Fishery Data Series No. 06-13

Sockeye Salmon Smolt Investigations on the Chignik River, 2005

by

Heather Finkle

March 2006

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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by

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March 2006

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This document should be cited as:
Finkle, H. 2006. Sockeye salmon smolt investigations on the Chignik River, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-13, Anchorage.

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ABSTRACT

This paper provides the results from the twelfth year of the Chignik River sockeye salmon *Oncorhynchus nerka* smolt enumeration project. Outmigrating 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 2005, a total of 4,435,988 sockeye salmon smolt were estimated to pass downstream of the traps from April 26 to July 11. Of these, 859,211 (19.4%) were age-0., 2,075,681 (46.8%) were age-1., 1,468,208 (33.1%) were age-2., and 32,889 (0.7%) were age-.3 smolt. The Chignik River watershed run is formally forecast using sibling and temperature index relationships. The forecast using smolt information is considered ancillary data. The formal forecast is for a total run of 1.49 million sockeye salmon in 2006 with an expected harvest of 887 thousand fish. Smolt abundance data, by brood year, and temperature data from the King Salmon Airport during the smolt outmigration year were regressed against ocean-age-3 returns from their respective brood years to forecast the 2006 sockeye salmon run. It was estimated that approximately 954 thousand sockeye salmon are expected to return in 2006, equating to a harvest of about 279 thousand sockeye salmon. 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

The Chignik River watershed, which is the primary sockeye salmon *Oncorhynchus nerka* producer in the Chignik Management Area (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 watershed (Templin et al. 1999). The early run (sustainable escapement goal [SEG] range of 350,000 to 400,000 fish) 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 (Roos 1957, 1959; Iverson 1966; Phinney 1968; ADF&G unpublished data). 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 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 *In prep*). 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 *In prep*). Smolt emigration estimates by age, and potentially stock, are expected to add accuracy to the forecast models currently used.

The 2005 field season completed the twelfth 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; 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 2005 Chignik River Sockeye Salmon Smolt Enumeration Project, comparisons of 2005 smolt data to past smolt data, and adult sockeye salmon forecast estimates for 2006 and 2007, based on smolt emigration data.

OBJECTIVES

The objectives for the 2005 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, and

3) Continue to build a smolt model 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 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.

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 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 10’x12’ 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 2005 field season, both of the traps were operated continuously from 1200 hours on April 26 to 1200 hours, July 10. 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 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; 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 approximately 600 and 2,500 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 Bismark Brown Y dye solution (3.9 g of dye to 75.5 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 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 were 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

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

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

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

and 95% confidence intervals were estimated from

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

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

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

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

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

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

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

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:

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

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 2 and ending July 10. All sockeye salmon including juveniles < 45 mm FL were measured for fork length. A length frequency analysis was conducted to investigate the fry or presmolt 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 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); 5 AAC 18.360(d); ADF&G 2002). 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 3-ocean component (historically approximately 83% of the entire run) of the 2006 adult sockeye salmon runs 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 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 76 days beginning on April 26 and ending on July 10 (Appendix A1). The duration of the 2005 trapping season was 18 days longer than the 2004 season.

TRAP CATCH

A total of 24,918 sockeye salmon smolt were captured in the traps in 2005 (Appendix A1). In addition to sockeye salmon smolt, a total of 31,008 sockeye salmon fry, 2,302 juvenile coho salmon, 1 pink salmon fry, 120 juvenile Chinook salmon, 184 Dolly Varden char, 12,760 stickleback, 555 pond smelt, 314 pygmy whitefish, 83 starry flounders, and 174 sculpin were captured (Appendix A1). The small screw trap caught approximately 41.7% of the sockeye salmon smolt while the large trap caught 58.3% of the sockeye salmon smolt (Appendix B).

SOCKEYE SALMON SMOLT EMIGRATION AND TIMING

The estimated number of sockeye salmon smolt that emigrated in 2005 was 4,435,988 (±2,028,388; 95% CI.; Table 1; Figure 3). The majority of these fish emigrated in late May (Table 2; Figure 4). The 2005 emigration consisted of 859,211 age-0., 2,075,681 age-1., 1,468,208 age-2., and 32,889 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 in the beginning of the smolt outmigration (Table 2; Figure 6).

TRAP EFFICIENCY ESTIMATES

Mark-recapture experiments were conducted on nine occasions beginning on May 2 and ending on July 2, 2005. A total of 11,771 smolt, approximately 47% of the total catch, were marked and released. Ninety-two smolt were recaptured and trap efficiency estimates ranged from 0.17% to 1.37% (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 1,950 sockeye salmon smolt were sampled for AWL data in 2005 (Table 4), of which 33.5% were age-0.(BY 04), 45.7% were age 1. (BY 03), 20.4% were age-2. (BY 02), and 0.4% were age-3. (BY 01; Table 4). The mean length and weight of age-0. smolt were 56 mm and 1.5 g (Table 5; Figure 7). The mean length and weight of age-1. smolt were 69 mm and 2.7 g (Table 5). The mean length and weight of age-2. smolt were 75 mm and 3.5 g. and the mean length and weight of age-3. smolt were 108 mm and 11.4 g. (Table 5). Smolt length was plotted in a length frequency histogram to investigate any modalities in age classes (Figure 8). Juvenile sockeye <45 mm FL were present throughout the trapping season, but were most abundant at 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 2005 climate data, are reported in Appendix C1. The absolute water depth at the trap location varied between 110 to 165 cm during the 2005 season. Water temperatures averaged near 4.7^{o}C during the first week that traps were installed (April 26 through May 3) and increased steadily throughout the season. Comparatively stable and relatively high water levels and calm winds (Figure 12) generally characterized the 2005 season.

MARINE SURVIVAL ESTIMATES AND FUTURE RUN FORECASTING

All adult sockeye salmon from BYs 1993 through 1998 and for the most of the 1999 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 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 2001 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 2001 averaged 12%.

A multiple regression model displayed significant relationships ($P<0.03$, $P<0.08$; $R^2>0.67$) among total smolt outmigration, King Salmon air temperature during smolt outmigration, and ocean-age-3 adult returns. Based on the regression model, the 2006 total adult run forecast is 954 thousand sockeye salmon.

DISCUSSION

The point estimate of the 2005 total smolt emigration was the second lowest estimated emigration on record since 1994. The confidence in the 2005 estimate is fair considering that the 2005 mark-recapture experiment results compared similarly to those from past years. In 2005, a total of 11,771 smolt were marked and 92 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 2005 trap efficiency (0.79%) was similar to 1999, 2000, and 2001 trap efficiencies. The low trap efficiencies are reasonable considering that the cross-sectional area of Chignik River is roughly 106 m^2 at the trap location and the traps fished approximately 3.0% (3.22 m^2) of the Chignik River. Furthermore, an Interphase VISTA Forward Scanning Sonar, capable of detecting smolt-sized fish from distances greater than 60 m (the river’s width at the trap site), was mounted on the large trap both facing forward from and perpendicular to the trap to assess if juvenile fishes were avoiding the trap. A fyke net was deployed on multiple occasions parallel to and downstream from the smolt traps to also assess trap avoidance. Both gear types were checked during daylight and darkness hours and did not indicate that a large portion of outmigrating smolt were avoiding the traps.

There has been concern a significant portion of the sockeye salmon smolt emigration has been missed prior the trap being installed in the spring. In 2005, the peak smolt emigration took place on June 11, 47 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. This data suggests that installation of the trap during the later part of April is sufficiently early to capture the majority of the emigration.

The smolt that emigrated in 2005 were generally comparable in size compared to smolt that emigrated between 2001 and 2004. Sockeye salmon smolt that emigrated from the watershed between 1994 and 1997 were generally smaller than outmigrating smolt in 2005. The mean length and weight of the age-1. sockeye salmon that emigrated in 2005 were similar to those that emigrated in 1998 and 2004. These fish were both heavier and longer than age-1. smolt from 2001 to 2003. The age-2. smolt, were similar in length, but slightly lighter than those fish emigrating in 2003 and 2004 (Table 6; Figure 7).

The total abundance of age-1 and -2. smolt were low, and there were proportionately fewer age-1. and -2. smolt during 2005. 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 2005 suggest that subsequent early-run (primarily in 2007) and late-run returns (primarily in 2008) may be poor.

The low total abundance of smolt could be the result of poor rearing conditions during their freshwater residence. During 2003 and 2004, when the 2005 age-2. smolt were rearing as age-0. and -1. juveniles, Chignik Lake experienced low zooplankton biomasses (Finkle 2005; Finkle *In prep*). Recent water temperatures were warmer on average in both lakes compared to past years and Chignik Lake was more turbid in 2004 than from 2000 to 2003 and 2005 (Finkle *In prep*). Age-1. sockeye salmon would also be affected by these same conditions in 2004 as age-0. fish. If these fish emigrated early 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 2005, a total of 31,008 sockeye salmon fry (presmolt) were captured during the field season, which was substantially more than in all past years (Finkle and Newland 2005). This high fry count coincided with low zooplankton levels and unfavorable temperatures and turbidity (Finkle *In prep*).

Observed marine survivals, by emigration year (excluding 1996), of Chignik smolt have ranged from five percent to 17 percent (Table 9). These figures 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 2006 Chignik sockeye salmon forecast is 1.49 million (Eggers *In prep*).

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 multiple regression model was developed to forecast the 2006 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 King Salmon air temperature during April through December during the smolt outmigration year and smolt survival to adult (R^2=0.75). Integration of this information should result in a more accurate smolt based forecast of adult returns. The 2006 smolt-based forecast of 954 thousand sockeye salmon is approximately 533 thousand less than was forecasted using sibling and temperature regression relationships. The lower-than-average forecast is due primarily to low outmigration rather than an unfavorable temperature. 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 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) explains a higher percent (67%) of the variability of the dependent variable as explained by the independent variable than past models and may be a good predictor. Because of the small data set and model significance, our confidence in the smolt-based forecast is only fair.

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 2005.

		Number of Smolt							95% C.I.	
Year		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			
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			
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			

Table 2.-Estimated sockeye salmon smolt emigration from the Chignik River, by age class and statistical week, 2005.

Statistical Week	Starting Date	Number of Smolt				
		Age 0.	Age 1.	Age 2.	Age 3.	Total
18	4/26	211,408	281,877	211,408	0	704,693
19	5/3	140,006	170,008	90,004	0	400,018
20	5/10	63,475	167,467	37,815	0	268,757
21	5/17	108,470	235,713	62,579	0	406,762
22	5/24	16,664	153,675	198,111	1,852	368,449
23	5/31	113,236	736,034	745,470	28,309	1,594,741
24	6/7	40,154	211,723	104,036	1,825	355,913
25	6/14	38,706	56,953	13,271	553	108,930
26	6/21	31,143	36,042	2,100	350	69,285
27	6/28	50,454	21,244	3,414	0	75,112
28	7/5	45,494	4,945	0	0	50,439
Total		859,211	2,075,681	1,468,208	32,889	4,435,988

Table 3.-Results from mark-recapture tests performed on sockeye salmon smolt migrating through the Chignik River, 2005.

Date	No. Marked	Total Recaptures	Trap Efficiency[a]
5/2	1,442	8	0.62%
5/9	1,181	7	0.68%
5/17	910	7	0.88%
5/23	1,010	7	0.79%
5/30	1,156	1	0.17%
6/6	2,193	21	1.00%
6/13	2,440	26	1.11%
6/22	784	7	1.02%
7/2	655	8	1.37%
Total	11,771	92	0.79%

[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, 2005.

Stat	Sample		Number of Smolt				
Week	Size		Age .0	Age .1	Age .2	Age .3	Total
18	40	Percent	30.0	40.0	30.0	0.0	100.0
		Numbers	12	16	12	0	40
19	200	Percent	35.0	42.5	22.5	0.0	100.0
		Numbers	70	85	45	0	200
20	199	Percent	23.6	62.3	14.1	0.0	100.0
		Numbers	47	124	28	0	199
21	195	Percent	26.7	57.9	15.4	0.0	100.0
		Numbers	52	113	30	0	195
22	200	Percent	4.5	41.5	53.5	0.5	100.0
		Numbers	9	83	107	1	200
23	172	Percent	7.0	45.3	45.9	1.7	100.0
		Numbers	12	78	79	3	172
24	196	Percent	11.2	59.2	29.1	0.5	100.0
		Numbers	22	116	57	1	196
25	198	Percent	35.4	52.0	12.1	0.5	100.0
		Numbers	70	103	24	1	198
26	199	Percent	44.7	51.8	3.0	0.5	100.0
		Numbers	89	103	6	1	199
27	198	Percent	67.2	28.3	4.5	0.0	100.0
		Numbers	133	56	9	0	198
28	153	Percent	90.2	9.8	0.0	0.0	100.0
		Numbers	138	15	0	0	153
Total	1,950	Percent	33.5	45.7	20.4	0.4	100.0
		Numbers	654	892	397	7	1,950

Table 5.-Length, weight, and condition factor of Chignik River sockeye salmon smolt samples, by age and statistical week, 2005.

				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	12	48	1.43	0.7	0.07	0.61	0.02
0	19	5/3	70	50	0.57	0.9	0.04	0.69	0.01
0	20	5/10	47	53	0.94	1.1	0.08	0.74	0.02
0	21	5/17	52	56	1.19	1.3	0.10	0.68	0.02
0	22	5/24	9	49	0.94	0.8	0.04	0.70	0.03
0	23	5/31	12	53	3.10	1.4	0.28	0.77	0.03
0	24	6/7	22	55	1.09	1.3	0.08	0.80	0.02
0	25	6/14	68	53	0.60	1.3	0.05	0.87	0.01
0	26	6/21	89	57	0.93	1.8	0.09	0.88	0.01
0	27	6/28	133	59	0.58	2.0	0.06	0.92	0.01
0	28	7/5	138	57	0.42	1.7	0.04	0.90	0.01
Total			652	56	0.28	1.5	0.03	0.83	0.01
1	18	4/26	16	69	1.58	2.3	0.16	0.71	0.02
1	19	5/3	85	69	0.96	2.6	0.11	0.74	0.01
1	20	5/10	124	70	0.68	2.8	0.09	0.77	0.01
1	21	5/17	113	70	0.68	2.7	0.09	0.77	0.01
1	22	5/24	83	74	0.75	3.3	0.12	0.78	0.01
1	23	5/31	78	73	0.98	3.3	0.15	0.81	0.01
1	24	6/7	116	69	0.54	2.8	0.07	0.83	0.01
1	25	6/14	103	66	0.66	2.5	0.07	0.84	0.01
1	26	6/21	103	66	0.64	2.5	0.07	0.85	0.01
1	27	6/28	56	65	0.66	2.4	0.08	0.87	0.01
1	28	7/5	15	63	0.66	2.2	0.70	0.90	0.02
Total			892	69	0.25	2.7	0.03	0.81	0.00
2	18	4/26	12	73	0.97	2.8	0.10	0.72	0.01
2	19	5/3	45	72	0.88	2.8	0.11	0.74	0.01
2	20	5/10	28	75	1.05	3.3	0.16	0.78	0.01
2	21	5/17	30	79	1.38	3.9	0.24	0.77	0.01
2	22	5/24	107	77	0.59	3.6	0.10	0.78	0.01
2	23	5/31	79	77	0.65	3.6	0.10	0.79	0.01
2	24	6/7	57	75	1.14	3.7	0.25	0.83	0.01
2	25	6/14	24	73	0.65	3.2	0.09	0.83	0.02
2	26	6/21	6	78	1.89	4.0	0.23	0.86	0.04
2	27	6/28	9	74	1.96	3.8	0.38	0.93	0.05
Total			397	75	0.33	3.5	0.06	0.79	0.00
3	22	5/24	1	103	-	10.0	-	0.92	-
3	23	5/31	3	116	2.08	13.3	1.08	0.85	0.04
3	24	6/7	1	112	-	13.5	-	0.96	-
3	25	6/14	1	85	-	5.3	-	0.86	-
3	26	6/21	1	105	-	11.0	-	0.95	-
Total			7	108	4.35	11.4	1.21	0.89	0.02

Table 6.-Mean length, weight, and condition factor of sockeye salmon smolt samples from the Chignik River, by year and age, 1994 to 2005.

		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
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
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
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
2001	4	1	125	-	1	18.8	-	1	0.96	-

Table 7.-Estimated age composition of Chignik River sockeye salmon smolt samples, 1994 to 2005.

Year	Dates	Sample Size		Number of Smolt Age 0.	Age 1.	Age 2.	Age 3.	Age 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
2005	4/26-07/8	1,952	Percent	33.5	45.7	20.4	0.4	0.00	100.0
			Numbers	654	892	397	7	0	1,950

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 2005.

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	923,261	407,090	109	0	1,359,653	1.90	6%
2000	805,225	521,546	13,980,423	1,449,494	0	0	15,951,463	19.81								
2001	1,136,918	440,947	5,146,278	2,239,716	32,889		7,859,830	6.91								
2002	725,220	155,047	6,172,902	1,468,208												
2003	684,145	244,206	2,075,681													
2004	578,259	859,211														
2005	581,382															

[a] Minor age classes are not fully recruited for adult age-2., -3., and from other returns brood year 1999.

Table 9.-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 2005.

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	13,865	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	3,012	1,298,273	5%
2002	440,947	13,980,423	2,223,996	72,184	16,717,551	4,072	432,476	2,024,181		2,460,729	15%
2003	155,047	5,146,278	1,449,494	0	6,750,819	2,282	156,956				
2004	244,206	6,172,902	2,239,716	0	8,656,824	1,333					
2005	859,211	2,075,681	1,468,208	32,889	4,435,988						

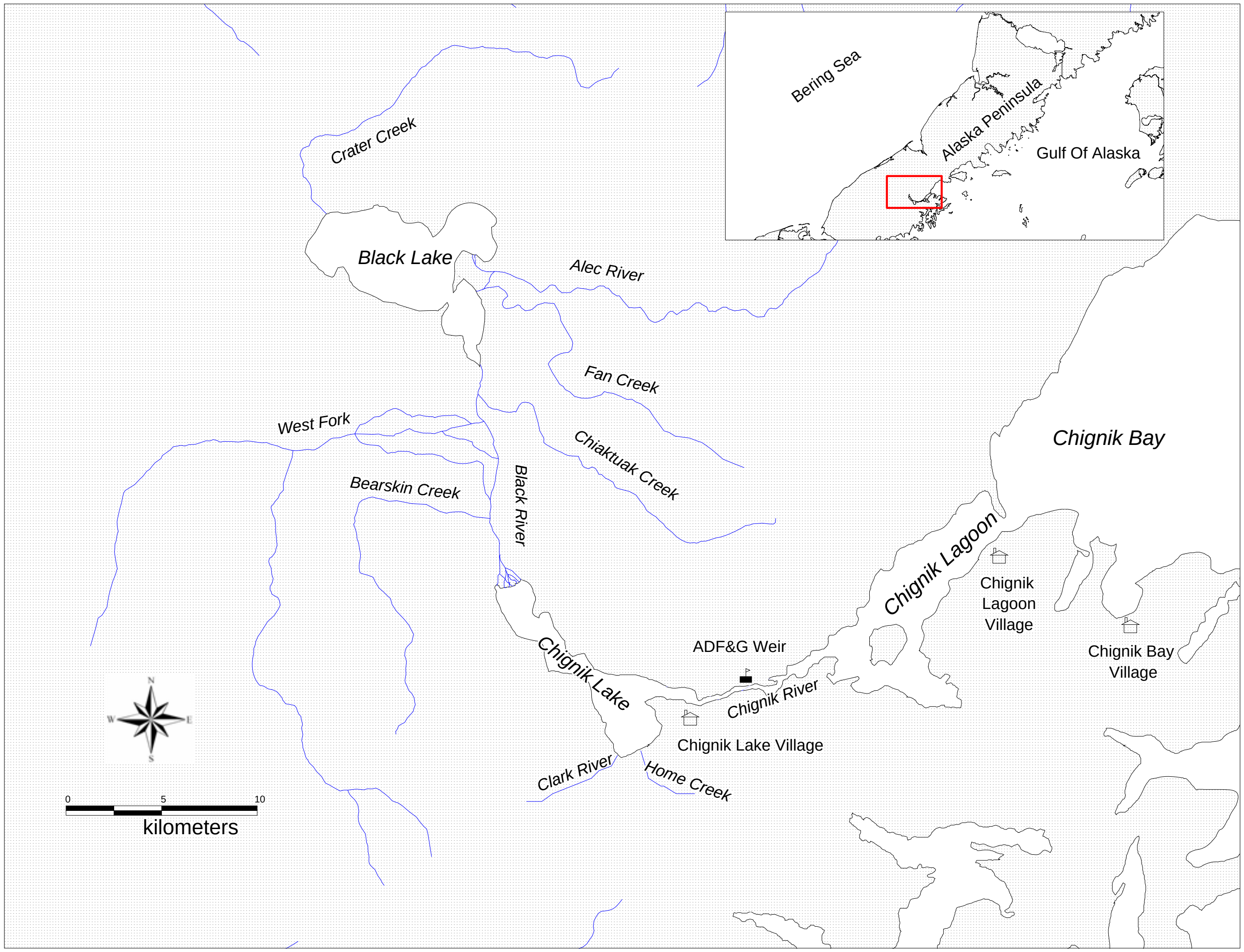

Figure 1.-Map of the Chignik River watershed.

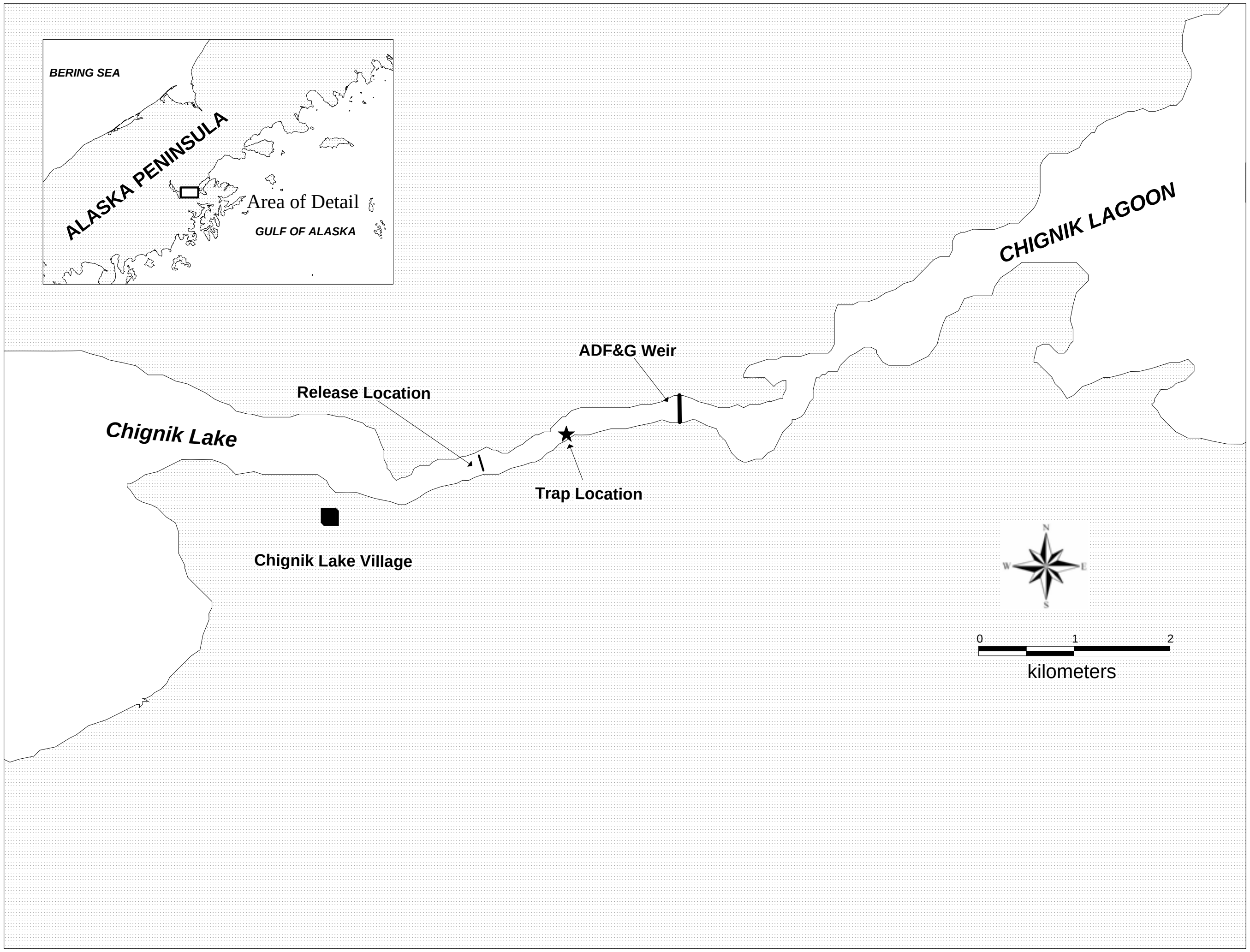

Figure 2.-Location of the traps and the release site of marked smolt in the Chignik River, Alaska, 2005.

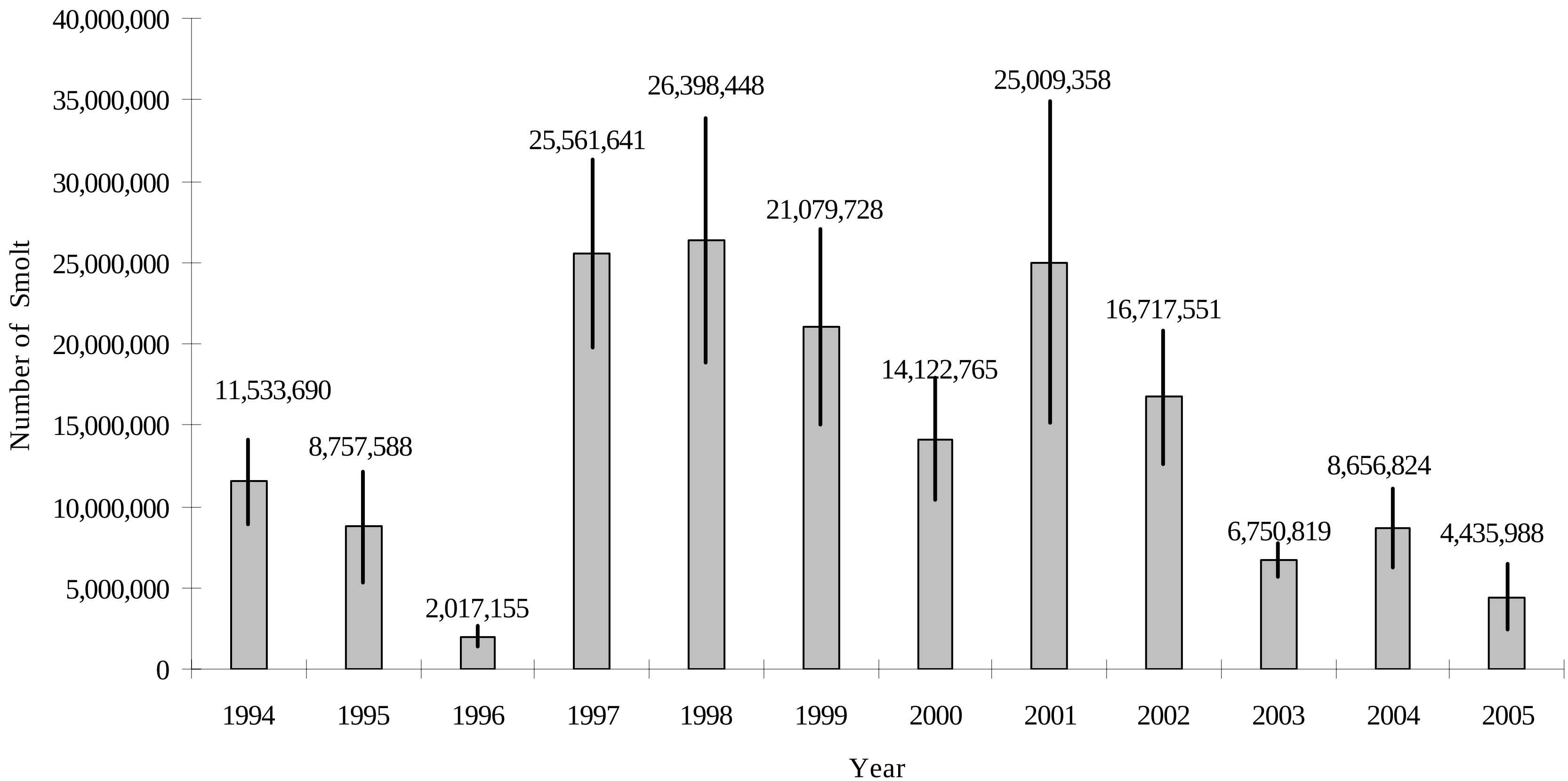

Figure 3.-Annual Chignik River sockeye salmon smolt emigration estimates and corresponding 95% confidence intervals, 1994 to 2005.

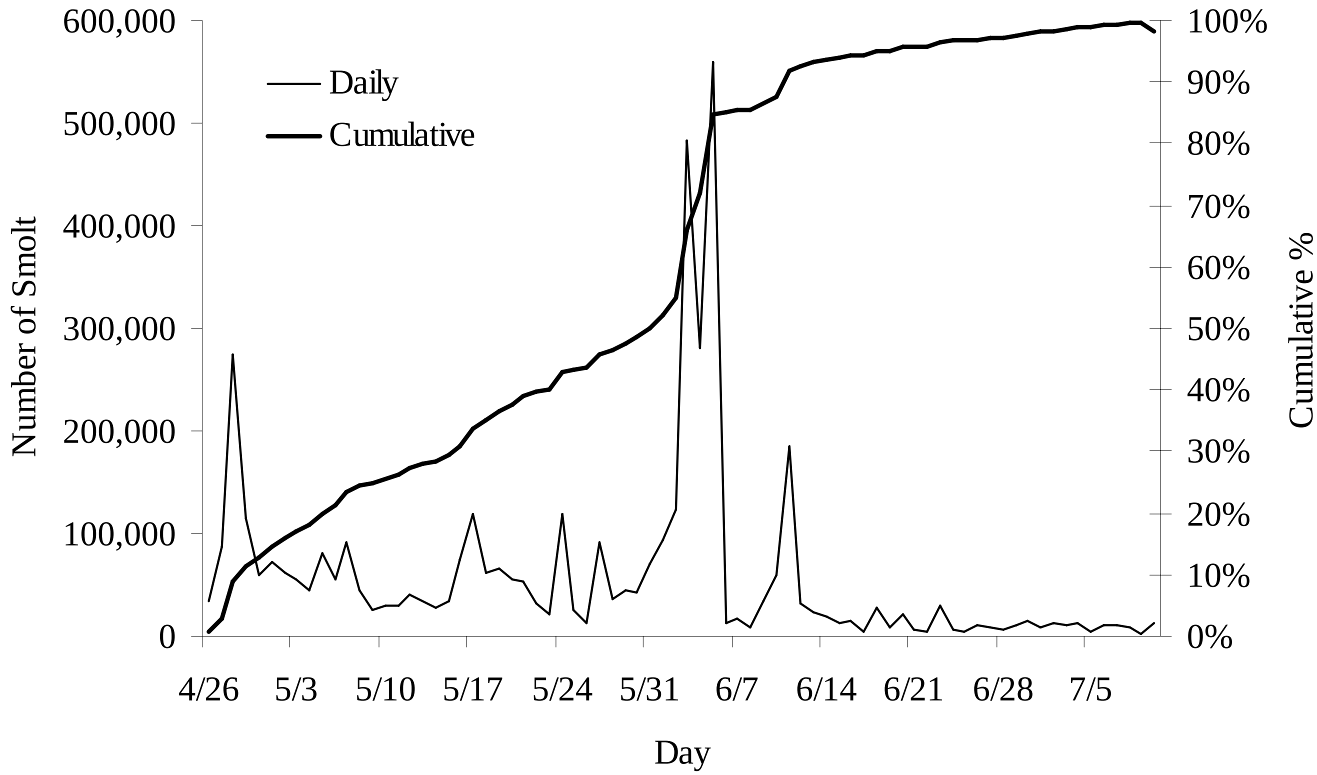

Figure 4.-Estimated daily and corresponding cumulative percentage of the sockeye salmon smolt emigration from the Chignik River, 2005.

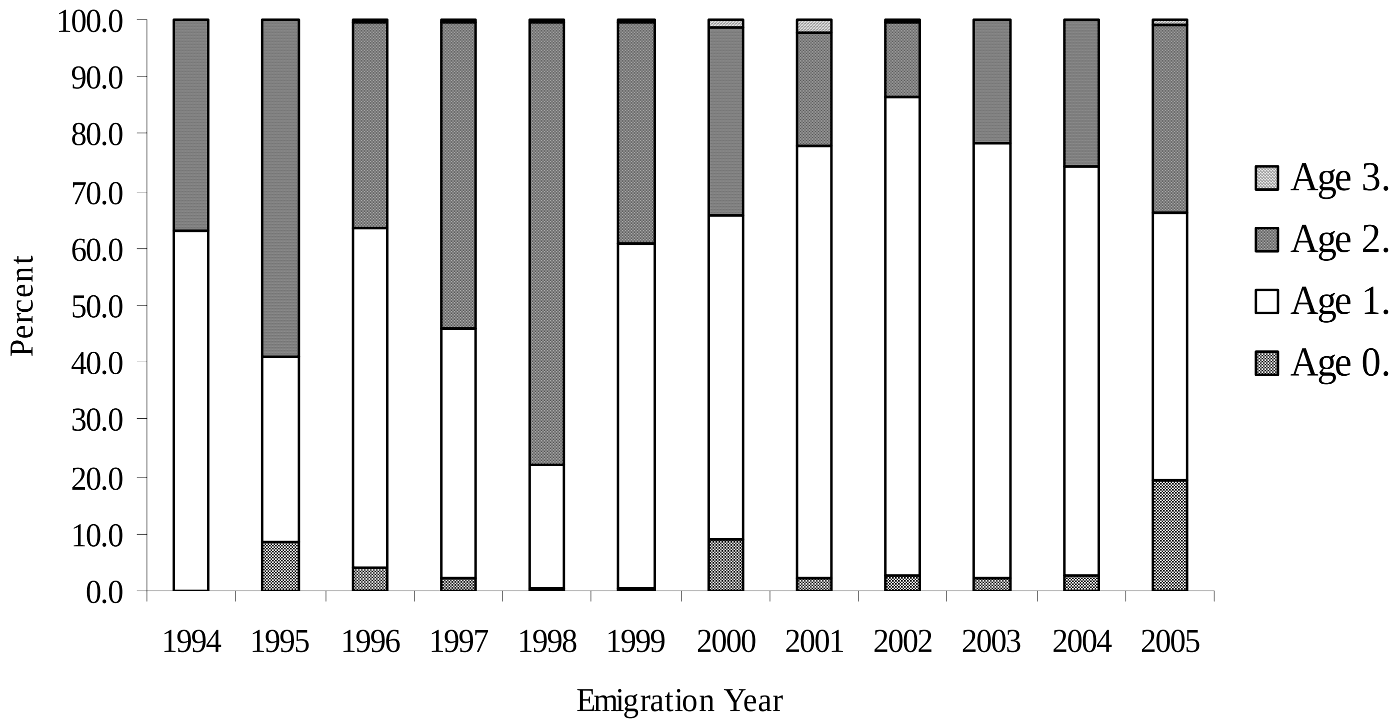

Figure 5.-A comparison of the estimated age structure of age 0. to age 3. sockeye salmon smolt emigrations from the Chignik River, 1994 to 2005.

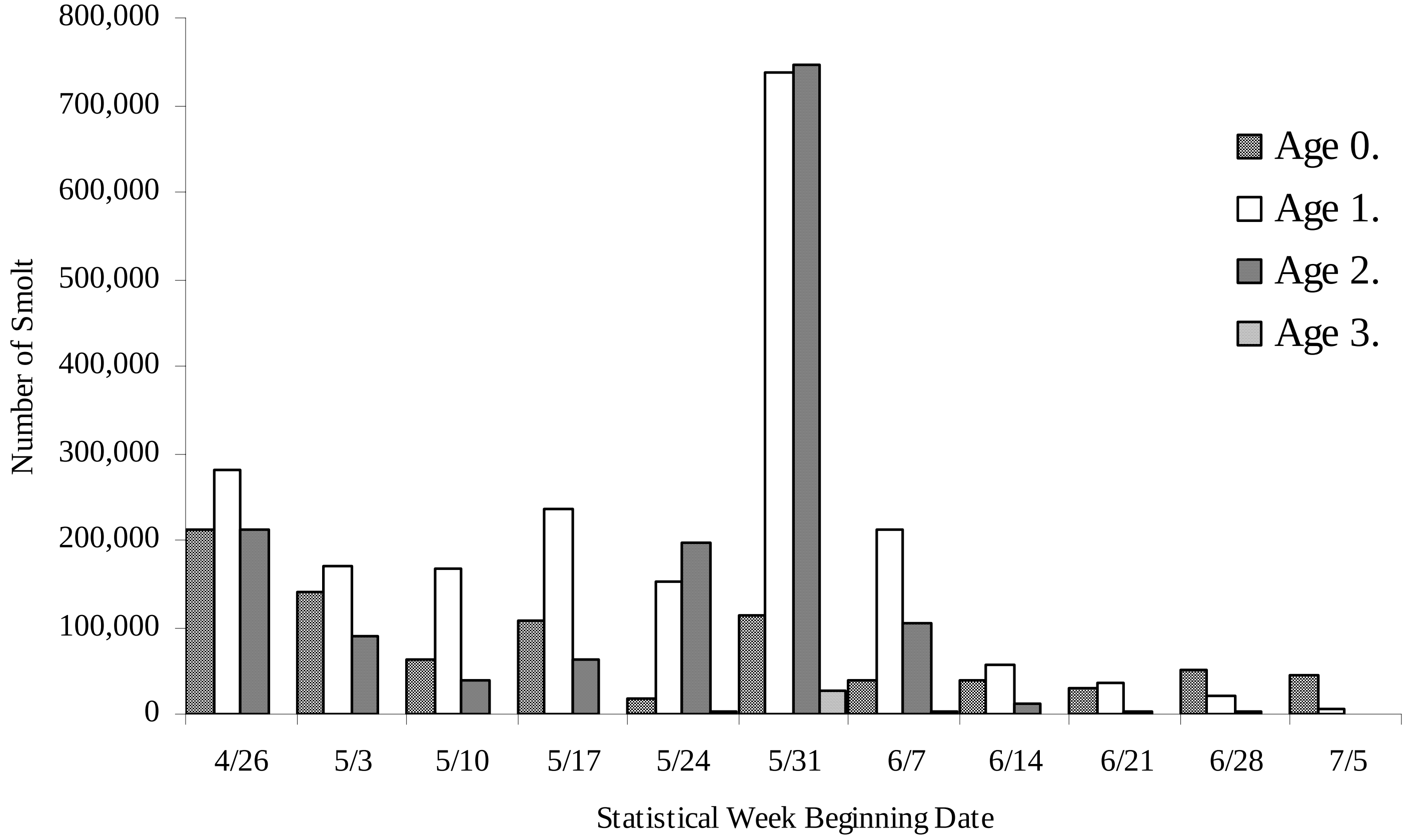

Figure 6.-Estimated smolt emigration of age 0. to age 3. sockeye salmon smolt, by statistical week beginning date, from the Chignik River, 2005.

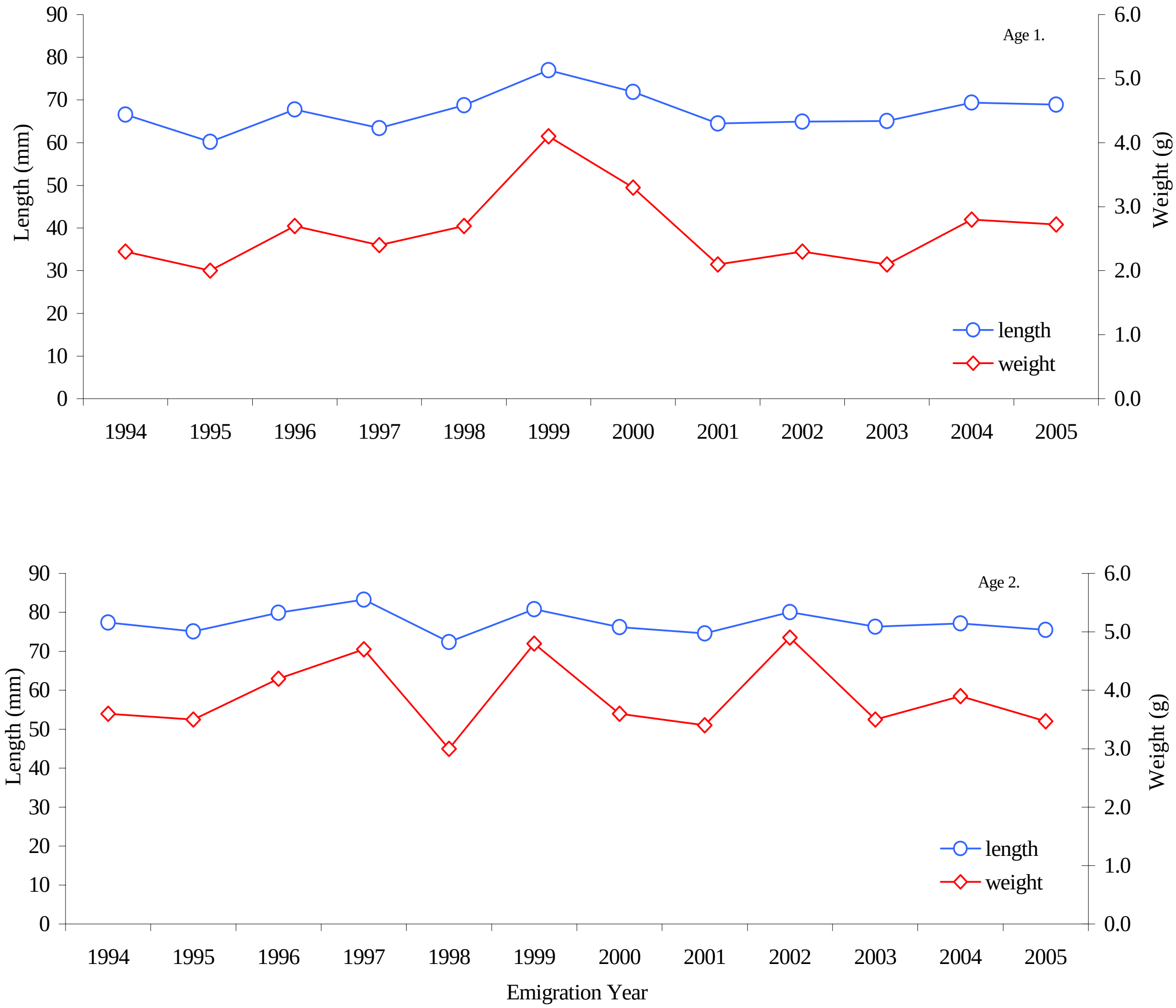

Figure 7.-Average length and weight of age 1. and age 2. sockeye salmon, by year, 1994 through 2005.

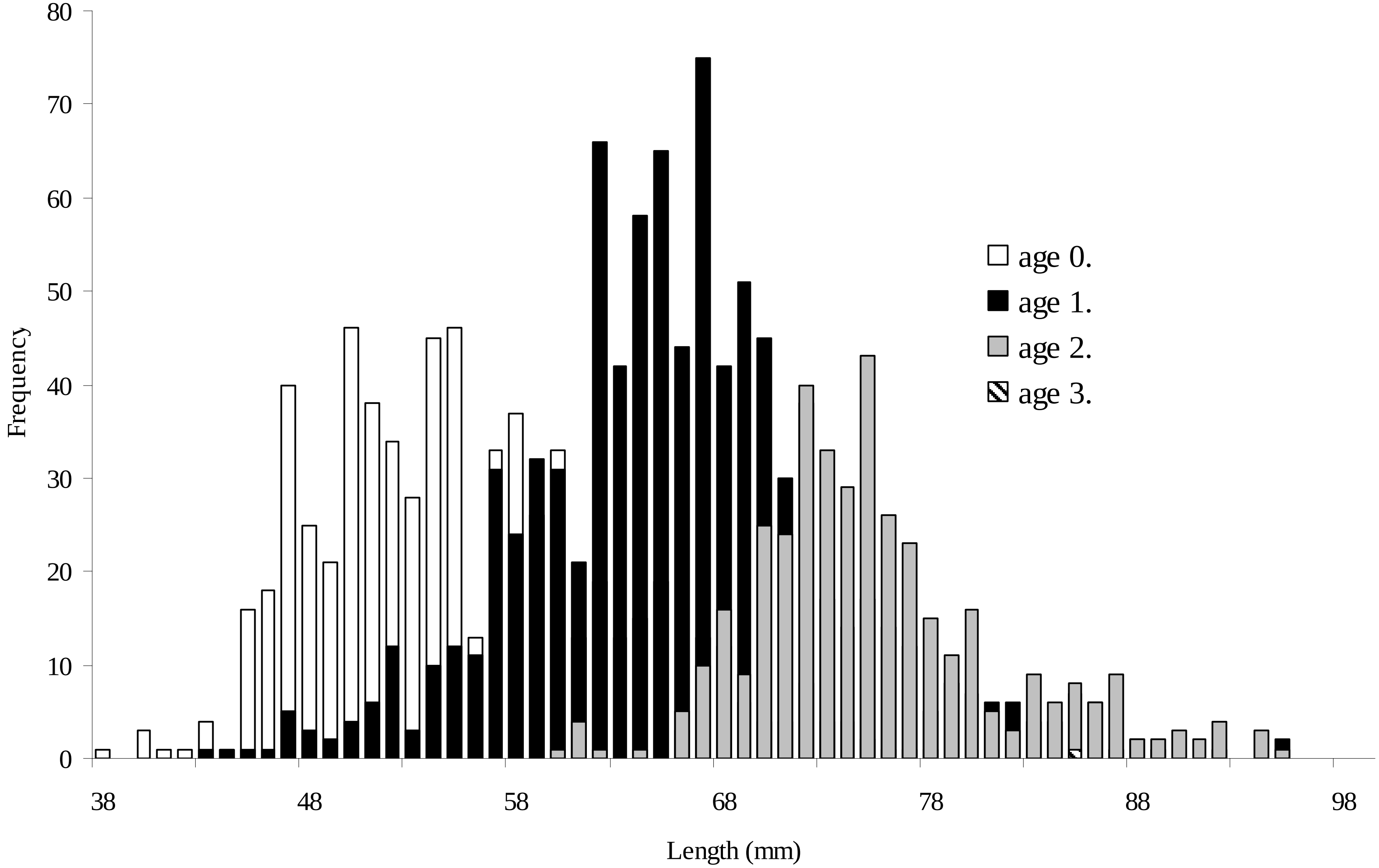

Figure 8.-Length frequency histogram of sockeye salmon smolt , by age sampled from the Chignik River, 2005.

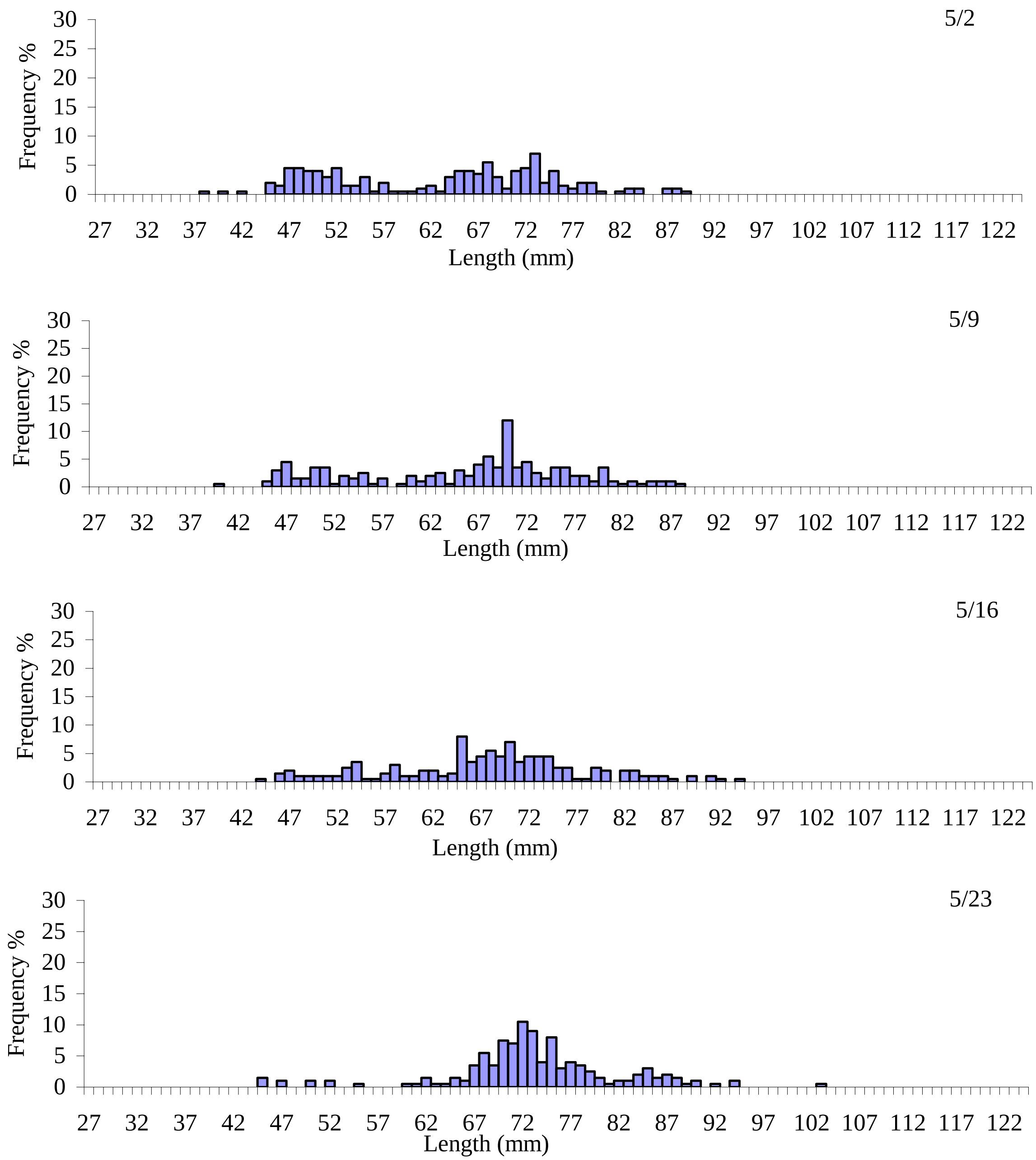

Figure 9.-Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps from May 2 to May 23, 2005.

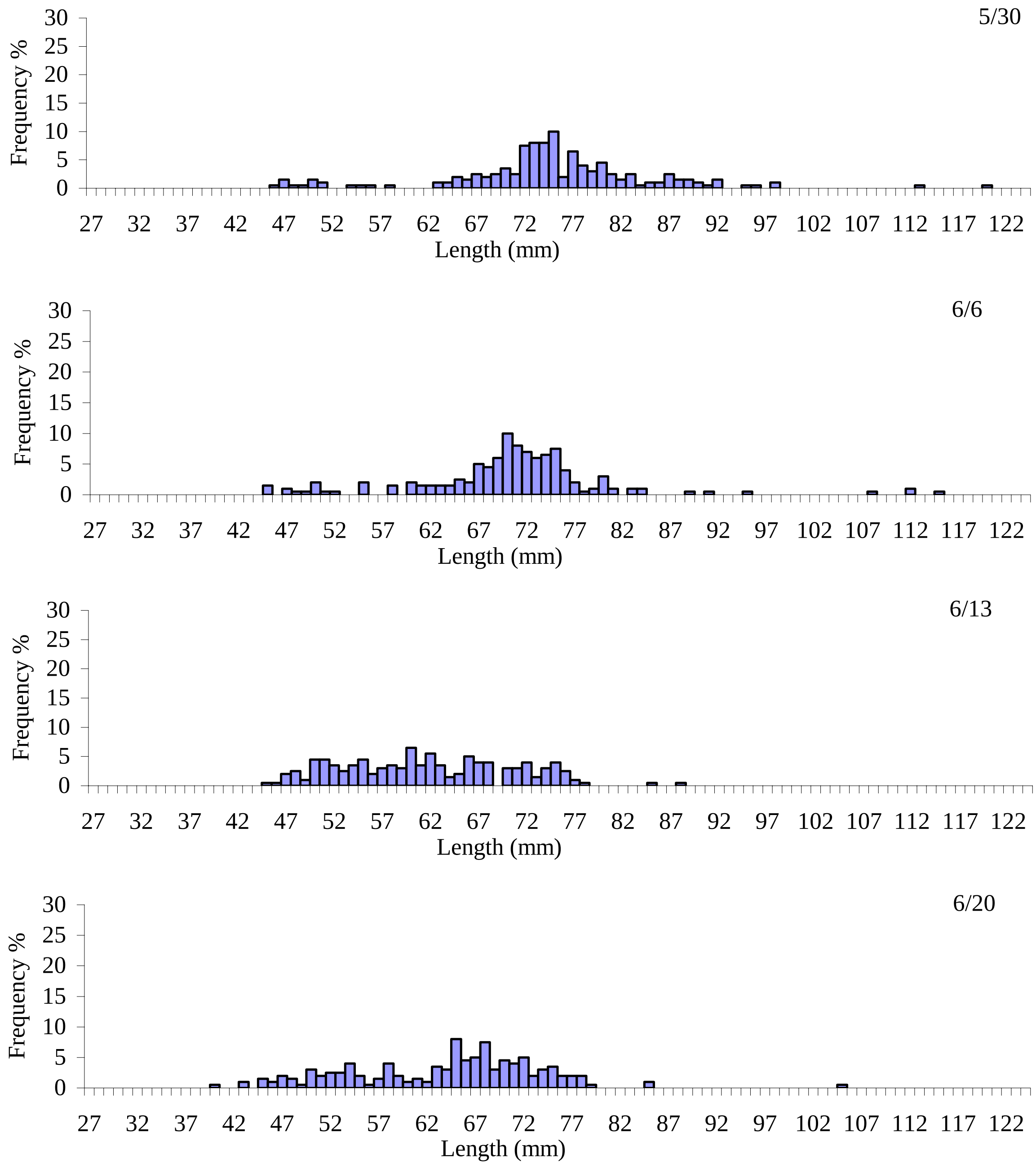

Figure 10.-Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps from May 30 to June 20, 2005.

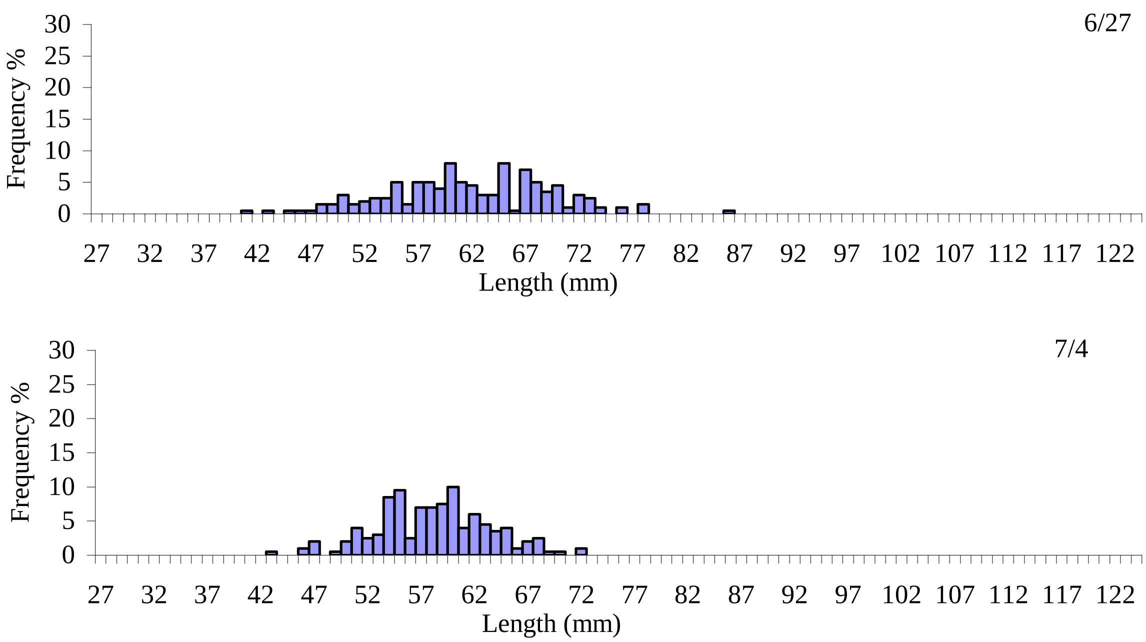

Figure 11.- Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps from June 27 to July 4, 2005.

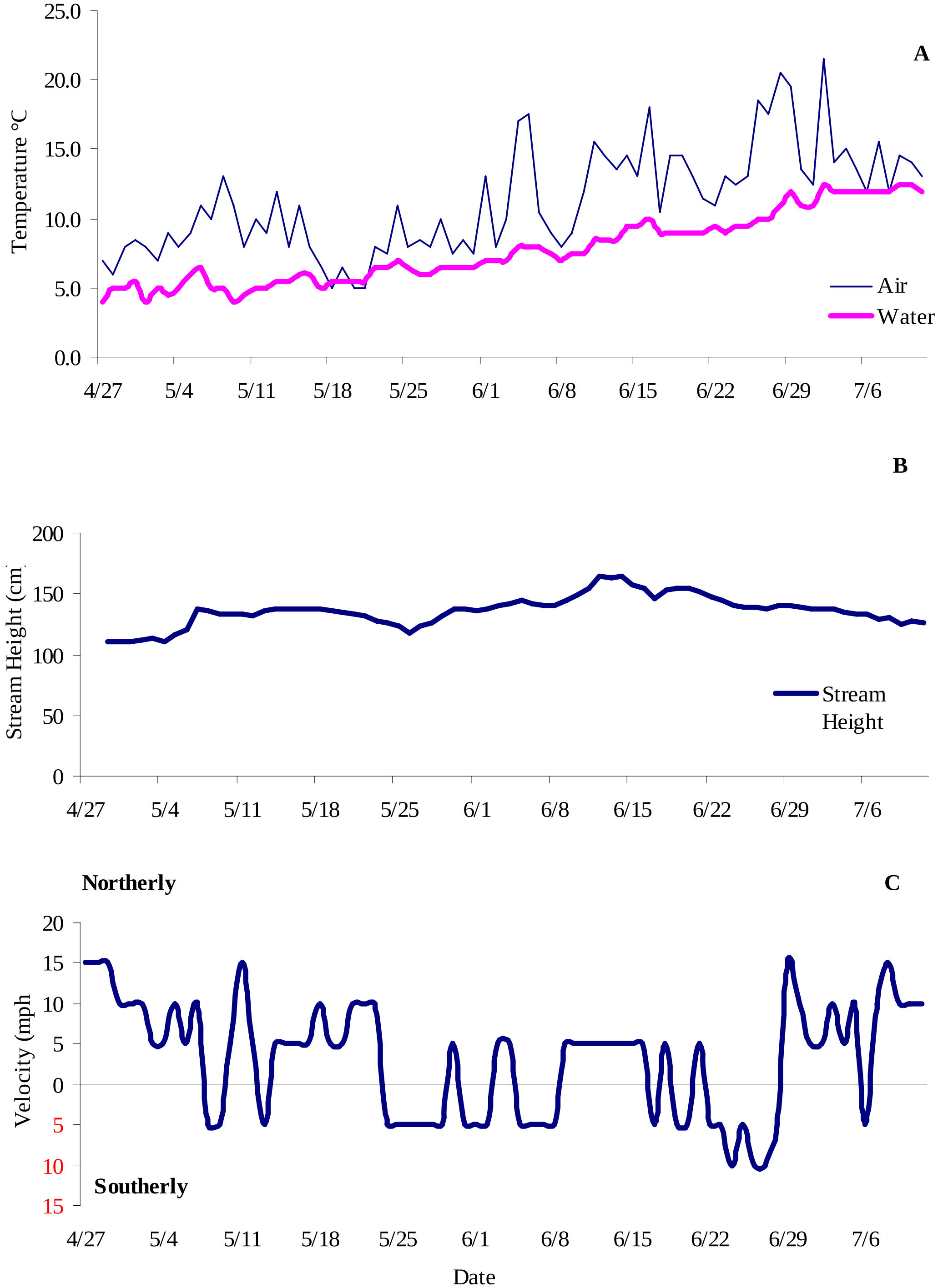

Figure 12.-Air and water temperature (A), stream gauge height (B), and wind velocity and direction data (C) gathered at the Chignik River smolt traps, 2005.

APPENDIX A: SMOLT TRAP CATCHES BY DAY

Appendix A1.-Actual daily counts and trap efficiency data of the Chignik River sockeye salmon smolt project, 2005.

	Actual		Trap Efficiency Test				Incidental Catch[a]									
	Sockeye Smolt Daily			Daily	Cum.											
Date		Cum.	Marked	Recoveries	Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	Chnk	DV	SB	SC	SF	PS	PW
4/26	216	216					403	26	0	12	1	33	0	1	0	1
4/27	537	753					940	61	0	7	5	220	5	0	1	0
4/28	1,702	2,455					4,008	72	0	2	1	474	2	1	2	2
4/29	717	3,172					4,007	48	0	4	11	309	2	2	50	5
4/30	375	3,547					2,657	13	0	5	1	252	2	4	3	0
5/1	445	3,992					1,610	18	0	3	0	206	0	0	2	1
5/2	388	4,380	1,442	4	4	0.28%	1,420	17	0	1	2	180	0	0	4	0
5/3	349	4,729		2	6	0.41%	1,091	28	0	2	0	209	2	1	6	1
5/4	280	5,009		1	7	0.48%	1,591	44	0	7	0	165	0	0	1	0
5/5	500	5,509		1	8	0.55%	1,407	52	0	5	2	202	2	4	2	2
5/6	340	5,849		0	8	0.55%	301	14	0	2	0	266	0	0	2	0
5/7	572	6,421		0	8	0.55%	767	32	0	3	0	320	3	6	5	3
5/8	280	6,701		0	8	0.55%	644	22	0	0	0	186	13	1	5	2
5/9	180	6,881	1,181	2	2	0.17%	559	24	0	4	0	136	1	0	3	1
5/10	196	7,077		3	5	0.42%	440	35	0	0	0	77	0	0	0	0
5/11	201	7,278		2	7	0.59%	1,027	40	0	0	1	114	2	1	2	0
5/12	279	7,557		0	7	0.59%	690	34	0	3	2	160	5	7	3	2
5/13	231	7,788		0	7	0.59%	486	33	0	0	0	105	1	0	2	0
5/14	181	7,969		0	7	0.59%	585	8	0	0	0	109	0	0	0	0
5/15	227	8,196		0	7	0.59%	251	13	0	1	0	92	2	2	0	0
5/16	504	8,700		0	7	0.59%	504	56	0	3	2	181	4	2	15	0
5/17	1,038	9,738	910	5	5	0.55%	396	77	0	7	3	221	5	2	16	0
5/18	548	10,286		1	6	0.66%	442	54	0	0	4	190	3	3	11	3
5/19	574	10,860		1	7	0.77%	196	77	0	0	8	123	2	7	10	5
5/20	490	11,350		0	7	0.77%	155	32	0	0	8	139	0	5	10	3
5/21	459	11,809		0	7	0.77%	120	57	0	0	2	125	1	3	4	1
5/22	281	12,090		0	7	0.77%	147	43	0	0	6	126	1	3	4	3
5/23	164	12,254	1,010	3	3	0.30%	90	52	0	5	4	85	0	1	4	0
5/24	938	13,192		3	6	0.59%	188	50	0	0	11	227	10	3	21	4

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	Actual		Trap Efficiency Test				Incidental Catch[a]									
	Sockeye Smolt Daily			Daily	Cum.											
Date		Cum.	Marked	Recoveries	Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	Chnk	DV	SB	SC	SF	PS	PW
5/25	200	13,392		0	6	0.59%	110	22	0	0	7	92	13	5	8	7
5/26	107	13,499		0	6	0.59%	57	16	0	0	3	91	9	0	5	2
5/27	717	14,216		0	6	0.59%	119	23	0	0	5	153	11	1	6	3
5/28	285	14,501		0	6	0.59%	112	24	0	0	2	96	22	2	8	4
5/29	349	14,850		1	7	0.59%	121	33	0	0	5	216	2	0	3	8
5/30	73	14,923	1,156	1	1	0.10%	256	25	0	0	3	131	3	0	6	0
5/31	122	15,045		0	1	0.09%	87	21	0	0	3	122	2	0	8	2
6/1	161	15,206		0	1	0.09%	81	29	0	0	5	81	2	1	10	5
6/2	213	15,419		0	1	0.09%	185	33	0	0	6	249	2	1	14	17
6/3	834	16,253		0	1	0.09%	347	66	0	0	4	339	0	0	20	7
6/4	485	16,738		0	1	0.09%	237	35	0	2	1	213	1	1	7	5
6/5	967	17,705		0	1	0.09%	223	42	0	5	8	325	2	0	15	17
6/6	137	17,842	2,193	17	17	0.78%	78	42	0	0	4	163	1	2	5	15
6/7	170	18,012		3	20	0.91%	147	31	0	0	3	166	1	0	10	8
6/8	77	18,089		0	20	0.91%	73	27	0	1	2	120	0	1	10	11
6/9	333	18,422		1	21	0.96%	84	36	0	0	1	110	0	0	9	3
6/10	606	19,028		0	21	0.96%	157	50	0	5	3	337	0	0	14	13
6/11	1,852	20,880		0	21	0.96%	400	182	0	11	16	1,090	8	4	24	42
6/12	318	21,198		0	21	0.96%	104	65	0	6	12	1,040	8	1	33	21
6/13	255	21,453	2,440	13	13	0.53%	175	30	0	1	2	940	4	0	19	13
6/14	206	21,659		4	17	0.70%	190	40	0	0	3	509	1	1	16	10
6/15	148	21,807		1	18	0.74%	126	28	1	0	1	259	1	1	20	14
6/16	174	21,981		1	19	0.78%	48	41	0	1	1	152	2	1	12	9
6/17	40	22,021		0	19	0.78%	11	35	0	5	1	43	1	0	4	10
6/18	307	22,328		2	21	0.86%	25	20	0	1	3	52	0	1	17	5
6/19	92	22,420		3	24	0.98%	174	34	0	2	3	130	5	0	17	9
6/20	244	22,664		0	24	0.98%	90	49	0	2	0	184	2	0	17	12
6/21	68	22,732		2	26	1.07%	44	53	0	0	2	58	1	1	17	3
6/22	49	22,781	784	3	3	0.38%	25	38	0	2	1	67	2	0	13	0

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Appendix A1.-Page 3 of 3.

	Actual		Trap Efficiency Test				Incidental Catch[a]									
	Sockeye Smolt Daily			Daily	Cum.											
Date	Cum.		Marked	Recoveries	Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	Chnk	DV	SB	SC	SF	PS	PW
6/23	293	23,074		3	6	0.77%	14	44	0	1	3	47	25	0	10	2
6/24	68	23,142		0	6	0.77%	0	36	0	0	6	40	0	0	13	3
6/25	44	23,186		0	6	0.77%	11	21	0	0	0	45	0	0	9	2
6/26	99	23,285		0	6	0.77%	9	38	0	0	0	68	1	0	20	0
6/27	94	23,379		1	7	0.89%	9	32	0	0	0	60	1	0	13	1
6/28	63	23,442		0	7	0.89%	12	27	0	0	0	105	1	0	16	3
6/29	111	23,553		0	7	0.32%	22	33	1	0	1	157	4	0	24	5
6/30	154	23,707		0	7	0.32%	22	32	0	1	2	107	1	0	19	5
7/1	78	23,785		0	7	0.32%	38	28	0	0	2	167	1	0	25	3
7/2	124	23,909	655	5	5	0.76%	16	17	0	0	2	125	0	0	40	2
7/3	143	24,052		2	7	1.07%	27	48	0	0	1	138	2	0	20	2
7/4	174	24,226		0	7	1.07%	20	58	0	0	2	107	0	0	31	2
7/5	70	24,296		0	7	1.07%	5	21	0	0	0	58	1	0	1	0
7/6	135	24,431		1	8	1.22%	11	23	0	0	2	44	1	1	29	2
7/7	151	24,582		0	8	1.22%	15	17	0	0	3	59	1	0	2	7
7/8	121	24,703		0	8	1.22%	13	21	0	1	2	65	2	0	18	4
7/9	34	24,737		0	8	1.22%	6	3	0	0	1	25	1	0	3	0
7/10	181	24,918		0	8	1.22%	2	26	0	0	7	54	1	1	22	4
Total		24,918	11,771	92	92	0.79%	31,008	2,302	1	120	184	12,760	174	83	555	314

[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.

[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 26 through July 10, 2005.

	Small Trap		Large Trap		Combined		Percent Total	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
4/26	3	3	213	213	216	216	1.4%	98.6%
4/27	75	78	462	675	537	753	14.0%	86.0%
4/28	443	521	1,259	1,934	1,702	2,455	26.0%	74.0%
4/29	206	727	511	2,445	717	3,172	28.7%	71.3%
4/30	124	851	251	2,696	375	3,547	33.1%	66.9%
5/1	195	1,046	250	2,946	445	3,992	43.8%	56.2%
5/2	176	1,222	212	3,158	388	4,380	45.4%	54.6%
5/3	155	1,377	194	3,352	349	4,729	44.4%	55.6%
5/4	123	1,500	157	3,509	280	5,009	43.9%	56.1%
5/5	215	1,715	285	3,794	500	5,509	43.0%	57.0%
5/6	80	1,795	260	4,054	340	5,849	23.5%	76.5%
5/7	222	2,017	350	4,404	572	6,421	38.8%	61.2%
5/8	168	2,185	112	4,516	280	6,701	60.0%	40.0%
5/9	132	2,317	48	4,564	180	6,881	73.3%	26.7%
5/10	105	2,422	91	4,655	196	7,077	53.6%	46.4%
5/11	119	2,541	82	4,737	201	7,278	59.2%	40.8%
5/12	115	2,656	164	4,901	279	7,557	41.2%	58.8%
5/13	87	2,743	144	5,045	231	7,788	37.7%	62.3%
5/14	90	2,833	91	5,136	181	7,969	49.7%	50.3%
5/15	110	2,943	117	5,253	227	8,196	48.5%	51.5%
5/16	401	3,344	103	5,356	504	8,700	79.6%	20.4%
5/17	596	3,940	442	5,798	1,038	9,738	57.4%	42.6%
5/18	338	4,278	210	6,008	548	10,286	61.7%	38.3%
5/19	386	4,664	188	6,196	574	10,860	67.2%	32.8%
5/20	364	5,028	126	6,322	490	11,350	74.3%	25.7%
5/21	359	5,387	100	6,422	459	11,809	78.2%	21.8%
5/22	216	5,603	65	6,487	281	12,090	76.9%	23.1%
5/23	125	5,728	39	6,526	164	12,254	76.2%	23.8%
5/24	840	6,568	98	6,624	938	13,192	89.6%	10.4%
5/25	159	6,727	41	6,665	200	13,392	79.5%	20.5%
5/26	78	6,805	29	6,694	107	13,499	72.9%	27.1%
5/27	576	7,381	141	6,835	717	14,216	80.3%	19.7%
5/28	85	7,466	200	7,035	285	14,501	29.8%	70.2%
5/29	197	7,663	152	7,187	349	14,850	56.4%	43.6%
5/30	26	7,689	47	7,234	73	14,923	35.6%	64.4%
5/31	39	7,728	83	7,317	122	15,045	32.0%	68.0%
6/1	54	7,782	107	7,424	161	15,206	33.5%	66.5%
6/2	83	7,865	130	7,554	213	15,419	39.0%	61.0%
6/3	271	8,136	563	8,117	834	16,253	32.5%	67.5%
6/4	146	8,282	339	8,456	485	16,738	30.1%	69.9%
6/5	466	8,748	501	8,957	967	17,705	48.2%	51.8%
6/6	37	8,785	100	9,057	137	17,842	27.0%	73.0%
6/7	45	8,830	125	9,182	170	18,012	26.5%	73.5%
6/8	25	8,855	52	9,234	77	18,089	32.5%	67.5%
6/9	96	8,951	237	9,471	333	18,422	28.8%	71.2%
6/10	157	9,108	449	9,920	606	19,028	25.9%	74.1%

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Appendix B1.-Page 2 of 2.

Date	Small Trap		Large Trap		Combined		Percent Total	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
6/11	393	9,501	1,459	11,379	1,852	20,880	21.2%	78.8%
6/12	58	9,559	260	11,639	318	21,198	18.2%	81.8%
6/13	39	9,598	216	11,855	255	21,453	15.3%	84.7%
6/14	55	9,653	151	12,006	206	21,659	26.7%	73.3%
6/15	36	9,689	112	12,118	148	21,807	24.3%	75.7%
6/16	32	9,721	142	12,260	174	21,981	18.4%	81.6%
6/17	9	9,730	31	12,291	40	22,021	22.5%	77.5%
6/18	53	9,783	254	12,545	307	22,328	17.3%	82.7%
6/19	27	9,810	65	12,610	92	22,420	29.3%	70.7%
6/20	58	9,868	186	12,796	244	22,664	23.8%	76.2%
6/21	22	9,890	46	12,842	68	22,732	32.4%	67.6%
6/22	15	9,905	34	12,876	49	22,781	30.6%	69.4%
6/23	76	9,981	217	13,093	293	23,074	25.9%	74.1%
6/24	17	9,998	51	13,144	68	23,142	25.0%	75.0%
6/25	9	10,007	35	13,179	44	23,186	20.5%	79.5%
6/26	22	10,029	77	13,256	99	23,285	22.2%	77.8%
6/27	36	10,065	58	13,314	94	23,379	38.3%	61.7%
6/28	16	10,081	47	13,361	63	23,442	25.4%	74.6%
6/29	21	10,102	90	13,451	111	23,553	18.9%	81.1%
6/30	25	10,127	129	13,580	154	23,707	16.2%	83.8%
7/1	20	10,147	58	13,638	78	23,785	25.6%	74.4%
7/2	27	10,174	97	13,735	124	23,909	21.8%	78.2%
7/3	30	10,204	113	13,848	143	24,052	21.0%	79.0%
7/4	32	10,236	142	13,990	174	24,226	18.4%	81.6%
7/5	16	10,252	54	14,044	70	24,296	22.9%	77.1%
7/6	28	10,280	107	14,151	135	24,431	20.7%	79.3%
7/7	28	10,308	123	14,274	151	24,582	18.5%	81.5%
7/8	30	10,338	91	14,365	121	24,703	24.8%	75.2%
7/9	7	10,345	27	14,392	34	24,737	20.6%	79.4%
7/10	42	10,387	139	14,531	181	24,918	23.2%	76.8%
Total		10,387		14,531		24,918	41.7	58.3

APPENDIX C: PHYSICAL OBSERVATIONS

Appendix C1.-Daily climatological observations for the Chignik River sockeye salmon smolt project, 2005.

				Cloud[b]			Trap Revolutions (rpm)		Stream	
		Air	Water	Cover	Wind[b]	Vel.[b]			Gauge	
Date[a]	Time	(°C)	(°C)	%	Dir	(Mph)	Small	Large	(cm)	Comments
4/27	10:00	7.0	4.0	80	SW	10-15	n/a	n/a	n/a	Small trap hitting bottom
4/28	12:15	6.0	5.0	100	SW	10-15	3.00	3.00	n/a	
4/29	12:00	8.0	5.0	40	NE	10-15	5.00	5.00	110	
4/30	12:00	8.5	5.5	90	NE	5-10	3.00	3.00	110	
5/1	12:00	8.0	4.0	100	NE	5-10	4.00	4.00	111	
5/2	12:00	7.0	5.0	100	NE	5-10	5.00	5.00	112	
5/3	12:00	9.0	4.5	100	NE	5	4.00	4.00	113	
5/4	12:00	8.0	5.0	80	NE	0-5	4.00	4.00	110	
5/5	12:00	9.0	6.0	100	NE	5-10	5.00	5.00	116	Rain
5/6	12:00	11.0	6.5	98	NE	0-5	6.00	6.00	120	
5/7	12:00	10.0	5.0	90	SW	5-10	6.00	6.00	137	
5/8	12:00	13.0	5.0	50	SW	0-5	7.00	7.00	136	
5/9	12:23	11.0	4.0	98	NE	0-5	6.00	6.00	134	
5/10	12:15	8.0	4.5	100	NE	0-5	7.00	7.00	134	
5/11	11:50	10.0	5.0	60	NE	10-15	6.00	6.00	134	
5/12	12:21	9.0	5.0	100	NE	0-5	6.00	6.00	132	
5/13	12:20	12.0	5.5	60	SE	0-5	6.00	6.00	136	Sunny
5/14	12:22	8.0	5.5	70	NE	0-5	7.00	7.00	138	
5/15	12:08	11.0	6.0	80	NE	0-5	7.00	7.00	137	
5/16	12:06	8.0	6.0	100	NE	0-5	7.00	7.00	137	Drizzle
5/17	12:00	6.5	5.0	100	NE	0-5	7.25	7.25	138	Overcast Windy
5/18	12:00	5.0	5.5	50	NE	5-10	7.00	7.00	137	Sunny
5/19	12:00	6.5	5.5	100	NE	0-5	7.00	7.00	136	Overcast Windy
5/20	12:20	5.0	5.5	95	NE	0-5	7.00	7.00	135	Overcast Windy
5/21	12:10	5.0	5.5	98	NE	10	6.50	6.50	134	Overcast Windy
5/22	12:15	8.0	6.5	30	NE	5-10	6.00	6.00	132	Sunny
5/23	12:20	7.5	6.5	70	NE	10	6.25	6.25	128	Overcast Windy
5/24	12:22	11.0	7.0	20	SE	0-5	5.75	5.75	126	Sunny
5/25	12:20	8.0	6.5	100	SE	0-5	5.00	5.00	123	Overcast Windy

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Appendix C1.-Page 2 of 3.

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
5/26	12:10	8.5	6.0	100	SE	10-15	5.00	5.25	118	Overcast Windy
5/27	12:15	8.0	6.0	97	SE	0-5	5.50	5.75	124	Overcast Windy
5/28	12:20	10.0	6.5	100	SE	0-5	5.00	4.75	126	Scattered showers
5/29	12:45	7.5	6.5	100	SE	0-5	6.25	6.00	132	Light rain
5/30	12:45	8.5	6.5	95	NE	0-5	7.00	6.50	137	Light, intermittent rain
5/31	12:10	7.5	6.5	100	SE	0-5	7.25	6.50	138	Overcast, rain
6/1	12:05	13.0	7.0	80	SE	0-5	7.00	6.50	136	Overcast
6/2	12:20	8.0	7.0	100	SE	0-5	7.25	6.75	137	Rain
6/3	12:15	10.0	7.0	50	NE	0-5	7.50	6.75	140	Sunny
6/4	12:30	17.0	8.0	20	NE	0-5	7.50	6.75	142	Sunny
6/5	12:45	17.5	8.0	30	SE	0-5	7.25	6.75	144	Sunny
6/6	12:35	10.5	8.0	100	SE	0-5	7.25	6.75	142	Overcast
6/7	12:25	9.0	7.5	100	SE	0-5	7.25	6.75	140	Overcast, rain
6/8	12:32	8.0	7.0	100	SE	0-5	7.50	6.75	141	Overcast, rain
6/9	12:31	9.0	7.5	100	NE	0-5	7.75	6.75	144	Overcast, rain
6/10	12:49	12.0	7.5	98	NE	0-5	8.00	7.00	149	Overcast
6/11	14:05	15.5	8.5	95	NE	0-5	8.00	7.00	155	Overcast
6/12	13:01	14.5	8.5	80	NE	0-5	8.50	7.50	165	Sunny
6/13	12:37	13.5	8.5	60	NE	0-5	8.75	7.50	163	Sunny
6/14	12:42	14.5	9.5	60	NE	0-5	8.75	7.75	164	Overcast Sunny
6/15	12:45	13.0	9.5	30	NE	0-5	8.50	7.50	158	Sunny
6/16	12:31	18.0	10.0	20	NE	0-5	8.25	7.25	155	Sunny
6/17	12:40	10.5	9.0	100	SE	0-5	7.75	7.00	146	Overcast, rain
6/18	12:42	14.5	9.0	75	NE	0-5	7.75	7.00	153	Sunny
6/19	12:12	14.5	9.0	90	SE	0-5	8.00	7.25	155	Sunny
6/20	12:30	13.0	9.0	30	SE	0-5	8.00	7.00	155	Sunny
6/21	12:20	11.5	9.0	100	NE	0-5	7.75	7.00	152	Overcast
6/22	12:45	11.0	9.5	100	SE	0-5	7.50	6.75	148	Overcast

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Appendix C1.-Page 3 of 3.

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
6/23	12:40	13.0	9.0	100	SE	0-5	7.00	6.50	145	Overcast
6/24	12:45	12.5	9.5	100	SE	5-10	7.00	6.50	141	Overcast
6/25	12:45	13.0	9.5	100	SE	0-5	7.00	6.00	139	Overcast
6/26	12:30	18.5	10.0	90	SE	5-10	7.00	5.75	139	Overcast
6/27	12:20	17.5	10.0	15	SE	5-10	7.00	6.25	138	Sunny
6/28	12:40	20.5	11.0	45	NE	0-5	7.00	6.25	140	Sunny
6/29	12:20	19.5	12.0	60	NE	10-15	6.50	6.00	140	Sunny
6/30	12:30	13.5	11.0	100	NE	5-10	7.25	6.00	139	Overcast
7/1	12:40	12.5	11.0	98	NE	0-5	7.50	6.34	137	Overcast
7/2	12:45	21.5	12.5	50	NE	0-5	7.00	6.25	137	Sunny
7/3	12:25	14.0	12.0	100	NE	5-10	7.00	6.25	137	Overcast, rain
7/4	12:30	15.0	12.0	100	NE	0-5	7.00	6.00	135	Overcast
7/5	12:06	13.5	12.0	100	NE	5-10	7.00	6.00	133	Overcast
7/6	12:45	12.0	12.0	60	SE	0-5	6.00	6.00	133	Sunny
7/7	12:30	15.5	12.0	60	NE	5-10	6.00	6.00	129	Sunny
7/8	12:15	12.0	12.0	0	NE	10-15	6.00	6.00	130	Sunny
7/9	12:35	14.5	12.5	60	NE	10	6.00	5.75	125	Sunny
7/10	12:20	14.0	12.5	100	NE	10	6.00	6.00	127	Overcast
7/11	12:15	13.0	12.0	100	NE	5-10	6.00	6.00	126	Rain

[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