CHIGNIK LAKES SOCKEYE SMOLT ABUNDANCE, AGE COMPOSITION, AND SIZE CHARACTERISTICS, 1996

By

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Appendix I. Mean length, weight, and condition factor by age and date for sockeye salmon smolts, Chignik River, post 30 June, 1996.

		Length (mm)			Weight (g)			Condition		
Age	Week beginning	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
0	07/01	6	51.0	1.3	6	1.2	0.1	6	0.93	0.05
0	07/05	17	53.8	0.8	14	1.4	0.1	14	0.93	0.02
0	07/12	8	49.0	1.6	8	1.2	0.1	8	1.00	0.03
0	07/19	10	45.3	1.7	10	0.9	0.1	10	0.96	0.03
0	07/26	1	43.0	0.0	1	0.7	0.0	1	0.89	0.0
	Totals	42	50.2	0.8	39	1.2	0.1	39	0.95	0.02
1	07/01	67	75.9	1.1	67	4.1	0.2	67	0.90	0.01
1	07/05	170	68.5	0.8	154	3.2	0.1	154	0.93	0.01
1	07/12	96	69.4	1.1	96	3.3	0.1	96	0.94	0.01
1	07/19	127	68.7	0.9	127	3.3	0.1	127	0.96	0.01
1	07/26	25	65.4	1.9	25	2.9	0.3	25	0.98	0.02
	Totals	485	69.6	0.5	469	3.4	0.1	469	0.94	0.01
2	07/01	20	82.5	1.0	20	5.3	0.2	20	0.93	0.01
2	07/05	56	82.7	0.5	52	5.2	0.1	52	0.92	0.01
2	07/12	29	81.4	0.8	29	4.9	0.1	29	0.91	0.01
2	07/19	10	80.5	1.4	10	4.8	0.2	10	0.92	0.02
2	07/26	2	72.5	8.5	2	4.1	1.2	2	1.06	0.06
	Totals	117	82.0	0.4	113	5.1	0.1	113	0.92	0.01

[a] Of the 644 smolts sampled, 23 smolts do not contribute weights or condition factors.

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EXECUTIVE SUMMARY

This was the third successive year that sockeye salmon smolt studies have been conducted by the Alaska Department of Fish and Game under contract with the Chignik Regional Aquaculture Association (CRAA; Stopha and Barrett 1994; Vania and Swanton 1996). This research is intended to annually estimate the numbers of sockeye salmon smolts emigrating from Chignik Lakes by age class. The long term objective is to enhance the understanding of Chignik Lakes sockeye salmon lacustrine production parameters; increase understanding of density dependent rearing fry interactions; and to determine whether competition between stock specific fry productivity is occurring in Chignik Lake. This report summarizes data collected during the 1996 field season.

A total of 24,695 sockeye smolts were captured in two rotary-screw traps operated on the Chignik River from 6 May through 30 June. Overall trap efficiency was 1.14%, and the total sockeye smolt outmigration estimate was 2.2 million fish (95% CI 1.6 to 2.8 million). The peak outmigration occurred on 24 May. Age-0. smolts composed 2.2% of the total outmigration, age-1. smolts 58.9%, age-2. smolts 38.6%, and age-3. smolts composed 0.3%. Delayed mortality of marked smolts was estimated to be 3.6% but needs to be substantiated with additional data collection and analysis. This mortality estimate if accurate would, in effect, decrease the sockeye smolt population estimates. Previously, preliminary adult run estimates have been generated from sockeye smolt numbers documented during 1994-95. We feel that these estimates, owing to the absence of smolt to adult survival rates specific to Chignik Lakes stocks, should be viewed as indices. The 1997 age-1.3 and 1998 age-2.3 adult returns will provide cursory information with which to evaluate the utility of the smolt population estimates and smolt to adult survival specific to this system.

During 1996 an additional study component was to ascertain if sockeye smolts continued to outmigrate post 30 June. A trap operated from 1-30 July captured 2,320 sockeye smolts in the Chignik River below the weir site. These numbers confirm that at least for 1996, significant numbers of sockeye smolts continued to emigrate from the Chignik Lakes system post 30 June.

INTRODUCTION

Forecasts of salmon returns are an important aspect of Alaska's commercial salmon fishing industry. The accuracy of forecasts is crucial to fish processors for estimating fish prices, personnel and equipment needs, and to commercial fisherman for timing capital investments. Economically, sockeye salmon *Oncorhynchus nerka* are the most important commercial salmon species in the Chignik Management Area (CMA). Preseason forecast methods used for predicting adult runs to the Chignik River watershed (Figure 1), the primary producer of sockeye salmon in the CMA, currently employ historic age class relationships for the Black Lake stock, and average return per spawner for the Chignik Lake stock. Historically, forecast accuracy specific to adult runs for the Chignik Lake (late run sockeye) stock have been variable. From 1984-1993, the percent difference between the preseason forecast and actual run for the Chignik system has ranged from 78.0% underforecast to 27.0% overforecast, with an average absolute difference of 17.0% (Stopha and Barrett 1994). Prediction accuracy for a given year can be viewed as a manifestation of our understanding of the freshwater and marine variables which control adult sockeye salmon production.

Many of the variables related to the freshwater life history of sockeye salmon within the Chignik Lakes system are not well understood, particularly with regard to the interaction of the Black and Chignik Lakes stocks. Annual growth of juvenile sockeye varies between lakes, years, and within individual populations (Bumgarner 1993). Evaluation of the freshwater growth of Black and Chignik Lakes fry coupled with length and weight data from smolts should allow us to determine if competition between these two stocks is occurring within Chignik Lake. The Chignik Regional Aquaculture Association (CRAA) and Alaska Department of Fish and Game (ADF&G) are committed to scientifically evaluate potential habitat enhancement and rehabilitation projects, escapement goals, and management plans. This research includes estimating annual sockeye smolt population numbers, size-at-age, and growth characteristics over time.

The growth of juvenile sockeye salmon within both Chignik and Black Lakes is inversely related to the density of the parent population within each of the two lakes (Burgner 1969). Therefore, knowledge of the number, age-class structure, and physical condition of outmigrating sockeye smolt along with over-wintering juveniles could provide insight into improving current forecasting methods. These variables either directly or indirectly account for a portion of the variability of adult returns caused by changes in freshwater nursery conditions.

In years past, upstream and downstream movements of juvenile sockeye salmon have been observed post 30 June in Chignik River. Some of these movements were extensive, and raised questions as to the origins of these fish, and the importance of Chignik River, relative to other parts of the watershed, for sockeye salmon production (Iverson 1966).

Since May of 1994, the ADF&G has conducted sockeye salmon smolt emigration studies under contract with CRAA in the Chignik Lakes system. The agreed upon objectives for the 1996 field season were: 1) estimate the total number of outmigrant sockeye smolt by age class from the Chignik River system; 2) estimate sockeye smolt timing and growth characteristics (length, weight, and condition) by age class; 3) estimate delayed mortality of both marked and unmarked smolts for

use in evaluating trap efficiency; 4) archive the smolt scales for future potential use with scale pattern analysis in determining stock composition of the 1996 outmigration from future returns; and 5) determine the extent of the smolt outmigration occurring post 30 June.

METHODS

Rotary-screw Traps and Site Description

Emigrating sockeye smolts were captured using two rotary-screw traps operated in tandem on a daily basis within the Chignik River, from 6 May through 30 June. These traps have been operated by the ADF&G during both 1994 and 1995 (Stopha and Barrett 1994; Vania and Swanton 1996). Each trap is constructed of a stainless-steel, 2-mm-mesh cone mounted on two aluminum pontoons (Figure 2). The cone entrance diameter was 1.5 m on the inshore trap (referred to as small trap), and 2.4 m on the offshore trap (referenced as the large trap), with one-half of each cone's area submerged (small trap=0.9 m^2, large trap 1.1 m^2). The current propels an internal screw which rotates the cone approximately 3-8 rpm during average flow conditions. Fish are funneled through the cone into a live box on the downstream end of the trap. The small trap live box measures 0.7 m^3 and the large trap 0.6 m^3. The large trap livebox was fitted with a rotating perforated stainless-steel drum for debris removal. To prevent mammalian and avian predation, vexar plastic cloth was secured over openings in each of the traps live boxes and was modified as needed. Traps were tied together and a 10-cm (4-in) x 10-cm (4-in) x 4.9-m (16-ft) plank was lashed across the top of the pontoons, perpendicular to the current extended to shore. This served as a fulcrum to maintain and adjust the trap position; each trap was additionally secured to the riparian vegetation with polypropylene line above river flood stage height.

The traps were operated in the Chignik River directly downstream of a location referred to locally as the "King Hole". This site is 8.6 km upstream from Chignik Lagoon and 1.9 km downstream from the outlet of Chignik Lake (Figure 1). River width at this location is 46 m with an average depth of 2.7 m. Both traps were fished continuously except during daily cleaning.

Traps were positioned close to shore in a depth that allowed the cones to rotate freely. Initially, the center of the small trap cone was positioned 6.7 m offshore, approximately 50-60 cm above the substrate. The center of the large trap cone was positioned 10.1 m offshore and approximately 40-50 cm above the substrate. A 5.5 m lead, constructed of aluminum weir panels and supported by wooden tripods, was placed between the inshore pontoon of the small trap and shore to deflect fish towards the traps. As the water level fluctuated the traps and leads were adjusted accordingly. An offshore lead was not used owing to current, depth, and the potential for posing a navigational hazard.

Beginning 1 July , the small trap was repositioned 4-5 m directly below the adult counting weir,(4.8 km upstream from Chignik Lagoon) approximately 25m offshore from the North bank and operated through 30 July (Figure1); the large trap at this time was retired for the season.

Smolt Enumeration

Captured sockeye salmon smolts were removed and enumerated daily from each trap. Minimally, the traps were checked daily approximately every 60 minutes between 2100 and 0400 h, and again at 1200 h. Traps were checked more frequently as catches increased to maintain trap efficiency and minimize trap induced mortality. All catch data was recorded by sampling day, which extended from noon to noon and was identified by the calendar day of the noon to midnight period (e.g. counts for 6 May represent smolt enumerated from noon 6 May until noon on 7 May).

Species identification of salmonids were made by visual examination of external characteristics (McConnell and Snyder 1972). Only sockeye salmon smolt were enumerated daily; catch of sockeye fry and other species were indexed counts which reflect some unknown fraction of the total number caught. Juvenile sockeye greater than approximately 40 mm in length with silvery body coloration and eyes small relative to head size were considered smolts (Thedinga et al. 1994). Similar size fish and smaller with prominent parr marks and large eyes relative to head size were assumed to be fry and were not enumerated. All juveniles greater than about 55 mm were considered to be outmigrating smolts, regardless of coloration or proportional body morphology.

Age, Weight, and Length Sampling

Subject to availability, seventy sockeye smolts were sampled daily, five days a week. The sample was generally obtained between 2100 and 0500 h using a dip net to remove fish from the live box. Smolts were kept alive and sampled on the day of capture. Smolts were anesthetized prior to sampling in a tricaine methanesulfonate (MS-222) solution, and measured for length (tip-of-snout to fork-of-tail) to the nearest 1.0 mm, and weighed to the nearest 0.1 g with an electronic digital scale. A scale smear was removed from the preferred area (INPFC 1963) and mounted on a standard microscope slide for aging with a microfiche reader under 42X or 48X magnification (Figure 3). Ages were recorded in European notation (Koo 1962). After sampling, fish were revived in aerated water and released downstream from the traps. Condition factor (K) for each smolt sampled was determined using:

$$K = \frac{W * 10^5}{L^3} \qquad (1)$$

where:
W = weight (grams) and L = length (tip-of-snout to fork-of-tail; in millimeters ;Barrett et al. 1993).

Estimation of Trap Efficiency

The operational plan called for estimating trap efficiency weekly through mark-recapture experiments using Bismark Brown dye to mark smolt. Smolts used for trap efficiency trials were

collected from the traps and transferred in 19 L plastic buckets to instream covered live boxes. Smolt were retained for a minimum of 10 hours to a maximum of three nights prior to dyeing, depending on smolt availability. If the target number of smolts collected for dyeing was not met after three nights, those available were dyed and released. Initially, an attempt was made to mark and release at least 1,000 sockeye smolt weekly. Later the target sample size was increased to 2,000 smolts in an attempt to increase the precision of trap efficiency estimates.

Smolts were dyed in the evening at approximately 2100 hours. Smolts were transferred from the live boxes into a continuously oxygenated or aerated solution of 1.9 g Bismark Brown dye to 57 L water for 30 minutes at a rate of up to 1,000 smolt/76 L dye solution (Ward and Verhoeven 1963; Lawler and Fitz-Earle 1968). After marking, smolts were returned to the liveboxes and held for about 30 minutes to allow for recovery. At approximately 2230 hours, dyed smolts were collected from the liveboxes, transported 1.3 km upstream from the traps, and released evenly across the stream channel. At each step of the dyeing process, dead or stressed smolts were counted and removed.

Following the release of dyed fish, trap catches were examined for recaptures for three successive days. Recaptured smolts were recorded separately from unmarked fish and excluded from daily catch totals. Estimated trap efficiency is represented as:

$$\hat{e} = \frac{d_i}{D}, \qquad \text{and} \tag{2}$$

$$d_i = \sum_{i=1}^{k} d_i \quad , \tag{3}$$

where d_i is the number of marked fish recaptured on day i of k successive days after release of marked fish, and D is the number of marked fish released.

Rawson (1984) reported statistical models for treating sockeye smolt mark-recapture data derived on a daily basis with population estimates generated by:

$$\hat{N}_i = n_i \left[\frac{D}{d_i} + \frac{(D - d_i)}{d_i^2} \right]; \tag{4}$$

with variance

$$\hat{\text{var}}\left[\hat{N}_i\right] = n_i (n_i + d_i)\, D(D - d_i)/d_i^2 . \tag{5}$$

The overall annual smolt outmigration for a particular system was estimated by:

$$\hat{N} = \sum_{i=1}^{n} \hat{N}_i \tag{6}$$

with the overall variance estimated by:

$$\hat{\text{var}}\left[\hat{N}\right] = \sum_{i=1}^{m} \hat{\text{var}}\left[\hat{N}_i\right] \qquad (7)$$

where:

i) $\hat{N}_i$ = Total population of smolt outmigrating on day i;

ii) n_i = Number of unmarked fish captured in traps during day i;

iii) $\hat{N}$ = Total smolt population outmigrating over m days.

The (1-a) confidence intervals for the smolt population estimates were derived assuming a normal distribution (Rawson 1984).

A chi-square test was used to test for homogeneity (α=0.05) among weekly mark-recapture events and the seasonal total (α=0.05; Zar 1984).

In situations where one of the traps became inoperable during the season we employed linear interpolation to estimate foregone trap catches. Generally we used five prior and five post paired (small and large trap catches) data points to define the linear relationship.

There are two components related to estimating and accounting for error associated with mark-recapture trials used for smolt population estimation that have not been previously quantified. The first is whether or not significant delayed mortality exists after sockeye smolt are marked and released; and the second is detection of marked fish over time. Vania and Swanton (1996) addressed marked fish detectablity during 1995 and found there to be virtually no observed bias, however they suggested that the delayed mortality component be replicated during 1996.

Delayed Mortality Associated With Marked Fish

An instream live box was constructed for mortality experiments for estimating marked smolt mortality that occurs over time after having been subjected to the dye process. The live box was 0.9 m (3-ft) wide x 1.5 m (5-ft) long x 0.9 m (3-ft) deep with perforated side and end panels, and divided into ten separate 30 cm (1-ft) x 46 cm (1.5-ft) compartments. Compartments on one side of the live box were labeled "Unmarked" and numbered 1 - 5; with the opposite side being labeled "Marked" and numbered 1-5. The live box was placed across the river from the traps parallel to the flow, in slow moving water adjacent to the river bank to facilitate ease of examination.

The design involved five replicate experiments to be conducted on a weekly basis and initiated as soon as the trap catches were such that 300 smolts could be secured without impacting either mark-recapture or AWL sampling. The sample was then divided into two equal groups. One group was subjected to the same dye process that was used for mark-recapture trials (i.e. dye concentration, emersion period, aeration, recovery time, and transport procedures) and second group of smolts were left unmarked but were also subjected to the same handling procedures as mark-recapture trials (i.e. aeration, recovery time, and transportation). Only robust and healthy smolts were placed

in the live box; defined as actively swimming fish maintaining routine respiration and responding to external stimuli. Any smolts not displaying this behavior were released down stream of the trap.

All marked and unmarked smolts were then placed into the 10 compartments of the live box with compartments randomized so as to minimize any live box location affect. Marked and unmarked fish were then inspected over a five day period and the number of dead smolt counted, removed, measured for weight and length, and the data recorded specific to each live box compartment.

Climate and Hydrology

Trap revolutions per minute (rpm) and daily climate observations, including air and stream temperature (C), stream height (cm), cloud cover (%), wind velocity (mph) and direction were recorded at approximately 1200 daily at the smolt trap site. During this time period, both traps were cleaned and any trap or lead adjustments were made accordingly due to the rise and fall of the water level.

RESULTS

In 1996 the traps were operated from 6 May through 30 June during which time 24,695 sockeye salmon smolts were caught. On 23 June damage sustained (over the season) to the large trap cone became a concern and it was removed from operation. During 23-30 June we estimated 171 smolts would have been caught in the large trap had it been operating. A total of 3,180 smolts were marked and released for trap efficiency trials and there were 49 recaptures (Appendix A). Mark-recapture trap efficiency trials were initiated on 25 May, 4 June, and 7 June. Tests for homogeneity between events and the pooled seasonal trap efficiency resulted in there being no significant difference between the three trials and the seasonal total (χ^2=0.206, P=0.902). We therefore employed the seasonal trap efficiency (1.14%) to estimate sockeye smolt emigration on a daily basis through 30 June. The total estimated sockeye smolt outmigration was 2.2 million fish (Table 1; Figure 4). Age-0. smolts composed about 2.2% (48,000) of the outmigration, age-1. smolts approximately 58.9% (1,301,000), age-2. smolts 38.6% (850,000), and age-3. smolts 0.3% (6,000; Table 1). Overall, 92% of the sockeye smolts were caught in the large trap, and 8% in the small trap (Appendix B). Other species captured included coastrange sculpin *Cottus aleuticus*, coho salmon *O. kisutch*, Dolly Varden *Salvelinus malma*, ninespine stickleback *Pungitius pungitius*, pond smelt *Hypomesus olidus*, pygmy whitefish *Prosopium coulteri*, starry flounder *Platichthys stellatus*, and threespine stickleback *Gasterosteus aculeatus*.

The overall smolt outmigration peak occurred on 24 May (Figure 5, Appendix C), with modes for age-1. and age-2. smolts occurring on 24 May, and for age-0. fish about 31 May (Figure 6). The percentage of age-0 smolts increased over the season from 2.2% (6-23 May) to 20.4% (14-30 June; Appendix D). The percentage of age-1. smolts increased over time from 53.7%(6-23 May) to 72.4% (14-30 June; Figure 8) whereas age-2. fish steadily declined in abundance. There were only three age-3. smolts captured from 6 May through 30 June.

A total of 1,450 smolts were sampled for age, weight, and length data (Appendix E). The average length of age-0. smolts was 48 mm and possibly shows a decline from 51 mm (6-23 May) to 49 mm (14-30 June; Figure 9). The mean length of age-1. smolts was 67 mm and declined over time from 66 mm (6-23 May) to 60 mm (14-30 June); mean length of age-2. smolts was 79 mm and increased over time (Appendix F). Comparisons of length at age for 1. and 2. fish show that larger smolts outmigrated during 1996 than either 1994-95 (Table 3).

Post 30 June with the small trap located downstream of the counting weir a total of 2,320 smolts were captured of which 644 fish were sampled for age, weight, and length (Appendices H-I). We had initially planned on terminating smolt monitoring on 15 July, however the smolt catches remained at levels that warranted continuing through 30 July. The 2,320 smolts caught during July represents 9.4% of the smolts caught during routine operations from 6 May- 30 June.

The mean length of age-0. smolts was 50 mm declining from 52 mm (1-11 July) to 44 mm (19-30 July); average length of age-1. smolts was 70 mm declining from 72 mm (1-11 July) to 67 mm (19-30 July). Mean length of age-2. smolts was 82 mm and also declined over time (Figure 10). No population estimates were generated from the smolt caught post 30 June.

Comparison of the freshwater scale patterns of Chignik Lakes sockeye smolt over time by age class are shown in Figure 3. Generally, throughout the season, age-0. fish had scales with freshwater growth comprised of 2-3 circuli and remained fairly constant. Smolts designated as age-1. were comprised of essentially two groups one with a growth pattern consisting of 10-14 freshwater circuli and the second with 8-10 circuli some of which had 4-6 circuli of spring growth (fish sampled on 12 July; Figure 3). Age-2. smolts were generally catagorized into three groups of scale patterns, the first with an annulus formed 3-4 circuli beyond the focus, the second at 6-8 circuli, and the third at about 10-12 circuli. The second annulus was somewhat consistent between these groups occurring about 6-8 circuli from the first annulus.

The freshwater scale pattern for age-0. fish collected post 30 June was generally comprised of 3 -5 circuli. Age-1. fish were generally comprised of two groups of scale patterns, 6-8 circuli with 1-3 circuli of spring growth and a second with 8-10 circuli having 4-5 circuli of spring growth. Age-2. fish were comprised of two groups: the first with an annulus formed at 3-5 circuli and the second at 6-8 circuli from the focus; the second annulus occurred about 3-6 circuli from the first annulus for both patterns. There were an additional 1-3 circuli of spring growth for both age-2. patterns beyond the margin of the second annulus.

Daily Climatological observations collected during the 1996 field season are listed in Appendix G.

Technical difficulties (live box shifted position during first night) experienced with the first replicate of the delayed mortality experiment caused these results to be discarded. The second replicate resulted in an estimate of unmarked smolt mortality of 1.6% and for marked fish 5.2% over a five day period. The difference between the two being 3.6% which is the mortality we attribute to conducting the trap efficiency trials.

DISCUSSION

Smolt population estimates for 1996 (2.2 million) were substantially lower than those from either 1994 (12.7 million) or 1995 (11.3 million). This very low number of sockeye salmon smolt could have resulted from fish outmigrating earlier than either 1994-95. The graph of cumulative smolt outmigration by day and year is partially supportive of this contention. Anecdotal environmental observations suggest that the Chignik Lakes area experienced a mild winter and early spring conditions during 1996 which further support an earlier than average smolt emigration. The sockeye smolt emigration at Frazer Lake (Southern end of Kodiak Island) during 1996 was such that we feel substantial numbers of smolts outmigrated prior to initiating smolt monitoring (Swanton et al. *in prep*). With three years (1994-96) of trap catches from the Chignik Lakes system all initiating about 5-6 May, further discussion is unwarranted. There are no indications from trap operation or other monitoring activities that would suggest emigrating smolts expressed deviant inriver migration patterns nor abnormally high trap avoidance. Another plausible explanation is that there was a depensatory response (reduced survival of fry to age-1. smolt) from the estimated 766,000 Black Lake escapement. A future study component is to investigate if substantial numbers of smolts are emigrating prior to early May.

Trap efficiency results over the season varied from 1.0% to 1.2%, however, only three mark-recapture experiments over the season were performed. Stream width at the King Hole site was 46 m compared to 73 m at Hawk's Bluff (1994 site). This narrow constriction has possibly contributed to the increased overall trap efficiency experienced during both 1995 and 1996 of 1.0% compared to the 0.5% trap efficiency estimate from 1994 (Vania and Swanton 1996; Stopha and Barrett 1994). Thedinga et al. (1994) found that trap efficiency was affected by water level, trap placement, and cone rotation speed, and varies also among species and life stages. In following years we plan on conducting mark-recapture trials every four days as opposed to seven which should improve the trap efficiency results and reduce perceived bias in the smolt population estimates.

The differential growth between juvenile salmon rearing in Black Lake and Chignik Lake may be used to identify the primary rearing area for sockeye smolts during their freshwater residence. Harvey (1994) noted that sockeye fry will undergo one of three types of lakeward migration: downstream migration from an inlet spawning stream; upstream migration from an outlet spawning stream; or dispersal migration from a spawning beach to pelagic rearing areas. Sockeye salmon fry rearing in Black Lake emerge earlier and grow at a faster rate than fry rearing in Chignik Lake (Narver 1966). Studies of the lacustrine life history stage of Black Lake juveniles indicate that a portion of yearlings rear in Black Lake, while others emigrate to Chignik Lake (Roos 1959; Narver 1966; Ruggerone et al. 1993; Ruggerone 1994). The contrast in growth rates between rearing fry from the two lakes and outmigrating smolt could be reflected in length-frequency distributions coupled with growth records from scales. Testing this hypothesis will be feasible with several additional years of both smolt and rearing fry data collection.

A cursory analysis of length-at-age coupled with freshwater growth as reflected by scale interpretation eludes to there being two and possibly three populations of age-1 smolts (Vania and Swanton 1996). The two perceived modes from the 1996 migration of age-1.smolts were one with a

$\bar{x}$=55 mm, range 49-64mm and the second with a $\bar{x}$=78mm, range 67-90+mm. These groups persisted from 6 May through 13 June, after which there was no apparent groupings based upon length at age. Ruggerone (1994) suggested that there were three patterns, two of which were substantiated during both 1995 and 1996; the third group with smolts averaging 98mm in length as reported in Ruggerone (1994) were virtually absent from samples collected during 1996.

A single size mode of age-2. smolts appears to persist from 6 May through mid June, $\bar{x}$=76mm fork length, ranging from 64mm to 94mm, which is similar to that observed during 1995 ($\bar{x}$=74mm, range 65mm to 95mm fork length). Conversely, the 1994 emigration of age-2. fish seemed to decrease in length over time with the modal length during 5-20 May being 10mm larger than fish emigrating during 22 May-11 June. This could be attributable to sampling bias, trap site (Hawks bluff versus King Hole locations), age error, or due to periodic shifts in freshwater rearing area utilization that can only be addressed over time. The decline in relative abundance of age-2. smolts over time is somewhat typical of sockeye smolt migrations where larger and older smolts tend to emigrate earlier (Figure 8; Ruggerone 1994).

The age-0. smolt component was addressed first during 1995 so very little comparison can be made other than the percent of the overall migration was 2.2% in 1996 versus 6.0% (637,00) in 1995. Length at age for this age class was very similar between years averaging about 45-47mm. During 1994, fish emigrating that were subjectively considered to be less than 55mm were not sampled.

The post 30 June outmigration study provides a initial benchmark for smolts emigrating from the Chignik Lakes system during July and possibly into late summer. Numerous observations have been forwarded suggesting upstream and downstream movements of smolt/fry both in early spring and during late summer. The earliest recorded observations were those of Holmes (1929), who noted an extensive upstream movement of "fingerling" sockeye in the lower river in late August. Roos (1959) recorded upstream and downstream movements of fry and age-1.+ fish in the upper and lower Chignik River as cited in Iverson (1966). Although only 2,320 sockeye smolt were caught in the small trap post 30 June, it does partially substantiate previous observations. However, further evaluation is needed to address if these movements and relative abundance indices are annual occurrences.

The marked versus unmarked mortality experiment's data analysis was limited to comparisons of average survival between marked and unmarked fish because only a single replicate was conducted. The estimate of 96.4% survival is substantially higher than the 1995 estimate of 88% but closely aligned with a marked fish survival estimate of 95% from a similar experiment conducted on sockeye salmon within the Situk River (Thedinga et al. 1994). We propose to conduct the mortality experiments again during subsequent field seasons, with modifications, to confirm or refute the limited marked smolt mortality data collected during both 1995-96 . If this mortality estimate holds true then the smolt population estimates generated during 1994-96 will be adjusted accordingly.

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Table 1. Sockeye salmon smolt population estimates and age composition for the Chignik Lakes system, 1993-1996.

Smolt Year		Smolt Population Estimate and Age Compopsition (%)					95% CI	
		Age-0.	Age1.	Age-2.	Age-3.	Total	Lower	Upper
1993	No.	[a]	25,397,684	8,754,782	[b]	34,152,467[c]	2,607,046	65,697,887
	%		74.4	25.6		100.0		
1994	No.	[a]	7,736,438	5,016,654	[b]	12,753,093	12,317,017	13,245,169
	%		60.7	39.3		100.0		
1995	No.	673,867	3,378,427	7,261,223	[b]	11,313,517	4,062,384	18,564,649
	%	6.0	29.9	64.1		100.0		
1996	No.	47,528	1,301,339	850,454	6,371	2,205,692	1,579,991	2,831,626
	%	2.2	58.9	38.6	0.3	100.0		

[a] Population estimates not available.

[b] Estimates may not be accurate.

[c] No samples collected.

Table 2. Sockeye salmon escapement and estimated number of smolt produced by brood year from Chignik and Black lakes, 1990-1994.

Brood Year	Estimated Escapement by Lake System		Smolt Produced by Age Class (Both Lakes Combined) 1.	2.	Total No. Smolts
1990	Black :	434,543	[a]	8,754,782 [b]	8,754,782c
	Chignik :	335,867			
1991	Black :	657,511	25,397,684 [b]	5,016,654	30,414,338
	Chignik :	382,587	(84%)	(16%)	
1992	Black :	360,681	7,736,438	7,261,233	14,997,661
	Chignik :	405,922	(52%)	(48%)	
1993	Black :	364,263	3,378,427	850,454	4,228,881
	Chignik :	333,114	(80%)	(20%)	
1994	Black :	766,909	1,301,339	[c]	
	Chignik :	200,000			

[a] Population estimates not available.

[b] Estimates may not be accurate.

[c] Incomplete brood year.

Table 3. Summary of mean length, weight, and condition by age class of smolt sampled from the Chignik River, 1994-1996.

			Smolt					
Outmigration Year	Freshwater Age Class	N	Mean Length (mm)	SE	Mean Weight (g)	SE[a]	Condition Factor (k)	SE
1994	0	[b]	[b]		[b]		[b]	
1995	0	286	45.7	0.2	0.7		0.74	0.01
1996	0	83	47.9	0.5	0.9		0.76	0.02
1994	1	1,722	66.6[c]		2.3		0.75	
1995	1	1,275	60.2	0.3	2.0		0.83	0.01
1996	1	935	66.9	0.3	2.4		0.76	0.01
1994	2	1,096	77.4		3.6		0.75	
1995	2	1,009	75.1	0.2	3.5		0.80	0.01
1996	2	429	79.5	0.4	4.1		0.79	0.01
1996	3	3	100.3	5.5	8.4		0.81	0.07

[a] Standard errors for weight estimates were less than the precision level of measurement (0.1g) therefore they were not reported.

[b] Age-0. smolts not sampled.

[c] Age-1. smolts <55 not sampled.

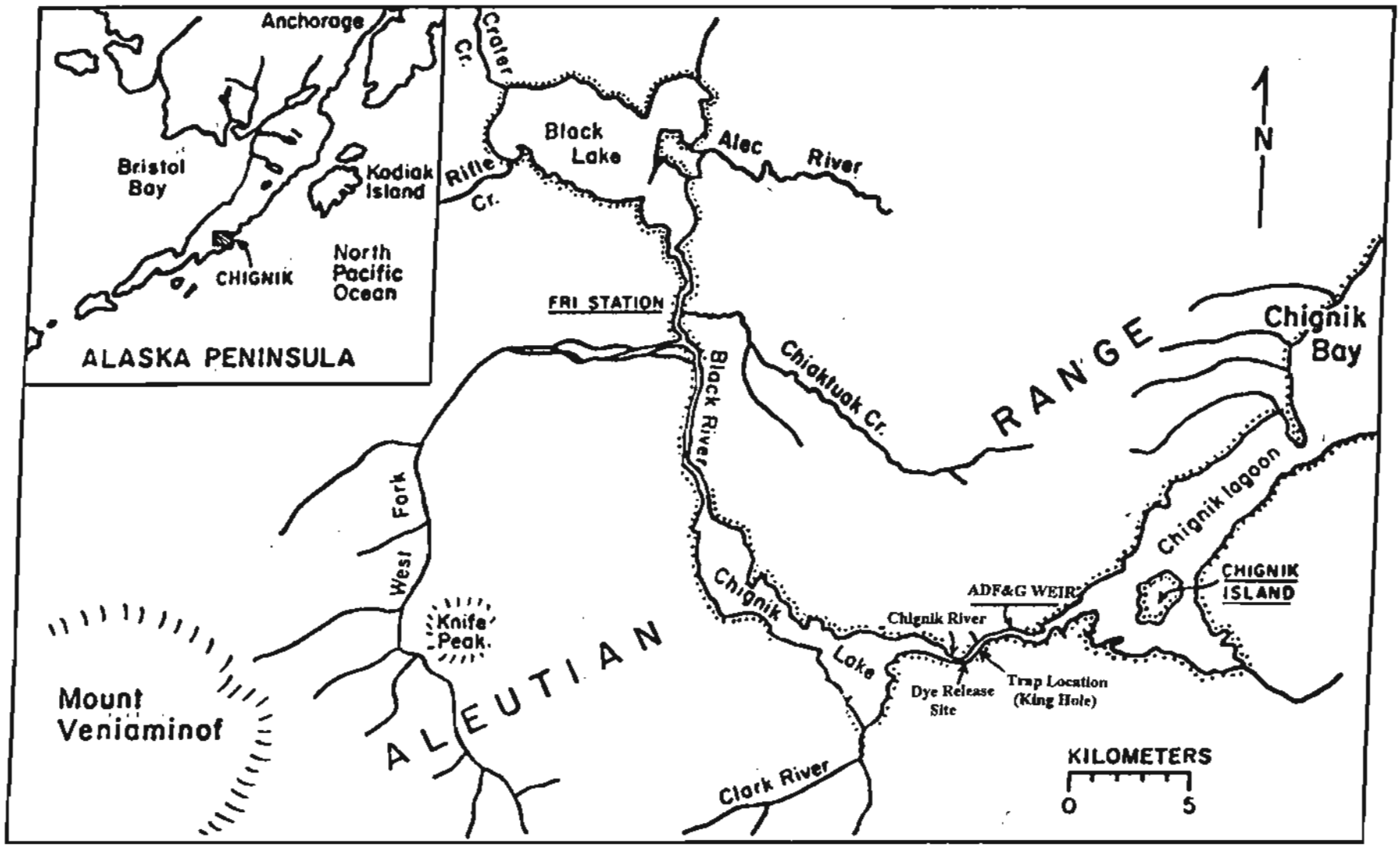

Figure 1. Map of the Chignik watershed, with inset of southwest Alaska.

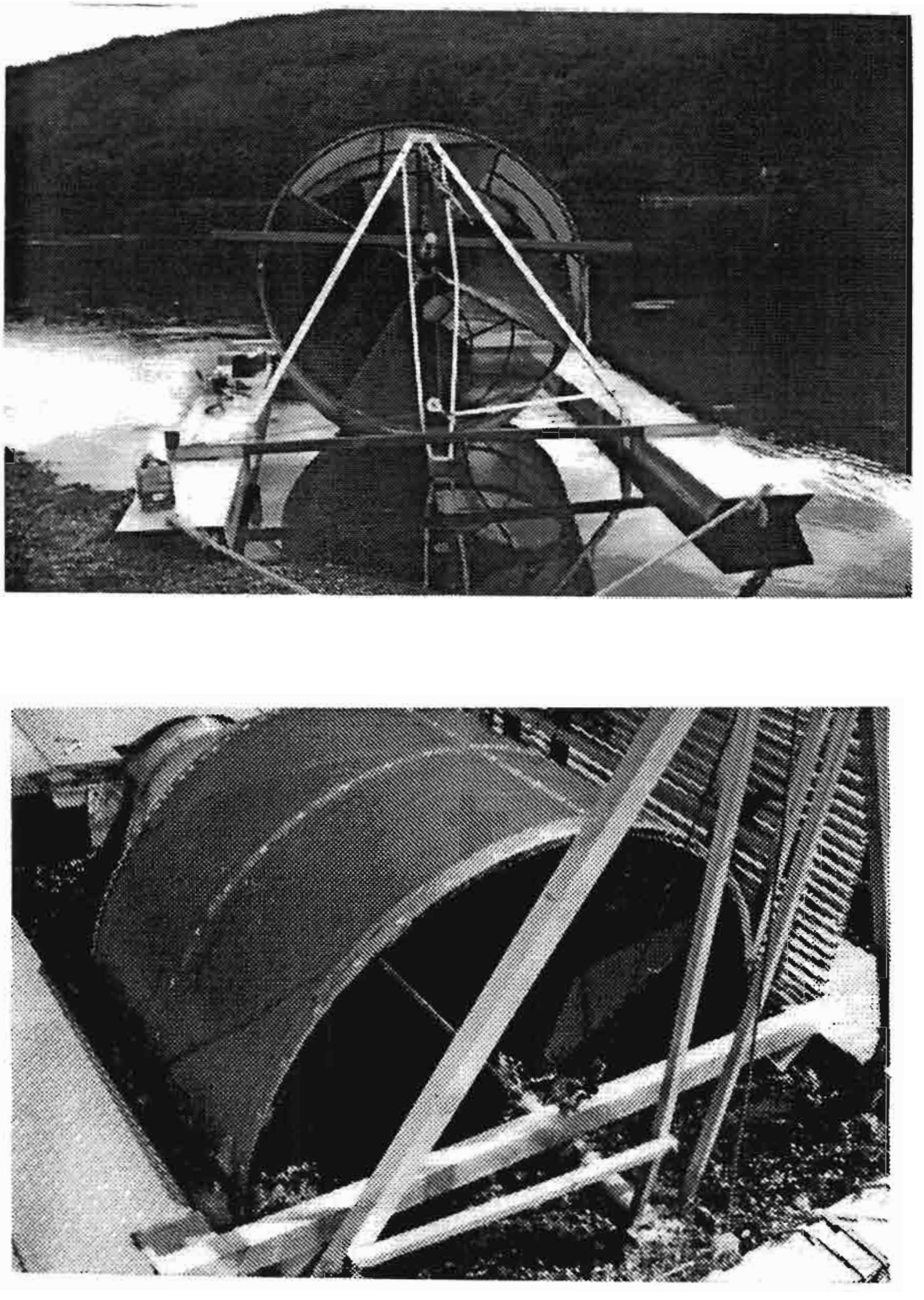

Figure 2. Photographs of rotary-screw traps with 2.4-m and 1.5-m diameter cones.

Age-0.
Length : 50 mm
Weight : 0.9 g
May 20, 1996

Age-0.
Length : 49 mm
Weight : 0.8 g
June 10, 1996

Age-0.
Length : 46 mm
Weight : 0.7 g
July 12, 1996

Age-1.
Length : 94 mm
Weight : 7.0 g
May 20, 1996

Age-1.
Length : 80 mm
Weight : 4.0 g
June 10, 1996

Age-1.
Length : 85 mm
Weight : 5.1 g
July 12, 1996

Age-2.
Length : 85 mm
Weight : 4.4 g
May 20, 1996

Age-2.
Length : 103 mm
Weight : 9.9 g
June 10, 1996

Age-2.
Length : 88 mm
Weight : 6.0 g
July 12, 1996

Figure 3. Examples of age-0., age-1., and age-2. sockeye salmon smolt scales (54X), Chignik Lakes, 1996.

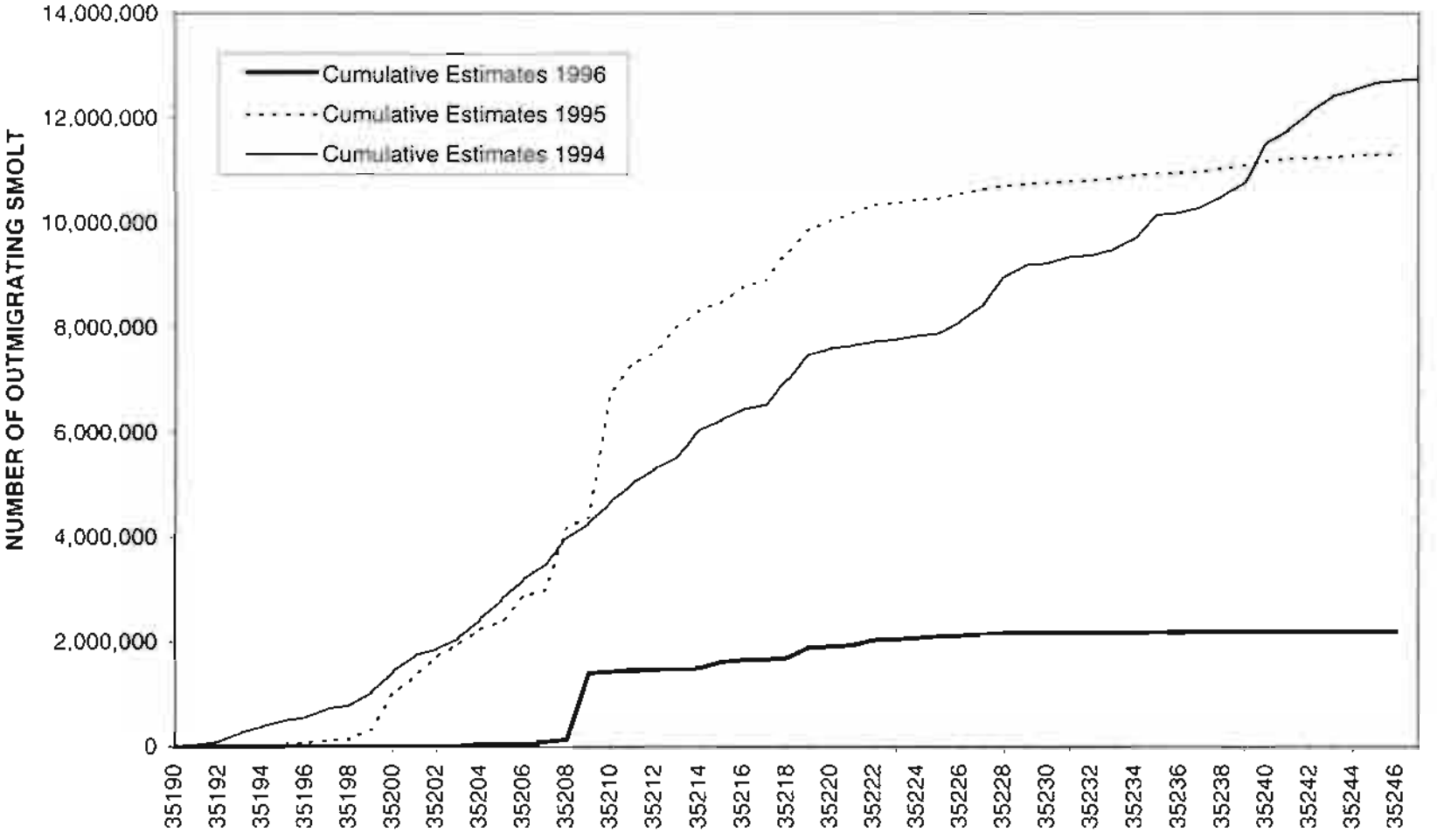

Figure 4. Cumulative number of sockeye salmon smolts estimated to have emigrated from the Chignik Lakes by year, 1994-1996.

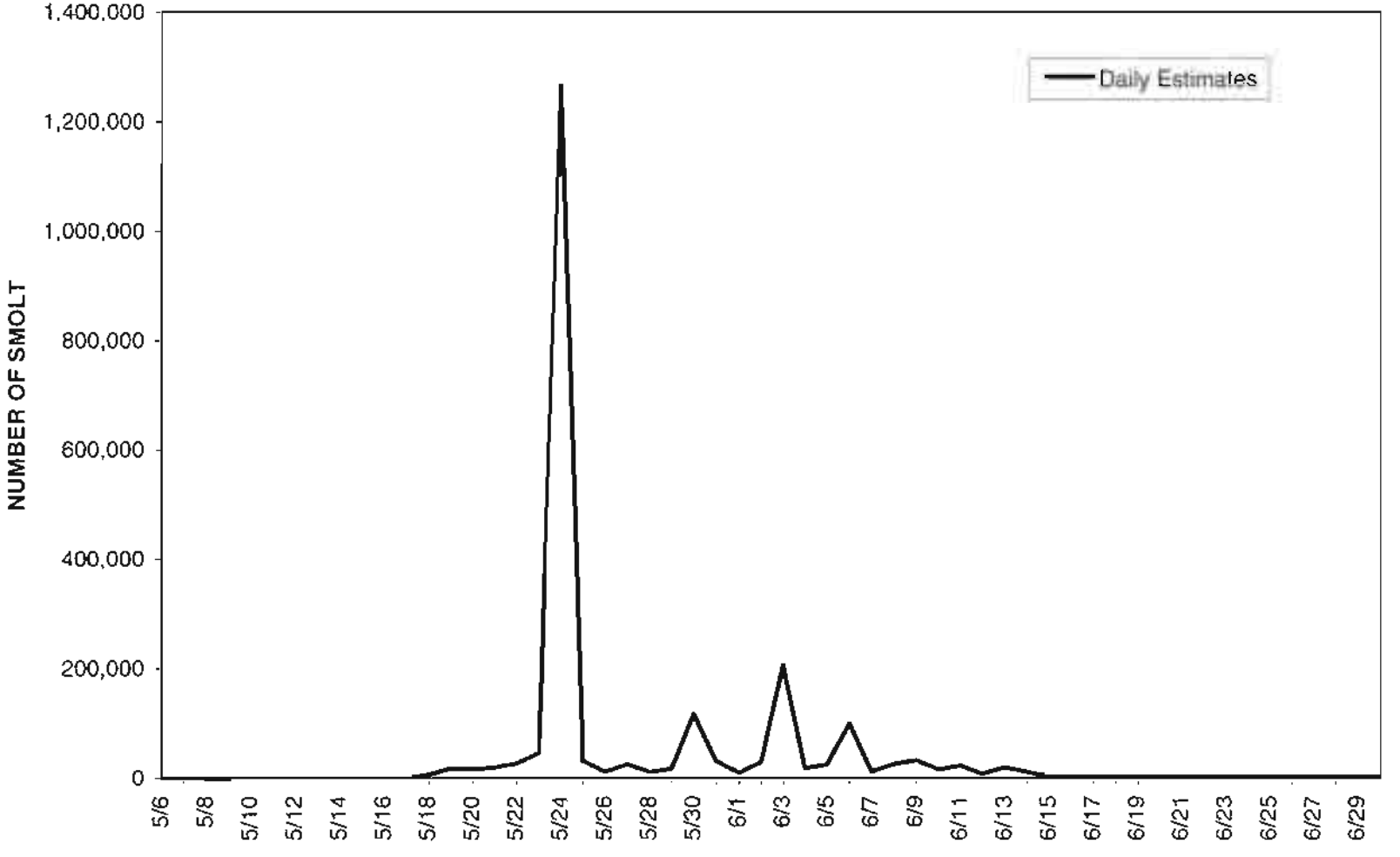

Figure 5. Daily estimates of emigrating sockeye salmon smolts from the Chignik Lakes by week, 6 May through 30 June, 1996.

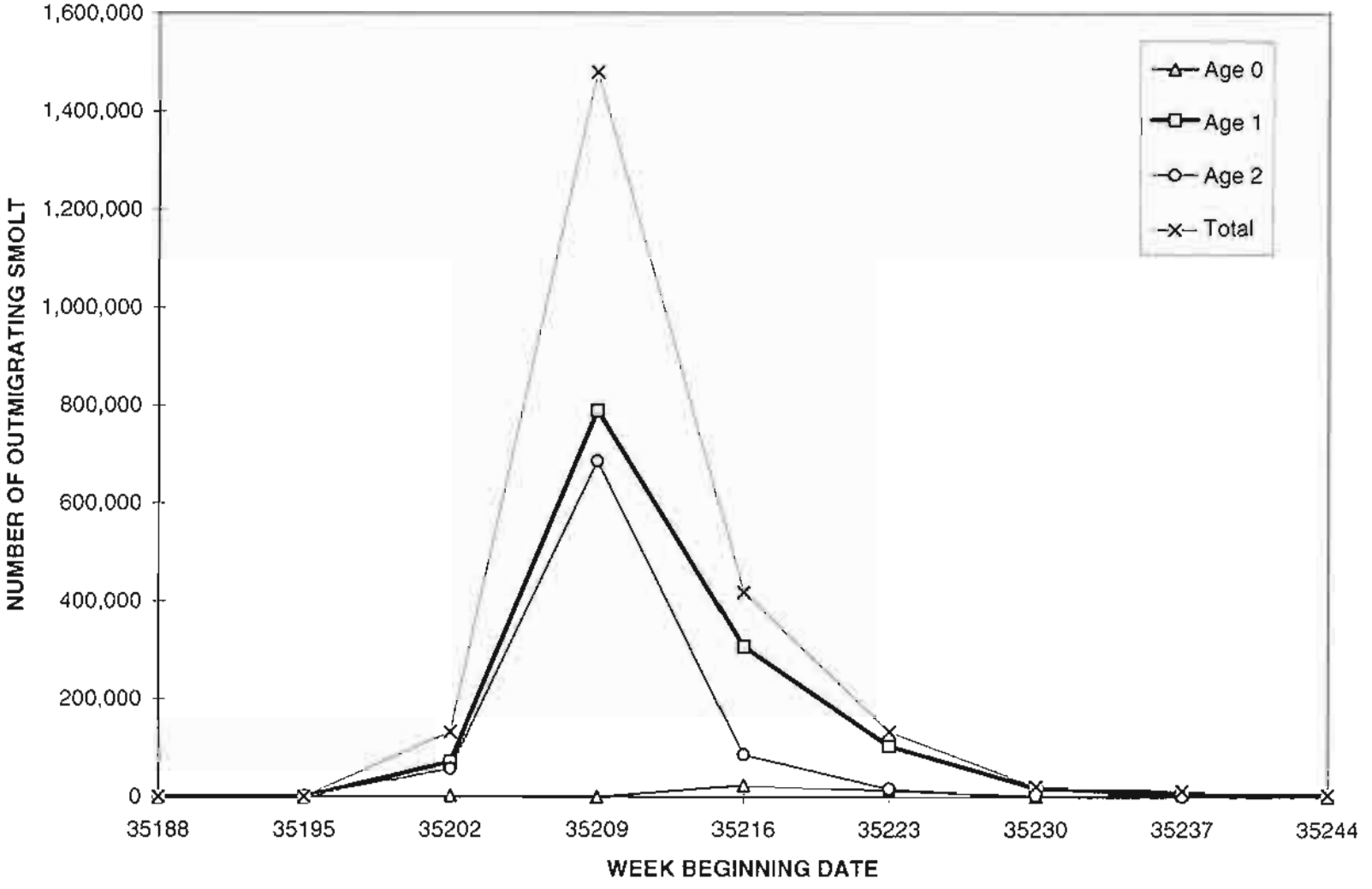

Figure 6. Weekly estimates of outmigrating sockeye salmon smolts by age class from the Chignik Lakes, 1996.

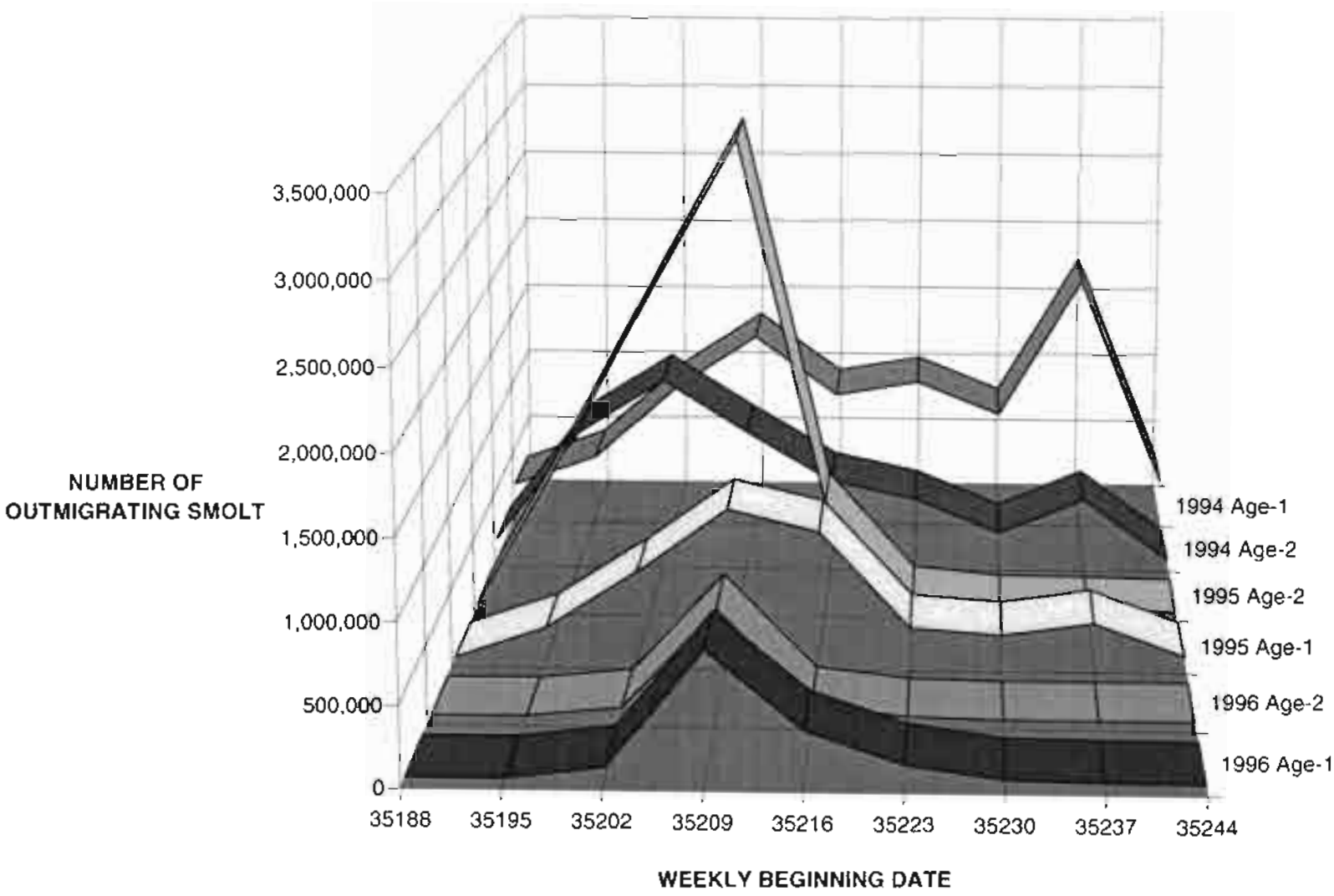

Figure 7. Weekly estimates of freshwater age-1. and age-2. sockeye salmon smolts from Chignik Lakes by year, 1994-1996.

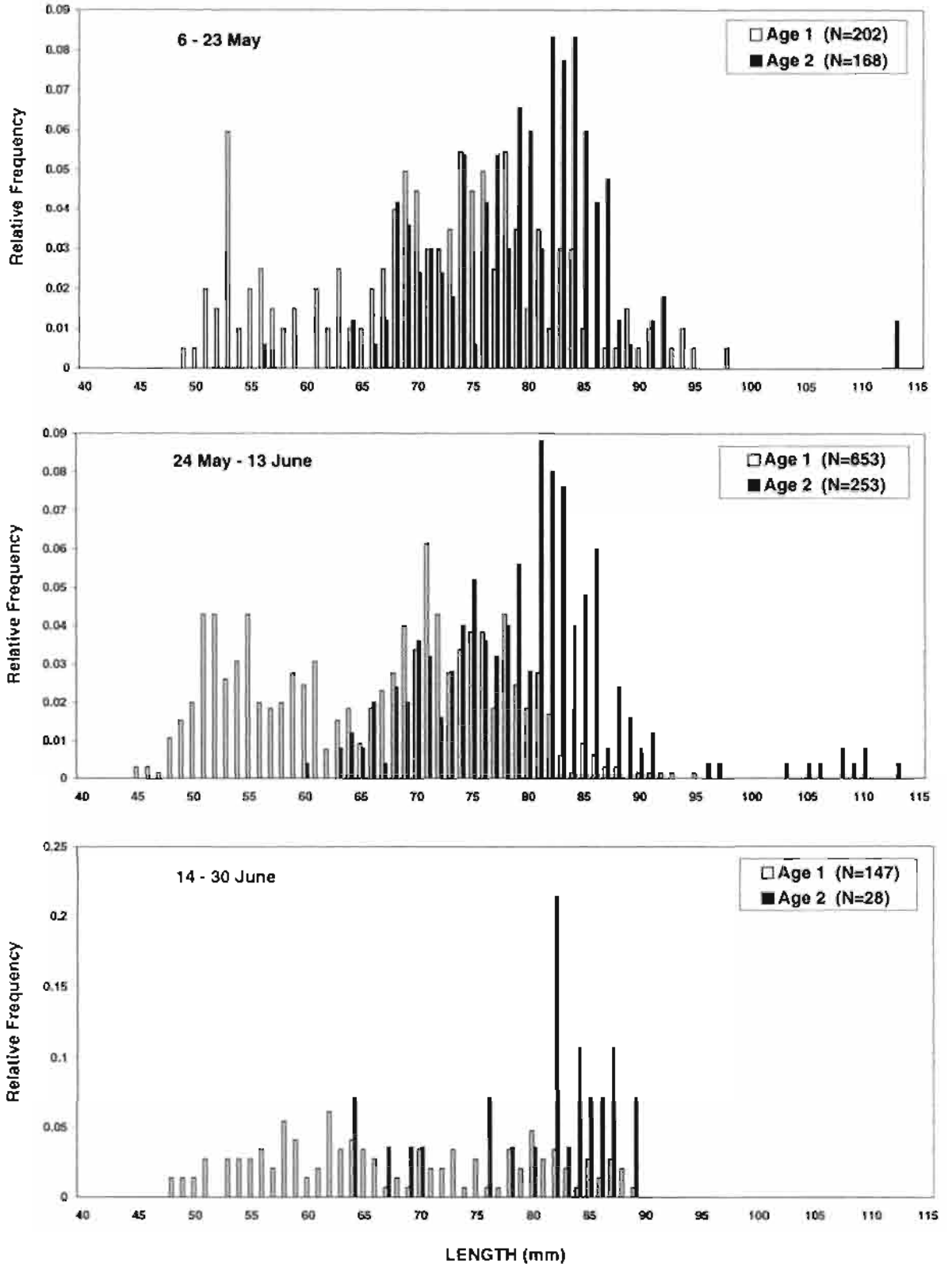

Figure 8. Relative length frequency of age-1. and age-2. sockeye smolts emigrating from the Chignik Lakes, 6 May through 30 June, 1996.

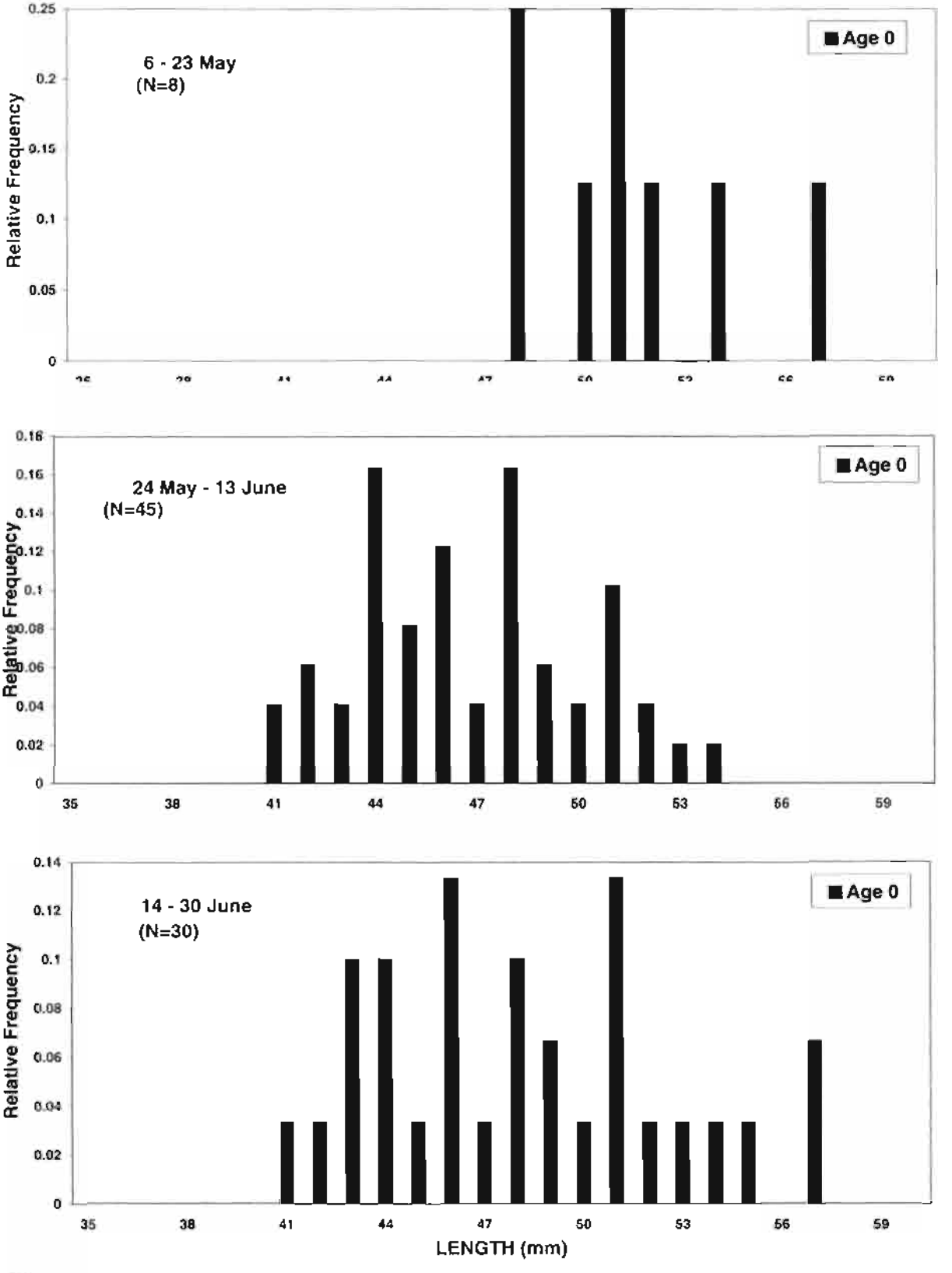

Figure 9. Relative length frequency of age-0. outmigrating sockeye smolts from the Chignik Lakes, 6 May - 30 June, 1996

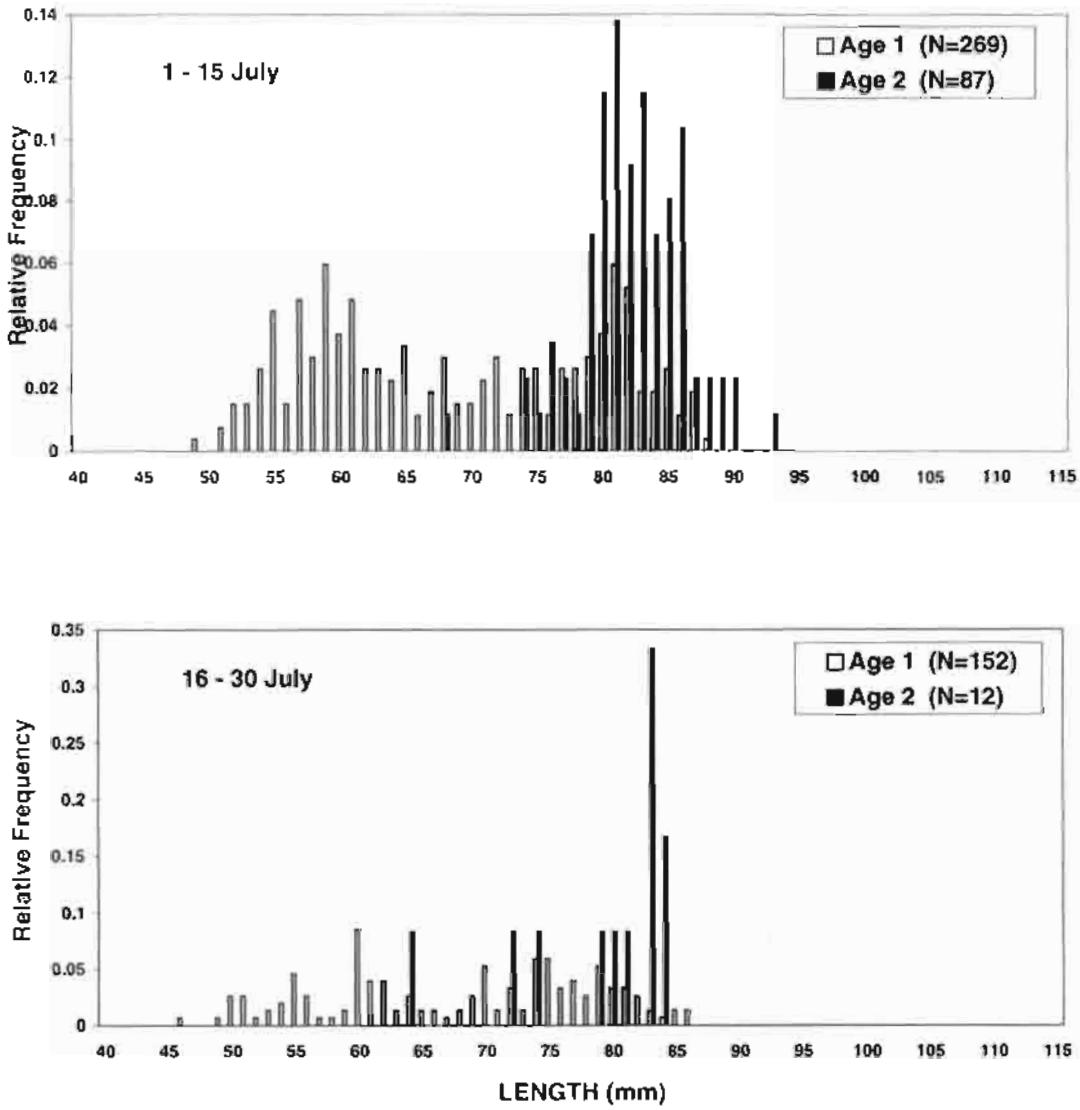

Figure 10. Relative length frequency of age-1. and age-2. sockeye smolts emigrating from the Chignik Lakes post 30 June, 1996.

APPENDIX

Appendix A. Daily number of sockeye salmon smolts caught with rotary-screw traps, Chignik River, 6 May through 30 June, 1996.

	Combined Trap Catch[a]		Trap Efficiency Test					
Date[b]	Daily[c]	Cum.	Marked (Dyed)	Examined For Marks	Marked Recoveries	Est. Marked Recoveries For Dye Test Period[d]	Recovery Rate %[e]	Comments
6-May	9	9	0	0				Lrg. and sm. traps begins fishing @ 1530 hrs
7-May	11	20	0	0				Installed inshore lead to trap apparatus
8-May	2	22	0	0				Approx. 80 coho smolt/fry caught in both traps
9-May	0	22	0	0				110 coho smolt/fry; 31 stickleback; 20 Dolly Varden
10-May	5	27	0	0				96 coho smolt/fry
11-May	4	31	0	0				170 coho smolt/fry; 57 stickleback; 34 Dolly Varden
12-May	1	32	0	0				145 coho smolt/fry; 44 stickleback; 9 Dolly Varden
13-May	0	32	0	0				150 coho smolt/fry; 51 stickleback; 27 Dolly Varden
14-May	1	33	0	0				136 coho smolt/fry; 23 stickleback; 25 Dolly Varden
15-May	0	33	0	0				140 coho smolt/fry; 27stickleback; 19 Dolly Varden
16-May	0	33	0	0				85 coho smolt/fry; 27 stickleback; 22 Dolly Varden
17-May	0	33	0	0				83 coho smolt/fry; 52 stickleback; 24 Dolly Varden
18-May	76	109	0	0				113 coho smolt/fry; 67 stickleback; 36 Dolly Varden
19-May	203	312	0	0				80 coho smolt/fry; 44 sticleback; 32 Dolly Varden
20-May	177	489	0	0				84 coho smolt/fry; 37 stickleback; 22 Dolly Varden
21-May	217	706	0	0				93 coho smolt/fry; 55 stickleback; 28 Dolly Varden
22-May	301	1,007	0	0				79 coho smolt/fry; 66 stickleback; 32 Dolly Varden
23-May	512	1,519	0	0				Transferred 300+ sockeye smolt to live box for dye test
24-May	14,184	15,703	0	0				Highest percentage of catch occured 0100-0400; 16 morts.
25-May	354	16,057	1,502	365	11	18	1.20%	All dyed smolt held in live box for two days; 1 mort.
26-May	132	16,189	0	136	4			13 sockeye fry; 2 whitefish; 54 coho smolt/fry
27-May	285	16,474	0	288	3			49 sockeye fry; 61 coho smolt/fry
28-May	127	16,601	0	0				22 sockeye fry; 48 coho smolt/fry; 1 starry flounder
29-May	188	16,789	0	0				185 sockeye fry; inshore lead damaged(need to repair)
30-May	1,307	18,096	0	0				Inshore lead out for repairs (damaged from high water)
31-May	354	18,450	0	0				Moved traps inshore(approx. 4 m); lead modified

-Continued-

Appendix A. (page 2 of 3)

Date[b]	Combined Trap Catch[a] Daily[c]	Cum.	Trap Efficiency Test Marked (Dyed)	Examined For Marks	Marked Recoveries	Est. Marked Recoveries For Dye Test Period[d]	Recovery Rate %[e]	Comments
1-Jun	112	18,562	0	0				60 sockeye fry; 160 coho smolt/fry; 48 Dolly Varden
2-Jun	322	18,884	0	0				Repositioned traps (approx. 3.5 m from shore)
3-Jun	2,304	21,188	0	0				Collected and holding 1000+ smolt for dye test
4-Jun	195	21,383	1,624	197	2	17	1.04%	All dyed smolt held in live box for two days; 8 morts.
5-Jun	277	21,660	0	289	12			Lead out (producing too much back pressure on fulcrum)
6-Jun	1,114	22,774	0	1,117	3			Holding 1000 smolt for another dye test
7-Jun	128	22,902	1,164	131	3	14	1.20%	All dyed smolt held in live box for one day; 15 morts.
8-Jun	285	23,187	0	294	9			Lead out (too much back pressure exerted on fulcrum)
9-Jun	361	23,548	0	363	2			130 sockeye fry; 57 coho smolt/fry; 17 Dolly Varden
10-Jun	172	23,720	0	0				Repositioned traps for better angle (perpendicular) to current
11-Jun	248	23,968	0	0				112 sockeye fry; 54 coho smolt/fry; 3 whitefish; 12 Dolly Varden
12-Jun	79	24,047	0	0				58 sockeye fry; 44 coho smolt/fry; 13 Dolly Varden; 25 stickleback
13-Jun	219	24,266	0	0				Reset lead; pushed traps out 1 m for better angle of catchment
14-Jun	121	24,387	0	0				Adjusted depth of Lrg. trap (rotating approx. 6" above subsrate)
15-Jun	35	24,422	0	0				Observed pop-rivets dislodging from mid-section of Lrg. trap
16-Jun	31	24,453	0	0				30 sockeye fry; 26 coho smolt/fry; 3 king smolt; 11 Dolly Varden
17-Jun	12	24,465	0	0				7 sockeye fry; 17 coho smolt/fry; 3 king smolt; 3 Dolly Varden
18-Jun	16	24,481	0	0				Lots of misc. debris clogging small trap
19-Jun	10	24,491	0	0				15 sockeye fry; 24 coho smolt/fry; 2 king smolt; 4 Dolly Varden
20-Jun	13	24,504	0	0				8 sockeye fry; 31 coho smolt/fry; 4 king smolt; 4 Dolly Varden
21-Jun	9	24,513	0	0				Mink observed trying to enter live box; reinforced mink excluder device
22-Jun	11	24,524	0	0				Pulled large trap for season to minimze potential damage
23-Jun	29	24,553	0	0				Fishing only with small trap; large trap to be repaired
24-Jun	11	24,564	0	0				Fulcrum cracked/split; wood and misc. debris clogging trap
25-Jun	18	24,582	0	0				20 sockeye fry; 13 coho smolt/fry; 1 king smolt; 1 whitefish
26-Jun	33	24,615	0	0				stablized fulcrum; 12 sockeye fry; 14 coho smolt/fry; 1 starry flounder
27-Jun	25	24,640	0	0				20 sockeye fry; 13 coho smolt/fry, 2 king smolt; 1 Dolly varden

-Continued-

	Combined Trap Catch[a]		Trap Efficiency Test					
Date[b]	Daily[c]	Cum.	Marked (Dyed)	Examined For Marks	Marked Recoveries	Est. Marked Recoveries For Dye Test Period[d]	Recovery Rate %[e]	Comments
28-Jun	15	24,655	0	0				Readjusted lead and added braces to fulcrum
29-Jun	25	24,680	0	0				Very slow; few smolt
30-Jun	15	24,695	0	0				Last day fishing small trap at original site

[a] Traps fished had cone diameters of 1.5 m (small trap) and 2.4 m (large trap).

[b] Each date listed covers a 24-hr period extending from noon to noon and identifies the date of the 24-hr period.

[c] Number of fish caught does not include mark recoveries from trap efficiency test.

[d] Represents the estimated sum of marked recoveries for a particular dye test period.

[e] Determined from the number of marked and recovered fish by test period.

Appendix B. Daily number of sockeye salmon smolts caught by trap, Chignik River, 6 May through 30 June, 1996.

	Small Trap		Large Trap		Combined		Percent of Total Daily Catch by Trap	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
5/6/96	4	4	5	5	9	9	44	56
5/7/96	2	6	9	14	11	20	18	82
5/8/96	0	6	2	16	2	22	0	100
5/9/96	0	6	0	16	0	22	0	0
5/10/96	1	7	4	20	5	27	20	80
5/11/96	1	8	3	23	4	31	25	75
5/12/96	1	9	0	23	1	32	100	0
5/13/96	0	9	0	23	0	32	0	0
5/14/96	0	9	1	24	1	33	0	100
5/15/96	0	9	0	24	0	33	0	0
5/16/96	0	9	0	24	0	33	0	0
5/17/96	0	9	0	24	0	33	0	0
5/18/96	24	33	52	76	76	109	32	68
5/19/96	28	61	175	251	203	312	14	86
5/20/96	42	103	135	386	177	489	24	76
5/21/96	47	150	170	556	217	706	22	78
5/22/96	50	200	251	807	301	1,007	17	83
5/23/96	85	285	427	1,234	512	1,519	17	83
5/24/96	193	478	13,991	15,225	14,184	15,703	01	99
5/25/96	45	523	309	15,534	354	16,057	13	87
5/26/96	35	558	97	15,631	132	16,189	27	73
5/27/96	28	586	257	15,888	285	16,474	1	9
5/28/96	33	619	94	15,982	127	16,601	26	74
5/29/96	35	654	153	16,135	188	16,789	19	81
5/30/96	172	826	1,135	17,270	1,307	18,096	13	87
5/31/96	64	890	290	17,560	354	18,450	18	82
6/1/96	29	919	83	17,643	112	18,562	26	74
6/2/96	101	1,020	221	17,864	322	18,884	31	69
6/3/96	152	1,172	2,152	20,016	2,304	21,188	07	93
6/4/96	47	1,219	148	20,164	195	21,383	24	76
6/5/96	49	1,268	228	20,392	277	21,660	18	82
6/6/96	119	1,387	995	21,387	1,114	22,774	11	89
6/7/96	37	1,424	91	21,478	128	22,902	29	71
6/8/96	93	1,517	192	21,670	285	23,187	33	67
6/9/96	83	1,600	278	21,948	361	23,548	23	77
6/10/96	46	1,646	122	22,070	172	23,720	29	71
6/11/96	82	1,728	166	22,236	248	23,968	33	67
6/12/96	31	1,759	48	22,284	79	24,047	39	61
6/13/96	57	1,816	162	22,446	219	24,266	26	74
6/14/96	30	1,846	91	22,537	121	24,387	25	75
6/15/96	16	1,862	19	22,556	35	24,422	46	54
6/16/96	12	1,874	19	22,575	31	24,453	39	61
6/17/96	4	1,878	8	22,583	12	24,465	25	75

-Continued-

Appendix B. (page 2 of 2)

	Small Trap		Large Trap		Combined		Percent of Total Daily Catch by Trap	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
6/18/96	7	1,885	9	22,592	16	24,481	44	56
6/19/96	3	1,888	7	22,599	10	24,491	3	7
6/20/96	5	1,893	8	22,607	13	24,504	38	62
6/21/96	4	1,897	5	22,612	9	24,513	44	56
6/22/96	8	1,905	3	22,615	11	24,524	73	27
6/23/95	8	1,913	21	22,636	29	24,553	28	72
6/24/95	3	1,916	8	22,644	11	24,564	27	73
6/25/95	5	1,921	13	22,657	18	24,582	28	72
6/26/95	9	1,930	24	22,681	33	24,615	27	73
6/27/95	7	1,937	18	22,699	25	24,640	28	72
6/28/95	4	1,941	11	22,710	15	24,655	27	73
6/29/95	7	1,948	18	22,728	25	24,680	28	72
6/30/95	4	1,952	11	22,739	15	24,695	27	73
Total	1952	1,952	22,739	22,739	24,695	24,695	8	92

[a] Large trap inoperable 23-30 June; estimated 171 smolts caught between large and small traps during this time period.

Appendix C. Daily population estimates of outmigrating sockeye salmon smolts, 6 May - 30 June, 1996.

Date	Population Estimate	95% CI Lower	95% CI Upper
6-May	804	247	1,361
7-May	982	356	1,609
8-May	179	0	425
9-May	0	0	0
10-May	447	46	847
11-May	357	2	712
12-May	89	0	262
13-May	0	0	0
14-May	89	0	262
15-May	0	0	0
16-May	0	0	0
17-May	0	0	0
18-May	6,788	4,412	9,164
19-May	18,131	12,619	23,644
20-May	15,809	10,934	20,684
21-May	19,382	13,526	25,238
22-May	26,885	18,973	34,796
23-May	45,730	32,668	58,793
24-May	1,266,878	920,569	1,613,186
25-May	31,618	22,412	40,824
26-May	11,790	8,022	15,557
27-May	25,455	17,936	32,975
28-May	11,343	7,699	14,987
29-May	16,792	11,647	21,936
30-May	116,738	84,290	149,185
31-May	31,618	22,412	40,824
1-Jun	10,004	6,731	13,276
2-Jun	28,760	20,336	37,184
3-Jun	205,787	149,037	262,538
4-Jun	17,417	12,100	22,733
5-Jun	24,741	17,417	32,065
6-Jun	99,500	71,757	127,242
7-Jun	11,433	7,764	15,101
8-Jun	25,455	17,936	32,975
9-Jun	32,244	22,867	41,621
10-Jun	15,363	10,611	20,115
11-Jun	22,151	15,536	28,766
12-Jun	7,056	4,605	9,507
13-Jun	19,561	13,656	25,465
14-Jun	10,807	7,312	14,303
15-Jun	3,126	1,805	4,448

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Date	Population Estimate	95% CI Lower	95% CI Upper
16-Jun	2,769	1,555	3,983
17-Jun	1,072	412	1,731
18-Jun	1,429	643	2,215
19-Jun	893	301	1,485
20-Jun	1,161	469	1,853
21-Jun	804	247	1,361
22-Jun	982	356	1,609
23-Jun	2,590	1,431	3,749
24-Jun	982	356	1,609
25-Jun	1,608	761	2,454
26-Jun	2,947	1,680	4,215
27-Jun	2,233	1,185	3,281
28-Jun	1,340	585	2,095
29-Jun	2,233	1,185	3,281
30-Jun	1,340	585	2,095
Total	2,205,692	1,579,991	2,831,626

[a] The large trap was inoperative from 23-30 June. Trap efficiency and resulting population estimate for this time period was derived from the average percent of the small trap catches relative to the total smolt catch for 14 days prior.

Appendix D. Outmigrating sockeye salmon smolt estimates by age class and sample period for Chignik Lakes, 1994-1996.

Year	Sample Week	Number of Smolt (by Age) Age-0.	Age-1.	Age-2.	Age-3.	Total
1994	5/3	[a]	230,760	150,700	[b]	381,460
	5/10	[a]	440,286	916,183	[b]	1,356,469
	5/17	[a]	957,880	1,285,745	[b]	2,243,625
	5/24	[a]	1,336,675	923,403	[b]	2,260,078
	5/31	[a]	914,759	581,342	[b]	1,496,101
	6/7	[a]	1,014,467	452,738	[b]	1,467,205
	6/14	[a]	779,846	216,308	[b]	996,154
	6/21	[a]	1,762,310	456,426	[b]	2,218,736
	6/28	[a]	299,455	33,809	[b]	333,264
	Total		**7,736,438**	**5,016,654**		**12,753,092**
1995	5/3	17,758	7,523	15,052	[b]	40,333
	5/10	47,514	206,276	1,052,966	[b]	1,306,756
	5/17	104,296	583,855	2,149,333	[b]	2,837,484
	5/24	122,549	998,742	3,178,626	[b]	4,299,917
	5/31	271,198	855,904	739,529	[b]	1,866,631
	6/7	85,617	225,604	83,619	[b]	394,840
	6/14	15,652	183,209	23,865	[b]	222,726
	6/21	9,283	264,598	16,017	[b]	289,898
	6/28	0	52,716	2,216	[b]	54,932
	Total	**673,867**	**3,378,427**	**7,261,223**		**11,313,517**

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Appendix D. (page 2 of 2)

Year	Sample Week	Number of Smolt (by Age) Age-0.	Age-1.	Age-2.	Age-3.	Total
1996	5/3	0	1,029	936	0	1,965
	5/10	0	327	655	0	982
	5/17	3,042	71,497	57,806	380	132,725
	5/24	0	789,962	686,138	4,514	1,480,614
	5/31	23,623	307,095	85,632	1,476	417,826
	6/7	13,057	103,691	16,514	0	133,262
	6/14	1,329	17,936	1,993	0	21,258
	6/21	5,495	6,363	289	0	12,147
	6/28	982	3,439	491	0	4,912
	Total	**47,528**	**1,301,339**	**850,454**	**6,370**	**2,205,691**

[a] Age-0. smolts not sampled.

[b] No age -3. smolts sampled.

Appendix E. Mean length, weight, and condition factor, and population size by age class and date for sockeye salmon smolts, Chignik River, 6 May - 30 June, 1996.

		Length (mm)			Weight (g)			Condition			Population			
Age	Week Beginning	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Population Size	Mean Length	Mean Weight	Mean Condition
0	05/17	8	51.4	1.1	8	0.9	0.1	8	0.66	0.03	3,042	51.4	0.9	0.66
0	05/31	16	47.8	1.7	13	0.9	0.2	13	0.69	0.05	23,623	47.8	0.9	0.69
0	06/07	34	47.0	0.5	34	0.8	0.0	34	0.76	0.02	13,057	47.0	0.8	0.76
0	06/14	4	48.8	3.0	4	1.0	0.2	4	0.88	0.03	1,329	48.8	1.0	0.88
0	06/21	19	47.6	1.3	13	1.0	0.1	13	0.83	0.03	5,495	47.6	1.0	0.83
0	06/28	2	51.0	2.0	2	1.3	0.1	2	0.96	0.06	982	51.0	1.3	0.96
	Totals	83	47.9	0.5	74	0.9	0.0	74	0.76	0.02	47,528	47.9	0.9	0.76
1	05/03	11	65.5	3.5	11	2.2	0.4	11	0.71	0.03	1,029	65.5	2.2	0.71
1	05/10	3	61.7	7.2	3	1.9	0.6	3	0.79	0.09	327	61.7	1.9	0.79
1	05/17	188	71.3	0.8	188	2.9	0.1	188	0.75	0.01	71,497	71.3	2.9	0.75
1	05/24	175	74.6	0.5	175	3.2	0.1	175	0.76	0.01	789,962	74.6	3.2	0.76
1	05/31	208	69.2	0.7	157	2.6	0.1	157	0.74	0.01	307,095	69.2	2.6	0.74
1	06/07	270	58.7	0.5	270	1.6	0.1	270	0.75	0.01	103,691	58.7	1.6	0.75
1	06/14	54	61.6	1.2	54	2.0	0.1	54	0.80	0.02	17,936	61.6	2.0	0.80
1	06/21	22	60.0	1.1	22	1.9	0.1	22	0.88	0.03	6,363	60.0	1.9	0.88
1	06/28	7	75.0	1.2	7	4.0	0.2	7	0.90	0.01	3,439	75.0	4.0	0.90
	Totals	935	66.9	0.4	884	2.4	0.0	884	0.76	0.01	1,301,339	66.9	2.4	0.76

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Appendix E. (page 2 of 2)

		Length (mm)			Weight (g)			Condition			Population			
Age	Week Beginning	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Population Size	Mean Length	Mean Weight	Mean Condition
2	05/03	10	81.1	2.2	10	4.3	0.3	10	0.80	0.02	936	81.1	4.3	0.80
2	05/10	6	81.5	2.1	6	4.1	0.4	6	0.75	0.03	655	81.5	4.1	0.75
2	05/17	152	79.3	0.6	152	3.9	0.1	152	0.77	0.01	57,806	79.3	3.9	0.77
2	05/24	152	82.2	0.6	152	4.4	0.1	152	0.78	0.01	686,138	82.2	4.4	0.78
2	05/31	58	74.6	1.2	48	3.3	0.2	48	0.78	0.02	85,632	74.6	3.3	0.78
2	06/07	43	76.2	1.5	43	3.8	0.3	43	0.80	0.02	16,514	76.2	3.8	0.80
2	06/14	6	71.3	3.5	6	3.1	0.5	6	0.84	0.01	1,993	71.3	3.1	0.84
2	06/21	1	86.0	0.0	0	0.0	0.0	0	0.00	0.00	289	86.0	0.0	0.00
2	06/28	1	82.8	1.0	21	5.2	0.2	21	0.92	0.02	491	82.8	5.2	0.92
	Totals	429	79.4	0.4	418	4.1	0.1	418	0.79	0.01	850,454	79.4	4.1	0.79
3	05/17	1	90.0	0.0	1	5.1	0.0	1	0.70	0.00	380	90.0	5.1	0.70
3	05/24	1	109.0	0.0	1	10.5	0.0	1	0.82	0.00	4,514	109.0	10.5	0.82
3	05/31	1	102.0	0.0	1	9.7	0.0	1	0.92	0.00	1,476	102.0	9.7	0.92
	Totals	3	100.3	5.5	3	8.4	1.7	3	0.81	0.07	6,370	100.3	8.4	0.81

[a] Of the 1,450 smolts sampled, 71 smolts do not contribute weights or condition factors.

Appendix F. Summary of mean length at age and percent age composition of outmigrating sockeye salmon smolts, Chignik River, for various years.

Outmigration Year	Smolt: Mean Length (mm) Age-1.	Smolt: Mean Length (mm) Age-2.	Smolt: Percent Age Composition Age-1.	Smolt: Percent Age Composition Age-2.	Parent Year Escapements: Black Lake[a]	Parent Year Escapements: Chignik Lake[a]	Total Adult Return Produced by Parent Year Escapment[b]: Black Lake	Total Adult Return Produced by Parent Year Escapment[b]: Chignik Lake
1957	80	83	24	75	257,000	278,000	526,000[c]	776,000[c]
1958	78	79	9	90	289,000	201,000	195,000[d]	534,000[d]
1993	80	91	73	27	658,000	336,000	2,100,000[e]	1,200,000[e]
1994	67	77	61	39	361,000	383,000	[f]	[f]
1995	60	75	30	64	364,000	406,000	[f]	[f]
1996	67	79	59	39	767,000	333,000	[f]	[f]

[a] Historically Black Lake stocks have been generalized as age-1. smolts and Chignik Lake stocks as age-2. smolts.

[b] Total adult return includes estimated total catch and escapement of sockeye salmon. Catch figures do not include subsistence harvests.

[c] Adults returned in 1960.

[d] Adults returned in 1961.

[e] Adults returned in 1996.

[f] Adults will return in three years.

Appendix G. Daily climatological observations, water temperature, water depth, and trap rpm, Chignik River, 1996.

Date	Time	Air (c)	Water (c)	Cloud Cover %	Wind Dir	Vel. (Mph)	Stream Guage (cm)	Trap RPM Small	Trap RPM Large	Comments
6-May	1530	14.0	3.0	25	NW	5-10	41	3.50	5.00	Traps commenced fishing
7-May	1200	15.0	3.0	10	NW	5-10	44	3.50	5.00	Installed inshore lead
8-May	1200	15.0	3.5	5	NW	5-10	49	4.00	4.75	Sunny/clear skies, vis. unlimited
9-May	1205	15.0	4.0	0	NW	5-10	52	4.50	5.25	Sunny/clear skies, vis. unlimited
10-May	1150	14.0	4.0	0	NW	5-10	56	4.00	6.00	Sunny/clear skies, vis. unlimited
11-May	1155	16.0	3.5	5	NW	5-10	55	4.00	6.00	3000 scattered
12-May	1155	16.0	4.0	40	NW	5-10	57	3.75	5.75	Sunny/clear skies, vis. unlimited
13-May	1200	16.5	4.0	0	NW	10-15	59	3.50	5.00	Sunny/clear skies, vis. unlimited
14-May	1205	15.0	4.0	0	NW	5-10	57	3.50	5.00	Sunny/clear skies, vis. unlimited
15-May	1200	16.0	4.0	0	NW	5-10	61	3.75	5.75	Sunny/clear skies, vis. unlimited
16-May	1155	15.0	4.0	10	NW	5-10	63	4.00	5.50	Sunny/clear skies, vis. unlimited
17-May	1150	14.0	4.0	15	NW	0-5	66	4.00	6.25	2500-3000 broken, adjusted lead
18-May	1200	14.0	5.0	10	NW	0-5	71	4.25	6.50	Sunny/clear skies, vis. unlimited
19-May	1205	13.0	4.5	0	NW	0-5	74	3.50	6.00	Sunny/clear skies, vis. unlimited
20-May	1200	14.0	4.5	0	NW	5-10	83	3.50	5.50	Sunny/clear skies, vis. unlimited
21-May	1200	10.0	5.0	90	SE	5-10	91	3.75	6.00	1000 solid, rain/drizzle
22-May	1210	11.0	5.5	100	SE	10	94	4.25	6.00	500 solid, rain/drizzle
23-May	1210	11.0	5.0	100	SE	10-15	92	3.75	6.25	1000 solid , rain
24-May	1155	12.0	5.0	100	SE	10-15	97	4.50	6.50	1001 solid , rain
25-May	1155	14.0	5.5	50	NW	5	94	4.50	7.00	1500 broken, drizzle
26-May	1200	12.0	5.0	75	NW	5-10	91	4.00	6.76	1500 broken, river rising
27-May	1155	11.0	5.5	85	SE	5-10	96	4.50	7.00	Rain/drizzle, windy
28-May	1215	10.0	6.0	100	NW	5-10	94	4.50	7.50	Rain, adjusted lead
29-May	1210	11.0	6.0	100	NW	5-10	101	7.00	8.00	Rain, adjusted lead
30-May	1150	12.0	6.5	0	NW	0-5	106	8.25	8.00	Lead out for repairs
31-May	1155	14.0	6.0	0	NW	0-5	108	5.50	6.50	Lead back in with modifications
1-Jun	1200	14.0	7.0	0	NW	0-5	102	5.00	7.00	Sunny/clear skies, vis. unlimited

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Date	Time	Air (c)	Water (c)	Cloud Cover %	Wind Dir	Vel. (Mph)	Stream Guage (cm)	Trap RPM Small	Trap RPM Large	Comments
2-Jun	1200	12.0	7.0	60	SE	10-15	110	6.00	7.50	2500 broken,rain/drizzle
3-Jun	1205	13.0	7.0	10	SE	5-10	104	6.50	9.00	Repositioned traps, river still rising
4-Jun	1155	11.0	6.5	10	SE	10-15	106	7.00	8.50	2500 scattered, partly sunny
5-Jun	1155	12.0	7.5	10	NW	0-5	102	5.50	8.00	Lead out for repairs
6-Jun	1200	12.0	7.0	100	SE	10-15	103	6.00	8.00	2000 solid, lead back in
7-Jun	1205	13.0	7.0	85	SE	10-15	94	6.00	8.25	2500 sightly broken, adjusted lead
8-Jun	1210	14.0	7.0	90	SE	5-10	91	6.00	8.50	1500 broken, rain
9-Jun	1150	11.0	7.0	50	SE	15-20	83	6.50	8.00	2000 broken, rain, lead out
10-Jun	1155	10.0	7.5	60	SE	15-20	71	6.00	8.50	Repositioned traps, lead back in
11-Jun	1205	11.0	8.0	100	NW	15-20	64	6.00	7.50	500 solid, rain and windy
12-Jun	1200	12.0	8.5	20	NW	5	61	5.50	6.50	2500 broken, lead out
13-Jun	1200	11.0	8.0	10	NW	5	63	4.75	6.75	Repositioned traps, lead back in
14-Jun	1205	11.0	8.0	20	NW	5-10	64	4.50	6.00	3000 broken
15-Jun	1200	13.0	7.5	0	NW	10	60	5.75	6.00	Sunny/clear skies, vis. unlimited
16-Jun	1155	13.0	8.0	100	NW	10-15	61	6.00	7.00	1000 solid, windy
17-Jun	1150	14.0	8.0	100	NW	5-10	55	6.50	8.25	1000 solid, rain
18-Jun	1155	14.0	8.0	100	NW	5	52	7.25	8.00	1000 solid, rain
19-Jun	1205	11.0	8.5	95	SE	5-10	45	7.00	8.00	1500 solid, rain
20-Jun	1200	12.0	8.5	80	SE	5	45	6.25	7.50	2000 slightly broken, drizzle
21-Jun	1200	13.0	9.0	50	SE	0-5	41	6.25	7.25	2001 slightly broken, drizzle
22-Jun	1200	13.0	9.0	50	SE	10	41	6.50	7.25	Pulled large trap for major repairs
23-Jun	1155	13.0	9.0	100	SE	10-15	40	6.50		Fishing only with small trap
24-Jun	1155	14.0	9.0	100	SE	10	40	7.50		Trap fulcrum broken, repaired
25-Jun	1205	14.0	9.0	80	NW	5	41	7.75		1000 solid, rain
26-Jun	1200	14.0	9.0	70	NW	5	45	8.00		2500 broken, light rain
27-Jun	1200	15.0	9.0	60	NW	5	40	8.25		2000 broken, drizzle
28-Jun	1155	15.0	9.0	40	NW	10-15	41	8.50		2000 broken, readjusted lead

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Date	Time	Air (c)	Water (c)	Cloud Cover %	Wind Dir	Vel. (Mph)	Stream Guage (cm)	Trap RPM Small	Trap RPM Large	Comments
29-Jun	1150	14.0	9.0	50	NW	5-10	41	8.75		2500 broken, adjusted fulcrum
30-Jun	1200	11.0	9.5	10	SE	5-10	40	8.25		Last day fishing at original site
1-Jul	1155	12.0	9.5	10	SE	5-10	89	4.50		Moved small trap behind weir
2-Jul	1200	12.0	9.5	30	SE	5-10	94	4.25		2500 broken, sunny
3-Jul	1200	13.0	9.5	40	SE	10-15	97	4.00		2000 broken, partly sunny
4-Jul	1200	10.0	9.0	100	SE	10-15	99	3.75		1000 solid, rain/drizzle
5-Jul	1155	13.0	9.5	100	SE	10-15	106	3.25		1500 solid, rain
6-Jul	1200	14.0	9.0	100	SE	5-10	104	3.50		1000 solid rain/drizzle
7-Jul	1200	13.0	9.5	90	SE	0-5	111	3.25		1500 slightly broken, drizzle
8-Jul	1200	13.0	9.5	90	SE	0-5	109	3.75		2000 slightly broken, drizzle
9-Jul	1150	12.0	9.5	80	SE	5	104	3.00		1500 slightly broken, drizzle
10-Jul	1205	13.0	9.5	100	SE	5-10	97	3.25		1000 solid, rain
11-Jul	1200	12.0	10.0	80	SE	5-10	99	3.50		1500 broken, drizzle
12-Jul	1200	12.0	10.0	50	SE	5	97	3.50		2500 broken, partly sunny
13-Jul	1205	13.0	10.0	50	NW	5	98	3.75		3000 broken, partly sunny
14-Jul	1200	12.0	10.0	60	NW	5	96	4.00		2500 broken, sunny
15-Jul	1205	12.0	10.5	30	SE	5	99	4.00		3000 broken, partly sunny
16-Jul	1155	13.0	10.5	90	SE	5	102	4.25		1500 broken, light drizzle
17-Jul	1200	19.0	11.0	50	SE	0-5	105	4.00		3000 broken, sunny, hot and humid
18-Jul	1200	16.0	11.0	90	SE	0-5	103	4.00		2500 broken, drizzle
19-Jul	1200	14.0	11.0	80	NW	0-5	105	4.25		2500 broken
20-Jul	1200	15.0	11.0	100	NW	0-5	102	4.25		1000 solid, rain/drizzle
21-Jul	1200	15.0	11.0	100	NW	0-5	101	4.25		1500 solid, drizzle
22-Jul	1200	16.0	11.5	80	SE	5	99	4.50		1500 solid, drizzle
23-Jul	1200	14.0	11.5	90	SE	0-5	102	4.50		2000 broken
24-Jul	1200	16.0	12.0	60	SE	0-5	96	4.75		2500 broken, sunny

-Continued-

Date	Time	Air (c)	Water (c)	Cloud Cover %	Wind Dir	Vel. (Mph)	Stream Guage (cm)	Trap RPM Small	Trap RPM Large	Comments
25-Jul	1200	17.0	12.0	50	SE	5-10	95	4.25		3000 broken, sunny
26-Jul	1200	17.0	12.0	70	SE	0-5	92	4.75		2500 broken, partly sunny
27-Jul	1200	18.0	12.0	60	SE	0-5	93	5.00		2500 broken, partly sunny
28-Jul	1200	17.0	12.0	50	SE	0-5	94	4.75		3000 broken, sunny
29-Jul	1200	18.0	12.0	80	SE	0-5	90	5.00		2000 broken, light drizzle
30-Jul	1200	17.0	12.0	70	NW	0-5	92	4.50		Pulled small trap

[a] Large trap inoperable 23 June and pulled for season.

Appendix H. Daily number of sockeye salmon smolts caught by the small trap, Chignik River, post 30 June, 1996.

Date	Small Trap Daily	Small Trap Cumulative	Comments
7/1/96	25	25	Moved small trap behind ADF&G weir, commenced fishing at 1445
7/2/96	193	218	8 sockeye fry; 8 coho smolt/fry; 3 king smolt; 12 Dolly Varden; 20 stickleback
7/3/96	74	292	10 sockeye fry; 3 coho smolt/fry; 4 king smolt; 4 whitefish; 3 Dolly Varden
7/4/96	41	333	5 sockeye fry; 3 coho smolt/fry; 1 king smolt; 1 pond smelt; 4 Dolly Varden
7/5/96	73	406	3 sockeye fry; 7 coho smolt/fry; 5 king smolt; 18 stickleback; 2 pond smelt
7/6/96	97	503	11 sockeye fry; 3 coho smolt/fry; 13 stickleback; 5 king smolt; 5 Dolly Varden
7/7/96	271	774	12 sockeye fry; 5 coho smolt/fry; 21 stickleback; 6 king smolt; 2 Dolly Varden
7/8/96	234	1,008	7 sockeye fry; 3 coho smolt/fry; 12 stickleback; 6 king smolt; 5 Dolly Varden
7/9/96	131	1,139	2 sockeye fry; 1 coho smolt; 5 king smolt; 7 stickleback; 3 Dolly Varden; 2 sculpin
7/10/96	62	1,201	2 coho smolt; 6 king smolt; 10 stickleback; 2 Dolly Varden; 7 sculpin; 1 pond smelt
7/11/96	34	1,235	10 sockeye fry; 2 coho smolt; 5 king smolt; 7 stickleback; 5 Dolly Varden; 8 sculpin
7/12/96	43	1,278	12 sockeye fry; 3 coho smolt/fry; 8 king smolt; 5 stickleback; 5 Dolly Varden
7/13/96	34	1,312	11 sockeye fry; 2 coho smolt/fry; 11 king smolt; 7 stickleback; 7 Dolly Varden
7/14/96	75	1,387	10 sockeye fry; 2 coho smolt/fry; 5 king smolt; 12 stickleback; 2 pond smelt
7/15/96	54	1,441	14 sockeye fry; 2 coho smolt/fry; 10 king smolt; 11 stickleback; 6 Dolly Varden
7/16/96	81	1,522	Observed 5000+ sockeye smolt moving downstream at weir, 4-5 m from trap
7/17/96	97	1,619	12 sockeye fry; 6 king smolt; 11 stickleback; 12 Dolly Varden; 2 pond smelt; 24 sculpin
7/18/96	101	1,720	9 sockeye fry; 7 king smolt; 12 stickleback; 11 Dolly Varden; 5 pond smelt; 11 sculpin
7/19/96	72	1,792	19 sockeye fry; 7 king smolt; 6 stickleback; 5 Dolly Varden; 2 pond smelt; 7 sculpin
7/20/96	83	1,875	13 sockeye fry; 10 king smolt; 10 stickleback; 9 Dolly Varden; 7 pond smelt; 16 sculpin
7/21/96	56	1,931	9 sockeye fry; 2 king smolt; 8 stickleback; 4 Dolly Varden; 6 pond smelt; 2 whitefish
7/22/96	148	2,079	14 sockeye fry; 6 king smolt; 5 stickleback; 8 sculpin
7/23/96	17	2,096	15 sockeye fry; 6 king smolt; 9 stickleback; 5 Dolly Varden; 3 pond smelt; 17 sculpin
7/24/96	56	2,152	9 sockeye fry; 6 king smolt; 9 stickleback; 4 Dolly Varden; 7 pond smelt; 8 sculpin
7/25/96	28	2,180	7 sockeye fry; 1 king smolt; 4 stickleback; 5 Dolly Varden; 5 pond smelt; 7 sculpin
7/26/96	38	2,218	4 sockeye fry; 2 coho smolt; 3 king smolt; 8 stickleback; 3 Dolly Varden; 8 sculpin
7/27/96	6	2,224	8 sockeye fry; 1 coho smolt; 4 king smolt; 6 stickleback; 4 Dolly Varden; 7 sculpin
7/28/96	31	2,255	12 sockeye fry; 1 coho smolt; 4 king smolt; 8 stickleback; 4 Dolly Varden; 8 sculpin
7/29/96	26	2,281	7 sockeye fry; 1 king smolt; 7 stickleback; 1 Dolly Varden; 4 pond smelt; 14 sculpin
7/30/96	39	2,320	Pulled small trap; sockeye smolt still being caught and observed at weir site
Total	2,320	2,320	