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Sockeye Salmon Smolt Investigations on the Chignik River, 2006

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**

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

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ABSTRACT

This report provides the results from the thirteenth year of the Chignik River sockeye salmon smolt enumeration project operated by the Alaska Department of Fish and Game (ADF&G). Outmigrating juvenile sockeye salmon *Oncorhynchus nerka* were captured in a rotary-screw trap array and abundance was estimated using mark-recapture techniques. Sockeye salmon smolt were measured throughout the emigration for age, length, and weight data and genetic samples were collected from these same fish. In 2006, a total of 7,560,651 sockeye salmon smolt were estimated to pass downstream of the traps from April 27 to July 9. Of these, 1,744,370 (23.1%) were age-0, 2,849,043 (37.7%) were age-1, 2,847,624 (37.7%) were age-2, and 119,614 (1.6%) were age-3 smolt. The Chignik River watershed sockeye salmon run is formally forecasted using sibling and temperature index relationships. The forecast using smolt information is considered ancillary data. The formal forecast is for a total run of 1.92 million sockeye salmon in 2007 with an expected harvest of 1.32 million fish. Smolt abundance data, by outmigration year, and temperature data from the King Salmon Airport during the smolt outmigration year were regressed against saltwater-age-3 returns from their respective outmigration years to forecast the 2007 sockeye salmon run. It was estimated that approximately 2.06 million sockeye salmon are expected to return in 2007, equating to a harvest of about 1.39 million sockeye salmon. Because only up to nine years of smolt and corresponding adult return data were used to produce this forecast, the confidence in this forecast is fair.

Key words: Sockeye salmon, smolt, Chignik River, forecast, mark-recapture.

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) manages the commercial salmon fishery in the Chignik Management Area (CMA). ADF&G has enumerated sockeye salmon smolt emigration in the Chignik River annually since 1994 to gauge the health of the smolt leaving the system, estimate the marine survival of sockeye salmon smolt, and provide a preseason forecast of the Chignik River watershed sockeye salmon run. The Chignik River watershed, which is the primary sockeye salmon *Oncorhynchus nerka* producer in the CMA (Bouwens 2004), consists of a large, shallow lagoon, two large lakes (Chignik and Black Lakes), and several tributaries that provide spawning and rearing habitat for sockeye salmon (Figure 1). Two genetically distinct, but temporally overlapping, runs of sockeye salmon return to the Chignik River watershed (Templin et al. 1999). The early run (sustainable escapement goal (SEG) range of 350,000 to 400,000 fish through July 4) spawns in Black Lake and its tributaries and enters the watershed from June through mid July. The late run (SEG range of 200,000 to 250,000 fish through August 31), returns from late June through September and later into the fall. The late run typically spawns in the tributaries and the shoals of Chignik Lake. A management objective for an additional 25,000 fish escapement during August and 25,000 fish during September 1-15 was added in 2004 to address subsistence concerns. The interactions between the Black Lake (early run) and Chignik Lake (late run) stocks are poorly understood. The usage of available rearing habitat specific to each stock has not been clearly defined (Bumgarner 1993). Specifically, the influence of physical and environmental factors upon the outmigration of Chignik juvenile sockeye salmon requires further investigation (Bouwens and Finkle 2003b).

Juvenile salmon are known to migrate to sea after certain size thresholds are met, during specific seasons, and under certain physical conditions (Clarke and Hirano 1995). However, it is difficult to directly measure the interactions and impacts of these effects on juvenile fishes. Salmon smolt emigration may be triggered by warmer springtime water temperatures (3-4 ^{o}C), and increased photoperiod (Clarke and Hirano 1995). Variables affecting growth in juvenile salmon include temperature, competition, food quality and availability, and various water chemistry parameters (Moyle and Cech 1988). Because of these dynamic factors, annual growth of juvenile sockeye salmon often varies among lakes, years, and within individual populations (Bumgarner 1993). If growth rates are not sufficient to achieve the threshold size necessary to emigrate in the spring, juvenile fish may remain in a lake to feed for another year (Burgner 1991), possibly increasing competition among younger brood in the same rearing area. These interactions can be investigated via smolt emigration data.

Typically, sockeye salmon smolt quickly migrate to saltwater from their nursery lakes and spend only enough time in a river to travel to the marine environment (Burgner 1991). However, not all juvenile sockeye salmon emigrating from Chignik and Black Lakes have gone directly to sea, which has hindered stock identification. Past studies have suggested that a component of juvenile sockeye salmon rear in the Chignik River and Lagoon in the summer and subsequently return to Chignik Lake in the fall to offset or avoid taxed Chignik Lake rearing conditions (Iverson 1966; Phinney 1968; Roos 1957, 1959). Historically, sockeye smolt emigrations from the Chignik River watershed have been estimated to range between two and 26 million fish (Bouwens and Newland 2003). Small young-of-the-year sockeye salmon have been captured in large numbers in the Chignik River and Chignik Lagoon during the summer months (Bouwens and Finkle 2003a,b; Bouwens and Edwards 2001; Finkle and Bouwens 2001). Further studies are being conducted to investigate to what extent juvenile sockeye salmon use the Chignik River and Lagoon as a rearing area (Finkle and Bouwens 2002).

Smolt emigration data can serve as an indicator of future run strength and overall stock status. These data have been combined into a model that is used to generate an adult sockeye salmon forecast to the Chignik watershed (Bouwens and Edwards 2001; Bouwens and Newland 2003; Eggers 2007). Forecasts enable harvesters and fish processors to estimate their potential supply and production needs. Current formal forecast methods used to predict the adult runs to the Chignik watershed employ historic age class relationships for the early run and return-per-spawner relationships for the late-run stocks (Eggers 2007). Smolt emigration estimates by age, and potentially stock, are expected to add accuracy to the forecast models currently used.

The 2006 field season completed the thirteenth season of the ADF&G smolt project on the Chignik River, which has been funded since project commencement, by the Chignik Regional Aquaculture Association (CRAA; Bouwens and Edwards 2001; Bouwens and Newland 2003; Finkle and Newland 2005). The Chignik River Sockeye Salmon Smolt Enumeration Project has consistently maintained its sampling protocol since the project's inception. This report presents data collected during the 2006 Chignik River Sockeye Salmon Smolt Enumeration Project, comparisons of 2006 smolt data to past smolt data, and adult sockeye salmon forecast estimates for 2007 and 2008, based on smolt emigration data.

OBJECTIVES

The objectives for the 2006 season were to:

1) Estimate the total number of emigrating sockeye salmon smolt, by age, from the Chignik River watershed,

2) Describe sockeye salmon smolt emigration timing and growth characteristics (length, weight, and condition factor) by age for the Chignik River watershed,

3) Continue to build a smolt forecast model in an effort to estimate marine survival and future runs,

4) Present an informative sockeye salmon smolt PowerPoint presentation to students at Chignik Lake school, and

5) Collect genetic samples from emigrating sockeye salmon smolt for use in a future stock separation study.

METHODS

STUDY SITE AND TRAP DESCRIPTION

Two rotary-screw traps were operated side by side to capture smolt emigrating from Chignik Lake. Another trap was modified and used as a live box and work station platform. The live box was placed behind the small trap, which was closest to shore. The trapping site was located 8.6 km upstream from Chignik Lagoon (Mensis Point) and 1.9 km downstream from the outlet of Chignik Lake (56° 15’ 26” N. lat., 158° 43’ 49” W. long.; Figure 2). The traps were located near a bend in the river with the highest current and narrowest span. Each trap was secured to shore with highly visible polypropylene line. The highly visible line and a strobe light attached to the safety railing of the offshore trap were employed to address safe navigation around the traps and lines for local boat traffic. The strobe was positioned behind the mouth of large trap to minimize trap avoidance by sockeye salmon smolt.

Each trap consisted of a cone constructed of aluminum perforated plate (5 mm holes) mounted on two aluminum pontoons, with the large ends of the cones pointed upstream. The cone mouth diameter was 1.5 m on the small trap (placed nearshore), and 2.4 m on the large trap (placed offshore). The small trap sampled an area of approximately 0.73 m^2 and the large trap sampled an area of approximately 2.02 m^2 of the river’s profile because only the bottom portion of the cone was submerged. The river current propelled an internal screw, which rotated the cone at approximately 3-9 revolutions per minute (RPM) during average water flow conditions. Fish were funneled through the cone into one of two live boxes, each approximately 0.7 m^3 in volume The live boxes sat on the downstream end of each trap. A pair of adjustable aluminum support legs were utilized to maintain and adjust the traps’ positions from the shore and their orientation in the current.

A floating platform for a 3m x 4m weatherport was tied directly behind the live box work station. The weatherport provided shelter for the crew when processing samples taken from the traps.

During the 2006 field season, both of the traps were operated continuously from 1300 hours on April 27 to 1230 hours on July 10. At the completion of the project, both traps were disassembled and stored.

SMOLT ENUMERATION

Because smolt primarily emigrate at night, sampling days extended from noon to noon and were identified by the date of the first noon-to-midnight period. The traps were checked at least every six hours each day including checks at the end of the smolt day at 1200 hours and again at 1800 hours.

Juvenile sockeye salmon greater than 45 mm fork length (FL; measured from mid eye to tail fork) were considered smolt (Thedinga et al. 1994). All fish caught in the traps were counted. Fish were netted out of the traps’ holding boxes, identified (McConnell and Snyder 1972; Pollard et al. 1997), and enumerated. Sockeye salmon smolt recaptured during mark-recapture experiments were recorded separately from unmarked smolt and excluded from daily total catch to prevent double counting. Sockeye salmon fry (< 45 mm FL), coho salmon *O. kisutch* juveniles, pink salmon fry *O. gorbuscha*, Chinook salmon *O. tshawytscha* juveniles, chum salmon *O. keta* juveniles, Dolly Varden *Salvelinus malma*, stickleback of the family Gasterosteidae, pond smelt *Hypomesus olidus*, pygmy whitefish *Prosopium coulteri*, starry flounder *Platichthys stellatus*, and coastrange sculpin *Cottus aleutus* were also counted. The isopod *Mesidotea entomon* (Merrit and Cummings 1984; Pennak 1989) was also identified and enumerated.

TRAP EFFICIENCY ESTIMATES

Mark-recapture experiments were conducted weekly to determine trap efficiency when sufficient numbers of smolt were captured for a marking event. Between approximately 700 and 2,700 sockeye salmon smolt for each experiment were collected from the traps and transferred to the live box. Smolt were retained in the live box for up to three nights if sufficient numbers were not initially captured. Past mark retention and delayed mortality experiments indicated that most of the captured smolt mortalities occurred during the first three days of capture (Bouwens and Newland 2003). Thus, after three nights, all captured smolt were marked if the minimum sample size was met or released if the minimum sample size was not met.

Sockeye salmon smolt were netted from the live box, counted, and marked. Fish were transferred into a repository containing an aerated Bismarck Brown Y dye solution (6.2 g of dye to 121.1 L of water) for 15 minutes. Fresh water was then pumped into the container to slowly flush out the dye (90 min). The smolt were allowed to recover in the circulating water. At the end of the marking process, dead and stressed smolt were removed, counted, and disposed of downstream of the traps.

The remaining marked smolt were taken to the upriver release site (56° 15’ 15” N. lat., 158° 44’ 51” W. long), approximately 1.3 km upstream of the traps (Figure 2). Smolt were transported upstream in aerated containers and released evenly across the breadth of the river from the left bank to the right bank. The marking event was performed so that the marked fish were released before midnight. The number of smolt recaptured in the traps was recorded for several days until recoveries ceased.

The trap efficiency E was calculated by

$$E_h = \frac{\left(M_h + 1\right)}{m_h + 1} \qquad (1)$$

where

h = stratum or time period index (release event paired with a recovery period),

M_h = the total number of marked releases in stratum *h*,

and

m_h = the total number of marked recaptures in stratum *h*.

The Chignik River watershed smolt population size was estimated by using methods described in Carlson et al. (1998). The approximately unbiased estimator of the total population within each stratum ($\hat{U}_h$) was calculated by

$$\hat{U}_h = \frac{u_h(M_h + 1)}{m_h + 1}, \tag{2}$$

where

u_h = the number of unmarked smolt captured in stratum *h*,

Variance was estimated by

$$v(\hat{U}_h) = \frac{(M_h + 1)(u_h + m_h + 1)(M_h - m_h)u_h}{(m_h + 1)^2(m_h + 2)}. \tag{3}$$

The estimate of $\hat{U}$ for all strata combined was estimated by

$$\hat{U} = \sum_{h=1}^{L} \hat{U}_h, \tag{4}$$

where *L* was the number of strata. Variance for $\hat{U}$ was estimated by

$$v(\hat{U}) = \sum_{h=1}^{L} v(\hat{U}_h), \tag{5}$$

and 95% confidence intervals were estimated from

$$\hat{U} \pm 1.96\sqrt{v(\hat{U})}, \tag{6}$$

which assumed that $\hat{U}$ was asymptotically normally distributed.

The estimate of emigrating smolt by age class for each stratum *h* was determined by first calculating the proportion of each age class of smolt in the sample population as:

$$\hat{\theta}_{jh} = \frac{A_{jh}}{A_h}, \tag{7}$$

where

A_{jh} = the number of age *j* smolt sampled in stratum *h*, and

A_h = the number of smolt sampled in stratum *h*

with the variance estimated as

$$v(\hat{\theta}_{jh}) = \frac{\hat{\theta}_{jh}(1 - \hat{\theta}_{jh})}{A_h}. \tag{8}$$

For each stratum, the total population by age class was estimated as

$$\hat{U}_{jh} = \hat{U}_j \hat{\theta}_{jh}, \tag{9}$$

where $\hat{U}_j$ was the total population size of age *j* smolt, excluding the marked releases ($= \sum U_{jh}$).

The variance for $\hat{U}_{jh}$, ignoring the covariance term, was estimated as

$$v(\hat{U}_{jh}) = \hat{U}_h^{\,2} v(\hat{\theta}_{jh}) + \hat{U}_h v(\hat{\theta}_{jh})^2 . \tag{10}$$

The total population size of each age class over all strata was estimated as:

$$\hat{U}_j = \sum_{h=1}^{L} \hat{U}_{jh} , \tag{11}$$

with the variance estimated by

$$v(\hat{U}_j) = \sum_{h=1}^{L} v(\hat{U}_{jh}) . \tag{12}$$

AGE, WEIGHT, AND LENGTH SAMPLING

A daily sample of 40 sockeye salmon smolt was collected on five days per statistical week for age-weight-length (AWL) data. All smolt sampling data reflected the smolt day in which the fish were captured, and samples were not mixed between days. Smolt were collected throughout the night's migration and held in an instream live box. Forty smolt were then randomly collected from the live box, anesthetized with Tricaine methanesulfonate (MS-222), and sampled for AWL data, and the remaining smolt were released downstream from the traps.

Fork length (FL) was measured to the nearest 1 mm, and smolt were weighed to the nearest 0.1 g. Scales were removed from the preferred area (INPFC 1963) and mounted on a microscope slide for age determination. After sampling, fish were held in aerated water until they completely recovered from the anesthetic, and were released downstream from the traps upon revival. Age was estimated from scales under 60X magnification. All data were recorded in European notation (Koo 1962).

Condition factor (Bagenal and Tesch 1978), which is a quantitative measure of the isometric growth of a fish, was determined for each smolt sampled using:

$$K = \frac{W}{L^3} 10^5 , \tag{13}$$

where K is smolt condition factor, W is weight in g, and L is FL in mm.

Additionally, fin clips were collected from all AWL-sampled fish for future genetic analysis and stored in ethanol following ADF&G protocol (Appendix E1).

CLIMATE AND HYDROLOGY

Trap RPM, water depth (cm), and climate observations including air and water temperature (°C), estimated cloud cover (%), and estimated wind velocity (mph) and direction were recorded daily at 1200 hours.

MARINE SURVIVAL ESTIMATES AND FUTURE RUN FORECASTING

Estimates of smolt abundance, by age, were paired with corresponding adult returns from the respective smolt year. The total return to the Chignik River watershed was calculated by adding the total Chignik River sockeye salmon escapement, the total harvest from the CMA, and a portion of the sockeye salmon catch from the Southeastern District Mainland (SEDM) of the

Alaska Peninsula Management Area and the Cape Igvak Section of the Kodiak Management Area (5 AAC 09.360(g); 5AAC 18.360(d); ADF&G 2005). Marine survival, by age, and the number of smolt produced per spawner from their respective BYs (brood year) were also calculated.

Simple linear and multiple regression relationships were explored between smolt abundance estimates and the corresponding adult returns, by both emigration and brood years, to investigate the potential of using smolt emigration estimates to forecast future adult sockeye salmon runs. Standard regression diagnostic techniques were used to indicate violations of model assumptions. Regressions were developed between individual freshwater age classes and their corresponding adult returns (by freshwater age) and between total smolt emigration estimates and corresponding adult returns (by ocean age). It was clear from an impossible marine survival estimate (greater than 100% survival) of emigration year 1996 that the smolt abundance was underestimated in this year. Therefore, data from 1996 were not included in regression analyses for predicting future adult returns.

A statistically significant multiple regression relationship was used to forecast the saltwater-age-3 (3-ocean) component (historically, about 83% of the entire run) of the 2007 adult sockeye salmon run from the smolt emigration data. Temperature data from the King Salmon Airport from April through December of the smolt outmigration year was found to have a significant positive correlation with smolt survival. These data were integrated with the total smolt outmigration to estimate 3-ocean returns using a multiple linear regression relationship. The adult return estimates for the 3-ocean age classes were expanded to account for the total run from their historical proportion of the total run.

RESULTS

TRAPPING EFFORT

Both traps were in place for a total of 74 days beginning on the smolt dates of April 27 and ending on July 9 (Appendix A1). The duration of the 2006 trapping season was 2 days less than the 2005 season.

TRAP CATCH

A total of 31,540 sockeye salmon smolt was captured in the traps in 2006 (Appendix A1). In addition to sockeye salmon smolt, 18,055 sockeye salmon fry, 5,291 juvenile coho salmon, 97 pink salmon fry, 1,572 juvenile Chinook salmon, 649 Dolly Varden char, 131,571 stickleback, 237 sculpin, 32 starry flounders, 6,705 pond smelt, 96 pygmy whitefish, and 44 isopods were captured (Appendix A1). The small screw trap caught approximately 26.7% of the sockeye salmon smolt while the large trap caught 73.3% of the sockeye salmon smolt (Appendix B1).

SOCKEYE SALMON SMOLT EMIGRATION AND TIMING

The estimated number of sockeye salmon smolt that emigrated in 2006 was 7,560,651 (Table 1; Figure 3). The majority of these fish emigrated in mid May (Table 2; Figure 4). The 2006 emigration consisted of 1,744,370 age-0, 2,849,043 age-1, 2,847,624 age-2, and 119,614 age-3 sockeye salmon smolt (Tables 1 and 2; Figure 5). The age-1 and -2 smolt tended to emigrate together during the season (Table 2; Figure 6). Age-0 sockeye salmon smolt were more abundant in trap catches during May (Table 2; Figure 6).

TRAP EFFICIENCY ESTIMATES

Mark-recapture experiments were conducted on six occasions beginning on May 23 and ending on June 27, 2006 (Table 3; Appendix A1). A total of 9,534 smolt, approximately 30% of the total catch, were marked and released. Fifty-four smolt were recaptured and trap efficiency estimates ranged from 0.11% to 2.54% (Table 3). The majority of the marked smolt were recaptured within two days of being released (Appendix A1).

AGE, WEIGHT, AND LENGTH DATA

A total of 1,644 sockeye salmon smolt were sampled for AWL data in 2006, of which 26.2% were age-0 (Brood Year [BY] 05), 40.3% were age 1 (BY 04), 31.6% were age-2 (BY 03), and 1.95% were age-3 (BY 02; Table 4). The mean length and weight of age-0 smolt were 52 mm and 1.0 g (Table 5). The mean length and weight of age-1 smolt were 68 mm and 2.4 g (Table 5; Figure 7). The mean length and weight of age-2 smolt were 78 mm and 3.8 g. and the mean length and weight of age-3 smolt were 99 mm and 8.9 g. (Table 5; Figure 7). Smolt length was plotted in a length frequency histogram to investigate any modalities in age classes (Figure 8), however, none were found and all age classes were normally distributed.. Juvenile sockeye < 45 mm FL were present throughout the trapping season, but were most abundant toward the beginning of the season (Figures 9 through 11).

PHYSICAL DATA

Daily measurements of river depth and velocity (based on trap RPM), along with the 2006 climate data, are reported in Appendix C1. The absolute water depth at the trap location varied from 90 to 225 cm during the 2006 season (Figure 12). Water temperatures averaged near 2.8 ^{o}C during the first week that traps were installed (April 27 through May 4) and increased steadily throughout the season (Figure 12). Comparatively stable and relatively high water levels and calm winds (Figure 12) generally characterized the 2006 season.

MARINE SURVIVAL ESTIMATES AND FUTURE RUN FORECASTING

All adult sockeye salmon from BYs 1993 through 1999 and for the most of the 2000 BY have returned to the Chignik River watershed, and the overall marine survival of smolt ranged from 6% for BY 1999 to 66% for BY 1993 (Table 6). The estimation of the 1993 and 1994 BY marine survival includes a portion of the emigration estimate from 1996, which is considered an outlier (Edwards and Bouwens 2002). When the data were presented by emigration year, however, the marine survivals ranged from 5% for emigration year 2001 to 195% for emigration year 1996, with 1996 being an obvious outlier (Table 7). Therefore, after removing smolt year 1996, the marine survival from smolt years 1992 to 2003 averaged 14 percent.

Multiple regression models displayed significant relationships ($P=0.02$, $P=0.09$; $R^2>0.60$) among total smolt outmigration, King Salmon air temperature during smolt outmigration, and 3-ocean adult returns. Based on the regression model, the 2007 total adult run forecast is 2.06 million sockeye salmon while the 2008 total adult forecast is 1.05 million.

DISCUSSION

The point estimate of the 2006 total smolt emigration was the third lowest estimated emigration on record since 1994. The confidence in the 2006 estimate is fair considering that the 2006 mark-recapture experiment results compared similarly to those from past years. In 2006, a total of 9,534 smolt were marked and 54 were recaptured in comparison to 1996, the year of the lowest estimated smolt emigration, when only 3,180 were marked and 49 smolt were recaptured. The overall 2006 trap efficiency (0.58%) was similar to 1998 and 2004 trap efficiencies. The accuracy of the initial 0.11% trap efficiency may overestimate the population estimate from April 27 to May 26. However, the low trap efficiencies are reasonable considering multiple factors: 1) the cross-sectional area of the Chignik River is roughly 106 m^2 at the trap location and the traps fished approximately 3.0% (2.75 m^2) of the Chignik River, 2) the water velocity was not strong enough to effectively turn the small trap (0 to 1.5 RPMs) for the first 3 weeks of the project despite reorienting the traps in the current (Appendix C), 3) the large trap spun at speeds (~3 RPMs) considered to be less than optimal (> 5 RPMs) by the trap manufacturer, 4) delayed mortality and mark-retention trials did not indicate the need to adjust trap efficiency or population estimates, and 5) physical conditions (stream depth) in the Chignik River were substantially different between the initial and subsequent mark-recapture experiments. Additionally, historic data from 1994 though 1997, 1999, 2000, 2003, and 2004 indicated that it was not uncommon for roughly one million smolt to emigrate from the system on a single day. Furthermore, a Chi-squared test ($P<0.0001$) indicated that the trap efficiencies should not be pooled to adjust the population estimate, which would also bias the population estimate because of the covariance created by pooling the data.

There has also been a concern that a significant portion of the sockeye salmon smolt emigration has been missed prior to the trap being installed in the spring. In 2006, the peak smolt emigration took place on May 31, 35 days after the traps were installed. Since 1996, all peak emigration days have occurred after May 2 and eight out of nine of the peak emigration events have occurred after May 20. These data suggest that installation of the trap during the later part of April is sufficiently early to capture the majority of the emigration.

In general, the smolt that emigrated in 2006 were generally comparable in size to smolt that emigrated between 2001 and 2004. The mean length and weight of the age-1 sockeye salmon that emigrated in 2006 were similar to those that emigrated in 1996, 2004 and 2005. These fish were both heavier and longer than age-1 smolt from 2001 to 2003. The age-2 smolt were comparable in length to those fish emigrating in 2004 and 2005 (Table 8; Figure 7).

The total abundance of age-1 and -2 smolt were low, and there were proportionately fewer age-1 and -2 smolt during 2006 than in the recent past (Table 9). Generally, the early run is primarily composed of age-1 sockeye salmon and the late run is primarily composed of age-2 sockeye salmon. The low age-1 and -2 smolt abundances in 2006 suggest that subsequent early-run and late-run returns (primarily in 2009) may be poor.

The low total abundance of smolt could be the result of poor rearing conditions during their freshwater residence. During 2004 and 2005, when the 2006 age-2 smolt were rearing as age-0 and -1 juveniles, Chignik Lake experienced low zooplankton biomasses from May through June (Finkle 2005; Finkle *In prep*). Recent conditions were warmer and more turbid on average in Black Lake compared to past years (Finkle *In prep*). Age-1 sockeye salmon would also be affected by these same conditions in 2005 as age-0 fish. If these fish emigrated as age-0 fish and survived, it could be expected that a larger-than-average component of age-0.3 adults would return to the watershed. There have not been, however, large numbers of freshwater age-0 adult sockeye salmon returning to Chignik in past years under similar rearing conditions (Bouwens and Finkle 2003b; Witteveen et al. 2005). In 2006, a total of 18,055 sockeye salmon fry (presmolt) were captured during the field season, which was substantially less than in 2005 but comparable to past years (Finkle and Newland 2005). This fry count coincided with low zooplankton levels and warm temperatures and turbidity in Black Lake (Finkle *In prep*).

Observed marine survivals, by fully recruited emigration year (excluding 1996), of Chignik smolt have ranged from five to 17 percent (Table 7). These estimates are well within the ranges observed in other systems (Burgner 1991). This estimated variability in marine survival implies that given constant freshwater production, the resultant adult returns would still fluctuate with annual differences in productivity of the marine environment.

A formal forecast was prepared which predicts specific age classes based on sibling relationships (e.g., age-2.3 abundance in 2004 from age-2.2 abundance in 2003), sibling ratios (age 2.2:age 2.3), temperature indices when possible, and median values when sibling relationships did not exist. Using these sibling methods, the 2007 Chignik sockeye salmon forecast is 1.92 million (Eggers 2007).

For forecasting purposes, the emigration during 1996 was excluded from the analysis since adult return and marine survival data indicated that the emigration was likely underestimated. Further discussion on the removal of the 1996 data can be found in Edwards and Bouwens (2002). A simple regression model was developed to forecast the 2007 adult run using smolt emigration data. The regression relationship using total smolt outmigration and King Salmon air temperature was statistically significant and accounted for 83% of the total return. A strong relationship was revealed between the average King Salmon air temperature from April to December during the smolt outmigration year and smolt survival to adult (R^2=0.76). Integration of this information should result in a more accurate smolt based forecast of adult returns. The 2007 smolt-based forecast of 2.06 million sockeye salmon is approximately 139 thousand fish more than was forecasted using sibling and temperature regression relationships. The smolt forecast corroborates the sibling and temperature regression relationships. This forecasting method does not have the resolution to forecast by run because we cannot determine stock-of-origin of the smolt.

A smolt-based forecast was available for the first time in 2002. The sibling forecast over-forecasted the total run by about 7%, while the smolt forecast over-forecasted by about 31% in 2002 (Bouwens and Newland 2003). In 2003, the smolt forecast was more accurate; it under-forecasted the total run by about 9%, while the sibling forecast over-forecasted by about 30% (Bouwens and Newland 2004). In 2004, however, the smolt forecast overestimated the return by 45% (Finkle and Newland 2005). It should be noted that these were simple linear regression models and the relationship broke down with the relatively low 2004 return from a high smolt emigration estimate. A multiple regression smolt-based forecasting model was used for the first time to predict 2005 adult returns. This model underestimated the 2005 adult returns by 41% compared to the sibling-based forecast models, which overestimated the total adult returns by 9% (Finkle and Newland 2005). The multiple regression smolt forecast relationship for 2006 adult return estimates with a new variable (temperature) underestimated the total return by 45%. The multiple regression smolt forecast relationship for 2007 adult return estimates explains a high percent (67%) of the variability of the dependent variable as explained by the independent variable than past models. Because of the small data set and the past predictive ability of the model our confidence in the smolt-based forecast is fair.

Genetic samples collected from the outmigrating sockeye salmon smolt will provide a better understanding of ecological events in the watershed after they are processed and analyzed in the future.

Additionally, a presentation describing the sockeye salmon life cycle and the Chignik Sockeye Salmon Smolt project was given to students attending the Chignik Lake school on May 15. Informing young people on the value of the smolt project and community involvement is important to the education of future leaders so that the importance of the factors affecting the sustainability of this resource is recognized and it can remain sustainable.

Data from this project are essential for monitoring the health of sockeye salmon in Chignik River watershed. Smolt emigration information may be the only available means to link changes in run strength to freshwater or marine influences. As more data become available, the smolt-based forecast should provide a more accurate estimate of adult returns.

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TABLES AND FIGURES

Table 1.-Chignik River sockeye salmon smolt population estimates, by age class, 1994 to 2006.

Year		Number of Smolt							95% C.I.	
		Age-0	Age-1	Age-2	Age-3	Age-4	Total	S.E.	Lower	Upper
1994	Numbers	0	7,263,054	4,270,636	0	0	11,533,690	1,332,321	8,922,341	14,145,038
	Percent	0.0	63.0	37.0	0.0	0.0	100.0			
1995	Numbers	735,916	2,843,222	5,178,450	0	0	8,757,588	1,753,022	5,321,664	12,193,512
	Percent	8.4	32.5	59.1	0.0	0.0	100.0			
1996	Numbers	80,245	1,200,793	731,099	5,018	0	2,017,155	318,522	1,392,852	2,641,459
	Percent	4.0	59.5	36.2	0.2	0.0	100.0			
1997	Numbers	528,846	11,172,150	13,738,356	122,289	0	25,561,641	2,962,497	19,755,145	31,368,136
	Percent	2.1	43.7	53.7	0.5	0.0	100.0			
1998	Numbers	75,560	5,790,587	20,374,245	158,056	0	26,398,448	3,834,506	18,882,817	33,914,080
	Percent	0.3	21.9	77.2	0.6	0.0	100.0			
1999	Numbers	73,364	12,705,935	8,221,631	78,798	0	21,079,728	3,070,060	15,062,412	27,097,045
	Percent	0.3	60.3	39.0	0.4	0.0	100.0			
2000	Numbers	1,270,101	8,047,526	4,645,121	160,017	0	14,122,765	1,924,922	10,349,918	17,895,611
	Percent	9.0	57.0	32.9	1.1	0.0	100.0			
2001	Numbers	521,546	18,940,752	5,024,666	516,723	5,671	25,009,358	5,042,604	15,125,854	34,892,862
	Percent	2.1	75.7	20.1	2.1	0.0	100.0			
2002	Numbers	440,947	13,980,423	2,223,996	72,184	0	16,717,551	2,112,220	12,577,007	20,856,909
	Percent	2.6	83.6	13.3	0.4	0.0	100.0			
2003	Numbers	155,047	5,146,278	1,449,494	0	0	6,750,819	527,041	5,717,820	7,783,819
	Percent	2.3	76.2	21.5	0.0	0.0	100.0			
2004	Numbers	244,206	6,172,902	2,239,716	0	0	8,656,824	1,219,278	6,267,039	11,046,609
	Percent	2.8	71.3	25.9	0.0	0.0	100.0			
2005	Numbers	859,211	2,075,681	1,468,208	32,889	0	4,435,988	1,034,892	2,407,600	6,464,376
	Percent	19.4	46.8	33.1	0.7	0.0	100.0			
2006	Numbers	1,744,370	2,849,043	2,847,624	119,614	0	7,560,651	2,280,536	3,090,799	12,030,502
	Percent	23.1	37.7	37.7	1.6	0.0	100.0			

Table 2.-Estimated sockeye salmon smolt emigration from the Chignik River, by age class and statistical week, 2006.

Statistical Week	Starting Date	Number of Smolt				
		Age-0	Age-1	Age-2	Age-3	Total
18	4/26	19,242	38,483	76,966	19,242	153,932
19	5/3	28,995	64,094	90,037	0	183,126
20	5/10	44,075	100,947	88,151	5,687	238,860
21	5/17	644,825	1,018,144	1,408,433	16,969	3,088,371
22	5/24	339,272	437,969	252,912	0	1,030,153
23	5/31	360,597	476,721	305,591	6,112	1,149,020
24	6/7	84,263	165,892	223,823	52,664	526,642
25	6/14	68,186	321,989	340,930	18,941	750,046
26	6/21	113,257	198,664	55,700	0	367,621
27	6/28	38,690	15,997	4,092	0	58,779
28	7/5	2,968	10,142	989	0	14,100
Total		1,744,370	2,849,043	2,847,624	119,614	7,560,651

Table 3.-Results from mark-recapture tests performed on sockeye salmon smolt migrating through the Chignik River, 2006.

Date	No. Marked	Total Recaptures	Trap Efficiency[a]
5/23	2,653	2	0.11%
5/27	707	17	2.54%
5/31	2,288	12	0.57%
6/7	1,401	10	0.78%
6/15	1,781	6	0.39%
6/27	704	7	1.13%
Total	9,534	54	0.58%

[a] Calculated by: = {(R+1)/(M+1)}*100 where: R = number of marked fish recaptured, and M = number of marked fish (Carlson et al. 1998).

Table 4.-Estimated age composition of Chignik Lake sockeye salmon smolt samples, by week, 2006.

Stat Week	Sample Size		Number of Smolt Age 0	Age 1	Age 2	Age 3	Total
18	8	Percent	12.5	25.0	50.0	12.5	100.0
		Numbers	1	2	4	1	8
19	120	Percent	15.8	35.0	49.2	0.0	100.0
		Numbers	19	42	59	0	120
20	168	Percent	18.5	42.3	36.9	2.4	100.0
		Numbers	31	71	62	4	168
21	182	Percent	20.9	33.0	45.6	0.5	100.0
		Numbers	38	60	83	1	182
22	167	Percent	32.9	42.5	24.6	0.0	100.0
		Numbers	55	71	41	0	167
23	188	Percent	31.4	41.5	26.6	0.5	100.0
		Numbers	59	78	50	1	188
24	200	Percent	16.0	31.5	42.5	10.0	100.0
		Numbers	32	63	85	20	200
25	198	Percent	9.1	42.9	45.5	2.5	100.0
		Numbers	18	85	90	5	198
26	198	Percent	30.8	54.0	15.2	0.0	100.0
		Numbers	61	107	30	0	198
27	158	Percent	65.8	27.2	7.0	0.0	100.0
		Numbers	104	43	11	0	158
28	57	Percent	21.1	71.9	7.0	0.0	100.0
		Numbers	12	41	4	0	57
Total	1,644	Percent	26.2	40.3	31.6	1.9	100
		Numbers	430	663	519	32	1,644

Table 5.-Length, weight, and condition factor of Chignik River sockeye salmon smolt samples, by age and statistical week, 2006.

				Length (mm)		Weight (g)		Condition Factor	
Age	Stat Week	Starting Date	Sample Size	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
0	18	4/26	1	50	0.00	0.8	0.00	0.64	0.00
0	19	5/3	19	52	0.88	1.0	0.05	0.71	0.03
0	20	5/10	31	52	0.70	0.9	0.04	0.66	0.02
0	21	5/17	38	53	0.76	0.9	0.05	0.61	0.01
0	22	5/24	54	49	0.54	0.7	0.03	0.61	0.02
0	23	5/31	57	51	0.53	0.9	0.03	0.63	0.01
0	24	6/7	32	50	0.72	0.9	0.04	0.67	0.02
0	25	6/14	18	57	1.25	1.6	0.11	0.86	0.03
0	26	6/21	61	53	0.59	1.2	0.05	0.76	0.02
0	27	6/28	104	54	0.51	1.2	0.04	0.77	0.01
0	28	7/5	12	56	0.98	1.3	0.06	0.75	0.03
Total			427	52	0.24	1.0	0.02	0.70	0.01
1	18	4/26	2	73	7.50	2.8	0.80	0.72	0.01
1	19	5/3	42	71	0.93	2.6	0.09	0.74	0.01
1	20	5/10	71	69	1.02	2.5	0.11	0.74	0.01
1	21	5/17	60	69	0.89	2.5	0.10	0.72	0.01
1	22	5/24	71	63	1.13	1.8	0.12	0.67	0.01
1	23	5/31	77	66	0.78	2.0	0.08	0.69	0.01
1	24	6/7	63	68	0.95	2.6	0.12	0.80	0.01
1	25	6/14	85	70	0.58	2.8	0.08	0.83	0.01
1	26	6/21	107	68	0.53	2.5	0.07	0.80	0.01
1	27	6/28	43	68	1.00	2.6	0.12	0.80	0.01
1	28	7/5	41	67	0.85	2.3	0.09	0.76	0.01
Total			662	68	0.28	2.4	0.03	0.76	0.00
2	18	4/26	4	86	4.63	4.5	0.59	0.72	0.03
2	19	5/3	59	79	0.82	3.7	0.12	0.74	0.01
2	20	5/10	62	79	0.89	3.9	0.15	0.76	0.01
2	21	5/17	83	78	0.67	3.6	0.11	0.73	0.01
2	22	5/24	41	74	1.01	3.1	0.15	0.73	0.01
2	23	5/31	50	72	0.71	2.7	0.09	0.72	0.01
2	24	6/7	85	81	1.38	5.0	0.35	0.84	0.01
2	25	6/14	90	76	0.48	3.6	0.07	0.81	0.01
2	26	6/21	30	77	1.17	3.9	0.26	0.83	0.01
2	27	6/28	10	78	2.17	3.9	0.33	0.80	0.02
2	28	7/5	4	83	5.40	5.4	1.39	0.88	0.03
Total			518	78	0.35	3.8	0.08	0.78	0.00
3	18	4/26	1	78	0	3.3	0	0.70	0.00
3	20	5/10	4	88	5.48	5.4	1.07	0.77	0.03
3	21	5/17	1	92	0	5.4	0	0.69	0.00
3	23	5/31	1	98	0	9.7	0	1.03	0.00
3	24	6/7	20	104	0.88	10.6	0.29	0.94	0.01
3	25	6/14	5	90	6.71	6.7	1.92	0.82	0.08
Total			32	99	1.89	8.9	0.55	0.89	0.02

Table 6.-Chignik River sockeye salmon escapement, estimated number of smolt by freshwater age, smolt per spawner, adult return by freshwater age, return per spawner, marine survival, by brood year, 1991 to 2006.

Brood Year	Escapement	Smolt Produced					Total smolt	Smolt / spawner	Adult Returns						Return / spawner	Marine Survival
		Age-0	Age-1	Age-2	Age-3	Age-4			Age 0.	Age 1.	Age 2.[a]	Age 3.	Other	Total		
1991	1,040,098	NA	NA	4,270,636	0	0	4,270,636	4.11	3,570	1,708,052	718,400	10,806	4,577	2,445,407	2.35	NA
1992	764,436	NA	7,263,054	5,178,450	5,018	0	12,446,522	16.28	138,761	649,860	1,100,542	93,435	982	1,983,580	2.59	16%
1993	697,377	0	2,843,222	731,099	122,289	0	3,696,610	5.30	17,489	404,651	2,000,010	7,675	155	2,429,982	3.48	66%
1994	966,909	735,916	1,200,793	13,738,356	158,056	0	15,833,121	16.37	313	1,806,184	1,445,783	2,320	793	3,255,393	3.37	21%
1995	739,920	80,254	11,172,150	20,374,245	78,798	0	31,705,447	42.85	38,229	2,435,328	968,403	18,148	724	3,460,823	4.68	11%
1996	749,137	528,846	5,790,587	8,221,631	160,017	5,671	14,706,752	19.63	128,029	1,954,243	865,346	14,443	0	2,962,061	3.95	20%
1997	775,618	75,560	12,705,935	4,645,121	516,723	0	17,943,339	23.13	14,543	792,029	984,554	5,408	0	1,796,534	2.32	10%
1998	701,128	73,364	8,047,526	5,024,666	72,184	0	13,217,740	18.85	5,786	1,116,404	354,245	1,052	218	1,477,706	2.11	11%
1999	715,966	1,270,101	18,940,752	2,223,996	0	0	22,434,849	31.34	29,193	923,252	403,493	1,663	0	1,357,601	1.90	6%
2000	805,225	521,546	13,980,423	1,449,494	0	0	15,951,463	19.81	15,340	1,988,351	684,538	0	0	2,688,229	3.34	17%
2001	1,136,918	440,947	5,146,278	2,239,716	32,889	0	7,859,830	6.91								
2002	725,220	155,047	6,172,902	1,468,208	119,614		8,640,991									
2003	684,145	244,206	2,075,681	2,847,624			5,851,656									
2004	578,259	859,211	2,849,043													
2005	581,382	1,744,370														
2006	735,493															

[a] Minor age classes are not fully recruited for adult age-2, -3, and from other returns brood year 2000.

Table 7.-Estimated marine survival of sockeye salmon smolt from the Chignik River by emigration year and ocean age adult returns for each emigration year from 1994 to 2006.

Emigration	Smolt estimates					Adult returns					Marine
Year	Age-0	Age-1	Age-2	Age-3	Total	Age x.1	Age x.2	Age x.3	Age x.4	Total	Survival
1994	0	7,263,054	4,270,636	0	11,533,690	3,492	216,654	1,180,531	9,174	1,409,850	12%
1995	735,916	2,843,222	5,178,450	0	8,757,588	23,193	335,462	1,153,544	4,113	1,516,312	17%
1996	80,245	1,200,793	731,099	5,018	2,017,155	20,762	652,836	3,244,567	19,693	3,937,858	195%
1997	528,846	11,172,150	13,738,356	122,289	25,561,641	10,875	1,211,951	2,780,125	13,865	4,016,815	16%
1998	75,560	5,790,587	20,374,245	158,056	26,398,448	622	156,444	2,749,174	33,270	2,939,510	11%
1999	73,364	12,705,935	8,221,631	78,798	21,079,728	260	145,459	1,525,671	9,919	1,681,309	8%
2000	1,270,101	8,047,526	4,645,121	160,017	14,122,765	5,106	415,338	1,718,912	5,237	2,144,594	15%
2001	521,546	18,940,752	5,024,666	516,723	25,003,687	283	243,377	1,051,601	2,985	1,298,246	5%
2002	440,947	13,980,423	2,223,996	72,184	16,717,551	4,072	432,476	2,013,710	22,265	2,472,523	15%
2003	155,047	5,146,278	1,449,494	0	6,750,819	2,282	158,558	1,540,697		1,701,538	25%
2004	244,206	6,172,902	2,239,716	0	8,656,824	1,316	178,278				
2005	859,211	2,075,681	1,468,208	32,889	4,435,988	804					
2006	1,744,370	2,849,043	2,847,624	119,614	7,560,651						
1994-2003 Average (Excluding 1996)											14%

Table 8.-Mean length, weight, and condition factor of sockeye salmon smolt samples from the Chignik River, by year and age, 1994 to 2006.

		Length (mm)			Weight (g)			Condition Factor		
Year	Age	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
1995	0	272	46	0.18	272	0.7	0.01	272	0.74	0.01
1996	0	125	49	0.45	113	1.0	0.03	113	0.82	0.01
1997	0	195	46	0.22	195	0.8	0.01	195	0.83	0.01
1998	0	15	45	0.96	15	0.7	0.03	15	0.73	0.03
1999	0	40	52	0.79	40	1.3	0.06	40	0.97	0.03
2000	0	223	60	0.52	223	2.1	0.05	223	0.91	0.01
2001	0	96	56	0.51	96	1.5	0.04	96	0.88	0.01
2002	0	217	49	0.27	217	1.2	0.02	217	0.98	0.01
2003	0	149	56	0.53	149	1.5	0.05	149	0.79	0.01
2004	0	347	56	0.44	347	1.7	0.05	347	0.91	0.01
2005	0	652	56	0.28	649	1.5	0.03	649	0.83	0.01
2006	0	427	52	0.24	427	1.0	0.02	427	0.70	0.01
1994	1	1,715	67	0.16	1,706	2.3	0.02	1,706	0.75	0.00
1995	1	1,272	60	0.34	1,272	2.0	0.04	1,272	0.82	0.00
1996	1	1,423	68	0.29	1,356	2.7	0.04	1,356	0.81	0.00
1997	1	1,673	63	0.35	1,673	2.4	0.04	1,673	0.81	0.00
1998	1	785	69	0.38	780	2.7	0.06	780	0.78	0.01
1999	1	1,344	77	0.17	1,344	4.1	0.03	1,344	0.89	0.00
2000	1	1,175	72	0.22	1,175	3.3	0.04	1,175	0.86	0.00
2001	1	1,647	65	0.13	1,647	2.1	0.02	1,647	0.76	0.00
2002	1	1,588	65	0.18	1,588	2.3	0.02	1,588	0.83	0.00
2003	1	1,665	65	0.11	1,665	2.1	0.01	1,665	0.75	0.00
2004	1	1,030	69	0.20	1,030	2.8	0.03	1,030	0.83	0.00
2005	1	892	69	0.25	892	2.7	0.03	892	0.81	0.00
2006	1	662	68	0.28	662	2.4	0.03	662	0.76	0.00
1994	2	1,091	77	0.22	1,068	3.6	0.04	1,068	0.74	0.00
1995	2	1,008	75	0.23	1,008	3.5	0.04	1,008	0.80	0.00
1996	2	548	80	0.34	533	4.2	0.06	533	0.81	0.00
1997	2	772	83	0.25	772	4.7	0.05	772	0.80	0.00
1998	2	1,925	72	0.13	1,881	3.0	0.03	1,881	0.76	0.00
1999	2	784	81	0.28	784	4.8	0.07	784	0.89	0.00
2000	2	503	76	0.34	503	3.6	0.07	503	0.80	0.00
2001	2	389	75	0.45	387	3.4	0.09	387	0.77	0.01
2002	2	225	80	0.78	225	4.9	0.18	225	0.88	0.01
2003	2	279	76	0.48	279	3.5	0.09	279	0.76	0.01
2004	2	274	77	0.41	274	3.9	0.09	274	0.82	0.00
2005	2	397	76	0.33	397	3.5	0.06	397	0.79	0.00
2006	2	518	78	0.35	518	3.8	0.08	518	0.78	0.00
1996	3	3	100	5.55	3	8.4	1.68	3	0.81	0.06
1997	3	12	87	1.34	12	5.2	0.35	12	0.77	0.02
1998	3	20	84	3.39	19	5.5	0.99	19	0.81	0.02
1999	3	7	90	5.76	7	6.8	1.66	7	0.85	0.03
2000	3	14	86	2.36	14	5.3	0.63	14	0.79	0.01
2001	3	62	90	1.60	61	6.9	0.42	61	0.86	0.01
2002	3	6	110	7.24	6	13.8	2.67	6	1.00	0.03
2005	3	7	108	4.35	7	11.4	1.21	7	0.89	0.02
2006	3	32	99	1.89	32	8.9	0.55	32	0.89	0.02
2001	4	1	125	-	1	18.8	-	1	0.96	-

Table 9.-Estimated age composition of Chignik River sockeye salmon smolt samples, 1994 to 2006.

Year	Dates	Sample Size		Number of Smolt Age 0	Age 1	Age 2	Age 3	Age 4	Total
1994	5/06-6/30	2,806	Percent	0.0	61.1	38.9	0.0	0.0	100.0
			Numbers	0	1,715	1,091	0	0	2,806
1995	5/06-6/29	2,557	Percent	10.7	49.8	39.5	0.0	0.0	100.0
			Numbers	273	1,274	1,010	0	0	2,557
1996	5/06-7/28	2,099	Percent	6.0	67.8	26.1	0.1	0.0	100.0
			Numbers	125	1,423	548	3	0	2,099
1997	5/04-7/22	2,657	Percent	7.3	63.1	29.1	0.5	0.0	100.0
			Numbers	195	1,676	774	12	0	2,657
1998	5/02-7/30	2,745	Percent	0.5	28.6	70.1	0.7	0.0	100.0
			Numbers	15	785	1,925	20	0	2,745
1999	5/10-7/03	2,180	Percent	1.8	61.7	36.1	0.3	0.0	100.0
			Numbers	40	1,345	788	7	0	2,180
2000	4/22-7/20	1,915	Percent	11.6	61.4	26.3	0.7	0.0	100.0
			Numbers	223	1,175	503	14	0	1,915
2001	4/29-7/12	2,195	Percent	4.4	75.0	17.7	2.8	0.0	100.0
			Numbers	96	1,647	389	62	1	2,195
2002	5/01-7/08	2,038	Percent	10.6	77.9	11.1	0.3	0.0	100.0
			Numbers	217	1,588	227	6	0	2,038
2003	4/25-7/08	2,098	Percent	7.1	79.6	13.3	0.0	0.0	100.0
			Numbers	149	1,670	279	0	0	2,098
2004	5/6-7/1	1,651	Percent	21.0	62.4	16.6	0.0	0.0	100.0
			Numbers	347	1,030	274	0	0	1,651
2005	4/26-7/8	1,950	Percent	33.5	45.7	20.4	0.4	0.0	100.0
			Numbers	654	892	397	7	0	1,950
2006	4/27-7/9	1,644	Percent	26.2	40.3	31.6	1.9	0.0	100.0
			Numbers	430	663	519	32	0	1,644

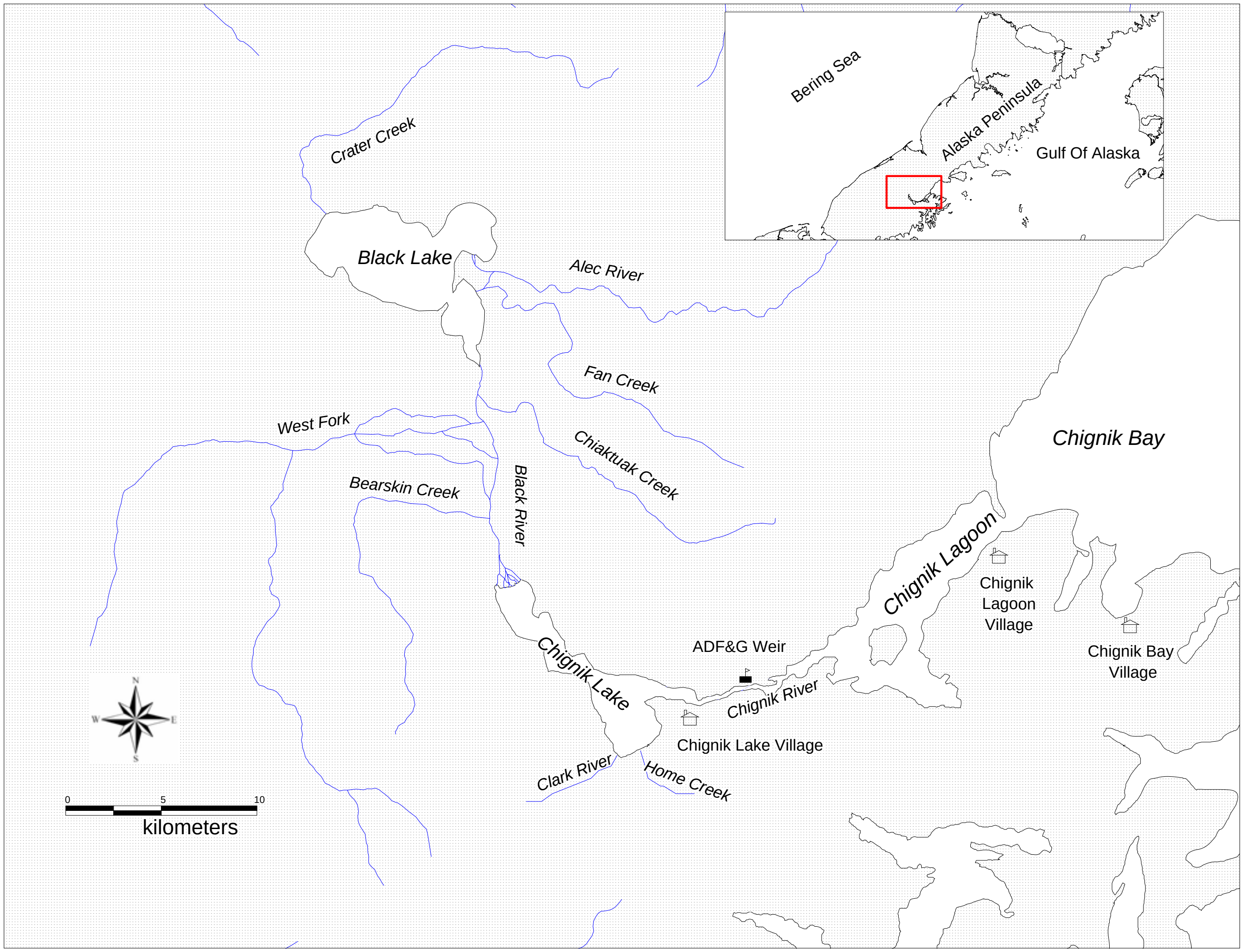

Figure 1.-Map of the Chignik River watershed.

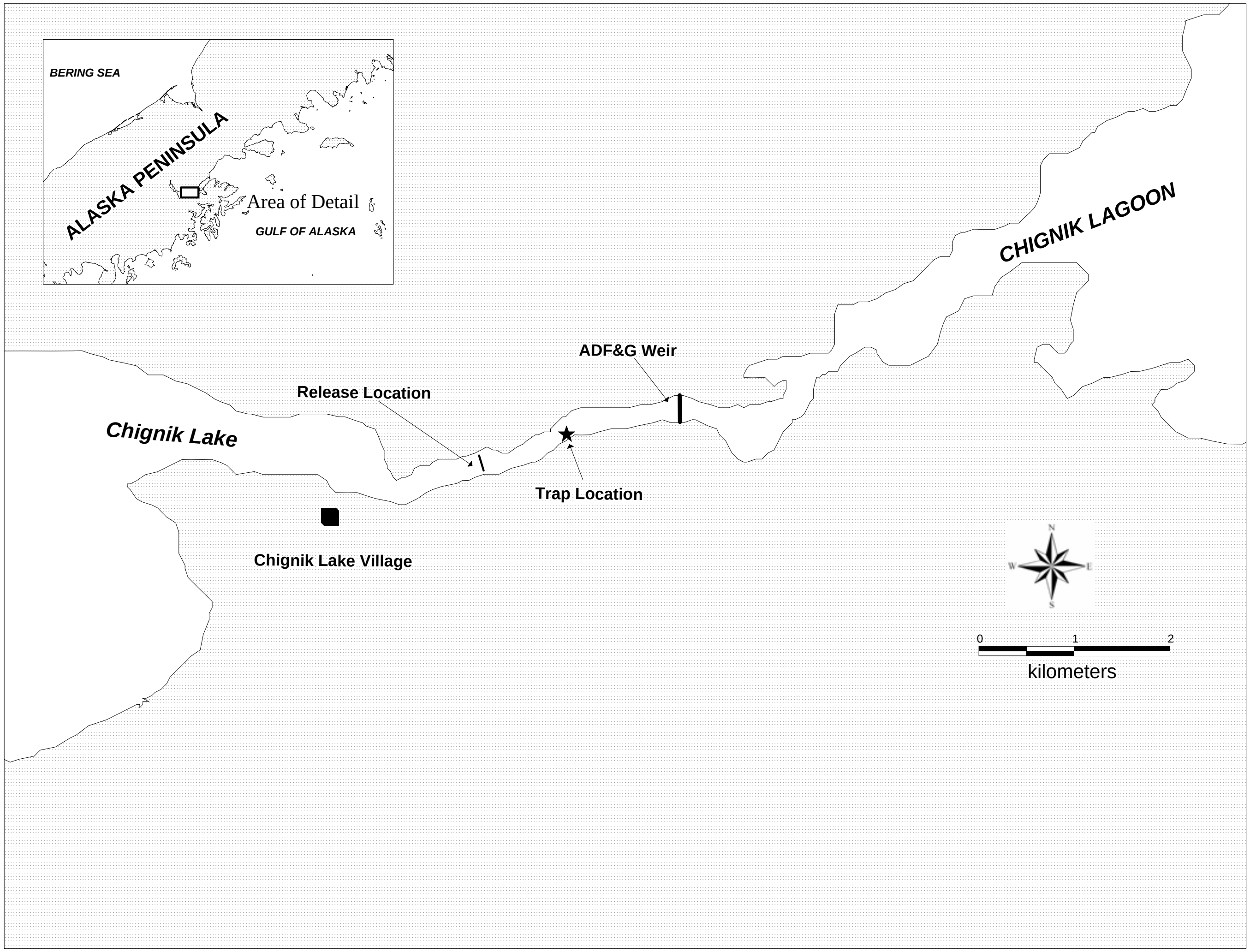

Figure 2.-Location of the traps and the release site of marked smolt in the Chignik River, Alaska, 2006.

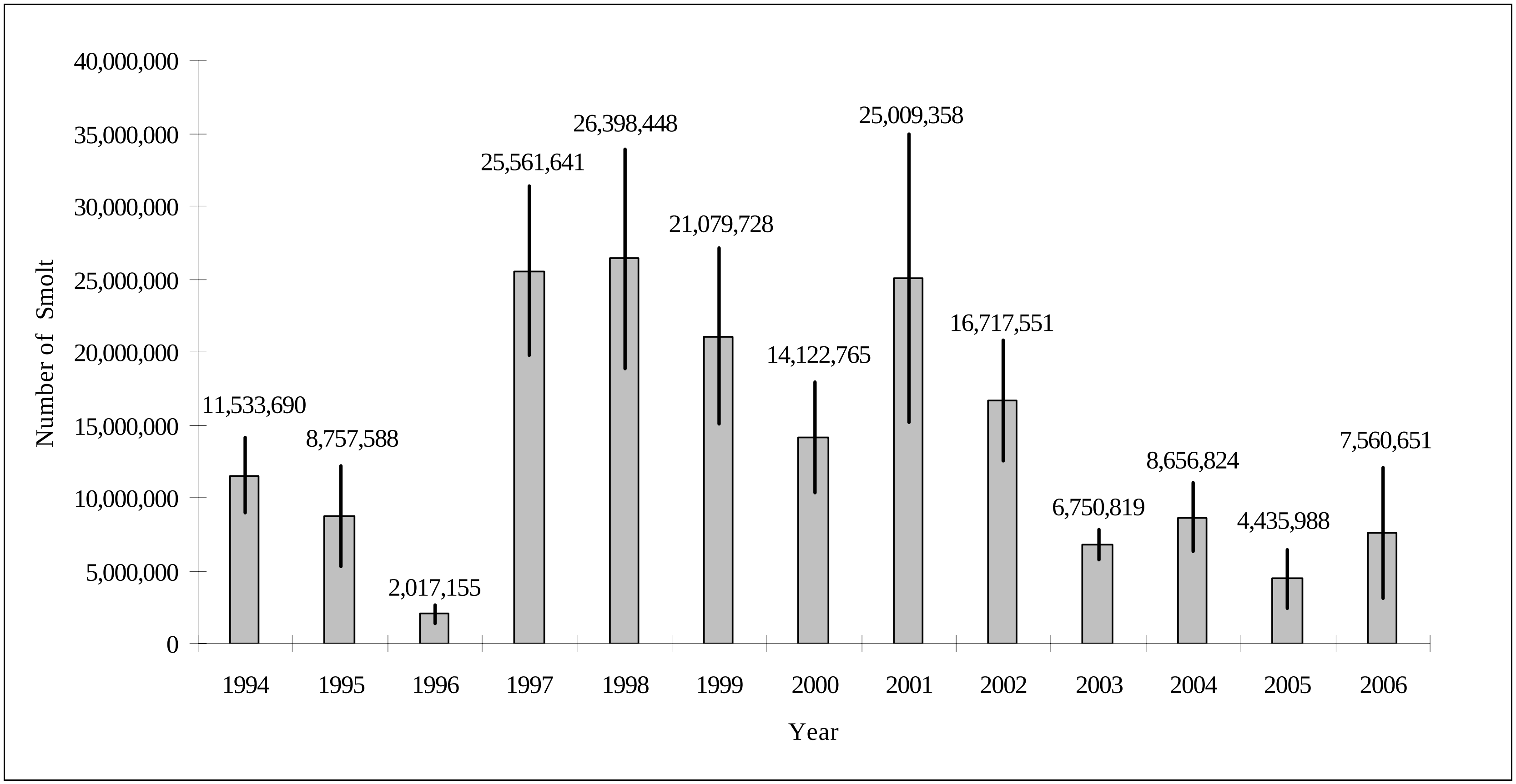

Figure 3.-Annual Chignik River sockeye salmon smolt emigration estimates and corresponding 95% confidence intervals, 1994 to 2006.

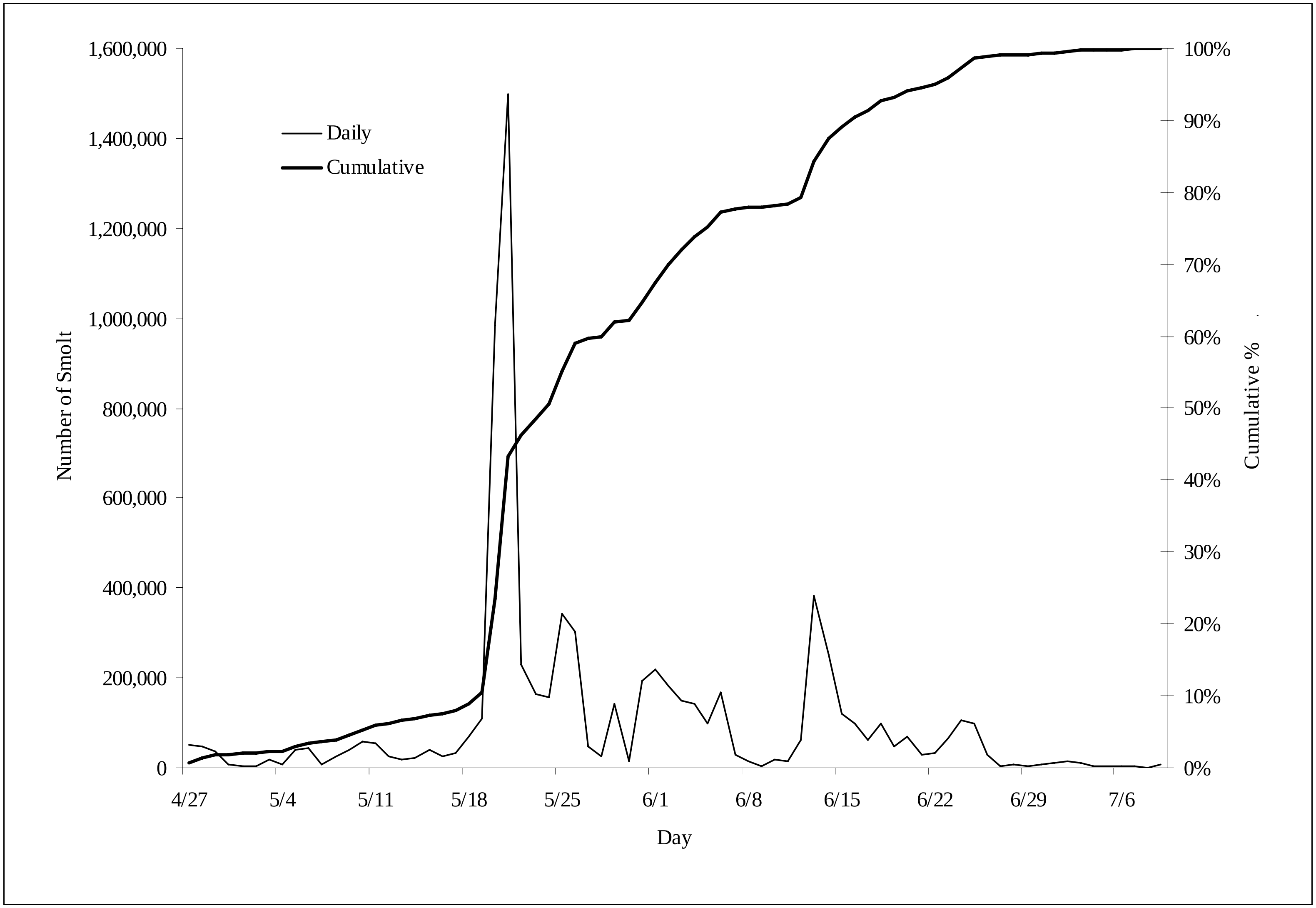

Figure 4.-Estimated daily and corresponding cumulative percentage of the sockeye salmon smolt emigration from the Chignik River, 2006.

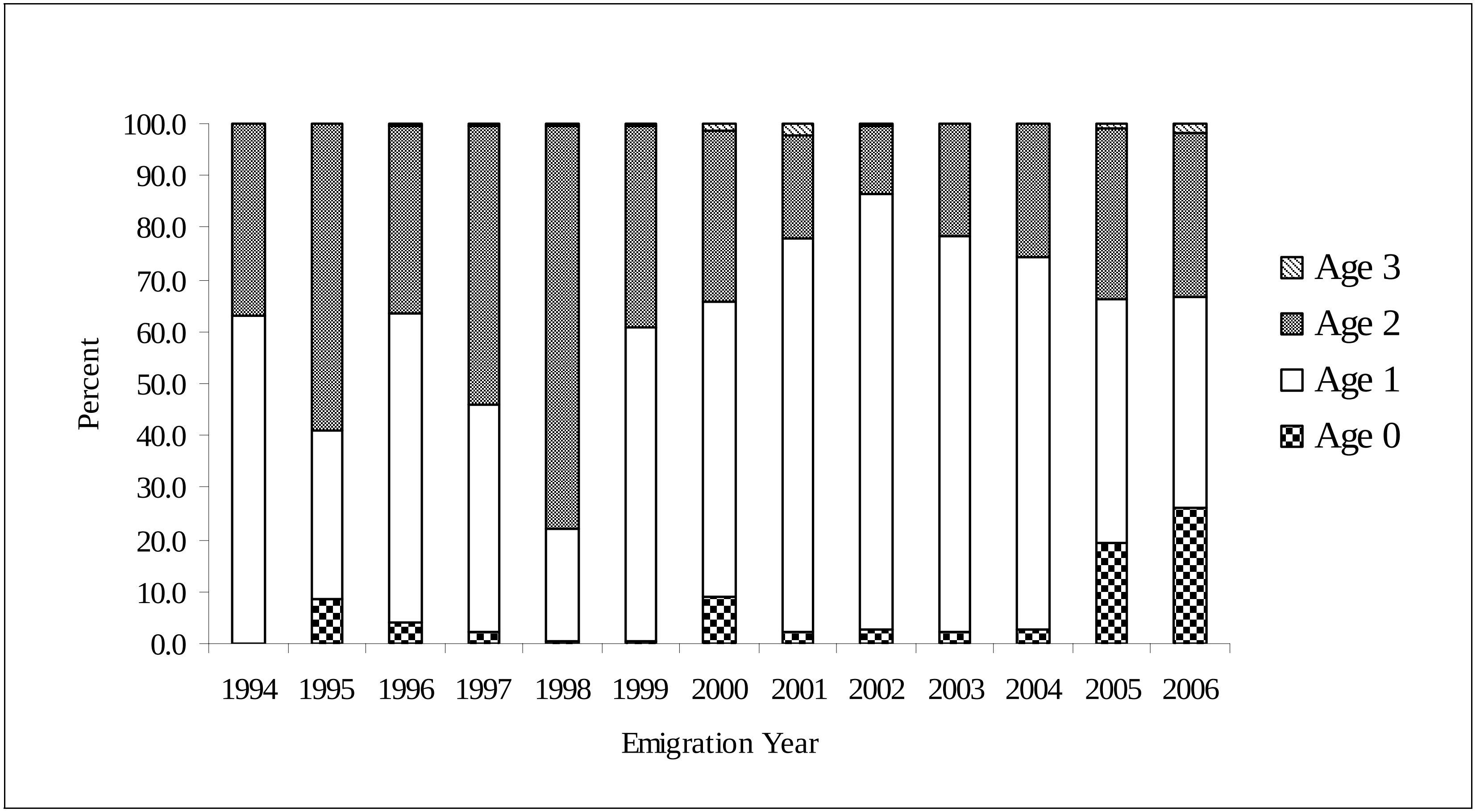

Figure 5.-A comparison of the estimated age structure of age-0 to age -3 sockeye salmon smolt emigrations from the Chignik River, 1994 to 2006.

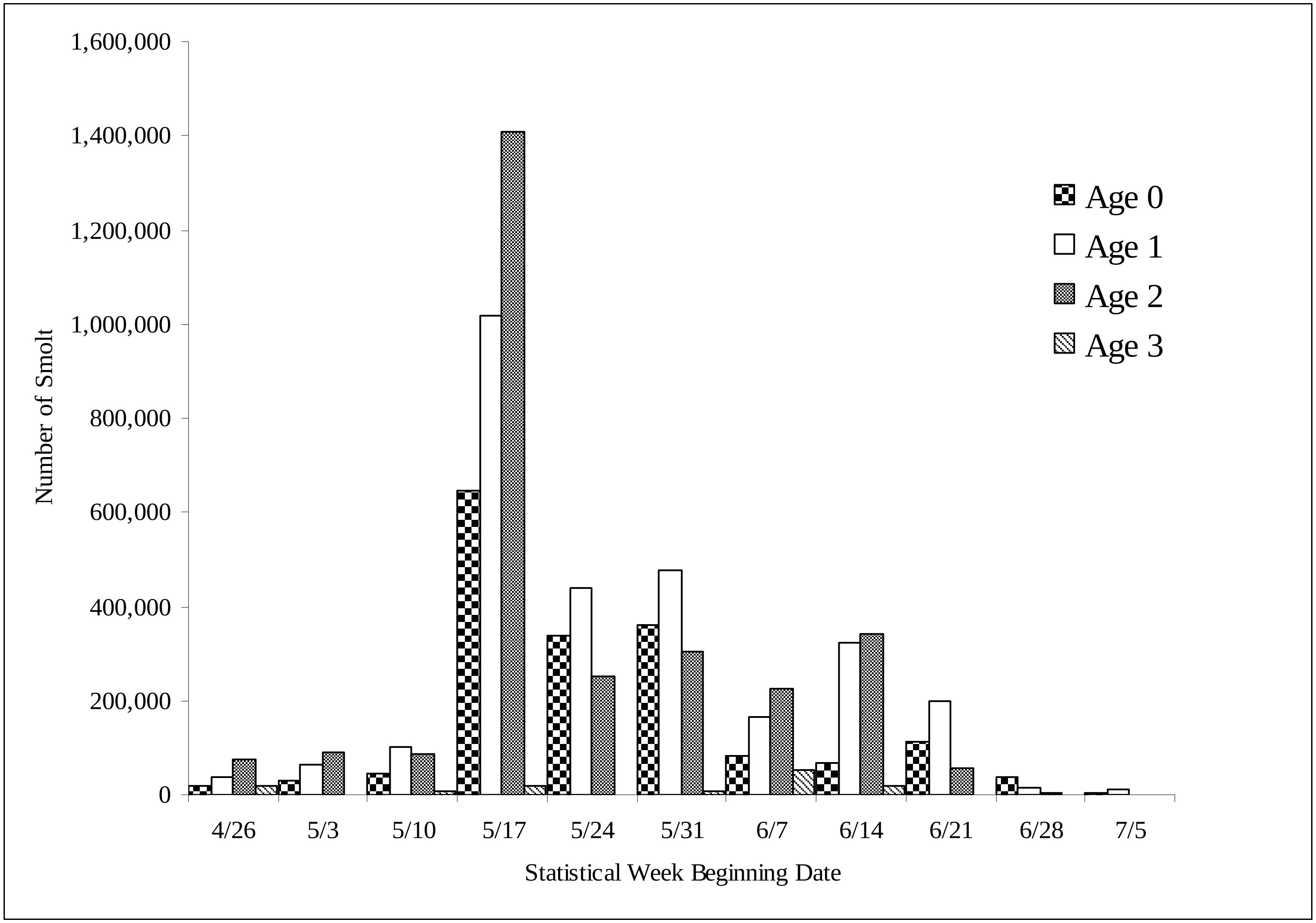

Figure 6.-Estimated smolt emigration of age-0 to age-3 sockeye salmon smolt, by statistical week beginning date, from the Chignik River, 2006.

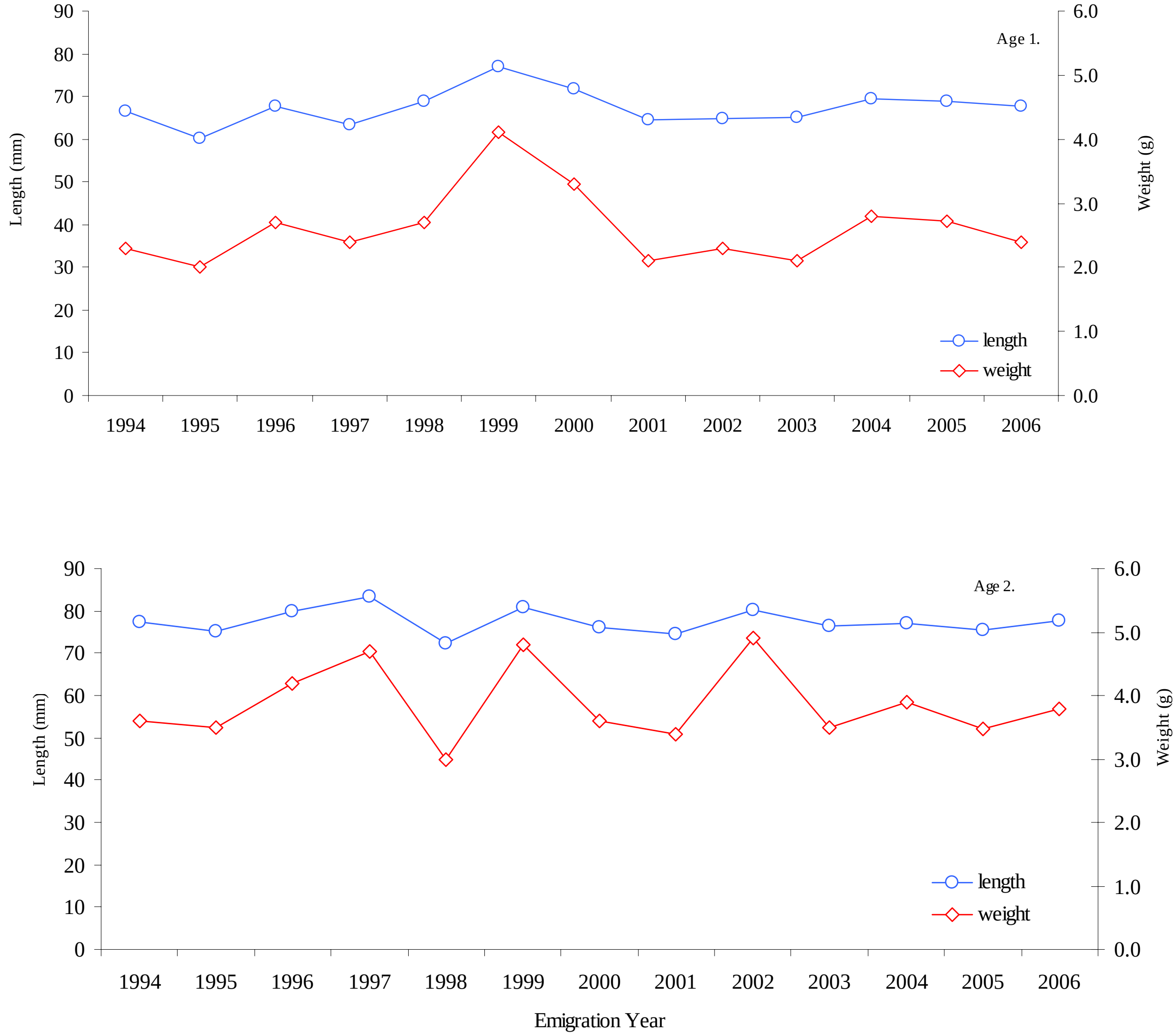

Figure 7.-Average length and weight of age-1 and age-2 sockeye salmon, by year, 1994 through 2006.

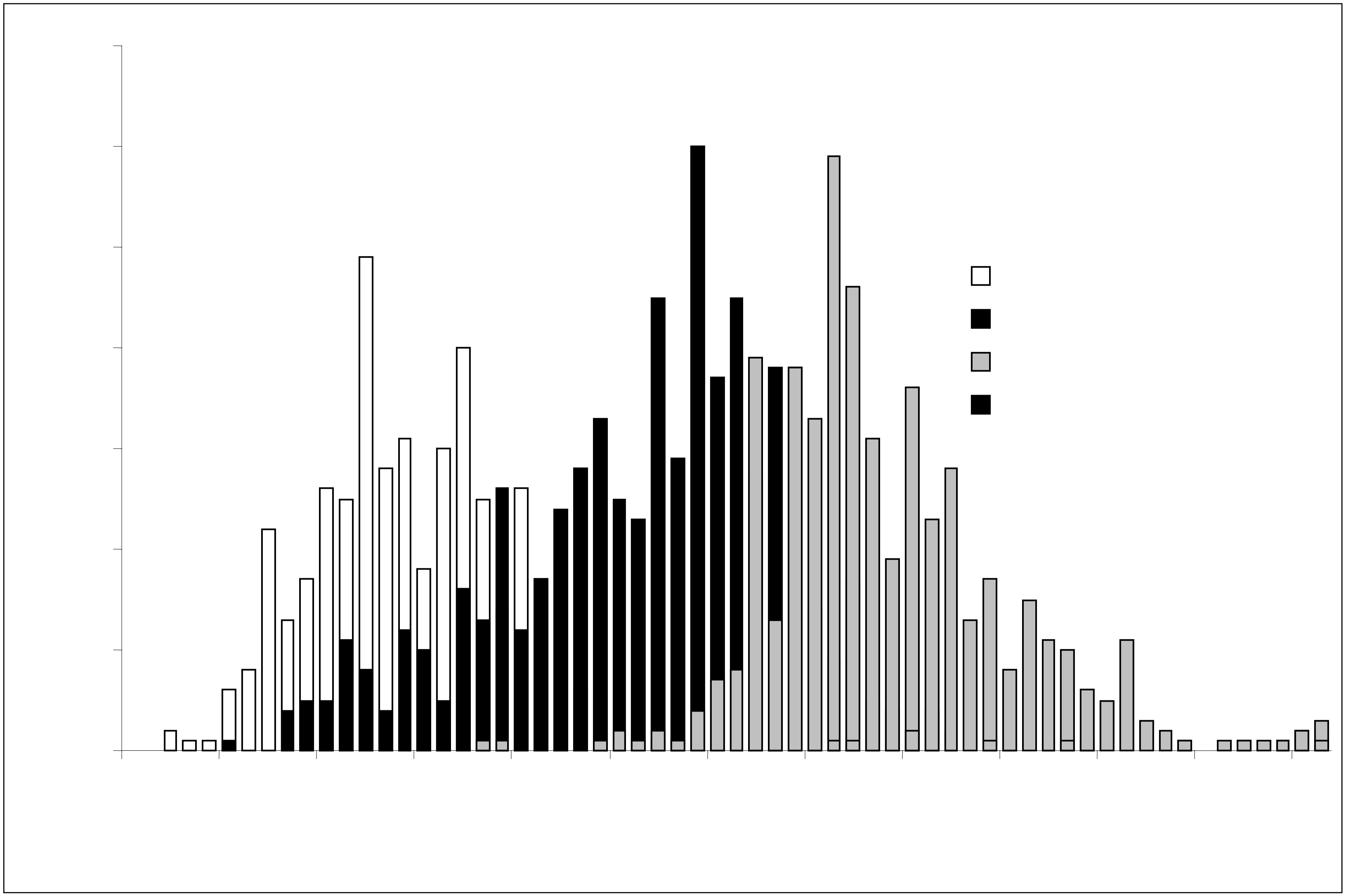

Figure 8.-Length frequency histogram of sockeye salmon smolt, by age sampled from the Chignik River, 2006.

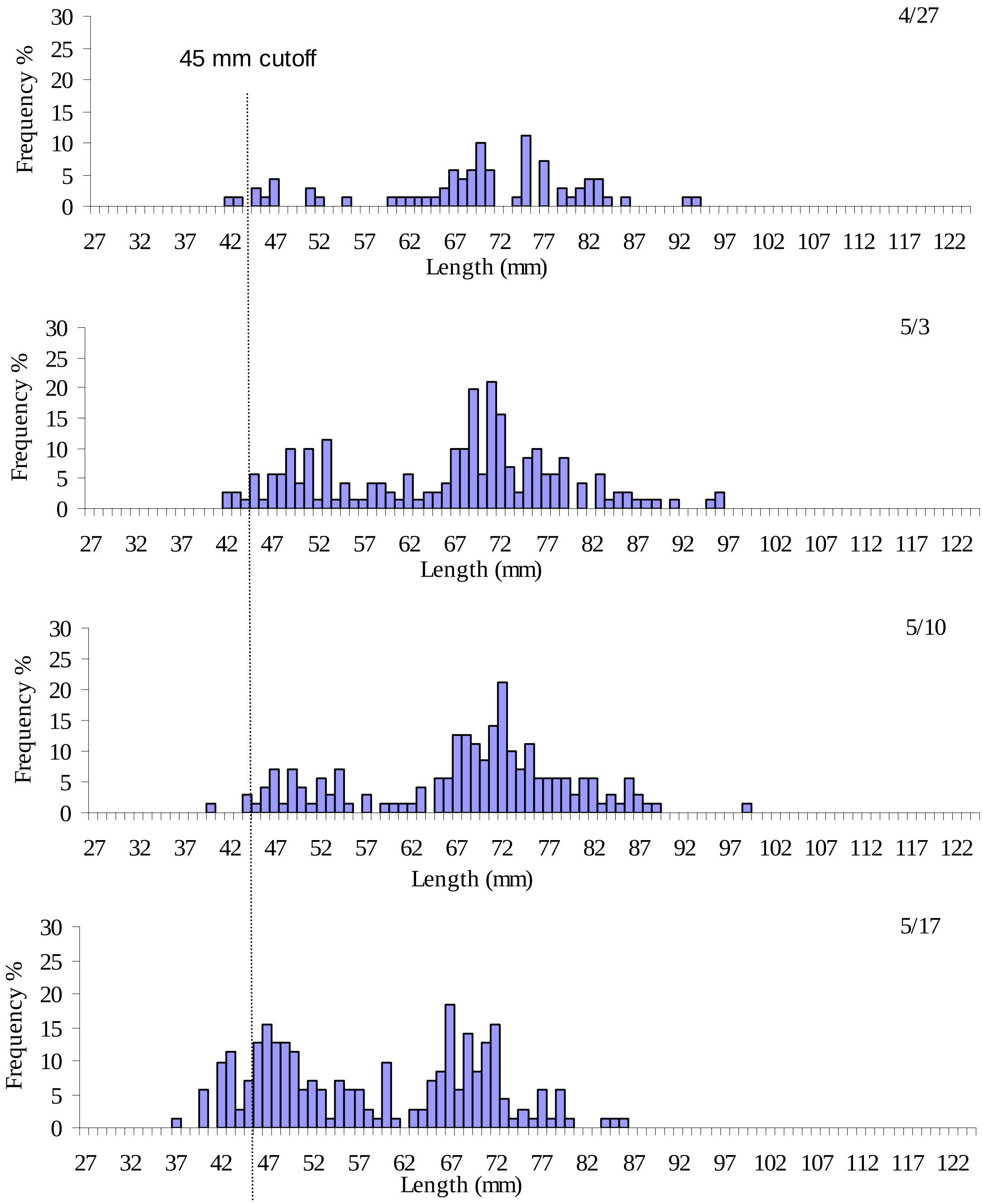

Figure 9.-Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps from April 27 to May 23, 2006.

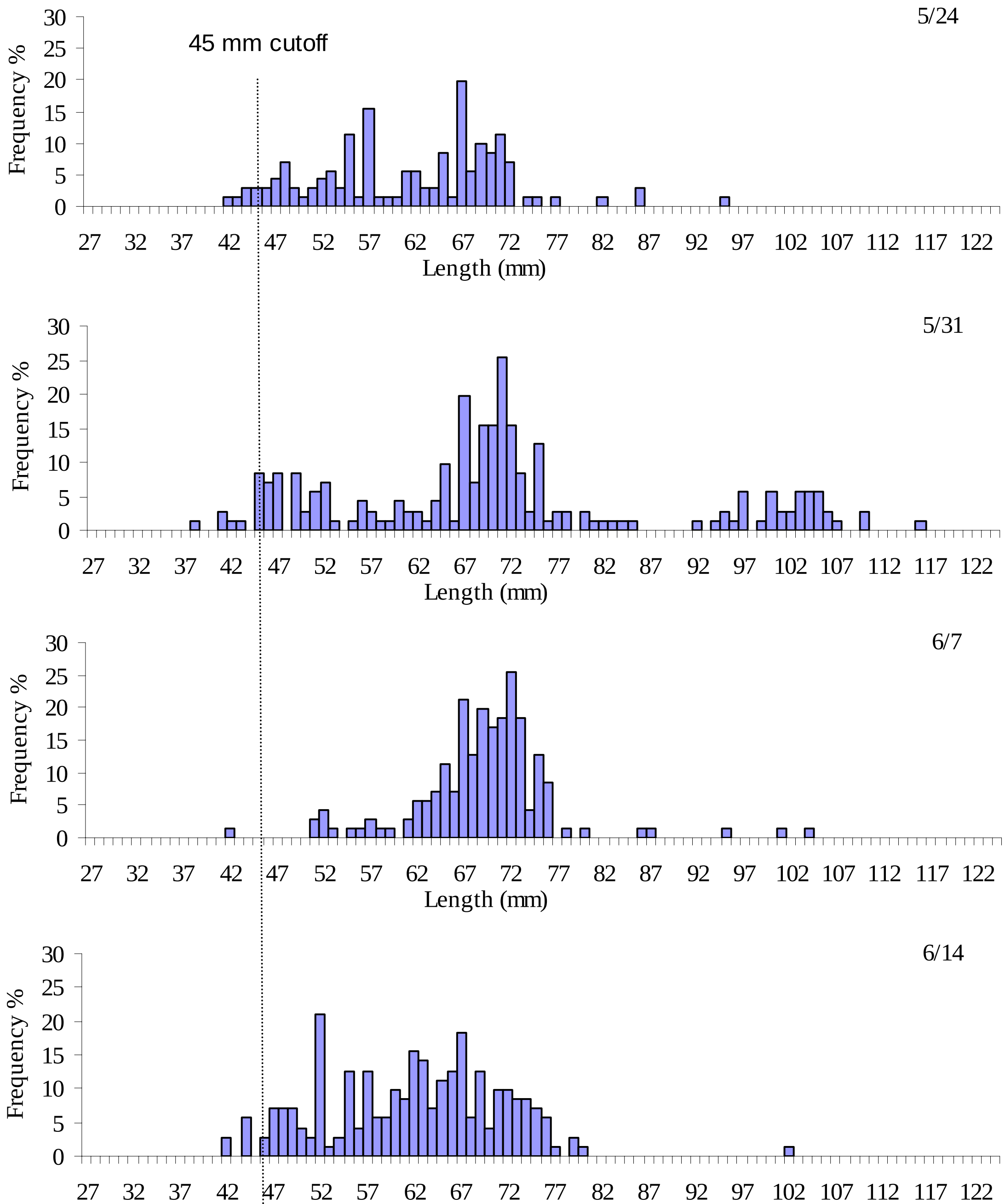

Figure 10.-Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps from May 24 to June 20, 2006.

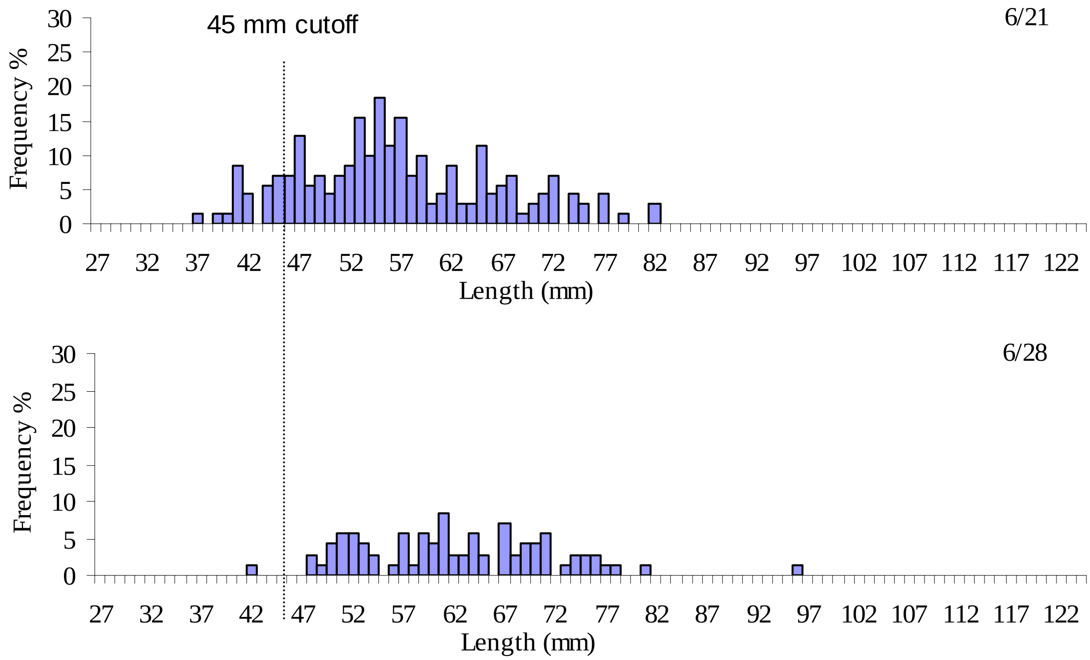

Figure 11.-Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps from June 21 to July 7, 2006.

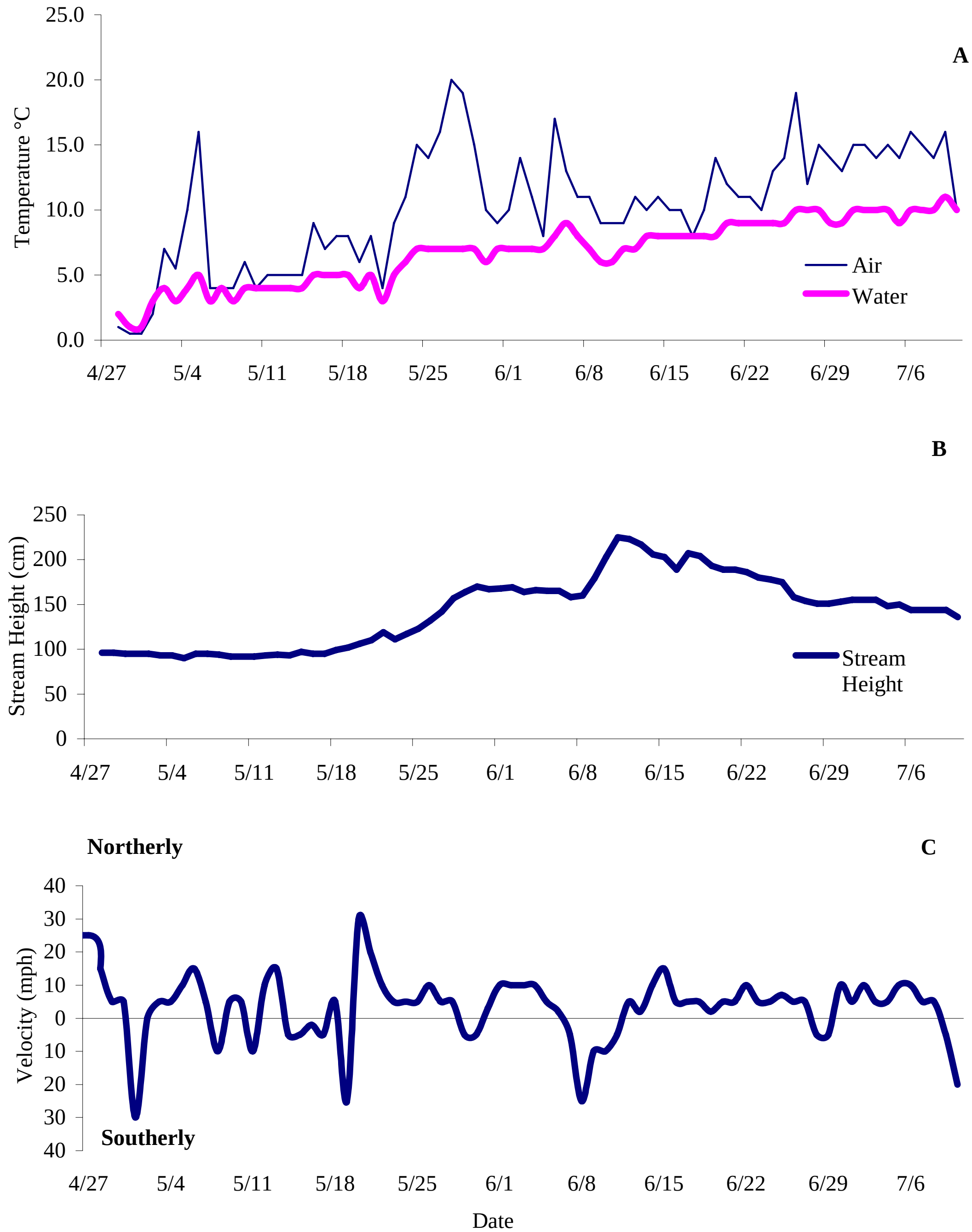

Figure 12.-Air and water temperature (A), stream gauge height (B), and wind velocity and direction data (C) gathered at the Chignik River smolt traps, 2006.

APPENDIX A. SMOLT TRAP CATCHES BY DAY

Appendix A1.-Actual daily counts and trap efficiency data of the Chignik River sockeye salmon smolt project, 2006.

	Actual Sockeye Smolt		Trap Efficiency Test				Incidental Catch[a]										
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	Chnk	DV	SB	SC	SF	PS	PW	ISO
4/27	59	59				0.11%	394	25	0	0	1	206	0	0	0	0	0
4/28	54	113				0.11%	130	23	3	0	0	144	2	0	0	0	0
4/29	43	156				0.11%	22	4	0	0	0	169	0	0	0	0	0
4/30	7	163				0.11%	30	0	0	0	0	122	0	0	0	0	0
5/1	6	169				0.11%	38	4	5	0	0	171	0	0	0	0	0
5/2	5	174				0.11%	29	3	1	0	0	91	0	0	0	0	0
5/3	21	195				0.11%	46	10	0	0	0	150	0	0	2	0	0
5/4	8	203				0.11%	18	1	0	0	0	166	0	0	2	0	0
5/5	46	249				0.11%	189	13	0	0	2	220	2	0	1	0	0
5/6	49	298				0.11%	251	12	0	0	1	307	0	0	5	0	0
5/7	8	306				0.11%	70	0	0	0	1	184	0	0	0	0	0
5/8	28	334				0.11%	89	8	3	0	0	233	1	0	1	0	0
5/9	47	381				0.11%	337	4	4	0	1	291	0	0	4	0	0
5/10	64	445				0.11%	387	3	3	0	0	372	0	0	0	0	1
5/11	61	506				0.11%	338	12	1	0	0	308	1	0	0	0	0
5/12	28	534				0.11%	631	17	7	0	0	357	0	0	0	0	0
5/13	21	555				0.11%	176	60	0	0	0	203	0	0	6	0	0
5/14	23	578				0.11%	77	65	0	0	0	169	0	0	2	0	0
5/15	44	622				0.11%	156	48	0	0	0	240	1	0	0	0	0
5/16	29	651				0.11%	84	63	3	0	0	137	0	0	0	0	0
5/17	38	689				0.11%	97	198	3	0	0	221	1	0	0	0	0
5/18	78	767				0.11%	77	146	5	0	1	227	1	0	3	1	0
5/19	124	891				0.11%	500	349	9	0	0	324	0	0	0	0	0
5/20	1,113	2,004				0.11%	868	727	9	2	14	528	2	1	0	0	0
5/21	1,693	3,697				0.11%	500	165	6	1	4	237	2	2	6	0	0
5/22	261	3,958				0.11%	562	75	3	2	0	509	0	0	1	0	0
5/23	184	4,142	2,653	2	2	0.11%	476	98	4	0	1	499	1	0	5	0	0
5/24	176	4,318	0	0	2	0.11%	235	105	4	1	2	457	0	0	6	0	1
5/25	386	4,704	0	0	2	0.11%	498	283	6	1	4	1,147	2	1	1	1	1

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	Actual Sockeye Smolt		Trap Efficiency Test				Incidental Catch[a]										
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	Chnk	DV	SB	SC	SF	PS	PW	ISO
5/26	344	5,048	0	0	2	0.11%	651	417	0	2	2	2,575	1	0	0	0	2
5/27	1,172	6,220	707	14	14	2.12%	881	219	1	7	13	2,595	13	5	0	0	0
5/28	626	6,846	0	3	17	2.54%	308	118	2	0	10	3,605	8	1	1	2	0
5/29	3,599	10,445	0	0	17	2.54%	173	84	0	9	8	2,625	0	0	2	1	4
5/30	416	10,861	0	0	17	2.54%	105	42	0	1	7	2,003	0	3	1	0	0
5/31	4,869	15,730	2,288	0	0	0.04%	347	197	0	2	11	6,527	3	0	6	0	0
6/1	1,234	16,964	0	8	8	0.39%	143	59	0	18	22	11,306	5	1	7	0	0
6/2	1,037	18,001	0	4	12	0.57%	124	94	0	27	46	6,077	18	6	0	2	0
6/3	854	18,855	0	0	12	0.57%	140	64	0	6	16	2,355	3	2	89	1	0
6/4	814	19,669	0	0	12	0.57%	356	144	4	1	8	9,977	1	1	381	1	1
6/5	551	20,220	0	0	12	0.57%	235	77	0	9	8	10,958	1	1	614	2	0
6/6	948	21,168	0	0	12	0.57%	206	64	4	14	9	4,221	0	0	544	5	0
6/7	223	21,391	1,401	7	7	0.57%	86	28	0	10	7	727	5	0	297	1	0
6/8	104	21,495	0	3	10	0.78%	80	48	0	8	3	555	4	1	184	0	0
6/9	32	21,527	0	0	10	0.78%	11	11	0	11	9	343	3	0	238	0	0
6/10	138	21,665	0	0	10	0.78%	49	55	4	38	23	1,153	2	0	341	9	0
6/11	123	21,788	0	0	10	0.78%	63	51	0	43	19	496	4	1	185	0	1
6/12	496	22,284	0	0	10	0.78%	104	71	0	51	13	1,828	3	0	190	2	2
6/13	3,016	25,300	0	0	10	0.78%	92	24	0	60	12	3,025	4	0	17	0	0
6/14	1,972	27,272	0	0	10	0.78%	70	29	3	88	38	3,685	14	0	19	1	8
6/15	475	27,747	1,781	4	4	0.28%	104	38	0	47	23	695	3	1	10	1	0
6/16	392	28,139	0	1	5	0.34%	468	82	0	62	21	7,405	0	2	210	0	4
6/17	247	28,386	0	1	6	0.39%	609	11	0	57	31	6,645	0	0	142	2	9
6/18	385	28,771	0	0	6	0.39%	407	16	0	54	14	1,302	1	1	221	0	4
6/19	190	28,961	0	0	6	0.39%	633	49	0	59	19	982	7	0	235	3	2
6/20	270	29,231	0	0	6	0.39%	954	112	0	69	18	889	4	0	152	2	0
6/21	113	29,344	0	0	6	0.39%	326	37	0	53	21	636	9	0	109	0	0
6/22	127	29,471	0	0	6	0.39%	309	42	0	100	35	1,707	14	0	204	0	2
6/23	259	29,730	0	0	6	0.39%	547	67	0	101	18	4,551	14	0	334	0	1

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	Actual Sockeye Smolt		Trap Efficiency Test				Incidental Catch[a]										
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	Chnk	DV	SB	SC	SF	PS	PW	ISO
6/24	422	30,152	0	0	6	0.39%	778	108	0	103	24	6,853	19	0	270	29	0
6/25	385	30,537	0	0	6	0.39%	826	81	0	33	15	1,654	4	0	148	0	0
6/26	118	30,655	0	0	6	0.39%	140	41	0	42	10	866	5	0	98	9	0
6/27	58	30,713	704	6	6	0.99%	97	31	0	35	9	449	3	0	137	0	0
6/28	98	30,811	0	1	7	1.13%	186	20	0	37	10	2,209	8	0	148	8	0
6/29	39	30,850	0	0	7	1.13%	59	18	0	31	5	1,334	0	0	122	5	0
6/30	71	30,921	0	0	7	1.13%	100	21	0	27	7	490	2	0	40	1	1
7/1	123	31,044	0	0	7	1.13%	20	4	0	28	9	546	2	0	31	0	0
7/2	147	31,191	0	0	7	1.13%	63	12	0	50	5	1,111	5	2	92	2	0
7/3	138	31,329	0	0	7	1.13%	185	20	0	51	11	1,475	2	0	70	3	0
7/4	51	31,380	0	0	7	1.13%	74	2	0	18	5	840	0	0	41	0	0
7/5	26	31,406	0	0	7	1.13%	50	2	0	20	6	326	0	0	94	0	0
7/6	27	31,433	0	0	7	1.13%	32	2	0	16	6	428	10	0	90	2	0
7/7	21	31,454	0	0	7	1.13%	113	25	0	27	2	1,200	2	0	128	0	0
7/8	20	31,474	0	0	7	1.13%	32	13	0	15	7	1,292	5	0	149	0	0
7/9	66	31,540	0	0	7	1.13%	23	20	0	25	2	661	10	0	269	0	0
Total		31,540	9,534	54	54	0.58%	18,055	5,291	97	1,572	649	131,571	237	32	6,705	96	44

[a] Soc Fry = sockeye salmon fry, coho = juvenile coho salmon, pink = juvenile pink salmon, chnk = juvenile chinook salmon, DV = Dolly Varden, SB = stickleback, SC = sculpin, SF = starry flounder, PS = pond smelt, PW = pygmy whitefish, ISO = isopods.

[b] Calculated by: = {(R+1)/(M+1)}*100 where: R = number of marked fish recaptured, and M = number of marked fish (Carlson et al. 1998).

APPENDIX B. SMOLT TRAP CATCHES BY TRAP

Appendix B1.-Number of sockeye salmon smolt caught by trap, by day, from the Chignik River, April 27 through July 9, 2006.

	Small Trap		Large Trap		Combined		Percent Total	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
4/27	29	29	30	30	59	59	49.2%	50.8%
4/28	13	42	41	71	54	113	24.1%	75.9%
4/29	3	45	40	111	43	156	7.0%	93.0%
4/30	3	48	4	115	7	163	42.9%	57.1%
5/1	1	49	5	120	6	169	16.7%	83.3%
5/2	0	49	5	125	5	174	0.0%	100.0%
5/3	0	49	21	146	21	195	0.0%	100.0%
5/4	2	51	6	152	8	203	25.0%	75.0%
5/5	11	62	35	187	46	249	23.9%	76.1%
5/6	8	70	41	228	49	298	16.3%	83.7%
5/7	0	70	8	236	8	306	0.0%	100.0%
5/8	10	80	18	254	28	334	35.7%	64.3%
5/9	9	89	38	292	47	381	19.1%	80.9%
5/10	9	98	55	347	64	445	14.1%	85.9%
5/11	15	113	46	393	61	506	24.6%	75.4%
5/12	7	120	21	414	28	534	25.0%	75.0%
5/13	2	122	19	433	21	555	9.5%	90.5%
5/14	2	124	21	454	23	578	8.7%	91.3%
5/15	0	124	44	498	44	622	0.0%	100.0%
5/16	1	125	28	526	29	651	3.4%	96.6%
5/17	16	141	22	548	38	689	42.1%	57.9%
5/18	16	157	62	610	78	767	20.5%	79.5%
5/19	42	199	82	692	124	891	33.9%	66.1%
5/20	423	622	690	1,382	1,113	2,004	38.0%	62.0%
5/21	641	1,263	1,052	2,434	1,693	3,697	37.9%	62.1%
5/22	55	1,318	206	2,640	261	3,958	21.1%	78.9%
5/23	52	1,370	132	2,772	184	4,142	28.3%	71.7%
5/24	55	1,425	121	2,893	176	4,318	31.3%	68.8%
5/25	149	1,574	237	3,130	386	4,704	38.6%	61.4%
5/26	111	1,685	233	3,363	344	5,048	32.3%	67.7%
5/27	368	2,053	804	4,167	1,172	6,220	31.4%	68.6%
5/28	289	2,342	337	4,504	626	6,846	46.2%	53.8%
5/29	3,110	5,452	489	4,993	3,599	10,445	86.4%	13.6%
5/30	278	5,730	138	5,131	416	10,861	66.8%	33.2%
5/31	2,955	8,685	1,914	7,045	4,869	15,730	60.7%	39.3%
6/1	600	9,285	634	7,679	1,234	16,964	48.6%	51.4%
6/2	345	9,630	692	8,371	1,037	18,001	33.3%	66.7%
6/3	357	9,987	497	8,868	854	18,855	41.8%	58.2%
6/4	195	10,182	619	9,487	814	19,669	24.0%	76.0%
6/5	177	10,359	374	9,861	551	20,220	32.1%	67.9%
6/6	304	10,663	644	10,505	948	21,168	32.1%	67.9%
6/7	71	10,734	152	10,657	223	21,391	31.8%	68.2%
6/8	34	10,768	70	10,727	104	21,495	32.7%	67.3%
6/9	11	10,779	21	10,748	32	21,527	34.4%	65.6%
6/10	30	10,809	108	10,856	138	21,665	21.7%	78.3%
6/11	30	10,839	93	10,949	123	21,788	24.4%	75.6%

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Date	Small Trap		Large Trap		Combined		Percent Total	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
6/12	85	10,924	411	11,360	496	22,284	17.1%	82.9%
6/13	667	11,591	2,349	13,709	3,016	25,300	22.1%	77.9%
6/14	490	12,081	1,482	15,191	1,972	27,272	24.8%	75.2%
6/15	103	12,184	372	15,563	475	27,747	21.7%	78.3%
6/16	50	12,234	342	15,905	392	28,139	12.8%	87.2%
6/17	54	12,288	193	16,098	247	28,386	21.9%	78.1%
6/18	93	12,381	292	16,390	385	28,771	24.2%	75.8%
6/19	40	12,421	150	16,540	190	28,961	21.1%	78.9%
6/20	61	12,482	209	16,749	270	29,231	22.6%	77.4%
6/21	26	12,508	87	16,836	113	29,344	23.0%	77.0%
6/22	30	12,538	97	16,933	127	29,471	23.6%	76.4%
6/23	59	12,597	200	17,133	259	29,730	22.8%	77.2%
6/24	77	12,674	345	17,478	422	30,152	18.2%	81.8%
6/25	96	12,770	289	17,767	385	30,537	24.9%	75.1%
6/26	21	12,791	97	17,864	118	30,655	17.8%	82.2%
6/27	13	12,804	45	17,909	58	30,713	22.4%	77.6%
6/28	20	12,824	78	17,987	98	30,811	20.4%	79.6%
6/29	17	12,841	22	18,009	39	30,850	43.6%	56.4%
6/30	13	12,854	58	18,067	71	30,921	18.3%	81.7%
7/1	82	12,936	41	18,108	123	31,044	66.7%	33.3%
7/2	41	12,977	106	18,214	147	31,191	27.9%	72.1%
7/3	33	13,010	105	18,319	138	31,329	23.9%	76.1%
7/4	11	13,021	40	18,359	51	31,380	21.6%	78.4%
7/5	7	13,028	19	18,378	26	31,406	26.9%	73.1%
7/6	4	13,032	23	18,401	27	31,433	14.8%	85.2%
7/7	3	13,035	18	18,419	21	31,454	14.3%	85.7%
7/8	7	13,042	13	18,432	20	31,474	35.0%	65.0%
7/9	5	13,047	61	18,493	66	31,540	7.6%	92.4%
Total		13,047		18,493		31,540	26.7%	73.3%

APPENDIX C. PHYSICAL OBSERVATIONS

Appendix C1.-Daily climatological observations for the Chignik River sockeye salmon smolt project, 2006.

Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover %	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Large	Stream Gauge (cm)	Comments
4/28	1200	ND	ND	70%	NW	25	1.3	3.8	ND	Snowing
4/29	1150	1.0	2.0	95%	NW	10-15	1.0	3.5	96	Small trap not spinning well
4/30	1207	0.5	1.0	100%	NW	0-5	0.0	2.5	96	Small trap not spinning well
5/1	1207	0.5	1.0	100%	NW	0-5	0.0	2.3	95	Small trap not spinning well
5/2	1200	2.0	3.0	100%	SE	25-30	0.0	0.0	95	Wind blew traps into shore
5/3	1207	7.0	4.0	100%	SE	0	0.0	3.3	95	Overcast, calm
5/4	1204	5.5	3.0	100%	NW	0-5	0.0	3.3	93	Light wind
5/5	1215	10.0	4.0	75%	NW	0-5	0.3	3.3	93	Partly clear
5/6	1140	16.0	5.0	40%	NW	0-5	0.0	3.3	90	Mostly clear
5/7	1140	4.0	3.0	30%	NW	15	0.5	3.0	95	Mostly clear, blustery
5/8	1126	4.0	4.0	2%	NW	0-5	0.0	3.0	95	Clear
5/9	1155	4.0	3.0	100%	SE	5-10	0.0	3.0	94	Overcast
5/10	1200	6.0	4.0	100%	NW	0-5	0.0	3.0	92	Overcast, intermittent rain
5/11	1200	4.0	4.0	20%	NW	0-5	1.0	3.5	92	Mostly clear
5/12	1155	5.0	4.0	65%	S E	5-10	0.0	3.0	92	Partly clear
5/13	1150	5.0	4.0	3%	NW	5-10	0.0	3.5	93	Clear
5/14	1200	5.0	4.0	100%	NW	15	1.3	4.0	94	Overcast, light rain
5/15	1205	5.0	4.0	100%	SE	0-5	0.0	3.5	93	Overcast
5/16	1220	9.0	5.0	100%	SE	0-5	0.0	4.0	97	Overcast
5/17	1158	7.0	5.0	100%	SE	0-2	0.0	3.0	95	Overcast, calm
5/18	1150	8.0	5.0	100%	SE	0-5	0.0	3.0	95	Overcast
5/19	1202	8.0	5.0	90%	NW	0-5	0.0	3.0	99	Overcast
5/20	1207	6.0	4.0	100%	SE	20-25	0.0	3.3	102	Overcast, steady rain, gusts
5/21	1215	8.0	5.0	100%	NW	25-30	2.5	3.8	106	Overcast
5/22	1212	4.0	3.0	100%	NW	15-20	4.0	4.3	110	Overcast
5/23	1245	9.0	5.0	85%	NW	5-10	4.5	4.3	119	Partly clear
5/24	1330	11.0	6.0	2%	NW	0-5	4.5	4.5	111	Clear
5/25	1149	14.0	7.0	0%	NW	0-5	5.3	4.5	123	Clear
5/26	1336	16.0	7.0	0%	NW	5-10	6.5	5.0	132	Clear

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Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover (%)	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Large	Stream Gauge (cm)	Comments
5/27	1240	20.0	7.0	15%	NW	0-5	7.8	6.3	142	Mostly clear
5/28	1201	19.0	7.0	0%	NW	0-5	9.3	7.3	157	Clear
5/29	1203	15.0	7.0	0%	SE	0-5	10.0	8.3	164	Clear
5/30	1203	10.0	6.0	30%	SE	0-5	11.0	8.5	170	Mostly clear
5/31	1150	9.0	7.0	100%	NW	0-3	11.0	8.5	167	Overcast, repositioned traps
6/1	1140	10.0	7.0	0%	NW	5-10	11.0	8.5	168	Clear
6/2	1810	14.0	7.0	0%	NW	5-10	11.0	8.5	169	Clear
6/3	1200	11.0	7.0	10%	NW	5-10	10.0	8.0	164	Mostly clear
6/4	1206	8.0	7.0	0%	NW	5-10	10.3	8.3	166	Clear
6/5	1135	17.0	8.0	0%	NW	0-5	10.3	8.3	165	Clear
6/6	1210	13.0	9.0	0%	NW	0-2	10.3	8.3	165	Clear
6/7	1214	11.0	8.0	100%	SE	0-5	10.3	8.3	158	Overcast, intermittent rain
6/8	1150	11.0	7.0	100%	SE	20-25	9.3	9.5	160	Overcast, rain, gusty
6/9	1146	9.0	6.0	100%	SE	5-10	10.5	9.3	179	Overcast, rain
6/10	1148	9.0	6.0	100%	SE	5-10	12.8	10.0	203	Overcast, rain
6/11	1215	9.0	7.0	100%	SE	0-5	14.3	12.0	225	Overcast, rain
6/12	1220	11.0	7.0	100%	NW	0-5	14.3	11.8	223	Overcast
6/13	1148	10.0	8.0	100%	NW	0-2	14.0	12.0	217	Overcast
6/14	1210	11.0	8.0	100%	NW	5-10	13.8	10.0	206	Overcast
6/15	1222	10.0	8.0	100%	NW	10-15	13.8	10.3	203	Overcast
6/16	1130	10.0	8.0	100%	NW	0-5	13.3	10.3	189	Overcast
6/17	1126	8.0	8.0	100%	NW	0-5	13.5	10.8	207	Overcast, rain
6/18	1217	10.0	8.0	100%	NW	0-5	13.0	10.5	204	Overcast
6/19	1137	14.0	8.0	90%	NW	0-2	13.0	10.3	193	Partly clear
6/20	1221	12.0	9.0	100%	NW	0-5	12.5	10.0	189	Overcast
6/21	1207	11.0	9.0	100%	NW	0-5	12.8	10.0	189	Overcast
6/22	1205	11.0	9.0	30%	NW	7-10	12.5	10.0	186	Mostly clear
6/23	1207	10.0	9.0	100%	NW	0-5	12.5	9.8	180	Overcast

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Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover (%)	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Large	Stream Gauge (cm)	Comments
6/24	1215	13.0	9.0	70%	NW	0-5	11.8	9.3	178	Partly clear
6/25	1245	14.0	9.0	10%	NW	5-7	11.8	9.3	175	Mostly clear
6/26	1206	19.0	10.0	50%	NW	0-5	11.0	9.3	158	Mostly clear
6/27	1202	12.0	10.0	100%	NW	0-5	10.8	9.0	154	Overcast
6/28	1203	15.0	10.0	20%	SE	0-5	10.0	8.3	151	Mostly clear
6/29	1239	14.0	9.0	95%	SE	0-5	10.0	8.3	151	Mostly cloudy
6/30	1149	13.0	9.0	100%	NW	5-10	10.0	8.3	153	Overcast
7/1	1232	15.0	10.0	0%	NW	0-5	10.0	8.3	155	Clear
7/2	1159	15.0	10.0	20%	NW	5-10	10.0	8.3	155	Mostly clear
7/3	1204	14.0	10.0	25%	NW	0-5	10.0	8.3	155	Mostly clear
7/4	1202	15.0	10.0	0%	NW	0-5	9.8	8.0	148	Clear
7/5	1305	14.0	9.0	20%	NW	5-10	9.8	8.0	150	Mostly clear
7/6	1217	16.0	10.0	0%	NW	5-10	9.5	7.5	144	Clear
7/7	1220	15.0	10.0	100%	NW	0-5	9.5	7.5	144	Overcast
7/8	1210	14.0	10.0	100%	NW	0-5	9.5	7.5	144	Overcast
7/9	1221	16.0	11.0	80%	SE	0-5	9.5	7.5	144	Mostly clear
7/10	1230	10.0	10.0	100%	SE	20	8.5	6.3	136	Overcast

[a] Actual calendar dates.

[b] Based on observer estimates.

[c] ND = no data.

APPENDIX D. DISTRIBUTION LIST

Appendix D1.-Distribution list.

Individual	Organization	Address	# of copies
Chuck McCallum	Chignik Regional Aquaculture Assn.	2731 Meridian #B Bellingham WA 98225	10
Chuck McCallum	Lake and Peninsula Borough	1577 C St. Suite 330 Anchorage AK 99501	1
Ken Bouwens	ADF&G	Kodiak ADF&G Office	1
Heather Finkle	ADF&G	Kodiak ADF&G Office	3
Steve Honnold	ADF&G	Kodiak ADF&G Office	1
Jim McCullough	ADF&G	Kodiak ADF&G Office	1
Darin Ruhl	ADF&G	Kodiak ADF&G Office	1
Mark Stichert	ADF&G	Kodiak ADF&G Office	1
Mark Witteveen	ADF&G	Kodiak ADF&G Office	1
Dave Sterritt	ADF&G	Kodiak ADF&G Office	1
Steve Schrof	ADF&G	Kodiak ADF&G Office	1

APPENDIX E. ADF&G PROTOCOL FOR GENETIC SAMPLING

Appendix E1.-ADF&G protocol for genetic sampling

Collection of Axillary Process (AX) Tissue Samples for DNA

ADF&G GENE CONSERVATION LAB, ANCHORAGE

I. GENERAL INFORMATION

We use axillary processes (AX: see photo on reverse) from individual fish to determine the genetic characteristics and profile of a particular run or stock of fish or to determine the stock composition of fisheries. This is a non-lethal method of collecting genetic data from adult fish. The most important thing to remember in collecting samples is that **only quality samples give quality results**. If sampling from carcasses, fish need to be as freshly dead as possible. DO NOT sample tissue from fungal covered carcasses.

II. Sample procedure:

1. Set-up: Select sampling container that will provide at least 1ml per sampled AX (i.e. if you plan to sample 200 fish use at least a 250ml container). Fill sampling container with alcohol. Fill out adhesive label on container with information requested. Get out paper towels and dognail clipper.

2. Sample from the same side of every fish to avoid double-sampling individuals (only sample one piece of tissue from each fish).

3. Wipe the axillary process with a paper towel. Using dog toenail clipper, remove the entire AX and place the tissue into the sampling container.

4. Repeat process until the container has no more than 1 tissue per ml (ie. if you are sampling into 250ml bottle, stop at 200 samples). Replace lid on container. Invert container several times to distribute alcohol.

5. After 24 hours, "refresh" step - pour out the alcohol from the sampling container and pour in fresh alcohol to assure proper preservation.

6. Store 250ml bulk bottles containing tissues at room temperature, but away from heat and direct sun.

III. Supplies included with sampling kit:

1. (1) – Dog toenail clipper - use to cut off the axillary process (see photo)
2. 250ml (max: 200 samples) bulk bottles: Nalgene containers
3. Ethanol (ETOH) – bulk in 500 ml Nalgene bottles or 20-liter qubetainers.
4. Paper towels – use to blot excess water or fish slime off fin
5. Printout of sampling instructions
6. Return shipment materials: HAZMAT paperwork, 4-G box, absorbent material, laminated "return address" labels, return shipment instructions.

VI. SHIPPING: HAZMAT PAPERWORK IS REQUIRED FOR RETURN SHIPMENT OF THESE SAMPLES – SEE SHIPPING INSTRUCTIONS.