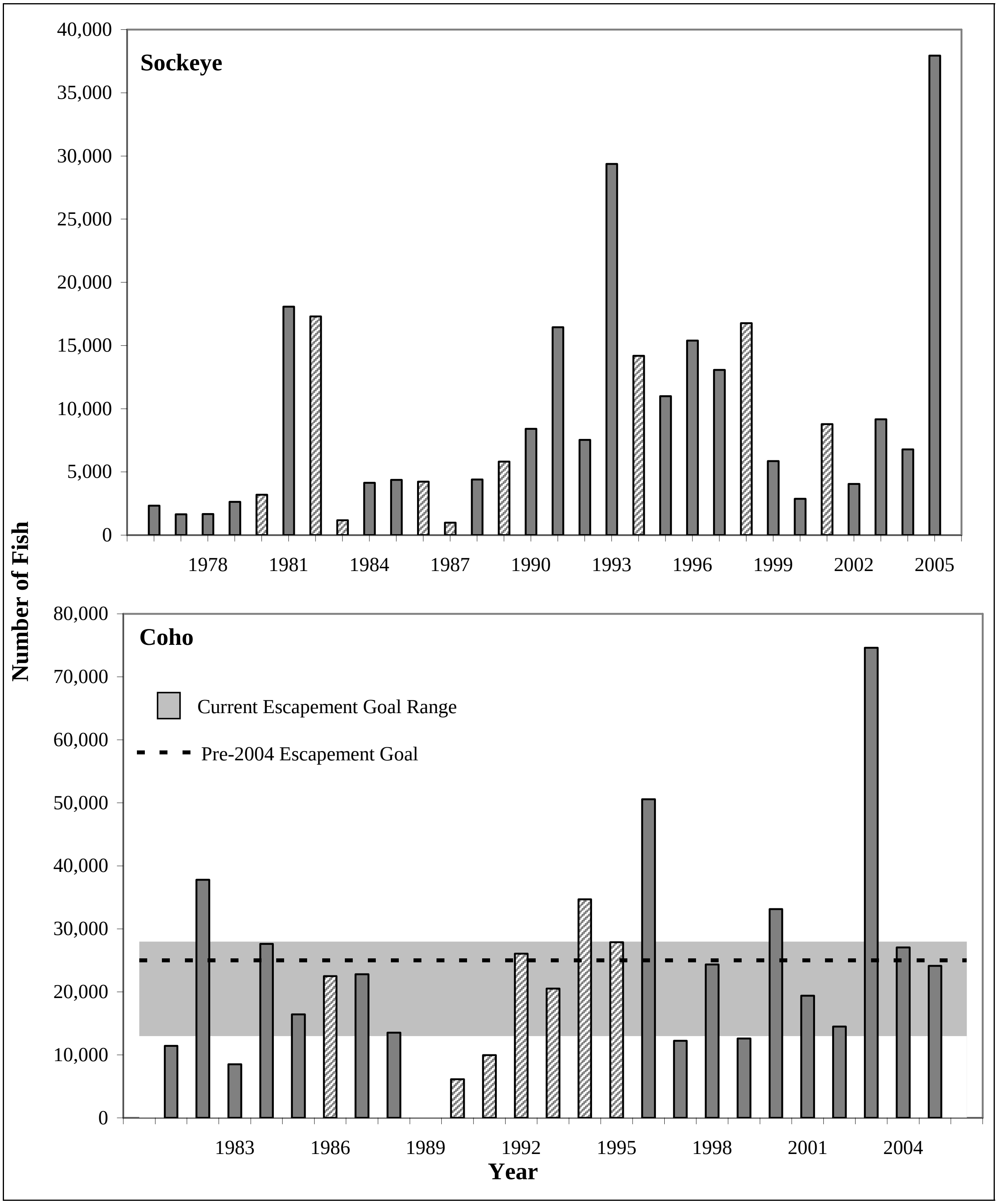
Note: Horizontal black lines represent dates when the central fifty percent of the run passed and cross-bars represent median passage dates.

Figure 7.–Historical annual run timing of Chinook and chum salmon based on cumulative percent passage at Kogrukluk River weir, 1991–2005.



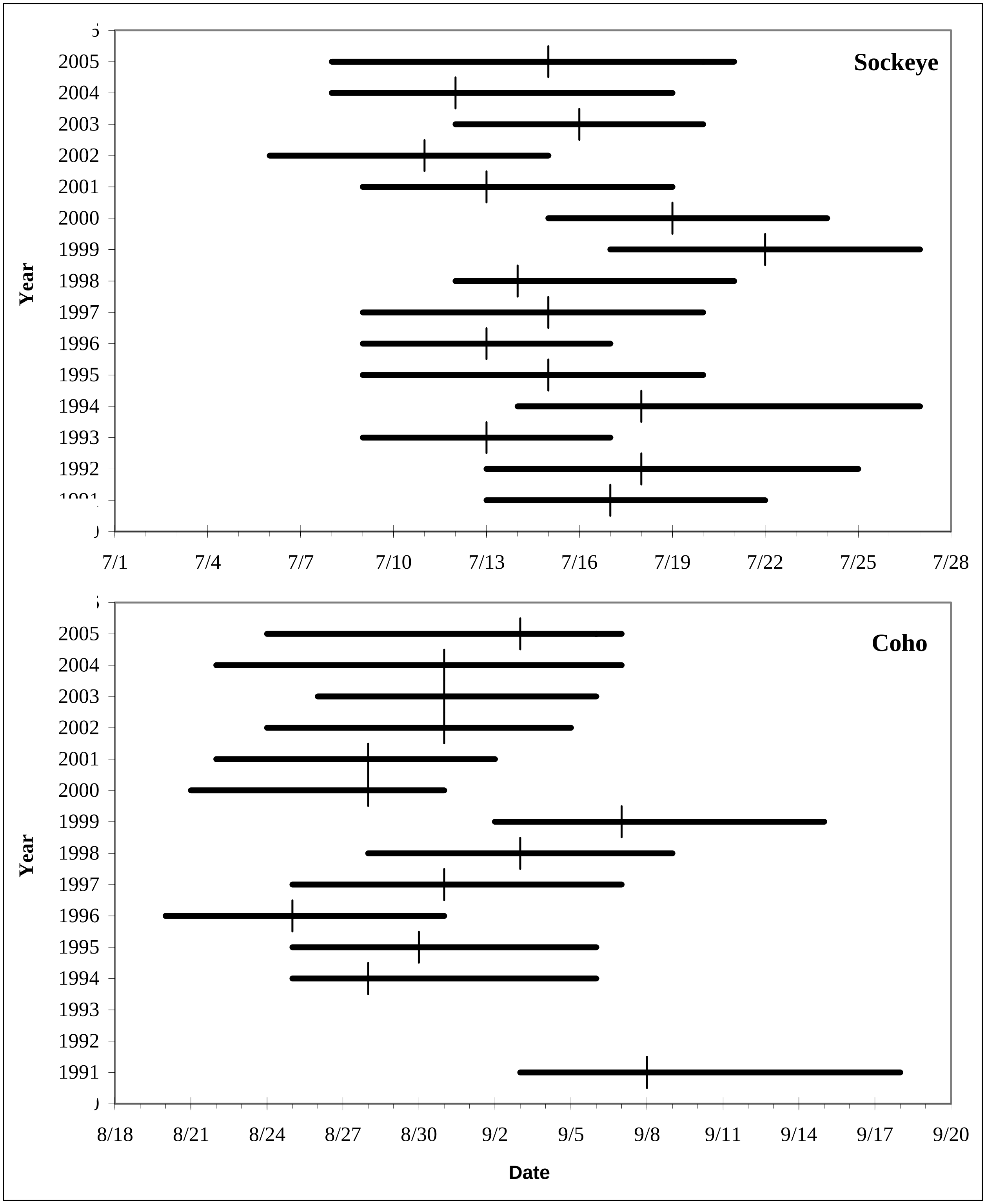
Sources: Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; McEwen *In prep*; Roettiger et al. 2005; Stewart et al. 2006; Zabkar et al. *In prep*.

Figure 8.–Historical chum salmon escapement into 7 Kuskokwim River tributaries, 1991–2005.



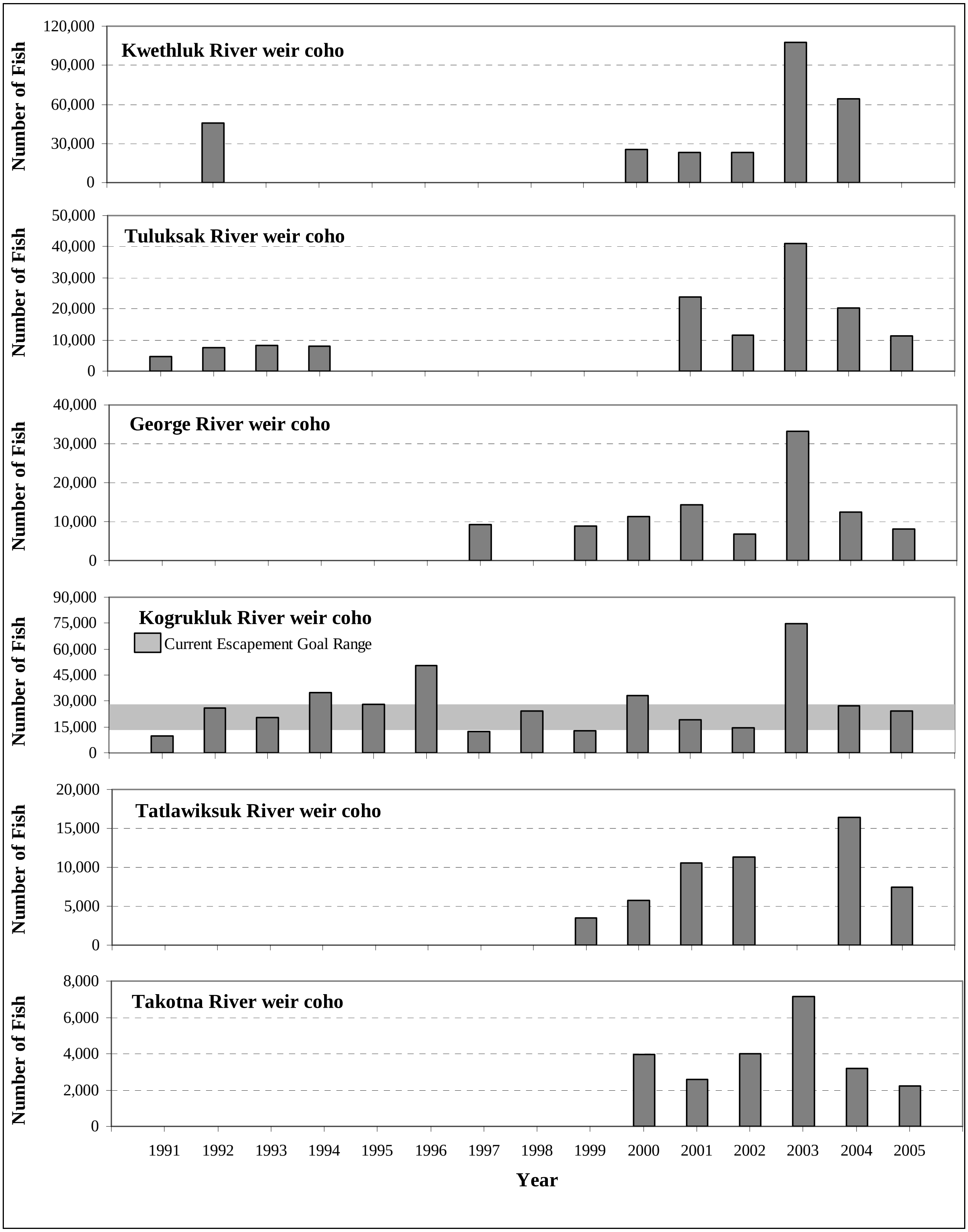
Note: Diagonally-hatched bars are years when more than 20% of the escapement was estimated.

Figure 9.–Historical sockeye and coho salmon escapement with the pre-2004 minimum escapement goal and the current escapement goal range.



Note: Horizontal black lines represent dates when the central fifty percent of the run passed and cross-bars represent median passage dates.

Figure 10.–Historical annual run timing of sockeye and coho salmon based on cumulative percent passage at Kogrukluk River weir, 1991–2005.



Sources: Costello, Molyneaux et al. 2006; Costello, Stewart et al. 2006; Roettiger et al. 2005; Stewart et al. 2006; Zabkar et al. *In prep*.

Figure 11.–Historical coho salmon escapement into 6 Kuskokwim River tributaries, 1991–2005.

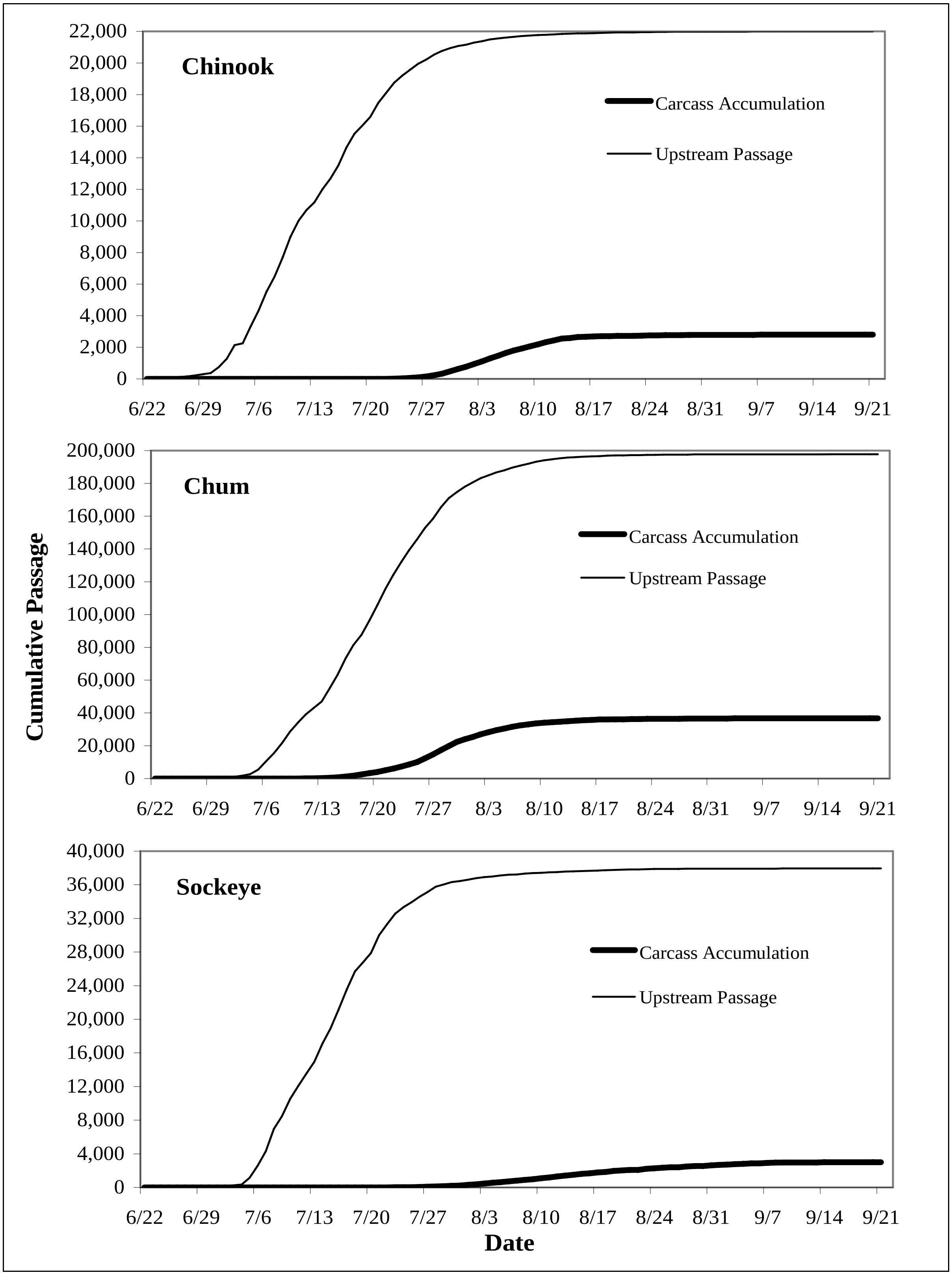
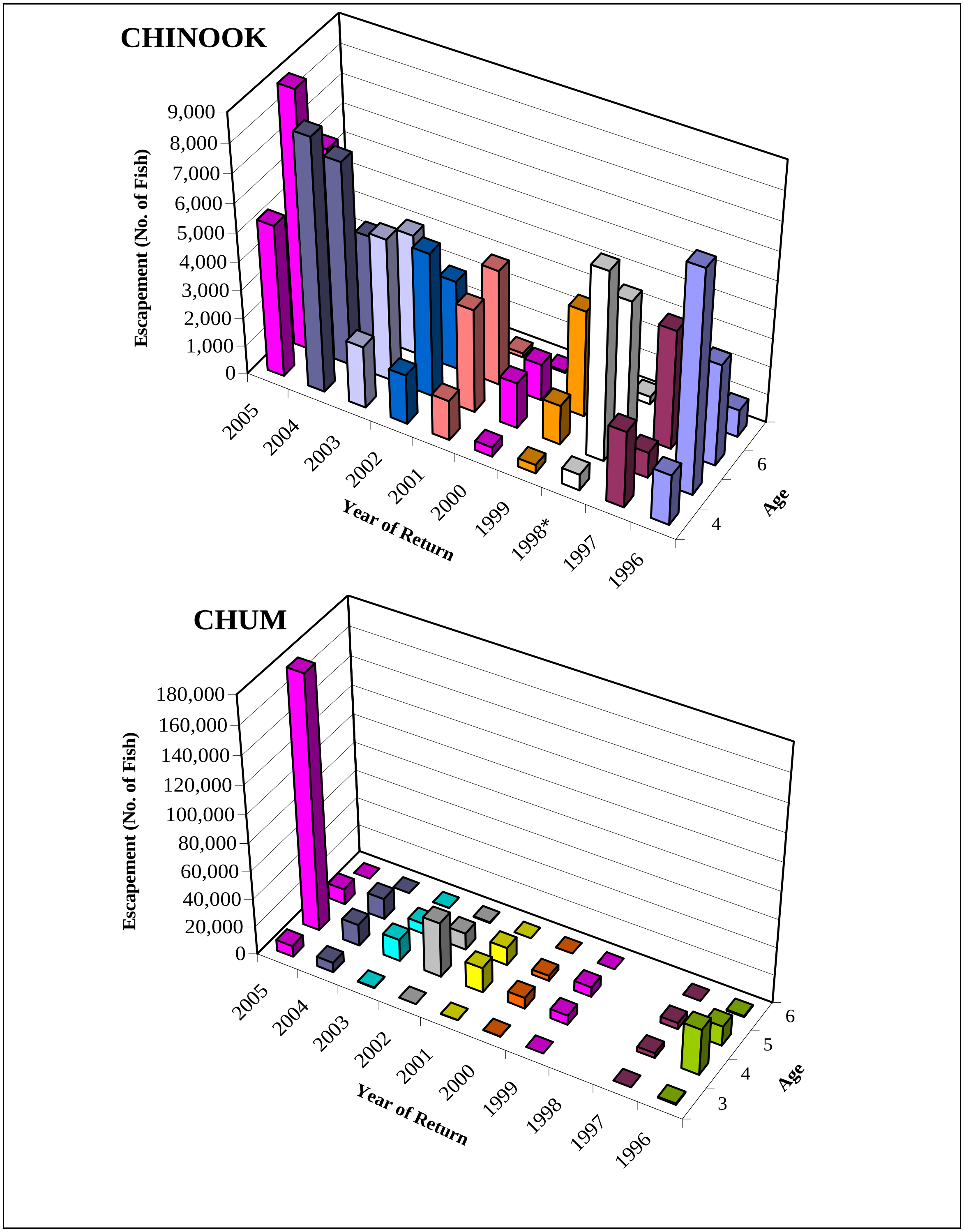
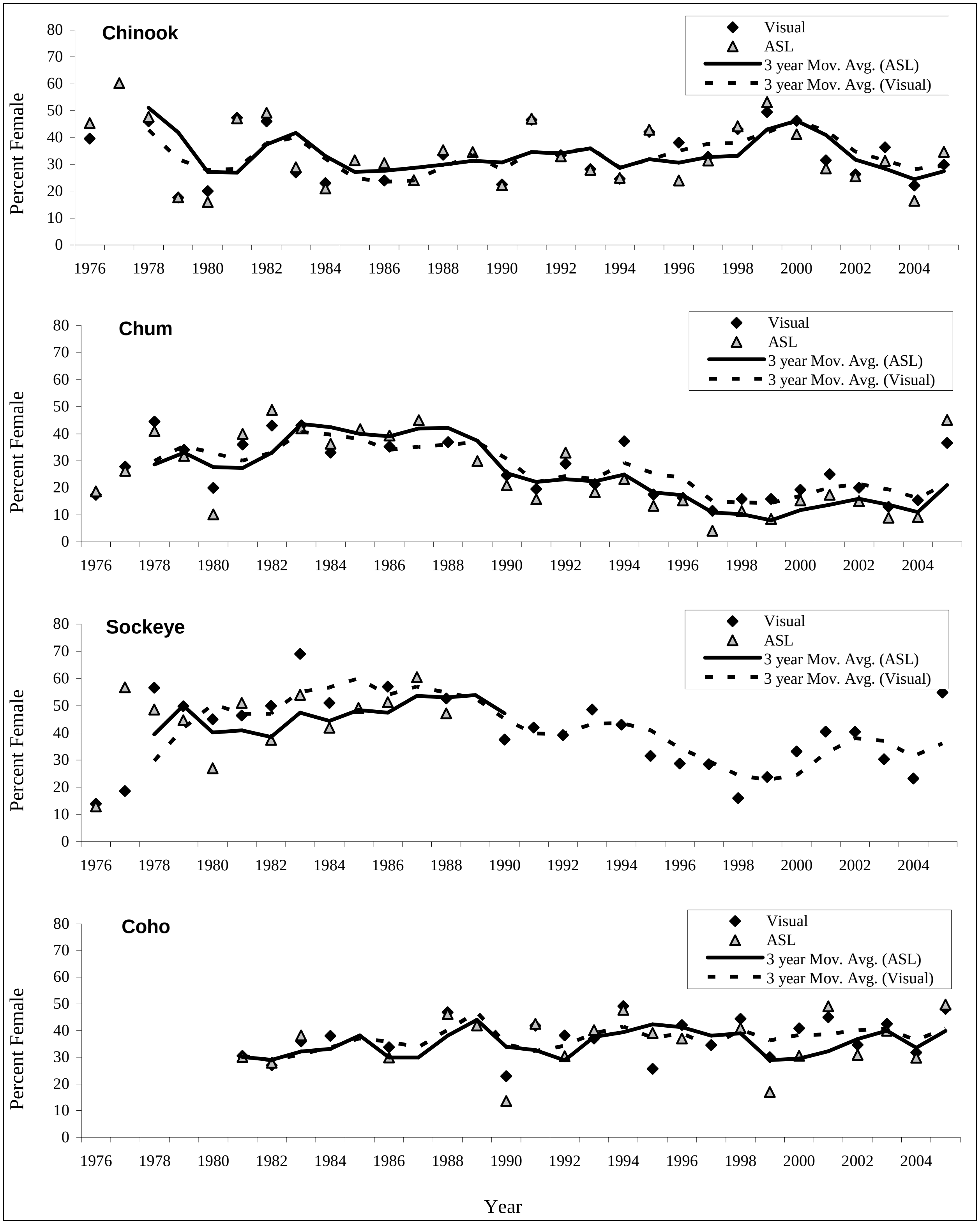


Figure 12.–Cumulative upstream passage and downstream carcass accumulation by species at Kogrukluk River weir, 2005.



Source: Molyneaux and Folletti 2005.
Note: An asterisk (*) denotes incomplete sampling or escapement estimates.

Figure 13.–Historical Chinook and chum salmon age distribution at Kogrukluk River weir.



Note: Trend lines represent 3-year moving averages.

Figure 14.–Historical annual percentage of female salmon as determined by weighted ASL sampling and visual identification at Kogrukluk River weir.

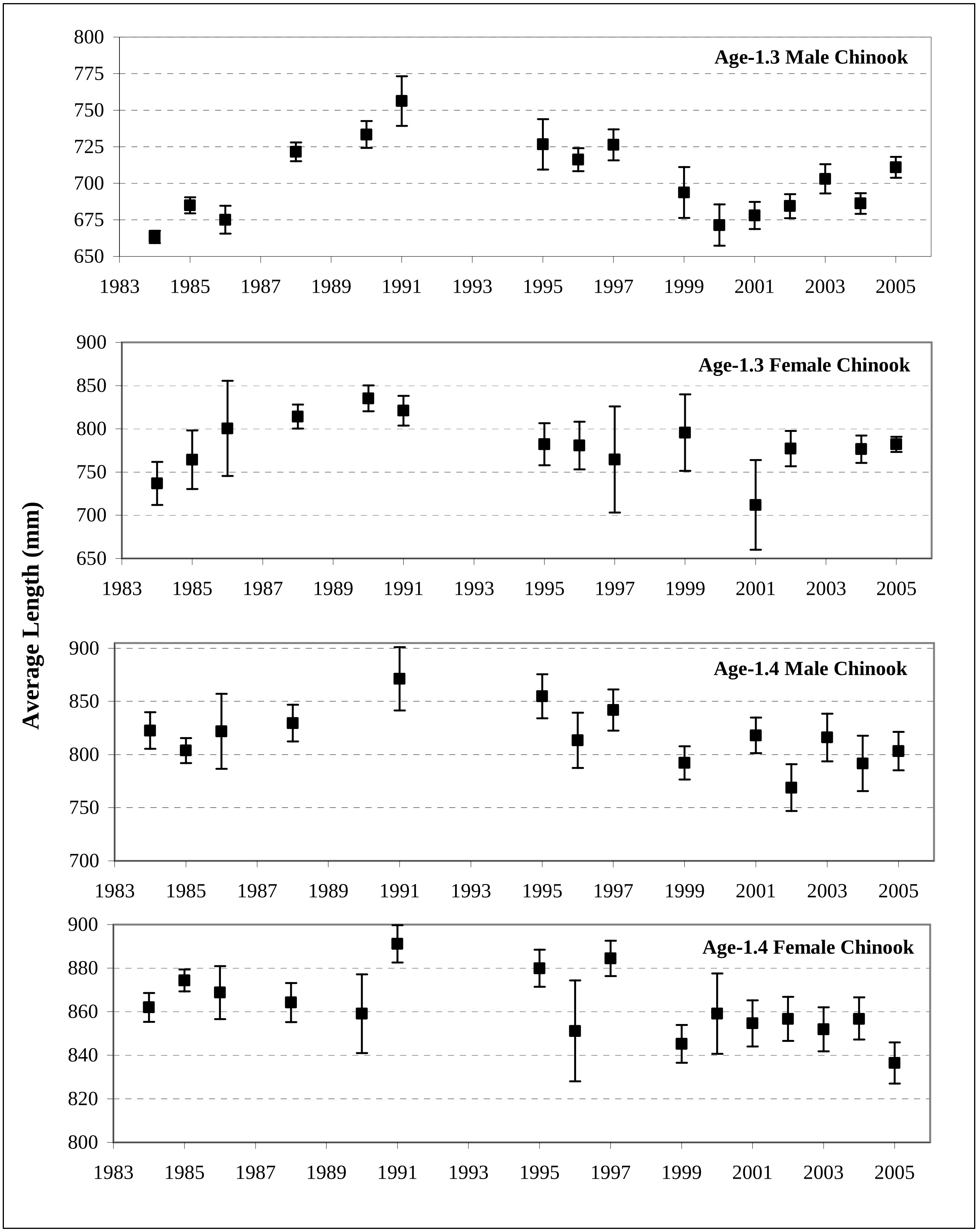


Figure 15.–Historical average annual length (METF) at age, by sex, of Chinook salmon at Kogrukluk River weir with 95% confidence intervals.

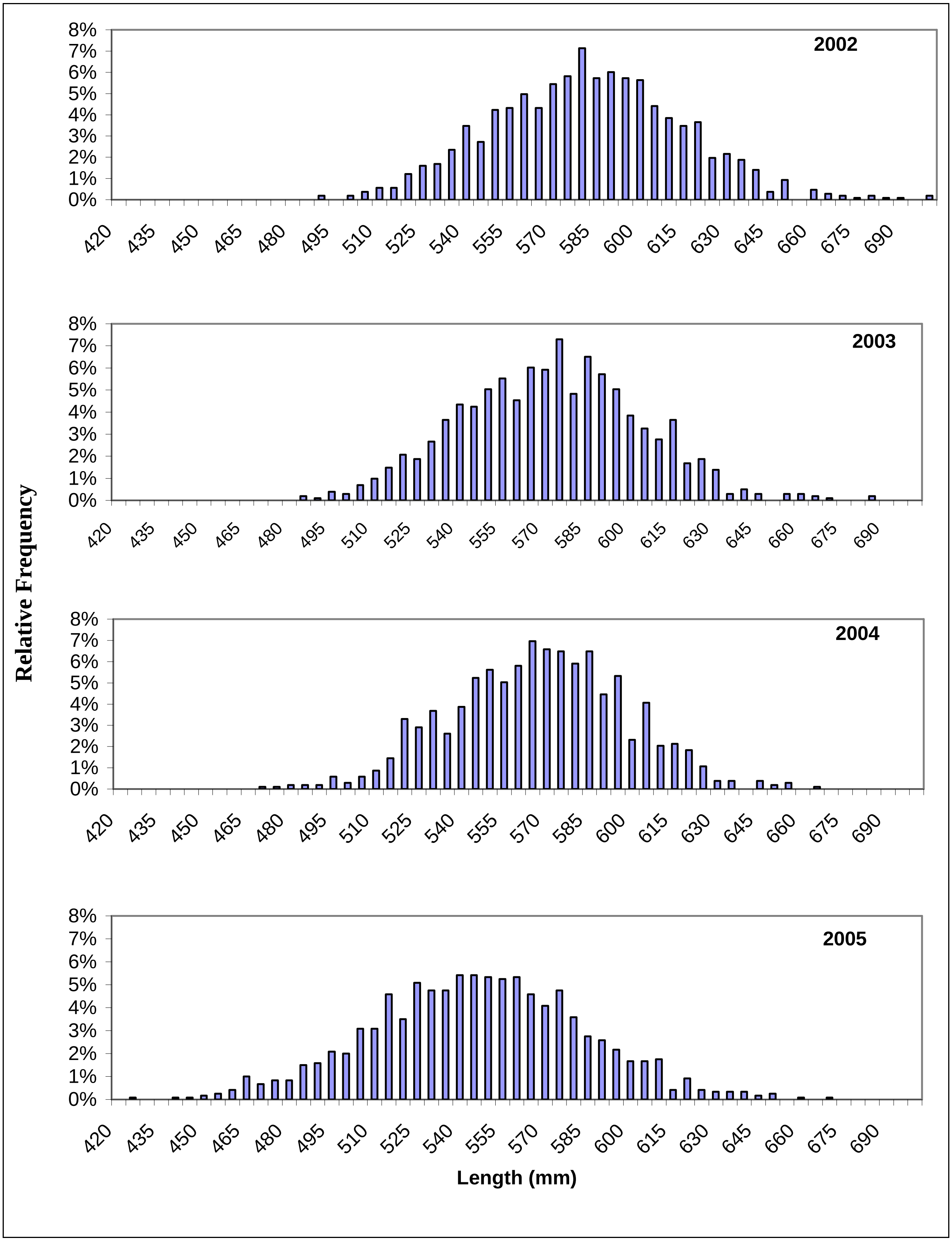


Figure 16.–Length frequency histograms for chum salmon at Kogrukluk River weir for 2002–2005.

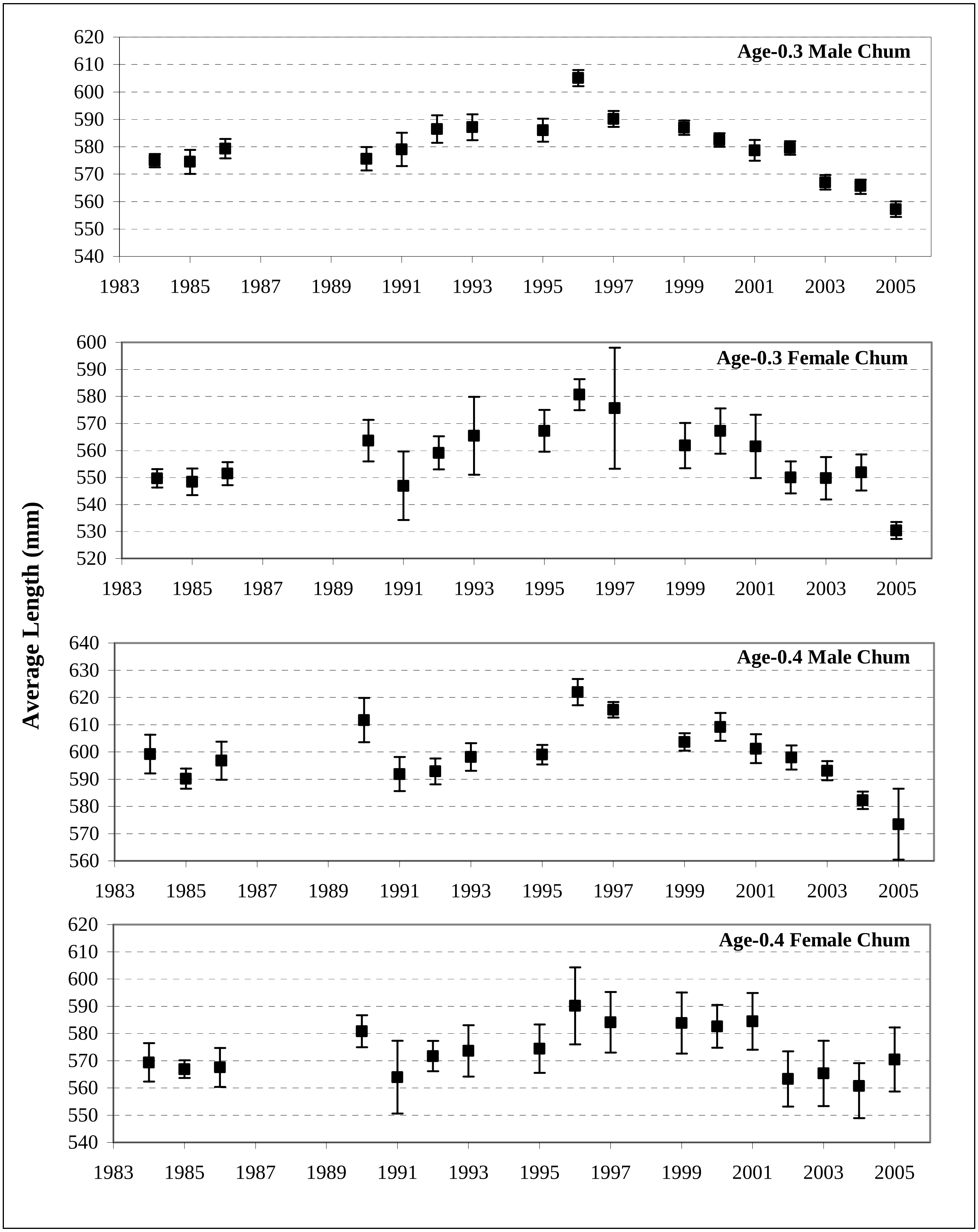


Figure 17.–Historical average annual length (METF) at age, by sex, of chum salmon at Kogrukluk River weir with 95% confidence intervals.

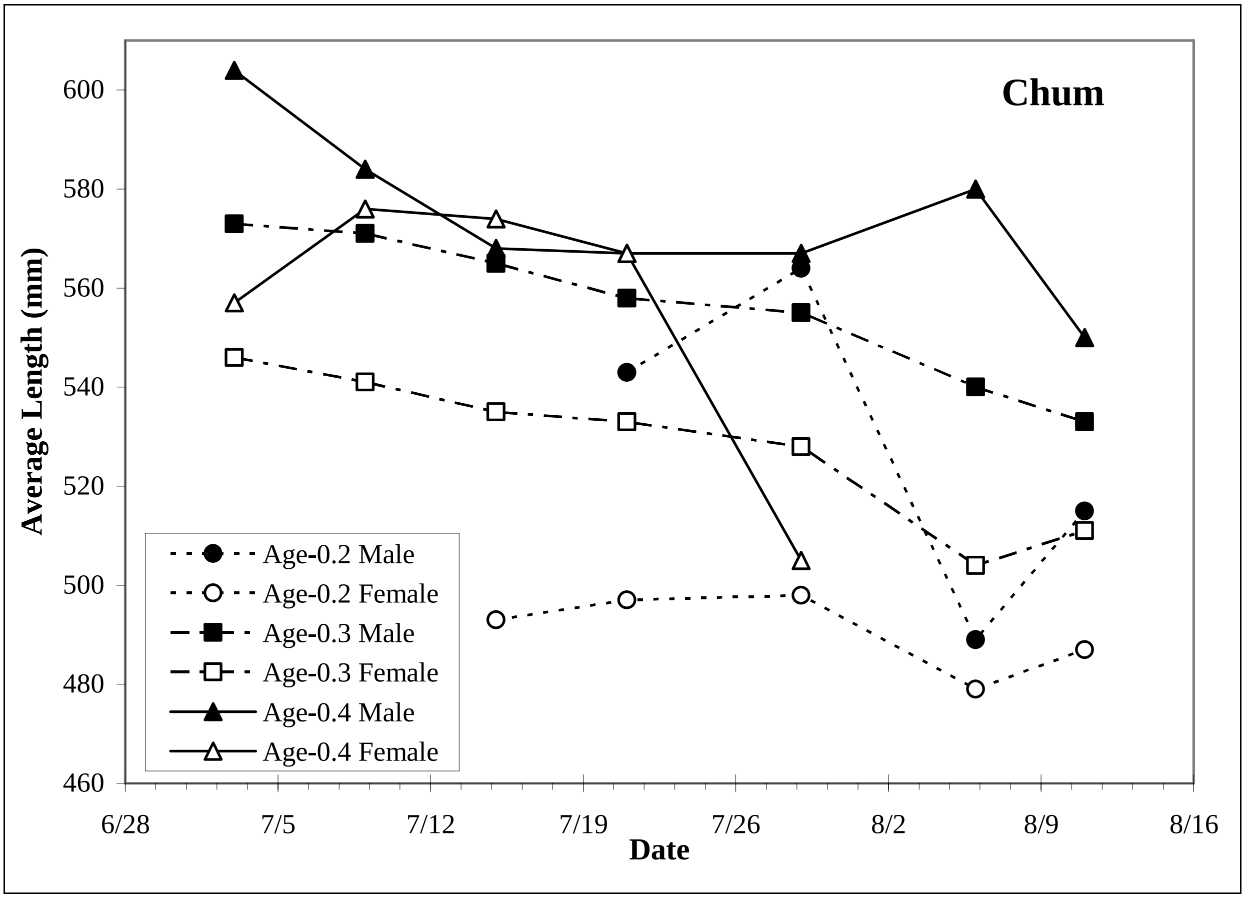


Figure 18.–Mean length (MEF) of chum salmon by date, age, and sex at Kogrukluk River weir, 2005.

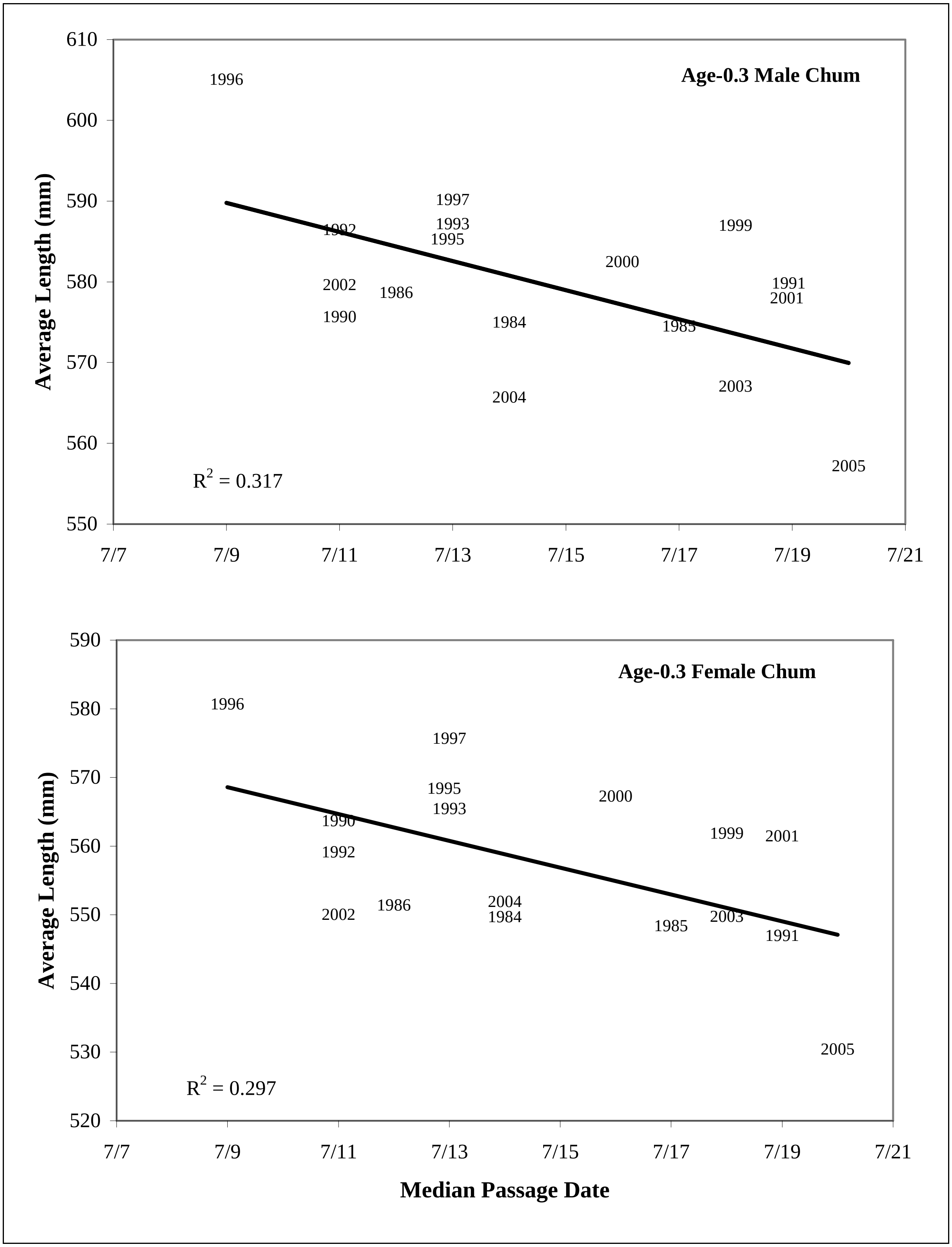


Figure 19.–Historical average length (MEF) of age-0.3 male and female chum salmon by median passage date,1984–2005.

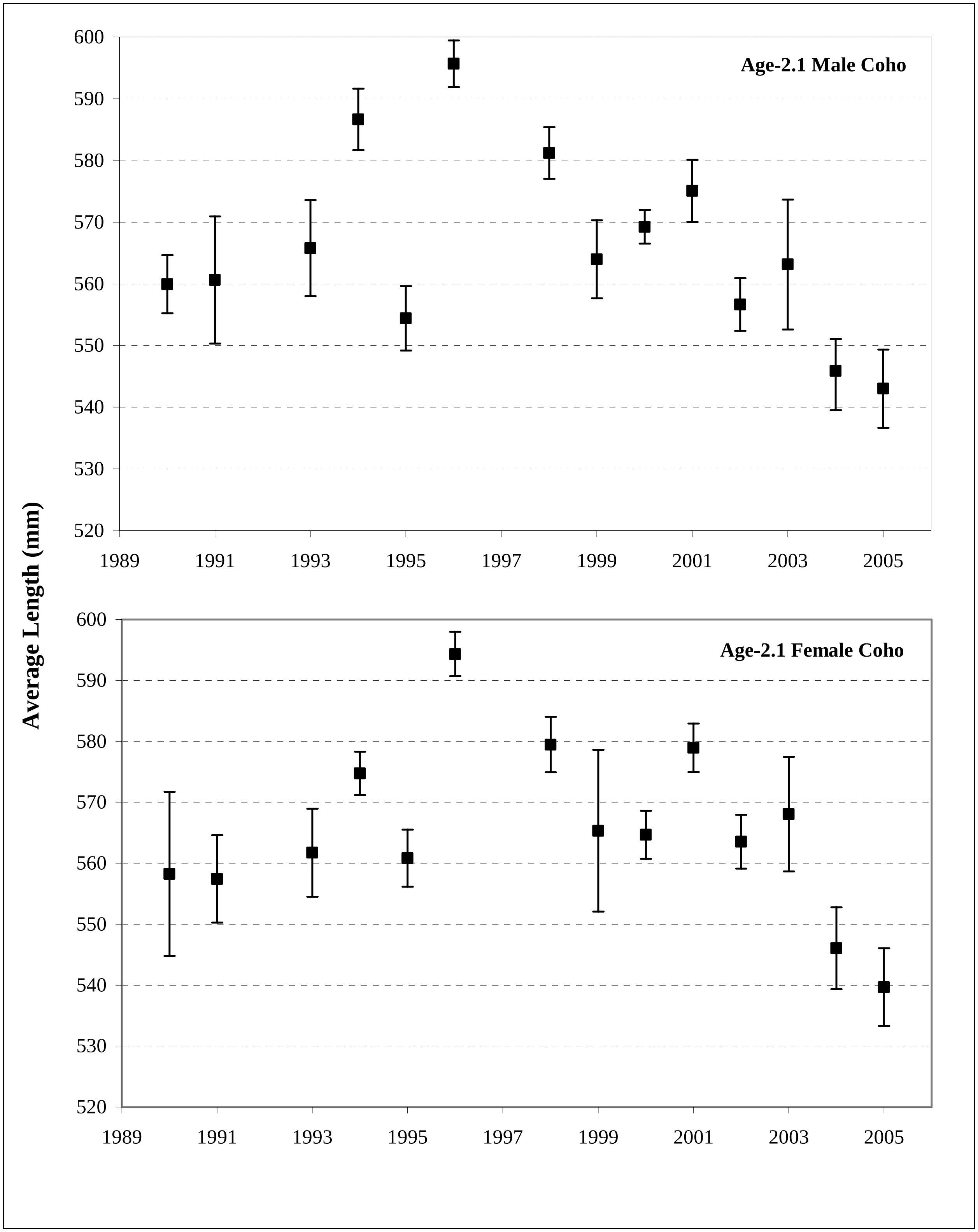


Figure 20.–Historical average annual length (METF) for coho salmon with 95% confidence intervals at Kogrukluk River weir.

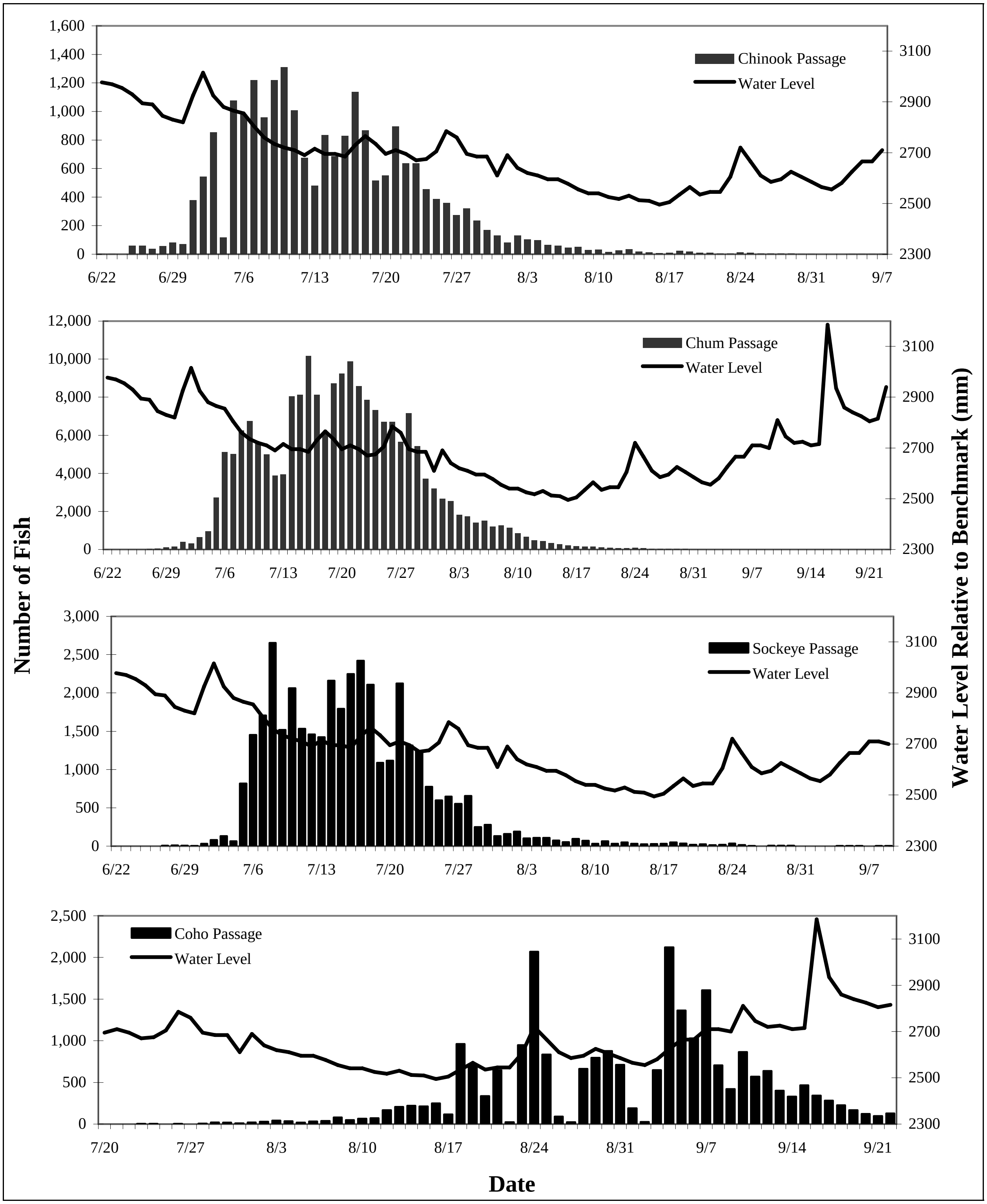


Figure 21.–Daily Chinook, chum, sockeye, and coho salmon passage at Kogrukluk River weir relative to water level, 2005.

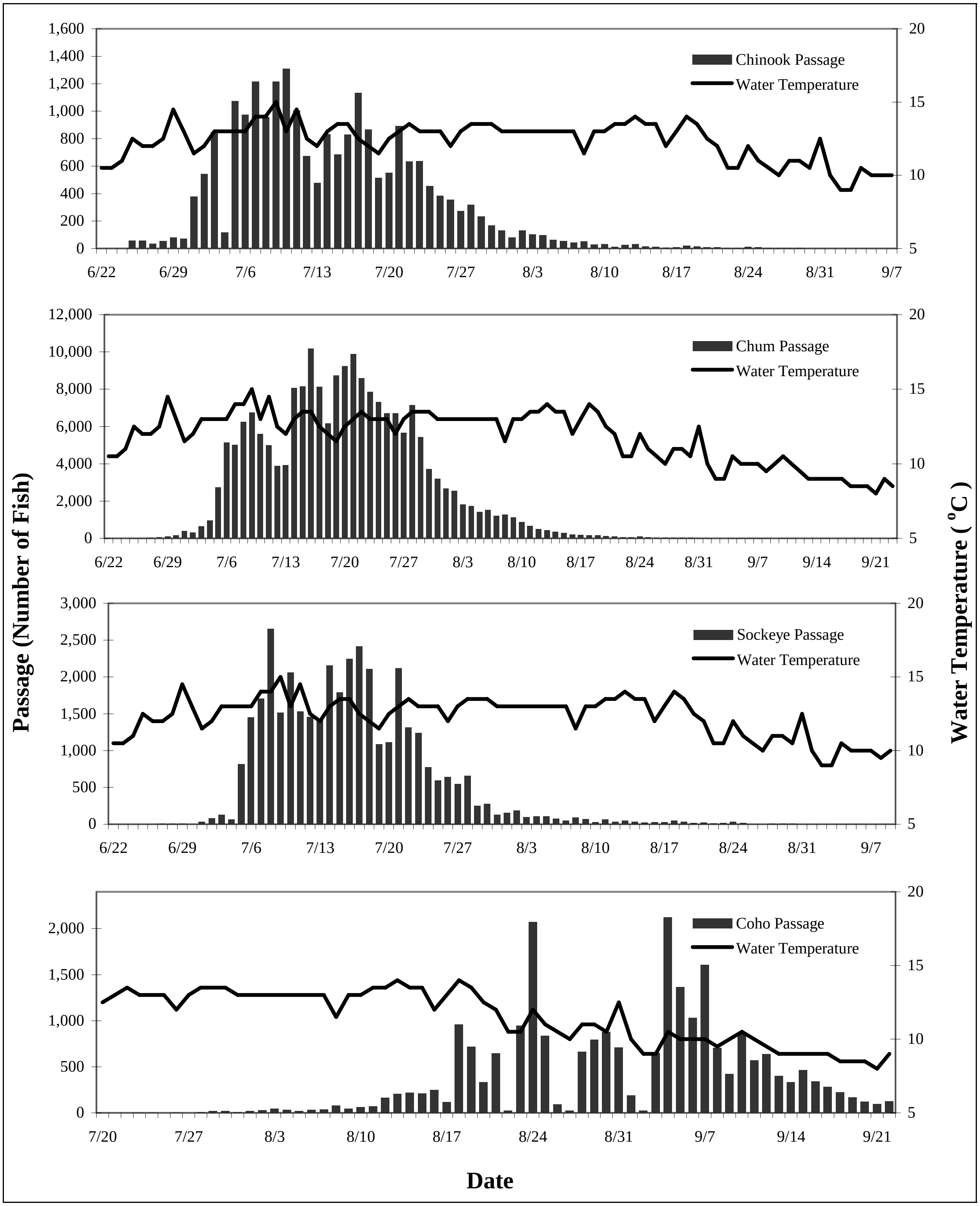
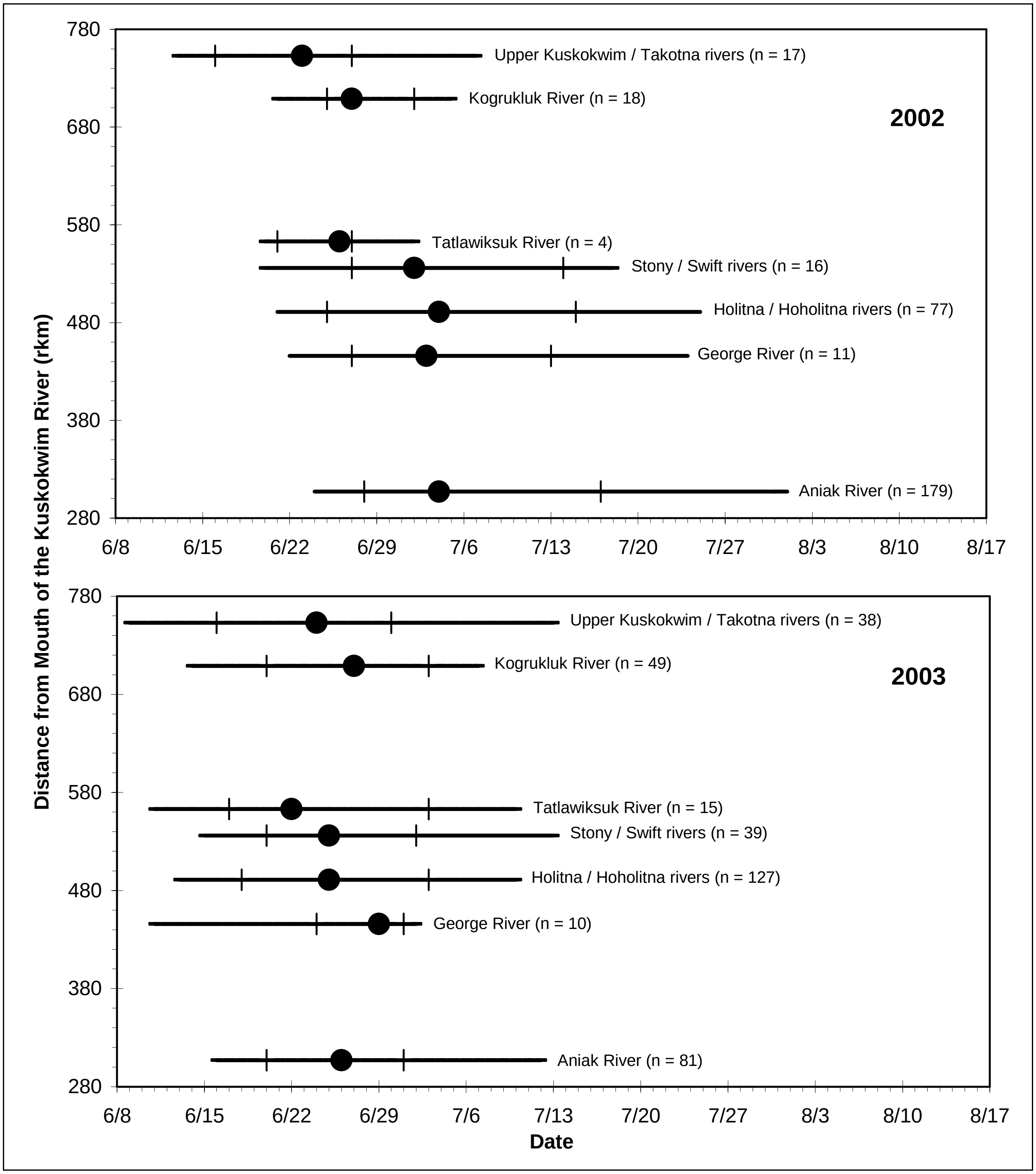
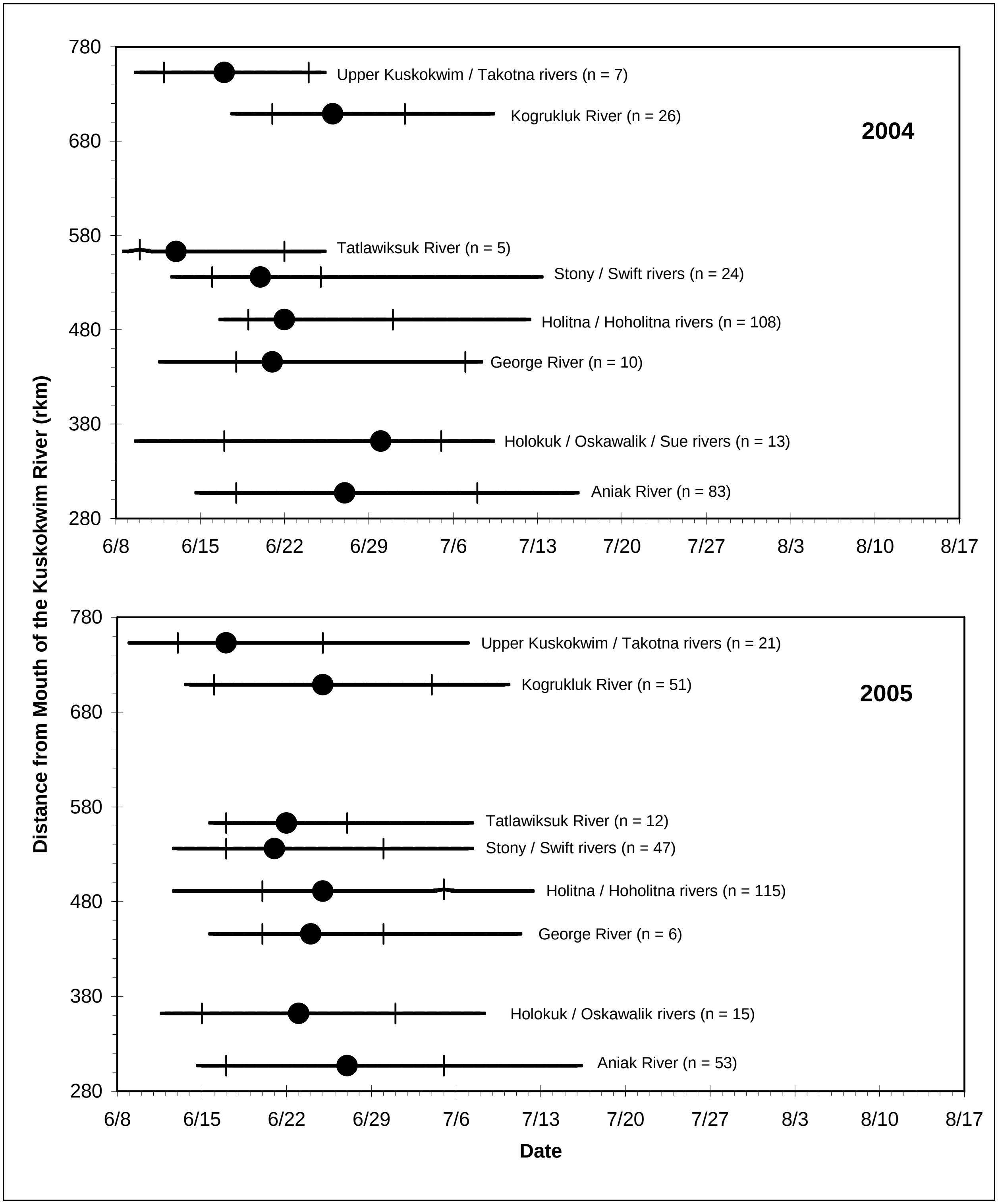


Figure 22.–Daily Chinook, chum, sockeye, and coho salmon passage at Kogrukluk River weir relative to daily water temperature, 2005.



Note: Data for this analysis were collected as part of Inriver Abundance of Chinook Salmon in the Kuskokwim River (Stuby 2003 and 2004). Horizontal lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock. Distances are from marine waters.

Figure 23.–Dates when individual Chinook salmon stocks pass through the Kalskag tagging sites (rkm 271) based on radiotelemetry, 2002–2003.



Note: Data for this analysis were collected as part of Inriver Abundance of Chinook Salmon in the Kuskokwim River (Stuby 2005 and *In prep*). Horizontal lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock. Distances are from marine waters.

Figure 24.–Dates when individual Chinook salmon stocks pass through the Kalskag tagging sites (rkm 271) based on radiotelemetry, 2004–2005.

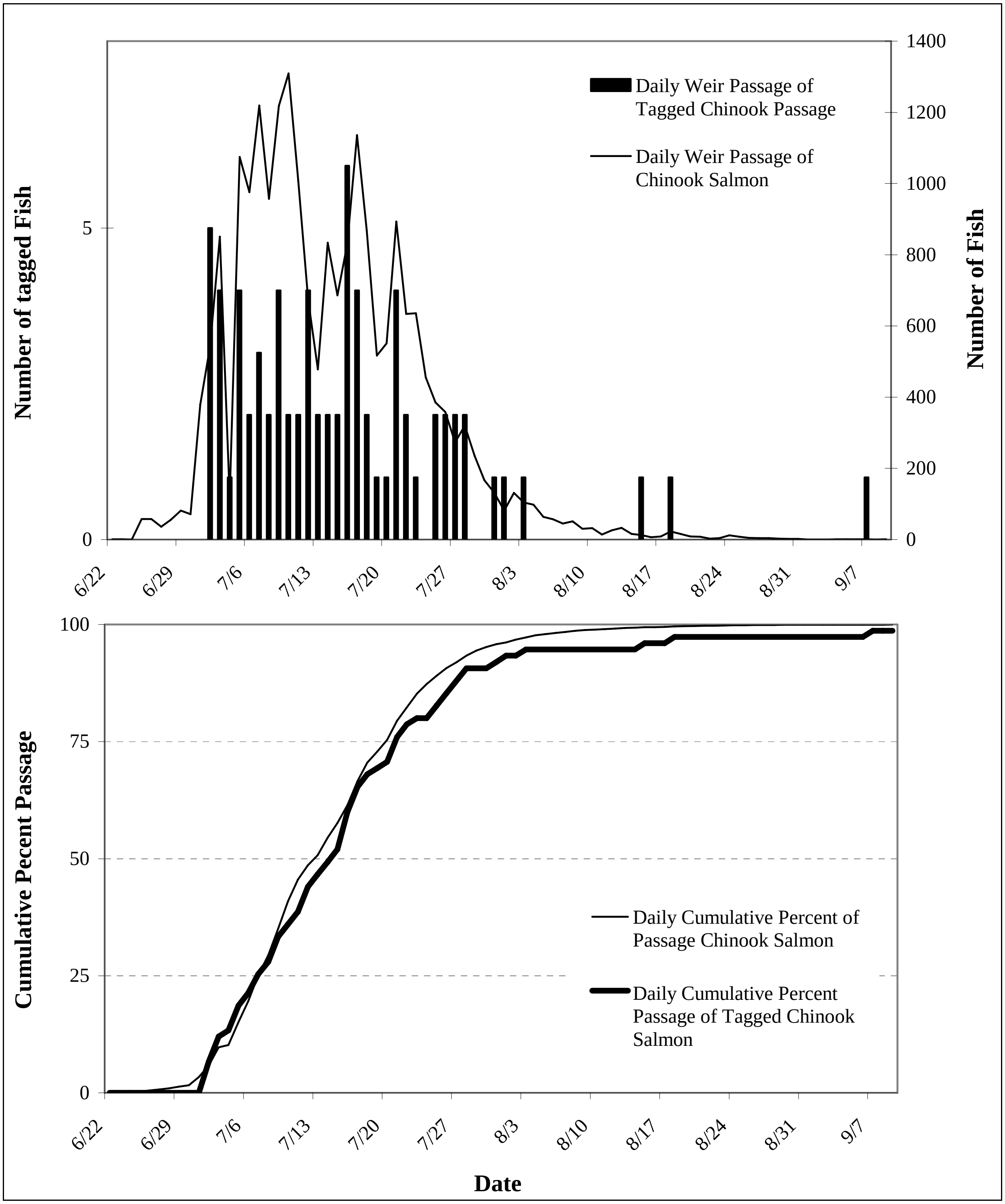
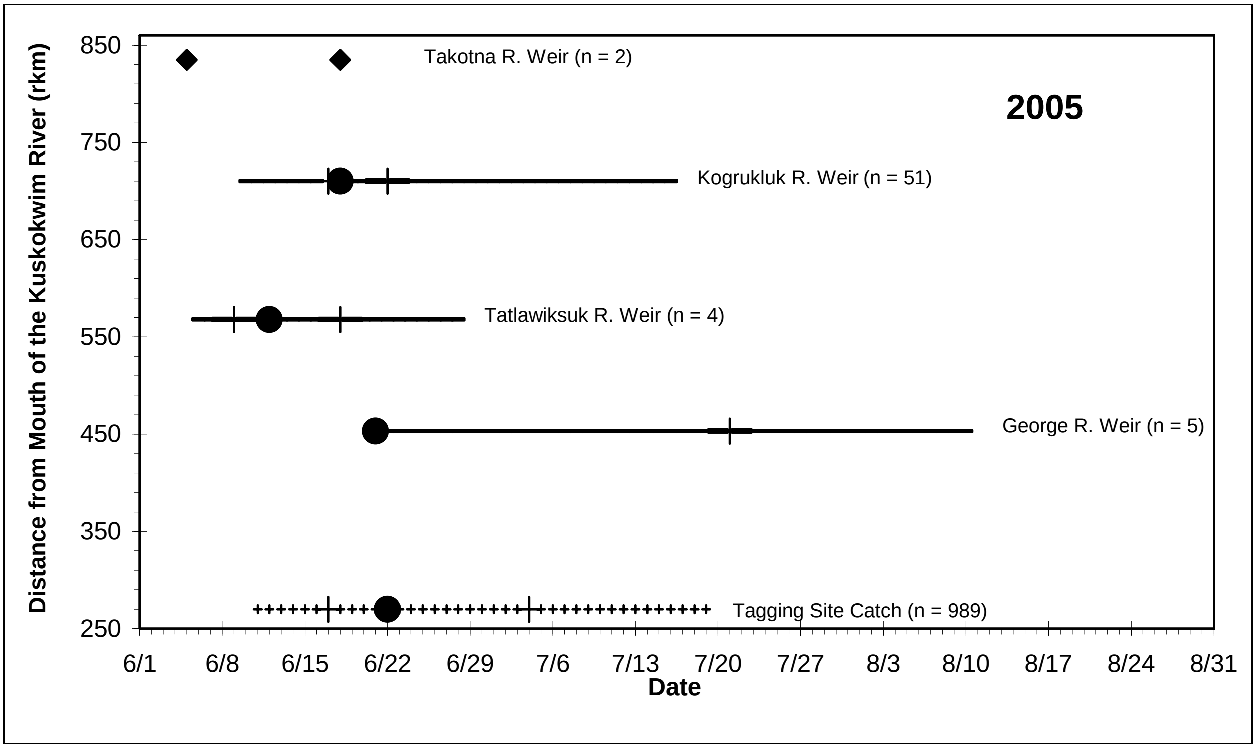


Figure 25.–Daily and cumulative percent passage of overall Chinook passage compared to tagged Chinook salmon passage at Kogrukluk River weir in 2005.



Source: Pawluk, Baumer et al. 2006.

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

Figure 26.–Dates when individual Chinook salmon stocks pass through the Kalskag tagging sites (rkm 271) based on an anchor-tagging study, 2005.

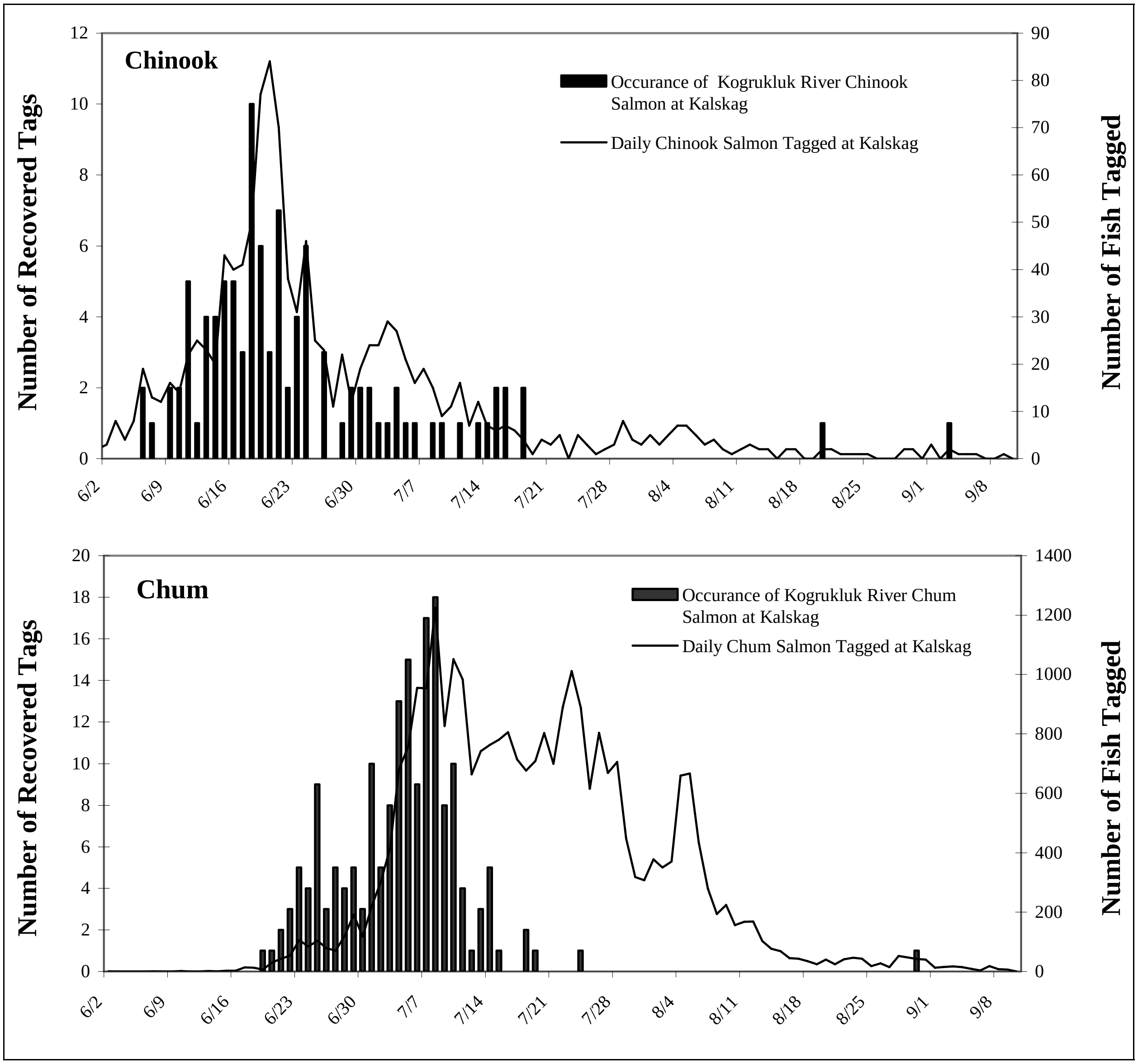


Figure 27.–Run timing of Chinook and chum salmon captured at the Kalskag tagging site, compared to run timing of salmon recovered at Kogrukluk River weir by date tagged, 2005.

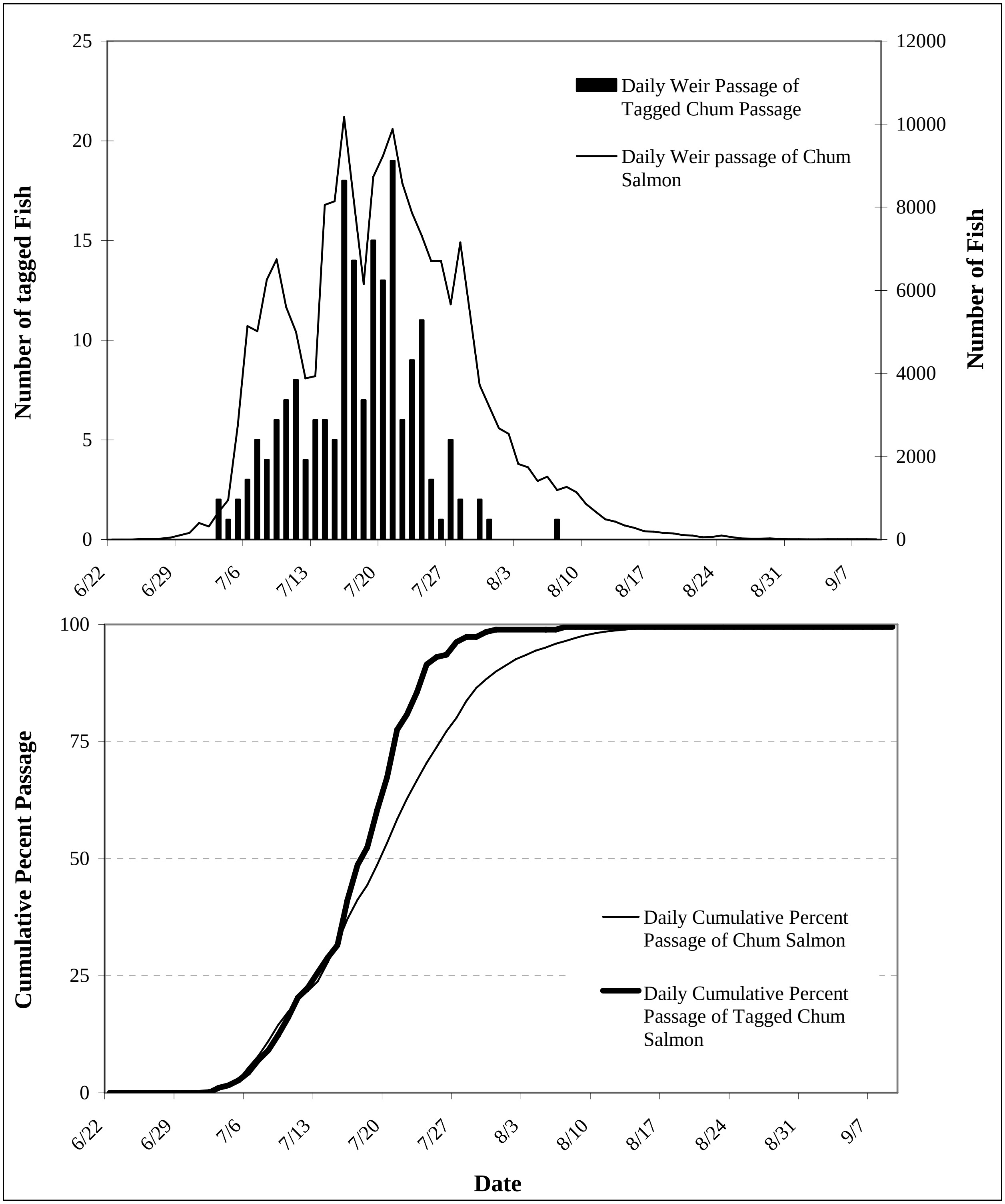
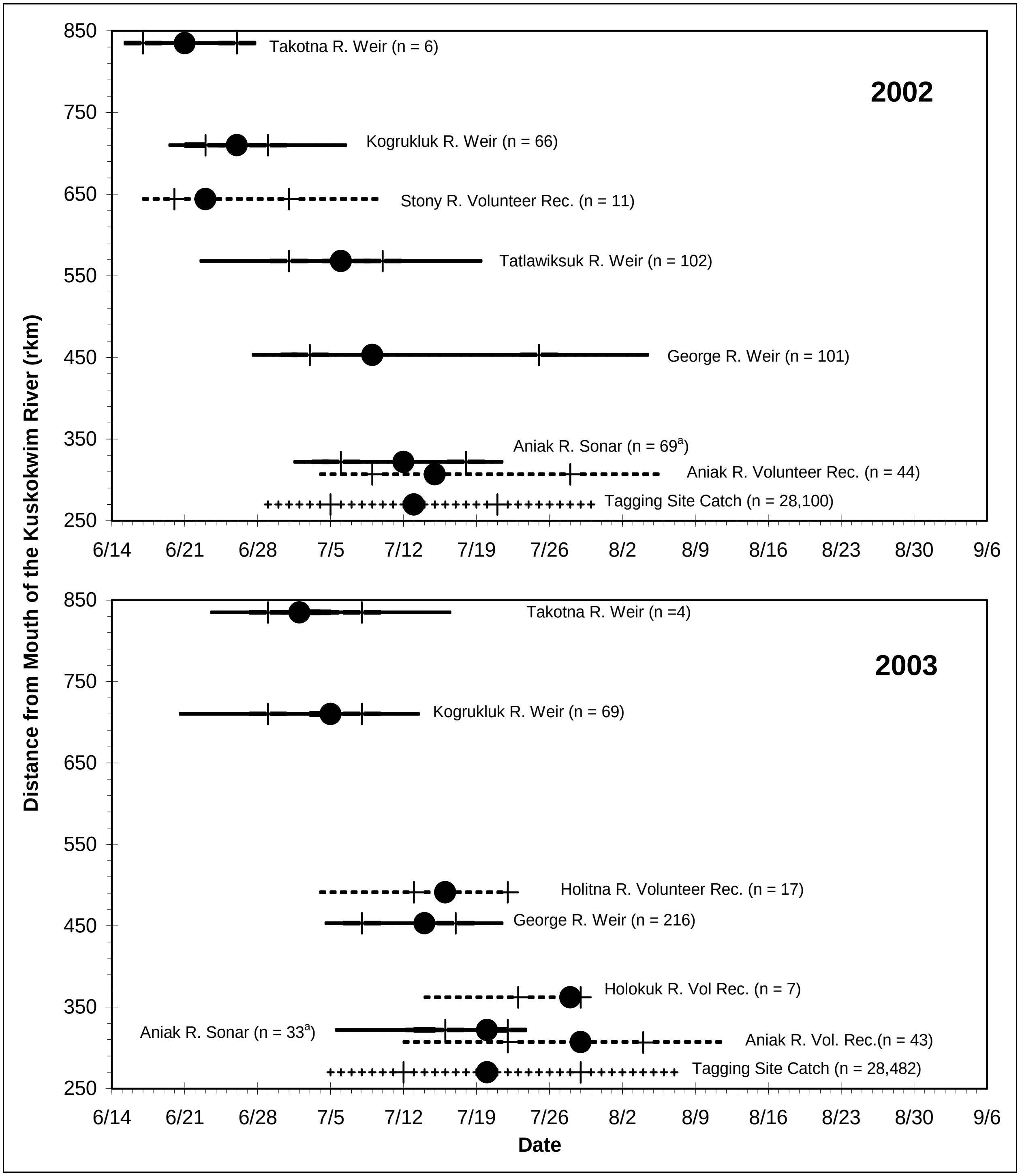


Figure 28.–Daily and cumulative percent passage of overall chum passage compared to tagged chum passage at Kogrukluk River weir in 2005.

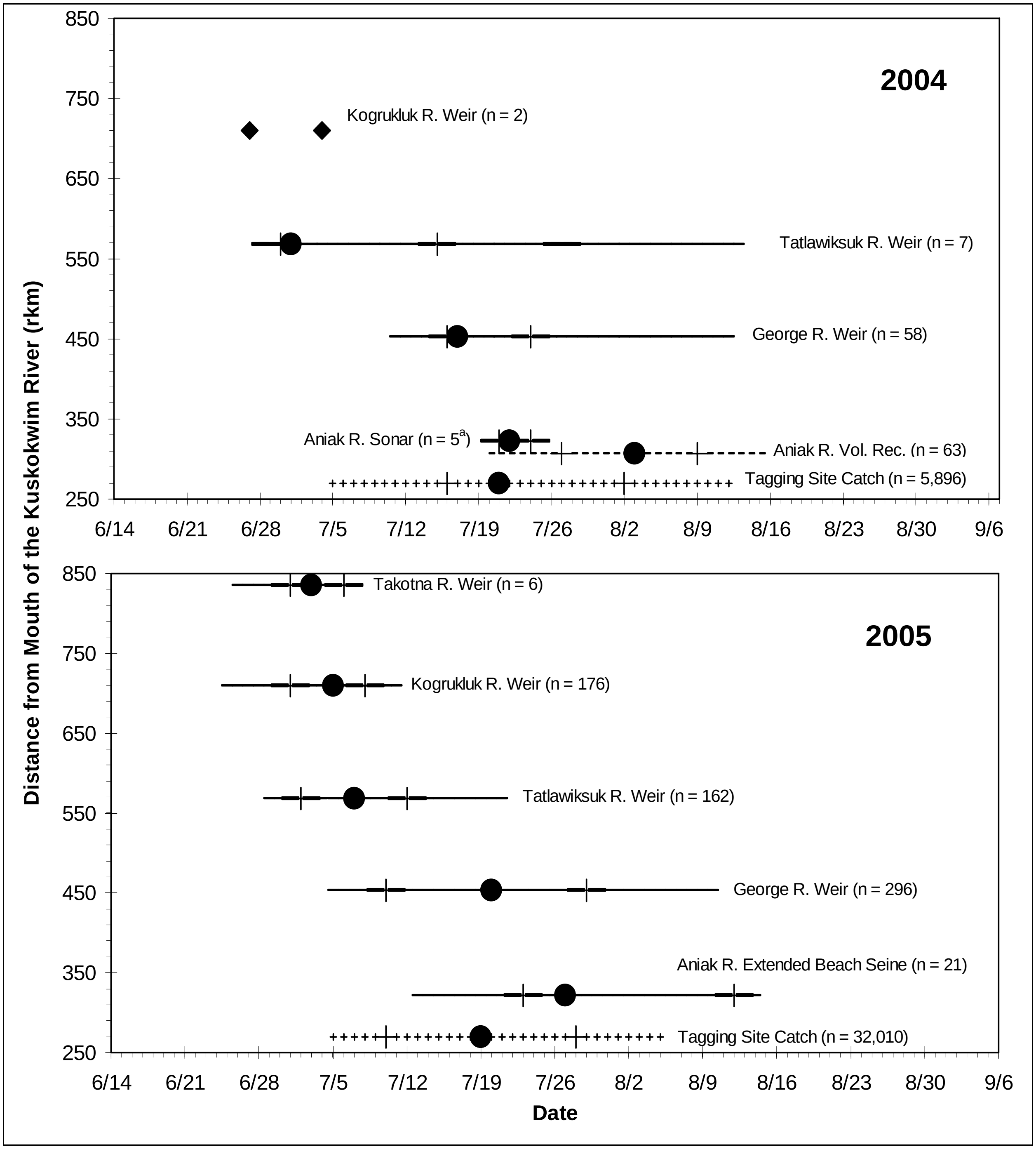


Source: Pawluk, Baumer et al. 2006.

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

[a] Aniak River sonar is biased early. Aniak River volunteer recovery probably more truly represents run timing.

Figure 29.–Dates when individual chum salmon stocks passed through the Kalskag tagging sites (rkm 271) based on a tagging study, 2002–2003.

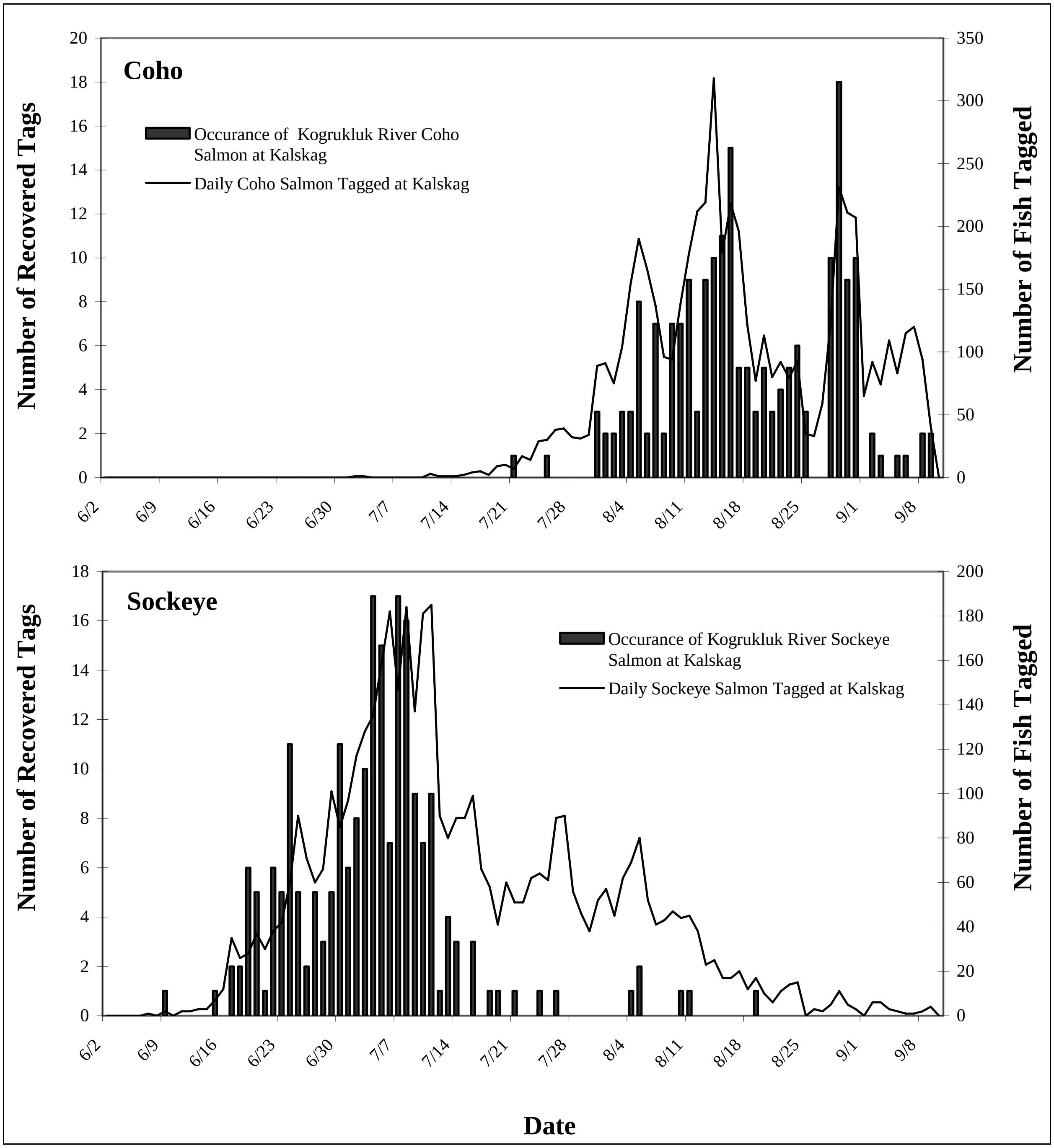


Source: Pawluk, Baumer et al. 2006.

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

[a] Aniak River sonar is biased early. Aniak River volunteer recovery probably more truly represents run timing.

Figure 30.–Dates when individual chum salmon stocks passed through the Kalskag tagging sites (rkm 271) based on a tagging study, 2004–2005.



Source: Pawluk, Baumer et al. 2006.

Figure 31.–Run timing of coho and sockeye salmon captured at the Kalskag tagging site, compared to run timing of salmon recovered at the Kogrukluk River weir by date tagged, 2005.

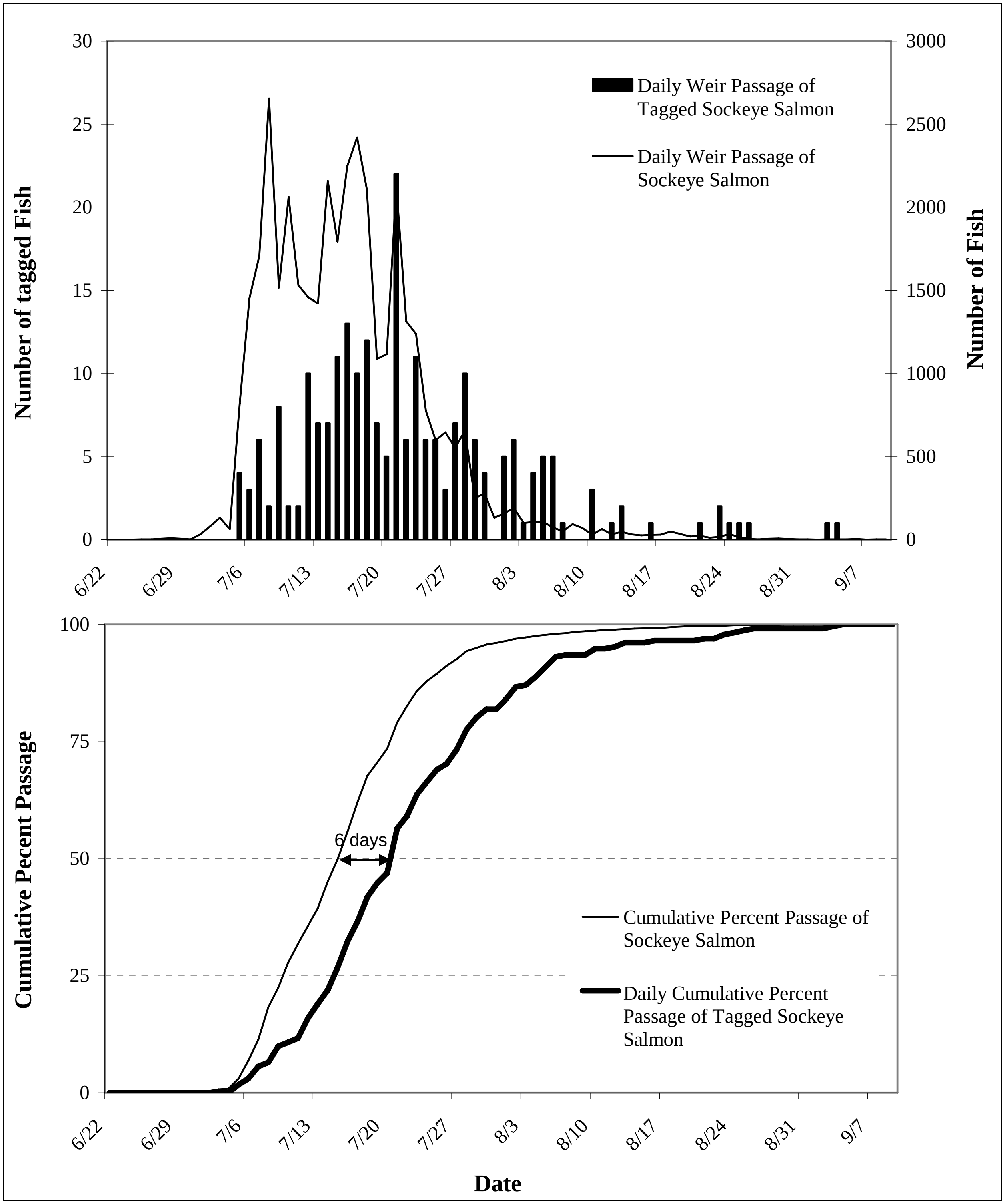
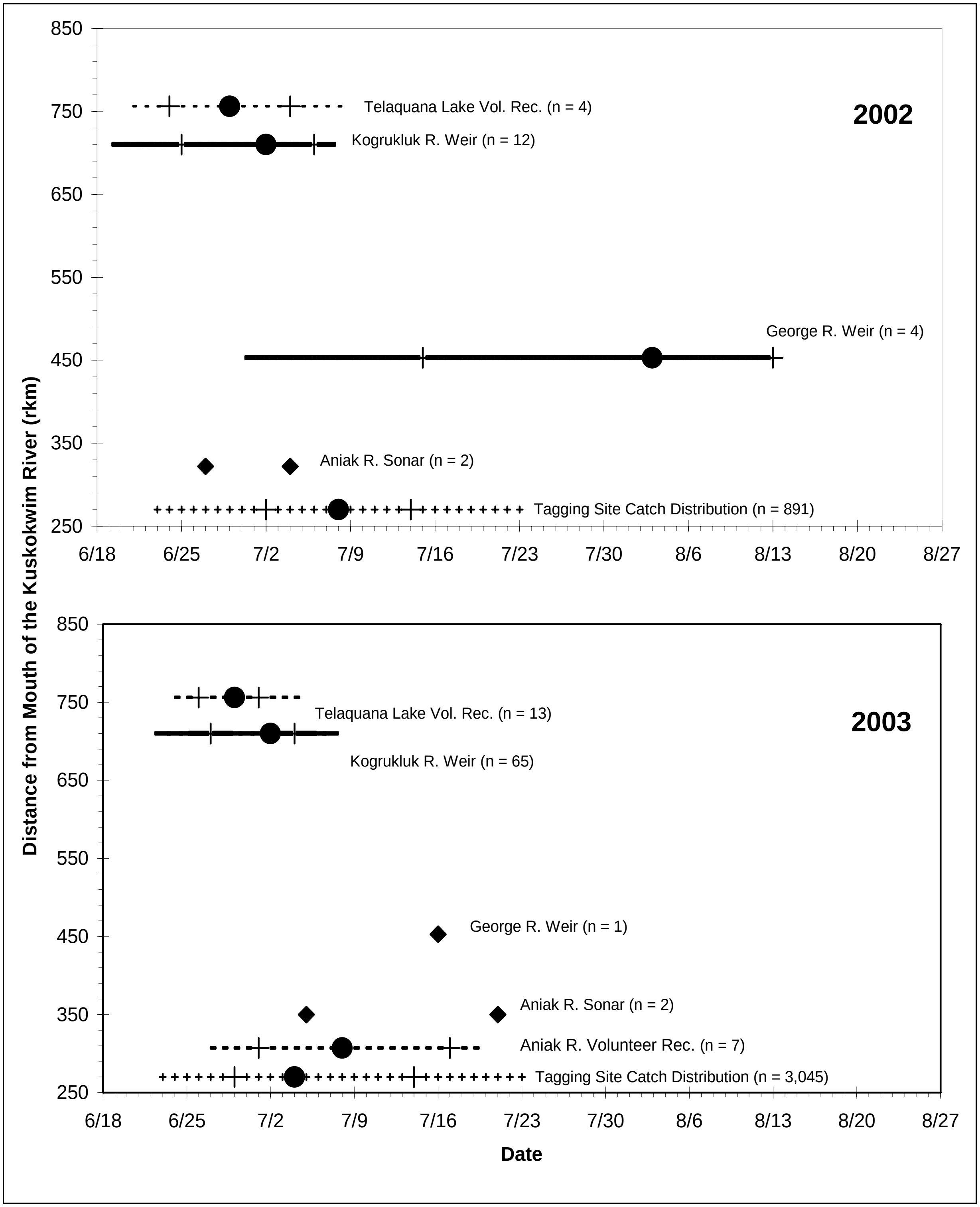


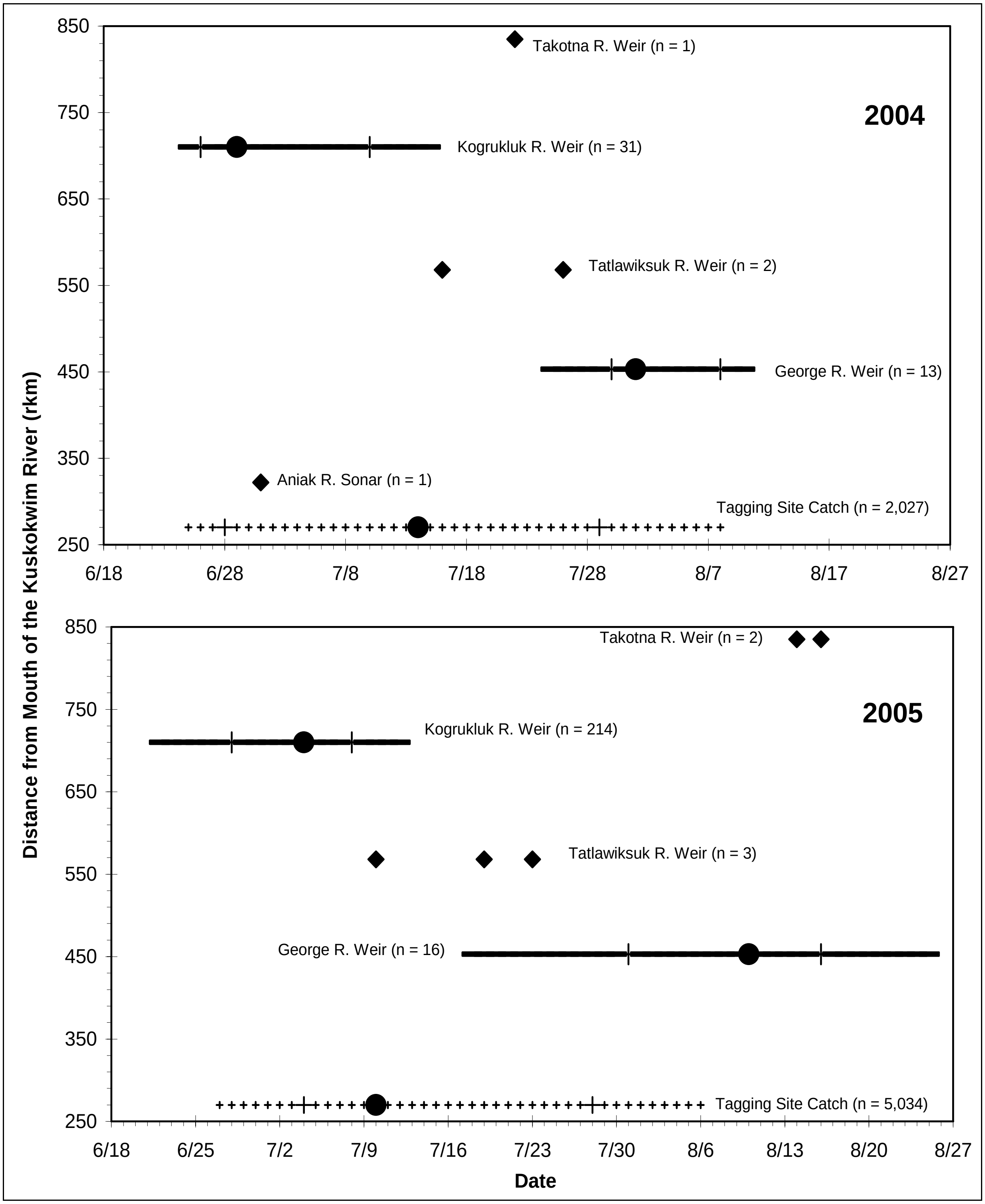
Figure 32.–Daily and cumulative percent passage of overall sockeye passage compared to tagged sockeye passage at Kogrukluk River weir in 2005.



Source: Pawluk, Baumer et al. 2006.

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

Figure 33.–Dates when individual sockeye salmon stocks pass through the Kalskag tagging sites (rkm 271) based on 2002 and 2003 tagging studies.



Source: Pawluk, Baumer et al. 2006.

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

Figure 34.–Dates when individual sockeye salmon stocks pass through the Kalskag tagging sites (rkm 271) based on 2004 and 2005 tagging studies.

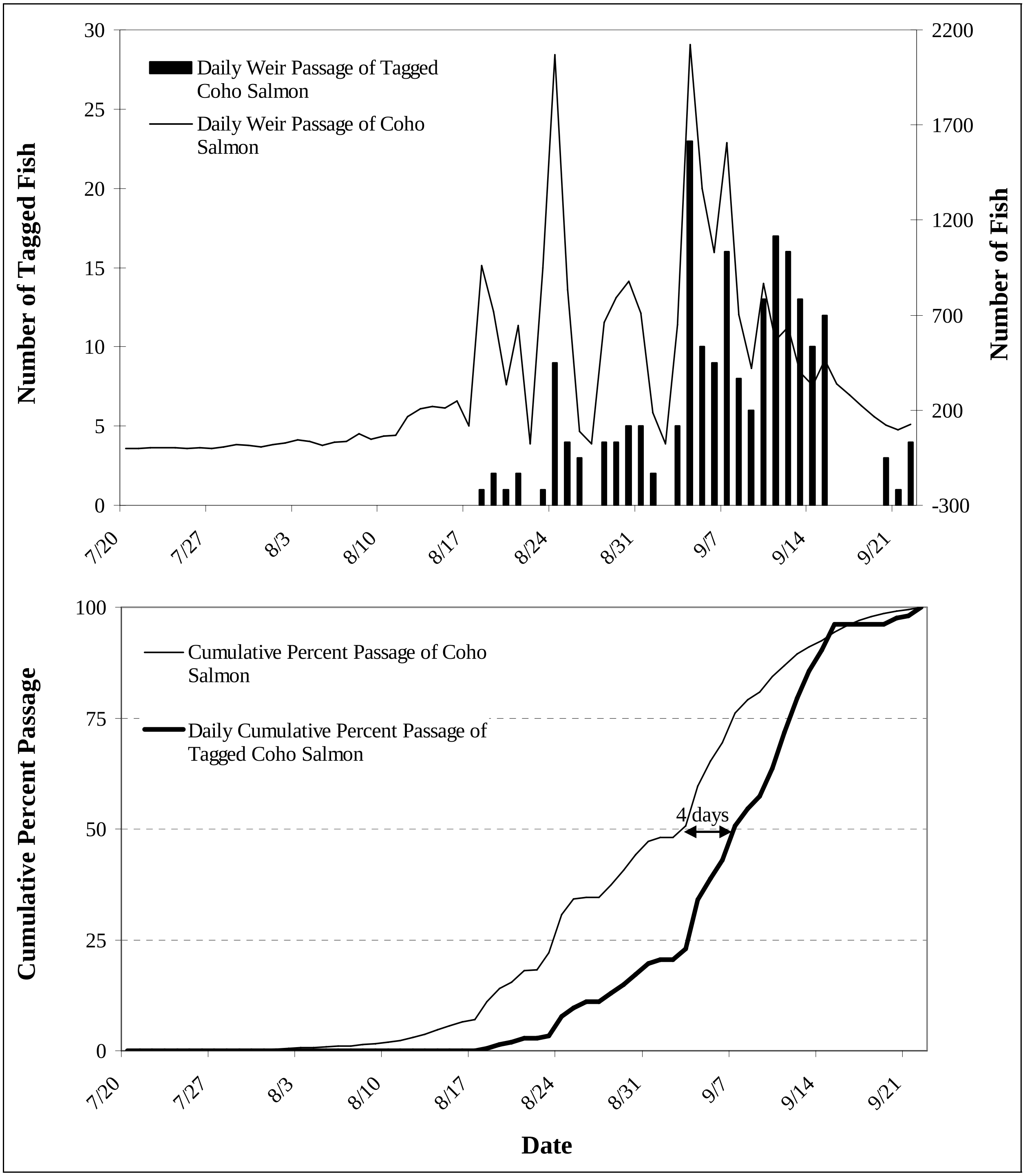
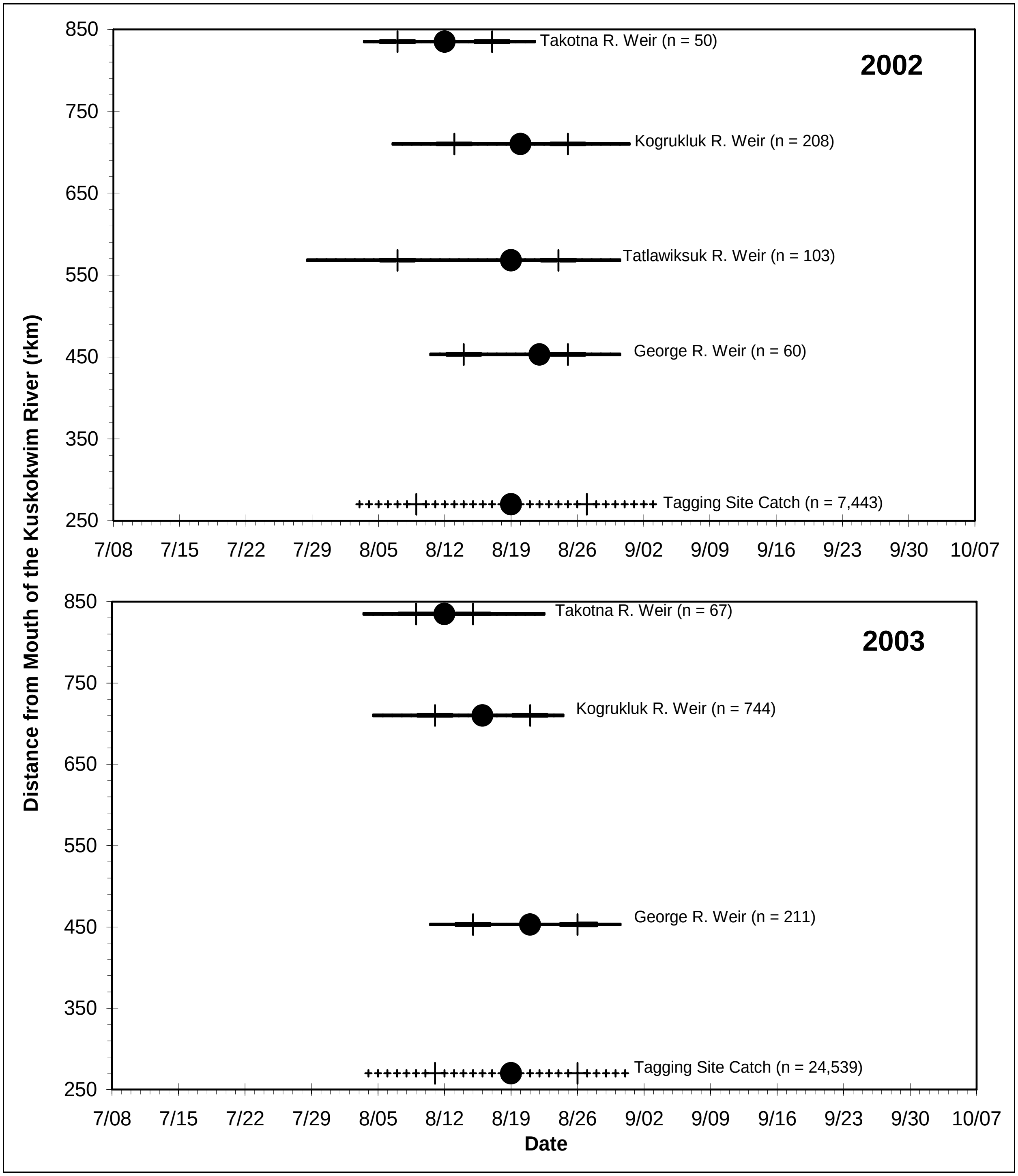


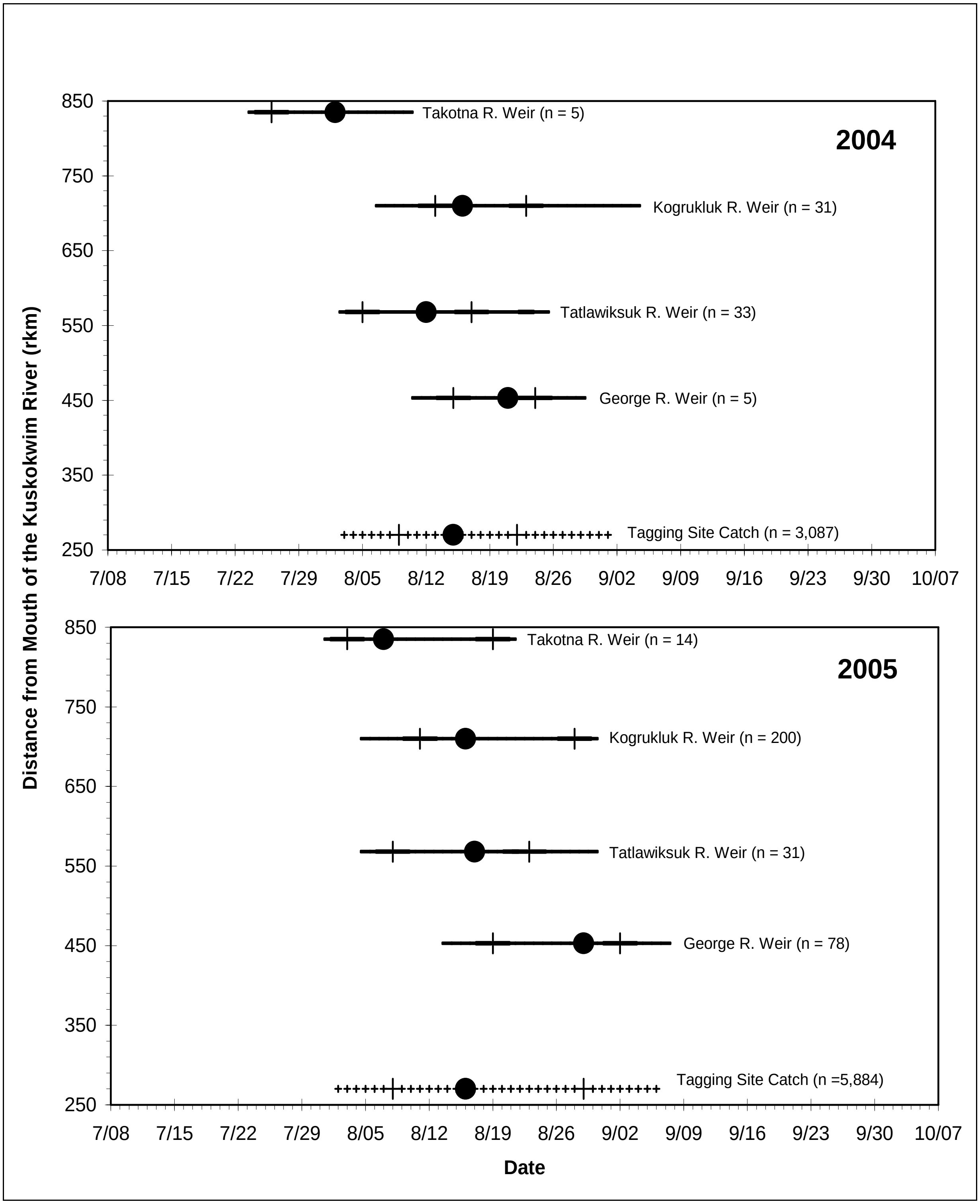
Figure 35.–Daily and cumulative percent passage of overall coho passage compared to tagged coho passage at Kogrukluk River weir in 2005.



Source: Pawluk, Baumer et al. 2006.

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

Figure 36.–Dates when individual coho salmon stocks pass through the Kalskag tagging sites (rkm 271) based on 2002 and 2003 tagging studies.



Source: Pawluk, Baumer et al. 2006.

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

Figure 37.–Dates when individual coho salmon stocks pass through the Kalskag tagging sites (rkm 271) based on 2004 and 2005 tagging studies.

APPENDIX A. SALMON PASSAGE AT THE KOGRUKLUK RIVER WEIR, 2005

Appendix A1.–Daily, cumulative, and percent passage for Chinook, chum, coho, and pink salmon at Kogrukluk River weir, 2005.

	Chinook Salmon			Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage
6/22	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0
6/23	1	2	0	2	3	0	0	0	0	0	0	0	0	0	0
6/24	0	2	0	1	4	0	0	0	0	0	0	0	0	0	0
6/25	58	60	0	15	19	0	0	0	0	1	1	0	0	0	0
6/26	58	118	1	16	35	0	0	0	0	1	2	0	0	0	0
6/27	36	154	1	25	60	0	0	0	0	6	8	0	0	0	0
6/28	56	210	1	45	105	0	0	0	0	9	17	0	0	0	0
6/29	81	291	1	105	210	0	0	0	0	6	23	0	0	0	0
6/30	71	362	2	160	370	0	0	0	0	2	25	0	0	0	0
7/01	379	741	3	398	768	0	0	0	0	32	57	0	0	0	0
7/02	543	1,284	6	316	1,084	1	0	0	0	80	137	0	0	0	0
7/03	851	2,135	10	655	1,739	1	0	0	0	133	270	1	0	0	0
7/04	117	2,252	10	949	2,688	1	0	0	0	63	333	1	0	0	0
7/05	1,075	3,327	15	2,742	5,430	3	0	0	0	819	1,152	3	0	0	0
7/06	976	4,303	20	5,136	10,566	5	0	0	0	1,452	2,604	7	0	0	0
7/07	1,219	5,522	25	5,016	15,582	8	0	0	0	1,707	4,311	11	1	1	1
7/08	957	6,479	29	6,258	21,840	11	0	0	0	2,655	6,966	18	4	5	4
7/09	1,218	7,697	35	6,746	28,586	14	0	0	0	1,516	8,482	22	1	6	5
7/10	1,309	9,006	41	5,600	34,186	17	0	0	0	2,063	10,545	28	2	8	7
7/11	1,007	10,013	46	4,999	39,185	20	0	0	0	1,531	12,076	32	8	16	14
7/12	674	10,687	49	3,880	43,065	22	0	0	0	1,458	13,534	36	6	22	19
7/13	478	11,165	51	3,934	46,999	24	0	0	0	1,422	14,956	39	4	26	23
7/14	834	11,999	55	8,057	55,056	28	0	0	0	2,159	17,115	45	14	40	35
7/15	686	12,685	58	8,145	63,201	32	0	0	0	1,793	18,908	50	1	41	36
7/16	829	13,514	61	10,174	73,375	37	0	0	0	2,247	21,155	56	6	47	41
7/17	1,136	14,650	67	8,127	81,502	41	0	0	0	2,421	23,576	62	3	50	44
7/18	868	15,518	71	6,153	87,655	44	0	0	0	2,109	25,685	68	2	52	46
7/19	517	16,035	73	8,734	96,389	49	0	0	0	1,088	26,773	71	4	56	49
7/20	551	16,586	75	9,241	105,630	53	0	0	0	1,116	27,889	74	4	60	53
7/21	893	17,479	79	9,884	115,514	58	0	0	0	2,124	30,013	79	10	70	61
7/211 [a]	634	18,113	82	8,579	124,093	63	1	1	0	1,314	31,327	83	5	75	66
7/23	636	18,749	85	7,869	131,962	67	3	4	0	1,239	32,566	86	4	79	69
7/24	456	19,205	87	7,323	139,285	70	2	6	0	776	33,342	88	1	80	70
7/25	385	19,590	89	6,701	145,986	74	0	6	0	597	33,939	89	8	88	77

-continued-

Appendix A1.–Page 2 of 3.

	Chinook Salmon			Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage	Daily	Cum.	Percent Passage
7/26 [a]	359	19,949	91	6,711	152,697	77	2	9	0	645	34,584	91	4	92	81
7/27	273	20,222	92	5,663	158,360	80	0	9	0	552	35,136	93	5	97	85
7/28	320	20,542	93	7,157	165,517	84	7	16	0	656	35,792	94	3	100	88
7/29	235	20,777	94	5,436	170,953	86	21	37	0	247	36,039	95	4	104	91
7/30	167	20,944	95	3,721	174,674	88	17	54	0	278	36,317	96	3	107	94
7/31	132	21,076	96	3,200	177,874	90	8	62	0	132	36,449	96	3	110	96
8/01	81	21,157	96	2,677	180,551	91	21	83	0	159	36,608	96	0	110	96
8/02	131	21,288	97	2,549	183,100	93	29	112	0	190	36,798	97	1	111	97
8/03	104	21,392	97	1,823	184,923	94	43	155	1	101	36,899	97	1	112	98
8/04	98	21,490	98	1,739	186,662	94	34	189	1	107	37,006	98	0	112	98
8/05	64	21,554	98	1,410	188,072	95	17	206	1	107	37,113	98	0	112	98
8/06	57	21,611	98	1,518	189,590	96	30	236	1	73	37,186	98	0	112	98
8/07	45	21,656	98	1,195	190,785	96	37	273	1	51	37,237	98	0	112	98
8/08	51	21,707	99	1,269	192,054	97	78	351	1	94	37,331	98	0	112	98
8/09	30	21,737	99	1,138	193,192	98	47	398	2	71	37,402	99	1	113	99
8/10	32	21,769	99	859	194,051	98	65	463	2	30	37,432	99	0	113	99
8/11	14	21,783	99	666	194,717	98	70	533	2	63	37,495	99	0	113	99
8/12	26	21,809	99	491	195,208	99	166	699	3	32	37,527	99	0	113	99
8/13	33	21,842	99	432	195,640	99	207	906	4	48	37,575	99	1	114	100
8/14	16	21,858	99	342	195,982	99	219	1,125	5	32	37,607	99	0	114	100
8/15	13	21,871	99	283	196,265	99	210	1,335	6	26	37,633	99	0	114	100
8/16	7	21,878	99	204	196,469	99	248	1,583	7	29	37,662	99	0	114	100
8/17	9	21,887	99	188	196,657	99	116	1,699	7	30	37,692	99	0	114	100
8/18	23	21,910	100	161	196,818	100	960	2,659	11	49	37,741	99	0	114	100
8/19	16	21,926	100	151	196,969	100	718	3,377	14	35	37,776	100	0	114	100
8/20	9	21,935	100	112	197,081	100	334	3,711	15	19	37,795	100	0	114	100
8/21	8	21,943	100	98	197,179	100	646	4,357	18	23	37,818	100	0	114	100
8/22	3	21,946	100	60	197,239	100	23	4,380	18	12	37,830	100	0	114	100
8/23	4	21,950	100	63	197,302	100	947	5,327	22	17	37,847	100	0	114	100
8/24	12	21,962	100	100	197,402	100	2,070	7,397	31	33	37,880	100	0	114	100
8/25	8	21,970	100	65	197,467	100	834	8,231	34	16	37,896	100	0	114	100
8/26	5	21,975	100	29	197,496	100	89	8,320	34	4	37,900	100	0	114	100
8/27	4	21,979	100	22	197,518	100	23	8,343	35	1	37,901	100	0	114	100

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	Chinook Salmon			Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**	**Daily**	**Cum.**	**Percent Passage**
8/28	4	21,983	100	25	197,543	100	663	9,006	37	6	37,907	100	0	114	100
8/29	3	21,986	100	26	197,569	100	794	9,800	41	7	37,914	100	0	114	100
8/30	2	21,988	100	20	197,589	100	877	10,677	44	5	37,919	100	0	114	100
8/31	2	21,990	100	12	197,601	100	710	11,387	47	1	37,920	100	0	114	100
9/01	0	21,990	100	9	197,610	100	188	11,575	48	1	37,921	100	0	114	100
9/02	0	21,990	100	5	197,615	100	24	11,599	48	0	37,921	100	0	114	100
9/03	0	21,990	100	5	197,620	100	648	12,247	51	1	37,922	100	0	114	100
9/04	1	21,991	100	11	197,631	100	2,122	14,369	60	2	37,924	100	0	114	100
9/05	1	21,992	100	10	197,641	100	1,364	15,733	65	2	37,926	100	0	114	100
9/06	1	21,993	100	9	197,650	100	1,029	16,762	70	4	37,930	100	0	114	100
9/07	1	21,994	100	10	197,660	100	1,607	18,369	76	0	37,930	100	0	114	100
9/08	0	21,994	100	10	197,670	100	704	19,073	79	2	37,932	100	0	114	100
9/09	1	21,995	100	4	197,674	100	419	19,492	81	2	37,934	100	0	114	100
9/10	0	21,995	100	9	197,683	100	866	20,358	84	1	37,935	100	0	114	100
9/11	0	21,995	100	9	197,692	100	569	20,927	87	2	37,937	100	0	114	100
9/12	0	21,995	100	4	197,696	100	637	21,564	89	2	37,939	100	0	114	100
9/13	3	21,998	100	0	197,696	100	401	21,965	91	0	37,939	100	0	114	100
9/14	0	21,998	100	3	197,699	100	331	22,296	92	0	37,939	100	0	114	100
9/15	1	21,999	100	7	197,706	100	464	22,760	94	0	37,939	100	0	114	100
9/16 [b]	0	21,999	100	4	197,711	100	340	23,099	96	0	37,939	100	0	114	100
9/17 [b]	0	21,999	100	4	197,714	100	282	23,381	97	0	37,939	100	0	114	100
9/18 [b]	0	21,999	100	3	197,717	100	224	23,605	98	0	37,939	100	0	114	100
9/19 [b]	0	22,000	100	2	197,719	100	166	23,772	99	0	37,939	100	0	114	100
9/20	0	22,000	100	3	197,722	100	122	23,894	99	0	37,939	100	0	114	100
9/21	0	22,000	100	0	197,722	100	95	23,989	99	0	37,939	100	0	114	100
9/22	0	22,000	100	1	197,723	100	127	24,116	100	0	37,939	100	0	114	100

[a] Estimated salmon passage (partial day).

[b] Estimated salmon passage (whole day).

APPENDIX B. DAILY CARCASS COUNTS AT THE KOGRUKLUK RIVER WEIR, 2005

Appendix B1.–Daily carcass counts for Chinook, chum, sockeye, coho, and pink salmon at the Kogrukluk River weir, 2005.

Date	Chinook	Sockeye	Chum	Coho	Pink	Date	Chinook	Sockeye	Chum	Coho	Pink
6/22	0	0	1	0	0	8/07	159	84	845	0	0
6/23	-	-	-	-	-	8/08	125	87	653	0	0
6/24	-	-	-	-	-	8/09	129	97	517	0	0
6/25	-	-	-	-	-	8/10	127	112	458	0	0
6/26	-	-	-	-	-	8/11	139	108	293	0	0
6/27	-	-	-	-	-	8/12	106	113	315	0	0
6/28	-	-	-	-	-	8/13	119	105	331	0	0
6/29	-	-	-	-	-	8/14	41	93	201	0	0
6/30	-	-	-	-	-	8/15	52	104	293	0	0
7/01	0	0	1	0	0	8/16	27	73	266	0	0
7/02	0	0	6	0	0	8/17	18	110	179	0	1
7/03	-	-	-	-	-	8/18	19	63	89	0	0
7/04	0	0	4	0	0	8/19	8	103	121	0	0
7/05	0	0	5	0	0	8/20	7	54	64	0	0
7/06	-	-	-	-	-	8/21	11	77	78	0	0
7/07	0	0	6	0	0	8/22	-	-	-	-	-
7/08	0	1	6	0	0	8/23	16	117	103	0	0
7/09	0	1	18	0	0	8/24	6	74	36	0	0
7/10	-	-	-	-	-	8/25	8	62	39	0	0
7/11	0	0	78	0	1	8/26	6	58	36	0	0
7/12	1	0	49	0	0	8/27	-	-	-	-	-
7/13	0	0	73	0	0	8/28	7	81	47	0	0
7/14	0	0	188	0	0	8/29	7	57	36	1	0
7/15	0	1	305	0	0	8/30	-	-	-	-	-
7/16	0	1	383	0	0	8/31	4	96	41	0	0
7/17	0	2	592	0	0	9/01	0	39	15	1	2
7/18	0	1	752	0	0	9/02	1	52	13	0	0
7/19	1	1	775	0	1	9/03	2	39	15	0	0
7/20	0	0	769	0	0	9/04	1	41	12	0	0
7/21	2	2	1,085	0	2	9/05	0	37	7	0	0
7/22	3	2	1,051	0	3	9/06	-	-	-	-	-
7/23	8	4	1,076	0	1	9/07	5	64	21	1	0
7/24	22	3	1,420	0	3	9/08	0	29	11	1	0
7/25	19	5	1,448	0	0	9/09	1	25	5	1	0
7/26	43	35	2,163	0	2	9/10	1	13	7	3	0
7/27	60	19	2,474	0	1	9/11	2	6	4	4	0
7/28	65	29	2,534	0	4	9/12	-	-	-	-	-
7/29	102	30	2,532	0	3	9/13	-	-	-	-	-
7/30	153	58	2,546	0	1	9/14	0	17	10	7	0
7/31	147	46	1,648	0	2	9/15	-	-	-	-	-
8/01	137	71	1,405	0	1	9/16	-	-	-	-	-
8/02	178	73	1,602	0	0	9/17	-	-	-	-	-
8/03	167	74	1,232	0	0	9/18	-	-	-	-	-
8/04	182	95	1,237	0	2	9/19	-	-	-	-	-
8/05	167	73	1,122	0	1	9/20	-	-	-	-	-
8/06	186	84	998	0	0	9/21	0	4	0	16	0
						Totals:	2,797	3,005	36,745	35	31

Note: Dashes (-) represent days when carcasses were not counted.

APPENDIX C. CLIMATE INFORMATION FOR THE KOGRUKLUK RIVER WEIR, 2005

Appendix C1.–Daily climate data collected at Kogrukluk river weir, 2005.

			Precipitation		Wind		Temperature (^{0}C)				River Stage			
Date	Time	Sky	Code	(mm)	Direction	Speed	Air	AVG Air	Water	AVG Water	Clarity	Reading (mm)	Adjusted (mm)	AVG Adj. (mm)
6/20	1100	2		-	NW	3-5	-	17.0	-	11.0	murky	620	3,045	3,035
	1700	2			NW	5	17		11		murky	600	3,025	
6/21	0730	1		0	calm	0	5	13.5	9	10.0	murky	570	2,995	2,985
	1700	3			W	0-7	22		11		ok	550	2,975	
6/22	0700	3		0	calm	0	9	11.5	10	10.5	ok	560	2,985	2,978
	1700	4	A		SE	5-10	14		11		ok	545	2,970	
6/23	0700	4	A	0	calm	0	10	14.5	10	10.5	ok	545	2,970	2,970
	1700	3			calm	0	19		11		ok	545	2,970	
6/24	0715	2		0	calm	0	12	12.0	11	11.0	ok	530	2,955	2,955
	-	-			-	-	-		-		-	-	-	
6/25	0900	3		0	calm	0	13	19.0	11	12.5	good	510	2,935	2,930
	1700	1	A		SW	0-5	25		14		good	500	2,925	
6/26	0730	1		5	calm	0	9	16.5	11	12.0	good	475	2,900	2,895
	1700	2	A		W	5	24		13		very good	465	2,890	
6/27	0700	1		0	calm	0	8	8.0	12	12.0	very good	465	2,890	2,890
	-	-			-	-	-		-		-	-	-	
6/28	0730	1		0	calm	0	10	18.0	11	12.5	very good	425	2,850	2,845
	1700	4			SE	5-10	26		14		very good	415	2,840	
6/29	0700	3		0	calm	0	15	20.0	13	14.5	very good	410	2,835	2,830
	1700	2			NW	5-10	25		16		very good	400	2,825	
6/30	0730	4	B	6	calm	0	15	15.5	13	13.0	clear	390	2,815	2,820
	1700	4	A		calm	0	16		13		clear	400	2,825	
7/01	0730	4	A	15	calm	0	13	16.0	11	11.5	murky	460	2,885	2,925
	1700	4			calm	0	19		12		murky	540	2,965	
7/02	0900	1		1	calm	0	10	17.5	11	12.0	murky	620	3,045	3,015
	1700	2			calm	0	25		13		murky	560	2,985	
7/03	1200	2	A	12	calm	0	11	16.0	12	13.0	murky	500	2,925	2,925
	1700	2			NW	5-10	21		14		ok	500	2,925	
7/04	0900	1	A	1	calm	0	10	14.0	12	13.0	ok	460	2,885	2,880
	1700	4	A		calm	0	18		14		ok	450	2,875	
7/05	0730	2		0	calm	0	11	17.5	11	13.0	0k	420	2,845	2,865
	1700	1			calm	0	24		15		ok	460	2,885	
7/06	0730	1		0	calm	0	12	17.0	12	13.0	ok	440	2,865	2,855
	1700	1			NW	5-10	22		14		ok	420	2,845	

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			Precipitation		Wind		Temperature (^{0}C)				River Stage			
Date	**Time**	**Sky**	**Code**	**(mm)**	**Direction**	**Speed**	**Air**	**AVG Air**	**Water**	**AVG Water**	**Clarity**	**Reading (mm)**	**Adjusted (mm)**	**AVG Adj. (mm)**
7/07	0700	3		0	calm	0	10	16.5	13	14.0	ok	390	2,815	2,805
	1700	1			calm	0	23		15		clear	370	2,795	
7/08	0700	1		0	calm	0	11	18.5	12	14.0	clear	340	2,765	2,760
	1700	1			calm	0	26		16		clear	330	2,755	
7/09	1000	3		0	calm	0	17	21.5	14	15.0	clear	320	2,745	2,735
	1700	3			NW	5-10	26		16		clear	300	2,725	
7/10	1000	2		0	calm	0	15	20.0	13	13.0	good	300	2,725	2,720
	1700	1			calm	0	25		13		good	290	2,715	
7/11	0700	3		0	calm	0	11	15.0	14	14.5	good	290	2,715	2,710
	1700	3			SW	5-10	19		15		clear	280	2,705	
7/12	0700	4		2	calm	0	11	12.5	12	12.5	clear	260	2,685	2,690
	2000	4			calm	0	14		13		clear	270	2,695	
7/13	0700	5		8	calm	0	8	13.0	11	12.0	clear	290	2,715	2,715
	1700	1			calm	0	18		13		clear	290	2,715	
7/14	0800	1		0	calm	0	8	16.0	12	13.0	clear	280	2,705	2,695
	1700	1			calm	0	24		14		clear	260	2,685	
7/15	0700	1		0	calm	0	8	15.0	13	13.5	clear	260	2,685	2,695
	1700	3			S	5-10	22		14		clear	280	2,705	
7/16	0700	4	A	1	calm	0	14	15.5	13	13.5	clear	260	2,685	2,685
	1700	4	A		calm	0	17		14		ok	260	2,685	
7/17	1000	4		5	calm	0	15	15.0	12	12.5	ok	300	2,725	2,730
	1700	4	A		calm	0	15		13		ok	310	2,735	
7/18	0700	4	A	11	calm	0	10	12.5	12	12.0	ok	380	2,805	2,765
	1700	4			calm	0	15		12		ok	300	2,725	
7/19	0700	2		0	calm	0	9	11.5	11	11.5	ok	340	2,765	2,735
	1700	4			calm	0	14		12		ok	280	2,705	
7/20	0730	4		2	calm	0	13	17.0	11	12.5	ok	300	2,725	2,695
	1700	3			calm	0	21		14		ok	240	2,665	
7/21	0730	1		0	calm	0	9	15.5	12	13.0	ok	340	2,765	2,710
	1700	2			S	5-10	22		14		ok	230	2,655	
7/22	0730	4		0	calm	0	14	19.0	13	13.5	ok	330	2,755	2,695
	1700	2			calm	0	24		14		good	210	2,635	
7/23	1000	1		0	calm	0	10	14.5	12	13.0	good	290	2,715	2,670
	1700	4			calm	0	19		14		good	200	2,625	
7/24	1000	3		0	calm	0	14	17.0	12	13.0	good	280	2,705	2,675
	1700	2			SW	5-10	20		14		good	220	2,645	

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			Precipitation		Wind		Temperature (^{0}C)				River Stage			
Date	Time	Sky	Code	(mm)	Direction	Speed	Air	AVG Air	Water	AVG Water	Clarity	Reading (mm)	Adjusted (mm)	AVG Adj. (mm)
7/25	0730	4	A	1	calm	0	11	13.0	12	13.0	good	300	2,725	2,705
	1700	3	A		calm	0	15		14		good	260	2,685	
7/26	0730	2		9	calm	0	9	11.5	11	12.0	good	430	2,855	2,785
	1700	4	A		calm	0	14		13		good	290	2,715	
7/27	0700	2		5	calm	0	9	16.0	12	13.0	good	380	2,805	2,760
	1700	1			N	10-20	23		14		good	290	2,715	
7/28	0730	4		0	calm	0	14	17.5	12	13.5	good	320	2,745	2,695
	1700	1			N	5-10	21		15		good	220	2,645	
7/29	0730	4		0	calm	0	13	16.5	13	13.5	good	320	2,745	2,685
	1700	1			calm	0	20		14		good	200	2,625	
7/30	1000	1		0	calm	0	14	19.0	12	13.5	good	340	2,765	2,685
	1700	1			calm	0	24		15		good	180	2,605	
7/31	0730	1		0	calm	0	8	11.0	13	13.0	good	200	2,625	2,610
	1700	4			calm	0	14		13		good	170	2,595	
8/01	0730	5		3.5	calm	0	7	14.0	11	13.0	good	320	2,745	2,690
	1700	1			calm	0	21		15		good	210	2,635	
8/02	0730	1		0	calm	0	8	14.5	12	13.0	good	240	2,665	2,640
	1700	3			calm	0	21		14		good	190	2,615	
8/03	0730	3		0	calm	0	8	14.5	12	13.0	good	210	2,635	2,620
	1700	2			S	15	21		14		good	180	2,605	
8/04	0730	2		0	calm	0	11	17.0	12	13.0	good	200	2,625	2,610
	1700	smoke			calm	0	23		14		good	170	2,595	
8/05	0730	smoke		0	calm	0	9	15.5	12	13.0	good	190	2,615	2,595
	1700	3			calm	0	22		14		good	150	2,575	
8/06	1000	1		0	calm	0	11	14.5	12	13.0	good	200	2,625	2,595
	1700	4			calm	0	18		14		good	140	2,565	
8/07	1000	3		0	calm	0	13	15.5	12	13.0	good	160	2,585	2,578
	1700	4			calm	0	18		14		good	145	2,570	
8/08	0730	1		0	calm	0	9	17.0	11	11.5	good	140	2,565	2,555
	1700	1			calm	0	25		12		good	120	2,545	
8/09	0730	1		0	calm	0	7	17.0	12	13.0	good	120	2,545	2,540
	1700	1			calm	0	27		14		spectacular	110	2,535	
8/10	0730	1		0	calm	0	9	15.5	12	13.0	awesome	130	2,555	2,540
	1700	1			calm	0	22		14		great	100	2,525	
8/11	0730	1		0	calm	0	9	18.0	12	13.5	good	110	2,535	2,525
	1700	1			calm	0	27		15		good	90	2,515	

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			Precipitation		Wind		Temperature (^{0}C)				River Stage			
Date	Time	Sky	Code	(mm)	Direction	Speed	Air	AVG Air	Water	AVG Water	Clarity	Reading (mm)	Adjusted (mm)	AVG Adj. (mm)
8/12	0730	1		0	calm	0	8	17.0	12	13.5	good	100	2,525	2,518
	1700	smoke			calm	0	26		15		good	85	2,510	
8/13	1000	1		0	calm	0	13	20.0	12	14.0	good	100	2,525	2,530
	1700	smoke			NW	0-5	27		16		good	110	2,535	
8/14	1000	1		0	calm	0	12	20.5	12	13.5	good	90	2,515	2,513
	1700	1			calm	0	29		15		good	85	2,510	
8/15	0730	smoke		0	calm	0	11	18.0	12	13.5	good	80	2,505	2,510
	1700	1			S	0-5	25		15		good	90	2,515	
8/16	0730	3		0	calm	0	10	14.5	11	12.0	good	70	2,495	2,495
	1700	4			S	15-20	19		13		good	70	2,495	
8/17	0730	3		0	calm	0	12	13.5	12	13.0	good	70	2,495	2,505
	1700	4	A		calm	0	15		14		good	90	2,515	
8/18	0730	4	A	5	calm	0	12	16.0	14	14.0	good	100	2,525	2,535
	1700	4	A		NW	5-10	20		14		good	120	2,545	
8/19	0730	5		0	calm	0	10	14.5	13	13.5	good	140	2,565	2,565
	1700	4			calm	0	19		14		good	140	2,565	
8/20	0730	2		0	calm	0	8	10.5	12	12.5	good	120	2,545	2,535
	1700	4	B		calm	0	13		13		good	100	2,525	
8/21	0730	2		6	calm	0	8	11.5	11	12.0	good	120	2,545	2,545
	1700	3			NW	5-10	15		13		good	120	2,545	
8/22	0730	4		0	calm	0	5	8.0	10	10.5	good	120	2,545	2,545
	1700	4	B		calm	0	11		11		ok	120	2,545	
8/23	0730	4	A	15	SE	20	10	11.5	10	10.5	ok	160	2,585	2,605
	1700	4			SE	25	13		11		murky	200	2,625	
8/24	0730	4	A	3	calm	0	10	12.0	11	12.0	murky	300	2,725	2,720
	1700	3			NW	10-15	14		13		murky	290	2,715	
8/25	0730	2		0	calm	0	4	9.0	10	11.0	ok	250	2,675	2,665
	1700	3			calm	0	14		12		ok	230	2,655	
8/26	0730	1		0	calm	0	4	8.0	10	10.5	good	190	2,615	2,610
	1700	4			NW	5-10	12		11		good	180	2,605	
8/27	1000	4		0	calm	0	10	10.5	10	10.0	good	160	2,585	2,585
	1700	4	A		calm	0	11		10		good	160	2,585	
8/28	1000	4		7	SE	10-15	11	12.5	10	11.0	good	170	2,595	2,595
	1700	4	A		calm	0	14		12		good	170	2,595	
8/29	0730	4	A	3	calm	0	8	10.0	11	11.0	ok	200	2,625	2,625
	1700	4	A		calm	0	12		11		ok	200	2,625	

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			Precipitation		Wind		Temperature (^{0}C)				River Stage			
Date	Time	Sky	Code	(mm)	Direction	Speed	Air	AVG Air	Water	AVG Water	Clarity	Reading (mm)	Adjusted (mm)	AVG Adj. (mm)
8/30	0730	4	A	2	calm	0	8	11.5	10	10.5	ok	180	2,605	2,605
	1700	4	A		calm	0	15		11		ok	180	2,605	
8/31	0730	4	A	1	calm	0	9	11.0	11	12.5	ok	160	2,585	2,585
	1700	2	A		NW	15-20	13		14		ok	160	2,585	
9/01	0730	1		0	calm	0	0	7.0	9	10.0	ok	140	2,565	2,565
	1700	1			calm	0	14		11		good	140	2,565	
9/02	0730	1		0	calm	0	0	5.0	9	9.0	good	130	2,555	2,555
	1700	4	B		calm	0	10		9		good	130	2,555	
9/03	0730	4	A	8	calm	0	9	9.5	9	9.0	good	150	2,575	2,580
	1700	4	A		SE	5-10	10		9		ok	160	2,585	
9/04	0730	4	A	4	calm	0	9	12.0	10	10.5	ok	190	2,615	2,625
	1700	3			SE	5-10	15		11		ok	210	2,635	
9/05	0730	4		1	SE	5-10	10	11.0	10	10.0	ok	240	2,665	2,665
	1700	4	B		calm	0	12		10		ok	240	2,665	
9/06	0730	4	A	3	calm	0	8	10.5	9	10.0	ok	230	2,655	2,665
	1700	4	A		calm	0	13		11		ok	250	2,675	
9/07	0730	4	A	9	calm	0	8	9.0	9	10.0	murky	280	2,705	2,710
	1700	4			NW	10	10		11		murky	290	2,715	
9/08	0730	1		0	calm	0	0	7.0	9	9.5	murky	290	2,715	2,710
	1700	4			calm	0	14		10		murky	280	2,705	
9/09	0730	4	A	7	SE	10-15	10	13.0	9	10.0	murky	270	2,695	2,700
	1700	2			SW	25	16		11		murky	280	2,705	
9/10	1000	4		4	calm	0	10	13.0	10	10.5	murky	390	2,815	2,810
	1700	3			S	10-15	16		11		murky	380	2,805	
9/11	1000	4	A	0	S	5	9	11.5	10	10.0	murky	330	2,755	2,745
	1700	4			S	25	14		10		murky	310	2,735	
9/12	1000	4		0	S	15	9	12.0	9	9.5	murky	290	2,715	2,720
	1700	4			S	10	15		10		ok	300	2,725	
9/13	1000	4	A	1	calm	0	8	9.5	9	9.0	ok	300	2,725	2,725
	1700	4	A		S	5	11		9		ok	300	2,725	
9/14	0100	4	A	2	S	5	9	11.0	9	9.0	ok	290	2,715	2,710
	1700	4			S	10	13		9		ok	280	2,705	
9/15	1000	4	B	2	S	15	10	11.0	9	9.0	ok	290	2,715	2,715
	1700	4	A		S	25	12		9		ok	290	2,715	
9/16	1000	2		1	calm	0	6	9.0	9	9.0	bad	780	3,205	3,185
	1700	4			S	5	12		9		bad	740	3,165	

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			Precipitation		Wind		Temperature (^{0}C)				River Stage			
Date	Time	Sky	Code	(mm)	Direction	Speed	Air	AVG Air	Water	AVG Water	Clarity	Reading (mm)	Adjusted (mm)	AVG Adj. (mm)
9/17	1000	4		0	calm	0	5	8.5	9	9.0	murky	530	2,955	2,935
	1700	4			calm	0	12		9		murky	490	2,915	
9/18	0700	1		0	calm	0	0	6.0	8	8.5	murky	450	2,875	2,860
	1700	3	A		calm	0	12		9		murky	420	2,845	
9/19	1000	3		0	calm	0	4	7.5	8	8.5	murky	410	2,835	2,840
	1700	3	A		N	5	11		9		murky	420	2,845	
9/20	1000	2		2	calm	0	6	9.0	8	8.5	ok	400	2,825	2,825
	1700	3			calm	0	12		9		ok	400	2,825	
9/21	1000	4	B	0	S	5-10	8	9.0	8	8.0	ok	380	2,805	2,805
	1700	4	B		S	15-20	10		8		ok	380	2,805	
9/22	1000	4	B	4	S	10-15	10	11.5	9	9.0	ok	380	2,805	2,815
	1700	4	A		S	20-30	13		9		ok	400	2,825	
9/23	0800	2		4	S	5-10	6	9.0	8	8.5	murky	500	2,925	2,940
	1700	4	A		S	5-10	12		9		murky	530	2,955	
9/24	1000	4		4	calm	0	5	7.5	8	8.0	murky	460	2,885	2,875
	1700	4			S	5-10	10		8		ok	440	2,865	
9/25	1000	4		0	calm	0	8	9.0	7	7.5	ok	400	2,825	2,825
	1700	4	A		calm	0	10		8		ok	400	2,825	
9/26	1000	4		1	calm	0	5	7.5	7	7.0	ok	370	2,795	2,790
	2000	4			calm	0	10		7		ok	360	2,785	
9/27	0800	4	A	1	calm	0	8	8.0	7	7.0	ok	360	2,785	2,785
Total Precipitation (6/21 to 9/27):				188		Averages:		13.4		11.6				2,717

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

[b] Precipitation Codes: A = intermittent rain
B = continuous rain
C = snow
D = snow and rain
E = hail
F = thunderstorm w/ or w/out rain

APPENDIX D. INFORMATIONAL SUMMARY FOR TAGS COLLECTED AT THE KOGRUKLUK RIVER WEIR, 2005

Appendix D1.–Tags observed and recovered at the Kogrukluk River weir by date, 2004.

	Kuskokwim River Radiotelemetry[a]				Kuskokwim River Tagging Project[b]							
	Chinook		Sockeye		Chinook		Chum		Sockeye		Coho	
Date	Obs.[c]	Rec.	Obs.[c]	Rec.	Obs.[c]	Rec.	Obs.[c]	Rec.	Obs.[c]	Rec.	Obs.[c]	Rec.
6/22												
6/23												
6/24												
6/25												
6/26												
6/27												
6/28												
6/29												
6/30												
7/01												
7/02		1				4						
7/03						4		2				
7/04		1						1				
7/05					1	3		2		4		
7/06						2		3		3		
7/07						3		5		6		
7/08						2	1	3		2		
7/09		2			1	1	1	5	1	7		
7/10		1		2		1		7				
7/11	1	1						8		2		
7/12		1				3		4		10		
7/13				2		2		6		5		
7/14				1		2	1	5		6		
7/15				1	1	1	1	4	2	8		
7/16	1	1				4	1	17	3	10		
7/17		1				3		14		10		
7/18						2	1	6		12		
7/19						1		15	1	6		
7/20		1						13		5		
7/21		1		1	1	2	1	17	1	21		
7/22	1					1		6		6		
7/23						1		9		11		
7/24							1	10	1	5		
7/25		1				1	1	2		6		
7/26	1					1		1	2	1		
7/27		1		1		1		5		6		
7/28		1				1		2	1	9		
7/29									1	5		
7/30								2		4		
7/31						1		1				
8/01						1				5		
8/02										6		
8/03		1								1		
8/04										4		
8/05									1	4		
8/06										5		
8/07								1		1		
8/08												
8/09												
8/10										3		
8/11												
8/12										1		
8/13										2		

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	Kuskokwim River Radiotelemetry [a]				Kuskokwim River Tagging Project [b]							
	Chinook		Sockeye		Chinook		Chum		Sockeye		Coho	
Date	**Obs.[c]**	**Rec.**	**Obs.[c]**	**Rec.**	**Obs.[c]**	**Rec.**	**Obs.[c]**	**Rec.**	**Obs.[c]**	**Rec.**	**Obs.[c]**	**Rec.**
8/14												
8/15						1						
8/16									1			
8/17												
8/18					1						1	
8/19											2	
8/20												1
8/21										1		2
8/22												
8/23										2		1
8/24										1		9
8/25									1			4
8/26										1		3
8/27												
8/28												4
8/29												4
8/30												5
8/31												5
9/01												2
9/02												
9/03										1		5
9/04										1	1	22
9/05												10
9/06												9
9/07						1					2	14
9/08												8
9/09											1	5
9/10												13
9/11												17
9/12											1	15
9/13						1						13
9/14								1				10
9/15												12
9/16												
9/17												
9/18												
9/19												
9/20												3
9/21												1
9/22												4
Total Tags Passed:	4	15	0	8	5	51	9	178	16	208	8	201

Note: Days with no data are days when no tagged fish were observed or recovered. Obs. = observed tags, Rec. = recovered tags.

[a] Utilized radio tags.

[b] Utilized anchor tags.

[c] Observed tags were those tags seen but not recovered.

APPENDIX E. FACTORS FOR HISTORICAL SALMON ESCAPEMENT ESTIMATES, KOGRUKLUK RIVER WEIR

Appendix E1.–Factor table for historical salmon escapement estimates, Kogrukluk River 1976–2005.

	Chinook				Chum				Sockeye				Coho[a]			
			Percent	Est'd			Percent	Est'd			Percent	Est'd			Percent	Est'd
Year	**T[b]**	**Count**	**Missed[c]**	**Total**	**T[b]**	**Count**	**Missed[c]**	**Total**	**T[b]**	**Count**	**Missed[c]**	**Total**	**T[b]**	**Count**	**Missed[c]**	**Total**
1976	L	5,507	1.7	5,600	N	8,046	0.9	8,117	N	2,302	1.0	2,326				
1977[d]		1,385	n.a.	1,385		10,388	n.a.	10,388		1,112	n.a.	1,112				
1978	N	13,132	3.9	13,667	N	47,099	2.1	48,125	N	1,646	1.4	1,670				
1979	L	10,125	10.7	11,338		13,966	24.9	18,599	N	2,432	7.5	2,628				
1980		843	87.2	843		6,323	84.9	6,323		404	87.4	404				
1981	E	16,070	4.4	16,807	E	56,271	1.9	57,372	E	17,702	2.1	18,076	N	11,450	0.0	11,455
1982		5,325	51.6	10,993		41,204	33.4	61,859		11,729	32.2	17,297	L	35,582	5.9	37,796
1983		1,082	64.2	3,025		3,248	65.5	4,085		375	68.1	375	L	8,327	2.5	8,538
1984	N	4,928	0.0	4,928	N	41,484	0.0	41,484	N	4,133	0.0	4,133	E	25,304	8.3	27,595
1985	L	4,287	7.2	4,619	L	13,843	7.7	15,005	L	4,344	0.3	4,359	N	14,618	11.1	16,441
1986		2,922	42.0	5,038	N	12,041	18.1	14,693		3,255	23.4	4,247		14,717	34.6	22,506
1987[e]		770	81.1	4,063		2,365	86.4	17,422		284	70.8	973	E	19,756	13.4	22,821
1988	N	7,665	10.0	8,520		28,499	27.9	39,543	E	4,240	3.7	4,402	N	11,722	13.3	13,512
1989[f]		4,911	58.9	11,940		15,543	60.7	39,547		2,599	55.3	5,810		1,272	n.a.	1,272
1990	N	10,097	1.2	10,218	E	26,555	0.8	26,765	N	8,383	0.3	8,407		2,736	55.4	6,132
1991		5,868	25.3	7,850	L	22,369	7.5	24,188	N	13,737	16.5	16,455		7,059	29.2	9,964
1992	N	6,397	5.3	6,755	E	31,902	6.5	34,104	L	7,344	2.6	7,539		2,712	89.6	26,231
1993	N	10,516	14.7	12,333	N	26,764	16.1	31,901	N	27,148	7.6	29,366		4,395	78.6	20,517
1994		8,305	45.5	15,227		23,147	50.4	46,635		5,695	59.9	14,192		27,057	22.0	34,695
1995	E	18,877	8.6	20,651	N	28,460	9.0	31,265	N	10,582	3.8	10,996		17,492	37.2	27,862
1996	E	13,764	3.1	14,199	E	47,095	2.9	48,478	N	15,222	1.1	15,386	E	47,011	7.0	50,555
1997	E	13,111	1.3	13,284	N	7,902	0.7	7,958	N	13,059	0.1	13,077	N	11,611	5.1	12,238
1998		3,009	75.1	12,107		13,013	64.3	36,441		5,321	68.3	16,773	N	22,614	7.1	24,348
1999	L	5,472	1.8	5,570	L	13,497	2.3	13,820	L	5,777	1.5	5,864	L	10,094	20.0	12,609
2000	L	3,180	3.9	3,310	N	11,077	3.6	11,491	L	2,776	3.1	2,865	E	32,875	0.8	33,135
2001		6,572	29.3	9,298		22,551	26.2	30,570		6,637	24.4	8,776	E	18,308	5.6	19,387
2002	N	9,590	5.1	10,104	E	49,494	4.0	51,570	E	3,913	3.4	4,050	N	14,501	0.1	14,516
2003	L	11,585	1.6	11,771	L	22,514	3.8	23,413	N	8,986	2.0	9,164	N	68,718	7.9	74,604
2004	N	19,432	1.1	19,651	N	24,174	0.1	24,201	N	6,767	0.1	6,775	N	26,078	3.6	27,041
2005	N	21,731	1.2	22,000	L	191,588	3.1	197,723	N	37,465	1.2	37,939	N	23,102	4.2	24,116

[a] Coho migrations were not monitored prior to 1981.

[b] The timing model used for estimating missed counts depends on the distribution of the mean date of migration (E-early, N-normal, L-late). Since the mean date of migration is a moving average, the run timing assessments (T) are updated each year. Thus, the letter designations in this table do not necessarily match those in previous years' reports.

[c] Only years when the proportion estimated was less than 0.20 were considered for the purposes of calculating mean date of migration. Thus, there is no "E", "N", or "L" designation for years when passage estimates represented a proportion greater than 0.20 of the total escapement.

[d] Estimates were made from counting tower data and are not included in the "Estimated Total."

[e] Chinook, chum, and sockeye escapements were estimated from a ratio of unknown 1987 escapement and known 1987 aerial assessments to known 1988 weir escapement and known 1988 aerial assessment. Coho escapements were estimated using time series techniques.

[f] Heavy rain and high river levels allowed only 2 days of counts during the coho migration. As a result, total escapement was not estimated.

APPENDIX F. HISTORICAL CUMULATIVE CARCASS COUNTS AT THE KOGRUKLUK RIVER WEIR

Appendix F1.–Historical cumulative carcass counts and percent carcasses return at the Kogrukluk River weir by year.

	Chinook					Chum					Sockeye				
Year	**Male Carcasses**	**Female Carcasses**	**Total Cumulative Carcasses**	**Observed Upstream Passage**	**Percent Carcasses**	**Male Carcasses**	**Female Carcasses**	**Total Cumulative Carcasses**	**Observed Upstream Passage**	**Percent Carcasses**	**Male Carcasses**	**Female Carcasses**	**Total Cumulative Carcasses**	**Observed Upstream Passage**	**Percent Carcasses**
1976	52	12	64	5,500	1	892	167	1,059	8,046	13	2	1	3	2,302	0
1977	6	6	12	1,385	1	514	57	571	10,388	5	0	2	2	1,112	0
1978	423	228	651	13,102	5	4,750	1,387	6,137	47,099	13	5	1	6	1,646	0
1979	14	8	22	10,104	0	1,187	227	1,414	13,959	10	1	1	2	2,432	0
1980[a]			0	843				0	6,323				0	404	
1981	345	393	738	15,917	5	1,891	507	2,398	56,262	4	1,697	189	1,886	17,691	11
1982			0	5,325				0	43,422				0	11,729	
1983[a]	40	14	54	1,032	5	162	123	285	3,248	9	215	13	228	375	61
1984	757	95	852	4,928	17	6,928	2,297	9,225	41,484	22	361	74	435	4,133	11
1985			0	4,287				0	13,843				0	4,359	
1986	5	3	8	2,922	0	248	87	335	11,956		136	54	190	4,244	4
1987[a]			0	525				0	2,325				0	278	
1988[b]	1,336	457	1,793	8,505	21	6,638	1,345	7,983	39,540	20	282	44	325	4,397	7
1989	0	1	1	4,911	0	323	69	392	15,543	3	2	1	3	2,599	0
1990			684	10,097	7			6,004	26,158	23			556	8,382	7
1991			852	5,781	15			6,453	22,481	29			547	13,687	4
1992			533	6,356	8			7,580	31,826	24			1,356	7,329	19
1993			1,117	10,190	11			7,112	29,223	24			1,313	26,943	5
1994			1,199	8,221	15			3,938	23,487	17			1,216	13,887	9
1995			3,450	18,856	18			11,051	28,379	39			2,448	10,581	23
1996			3,134	13,734	23			11,870	47,010	25			2,791	15,221	18
1997			749	13,112	6			2,621	7,858	33			470	13,059	4
1998			948	2,780	34			5,588	13,014	43			623	5,321	12
1999			507	5,472	9			3,286	13,497	24			446	5,777	8
2000			379	3,180	12			2,570	11,077	23			238	2,778	9
2001			978	6,572	15			6,191	22,550	27			822	6,634	12
2002			1,634	9,590	17			17,462	49,494	35			611	3,913	16
2003			1,352	11,585	12			8,111	22,514	36			934	8,986	10
2004	2,548	245	2,793	19,432	14	11,577	1,018	12,595	23,302	54	731	180	911	6,767	13
2005			2,797	21,731	13			36,745	191,588	19			3,005	37,465	8
Average % of observed escapement returned to the weir as carcasses**:**					11					23					10

[a] Majority of the run estimated; weir not in operation much of the season.

[b] In 1988, estimates were made for carcass accumulation. Percentages derived from estimated carcasses/estimated escapement. Values for all other years were generated from observed carcasses/observed escapement.