Fishery Data Series No. 05-16

Sockeye Salmon Smolt Investigations on the Chignik River, 2004

by

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and

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April 2005

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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April 2005

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This document should be cited as:
Finkle, H. and E. J. Newland. 2005. Sockeye salmon smolt investigations on the Chignik River, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-16, Anchorage.

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ABSTRACT

This paper provides the results from the eleventh year of the Chignik River sockeye salmon *Oncorhynchus nerka* smolt enumeration project. Juvenile sockeye salmon were captured in a rotary screw trap array and sockeye salmon smolt abundance was estimated using mark-recapture techniques. Sockeye salmon smolt were measured throughout the emigration for age, length, and weight data. In 2004, a total of 8,656,824 sockeye salmon smolt were estimated to pass downstream of the traps from May 6 to July 2. Of these, 244,206 (2.8%) were age 0., 6,172,902 (71.3%) were age 1., and 2,239,716 (25.9%) were age-2. smolt. The Chignik River watershed run is formally forecast using sibling and temperature index relationships, and the forecast using smolt information is considered ancillary data. The formal forecast is for a total run of 2.39 million sockeye salmon with a expected harvest of 1.79 million fish. Smolt abundance data, by brood year, were regressed against 2- and 3-ocean returns from that brood year to forecast the 2005 sockeye salmon run. Based on age-1. and age-2. smolt data and historic adult age compositions, it was estimated that approximately 1.28 million sockeye salmon are expected to return in 2005, equating to a harvest of about 680 thousand sockeye salmon. Using smolt data, the 2006 run is expected to be about 1.5 million sockeye salmon (900 thousand harvest). Because only up to eight years' 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

Sockeye salmon *Oncorhynchus nerka* are an economically important commercial salmon species in the Chignik Management Area (CMA; Pappas et al. 2001). The Chignik watershed, which is the primary sockeye salmon 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 runs of sockeye salmon return to the Chignik watershed (Templin et al. 1999). The early run (escapement goal range of 350,000 to 400,000 fish) spawns in Black Lake and its tributaries: it enters the watershed from June through mid-July. The late run (escapement goal range of 200,000 to 250,000 fish through August 31), which returns from late June through September and later into the fall, typically spawns in the tributaries and the shoals of Chignik Lake. A management objective for an additional 25,000 fish escapement during September 1-15 was added in 1989 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 emigration 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. 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. It has been 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 (Roos 1957, 1959; Iverson 1966; Phinney 1968). 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 Edwards 2001; Finkle and Bouwens 2001; Bouwens and Finkle 2003a,b). 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 potential future run strength and overall stock status. These data have been combined into a database that is used to generate an adult sockeye salmon forecast to the Chignik watershed (Bouwens and Edwards 2001; Bouwens and Newland 2003). 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 2005). Smolt emigration estimates by age, and potentially stock, are expected to add accuracy to the forecast models currently used.

The 2004 field season completed the eleventh season of the Alaska Department of Fish and Game (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). 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 2004 Chignik River Sockeye Salmon Smolt Enumeration Project, comparisons of 2004 smolt data to past smolt data, and adult sockeye salmon forecast estimates for 2005 and 2006, based on smolt emigration data.

OBJECTIVES

The objectives for the 2004 season were:

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 database in an effort to estimate marine survival and future runs.

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 furthest inshore as part of a three-component array. 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. Due to safety concerns about using steel cables in an area with high boat traffic, each trap was secured to the riparian vegetation with highly visible polypropylene line and a strobe light was attached to the top of the offshore trap.

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 half of the cone was submerged. The 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. 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 10'x12' weatherport was tied directly behind the traps and connected to the traps with a boardwalk. The weatherport provided shelter for the crew when processing samples taken from the traps.

During the 2004 field season, both of the traps were operated continuously from 1830 hours on May 6 to 1200 hours, June 15. A minor mechanical failure was observed in the small trap on June 15 and the trap cone was elevated out of operation. The small trap did not function for the remainder of the season. Both traps remained in the same location, and the large trap continued to operate until 1200 hours on July 3. At the completion of the project, both traps were disassembled and stored.

SMOLT ENUMERATION

Sampling days extended from noon to noon and were identified by the date of the first noon-to-midnight period. The traps were checked hourly between 2400 hours and 0530 hours on weekdays and from 2400 hours to 0400 hours on weekends. The traps were also checked 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; mid-eye-to-fork-of-tail) 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 500 and 3,000 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 insufficient numbers were initially captured. Past mark retention and delayed mortality experiments indicated that one percent of the sampled population experienced morality when held for greater than three days and 14% of the sampled population experienced mortality within the first three days (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 Bismark Brown Y dye solution (3.9 g of dye to 75.5 L of water) for 10-15 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 below the mouths 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 buckets 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 recaptured smolt was then recorded.

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

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

where

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

u_h = the number of unmarked smolt captured in stratum h

M_h = the total number of marked releases in stratum h

and

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

Variance was estimated by

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

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

$$\hat{U} = \sum_{h=1}^{L} \hat{U}_h \tag{3}$$

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

$$v\left(\hat{U}\right)=\sum_{h=1}^{L}v\left(\hat{U}_h\right) \tag{4}$$

and 95% confidence intervals were estimated from

$$\hat{U}\pm 1.96\sqrt{v\left(\hat{U}\right)} \tag{5}$$

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

$$\hat{\theta}_{jh}=\frac{A_{jh}}{A_h} \tag{6}$$

where

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

A_h = the number of smolt sampled in stratum h

with the variance estimated as

$$v\left(\hat{\theta}_{jh}\right)=\frac{\hat{\theta}_{jh}\left(1-\hat{\theta}_{jh}\right)}{A_h}\ . \tag{7}$$

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

$$\hat{U}_{jh}=\hat{U}_j\hat{\theta}_{jh} \tag{8}$$

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

$$v\left(\hat{U}_{jh}\right)=\hat{U}_h^{\,2}v\left(\hat{\theta}_{jh}\right)+\hat{U}_h v\left(\hat{\theta}_{jh}\right)^2. \tag{9}$$

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

$$\hat{U}_j=\sum_{h=1}^{L}\hat{U}_{jh} \tag{10}$$

with the variance estimated by

$$v\left(\hat{U}_j\right)=\sum_{h=1}^{L}v\left(\hat{U}_{jh}\right). \tag{11}$$

AGE, WEIGHT, AND LENGTH SAMPLING

A daily sample of 40 sockeye salmon smolt was collected for 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. A sample of smolt was collected hourly throughout the night's migration and held in an instream live box. The number of fish sampled hourly was proportional to the migration strength. Forty smolt were then randomly collected from the live box and sampled for AWL data, and the remaining smolt were released downstream from the traps.

Tricaine methanesulfonate (MS-222) was used to anesthetize smolt prior to sampling. 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:

$$K = \frac{W}{L^3} 10^5 \quad , \tag{12}$$

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

Additionally, a sample of 200 juvenile sockeye salmon was collected once a week beginning on May 14 and ending July 2. All sockeye salmon including juveniles < 45 mm FL were measured for fork length. A length frequency analysis was conducted to investigate the fry or pre-smolt component of the emigration. The sockeye juveniles < 45 mm FL were not included in the calculations for the smolt population estimate or for age and weight.

CLIMATE AND HYDROLOGY

Trap revolutions (rpm), water depth (cm), and daily climate observations, including air and water temperature (°C), estimated cloud cover (%), and estimated wind velocity (mph) and direction were recorded daily at 1200 hours and again at the first trap-checking occasion each night.

MARINE SURVIVAL ESTIMATES AND FUTURE RUN FORECASTING

Estimates of smolt abundance, by age, were paired with corresponding adult returns from the respective brood year (BY). 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 proportion 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 2002). Marine survival, by age, and the number of smolt produced per spawner from their respective BYs 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.

Statistically significant regression relationships were used to forecast the 2- and 3-ocean components (historically approximately 99% of the entire run) of the 2005 and 2006 adult sockeye salmon runs from the smolt emigration data. The adult return estimates for the 2- and 3-ocean age classes were pooled by return year. These estimates were then multiplied by the percentage of the age class composition that they comprised to account for the minor ocean ages and provide a total run point estimate.

RESULTS

TRAPPING EFFORT

The large trap was in place for a total of 58 days beginning on May 6 and ending on July 3 (Appendix A1). The small trap was operational for 40 days from May 6 through June 15. The duration of the 2004 trapping season was 17 days shorter than the 2003 season.

TRAP CATCH

A total of 43,534 sockeye salmon smolt were captured in the traps in 2004 (Appendix A1). In addition to sockeye salmon smolt, a total of 10,195 sockeye salmon fry, 1,501 juvenile coho salmon, 71 pink salmon fry, 448 Dolly Varden char, 4,462 stickleback, 136 juvenile chinook salmon, 9,346 pond smelt, 271 pygmy whitefish, 128 starry flounders, 301 sculpin, 6 isopods, and 2 juvenile chum salmon were captured (Appendix A1). Daily smolt catches, by trap, are listed in Appendix B.

SOCKEYE SALMON SMOLT EMIGRATION AND TIMING

The estimated number of sockeye salmon smolt that emigrated in 2004 was 8,656,824 (±2,389,785; 95% C.I.; Table 1; Figure 3). The majority of these fish emigrated in late May (Table 2; Figure 4). The 2004 emigration consisted of 244,206 age-0., 6,172,902 age-1., and 2,239,716 age-2. sockeye salmon smolt (Tables 1 and 2; Figure 5). The age-1. and -2. smolt tended to emigrate together during the early part of the season (Table 2; Figure 6).

TRAP EFFICIENCY ESTIMATES

Mark-recapture experiments were conducted on eight occasions beginning on May 9 and ending on June 19. A total of 16,267 smolt, approximately 37% of the total catch, were marked and released. A total of 106 smolt were recaptured and trap efficiency estimates ranged from a low of 0.34% to a high of 1.69% (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 1,651 sockeye salmon smolt were sampled for AWL data in 2004 (Table 4). Age 0. smolt from BY 2003 comprised 21.0% of the sample, 62.4% were age 1. (BY 02), and 16.6% were age 2. (BY 01; Table 4). The mean length and weight of age-0. smolt were 55.8 mm and 1.7 g (Table 5). The mean length and weight of age-1. smolt were 69.4 mm and 2.8 g (Table 5).

The mean length and weight of age-2. smolt were 77.2 mm and 3.9 g. (Table 5). The mean length and weight of the age-1. sockeye salmon that emigrated in 2004 were similar to those that emigrated in 1998. These fish were both heavier and longer than age-1. smolt in the previous three years. The age-2. smolt, were similar in length, but slightly heavier than those fish emigrating in 2003 (Table 6; Figure 7). Like 1994, 1995, and 2003, no age-3. smolt were sampled in 2004 (Table 8). Lengths of ages 0., 1., and 2., smolt were plotted in a length frequency histogram to investigate any modalities in age classes (Figure 8). Juvenile sockeye <45 mm FL were present in limited numbers throughout the trapping season, but became a substantial component by the end of June (Figures 9 and 10).

PHYSICAL DATA

The absolute water depth at the trap location varied between 107 to 154 cm during the 2004 season. Daily measurements of river depth and velocity (based trap RPMs), along with the 2004 climate data, are reported in Appendix C1. Water temperatures averaged near 5.2^{o}C during the first week that traps were installed (May 7 through May 14) and increased steadily throughout the season. Comparatively stable and relatively high water levels and calm winds (Figure 11) generally characterized the 2004 season.

MARINE SURVIVAL ESTIMATES AND FUTURE RUN FORECASTING

All adult sockeye salmon from BYs 1992, 1993, 1994, 1995, 1996, and for the most part, 1997 have returned to the Chignik River watershed, and the overall marine survival of smolt ranged from 10% for BY 1997 to 66% for BY 1993 (Table 8). 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 1999 to 195% for emigration year 1996, with 1996 being an obvious outlier (Table 9). Therefore, after removing smolt year 1996, the marine survival from smolt years 1992 to 1997 has averaged 12 percent.

Simple linear regression relationships failed to effectively describe smolt-adult return relationships ($P>0.05$). Multiple regression models displayed significant relationships ($P<0.015$; $R^2>0.81$) among age-1. and -2. smolt and 2- and 3-ocean adults (Table 10). Some relationships examined (age-0. smolt vs. age-0. adults, age-3. smolt vs. age-3. adults, total smolt vs. 1-ocean adults, total smolt vs. 2-ocean adults, age-0., -1., and -2. smolt vs. 3-ocean adults) were not significant ($P>0.05$). Other relationships (age-1. smolt vs. age-1. adults, age-2. smolt vs. age-2. adults) were significant, however, the proportion of variability in the dependent variable explained by the independent variable was poor for those models. Based on the two significant multiple regression models, the 2005 total adult run forecast was 1.28 million sockeye salmon, and the 2006 adult run forecast was about 1.52 million sockeye salmon (Figure 12).

DISCUSSION

The point estimate of the 2004 smolt emigration was the third lowest estimated emigration on record (the 1996 and 2003 smolt emigrations were lower). The confidence in the 2004 estimate is fair considering the homogenous results of the mark recapture experiments compared to past years. In 2004, a total of 16,267 smolt were marked and 106 were recaptured in comparison to 1996 when only 3,180 were marked and 49 smolt were recaptured. The overall trap efficiency was the lowest recorded since 1994, possibly resulting from the sustained moderate to high flows observed

during the season. In the past, similar trap efficiencies have been recorded during periods of high flow and strong winds (Bouwens and Edwards 2001; Edwards and Bouwens 2002).

There has been concern that smolt might have migrated from the watershed before the project was installed in the spring, thus missing a significant portion of the sockeye salmon smolt emigration. In 2004, the majority of the smolt emigration took place on May 25, 20 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.

The smolt that emigrated in 2004 were slightly larger in size when compared to smolt that emigrated in 2003. It should be noted that inseason AWL sampling indicated that larger fish (mean length 91 mm) were captured during statistical week 23 (May 31-June 6). Upon aging, these fish were identified as juvenile coho salmon and not incorporated in any sockeye salmon databases.

The total abundance of age 2. smolt was low, and there were proportionately fewer age-2. smolt in 2002 through 2004 than other years since 1994. The early run is generally composed of primarily age-1. sockeye salmon and the late run is generally composed of primarily age-2. sockeye salmon. The low age-2. smolt abundance in 2004 could indicate that subsequent late run returns (primarily in 2006) may be poor.

The low total abundance of age-2. smolt could be the result of poor rearing conditions during the first year of freshwater residence. In 2001, which was the brood year of 2004 age-2. smolt, Chignik Lake exhibited the lowest zooplankton biomass in the recent years of investigation and there was a concomitant large migration of juvenile sockeye salmon to the lagoon and river (Finkle and Bouwens 2001; Bouwens and Finkle 2003a,b). If these early emigrating fish (BY 2000) survived, it could be expected that a larger-than-average component of age-0.3 adults would return to the watershed in 2005 with fewer competitors (from BY 2000) in 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. *in press*). In 2003, a total of 15,111 sockeye salmon fry (pre-smolt) were captured during the field season, which was substantially less than the number caught in 2001 and 2002 (Edwards and Bouwens 2002). This low fry count coincided with better, albeit low, zooplankton levels in Chignik Lake in 2002 (Finkle and Bouwens 2001; Bouwens and Finkle 2003a,b).

Observed marine survivals, by emigration year (excluding 1996), of Chignik smolt have ranged from five percent to 17 percent. These figures are well within the ranges observed in other systems (Burgner 1991). This 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.

Given adult return data, the emigration of 1996 was severely underestimated and not included in the forecast analyses. Further discussion on the removal of the 1996 data can be found in Edwards and Bouwens (2002). The regression relationships that were statistically significant and useful for forecasting were total 2- and 3-ocean returns each predicted from the total number of age-1. and -2. smolt that emigrated within the past seven to eight years. This is reasonable, since the majority (about 99%) of the Chignik River watershed run consists of 2- and 3-ocean sockeye salmon. This forecasting method does not have the resolution to forecast by run because we cannot determine stock-of-origin of the smolt. However, it is adequate to forecast the combined

runs. Assuming the 2- and 3-ocean components of the run remain at roughly 99%, the 2005 total forecast is approximately 1.28 million sockeye salmon. Assuming equal strength between the two runs, this would result in a harvest of about 680 thousand sockeye salmon. The 2006 run is expected to be about 1.5 million sockeye salmon (900 thousand harvest). As next year's adult return data are added to the data set, assuming the age-1. and -2. smolt to 2- and 3-ocean return relationships remain strong, the 2006 forecast will be updated and may change.

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), temperature indices when possible, and median values to forecast the abundance of age classes when sibling relationships did not exist. Using these methods, the 2005 Chignik sockeye salmon forecast is 2.4 million (Eggers 2005). The 2005 smolt-based forecast of 1.3 million sockeye salmon is approximately 1.1 million less sockeye salmon than was forecasted using sibling and temperature regression relationships.

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. 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%. In 2004, however, the smolt forecast overestimated the return by 45%. 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. Until more data are collected to test the multiple regression smolt-based forecasting model, the smolt forecast will be provided as a supplemental tool for stakeholders to consider. Because of the small data set our confidence in the smolt-based forecast is only fair. If the current trends continue, however, forecasts incorporating smolt data may be more accurate than the forecasting methods using sibling relationships alone. Specifically, the variability in freshwater rearing success is removed from forecasts as smolt abundance is measured after the freshwater rearing period.

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TABLES AND FIGURES

Table 1.–Chignik River sockeye salmon smolt population estimates, by age class, 1994 to 2004.

Year		Number of Smolt						S.E.	95% C.I.	
		Age 0.	Age 1.	Age 2.	Age 3.	Age 4.	Total		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	0.0	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	0.0	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	0.0	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	0.0	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	0.0	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	0.0	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	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	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			

Table 2.–Estimated sockeye salmon smolt emigration from the Chignik River, by age class and statistical week, 2004.

		Age			
Statistical Week	Starting Date	0.	1.	2.	Total
19	5/3	0	643,474	428,982	1,072,456
20	5/10	10,301	1,524,614	515,072	2,049,988
21	5/17	0	2,018,996	836,441	2,855,437
22	5/24	28,016	1,466,163	364,206	1,858,386
23	5/31	17,110	211,544	49,775	278,429
24	6/7	73,000	175,481	29,481	277,961
25	6/14	37,912	88,460	13,339	139,711
26	6/21	41,146	19,950	1,247	62,342
27	6/28	36,721	24,220	1,172	62,113
Total		244,206	6,172,902	2,239,716	8,656,824

Table 3.–Results from mark-recapture tests performed on sockeye salmon smolts migrating through the Chignik River, 2004.

Date	No. Released	Total Recoveries	Trap Efficiency[a]
5/9	2,326	7	0.34%
5/13	2,764	13	0.51%
5/19	2,781	9	0.36%
5/24	2,850	17	0.63%
5/30	2,795	28	1.04%
6/6	1,059	10	1.04%
6/12	1,120	18	1.69%
6/19	572	4	0.87%
Total	16,267	106	0.66%

[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, 2004.

Stat Week	Sample Size		Ages 0	1	2	Total
19	120	Percent	0.0	60.0	40.0	100.0
		Numbers	0	72	48	120
20	199	Percent	0.5	74.4	25.1	100.0
		Numbers	1	148	50	199
21	198	Percent	0.0	70.7	29.3	100.0
		Numbers	0	140	58	198
22	199	Percent	1.5	78.9	19.6	100.0
		Numbers	3	157	39	199
23	179	Percent	6.1	76.0	17.9	100.0
		Numbers	11	136	32	179
24	198	Percent	26.3	63.1	10.6	100.0
		Numbers	52	125	21	198
25	199	Percent	27.1	63.3	9.5	100.0
		Numbers	54	126	19	199
26	200	Percent	66.0	32.0	2.0	100.0
		Numbers	132	64	4	200
27	159	Percent	59.1	39.0	1.9	100.0
		Numbers	94	62	3	159
Total	1,651	Percent	21.0	62.4	16.6	100.0
		Numbers	347	1,030	274	1,651

Table 5.–Length, weight, and condition factor of Chignik River sockeye salmon smolt samples, by age and statistical week, 2004.

				Length (mm)		Weight (g)		Condition Factor	
Age	Stat Week	Starting Date	Sample Size	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
0	20	5/10	1	58.0	0.00	1.6	0.00	0.82	0.000
0	22	5/24	3	57.7	1.76	1.7	0.07	0.92	0.112
0	23	5/31	11	49.2	2.68	1.2	0.15	0.98	0.046
0	24	6/7	52	50.2	0.49	1.1	0.03	0.87	0.015
0	25	6/14	54	52.9	0.61	1.4	0.05	0.90	0.010
0	26	6/21	132	52.6	0.37	1.3	0.03	0.89	0.007
0	27	6/28	94	65.6	0.80	2.8	0.10	0.94	0.006
Total			347	55.8	0.44	1.7	0.05	0.91	0.005
1	19	5/3	72	71.7	0.49	2.8	0.05	0.77	0.008
1	20	5/10	148	72.9	0.39	3.1	0.06	0.78	0.005
1	21	5/17	140	72.4	0.30	3.1	0.04	0.81	0.004
1	22	5/24	157	69.2	0.39	2.7	0.05	0.81	0.005
1	23	5/31	136	72.7	0.58	3.4	0.09	0.86	0.008
1	24	6/7	125	63.9	0.54	2.3	0.07	0.85	0.006
1	25	6/14	126	64.3	0.52	2.4	0.06	0.87	0.006
1	26	6/21	64	63.5	0.82	2.3	0.09	0.86	0.008
1	27	6/28	62	71.5	0.63	3.2	0.09	0.87	0.009
Total			1,030	69.4	0.20	2.8	0.03	0.83	0.002
2	19	5/3	48	75.6	0.50	3.4	0.08	0.78	0.007
2	20	5/10	50	77.0	0.92	3.7	0.17	0.79	0.006
2	21	5/17	58	77.5	0.90	4.0	0.19	0.83	0.007
2	22	5/24	39	75.6	0.84	3.6	0.17	0.81	0.009
2	23	5/31	32	82.8	1.89	5.1	0.47	0.84	0.015
2	24	6/7	21	76.0	1.65	4.0	0.36	0.86	0.015
2	25	6/14	19	75.3	0.78	3.8	0.11	0.88	0.011
2	26	6/21	4	81.5	3.52	5.0	0.47	0.92	0.032
2	27	6/28	3	77.7	0.33	4.2	0.06	0.90	0.006
Total			274	77.2	0.41	3.9	0.09	0.82	0.004

Table 6.–Mean length, weight, and condition factor of sockeye salmon smolt samples from the Chignik River, by year and age, 1994 to 2004.

		Length (mm)			Weight (g)			Condition Factor		
		Sample		Standard	Sample		Standard	Sample		Standard
Year	Age	Size	Mean	Error	Size	Mean	Error	Size	Mean	Error
1995	0	272	46.4	0.18	272	0.7	0.01	272	0.74	0.007
1996	0	125	48.7	0.45	113	1.0	0.03	113	0.82	0.014
1997	0	195	46.4	0.22	195	0.8	0.01	195	0.83	0.008
1998	0	15	44.8	0.96	15	0.7	0.03	15	0.73	0.031
1999	0	40	51.8	0.79	40	1.3	0.06	40	0.97	0.032
2000	0	223	60.3	0.52	223	2.1	0.05	223	0.91	0.008
2001	0	96	55.7	0.51	96	1.5	0.04	96	0.88	0.014
2002	0	217	48.9	0.27	217	1.2	0.02	217	0.98	0.012
2003	0	149	56.0	0.53	149	1.5	0.05	149	0.79	0.011
2004	0	347	55.8	0.44	347	1.7	0.05	347	0.91	0.005
1994	1	1,715	66.6	0.16	1,706	2.3	0.02	1,706	0.75	0.002
1995	1	1,272	60.2	0.34	1,272	2.0	0.04	1,272	0.82	0.002
1996	1	1,423	67.8	0.29	1,356	2.7	0.04	1,356	0.81	0.004
1997	1	1,673	63.4	0.35	1,673	2.4	0.04	1,673	0.81	0.002
1998	1	785	68.8	0.38	780	2.7	0.06	780	0.78	0.006
1999	1	1,344	77.0	0.17	1,344	4.1	0.03	1,344	0.89	0.003
2000	1	1,175	71.9	0.22	1,175	3.3	0.04	1,175	0.86	0.003
2001	1	1,647	64.5	0.13	1,647	2.1	0.02	1,647	0.76	0.003
2002	1	1,588	64.9	0.18	1,588	2.3	0.02	1,588	0.83	0.003
2003	1	1,665	65.1	0.11	1,665	2.1	0.01	1,665	0.75	0.003
2004	1	1,030	69.4	0.2	1,030	2.8	0.03	1,030	0.83	0.002
1994	2	1,091	77.4	0.22	1,068	3.6	0.04	1,068	0.74	0.003
1995	2	1,008	75.1	0.23	1,008	3.5	0.04	1,008	0.80	0.002
1996	2	548	79.9	0.34	533	4.2	0.06	533	0.81	0.004
1997	2	772	83.3	0.25	772	4.7	0.05	772	0.80	0.003
1998	2	1,925	72.4	0.13	1,881	3.0	0.03	1,881	0.76	0.003
1999	2	784	80.8	0.28	784	4.8	0.07	784	0.89	0.003
2000	2	503	76.2	0.34	503	3.6	0.07	503	0.80	0.004
2001	2	389	74.6	0.45	387	3.4	0.09	387	0.77	0.006
2002	2	225	80.1	0.78	225	4.9	0.18	225	0.88	0.008
2003	2	279	76.3	0.48	279	3.5	0.09	279	0.76	0.006
2004	2	274	77.2	0.41	274	3.9	0.09	274	0.82	0.004
1996	3	3	100.3	5.55	3	8.4	1.68	3	0.81	0.062
1997	3	12	87.3	1.34	12	5.2	0.35	12	0.77	0.019
1998	3	20	83.6	3.39	19	5.5	0.99	19	0.81	0.018
1999	3	7	90.1	5.76	7	6.8	1.66	7	0.85	0.028
2000	3	14	86.1	2.36	14	5.3	0.63	14	0.79	0.013
2001	3	62	90.4	1.6	61	6.9	0.42	61	0.86	0.011
2002	3	6	110.0	7.24	6	13.8	2.67	6	1.00	0.027
2001	4	1	125.0	NA	1	18.8	NA	1	0.96	NA

Table 7.–Estimated age composition of Chignik River sockeye salmon smolt samples, 1994 to 2004.

Year	Dates	Sample Size		Ages 0.	1.	2.	3.	4.	Total
1994	05/06-06/30	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	05/06-06/29	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	05/06-07/28	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	05/04-07/22	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	05/02-07/30	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	05/10-07/03	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	04/22-07/20	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	04/29-07/12	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	05/01-07/08	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	04/25-07/08	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	05/6-07/1	1,651	Percent	21.0	62.4	16.6	0.0	0.0	100.0
			Numbers	347	1,030	274	0	0	1,651

Table 8.–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 2004.

Brood		Smolt Produced						Smolt /	Adult Return						Return /
Year	Escapement	age 0.	age 1.	age 2.	age 3.	age 4.	Total smolt	spawner	Age 0.	Age 1.	Age 2.	Age 3.	Age 4.	Total	spawner
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	2,445,405	2.35
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
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	2,429,980	3.48
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
1995	739,920	80,254	11,172,150	20,374,245	78,798	0	31,705,447	42.85	38,229	2,435,328	968,399	18,143	724	3,460,823	4.68
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
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		1,796,534	2.32
1998	701,128	73,364	8,047,526	5,024,666	72,184	0	13,217,740	18.85	5,786	1,116,404	353,968			1,476,159	2.11
1999	715,966	1,270,101	18,940,752	2,223,996	0	0	22,434,849	31.34	29,193	920,544					
2000	805,225	521,546	13,980,423	1,449,494	0		15,951,463	19.81	15,340						
2001	1,136,918	440,947	5,146,278	2,239,716											
2002	725,220	155,047	6,172,902												
2003	684,145	244,206													
2004	578,259														

Table 9.–Estimated marine survival of sockeye salmon smolt from the Chignik River, by emigration year and ocean age, 1994 to 2004.

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	1,180,530	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	1,211,950	2,780,125	13,864	4,016,815	16%
1998	75,560	5,790,587	20,374,245	158,056	26,398,448	622	156,444	2,749,174	33,266	2,939,506	11%
1999	73,364	12,705,935	8,221,631	78,798	21,079,728	260	145,459	1,525,666	9,919	1,681,304	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			
2002	440,947	13,980,423	2,223,996	72,184	16,717,551	4,072	432,476				
2003	155,047	5,146,278	1,449,494	0	6,750,819	2,282					
2004	244,206	6,172,902	2,239,716	0	8,656,824						

Table 10.–Regression relationships between Chignik sockeye salmon smolt and ocean age adults with the predicted 2005 run shown.

Adults	Smolt	F	P	Regression equations[a]	Forecast returns by ocean age
X.2	1.X and 2.X	11.524	0.013	$Y=432{,}205.2 + (X_1 \times -0.01317) + (X_2 \times 0.01943)$	326,301
X.3	1.X and 2.X	12.660	0.019	$Y=1{,}669{,}689.3 + (X_1 \times -0.05411) + (X_2 \times 0.07389)$	937,401
All[b]	1.X and 2.X	N/A	N/A	N/A	1,277,819

[a] The X1 variable represents the age 1. emigration estimate while the X2 variable represents the age 2. emigration estimate.

[b] Total return was estimated by multiplying the sum of the X.2 and X.3 estimates by the percent from the total age composition that that those two ocean age groups composed. This enabled the estimation of minor age classes not included in the regression analyses.

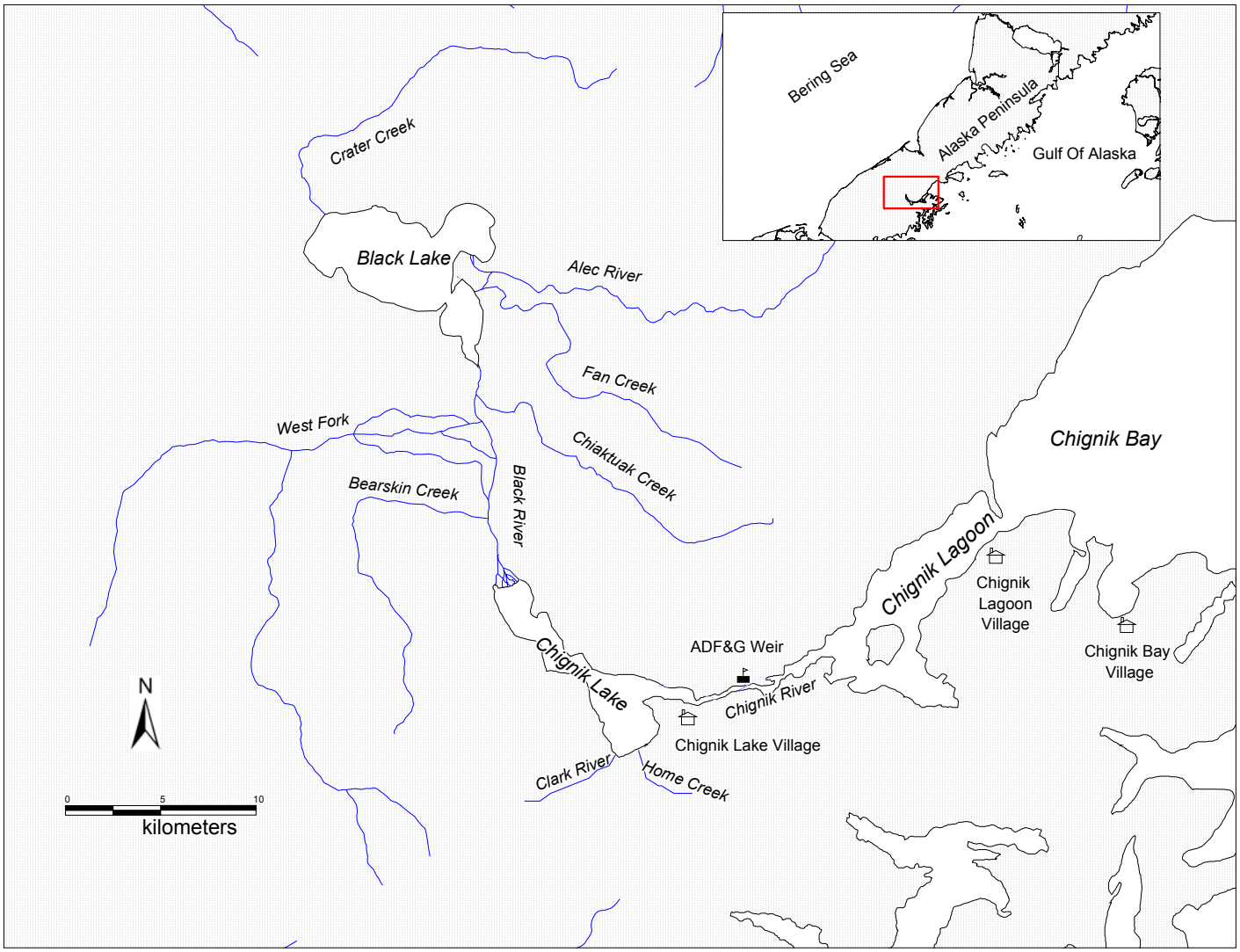

Figure 1.–Map of the Chignik River watershed.

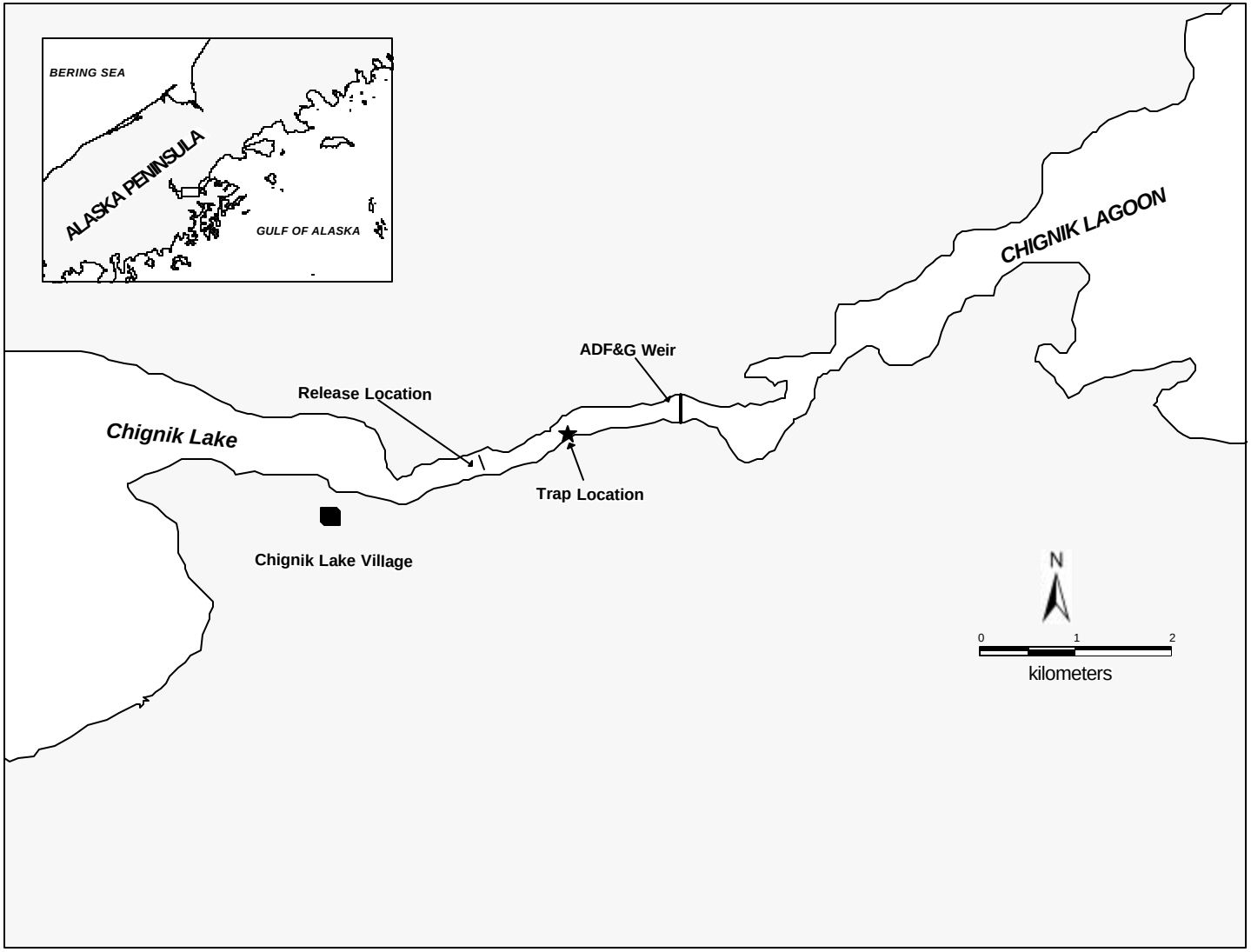

Figure 2.–Location of the traps and the release site of marked smolt in the Chignik River, Alaska, 2004.

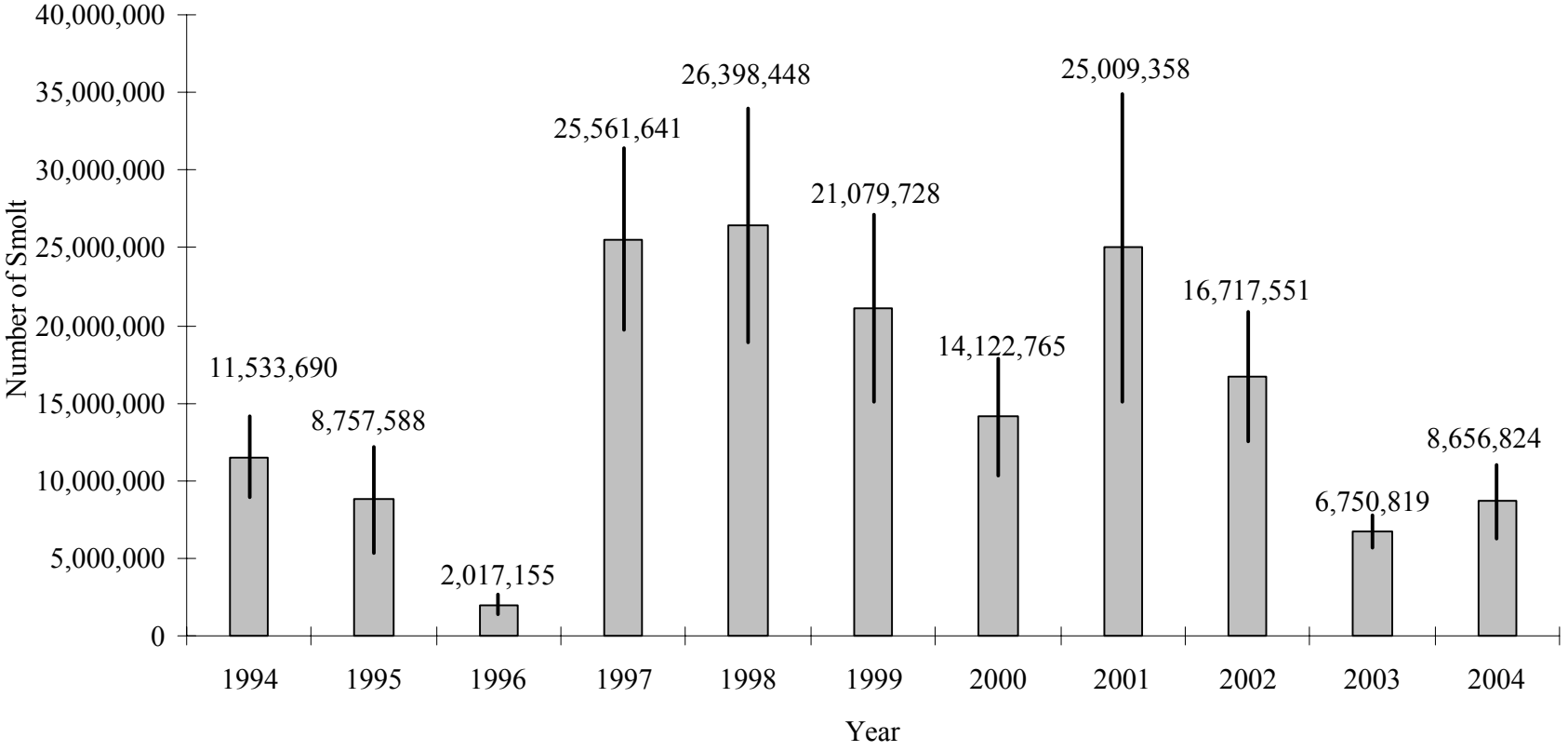

Figure 3.–Annual Chignik River sockeye salmon smolt emigration estimates and corresponding 95% confidence intervals, 1994 to 2004.

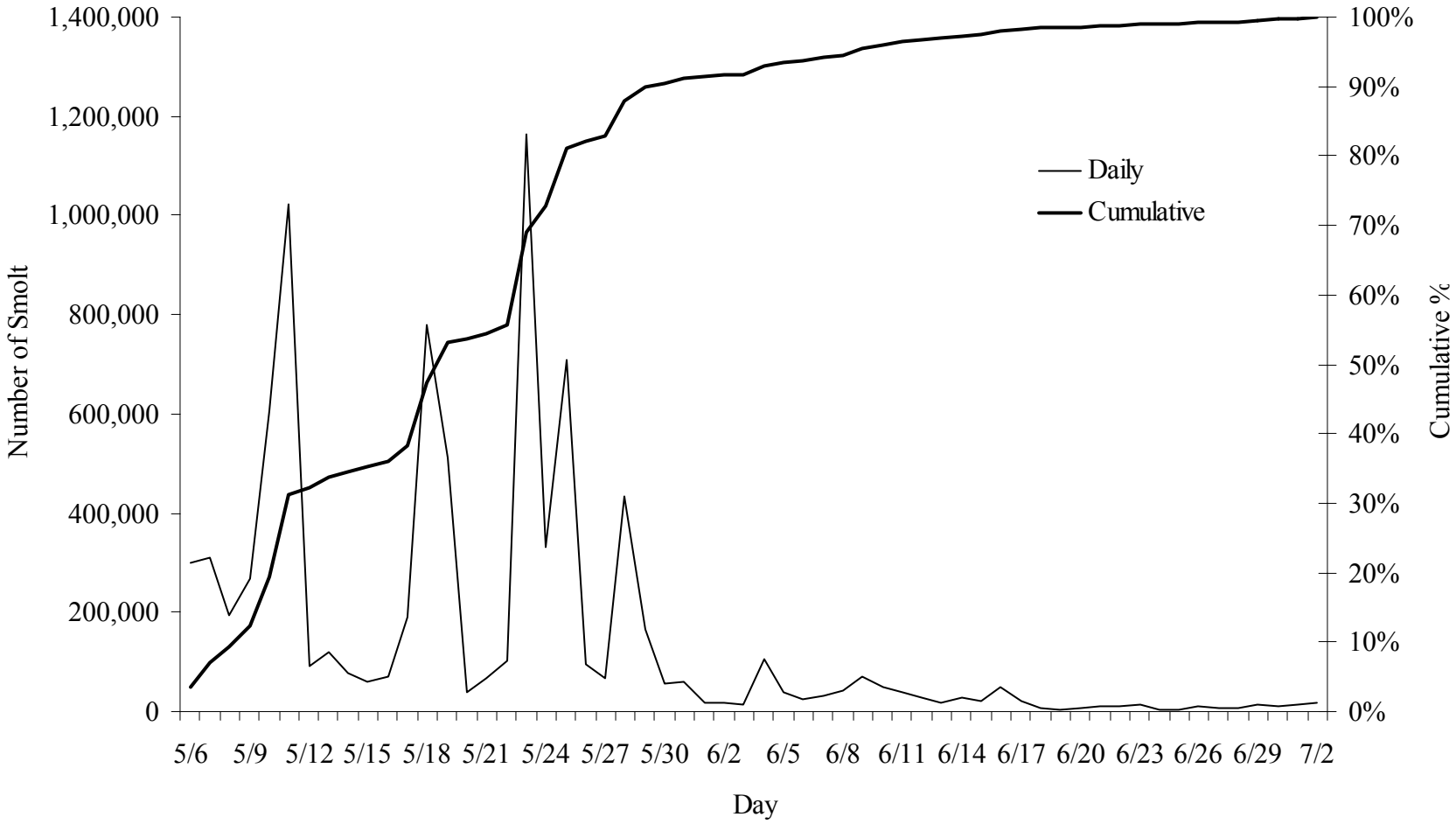

Figure 4.–Estimated daily and corresponding cumulative percentage of the sockeye salmon smolt emigration from the Chignik River, 2004.

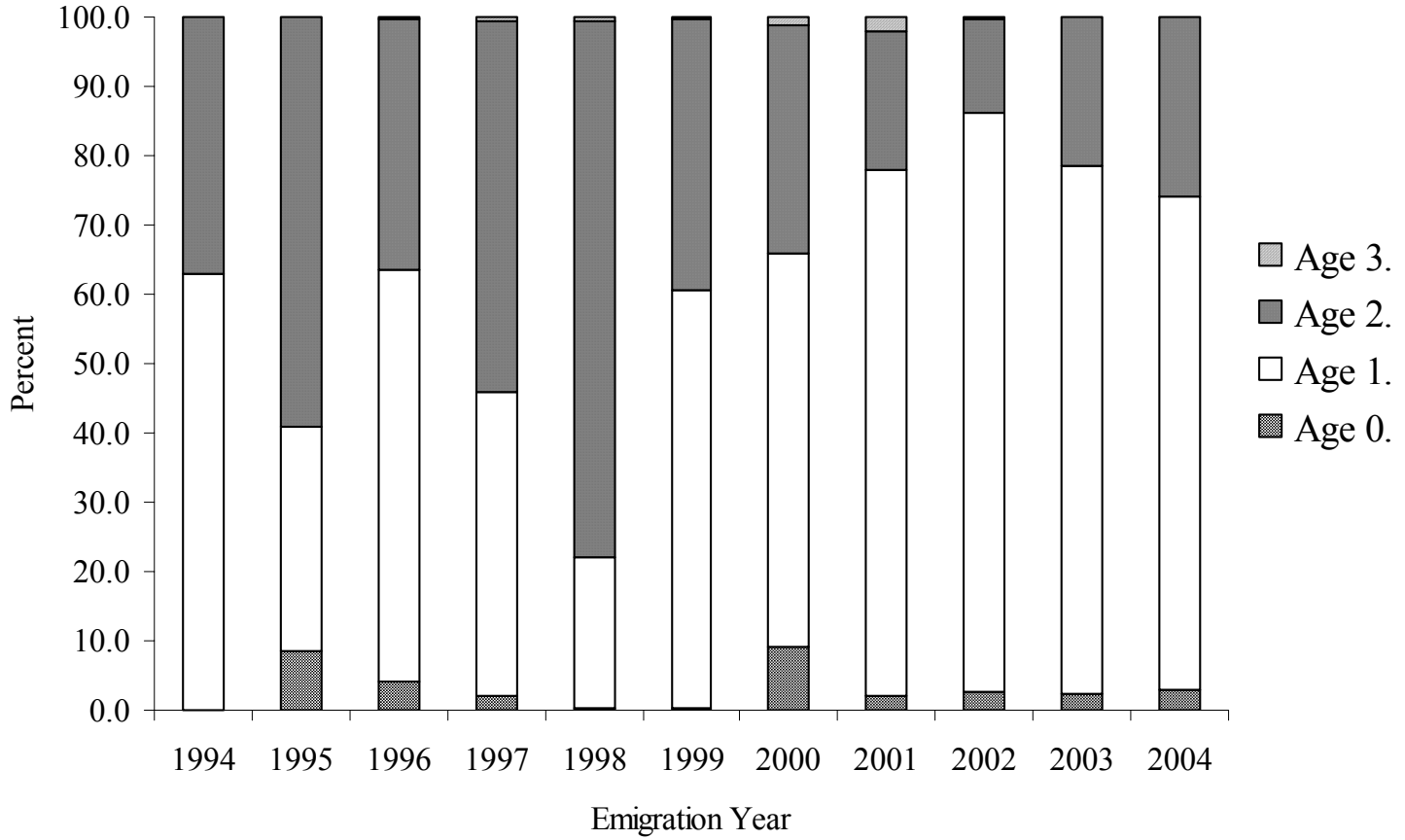

Figure 5.–A comparison of the estimated age structure of age 0. to age 3. sockeye salmon smolt emigrations from the Chignik River, 1994 to 2004.

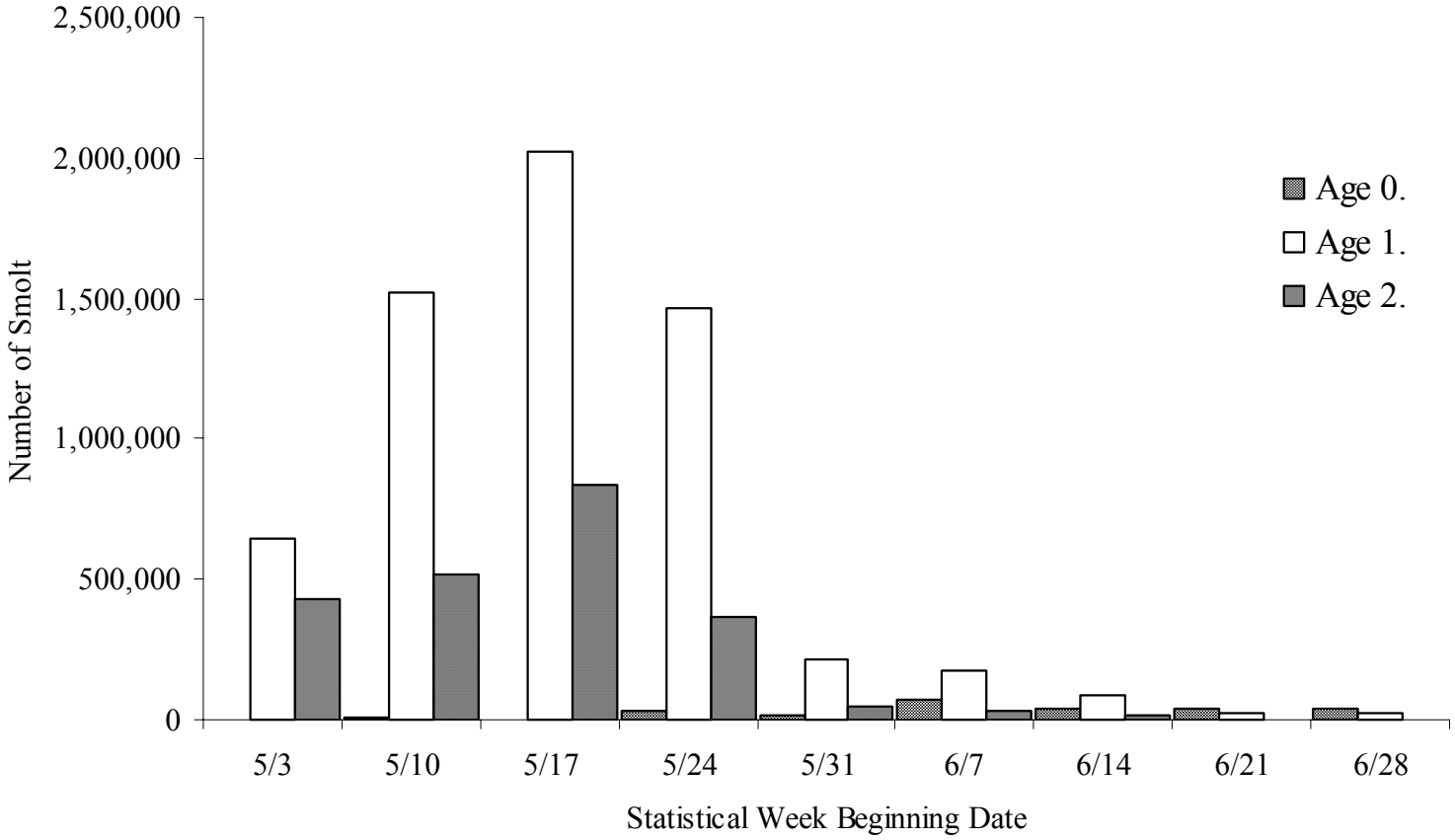

Figure 6.-Estimated smolt emigration of age 0. to age 2. sockeye salmon smolt, by statistical week beginning date, from the Chignik River, 2004.

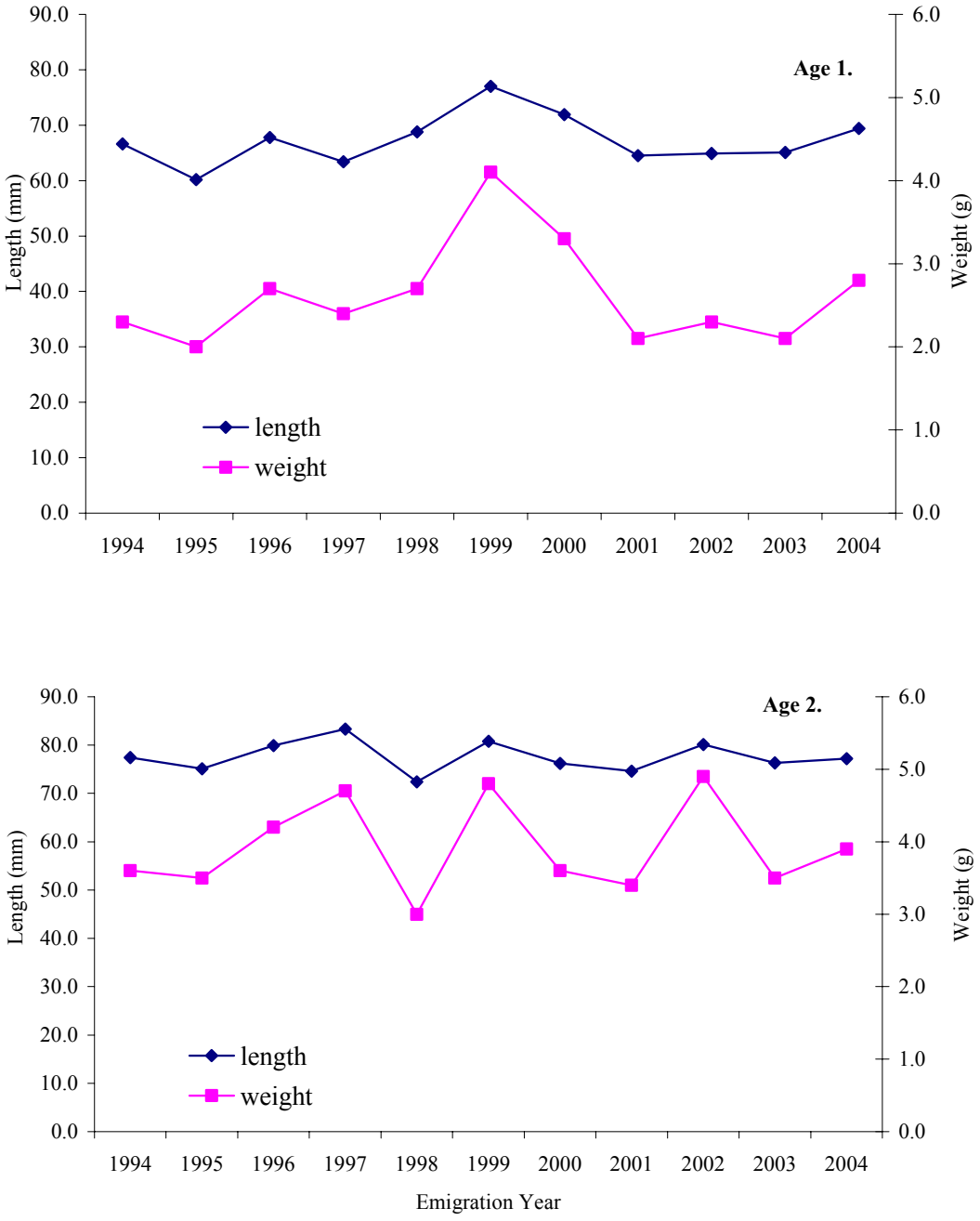

Figure 7.–Average length and weight of age 1. and age 2. sockeye salmon, by year, 1994 through 2004.

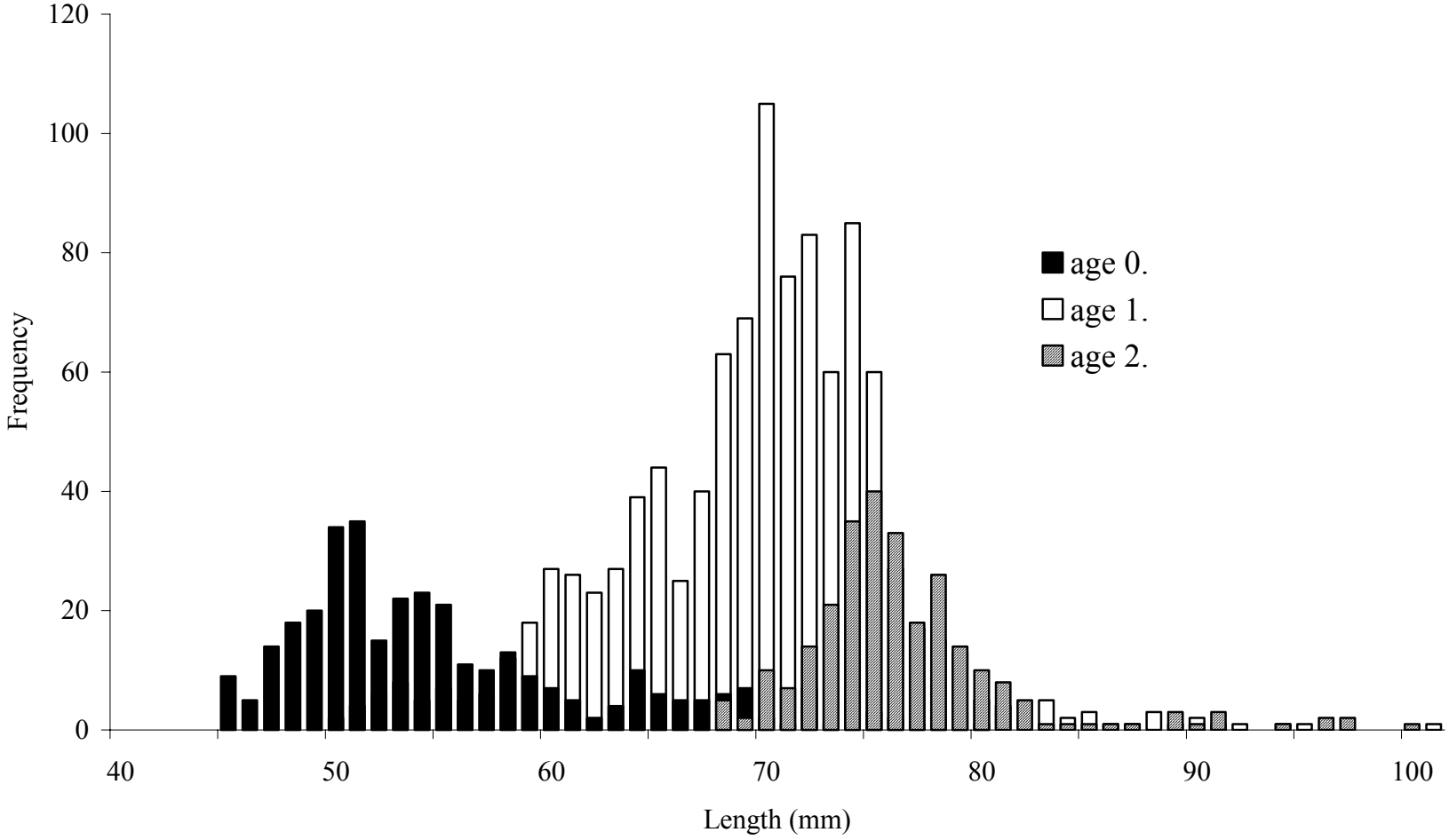

Figure 8.–Length frequency histogram of age 0., 1., and 2. sockeye salmon smolt sampled from the Chignik River, 2004.

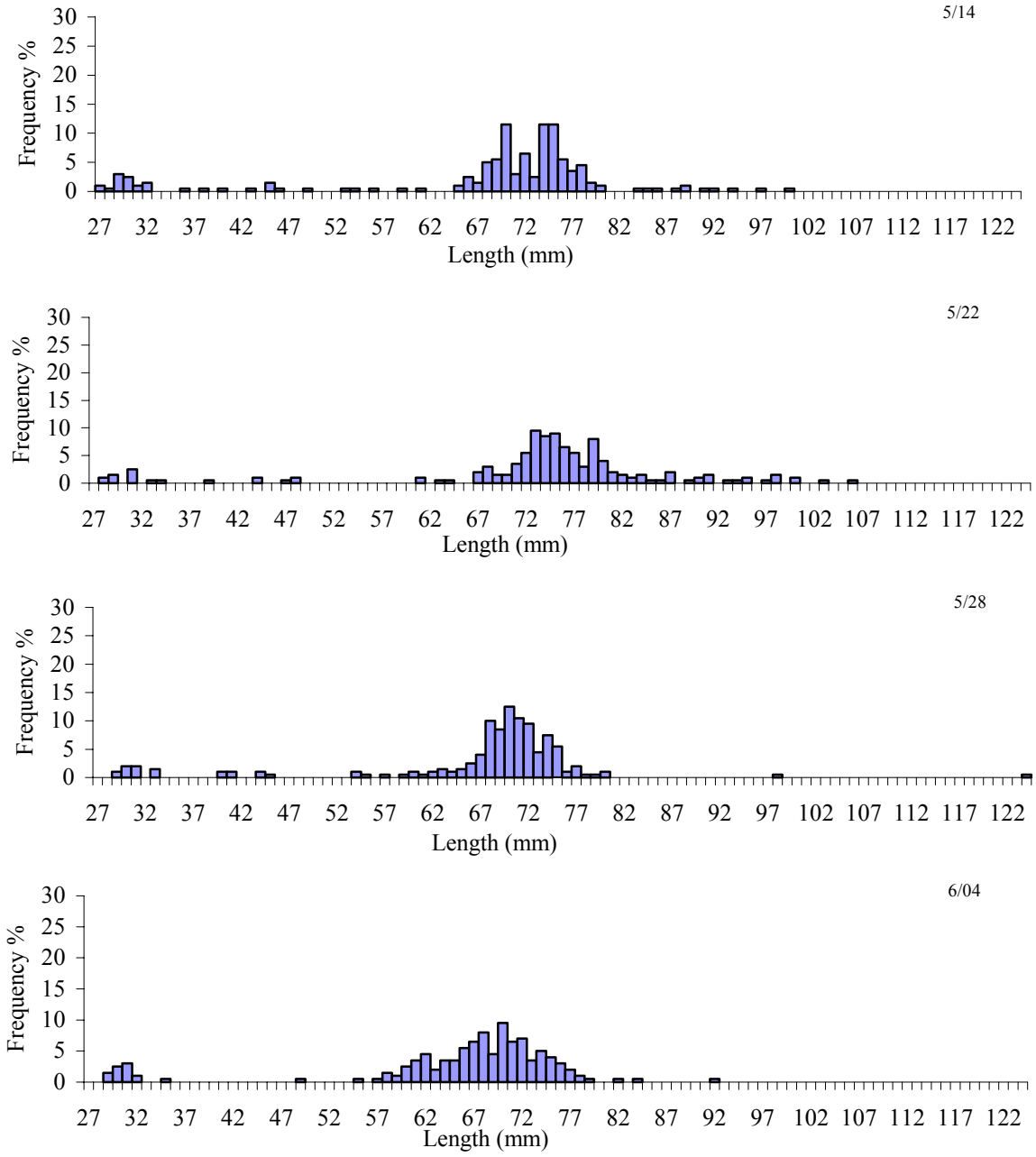

Figure 9.–Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps in May 14 to June 4, 2004.

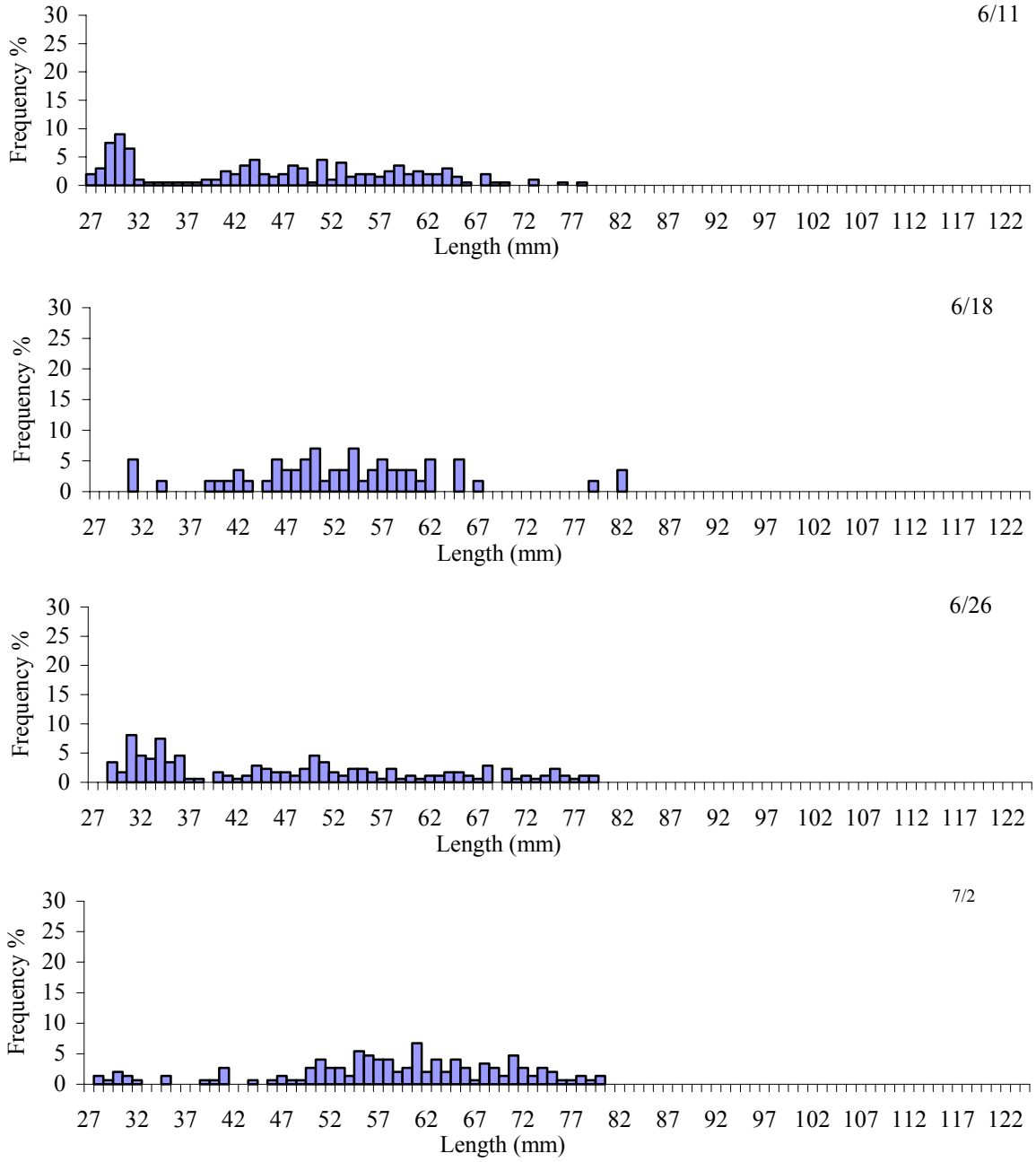

Figure 10.–Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps in June 11 to July 2, 2004.

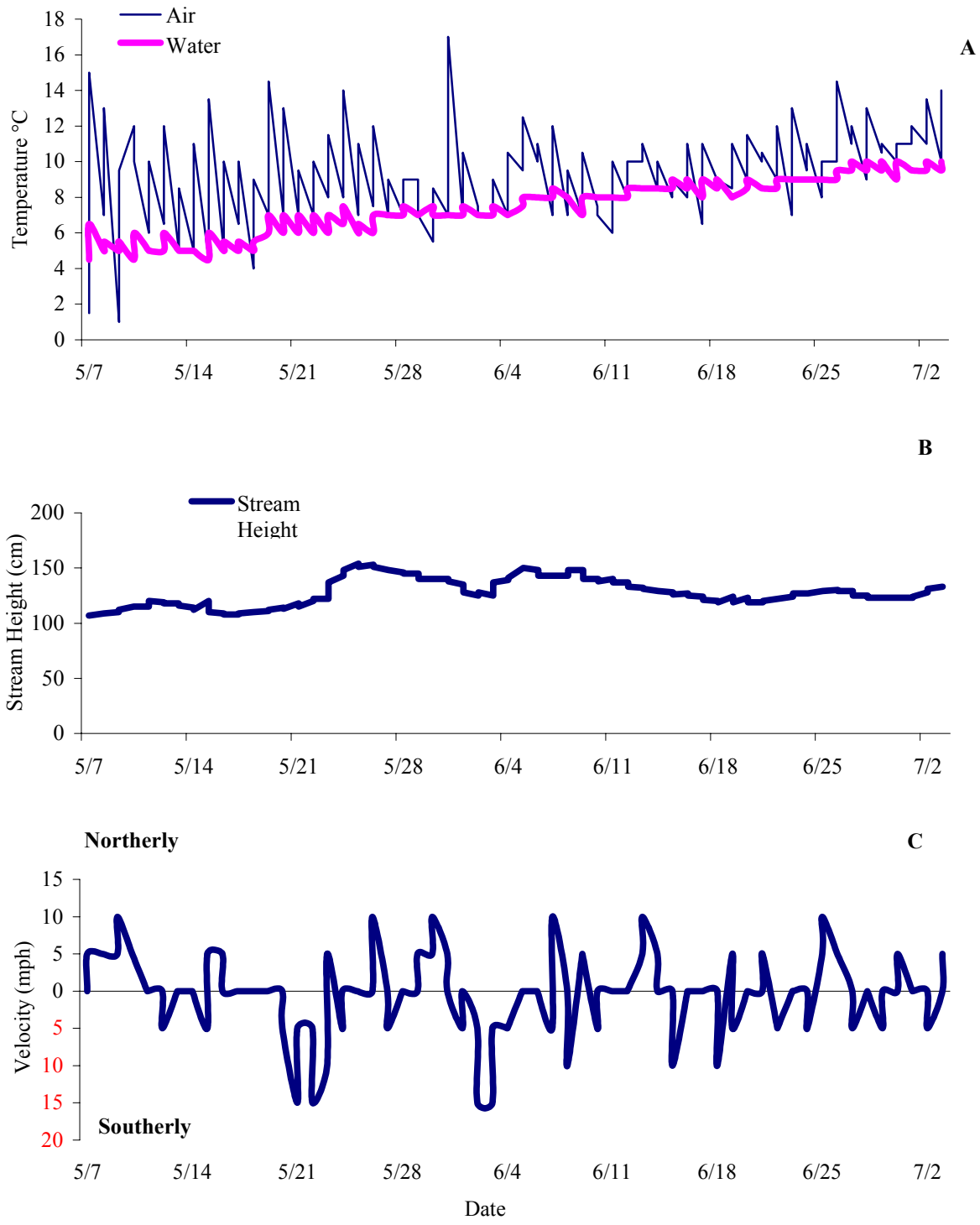

Figure 11.–Air and water temperature (A), stream gauge height (B), and wind velocity and direction data (C) gathered at the Chignik River smolt traps, 2004.

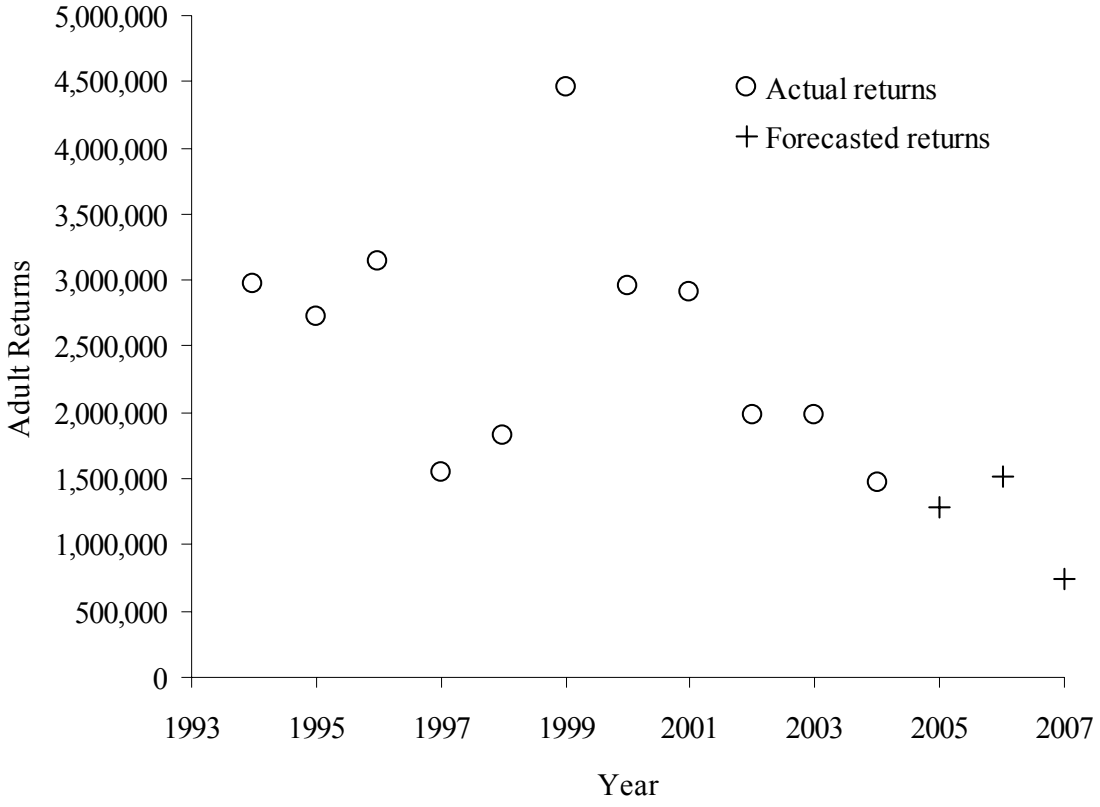

Figure 12.–Actual and forecasted returns of adult sockeye salmon to the Chignik River.

APPENDIX A:
SMOLT TRAP CATCHES BY DAY

Appendix A1.–Actual daily counts and trap efficiency data of the Chignik River sockeye salmon smolt project, 2004.

	Actual		Trap Efficiency Test				Incidental Catch[a]											
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	DV	SB	Chnk	PS	PW	SF	SC	ISO	Chm
5/6	1,035	1,035					322	0	11	2	15	0	7	0	1	6	0	0
5/7	1,071	2,106					253	5	17	3	27	0	3	1	7	3	0	0
5/8	661	2,767					282	6	1	1	91	0	4	0	2	0	0	0
5/9	920	3,687	2,326	7	7	0.34%	245	3	5	6	68	0	2	1	6	2	0	0
5/10	2,081	5,768		0	7	0.34%	250	0	0	2	5	0	0	0	0	1	0	0
5/11	3,510	9,278		0	7	0.34%	310	7	7	13	29	0	2	1	7	8	0	0
5/12	318	9,596		0	7	0.34%	95	2	0	4	6	0	0	0	0	2	0	0
5/13	607	10,203	2,764	13	13	0.51%	155	9	0	12	62	0	4	0	7	4	0	0
5/14	395	10,598		0	13	0.51%	95	8	0	7	60	0	0	2	1	0	0	0
5/15	310	10,908		0	13	0.51%	125	8	0	5	85	0	1	5	2	7	1	0
5/16	365	11,273		0	13	0.51%	105	13	0	7	45	0	3	5	1	5	0	0
5/17	971	12,244		0	13	0.51%	120	9	30	13	110	0	8	2	1	11	0	0
5/18	3,945	16,189	2,781	9	9	0.36%	345	12	0	12	190	0	1	0	3	16	0	0
5/19	1,839	18,028		0	9	0.36%	245	22	0	12	100	0	0	3	5	10	0	0
5/20	135	18,163		0	9	0.36%	110	16	0	6	60	0	2	3	6	9	0	0
5/21	245	18,408		0	9	0.36%	160	12	0	14	75	0	2	3	1	7	0	0
5/22	370	18,778		0	9	0.36%	170	17	0	5	80	0	18	0	7	9	0	0
5/23	4,185	22,963		0	9	0.36%	495	47	0	19	260	0	23	5	10	31	0	0
5/24	2,100	25,063	2,850	17	17	0.63%	280	14	0	14	140	0	8	0	8	8	2	0
5/25	4,475	29,538		0	17	0.63%	410	25	0	27	215	0	3	2	8	13	0	0
5/26	610	30,148		0	17	0.63%	270	7	0	20	210	0	14	4	6	8	0	0
5/27	415	30,563		0	17	0.63%	185	11	0	28	120	0	21	13	2	5	0	0
5/28	2,735	33,298		0	17	0.63%	525	37	0	33	270	0	65	7	4	7	1	0
5/29	1,045	34,343		0	17	0.63%	350	11	0	21	220	0	640	22	2	9	0	0
5/30	580	34,923	2,795	26	26	0.97%	240	8	0	7	75	0	175	5	3	1	0	0
5/31	610	35,533		2	28	1.04%	170	25	0	23	65	0	650	1	0	17	0	0
6/1	175	35,708		0	28	1.04%	80	6	0	5	50	0	1,690	4	1	0	0	0
6/2	196	35,904		0	28	1.04%	70	3	0	10	35	0	1,005	1	5	6	0	0
6/3	155	36,059		0	28	1.04%	40	8	0	5	105	0	1,510	1	5	10	0	0

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	Actual		Trap Efficiency Test				Incidental Catch[a]											
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	DV	SB	Chnk	PS	PW	SF	SC	ISO	Chm
6/4	1,083	37,142		0	28	1.04%	145	3	0	3	145	0	410	2	0	2	0	0
6/5	399	37,541		0	28	1.04%	100	7	0	3	80	0	390	3	0	0	0	0
6/6	270	37,811	1,059	10	10	1.04%	145	12	0	10	100	0	530	2	2	0	0	2
6/7	315	38,126		0	10	1.04%	195	28	0	5	105	5	485	20	2	1	0	0
6/8	445	38,571		0	10	1.04%	210	39	0	7	140	0	340	12	3	4	0	0
6/9	740	39,311		0	10	1.04%	220	28	0	5	75	0	155	6	2	4	0	0
6/10	505	39,816		0	10	1.04%	445	39	0	13	100	0	205	4	0	11	0	0
6/11	405	40,221		0	10	1.04%	750	38	0	7	80	0	210	0	0	0	0	0
6/12	495	40,716	1,120	15	15	1.43%	355	63	0	9	95	0	140	2	0	4	0	0
6/13	280	40,996		1	16	1.52%	285	29	0	10	32	0	65	5	2	3	0	0
6/14	480	41,476		2	18	1.69%	185	51	0	4	131	10	110	15	1	10	1	0
6/15	177	41,653		0	18	1.69%	70	17	0	5	30	0	35	5	0	1	0	0
6/16	435	42,088		0	18	1.69%	65	22	0	10	55	1	40	2	1	7	0	0
6/17	190	42,278		0	18	1.69%	45	56	0	3	55	20	90	0	1	2	0	0
6/18	67	42,345		0	18	1.69%	30	30	0	2	35	0	50	8	1	4	0	0
6/19	45	42,390	572	2	2	0.52%	20	47	0	3	20	0	35	13	2	4	0	0
6/20	58	42,448		2	4	0.87%	25	40	0	1	15	0	30	10	0	2	0	0
6/21	94	42,542		0	4	0.87%	10	87	0	2	9	11	15	9	0	2	0	0
6/22	87	42,629		0	4	0.87%	40	19	0	2	15	5	5	7	0	0	0	0
6/23	124	42,753		0	4	0.87%	45	48	0	1	20	11	22	4	0	2	0	0
6/24	40	42,793		0	4	0.87%	30	28	0	0	15	3	10	2	0	0	0	0
6/25	43	42,836		0	4	0.87%	10	100	0	0	5	16	0	4	0	1	0	0
6/26	91	42,927		0	4	0.87%	100	57	0	0	65	10	5	10	0	8	0	0
6/27	65	42,992		0	4	0.87%	45	33	0	1	22	2	5	6	0	3	0	0
6/28	66	43,058		0	4	0.87%	15	52	0	1	5	0	7	6	0	1	0	0
6/29	109	43,167		0	4	0.87%	40	47	0	1	55	14	25	5	0	2	1	0
6/30	91	43,258		0	4	0.87%	35	45	0	2	40	12	35	9	0	4	0	0
7/1	136	43,394		0	4	0.87%	25	30	0	0	20	10	16	0	0	2	0	0
7/2	140	43,534		0	4	0.87%	8	55	0	2	25	6	20	9	0	2	0	0

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	Actual		Trap Efficiency Test				Incidental Catch[a]											
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	DV	SB	Chnk	PS	PW	SF	SC	ISO	Chm
Total		43,534	16,267	106	106	0.66%	10,195	1,501	71	448	4,462	136	9,346	271	128	301	6	2

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

[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, May 6 through July 2, 2004.

	Small Trap		Large Trap		Combined		Percent Total	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
5/6	500	500	535	535	1,035	1,035	48.3	51.7
5/7	580	1,080	491	1,026	1,071	2,106	54.2	45.8
5/8	216	1,296	445	1,471	661	2,767	32.7	67.3
5/9	380	1,676	540	2,011	920	3,687	41.3	58.7
5/10	1,364	3,040	717	2,728	2,081	5,768	65.5	34.5
5/11	1,370	4,410	2,140	4,868	3,510	9,278	39.0	61.0
5/12	185	4,595	133	5,001	318	9,596	58.2	41.8
5/13	280	4,875	327	5,328	607	10,203	46.1	53.9
5/14	165	5,040	230	5,558	395	10,598	41.8	58.2
5/15	110	5,150	200	5,758	310	10,908	35.5	64.5
5/16	165	5,315	200	5,958	365	11,273	45.2	54.8
5/17	270	5,585	701	6,659	971	12,244	27.8	72.2
5/18	1,070	6,655	2,875	9,534	3,945	16,189	27.1	72.9
5/19	450	7,105	1,389	10,923	1,839	18,028	24.5	75.5
5/20	65	7,170	70	10,993	135	18,163	48.1	51.9
5/21	80	7,250	165	11,158	245	18,408	32.7	67.3
5/22	150	7,400	220	11,378	370	18,778	40.5	59.5
5/23	1,095	8,495	3,090	14,468	4,185	22,963	26.2	73.8
5/24	600	9,095	1,500	15,968	2,100	25,063	28.6	71.4
5/25	1,135	10,230	3,340	19,308	4,475	29,538	25.4	74.6
5/26	140	10,370	470	19,778	610	30,148	23.0	77.0
5/27	140	10,510	275	20,053	415	30,563	33.7	66.3
5/28	980	11,490	1,755	21,808	2,735	33,298	35.8	64.2
5/29	315	11,805	730	22,538	1,045	34,343	30.1	69.9
5/30	205	12,010	375	22,913	580	34,923	35.3	64.7
5/31	155	12,165	455	23,368	610	35,533	25.4	74.6
6/1	55	12,220	120	23,488	175	35,708	31.4	68.6
6/2	76	12,296	120	23,608	196	35,904	38.8	61.2
6/3	35	12,331	120	23,728	155	36,059	22.6	77.4
6/4	278	12,609	805	24,533	1,083	37,142	25.7	74.3
6/5	87	12,696	312	24,845	399	37,541	21.8	78.2
6/6	105	12,801	165	25,010	270	37,811	38.9	61.1
6/7	80	12,881	235	25,245	315	38,126	25.4	74.6
6/8	145	13,026	300	25,545	445	38,571	32.6	67.4
6/9	145	13,171	595	26,140	740	39,311	19.6	80.4
6/10	135	13,306	370	26,510	505	39,816	26.7	73.3
6/11	55	13,361	350	26,860	405	40,221	13.6	86.4
6/12	175	13,536	320	27,180	495	40,716	35.4	64.6
6/13	125	13,661	155	27,335	280	40,996	44.6	55.4
6/14	120	13,781	360	27,695	480	41,476	25.0	75.0
6/15[a]		13,781	177	27,872	177	41,653	0.0	100.0
6/16		13,781	435	28,307	435	42,088	0.0	100.0
6/17		13,781	190	28,497	190	42,278	0.0	100.0
6/18		13,781	67	28,564	67	42,345	0.0	100.0
6/19		13,781	45	28,609	45	42,390	0.0	100.0
6/20		13,781	58	28,667	58	42,448	0.0	100.0

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Date	Small Trap		Large Trap		Combined		Percent Total	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
6/21		13,781	94	28,761	94	42,542	0.0	100.0
6/22		13,781	87	28,848	87	42,629	0.0	100.0
6/23		13,781	124	28,972	124	42,753	0.0	100.0
6/24		13,781	40	29,012	40	42,793	0.0	100.0
6/25		13,781	43	29,055	43	42,836	0.0	100.0
6/26		13,781	91	29,146	91	42,927	0.0	100.0
6/27		13,781	65	29,211	65	42,992	0.0	100.0
6/28		13,781	66	29,277	66	43,058	0.0	100.0
6/29		13,781	109	29,386	109	43,167	0.0	100.0
6/30		13,781	91	29,477	91	43,258	0.0	100.0
7/1		13,781	136	29,613	136	43,394	0.0	100.0
7/2		13,781	140	29,753	140	43,534	0.0	100.0
Total		13,781		29,753		43,534	31.7	68.3

[a] The small trap was not in operation due to mechanical failure from this date forward.

APPENDIX C: PHYSICAL OBSERVATIONS

Appendix C1.–Daily climatological observations for the Chignik River sockeye salmon smolt project, 2004.

Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover %	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Trap Revolutions (rpm) Large	Stream Gauge (cm)	Comments
5/7	0:00	1.5	4.5	0		0	8.00	8.75	107	Clear
5/7	12:00	15.0	6.5	5	NW	5	8.00	9.13	107	Clear, Sunny
5/8	0:00	7.0	5.0	100	NW	5	8.50	7.63	109	Overcast
5/8	12:00	13.0	5.5	40	NW	5	8.50	8.00	109	Partly Cloudy
5/9	0:00	1.0	5.0	0		0	8.75	7.75	110	Clear
5/9	12:00	9.5	5.5	100	NW	10	9.00	7.75	112	Overcast
5/10	0:00	12.0	4.5	100	NW	5	9.25	8.00	115	Overcast
5/10	12:00	10.0	6.0	100	NW	5	9.50	8.00	115	Overcast
5/11	0:00	6.0	5.0	100		0	9.50	8.25	115	Overcast
5/11	12:00	10.0	5.0	40		0	9.75	8.13	120	Partly Cloudy
5/12	0:00	6.5	5.0	100		0	9.38	8.25	119	Overcast
5/12	12:00	12.0	6.0	65	SE	5	9.25	8.13	118	Partly Cloudy
5/13	0:00	5.0	5.0	100		0	8.50	8.13	118	Overcast
5/13	12:00	8.5	5.0	100		0	9.13	8.00	116	Overcast
5/14	0:00	5.0	5.0	100		0	9.13	8.00	114	Overcast
5/14	12:00	11.0	5.0	75		0	9.00	7.88	112	Partly Cloudy
5/15	0:00	4.5	4.5	100	SE	5	9.25	7.75	120	Overcast
5/15	12:00	13.5	6.0	60	NW	5	8.88	7.75	110	Partly Cloudy
5/16	0:00	5.0	5.0	100	SE	5	8.25	8.00	109	Rain
5/16	12:00	10.0	5.5	80		0	8.25	7.25	108	Overcast
5/17	0:00	6.5	5.0	100		0	8.25	7.75	108	Overcast
5/17	12:00	10.0	5.5	80		0	8.75	7.75	109	Overcast
5/18	0:00	4.0	5.0	20		0	8.50	7.88	110	Mostly Clear
5/18	12:00	9.0	5.5	100		0	8.50	7.75	110	Overcast
5/19	0:00	7.0	6.0	100		0	9.00	8.25	111	Cloudy
5/19	12:00	14.5	7.0	60		0	9.25	8.25	112	Mostly Overcast
5/20	0:00	7.0	6.0	100		0	9.25	7.75	114	Overcast
5/20	12:00	13.0	7.0	60	SE	5	9.25	8.25	113	Mostly Overcast
5/21	0:00	7.0	6.0	90	SE	15	9.25	8.00	118	Cloudy

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Appendix C1.–Page 2 of 4.

Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover (%)	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Trap Revolutions (rpm) Large	Stream Gauge (cm)	Comments
5/21	12:00	9.5	7.0	100	SE	5	9.25	8.00	115	Overcast
5/22	0:00	7.0	6.0	100	SE	5	9.50	8.25	120	Overcast
5/22	12:00	10.0	7.0	100	SE	15	9.50	8.13	122	Rain
5/23	0:00	8.0	6.0	100	SE	10	10.25	8.88	122	Overcast
5/23	12:00	11.5	7.0	100	NW	5	11.00	9.50	137	Cloudy/Rain
5/24	0:00	8.0	6.5	80	SE	5	11.50	9.38	143	Cloudy
5/24	12:00	14.0	7.5	100		0	12.00	9.50	148	Overcast
5/25	0:00	7.0	6.0	100		0	11.50	9.25	154	Overcast
5/25	12:00	11.0	6.5	100		0	11.25	9.00	151	Overcast
5/26	0:00	7.5	6.0	100		0	11.00	9.50	153	Overcast
5/26	12:00	12.0	7.0	25	NW	10	11.00	9.38	151	Sunny
5/27	0:00	7.0	7.0	50		0	11.00	9.50	148	Mostly Clear
5/27	12:00	9.0	7.0	100	SE	5	10.50	9.00	148	Overcast
5/28	0:00	7.0	7.0	100		0	10.00	9.13	146	Rain
5/28	12:00	9.0	7.5	100		0	10.00	9.00	145	Rain
5/29	0:00	9.0	7.0	100		0	10.00	8.50	145	Rain
5/29	12:00	7.0	7.0	100	NW	5	9.50	8.13	140	Overcast
5/30	0:00	5.5	7.5	100	NW	5	10.00	8.50	140	Overcast
5/30	12:00	8.5	7.0	50	NW	10	10.00	8.50	140	Partly Cloudy
5/31	0:00	7.0	7.0	100	NW	5	10.50	9.50	140	Overcast
5/31	12:00	17.0	7.0	50		0	9.50	8.75	138	Sunny
6/1	0:00	7.0	7.0	85	SE	5	9.00	8.00	135	Cloudy
6/1	12:00	10.5	7.5	100		0	9.50	8.00	128	Cloudy
6/2	0:00	7.5	7.0	100	SE	5	9.00	8.00	125	Overcast
6/2	12:00	7.0	7.0	100	SE	15	8.75	7.75	128	Rainy
6/3	0:00	7.0	7.0	100	SE	15	8.75	7.75	125	Rainy
6/3	12:00	9.0	7.5	100	SE	5	8.75	7.88	137	Rainy
6/4	0:00	7.0	7.0	100	SE	5	9.50	8.38	139	Overcast

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Appendix C1.–Page 3 of 4.

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
6/4	12:00	10.5	7.0	100	SE	5	10.00	8.75	141	Overcast
6/5	0:00	9.5	7.5	100		0	10.00	8.75	150	Overcast
6/5	12:00	12.5	8.0	50		0	10.25	8.75	150	Broken
6/6	0:00	10.0	8.0	90		0	10.25	9.00	148	Cloudy
6/6	12:00	11.0	8.0	100		0	10.00	9.00	143	Overcast
6/7	0:00	7.0	8.0	100	SE	5	9.75	8.38	143	Rain
6/7	12:00	12.0	8.5	50	NW	10	10.25	9.00	143	Broken
6/8	0:00	7.0	8.0	80		0	10.00	8.50	143	Overcast
6/8	12:00	9.5	8.0	90	SE	10	10.25	9.00	148	Cloudy
6/9	0:00	7.0	7.0	100	NW	5	9.50	8.38	148	Overcast
6/9	12:00	10.5	8.0	100	NW	5	9.50	8.75	140	Cloudy
6/10	0:00	7.5	8.0	100	SE	5	9.50	8.50	140	Overcast
6/10	12:00	7.0	8.0	100		0	9.00	8.50	138	Rain
6/11	0:00	6.0	8.0	100		0	9.00	8.00	140	Rain
6/11	12:00	10.0	8.0	100		0	9.00	8.38	137	Rain
6/12	0:00	8.0	8.0	100		0	9.00	8.00	137	Overcast
6/12	12:00	10.0	8.5	100		0	9.00	7.88	133	Rain
6/13	0:00	10.0	8.5	100	NW	5	9.00	8.38	132	Overcast
6/13	12:00	11.0	8.5	100	NW	10	9.00	8.00	131	Overcast
6/14	0:00	8.5	8.5	100	NW	5	9.25	8.00	129	Rain
6/14	12:00	10.0	8.5	100		0	8.50	8.00	129	Rain
6/15	0:00	8.0	8.5	100		0	8.50	7.88	128	Rain
6/15	12:00	9.0	9.0	100	SE	10	8.50	8.00	126	Rain
6/16	0:00	8.0	8.5	100		0	8.50	8.00	127	Overcast
6/16	12:00	11.0	9.0	100		0	N/A	7.75	125	Overcast
6/17	0:00	6.5	8.0	80		0	N/A	7.63	124	Overcast
6/17	12:00	11.0	9.0	100		0	N/A	7.50	121	Overcast
6/18	0:00	9.0	8.5	100		0	N/A	7.25	120	Overcast
6/18	12:00	9.0	9.0	100	SE	10	N/A	7.25	119	Rain

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Appendix C1.–Page 4 of 4.

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
6/19	0:00	8.5	8.0	95	NW	5	N/A	7.25	124	Cloudy
6/19	12:00	11.0	8.0	50	SE	5	N/A	7.25	119	Partly Cloudy
6/20	0:00	9.0	8.5	90		0	N/A	7.25	123	Cloudy
6/20	12:00	11.5	9.0	100		0	N/A	7.25	119	Overcast
6/21	0:00	10.0	8.5	100		0	N/A	7.50	119	Overcast
6/21	12:00	10.5	8.5	75	NW	5	N/A	7.25	120	Overcast
6/22	0:00	9.0	8.5	85	SE	5	N/A	7.50	122	Cloudy
6/22	12:00	12.0	9.0	100	SE	5	N/A	7.75	122	Overcast
6/23	0:00	7.0	9.0	60		0	N/A	7.5	124	Partly Cloudy
6/23	12:00	13.0	9.0	100		0	N/A	7.75	127	Overcast
6/24	0:00	9.5	9.0	100		0	N/A	7.88	127	Cloudy
6/24	12:00	11.0	9.0	100	SE	5	N/A	7.75	127	Rain
6/25	0:00	8.0	9.0	100	NW	5	N/A	8.00	129	Rain
6/25	12:00	10.0	9.0	100	NW	10	N/A	8.00	129	Overcast
6/26	0:00	10.0	9.0	100	NW	5	N/A	8.00	130	Overcast
6/26	12:00	14.5	9.5	100	NW	5	N/A	7.75	129	Overcast
6/27	0:00	11.0	9.5	80		0	N/A	7.50	129	Cloudy
6/27	12:00	12.0	10.0	10	SE	5	N/A	7.50	125	Overcast
6/28	0:00	9.0	9.5	70		0	N/A	7.63	125	Mostly Cloudy
6/28	12:00	13.0	10.0	100		0	N/A	7.75	123	Overcast
6/29	0:00	10.5	9.5	65	SE	5	N/A	7.50	123	Parly Cloudy
6/29	12:00	11.0	10.0	100		0	N/A	7.50	123	Overcast
6/30	0:00	10.0	9.0	100		0	N/A	7.00	123	Overcast
6/30	12:00	11.0	10.0	100	NW	5	N/A	7.00	123	Rain
7/1	0:00	11.0	9.5	100		0	N/A	7.63	123	Overcast
7/1	12:00	12.0	9.5	100		0	N/A	7.50	124	Overcast
7/2	0:00	11.0	9.5	100		0	N/A	6.75	128	Cloudy
7/2	12:00	13.5	10.0	100	SE	5	N/A	7.75	131	Overcast
7/3	0:00	10.0	9.5	100		0	N/A	7.75	133	Overcast
7/3	12:25	14.0	10.0	100	NW	5	N/A	7.50	133	Cloudy

[a] Actual calendar dates.

[b] Based on observer estimates.

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
Mark Witteveen	ADF&G	Kodiak ADF&G Office	1
Steve Honnold	ADF&G	Kodiak ADF&G Office	1
Heather Finkle	ADF&G	Kodiak ADF&G Office	3
Ken Bouwens	ADF&G	Kodiak ADF&G Office	1
Jim McCullough	ADF&G	Kodiak ADF&G Office	1
Drew Crawford	ADF&G	Anchorage ADF&G Office	1