SOCKEYE SALMON SMOLT INVESTIGATIONS ON THE CHIGNIK RIVER WATERSHED, 2003

By

Kenneth A. Bouwens
and
Eric J. Newland

Regional Information Report[1] No. 4K04-24

Alaska Department of Fish and Game
Division of Commercial Fisheries
211 Mission Road
Kodiak, AK 99615

May 2004

[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished division reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

AUTHORS

Kenneth A. Bouwens is the Region IV Alaska Peninsula Finfish Research Biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 211 Mission Road, Kodiak, AK 99615.

Eric J. Newland is a Region IV Salmon Research Biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 211 Mission Road, Kodiak, AK 99615.

ACKNOWLEDGMENTS

The authors would like to thank Alaska Department of Fish and Game, Division of Commercial Fisheries technician Hector Bravo, who was the seasonal staff dedicated to the project. In addition, Heather Finkle and Chris Owens helped out intermittently. Members of the Chignik weir crew, including Jim Emerson and Roy West also assisted at times. M.B. Foster provided past and present database summaries and archiving. George Pappas and Kevin Clark provided field support, and Alvin Boskofsky assisted with outboard motor and facility maintenance. Lucinda Neel added publication expertise. Kevin Clark, Switgard Duesterloh and Allison Birdsong reviewed previous versions of this manuscript. Patti Nelson and Mark Witteveen provided supervisory support. The Chignik Regional Aquaculture Association (CRAA) provided funding for this project.

COMMERCIAL VENDOR NAMES

Brand names used in this report do not imply product endorsement by the Alaska Department of Fish and Game.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

This paper provides the results from the tenth year of the Chignik River sockeye salmon smolt enumeration project. Juvenile sockeye salmon *Oncorhynchus nerka* 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 2003, a total of 6,750,819 sockeye salmon smolt were estimated to pass downstream of the traps from April 25 to July 8. Of these, 155,047 (2.3%) were age 0., 5,146,278 (76.2%) were age 1., and 1,449,494 (21.5%) were age 2. smolt. Smolt abundance data, by emigration year, were paired with 3-ocean returns from that emigration year to forecast the 2004 sockeye salmon run. Based on smolt data and historic adult age compositions, it was estimated that approximately 3.10 million sockeye salmon are expected to return in 2004, equating to a Chignik Management Area (CMA) harvest of about 2.07 million sockeye salmon. The 2005 run is expected to be about 2.18 million sockeye salmon (1.31 million CMA harvest) and the 2006 run is expected to be about 1.07 million sockeye salmon (410 thousand CMA harvest). Because only six years' smolt and corresponding adult return data were used to produce this forecast, the confidence in this forecast is fair.

INTRODUCTION

Sockeye salmon *Oncorhynchus nerka* is the most important economically commercial salmon species in the Chignik Management Area (CMA). The Chignik River watershed is the primary sockeye salmon producer in the CMA, and consists of a large, shallow lagoon, two large lakes (Chignik and Black Lakes), and several tributaries that provide both spawning and rearing habitat for sockeye salmon (Figure 1). The Chignik River watershed is also the largest sockeye salmon producing watershed on the south side of the Alaska Peninsula (Pappas et al. 2001). Two distinct runs of sockeye salmon return to the Chignik River watershed. The early run, with an escapement goal of 350,000 to 400,000 sockeye salmon, spawn in Black Lake and its tributaries and primarily enters the watershed from June through mid-July. The late run, with an escapement goal of 200,000 to 250,000 sockeye salmon (through August 31), typically spawns in the tributaries and on the shoals of Chignik Lake. Sockeye salmon that spawn in Black Lake are genetically distinct from sockeye salmon that spawn in Chignik Lake (Templin et al. 1999). The interactions between the Black Lake (early run) and Chignik Lake (late run) stocks are poorly understood. Specifically, Chignik Lake's role as a nursery area for the Black Lake stock is believed to be increasing with the natural sedimentation of Black Lake (Bumgarner 1993).

Juvenile salmon are known to emigrate to the sea (smolt) after certain size thresholds are met, during specific seasons, and under the influence of photoperiod and temperature (Clarke and Hirano 1995), although it is difficult to directly measure these effects as they all act together. Smolt migration is triggered by increasing springtime water temperatures (3-4 ^{o}C), and increasing day length (Clarke and Hirano 1995). Variables affecting growth in juvenile salmonids include temperature, competition, food availability, and various water chemistry parameters (Moyle and Cech 1988). Because of these factors that all vary annually, annual growth of juvenile sockeye salmon often varies between lakes, years, and within individual populations (Bumgarner 1993). Typically, if growth rates are not sufficient to achieve the threshold size necessary to emigrate in the spring, the juvenile fish will remain in the lake feeding for another year (Burgner 1991), possibly further increasing competition among younger broods. These interactions can be investigated via smolt emigration data.

Typically, sockeye salmon smolts migrate quickly to saltwater from their nursery lakes and spend only enough time in the 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. It has been speculated that a component of the rearing juveniles may have remained in the Chignik River in the summer to feed and subsequently returned to Chignik Lake in the fall (Roos 1957, 1959; Iverson 1966). 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 river and the lagoon as a rearing area (Finkle and Bouwens 2002).

The 2003 field season completed the tenth season of the Alaska Department of Fish and Game (ADF&G) smolt project on the Chignik River, which was funded by the Chignik Regional Aquaculture Association (Bouwens and Edwards 2001; Bouwens and Newland 2003; Bouwens et

al. 2000; Edwards and Bouwens 2002; Kaplan and Swanton 1997, 1998; Perez-Fuentetaja et al. 1999, Stopha and Barrett 1994; Vania and Swanton 1996). These data have been combined into a baseline database that is used to generate a smolt-based sockeye salmon forecast to the Chignik River watershed. Forecasts enable harvesters and fish processors to estimate their supply and personnel needs. Current formal forecast methods used to predict the adult runs to the Chignik River watershed employ historic age class relationships for the early run and return-per-spawner relationships for the late-run stocks (Witteveen et al. *in press*). Smolt emigration estimates by age, and potentially stock, are expected to add accuracy to the forecast models currently used.

OBJECTIVES

The objectives for the 2003 season were:

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

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

(3) Continue to build a smolt database in an effort to estimate smolt-to-adult survival and forecast future runs, and;

(4) Summarize the 2003 smolt emigration data in a report.

METHODS

Study Site and Trap Description

Two rotary-screw traps were operated side by side to capture smolts emigrating from Chignik Lake. 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 and were positioned in that portion of the river with the highest current. Due to safety concerns about using steel cables in an area with high boat traffic, each trap was secured to the riparian vegetation with highly visible polypropylene line and a strobe light was attached to the top of the offshore trap.

Each trap consisted of a cone constructed of aluminum perforated plate (5 mm holes) mounted on two aluminum pontoons, with the large ends of the cones pointed upstream. The cone mouth diameter was 1.5 m on the small trap (placed nearshore), and 2.4 m on the large trap (placed offshore). The small trap sampled approximately 0.73 m^2 and the large trap sampled 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 an approximately 0.7 m^3 rectangular live-box 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.

During the 2003 field season, both of the traps were operated continuously from 1430 hours on April 25 to 1200 hours, July 9, except when the cones were elevated to facilitate daily cleaning (<30 minutes per day). At the completion of the project, both traps were disassembled and stored.

A floating platform for a 10'x12' weatherport was tied directly behind the traps and connected to the traps with a boardwalk. The weatherport provided shelter for the crew when processing samples taken from the traps.

Smolt Enumeration

Sampling days extended from noon to noon and were identified by the date of the first noon-to-midnight period. The traps were checked hourly between 2400 hours and 0530 hours on the weekdays and from 2400 hours to 0400 hours on the weekends. The traps were also checked at the end of the smolt day at 1200 hours and again at 1800 hours.

Juvenile sockeye salmon greater than 45 mm fork length (FL; mid-eye-to-fork-of-tail) were considered smolts (Thedinga et al. 1994). All sockeye salmon smolts 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 individually counted. Sockeye salmon smolts recaptured during mark-recapture experiments were recorded separately from unmarked smolts 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, Dolly Varden *Salvelinus malma*, stickleback of the family Gasterosteidae, pond smelt *Hypomesus olidus*, Pygmy whitefish *Prosopium coulteri*, starry flounder *Platichthys stellatus*, coastrange sculpin *Cottus aleutus*, and eulachon *Thaleichthys pacificus* were also counted. The isopod *Mesidotea entomon* was also identified according to Merrit and Cummings (1984) and Pennak (1989) and counted.

Age, Weight, and Length Sampling

A daily sample of 40 sockeye salmon smolts was collected for five days per statistical week for age-weight-length (AWL) data. All smolt sampling data reflected the smolt day in which the fish were captured, and samples were not mixed between days. A sample of smolts was collected hourly throughout the night's migration and held in an in-stream live box. The number of fish sampled hourly was proportional to the migration strength. Forty smolts were then randomly collected from the live box and sampled for AWL data, and the remaining smolts were released downstream from the traps.

Tricaine methanesulfonate (MS-222) was used to anesthetize smolts prior to sampling. Fork length (FL) was measured to the nearest 1 mm, and smolts 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 recovered from the anesthetic, and subsequently were released downstream from the traps. 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 "fatness" of a fish, was determined for each smolt sampled using:

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

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

Additionally, a sample of 200 juvenile sockeye was collected once a week beginning on May 10 and ending June 27. All sockeye including juveniles < 45 mm FL were measured for fork length. Length frequency analysis was conducted to investigate the fry or pre-smolt component of the outmigration. These fish have not been accounted for in either the calculations for the smolt population estimate or sampled for age and weight.

Trap Efficiency Estimates

Mark-recapture experiments were conducted weekly when sufficient numbers of smolt were available to determine trap efficiency. Between 1,000 and 3,000 sockeye salmon smolts for each experiment were collected from the traps and transferred to a series of instream flow-through live boxes. Smolts were retained in the live boxes for up to three nights if insufficient numbers were captured. After three nights all captured smolts were marked if the minimum sample size was met or released if the minimum was not met.

Sockeye salmon smolts were netted from the live boxes, counted, and marked. Fish were transferred intoa repository containing an aerated Bismark Brown dye solution (3.9 g of dye to 75.5 L of water) for 10-15 minutes. Fresh water was then pumped into the container to slowly flush out the dye (45 min), and the smolts were allowed to recover in the circulating water. At the end of the marking process, dead and stressed smolts were removed, counted, and disposed of below the mouth of the traps.

The remaining marked smolts were taken to the release site (56^0 15' 15" N lat., 158^0 44' 51" W. long). Smolts were transported upstream in aerated buckets and released evenly across the breadth of the river from the left bank to the right bank. All releases occurred 1.3 km upriver from the traps (Figure 2). The marking was performed so that the marked fish were released by before midnight. The number of recaptured smolt was then recorded. The Chignik River watershed smolt population size was estimated by using methods described in Carlson et al. (1998).

Marine Survival Estimates and Future Run Forecasting

Estimates of smolt abundance, by age, were paired with corresponding adult returns from the respective brood year (BY). By regulation, the total return to the Chignik River watershed is calculated by adding the total Chignik River sockeye salmon escapement to the total harvest from the CMA plus a portion of the sockeye salmon catch from the Southeastern District Mainland of the Alaska Peninsula Management Area and the Cape Igvak Section of the Kodiak Management Area [5 AAC 09.360(g); 5AAC 18.360(d)]. Marine survival, by age, and the number of smolts produced per spawner from their respective BY was also calculated.

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

Statistically significant regression relationships were used to forecast the 3-ocean components (historically approximately 80% of the entire run) of the 2004, 2005, and 2006 adult sockeye salmon runs from the 2001, 2002, and 2003 smolt emigration data. These estimates were then expanded to account for the minor ocean ages to provide a point estimate.

Climate and Hydrology

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

RESULTS

Trapping Effort

Both the large and the small traps were in place for a total of 75 days beginning on April 25 and ending on July 9. The duration of the trapping season was the second longest in the history of the project. The traps fished continuously for the duration of the study, except when they were removed for daily cleaning.

Trap Catch

A total of 143,300 sockeye salmon smolts were captured in the traps in 2003 (Appendix A). In addition to sockeye salmon smolts, a total of 15,111 sockeye salmon fry, 2,796 juvenile coho salmon, 258 pink salmon fry, 473 Dolly Varden char, 7,798 stickleback, 85 juvenile chinook salmon, 178 pond smelt, 65 pygmy whitefish, 108 starry flounders, 492 sculpin, 38 isopods, and 3 eulachon were captured (Appendix A). Daily smolt catch, by trap, are listed in Appendix B.

Age, Weight, and Length Sampling

A total of 2,098 sockeye salmon smolts were sampled for AWL data in 2003. Age 0. smolts from BY 2002 comprised 7.1% of the sample, 79.6% were age 1. (BY 01), and 13.3% were age 2. (BY 00; Table 1). The mean length and weight of age 0. smolts were 56.0 mm and 1.5 g. The mean length and weight of age 1. smolts were 65.1 mm and 2.1 g. The mean length and weight of age 2. smolts were 76.3 mm and 3.5 g. (Table 2). The mean length of the age 1. sockeye salmon that emigrated in 2003 was similar to that of 2002 and 2001, which was shorter than the three prior years. The age 2. smolt, were similar in both length and weight to the fish emigrating in 2000 and 2001, but lighter than those in 2002 (Table 3; Figure 3). No age 3. smolts were sampled in 2003 (Table 4). Lengths of ages 0., 1., and 2., smolts were plotted in a length frequency histogram to investigate the possibility of using length frequency data to serve as an indicator of stock-of-origin (Figure 4). Juvenile sockeye < 45 mm FL were present in limited numbers throughout the trapping season, but become a substantial component by the end of June (Figures 5 and 6).

Trap Efficiency Estimates

Mark-recapture experiments were conducted on ten occasions beginning on May 2 and ending on June 24. A total of 18,108 smolt were marked and released, the highest number in the history of the project. A total of 352 smolt were recaptured and trap efficiency estimates ranged from a low of 1.07% to a high of 3.11% (Table 5). The majority of the marked smolts were recaptured within two days of being released (Appendix A).

Sockeye Salmon Smolt Emigration and Timing

The estimated number of sockeye salmon smolts that emigrated in 2003 was 6,750,819 (±1,032,999; 95% C.I.; Table 6; Figure 8). The majority of these fish emigrated in late May (Figure 9). The 2003 emigration consisted of 155,047 age 0., 5,146,278 age 1., and 1,449,494 age 2. sockeye salmon smolts (Tables 6 and 7; Figure 10). The majority of the smolts emigrated in 2003 during late May and early June (Figures 8 and 10). The age 1., and 2., smolts tended to emigrate together during the early part of the season (Figure 10).

Marine Survival Estimates and Future Run Forecasting

All adult sockeye salmon from BYs 1992, 1993, 1994, 1995, and for the most part, 1996 have returned to the Chignik River, and the overall marine survival of smolts ranged from 11% for BY 1995 to 66% for BY 1993 (Table 8). When the data were presented by emigration year, however, the marine survivals ranged from 8% for emigration year 1999 to 195% for emigration year 1996, with 1996 being an obvious outlier (Table 9). Therefore, after removing smolt year 1996, the marine survival from smolt years 1992 to 1996 has averaged 13 percent.

A significant regression relationship (P=0.01; R^2=0.81) was found between the total smolt emigration estimates, by year, and their subsequent 3-ocean returns (Figure 11). A marginally significant (P=0.06; R^2=0.62) relationship was found between the total smolt emigration estimates and the entire resulting adult return. All other relationships examined (age 0. smolts vs. age 0. adults, age 1. smolts vs. age 1. adults, age 2. smolts vs. age 2. adults, age 3. smolts vs. age 3. adults, total smolts vs. 1-ocean adults, total smolts vs. 2-ocean adults) were not significant (P>0.05). Using total number of emigrating smolts, by year, and assuming that the 3-ocean component of the run will remain at 80% of the entire sockeye salmon run in future years, the 2004 total adult run forecast is 3.10 million sockeye salmon, the 2005 adult run forecast is about 2.18 million sockeye salmon, and the 2005 adult run forecast is about 1.07 million sockeye salmon.

Physical Data

The absolute depth of the river varied during the course of the season from 65 cm to 129 cm. Daily measurements of the depth and velocity (through trap RPM's) of the Chignik River, along with the climatological observations that were collected in 2003, are reported in Appendix C. Water temperatures reached 5^{o}C on about May 17, and the 2003 season was generally characterized by comparatively stable water levels and calm winds (Figure 12).

DISCUSSION

The point estimate of the 2003 smolt emigration was the lowest estimated emigration on record except for the 1996 smolt emigration. Unlike the 1996 estimate, the confidence in the 2003 estimate is strong considering the results of the mark recapture experiments. In 2003, a total of 18,108 smolt were marked and 352 were recaptured in comparison to 1996 when only 3,180 were marked and 49 smolts were recaptured. The overall trap efficiency was the highest recorded since 1998, possibly resulting from the low flows and mild weather patterns observed during the season. In the past, lower trap efficiencies have been recorded during periods of high flow and strong winds. There has been concern that smolt might be actively migrating before the project was installed in the spring. In 2003, the majority of the smolt emigration took place in late May, a month after the traps were installed. Therefore, it is unlikely that significant numbers of smolts emigrated prior to the installation of the traps in 2003.

The smolts that emigrated in 2003 were similar in size to smolt that emigrated in 2001. The age 2. smolts in 2003 were almost 2 g lighter than the age 2. smolts in 2002. The total abundance of age 2. smolts was low, and proportionately there were fewer age 2. smolts in 2002 and 2003 than other years since 1994. The early run is typically composed of primarily age 1. sockeye salmon and the late run is mostly composed of age 2. sockeye salmon. The low age 2. smolt abundance in 2003 could indicate that the subsequent late run return (primarily in 2006) will be poor.

The low total abundance of age 2. smolts could be the result of poor rearing conditions in their first year causing the fish to emigrate to the lagoon as fry. In 2001, Chignik Lake exhibited the lowest zooplankton biomass in the recent years of investigation and there was a concomitant large migration of sockeye fry to the lagoon and river (Finkle and Bouwens 2001; Bouwens and Finkle 2003a,b). If these early emigrating fish survive, it is expected that there will be a larger-than-average component of 0.3 age fish to the 2004 run, although there have not been large numbers of age 0. sockeye salmon in the adult runs at Chignik. In 2003, a total of 15,111 sockeye salmon fry (pre-smolt) were captured during the field season, which was substantially less than the number caught in 2001 and 2002 (Edwards and Bouwens 2002). This low fry count coincided with substantially better zooplankton levels in Chignik Lake in 2003 (Finkle and Bouwens 2001; Bouwens and Finkle 2003a,b).

Observed marine survivals, by emigration year (excluding 1996), of Chignik smolt have ranged from 8 percent to 17 percent (Table 9). These figures are well within the ranges observed in other systems (Burgner 1991). This variability in marine survival implies that given constant freshwater production, the resultant adult returns would still fluctuate with annual differences in productivity of the marine environment.

Given adult return data, the estimate of 1996 was severely underestimated and not included in the forecast analyses. Further discussion on the removal of the 1996 data can be found in Edwards and Bouwens (2002). The regression relationship that was most statistically significant and useful for forecasting was total 3-ocean returns predicted from the total number of smolts that emigrated three years prior. This is reasonable, since the majority (about 80%) of the Chignik River watershed run consists of 3-ocean sockeye salmon. This forecasting method does not have the resolution to forecast by run because we cannot determine stock-of-origin of the smolt. However, it is adequate to forecast the combined runs. Assuming the 3-ocean component of the run remains at 80%, the 2004 total forecast is approximately 3.10 million sockeye salmon. Assuming equal strength between the two runs, this would result in a CMA harvest of about 2.07 million sockeye salmon. In addition to forecasting the 2004 run, it was possible to estimate the 2005 run from the 2002 smolt data and the 2006 run from the 2003 smolt data. As next year's adult return data are added to the data set, assuming the smolt to 3-ocean return relationship remains strong, these forecasts will be updated and they may change. Nonetheless, assuming the same 80% 3-ocean contribution, the 2005 run (based on smolt data alone) is expected to be about 2.18 million sockeye salmon (1.31 million CMA harvest) and the 2006 run is expected to be about 1.07 million sockeye salmon (410 thousand CMA harvest).

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) when possible and median values to forecast the abundance of age classes when sibling relationships did not exist. Using these

methods, the 2004 Chignik sockeye salmon forecast is 2.34 million (Witteveen et al. *in press*). The 2004 smolt-based forecast of 3.10 million sockeye salmon is approximately 760 thousand more sockeye salmon than was forecasted using sibling regression relationships.

A smolt-based forecast was available for the first time in 2002. The sibling forecast over-forecasted the total run by about 7%, while the smolt forecast over-forecasted by about 31% in 2002. In 2003, the smolt forecast was more accurate; it under-forecasted the total run by about 9%, while the sibling forecast over-forecasted by about 30%. Until more data is collected to test the smolt-based forecasting model, the smolt forecast will be provided as a supplemental tool for stakeholders to consider. Because of the small data set our confidence in the smolt-based forecast is only fair. If the current trends continue, however, forecasts incorporating smolt data may be more accurate than the forecasting methods using sibling relationships alone. Specifically, the variability in freshwater rearing success is removed from forecasts as smolt abundance is measured after the freshwater rearing period.

LITERATURE CITED

Bagenal, T.B., and F.W. Tesch. 1978. Age and growth. pp. 101-136 *in*: T. Bagenal, editor. Methods for assessment of fish production in fresh waters. IBP Handbook No. 3, third edition. Blackwell Scientific Publications. London.

Bouwens, K.A., and I.J. Edwards. 2001. Sockeye salmon smolt investigations on the Chignik River System, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 4K01-3, Kodiak.

Bouwens, K.A. and H. Finkle. 2003a. Results of the Chignik Lakes ecological assessment project, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Informational Report 4K03-10, Kodiak.

Bouwens, K.A. and H. Finkle. 2003b. Results of the Chignik Lakes ecological assessment project, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Informational Report 4K03-58, Kodiak.

Bouwens, K.A., and E.J. Newland. 2003. Sockeye salmon smolt investigations on the Chignik River System, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 4K03-8, Kodiak.

Bouwens, K.A., Pérez-Fuentetaja, A. and I.J. Edwards. 2000. Sockeye salmon smolt investigations on the Chignik River System, 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 4K00-35, Kodiak.

Bumgarner, J.D. 1993. Long-term trends in the growth of sockeye salmon from the Chignik Lakes, Alaska. Masters Thesis, University of Washington. Seattle, WA.

Burgner, R.L. 1991. Life history of sockeye salmon *(Oncorhynchus nerka)*. *in* C. Groot and L. Margolis, eds. Pacific salmon life histories. UBC Press. University of British Colombia, Vancouver.

Carlson, S.R., L.G. Coggins Jr., and C.O. Swanton. 1998. A simple stratified design for mark-recapture estimation of salmon smolt abundance. Alaska Fishery Research Bulletin 5(2):88-102.

Clarke, W.C. and T. Hirano. 1995. Osmoregulation. *in*: Physiological ecology of pacific salmon. C. Groot, L. Margolis and W.C. Clarke (eds). UBC Press, Vancouver. BC.

Edwards, I.J. and K.A. Bouwens. 2002. Sockeye salmon smolt investigations on the Chignik River watershed, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report No. 4K02-1. Kodiak.

LITERATURE CITED (Cont.)

Finkle, H. and K.A. Bouwens. 2001. Results of the Chignik Lakes ecological assessment project, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Informational Report 4K01-51, Kodiak.

Finkle, H. and K.A. Bouwens. 2002. Chignik Lakes Ecological Assessment Project Operational Plan, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Informational Report 4K02-35, Kodiak.

INPFC (International North Pacific Fisheries Commission). 1963. Annual report 1961. Vancouver, BC.

Iverson, R.W. 1966. Biology of juvenile sockeye salmon resident in Chignik River, Alaska. Masters Thesis, Oregon State University. Corvallis, OR.

Kaplan, D.F. and C.O. Swanton. 1997. Chignik Lakes sockeye smolt abundance, age composition, and size characteristics, 1996. Alaska Department of Fish and Game, Commercial Fish Management and Development Division. Regional Information Report 4K97-28. Kodiak.

Kaplan, D.F. and C.O. Swanton. 1998. Population estimates and biological attributes of the Chignik lakes sockeye salmon outmigration, 1997. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Regional Information Report 4K98-4, Kodiak.

Koo, T.S.Y. 1962. Age designation in salmon. *in*: Studies of Alaska red salmon. Univ. Wash. Publ. Fish. New Ser. 1. Seattle, WA.

McConnell, R.J. and G.R. Snyder. 1972. Key to field identification of anadromous juvenile salmonids in the Pacific Northwest. National Oceanic and Atmospheric Administration Technical Report, National Marine Fisheries Service Circular 366. Seattle, WA.

Merrit, R.W. and K.W. Cummings. 1984. An introduction to the aquatic insects of North America. Second ed. Kendall/Hall Publishing Co., Dubuque, IO.

Moyle, P.B. and J.J. Cech. 1988. Fishes: An introduction to ichthyology. Prentice Hall, Englewood Cliffs, NJ.

Pappas, G.E., R.T. Baer and M.A. LaCroix. 2001. Chignik management area annual finfish management report, 1999. Alaska department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K01-49.

Pennak, R.W. 1989. Fresh-water invertebrates of the United States: Protozoa to Mollusca. Third ed. John Wiley & sons, Inc. New York, NY.

LITERATURE CITED (Cont.)

Pérez-Fuentetaja, A., D.F. Kaplan, and T. Doubt. 1999. Sockeye salmon emigration studies. Chignik Lakes System, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report 4K99-26. Kodiak.

Pollard, W.R., G.F. Hartman, C. Groot, and P. Edgell. 1997. Field identification of coastal juvenile salmonids. Harbour Publishing, Madeira Park, British Colombia.

Roos, J. 1957. Report on Chignik adult red salmon studies, 1955-1956. University of Washington School of Fisheries, Fish. Res. Inst., MS. Seattle, WA.

Roos, J. 1959. Red salmon smolt studies at Chignik, Alaska in 1959. University of Washington School of Fisheries, Fish. Res. Inst., MS. Seattle, WA.

Stopha, M.E. and B.M. Barrett. 1994. Sockeye smolt and presmolt abundance, age composition, and condition, and the use of the parasite *Philomena oncorhynchi* as an inseason stock separation estimator for returning adult sockeye salmon, Chignik Lakes, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Regional Information Report 4K94-36, Kodiak.

Templin, W., L. Seeb, P. Crane, and J. Seeb. 1999. Genetic analysis of sockeye salmon populations from the Chignik Watershed. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report 5J99-08, Anchorage, AK.

Thedinga, J.F., M.L. Murphy, S.W. Johnson, J.M. Lorenz, and K.V. Koski. 1994. Salmonid smolt yield determined with rotary-screw traps in the Situk River, Alaska, to predict effects of glacial flooding. Draft. Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration Technical Report. Juneau, AK.

Vania, T.D. and C.O. Swanton. 1996. Chignik Lakes sockeye smolt abundance, age composition, and size characteristics, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Regional Information Report 4K96-22, Kodiak.

Witteveen, M.W., S. Schrof, K.A. Bouwens, N. Sagalkin, M.B. Foster, R. T. Baer, and D. Aro. *in press.* Westward Region Salmon Run Reconstruction for the 2002 Season and Forecasting for the 2003 Season. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division.

Table 1. Estimated age composition of Chignik Lake sockeye salmon smolt samples, by week, 2003.

Stat Week	Sample Size		Ages 0	1	2	Total
17	39	Percent	0.0	82.1	17.9	100.0
		Numbers	0	32	7	39
18	239	Percent	5.9	77.0	17.2	100.0
		Numbers	14	184	41	239
19	199	Percent	1.0	75.9	23.1	100.0
		Numbers	2	151	46	199
20	197	Percent	2.0	77.7	20.3	100.0
		Numbers	4	153	40	197
21	198	Percent	0.0	62.6	37.4	100.0
		Numbers	0	124	74	198
22	199	Percent	0.0	85.4	14.6	100.0
		Numbers	0	170	29	199
23	194	Percent	4.6	91.2	4.1	100.0
		Numbers	9	177	8	194
24	199	Percent	2.5	91.5	6.0	100.0
		Numbers	5	182	12	199
25	199	Percent	4.0	89.4	6.5	100.0
		Numbers	8	178	13	199
26	237	Percent	16.9	79.7	3.4	100.0
		Numbers	40	189	8	237
27	158	Percent	31.0	68.4	0.6	100.0
		Numbers	49	108	1	158
28	40	Percent	45.0	55.0	0.0	100.0
		Numbers	18	22	0	40
Total	2,098	Percent	7.1	79.6	13.3	100.0
		Numbers	149	1,670	279	2,098

Table 2. Length, weight, and condition factor of Chignik River sockeye salmon smolt samples , by age and statistical week, 2003.

				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	14	47.6	0.55	0.7	0.02	0.68	0.017
0	19	5/3	2	51.5	1.5	1	0.1	0.74	0.138
0	20	5/10	4	48.5	1.19	0.8	0.09	0.71	0.031
0	23	5/31	9	51.9	1.69	1.1	0.12	0.78	0.032
0	24	6/7	5	53.6	1.21	1	0.1	0.65	0.028
0	25	6/14	8	56.6	1.96	1.5	0.09	0.81	0.035
0	26	6/21	40	55.7	0.84	1.4	0.08	0.79	0.02
0	27	6/28	49	58.1	0.87	1.6	0.09	0.81	0.019
0	28	7/5	18	62.0	1.37	2.1	0.19	0.86	0.036
Total			149	56.0	0.53	1.5	0.05	0.79	0.011
1	17	4/19	32	65.0	0.93	1.9	0.08	0.68	0.017
1	18	4/26	184	63.0	0.48	1.7	0.04	0.68	0.006
1	19	5/3	150	65.5	0.34	2.0	0.03	0.70	0.007
1	20	5/10	152	65.0	0.4	1.9	0.03	0.70	0.008
1	21	5/17	124	67.5	0.36	2.2	0.04	0.72	0.007
1	22	5/24	170	65.9	0.26	2.0	0.03	0.71	0.006
1	23	5/31	177	64.8	0.27	2.1	0.03	0.76	0.008
1	24	6/7	180	64.4	0.27	2.0	0.03	0.74	0.007
1	25	6/14	178	65.0	0.3	2.2	0.04	0.80	0.007
1	26	6/21	189	66.3	0.29	2.4	0.04	0.80	0.005
1	27	6/28	107	63.7	0.49	2.3	0.06	0.87	0.011
1	28	7/5	22	64.3	0.74	2.3	0.09	0.86	0.013
Total			1,665	65.1	0.11	2.1	0.01	0.75	0.003
2	17	4/19	7	75.9	0.74	2.9	0.18	0.66	0.034
2	18	4/26	41	76.7	0.83	3.4	0.11	0.75	0.014
2	19	5/3	46	76.2	0.62	3.2	0.09	0.72	0.013
2	20	5/10	40	74.1	1.07	3.1	0.13	0.76	0.020
2	21	5/17	74	77.9	0.73	3.7	0.12	0.76	0.010
2	22	5/24	29	72.4	1.25	2.9	0.22	0.75	0.016
2	23	5/31	8	67.9	1.17	2.4	0.09	0.77	0.024
2	24	6/7	12	82.8	3.63	5.4	0.88	0.86	0.041
2	25	6/14	13	83.7	5.59	6.0	1.16	0.89	0.036
2	26	6/21	8	72.4	2.31	3.1	0.41	0.79	0.021
2	27	6/28	1	69.0	0.00	2.5	0.00	0.76	0.000
Total			279	76.3	0.48	3.5	0.09	0.76	0.006

Table 3. Mean length, weight, and condition factor of sockeye salmon smolt samples from the Chignik River, by year and age, 1994 to 2003.

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

Table 4. Estimated age composition of Chignik River sockeye salmon smolt samples, 1994 to 2003.

Year	Dates	Sample Size		Ages 0.	1.	2.	3.	4.	Total
1994	05/06-06/30	2,806	Percent	0.0	61.1	38.9	0.0	0.0	100.0
			Numbers	0	1,715	1,091	0	0	2,806
1995	05/06-06/29	2,557	Percent	10.7	49.8	39.5	0.0	0.0	100.0
			Numbers	273	1,274	1,010	0	0	2,557
1996	05/06-07/28	2,099	Percent	6.0	67.8	26.1	0.1	0.0	100.0
			Numbers	125	1,423	548	3	0	2,099
1997	05/04-07/22	2,657	Percent	7.3	63.1	29.1	0.5	0.0	100.0
			Numbers	195	1,676	774	12	0	2,657
1998	05/02-07/30	2,745	Percent	0.5	28.6	70.1	0.7	0.0	100.0
			Numbers	15	785	1,925	20	0	2,745
1999	05/10-07/03	2,180	Percent	1.8	61.7	36.1	0.3	0.0	100.0
			Numbers	40	1,345	788	7	0	2,180
2000	04/22-07/20	1,915	Percent	11.6	61.4	26.3	0.7	0.0	100.0
			Numbers	223	1,175	503	14	0	1,915
2001	04/29-07/12	2,195	Percent	4.4	75.0	17.7	2.8	0.0	100.0
			Numbers	96	1,647	389	62	1	2,195
2002	05/01-07/08	2,038	Percent	10.6	77.9	11.1	0.3	0.0	100.0
			Numbers	217	1,588	227	6	0	2,038
2003	4/25-07/08	2,098	Percent	7.1	79.6	13.3	0	0	100.0
			Numbers	149	1,670	279	0	0	2,098

Table 5. Results from mark-recapture tests performed on sockeye salmon smolts migrating through the Chignik River, 2003.

Date	No. Released	Total Recoveries	Trap Efficiency[a]
5/2	2,034	21	1.08%
5/8	1,696	19	1.18%
5/15	1,479	45	3.11%
5/22	1,138	31	2.81%
5/26	2,552	67	2.66%
5/30	2,154	29	1.39%
6/5	2,328	57	2.49%
6/9	1,376	34	2.54%
6/16	2,233	38	1.75%
6/24	1,118	11	1.07%
Total	18,108	352	1.95%

Table 6. Chignik River sockeye salmon smolt population estimates, by age class, 1994 to 2003.

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

Table 7. Estimated sockeye salmon smolt emigration from the Chignik River, by age class and statistical week, 2003.

		Age			
Statistical Week	Starting Date	0.	1.	2.	Total
17	4/19	0	29,600	6,475	36,075
18	4/26	35,155	462,032	102,953	600,140
19	5/3	6,959	525,411	160,059	692,429
20	5/10	9,033	345,505	90,328	444,866
21	5/17	0	1,392,711	831,134	2,223,845
22	5/24	0	1,137,207	193,994	1,331,201
23	5/31	34,330	675,161	30,516	740,007
24	6/7	4,972	180,968	11,932	197,872
25	6/14	10,698	238,031	17,384	266,113
26	6/21	21,777	102,898	4,355	129,031
27	6/28	17,814	39,264	364	57,442
28	7/5	14,309	17,489	0	31,798
Total		155,047	5,146,278	1,449,494	6,750,819

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 2003.

Brood Year	Escapement	Smolt Produced					Total smolt	Smolt / spawner	Adult Return						Return / spawner	Marine Survival
		age 0.	age 1.	age 2.	age 3.	age 4.			Age 0.	Age 1.	Age 2.	Age 3.	Age 4.	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	2,445,405	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	2,429,980	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	2,435,327	968,399	18,144	214	3,460,313	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	14,441		2,962,059	3.95	20%
1997	775,618	75,560	12,705,935	4,645,121	516,723	0	17,943,339	23.13	14,543	792,027	980,793					
1998	701,128	73,364	8,047,526	5,024,666	72,184	0	13,217,740	18.85	5,787	1,114,947						
1999	715,966	1,270,101	18,940,752	2,223,996	0		22,434,849	31.34	28,382							
2000	805,225	521,546	13,980,423	1,449,494												
2001	1,136,918	440,947	5,146,278													
2002	725,220	155,047														
2003	684,145															

Table 9. Estimated marine survival of sockeye salmon smolt from the Chignik River, by emigration year and ocean age, 1994 to 2003.

Emigration	Smolt estimates					Adult returns					Marine
Year	Age 0.	Age 1.	Age 2.	Age 3.	Total	Age x.1	Age x.2	Age x.3	Age x.4	Total	Survival
1994	0	7,263,054	4,270,636	0	11,533,690	3,492	216,654	1,180,530	9,174	1,409,850	12%
1995	735,916	2,843,222	5,178,450	0	8,757,588	23,193	335,462	1,153,544	4,113	1,516,312	17%
1996	80,245	1,200,793	731,099	5,018	2,017,155	20,762	652,836	3,244,567	19,693	3,937,858	195%
1997	528,846	11,172,150	13,738,356	122,289	25,561,641	10,875	1,211,950	2,780,125	13,864	4,016,814	16%
1998	75,560	5,790,587	20,374,245	158,056	26,398,448	622	156,443	2,749,174	33,266	2,939,505	11%
1999	73,364	12,705,935	8,221,631	78,798	21,079,728	260	145,459	1,525,665	9,920	1,681,304	8%
2000	1,270,101	8,047,526	4,645,121	160,017	14,122,765	5,105	414,528	1,718,930		2,138,563	15%
2001	521,546	18,940,752	5,024,666	516,723	25,003,687	283	243,378				
2002	440,947	13,980,423	2,223,996	72,184	16,717,551	4,072					
2003	155,047	5,146,278	1,449,494	0	6,750,819						

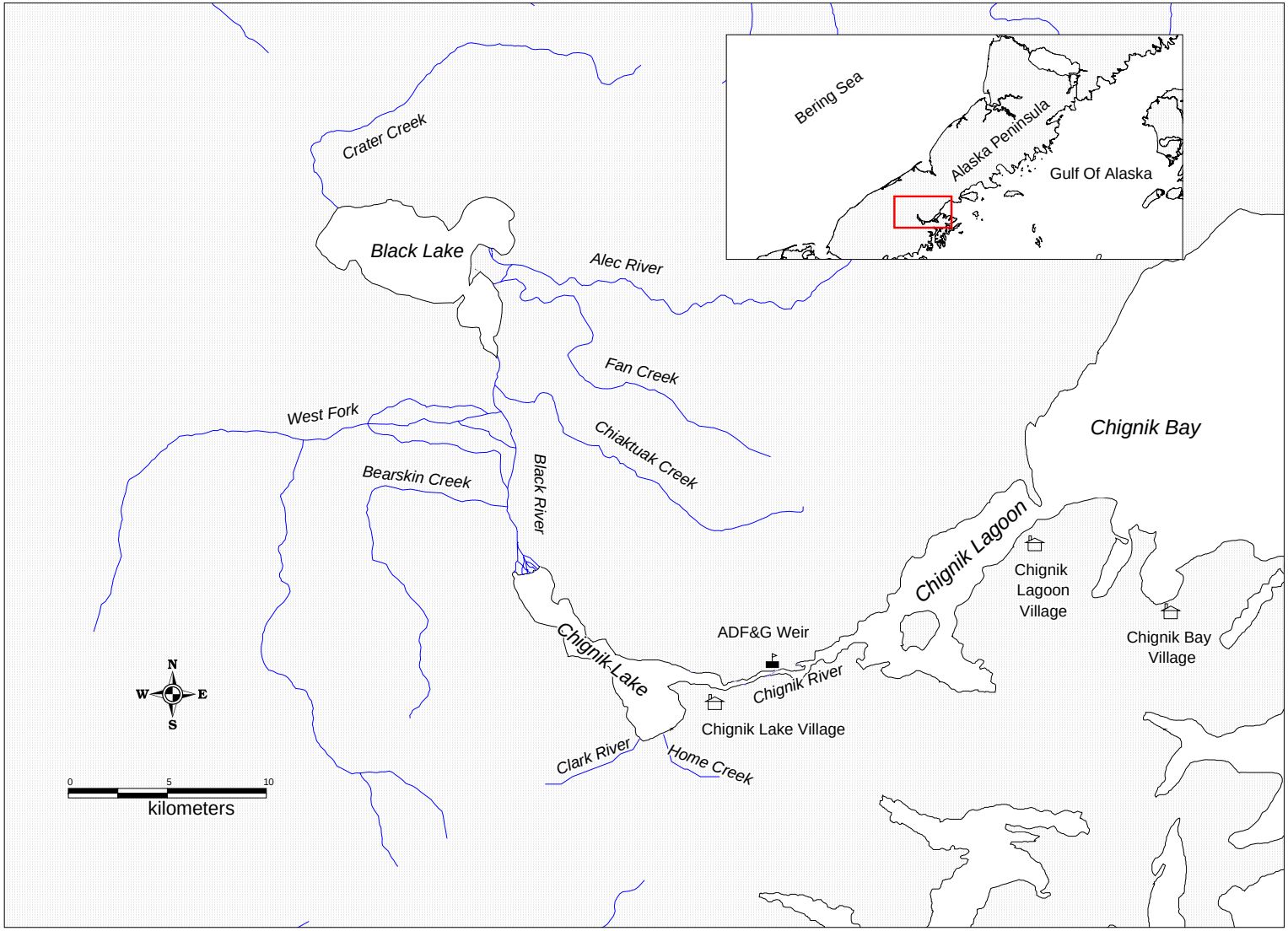

Figure 1. Map of the Chignik River watershed with inset of the Alaska Peninsula.

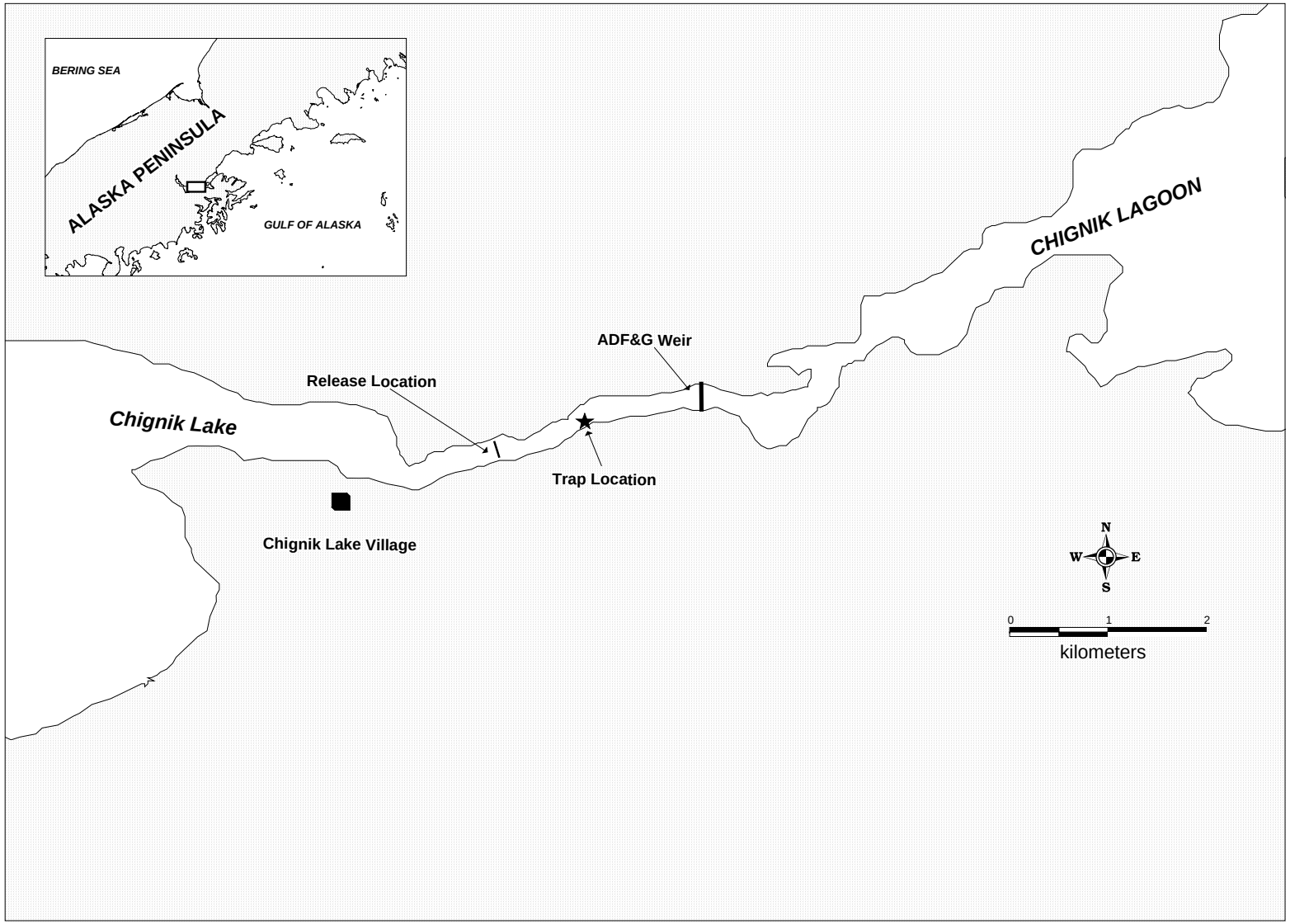

Figure 2. Location of the traps and the release site of marked smolt on the Chignik River, Alaska, 2003.

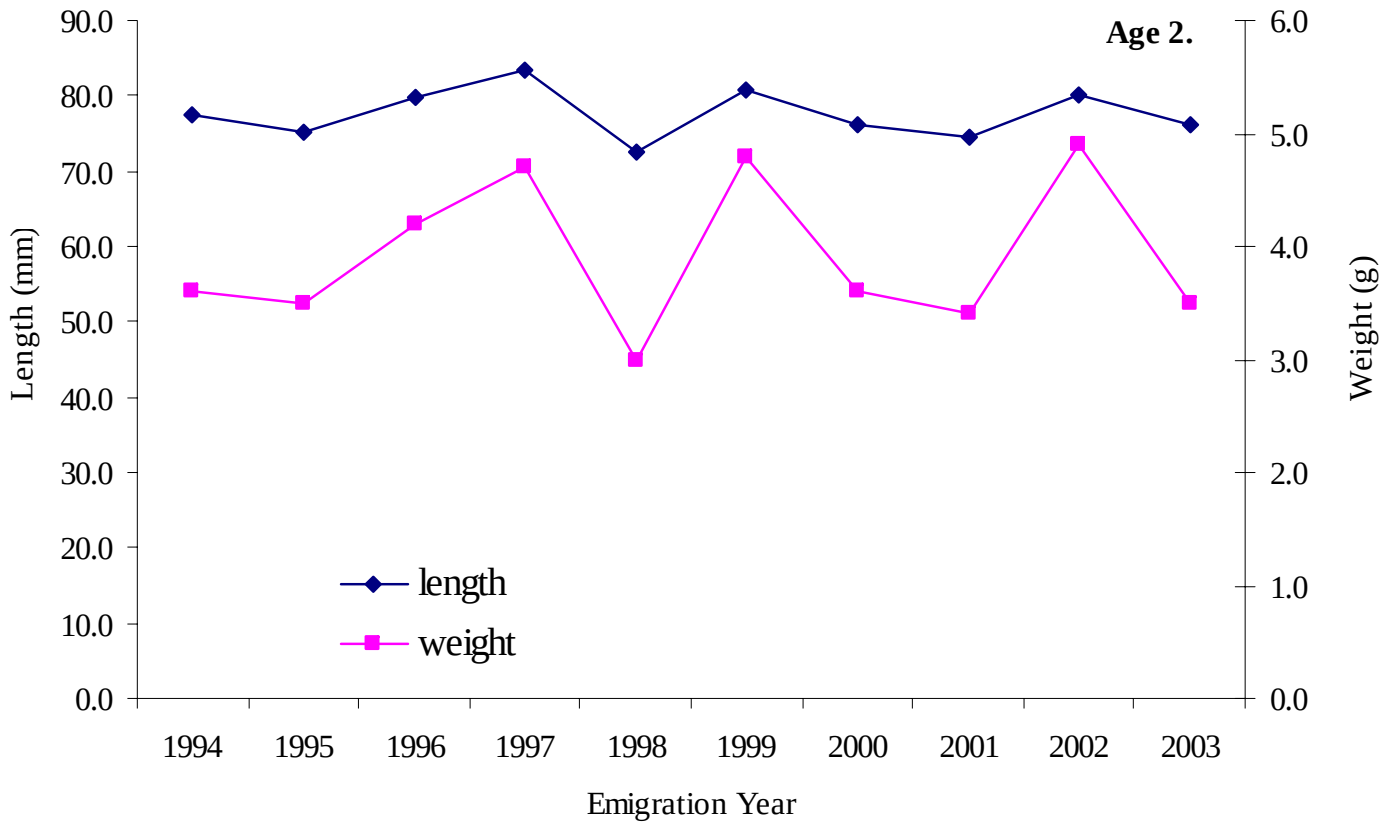

Figure 3. Average length and weight of age 1. and age 2. sockeye salmon, by year, 1994 through 2003.

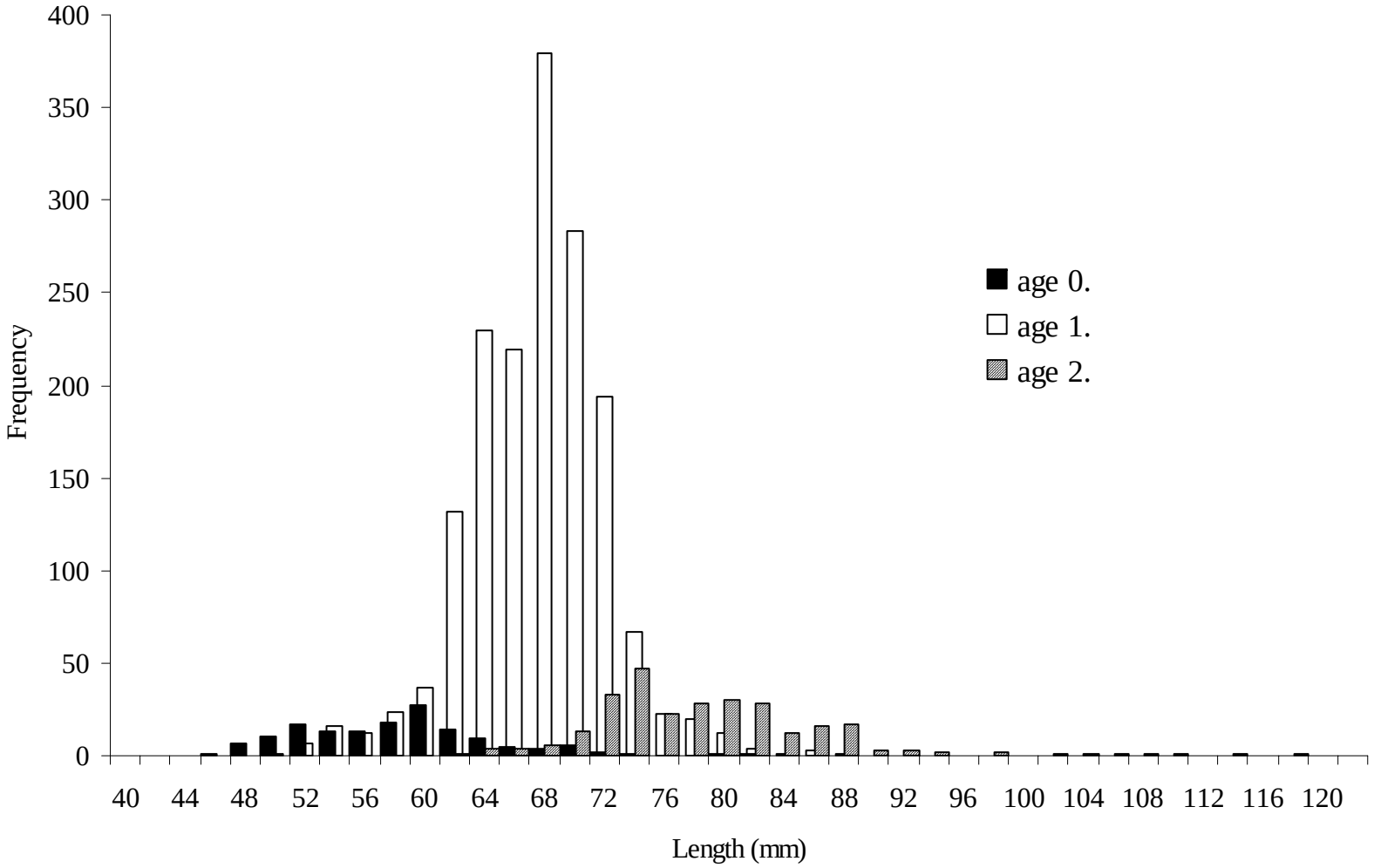

Figure 4. Length frequency histogram of age 0., 1., and 2. sockeye salmon smolt sampled from the Chignik River, 2003.

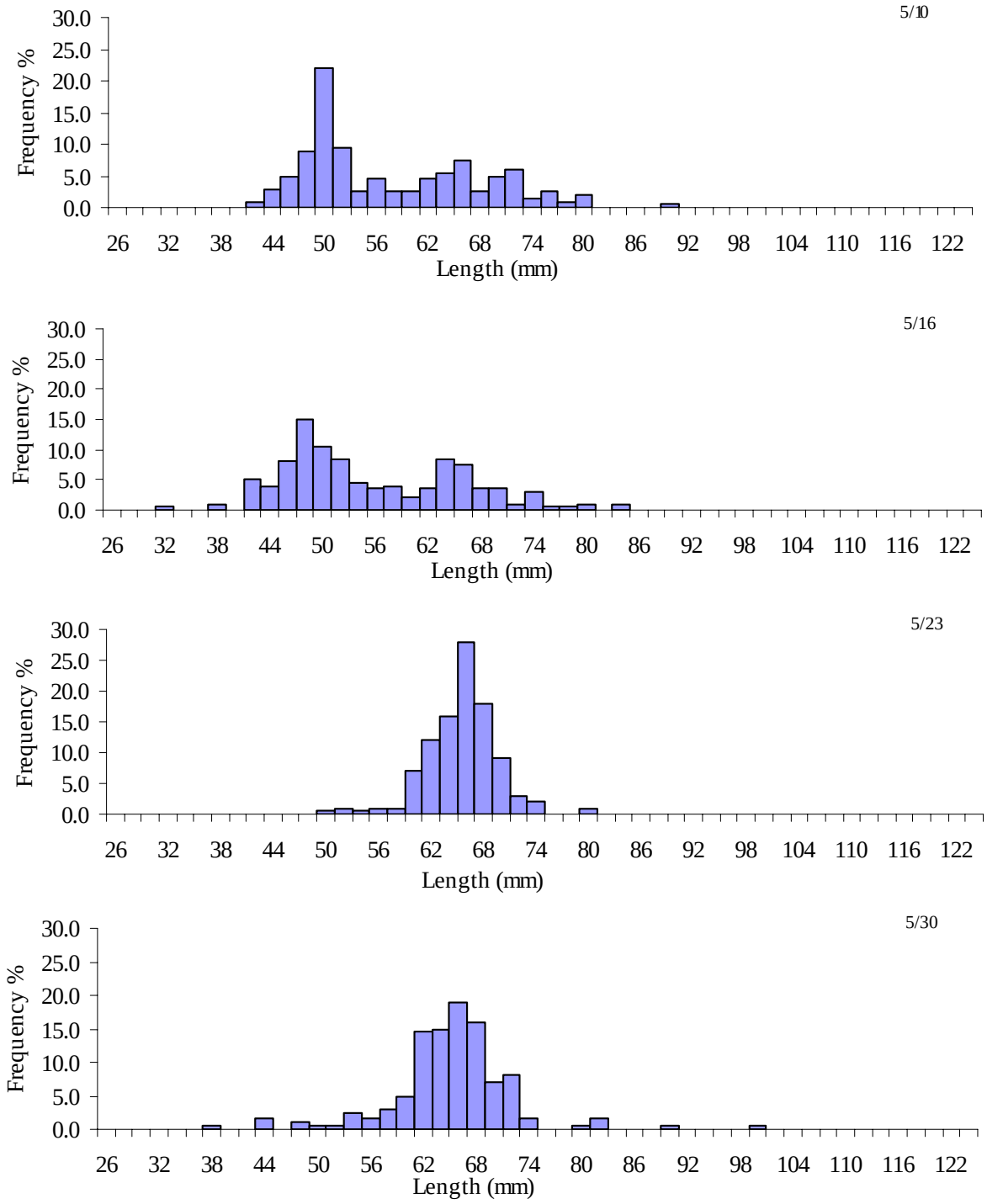

Figure 5. Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps in May, 2003.

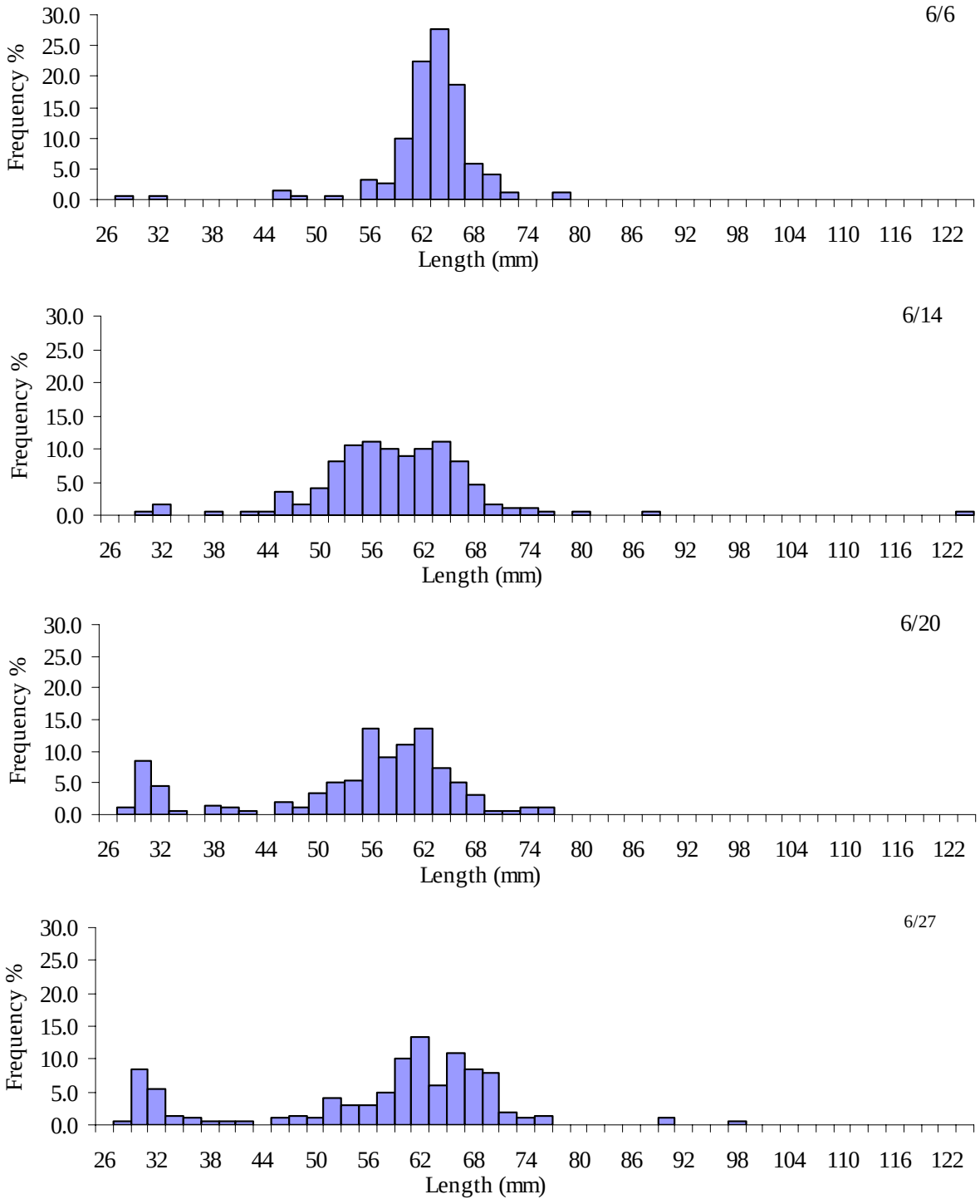

Figure 6. Length frequency histograms of weekly total sockeye salmon catch samples in the screw traps in June, 2003.

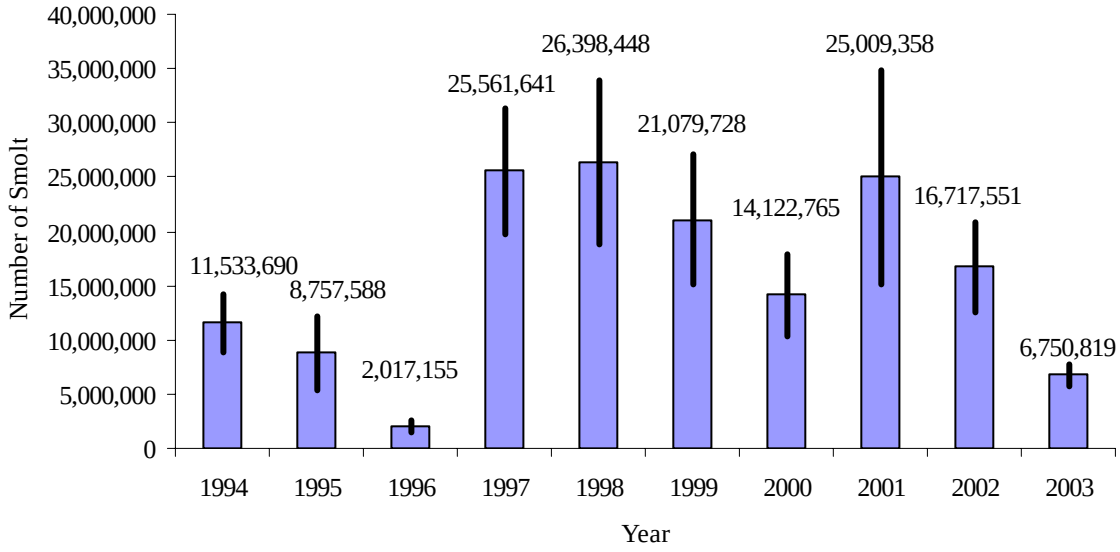

Figure 7. Annual Chignik River sockeye salmon smolt emigration estimates and corresponding 95% confidence intervals, 1994 to 2003.

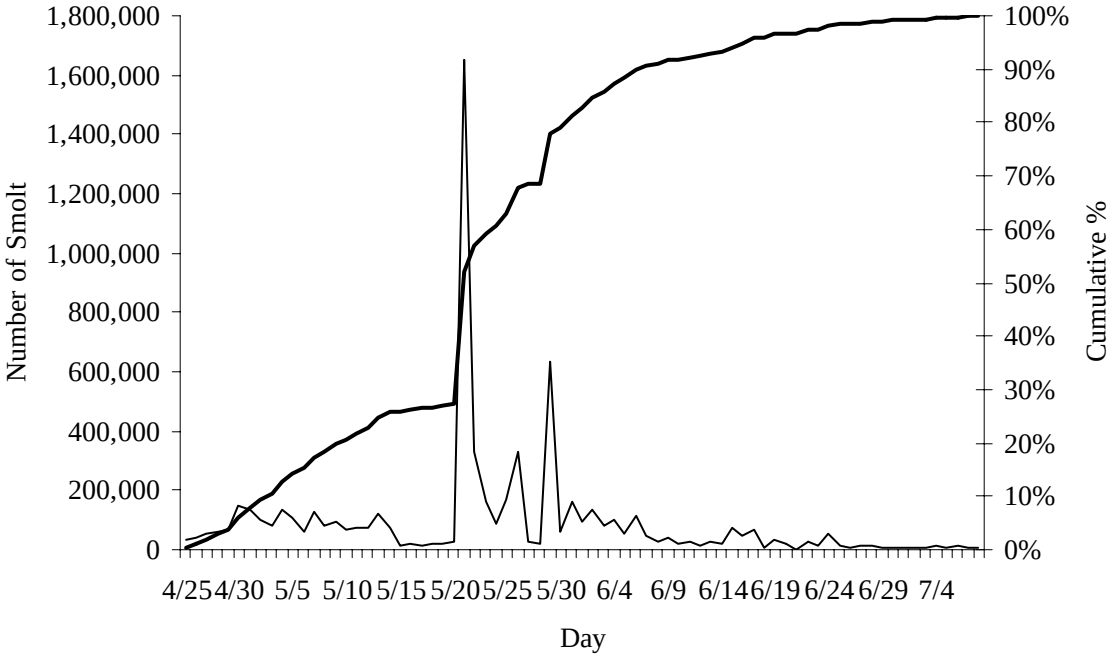

Figure 8. Estimated daily and corresponding cumulative percentage of the sockeye salmon smolt emigration from the Chignik River, 2003.

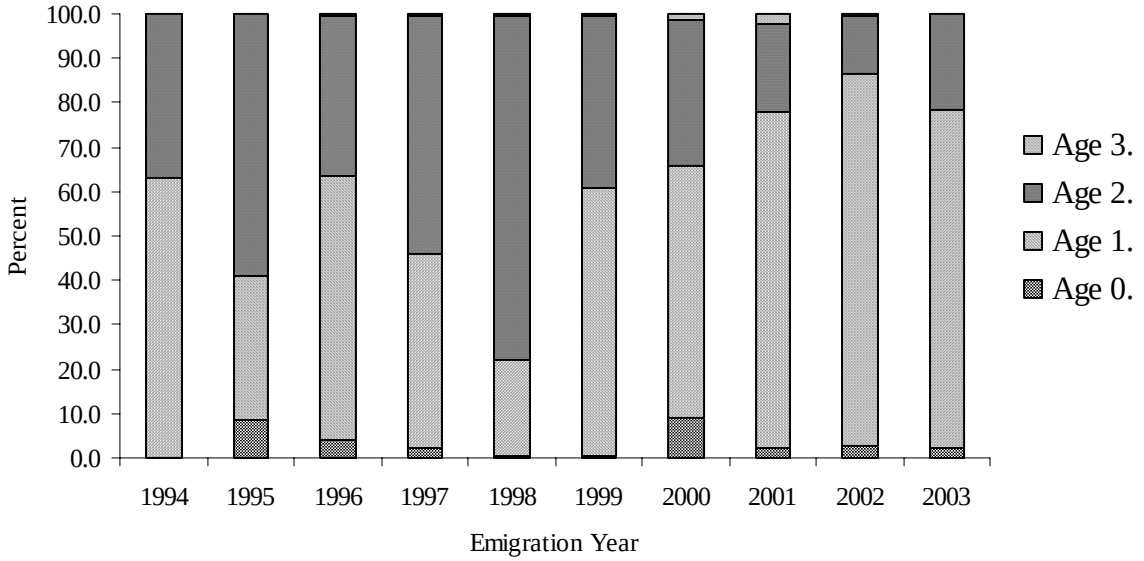

Figure 9. A comparison of the estimated age structure of age 0. to age 3. sockeye salmon smolt emigrations from the Chignik River, 1994 to 2003.

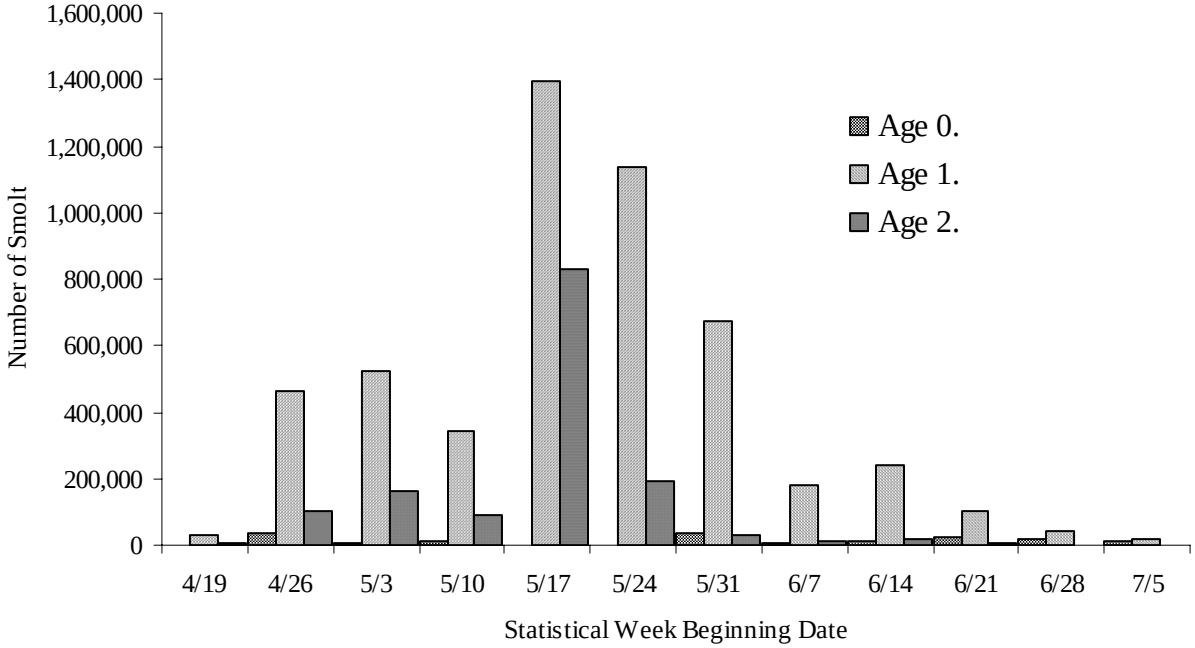

Figure 10. Estimated smolt emigration of age 0. to age 2. sockeye salmon smolt, by statistical week beginning date, from the Chignik River, 2003.

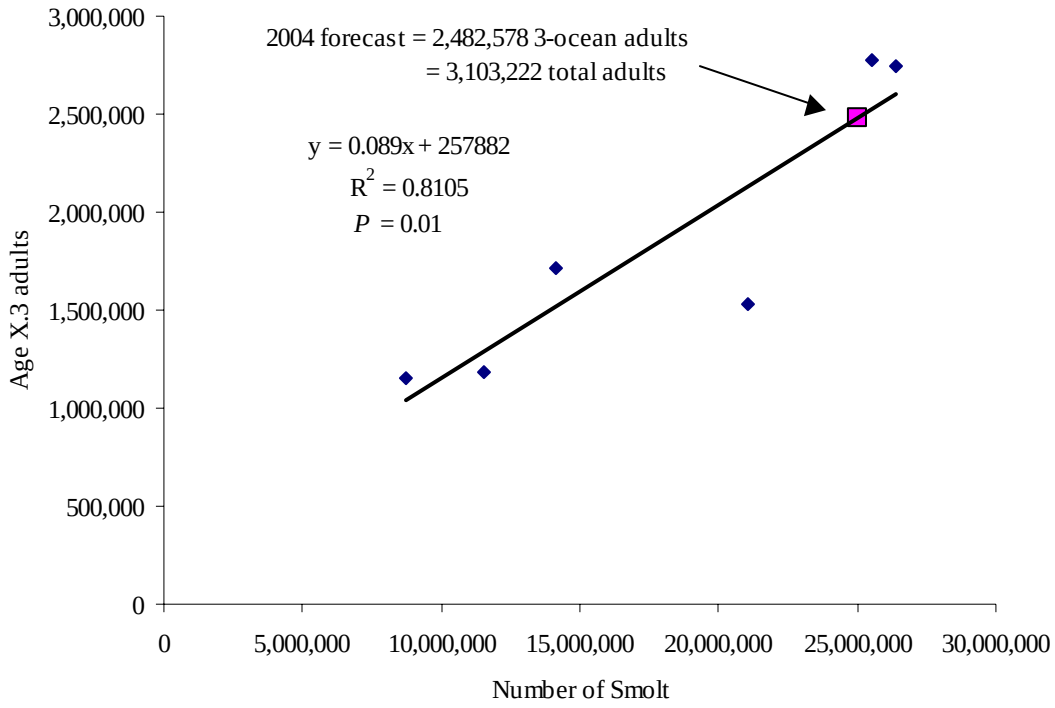

Figure 11. Regression relationship between the total Chignik River sockeye salmon smolt emigration estimate, by emigration year, and 3-ocean adult returns, with the predicted 2004 return indicated.

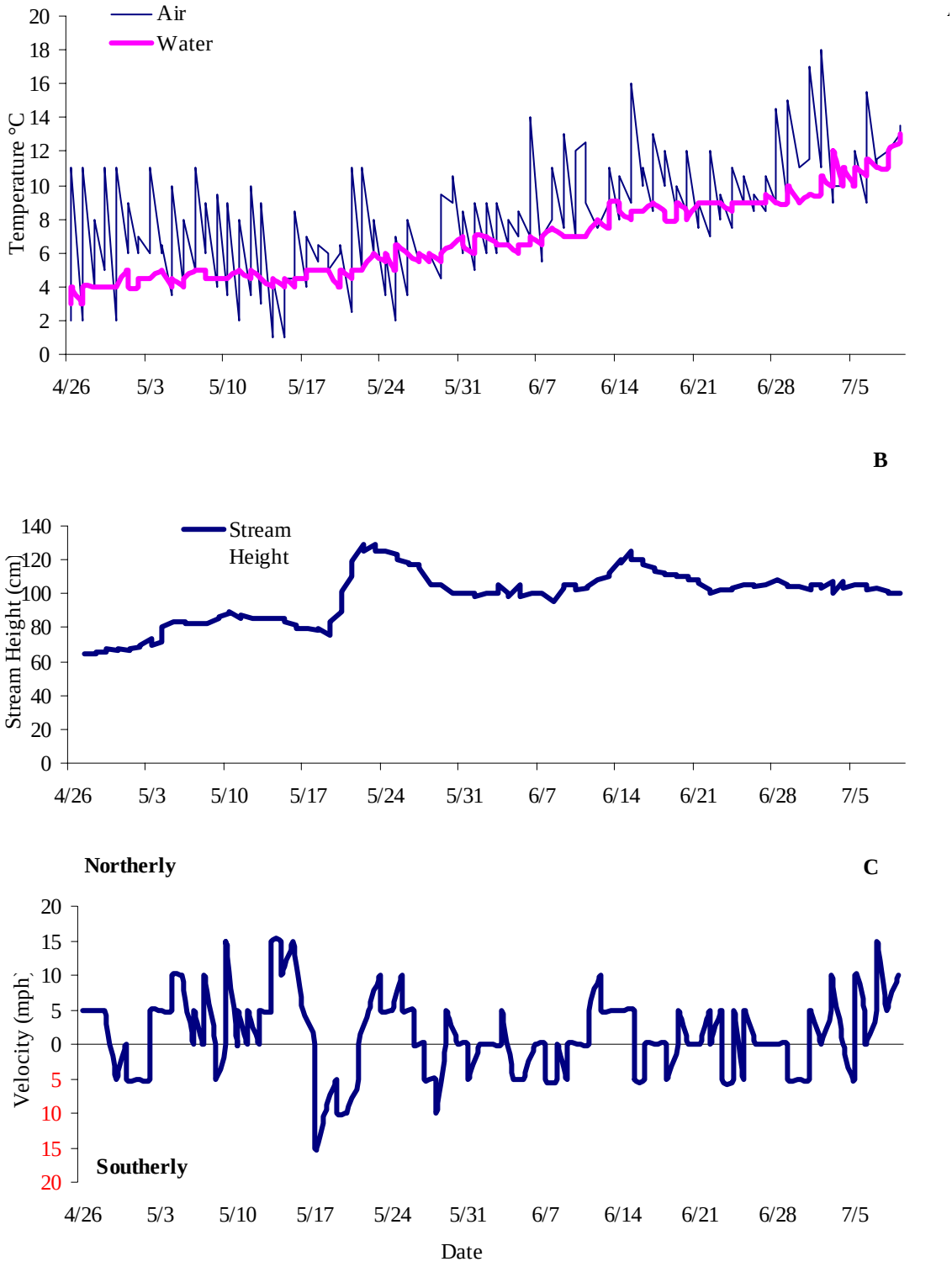

Figure 12. Air and water temperature (A), stream gauge height (B), and wind velocity and direction data (C) gathered at the Chignik River smolt traps, 2003.

APPENDIX

Appendix A. Actual daily counts and trap efficiency data of the Chignik River sockeye salmon smolt project, 2003.

	Actual		Trap Efficiency Test				Incidental Catch[a]											
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	DV	SB	Chnk	PS	PW	SF	SC	ISO	EUL
4/25	390	390					1,517	0	0	0	72	0	2	0	0	4	0	0
4/26	458	848					928	0	0	0	115	0	5	0	0	2	1	0
4/27	586	1,434					982	0	8	2	73	0	0	0	0	0	0	0
4/28	631	2,065					700	2	0	1	78	0	1	0	4	1	0	0
4/29	707	2,772					381	1	0	4	44	0	0	0	0	11	1	0
4/30	1,589	4,361					192	52	0	1	77	0	2	0	0	5	2	0
5/1	1,455	5,816					673	1	0	6	49	0	0	0	1	9	0	0
5/2	1,062	6,878	2,034	14	14	0.74%	220	16	5	1	78	0	0	0	1	1	1	0
5/3	867	7,745		6	20	1.03%	260	4	13	1	98	0	1	0	2	2	2	0
5/4	1,476	9,221		1	21	1.08%	682	31	35	4	125	0	3	0	1	6	1	0
5/5	1,176	10,397		0	21	1.08%	318	25	10	3	93	0	1	0	2	2	0	0
5/6	687	11,084		0	21	1.08%	190	4	7	1	31	0	0	0	0	7	0	0
5/7	1,391	12,475		0	21	1.08%	179	9	0	0	82	0	5	0	2	7	0	0
5/8	973	13,448	1,696	16	16	1.00%	239	6	15	1	112	0	2	0	2	6	0	0
5/9	1,086	14,534		2	18	1.12%	242	12	0	1	116	0	0	0	0	3	0	0
5/10	794	15,328		0	18	1.12%	176	16	10	3	87	0	0	0	0	1	0	0
5/11	858	16,186		0	18	1.12%	218	8	2	3	107	0	0	0	0	2	0	0
5/12	838	17,024		1	19	1.18%	233	5	5	6	120	1	0	0	0	1	0	0
5/13	1,446	18,470		0	19	1.18%	219	20	0	10	135	1	1	0	1	9	0	0
5/14	902	19,372		0	19	1.18%	260	23	15	4	165	0	4	0	5	5	0	0
5/15	457	19,829	1,479	41	41	2.84%	173	11	4	1	54	1	2	0	2	2	0	0
5/16	611	20,440		3	44	3.04%	155	3	0	1	132	0	1	0	3	1	0	0
5/17	360	20,800		0	44	3.04%	138	0	0	1	69	0	3	0	0	5	0	0
5/18	671	21,471		1	45	3.11%	216	22	5	2	81	0	3	0	0	9	0	0
5/19	712	22,183		0	45	3.11%	179	17	0	7	92	0	1	0	1	2	1	0
5/20	679	22,862		0	45	3.11%	214	34	0	7	161	0	2	0	0	6	0	0
5/21	46,484	69,346		0	45	3.11%	143	279	5	25	151	0	0	0	7	1	0	0
5/22	9,255	78,601	1,138	30	30	2.72%	205	236	0	53	144	0	10	0	6	38	0	0
5/23	4,485	83,086		1	31	2.81%	30	90	0	10	262	0	0	0	3	5	0	0

-Continued-

Appendix A. (page 2 of 3)

	Actual		Trap Efficiency Test				Incidental Catch[a]											
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	DV	SB	Chnk	PS	PW	SF	SC	ISO	EUL
5/24	2,533	85,619		0	31	2.81%	48	80	0	14	375	0	4	0	5	9	0	0
5/25	4,707	90,326		0	31	2.81%	38	114	0	27	271	2	3	0	7	8	3	0
5/26	8,820	99,146	2,552	61	61	2.43%	49	77	0	20	310	0	1	0	8	30	1	0
5/27	794	99,940		4	65	2.59%	88	41	0	11	170	0	2	0	5	8	1	0
5/28	551	100,491		2	67	2.66%	231	24	0	5	156	0	3	0	0	1	1	0
5/29	16,863	117,354		0	67	2.66%	129	17	0	6	259	1	2	0	1	7	0	0
5/30	818	118,172	2,154	27	27	1.30%	138	16	10	11	157	1	1	0	1	9	0	0
5/31	2,250	120,422		2	29	1.39%	115	58	47	3	154	0	2	0	1	16	1	0
6/1	1,299	121,721		0	29	1.39%	57	25	0	6	127	0	0	0	1	10	0	0
6/2	1,887	123,608		0	29	1.39%	265	43	0	7	238	39	16	0	3	11	1	0
6/3	1,100	124,708		0	29	1.39%	240	24	20	10	202	12	0	0	1	13	0	0
6/4	1,452	126,160		0	29	1.39%	290	77	0	3	136	6	25	0	0	6	0	0
6/5	1,302	127,462	2,328	53	53	2.32%	569	22	32	7	152	2	9	1	1	4	0	1
6/6	2,837	130,299		1	54	2.55%	445	30	10	4	187	7	13	0	0	54	0	1
6/7	1,195	131,494		1	55	2.40%	192	90	0	4	141	7	11	0	3	6	1	0
6/8	714	132,208		2	57	2.49%	144	50	0	25	141	1	2	0	3	13	1	0
6/9	1,033	133,241	1,376	31	31	2.32%	174	34	0	8	147	0	0	4	4	18	0	0
6/10	504	133,745		2	33	2.47%	241	31	0	8	54	1	6	0	4	3	0	0
6/11	621	134,366		0	33	2.47%	215	48	0	27	107	0	0	2	7	15	0	0
6/12	323	134,689		1	34	2.54%	142	39	0	13	77	0	4	0	0	7	0	0
6/13	600	135,289		0	34	2.54%	94	76	0	30	73	0	0	2	1	12	0	0
6/14	482	135,771		0	34	2.54%	172	42	0	8	141	0	0	3	3	4	0	0
6/15	1,866	137,637		0	34	2.54%	65	43	0	5	91	0	0	0	5	1	0	0
6/16	844	138,481	2,233	35	35	1.61%	97	35	0	6	153	0	1	1	0	7	1	0
6/17	1,127	139,608		2	37	1.70%	44	25	0	6	59	0	3	0	1	5	1	0
6/18	167	139,775		1	38	1.75%	55	21	0	2	63	0	3	0	0	3	1	0
6/19	582	140,357		0	38	1.75%	41	42	0	5	40	0	0	2	0	3	0	1
6/20	313	140,670		0	38	1.75%	112	42	0	5	70	0	1	2	0	5	1	0
6/21	55	140,725		0	38	1.75%	85	22	0	0	32	0	0	0	0	1	0	0
6/22	475	141,200		0	38	1.75%	12	17	0	1	8	0	0	0	0	3	2	0

-Continued-

Appendix A. (page 3 of 3)

	Actual		Trap Efficiency Test				Incidental Catch[a]											
Date	Daily	Cum.	Marked	Daily Recoveries	Cum. Recoveries	Efficiency[b]	Soc Fry	Coho	Pink	DV	SB	Chnk	PS	PW	SF	SC	ISO	EUL
6/23	220	141,420		0	38	1.75%	36	73	0	0	49	1	1	8	0	6	0	0
6/24	583	142,003	1,118	7	7	0.71%	37	75	0	1	22	0	6	0	0	12	7	0
6/25	176	142,179		1	8	0.80%	63	49	0	0	33	0	0	2	0	5	0	0
6/26	53	142,232		2	10	0.98%	35	36	0	1	17	1	1	3	0	4	0	0
6/27	111	142,343		0	10	0.98%	52	21	0	1	95	0	1	3	0	4	0	0
6/28	156	142,499		1	11	1.07%	2	41	0	1	33	0	4	0	0	11	5	0
6/29	59	142,558		0	11	1.07%	12	42	0	0	39	0	1	1	0	2	0	0
6/30	79	142,637		0	11	1.07%	4	34	0	0	32	0	1	6	0	0	0	0
7/1	65	142,702		0	11	1.07%	6	37	0	0	19	0	0	6	0	0	0	0
7/2	58	142,760		0	11	1.07%	3	32	0	3	22	1	1	1	0	0	0	0
7/3	75	142,835		0	11	1.07%	0	10	0	4	21	0	1	1	0	1	0	0
7/4	124	142,959		0	11	1.07%	0	32	0	2	19	0	0	5	0	0	0	0
7/5	55	143,014		0	11	1.07%	1	24	0	2	31	0	0	3	0	1	0	0
7/6	116	143,130		0	11	1.07%	6	19	0	4	33	0	0	4	0	1	0	0
7/7	102	143,232		0	11	1.07%	4	26	0	4	25	0	0	5	0	0	1	0
7/8	68	143,300		0	11	1.07%	1	13	0	4	14	0	0	0	0	0	0	0
Total		143,300	18,108	352	213	1.18%	15,111	2,796	258	473	7,798	85	178	65	108	492	38	3

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

[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. Number of sockeye salmon smolt caught by trap, by day, from the Chignik River, April 25 to July 8, 2003.

	Small Trap		Large Trap		Combined		Percent Total	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
4/25	105	105	285	285	390	390	26.9	73.1
4/26	115	220	343	628	458	848	25.1	74.9
4/27	124	344	462	1,090	586	1,434	21.2	78.8
4/28	113	457	518	1,608	631	2,065	17.9	82.1
4/29	215	672	492	2,100	707	2,772	30.4	69.6
4/30	511	1,183	1,078	3,178	1,589	4,361	32.2	67.8
5/1	668	1,851	787	3,965	1,455	5,816	45.9	54.1
5/2	732	2,583	330	4,295	1,062	6,878	68.9	31.1
5/3	254	2,837	613	4,908	867	7,745	29.3	70.7
5/4	580	3,417	896	5,804	1,476	9,221	39.3	60.7
5/5	401	3,818	775	6,579	1,176	10,397	34.1	65.9
5/6	279	4,097	408	6,987	687	11,084	40.6	59.4
5/7	481	4,578	910	7,897	1,391	12,475	34.6	65.4
5/8	405	4,983	568	8,465	973	13,448	41.6	58.4
5/9	304	5,287	782	9,247	1,086	14,534	28.0	72.0
5/10	279	5,566	515	9,762	794	15,328	35.1	64.9
5/11	212	5,778	646	10,408	858	16,186	24.7	75.3
5/12	247	6,025	591	10,999	838	17,024	29.5	70.5
5/13	391	6,416	1,055	12,054	1,446	18,470	27.0	73.0
5/14	213	6,629	689	12,743	902	19,372	23.6	76.4
5/15	97	6,726	360	13,103	457	19,829	21.2	78.8
5/16	158	6,884	453	13,556	611	20,440	25.9	74.1
5/17	81	6,965	279	13,835	360	20,800	22.5	77.5
5/18	185	7,150	486	14,321	671	21,471	27.6	72.4
5/19	173	7,323	539	14,860	712	22,183	24.3	75.7
5/20	241	7,564	438	15,298	679	22,862	35.5	64.5
5/21	15,717	23,281	30,767	46,065	46,484	69,346	33.8	66.2
5/22	3,268	26,549	5,987	52,052	9,255	78,601	35.3	64.7
5/23	1,376	27,925	3,109	55,161	4,485	83,086	30.7	69.3
5/24	1,040	28,965	1,493	56,654	2,533	85,619	41.1	58.9
5/25	1,123	30,088	3,584	60,238	4,707	90,326	23.9	76.1
5/26	3,040	33,128	5,780	66,018	8,820	99,146	34.5	65.5
5/27	182	33,310	612	66,630	794	99,940	22.9	77.1
5/28	214	33,524	337	66,967	551	100,491	38.8	61.2
5/29	4,387	37,911	12,476	79,443	16,863	117,354	26.0	74.0
5/30	367	38,278	451	79,894	818	118,172	44.9	55.1
5/31	393	38,671	1,857	81,751	2,250	120,422	17.5	82.5
6/1	350	39,021	949	82,700	1,299	121,721	26.9	73.1
6/2	362	39,383	1,525	84,225	1,887	123,608	19.2	80.8
6/3	180	39,563	920	85,145	1,100	124,708	16.4	83.6
6/4	302	39,865	1,150	86,295	1,452	126,160	20.8	79.2
6/5	536	40,401	766	87,061	1,302	127,462	41.2	58.8
6/6	487	40,888	2,350	89,411	2,837	130,299	17.2	82.8
6/7	239	41,127	956	90,367	1,195	131,494	20.0	80.0
6/8	147	41,274	567	90,934	714	132,208	20.6	79.4
6/9	169	41,443	864	91,798	1,033	133,241	16.4	83.6

-Continued-

Appendix B. (page 2 of 2)

	Small Trap		Large Trap		Combined		Percent Total	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Small	Large
6/10	111	41,554	393	92,191	504	133,745	22.0	78.0
6/11	113	41,667	508	92,699	621	134,366	18.2	81.8
6/12	69	41,736	254	92,953	323	134,689	21.4	78.6
6/13	118	41,854	482	93,435	600	135,289	19.7	80.3
6/14	91	41,945	391	93,826	482	135,771	18.9	81.1
6/15	378	42,323	1,488	95,314	1,866	137,637	20.3	79.7
6/16	120	42,443	724	96,038	844	138,481	14.2	85.8
6/17	134	42,577	993	97,031	1,127	139,608	11.9	88.1
6/18	41	42,618	126	97,157	167	139,775	24.6	75.4
6/19	59	42,677	523	97,680	582	140,357	10.1	89.9
6/20	53	42,730	260	97,940	313	140,670	16.9	83.1
6/21	22	42,752	33	97,973	55	140,725	40.0	60.0
6/22	42	42,794	433	98,406	475	141,200	8.8	91.2
6/23	50	42,844	170	98,576	220	141,420	22.7	77.3
6/24	39	42,883	544	99,120	583	142,003	6.7	93.3
6/25	30	42,913	146	99,266	176	142,179	17.0	83.0
6/26	19	42,932	34	99,300	53	142,232	35.8	64.2
6/27	14	42,946	97	99,397	111	142,343	12.6	87.4
6/28	16	42,962	140	99,537	156	142,499	10.3	89.7
6/29	14	42,976	45	99,582	59	142,558	23.7	76.3
6/30	19	42,995	60	99,642	79	142,637	24.1	75.9
7/1	17	43,012	48	99,690	65	142,702	26.2	73.8
7/2	15	43,027	43	99,733	58	142,760	25.9	74.1
7/3	16	43,043	59	99,792	75	142,835	21.3	78.7
7/4	38	43,081	86	99,878	124	142,959	30.6	69.4
7/5	20	43,101	35	99,913	55	143,014	36.4	63.6
7/6	39	43,140	77	99,990	116	143,130	33.6	66.4
7/7	61	43,201	41	100,031	102	143,232	59.8	40.2
7/8	23	43,224	45	100,076	68	143,300	33.8	66.2
Total		43,224		100,076		143,300	30.2	69.8

Appendix C. Daily climatological observations for the Chignik River sockeye salmon smolt project, 2003.

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
4/26	0:00	2.0	3.0	0	NW	5	2.75	4.00	N/A	Clear
4/26	13:15	11.0	4.0	0	NW	5	2.25	4.00	N/A	Clear
4/27	0:15	2.0	3.0	0	NW	5	2.25	4.00	N/A	Clear
4/27	12:00	11.0	4.0	0	NW	5	2.50	3.50	65	Clear
4/28	0:00	4.0	4.0	0	NW	5	2.50	3.38	65	Clear
4/28	12:00	8.0	4.0	100	NW	5	2.50	4.00	66	Overcast
4/29	0:00	5.0	4.0	0	SE	5	2.50	3.75	66	Overcast
4/29	12:00	11.0	4.0	80	SE	5	2.50	4.00	68	Overcast
4/30	0:00	2.0	4.0	0		0	2.75	4.00	67	Clear
4/30	12:30	11.0	4.0	0	SE	5	2.50	3.50	68	Clear
5/1	0:08	6.0	5.0	100	SE	5	2.25	3.25	67	Overcast
5/1	12:10	9.0	4.0	100	SE	5	2.25	3.75	68	Overcast
5/2	0:05	6.0	4.0	100	SE	5	2.50	4.00	69	Overcast
5/2	0:00	7.0	4.5	100	NW	5	2.50	4.00	70	Overcast
5/3	0:00	6.0	4.5	100	NW	5	3.00	4.13	73	Overcast
5/3	12:20	11.0	4.5	100	NW	5	2.75	4.00	70	Overcast
5/4	0:00	6.0	5.0	100	NW	5	3.00	4.50	71	Overcast
5/4	12:00	6.5	5.0	100	NW	10	3.25	4.88	80	Overcast
5/5	0:00	3.5	4.0	100	NW	10	3.75	4.75	83	Overcast
5/5	12:00	10.0	4.5	50	NW	10	4.00	4.75	83	Partly Cloudy
5/6	0:00	4.0	4.0	100		0	3.75	4.25	83	Rain
5/6	12:00	8.0	4.5	100	NW	5	4.00	4.75	82	Overcast
5/7	0:00	5.0	5.0	100		0	4.00	4.75	82	Calm
5/7	12:00	11.0	5.0	100	NW	10	4.00	4.75	82	Overcast
5/8	0:10	6.0	5.0	100		0	3.75	4.50	82	Overcast
5/8	12:00	9.0	4.5	100	SE	5	3.75	4.50	82	Overcast
5/9	0:00	4.0	4.5	100		0	4.00	4.63	85	Rain
5/9	12:00	9.5	4.5	80	NW	15	4.00	4.88	86	Broken Overcast
5/10	0:10	3.5	4.5	100		0	4.00	4.88	88	Overcast

-Continued-

Appendix C. (page 2 of 6)

Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover (%)	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Large	Stream Gauge (cm)	Comments
5/10	12:00	9.0	4.5	0	NW	5	4.00	4.88	89	Clear
5/11	0:08	2.0	5.0	100		0	4.00	4.75	85	Overcast
5/11	12:00	8.0	5.0	100	NW	5	4.00	5.00	87	Overcast
5/12	0:00	3.5	4.5	80		0	4.00	4.75	85	Overcast
5/12	12:00	10.0	5.0	90	NW	5	3.75	4.68	85	Overcast
5/13	0:00	3.0	4.5	90	NW	5	4.25	4.75	85	Overcast
5/13	12:00	9.0	4.5	100	NW	15	4.25	4.75	85	Overcast
5/14	0:00	1.0	4.0	100	NW	15	3.75	4.75	85	Overcast
5/14	12:00	4.5	4.5	80	NW	10	3.75	4.63	85	Overcast
5/15	0:00	1.0	4.0	100	NW	15	4.00	4.50	85	Overcast
5/15	12:00	4.5	4.5	80	NW	15	4.00	4.88	83	Overcast
5/16	0:00	4.5	4.0	80	NW	5	4.00	4.75	81	Overcast
5/16	12:00	8.5	4.5	70	NW	5	3.75	4.50	79	Overcast
5/17	0:00	4.0	4.5	10		0	3.50	4.25	79	Clear
5/17	12:00	7.0	5.0	100	SE	15	2.75	3.38	79	Rain
5/18	0:00	5.5	5.0	100	SE	10	2.75	3.38	78	Rain
5/18	12:00	6.5	5.0	100	SE	10	2.25	3.25	79	Rain
5/19	0:00	6.0	5.0	100	SE	5	2.25	4.25	75	Rain
5/19	12:00	5.0	5.0	100	SE	10	3.25	4.25	83	Rain
5/20	0:00	6.0	4.0	100	SE	10	4.00	4.50	89	Rain
5/20	12:00	6.5	5.0	100	SE	10	4.25	5.00	101	Overcast
5/21	0:00	2.5	4.5	10	SE	5	6.00	6.00	110	Clear
5/21	12:00	11.0	5.0	0		0	6.25	6.50	119	Clear
5/22	0:00	5.0	5.0	0	NW	5	6.75	6.75	129	Clear
5/22	12:10	11.0	5.0	25	NW	5	6.75	6.00	125	Partly Cloudy
5/23	0:00	6.0	6.0	75	NW	10	7.50	6.88	129	Partly Cloudy
5/23	12:00	8.0	6.0	85	NW	5	7.25	6.75	125	Overcast
5/24	0:10	3.5	5.5	100	NW	5	7.50	6.75	125	Overcast

-Continued-

Appendix C. (page 3 of 6)

Date[a]	Time	Air (°C)	Water (°C)	Cloud[b] Cover (%)	Wind[b] Dir	Vel.[b] (Mph)	Trap Revolutions (rpm) Small	Large	Stream Gauge (cm)	Comments
5/24	12:10	6.0	6.0	20	NW	5	7.50	7.25	125	Mostly Clear
5/25	0:00	2.0	5.0	75	NW	10	7.50	7.25	123	Overcast
5/25	12:10	7.0	6.5	60	NW	5	7.50	7.00	120	Partly Cloudy
5/26	0:00	3.5	6.0	60	NW	5	7.50	7.25	118	Overcast
5/26	12:07	8.0	6.0	100		0	7.50	7.00	117	Overcast
5/27	0:00	5.5	5.5	100		0	7.50	7.00	117	Overcast
5/27	12:10	6.0	6.0	100	SE	5	7.50	7.00	115	Rain
5/28	0:15	5.5	5.5	100	SE	5	7.25	6.75	105	Rain
5/28	12:15	6.0	6.0	100	SE	10	7.00	7.00	105	Rain
5/29	0:00	4.5	5.5	20		0	7.25	6.75	105	Mostly Clear
5/29	12:00	9.5	6.0	60	NW	5	7.25	6.75	105	Overcast
5/30	0:00	9.0	6.5	100		0	6.75	7.00	100	Overcast
5/30	12:05	10.5	6.5	50		0	7.50	7.00	100	Partly Sunny
5/31	0:00	6.0	7.0	100		0	7.50	7.13	100	Overcast
5/31	12:07	8.5	6.5	70	SE	5	7.25	6.75	100	
6/1	0:00	5.0	6.0	30		0	7.25	7.00	100	Partly Cloudy
6/1	12:00	9.0	7.0	40		0	7.25	6.88	98	
6/2	0:00	6.0	7.0	20		0	7.25	6.75	100	
6/2	12:07	9.0	7.0	100		0	7.25	6.63	100	Overcast
6/3	0:01	6.0	6.6	100		0	7.25	6.63	100	Overcast
6/3	12:00	9.0	6.5	100	NW	5	7.25	6.50	105	Overcast
6/4	0:01	6.5	6.5	100	SE	5	7.25	6.50	100	Overcast
6/4	12:08	8.0	6.5	100	SE	5	6.75	6.50	98	Rain
6/5	0:05	7.0	6.0	100	SE	5	7.00	6.75	105	Rain
6/5	12:07	8.5	6.5	75	SE	5	7.25	6.75	98	Overcast
6/6	0:12	7.0	6.5	80		0	7.25	6.88	100	Partly Overcast
6/6	12:13	14.0	7.0	50		0	7.50	7.00	100	Partly Sunny
6/7	0:04	5.5	6.5	30		0	7.00	6.25	100	Mostly Clear
6/7	12:03	7.0	7.0	100	SE	5	7.00	6.63	100	Overcast

-Continued-

Appendix C. (page 4 of 6)

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
6/8	0:00	8.0	7.5	100	SE	5	6.75	7.00	95	Rain
6/8	12:02	11.0	7.5	100		0	7.00	7.00	95	Overcast
6/9	0:01	7.5	7.0	100	SE	5	7.25	7.00	103	Rain
6/9	12:04	13.0	7.0	60		0	7.75	7.13	105	Partly Sunny
6/10	0:00	7.0	7.0	100		0	7.50	7.25	105	Overcast
6/10	12:10	12.0	7.0	100		0	7.50	7.25	102	Overcast
6/11	0:02	12.5	7.0	100		0	8.00	7.50	103	Overcast
6/11	12:10	9.0	7.0	100	NW	5	8.00	7.63	104	Overcast
6/12	0:00	7.5	8.0	100	NW	10	7.75	7.5	108	Overcast
6/12	12:13	7.5	8.0	80	NW	5	8.00	7.63	108	Overcast
6/13	0:00	9.0	7.5	80	NW	5	8.50	7.88	110	Overcast
6/13	12:10	11.0	9.0	100	NW	5	8.50	8.00	112	Overcast
6/14	0:00	8.0	9.0	80	NW	5	8.75	8.00	120	
6/14	12:08	10.5	8.5	30	NW	5	9.25	8.25	118	Partly Sunny
6/15	0:01	9.0	8.0	25	NW	5	9.00	8.00	125	Mostly Clear
6/15	12:12	16.0	8.5	20	SE	5	9.00	8.00	120	Mostly Clear
6/16	0:00	10.0	8.5	100	SE	5	9.00	7.88	120	Overcast
6/16	12:03	11.0	8.5	100		0	9.00	7.75	117	Overcast
6/17	0:00	8.5	9.0	100		0	8.75	8.00	115	Overcast
6/17	11:58	13.0	9.0	50		0	8.25	7.88	113	Partly Sunny
6/18	0:14	10.0	8.5	100		0	8.50	8.00	112	Overcast
6/18	11:57	12.0	8.0	100	SE	5	8.50	7.88	111	Overcast
6/19	0:11	8.5	8.0	100		0	8.75	7.50	111	Overcast
6/19	12:30	10.0	9.0	85	NW	5	8.50	7.75	110	Overcast
6/20	0:15	8.5	8.5	100		0	8.50	8.00	110	Overcast
6/20	11:46	12.0	8.0	100		0	8.25	7.13	108	Overcast
6/21	0:40	7.5	9.0	100		0	8.50	7.50	108	Overcast
6/21	12:40	9.0	9.0	100		0	8.25	7.25	106	Rain
6/22	0:25	7.0	9.0	80	NW	5	8.00	7.00	102	Broken Overcast

-Continued-

Appendix C. (page 5 of 6)

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
6/22	12:25	12.0	9.0	85		0	8.00	7.00	100	Overcast
6/23	0:00	8.0	9.0	100	NW	5	7.75	7.00	102	
6/23	12:15	9.5	9.0	100	SE	5	7.50	7.25	102	
6/24	0:03	7.5	8.5	100	SE	5	8.25	7.00	102	Rain
6/24	12:04	11.0	9.0	100	NW	5	8.25	7.00	103	Overcast
6/25	0:30	9.0	9.0	100	SE	5	8.00	7.25	105	Overcast
6/25	12:05	10.5	9.0	100	NW	5	8.50	7.38	105	Overcast
6/26	0:13	8.5	9.0	100		0	8.50	7.25	105	Overcast
6/26	11:50	9.5	9.0	100		0	8.50	7.38	104	Overcast
6/27	0:09	8.5	9.0	100		0	8.50	7.75	105	Overcast
6/27	11:45	10.5	9.5	80		0	8.50	7.50	105	Overcast
6/28	0:13	9.0	9.0	75		0	8.50	7.38	108	Overcast
6/28	11:57	14.5	9.0	80		0	8.25	7.38	108	Overcast
6/29	0:10	9.0	9.0	100		0	8.50	7.50	105	Overcast
6/29	12:05	15.0	10.0	45	SE	5	8.00	7.38	104	
6/30	0:10	11.0	9.0	100	SE	5	8.25	7.50	104	Overcast
6/30	11:45	11.0	9.0	80	SE	5	8.00	7.38	104	Overcast
7/1	0:14	11.5	9.5	100	SE	5	8.00	7.25	102	Overcast
7/1	11:35	17.0	9.5	90	NW	5	8.75	7.50	105	
7/2	0:40	11.0	9.5	100		0	8.25	7.25	105	Overcast
7/2	12:02	18.0	10.5	10		0	8.50	7.75	103	Sunny
7/3	0:01	9.0	10.0	40	NW	5	9.00	7.75	107	Broken Fog
7/3	11:45	10.0	12.0	30	NW	10	8.75	7.75	100	Mostly Sunny
7/4	0:13	10.0	10.0	10		0	8.25	7.50	107	Clear
7/4	12:25	11.0	11.0	100		0	8.00	7.38	103	Overcast

-Continued-

Appendix C. (page 6 of 6)

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
7/5	0:02	10.0	10.0	100	SE	5	8.50	7.50	105	Rain
7/5	12:17	12.0	11.0	100	NW	10	8.75	7.63	105	Overcast
7/6	0:38	9.0	10.5	75	NW	5	8.50	7.50	105	Overcast
7/6	14:35	15.5	11.5	30		0	8.00	6.75	102	Clearing
7/7	0:10	11.0	11.0	80	NW	5	8.00	7.00	103	Overcast
7/7	12:57	11.5	11.0	15	NW	15	8.25	7.13	103	Mostly Clear
7/8	0:15	12.0	11.0	10	NW	5	8.00	7.00	101	Clear
7/8	12:13	12.0	12.0	10	NW	5	8.00	7.00	100	Mostly Clear
7/9	0:00	13.0	12.5	20	NW	10	8.00	6.75	100	Mostly Clear
7/9	12:09	13.5	13	60	NW	10	7.75	7.00	100	Broken Overcast

[a] Actual calendar dates.
[b] Based on observer estimates.

Appendix D. 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
Kevin Clark	ADF&G	Kodiak ADF&G Office	2
Nick Sagalkin	ADF&G	Kodiak ADF&G Office	1
Kenneth Bouwens	ADF&G	Kodiak ADF&G Office	3
Jim McCullough	ADF&G	Kodiak ADF&G Office	1
Eric Newland	ADF&G	Kodiak ADF&G Office	1
Hector Bravo	ADF&G	Kodiak ADF&G Office	1
Drew Crawford	ADF&G	Anchorage ADF&G Office	1