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ALASKA DEPARTMENT OF FISH AND GAME

SUSITNA AQUATIC STUDIES PROGRAM

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REPORT NO. 7 Part 1

RESIDENT AND JUVENILE ANADROMOUS FISH INVESTIGATIONS (MAY - OCTOBER 1984)

Project Leader: Dana C. Schmidt
Acting Project Leader: Stephen S. Hale
Editors: Drew L. Crawford
Stephen S. Hale, and
Dana C. Schmidt

Prepared for:

Alaska Power Authority
334 W. Fifth Avenue, Second Floor
Anchorage, Alaska 99501

PREFACE

This report is one of a series of reports prepared for the Alaska Power Authority (APA) by the Alaska Department of Fish and Game (ADF&G) to provide information to be used in evaluating the feasibility of the proposed Susitna Hydroelectric Project. The ADF&G Susitna Hydro Aquatic Studies program was initiated in November 1980.

The report covers studies of juvenile salmon and resident fish species of the Susitna River conducted from May through October 1984. In addition, some information on overwintering of resident fish radio-tagged in 1983 is included. The majority of the effort during the 1984 open-water season was on the lower river (from the mouth to the Chulitna River confluence). No studies were conducted this year in the area above Devil Canyon. This volume consists of four parts.

Part 1 (RSA Tasks 16A and 16B) covers the migration and growth of juvenile salmon. Coded wire tagging of chum and sockeye fry in the middle river (Chulitna River confluence to Devil Canyon) and collecting of all species of outmigrating fry at Talkeetna Station were similar to 1983 studies. In addition, a mark-and-recapture cold branding study was conducted in tributaries, sloughs, and side channels of the middle river to obtain an index of chinook and coho juvenile salmon abundance and residence time in these rearing areas. This study complements the coded wire tagging studies of chum and sockeye fry in the middle river. Also, outmigrant traps were operated at Flathorn Station (River Mile 22.4) near the mouth of the river to obtain a timing index of outmigration from the lower river.

Studies of the distribution and relative abundance of juvenile salmon and modelling of rearing habitat in the lower river are discussed in Part 2 (RSA Tasks 14 and 36). These studies were similar to those conducted in the middle river in 1983. Habitat suitability criteria developed for the middle river were used for the lower river unless evidence of different conditions in the lower river necessitated modifications. Habitat modelling results from 14 RJHAB model sites and 6 IFIM model sites are presented. The RJHAB and IFIM models were compared by using both at two sites.

Part 3 (RSA Task 14) contains the results of resident fish studies in both the middle and lower river. Monitoring of fish movement through use of radio tags was continued and index sites in the middle river were sampled as part of the long term monitoring effort. Population estimates for some species were made from multiple year mark-recapture data.

Part 4 (RSA Task 16A) is a statistical time series analysis of 1983 and 1984 discharge, turbidity, and juvenile salmon outmigration data in the middle river. This part represents the beginning of an effort to analyze, integrate, and summarize the five years of data collected by the Susitna Aquatic Studies Program. The final report on this five year summary will be completed a year from now.

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TITLES IN THIS SERIES

Report Number	Title	Publication Date
1	Adult Anadromous Fish Investigations: May - October 1983	April 1984
2	Resident and Juvenile Anadromous Fish Investigations: May - October 1983	July 1984
3	Aquatic Habitat and Instream Flow Investigations: May - October 1983	September 1984
4	Access and Transmission Corridor Aquatic Investigations: May - October 1983	September 1984
5	Winter Aquatic Investigations: September 1983 to May 1984	March 1985
6	Adult Anadromous Fish Investigations: May - October 1984	1985
7	Resident and Juvenile Anadromous Fish Investigations: May - October 1984	1985

Questions concerning this report should be directed to:

Alaska Power Authority
334 West 5th Avenue
Anchorage, Alaska 99501
Telephone: (907) 276-0001

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PART 1

THE MIGRATION AND GROWTH OF JUVENILE SALMON IN THE SUSITNA RIVER

THE MIGRATION AND GROWTH OF JUVENILE SALMON IN THE SUSITNA RIVER

Report No. 7, Part 1

by Kent J. Roth and Mike E. Stratton

Alaska Department of Fish and Game
Susitna Aquatic Studies Program
620 East 10th Avenue, Suite 302
Anchorage, Alaska 99501

ABSTRACT

Studies of adult salmon spawning, embryo incubation, and juvenile rearing are all critical in understanding the current habitat dynamics of the Susitna River but the final measure of the value of a reach of river to the freshwater life stages of salmon is the number and condition of the fry which outmigrate from the reach to the ocean. Baseline data on salmon outmigration have been collected at Talkeetna Station (RM 103.0) for the past three years. The data from 1982 and 1983 had shown that a substantial number of chinook, coho, and sockeye fry outmigrate from the middle river during their first summer. Because the majority of returning adults have spent at least one winter rearing in freshwater, an important question was whether these age 0+ fish overwintered in the lower river of had a low survival rate. To help answer this question, outmigrant traps were also operated near the mouth of the Susitna River (RM 22.4) during 1984. Mark and recapture studies gave population estimates for chum and sockeye fry (marked by coded wire tags) in the Susitna River above Talkeetna Station (middle river) and for chinook and coho fry (marked by cold branding) in Indian River and other sites. The cold branding study also monitored outmigration timing from Indian River and obtained estimates of juvenile chinook residence time in mainstem rearing areas. The Talkeetna River and Deshka River were also intermittently sampled to help explain the mainstem outmigrant trap data. Age 0+ chinook fry apparently outmigrate from the middle river upon reaching a critical size. A large proportion remain to overwinter and outmigrate during their second summer. Coho fry outmigrate at a wider range of lengths than chinook fry so the cumulative biomass of coho fry lags behind the cumulative numbers of individuals by one or two weeks. Age 0+ chinook and coho fry grow about 30 mm in length during the open-water season. Juvenile sockeye salmon appear to seek out lake-like rearing areas at a size of about 50 mm. The limited amount of this habitat in the middle river forces them to the lower river. The estimated middle river population size was 299,000 for age 0+ sockeye and 2,039,000 for chum fry. Chum fry feeding in the middle river was demonstrated by their growth and by analysis of stomach contents.

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1.0 INTRODUCTION

Studies of the migration and growth of juvenile salmon in the mainstem Susitna River are a part of the ongoing investigations being conducted by the Resident and Juvenile Anadromous Fish Project (RJ) of the Susitna Aquatic Studies Program. The scope of these studies has been to describe the periods of freshwater residence, growth, and timing of outmigration for juvenile salmon in the Susitna River and to provide population estimates for the reach of river between Talkeetna and Devil Canyon. This report presents the results of juvenile salmon outmigration studies conducted on the Susitna River between Cook Inlet and Devil Canyon during the 1984 open-water season. Five Pacific salmon species are addressed in this report: chinook (Oncorhynchus tshawytscha), coho (O. kisutch), sockeye (O. nerka), chum (O. keta), and pink (O. gorbuscha).

Investigations of the distribution, abundance, and migration of juvenile salmon during 1982 and 1983 were focused primarily on the Susitna River reach above the Chulitna River confluence (ADF&G 1983, Schmidt et al. 1984). These studies included the operation of stationary outmigrant traps at Talkeetna Station river mile (RM) 103.0, during 1982 and 1983 and a mark-recapture program for post-emergent chum and sockeye salmon fry using half-length coded wire tags in 1983 (Roth et al. 1984). These techniques have provided valuable information on the success of previous spawning runs, the effect of discharge on redistribution of young-of-the-year salmon juveniles, and estimates of population and survival for chum and sockeye salmon fry.

During the 1984 open-water season, additional tasks were added to further describe juvenile salmon growth, migration timing, and response to changing habitat conditions. The study area was expanded to include the entire river between Cook Inlet and Devil Canyon. New tasks begun in 1984 were the addition of stationary and mobile outmigrant traps at Flathorn Station (RM 22.4), intermittent trapping of migrating chinook salmon juveniles in the Deshka and Talkeetna rivers, and mark-recapture by cold branding of juvenile chinook and coho salmon in the Curry Station to Devil Canyon reach.

Investigations of the migration and growth of juvenile salmon above Talkeetna during 1982 and 1983 indicated extensive migration of pre-smolt juveniles of all species to areas below this reach. This migration of pre-smolt chinook salmon was also observed in the Deshka River in 1980 (Delaney et al. 1981). If this movement is common in the major tributaries entering the Susitna River, extensive rearing and growth of juvenile salmon, particularly chinook, may occur in habitats associated with the mainstem river. Small habitat changes in the reach of river below Talkeetna could impact large numbers of rearing salmon.

The combined studies of juvenile salmon growth and migration conducted during the 1984 open-water season were developed to provide data to meet the following objectives:

- o Estimate the timing, relative abundance, and size of outmigrating juvenile salmon in the Susitna River above the Chulitna River confluence.

- o Estimate the population of outmigrating chum and sockeye salmon fry and egg to outmigrant fry survival in this reach of river.

- o Estimate the timing and size of outmigrating chum salmon from the Talkeetna River.

- o Estimate the timing and rate of movement of juvenile chinook and coho salmon out of Indian River and their residence time at selected macrohabitats associated with the mainstem Susitna River.

- o Estimate the timing and rate of outmigration of chinook salmon juveniles from the Deshka River into the mainstem Susitna.

- o Estimate the timing and rate of outmigration of juvenile salmon from the Susitna River into Cook Inlet.

- o Estimate the rate of growth of juvenile chum and chinook salmon from the time they enter the lower river (below the Chulitna River confluence) until they enter the marine environment.

- o Estimate the effect of changes in mainstem Susitna discharge and other environmental variables on juvenile salmon outmigration.

Sampling of chum salmon fry in the Talkeetna River was hindered by equipment failure and insufficient data were collected for this species, although some growth and relative abundance data for chinook salmon were collected.

Although initially designed as a survey of Portage Creek using a stationary outmigrant trap, the cold branding study was relocated to Indian River with minnow traps serving as the primary collection technique. The design of the original collection equipment did not lend itself well to the continually fluctuating hydraulic conditions present at Portage Creek. The low numbers of juvenile salmon observed in Portage Creek after June 15 combined with the comparative logistical inaccessibility of this stream made Indian River a better choice for a study site.

Juvenile salmon outmigration timing and rates during 1984 for the reach of river between Talkeetna and Devil Canyon (middle river) are presented. Population and survival estimates are provided for chum and sockeye salmon fry migrating downstream of this reach, and data on population size and intrastream movements of juvenile chinook and coho salmon are also given. Length comparisons by species and study area are provided to show the growth of juvenile salmon for all the sites surveyed.

The data presented in this report will provide an index that can be used to determine the size of the present fishery resource, its potential loss caused by hydroelectric development, and the mitigation requirements necessary to compensate for any reductions of the juvenile salmon populations in the Susitna River.

2.0 METHODS

2.1 Study Locations

Studies on the migration and growth of juvenile salmon in the mainstem Susitna River were conducted at survey sites from Flathorn Station (RM 22.4) upstream to Slough 22 (RM 144.3) during the 1984 open-water season (Fig. 1).

2.1.1 Flathorn Station

A stationary outmigrant trap was operated on the west bank of the Susitna River at Flathorn Station (RM 22.4) and a mobile outmigrant trap was used to sample a total of ten points along transects spanning three channels of the mainstem river at this station (Fig. 2). Five sampling points were located in the west channel (RM 22.8), one in the middle channel (RM 22.8), and four in the east channel (RM 23.9). A bottom profile of the Susitna River at these sampling points is provided in Fig. 1A.

2.1.2 Deshka River

An outmigrant fyke net weir was operated in the Deshka River (RM 40.6) between tributary river mile (TRM) 2.5 and TRM 5.0 to estimate the timing and rate of outmigration for juvenile chinook salmon (Fig. 3).

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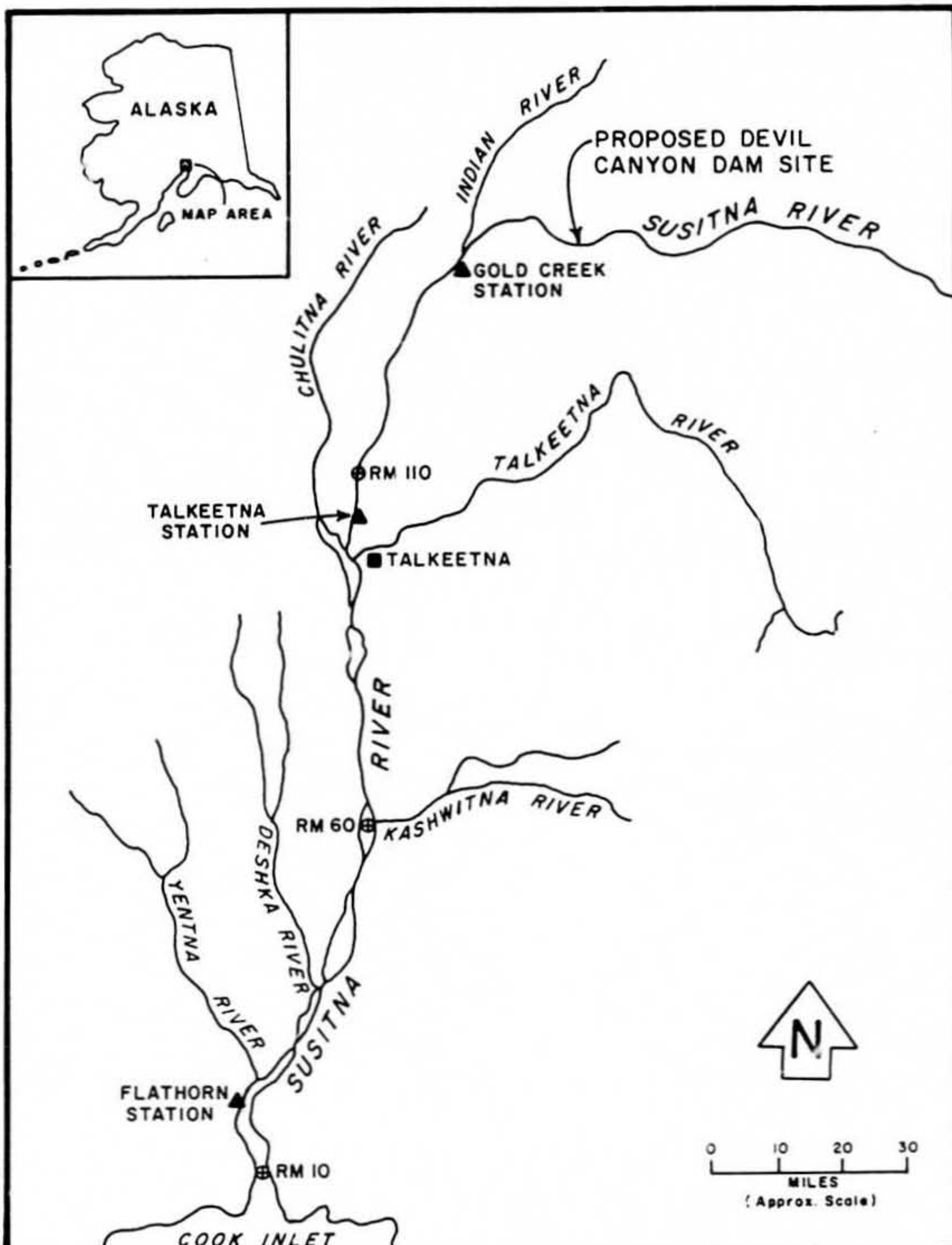

Figure 1. Map of juvenile salmon outmigration study field stations in the Susitna River basin, 1984.

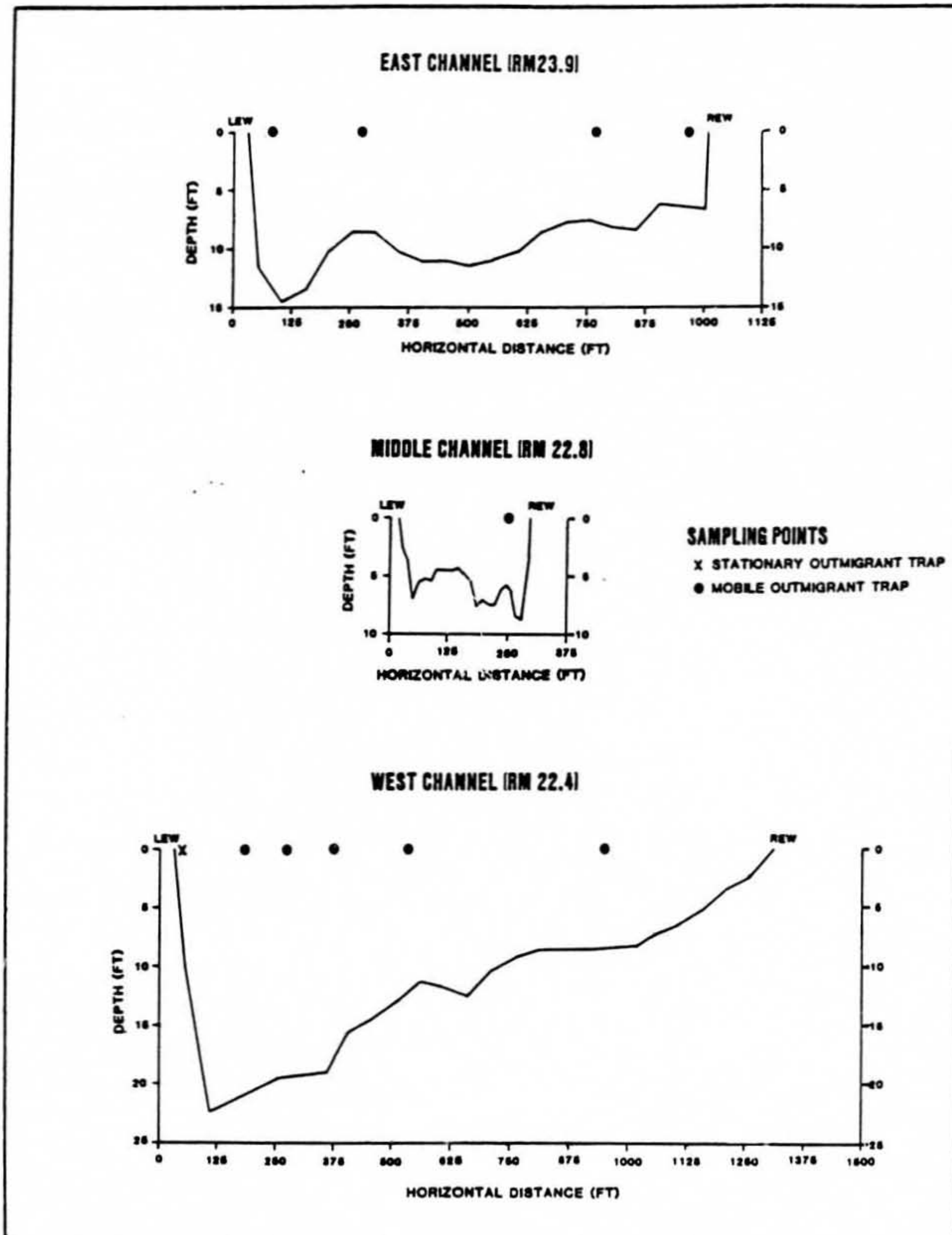

Figure 1A. Bottom profile of the Susitna River at the stationary and mobile outmigrant trap sampling points at Flathorn Station. Measured on August 23, 1984 at a mainstem discharge of 114,000 cfs at the USGS gaging station at Susitna Station.

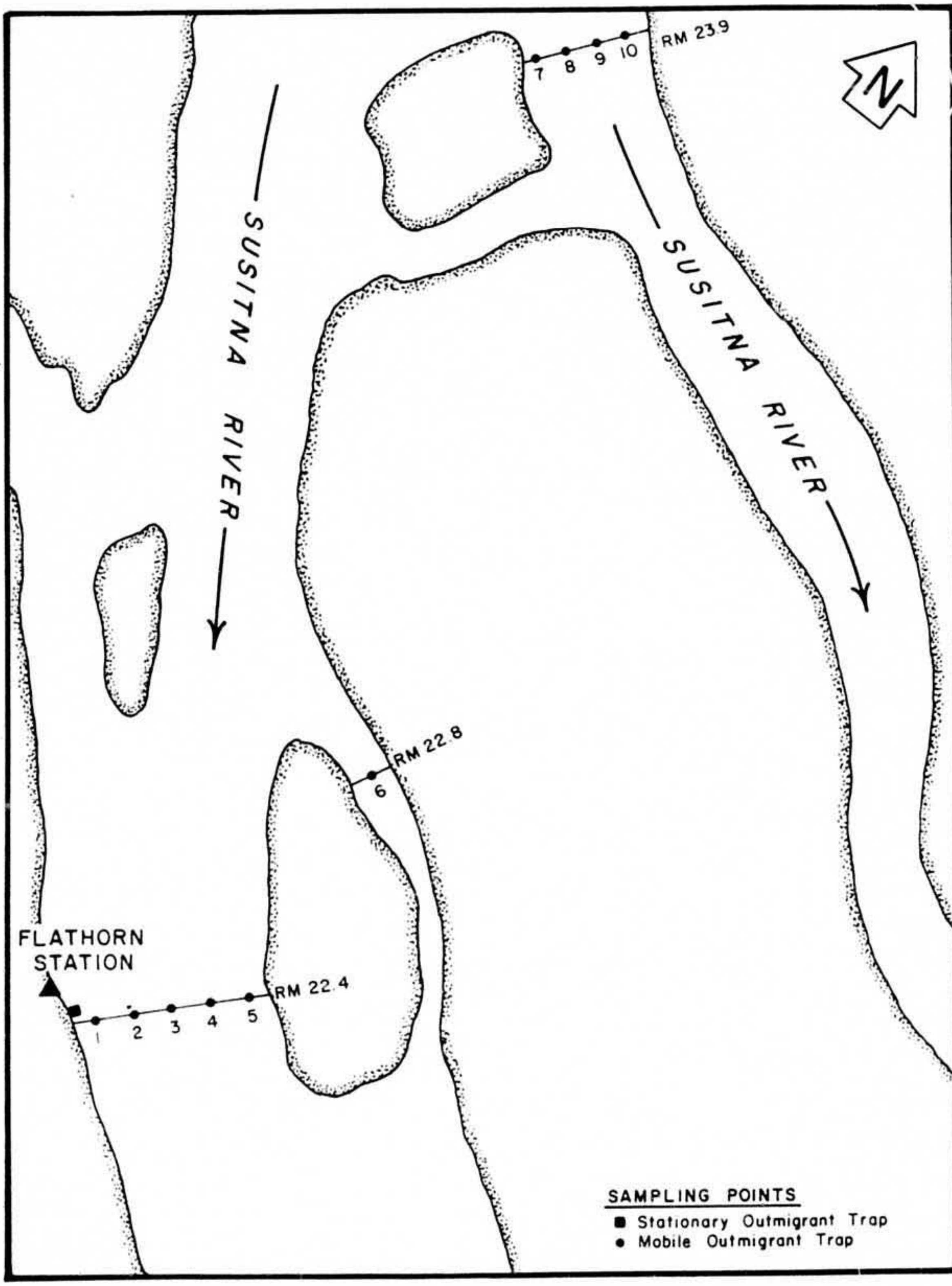

Figure 2. Map of the stationary outmigrant trap and the mobile outmigrant trap sampling points on the Susitna River at Flathorn Station, 1984.

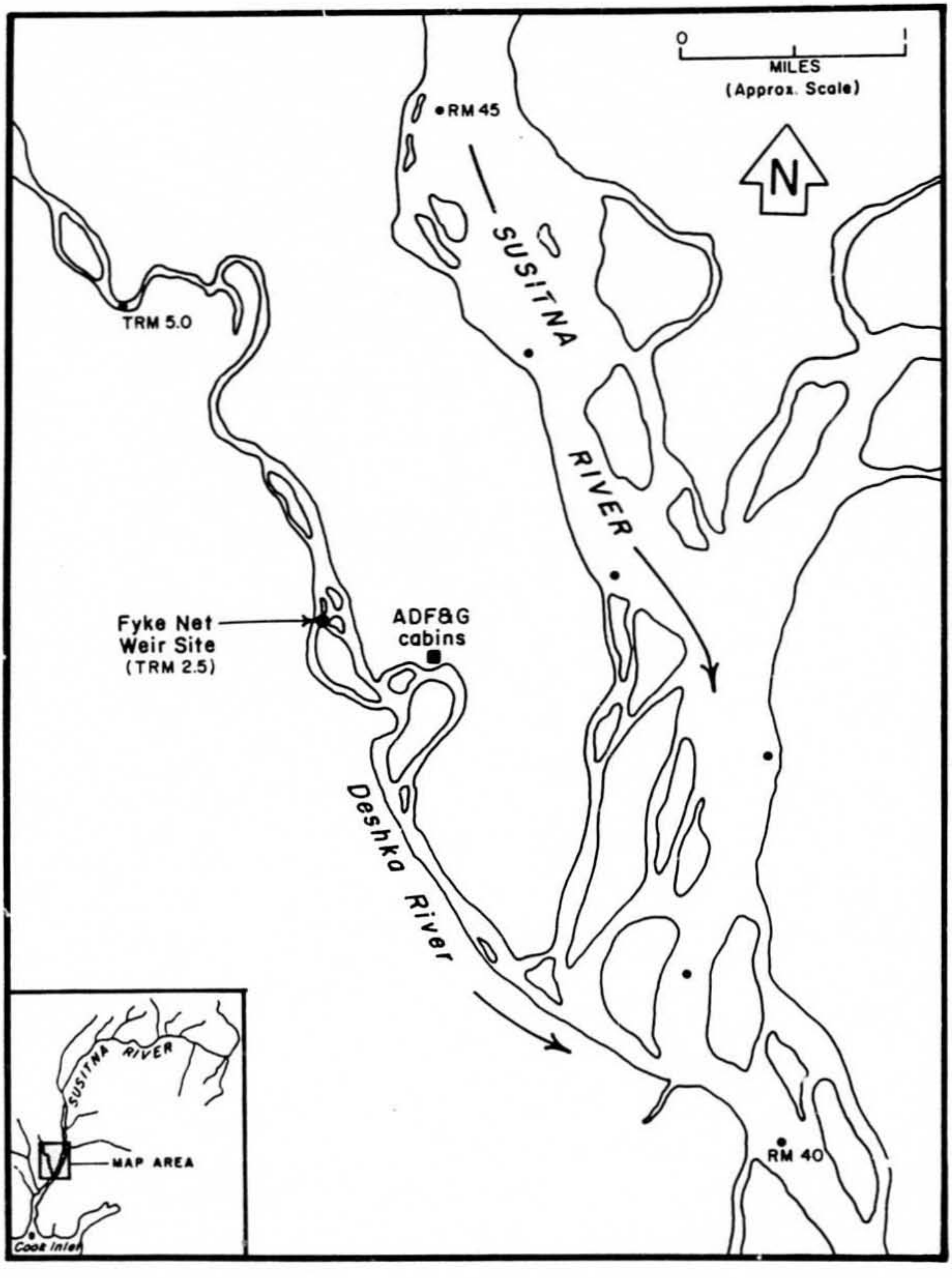

Figure 3. Map showing the location of the fyke net weir on the Deshka River, 1984.

2.1.3 Talkeetna River

A beach seine sampling site for outmigrants was located in the north channel of the Talkeetna River (RM 97.5) approximately one mile upstream from the river's mouth (Fig. 4).

2.1.4 Talkeetna Station

Two stationary outmigrant traps were deployed on the mainstem Susitna River above the Chulitna River confluence at Talkeetna Station (RM 103.0) at the same locations used in 1983. One trap was set off the east bank (Trap 1) and the other off the west bank (Trap 2) of the river (Fig. 4).

2.1.5 Coded wire tagging

Coded wire tagging sites were selected from those locations above the Chulitna River confluence where high density spawning by adults was recorded (Barrett et al. 1984), and from surveys of the availability of sufficient numbers of post-emergent chum and sockeye salmon fry for collection and tagging (Fig. 4). Specific coded wire tagging sites (Fig. 4A) were:

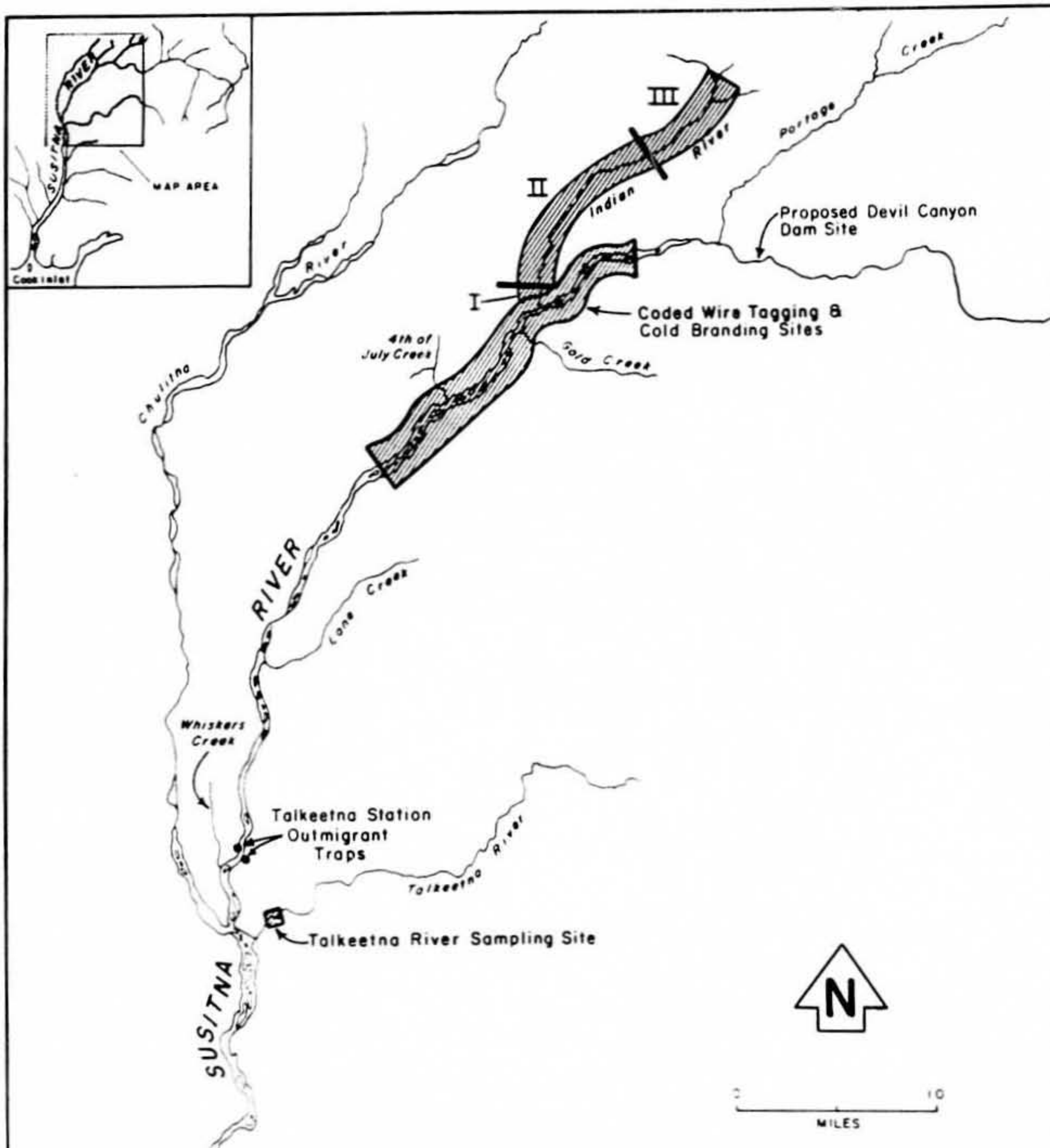

Figure 4. Map showing the reach where juvenile salmon mark-recapture sites are located (RM 122.2 to 144.8 and Indian River) and the locations of the Talkeetna stationary outmigrant traps (RM 103.0), and the Talkeetna River sampling site (TRM 1.0), 1984.

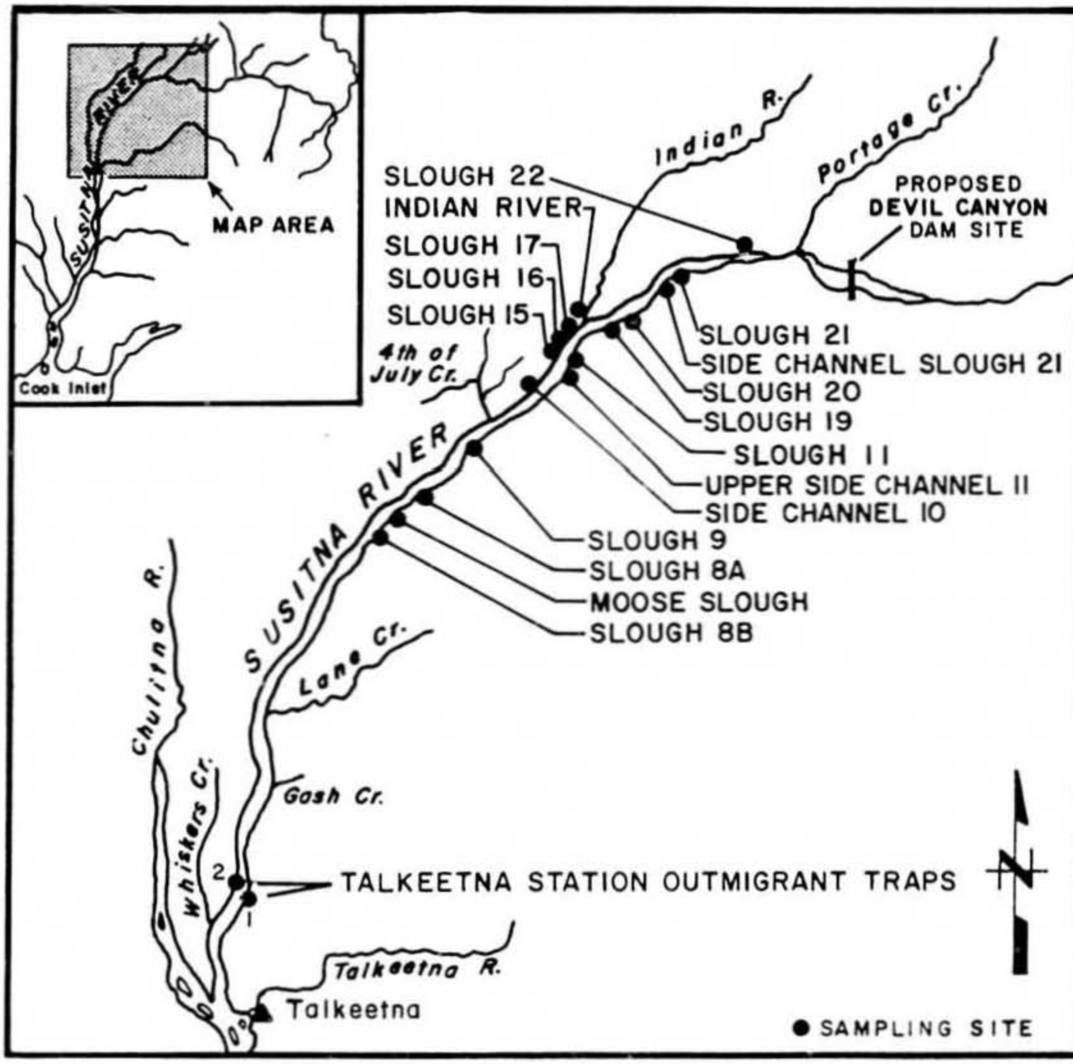

Figure 4A. Map of coded wire tagging and cold branding sites in the middle reach of the Susitna River, 1984.

CODED WIRE TAGGING SITES	RIVER MILE
Slough 8B	122.4
Slough 8A	125.3
Slough 9	129.2
Slough 11	135.3
Slough 15	137.3
Indian River	138.6
Slough 20	140.1
Slough 21	142.0
Slough 22	144.3

2.1.6 Cold branding

A cold brand mark-recapture study was conducted at the mouth and at numerous side channels and side sloughs of Indian River (RM 138.6) which were found to contain large concentrations of juvenile chinook and coho salmon. Indian River was divided into three sections for this study. Section I included the mouth upstream to TRM 0.5, Section II was the portion of Indian River from TRM 0.5 to 7.5 and Section III was from TRM 7.5 upstream to TRM 12.3 (Fig. 4).

Cold branding was also used to estimate the populations and study the movements of juvenile salmon at the following study sites (Fig. 4A):

COLD BRANDING SITES	RIVER MILE
Moose Slough	123.2
Side Channel 10	133.8
Upper Side Channel 11	135.9
Slough 16	137.7
Slough 17	138.9
Slough 19	139.7
Slough 20	140.1
Side Channel Slough 21	141.1
Slough 22	144.3

2.2 Field Data Collection and Recording

2.2.1 Flathorn Station outmigrant traps

The stationary outmigrant trap on the west bank of the Susitna River at Flathorn Station (RM 22.4) was operated from May 20 through October 1, 1984. A description of this outmigrant trap is provided in ADF&G (1985). The trap was checked at least twice each day to remove the captured fish and to clean the trap.

The mobile outmigrant trap at Flathorn Station was operated for approximately 20 days each month from July 12 through September 13, 1984. A description of the trap and its operation is presented in ADF&G (1985). The trap was fished for 20-minute periods at ten different transect points during a fishing day.

Habitat and biological data recorded for each check of the stationary outmigrant trap included fishing effort (hours), trap depth (feet), distance from shore (feet), and catch by species and age class. Mainstem stage was recorded once each day. The first 25 fish of each species and age class collected daily were measured for total length (tip of snout to tip of tail) in millimeters (mm).

Biological and habitat data for the stationary trap were entered directly into an Epson HX-20 microcomputer in the field. Operational procedures for the microcomputer and the associated data form program are presented in ADF&G (1985). Computer entries were made for each trap check throughout the field season. Printouts and cassettes were periodically transferred to Data Processing to be entered into a mainframe computer for later data retrieval and analysis.

Transect number, fishing effort, total water column depth, set velocity, and drift velocity (if the trap was not held stationary during the set) were recorded for each individual transect point at which the mobile outmigrant trap was fished. Total catch by species and age class was also recorded, and total length measurements were taken for all captured fish. Data were recorded on a field data form for later analysis.

2.2.2 Deshka River outmigrant weir

A weir was established on the Deshka River (RM 40.6) using a fyke net (3/16 inch square mesh) to block a portion of the river. The fyke net is described in ADF&G (1985). The weir was operated at varying tributary miles (TRM 2.0 - 5.0) periodically from May 10 through June 22. The weir was moved to TRM 2.5 on July 11 and was fished periodically through September 18. Minnow traps were fished intermittently from late June through mid October to supplement the weir data.

Fishing effort and total catch by species and age class were recorded for the outmigrant weir and the minnow traps. A sample of each species and age class captured were measured for total length and scale samples were collected for age determination.

2.2.3 Talkeetna River beach seining

Beach seining (1/8 inch square mesh) was conducted one to two times each week from June 5 through September 15. Sampling was conducted to obtain a sufficient sample for comparative length and outmigration timing data.

Total catch by species and age class was recorded. All captured fish were measured for total length and released.

2.2.4 Talkeetna Station outmigrant traps

Two inclined plane outmigrant traps were operated continuously in the mainstem Susitna River at Talkeetna Station (RM 103.0) from May 14 through October 6, 1984 using the methods outlined by Roth et al. (1984).

Measurements of the following habitat parameters were recorded daily at the outmigrant traps: air and surface water temperature (°C), turbidity (NTU), water velocity (ft/sec), and mainstem stage data. The equipment and methods used to collect the habitat data are given in ADF&G (1985).

Trap fishing depths and distances from shore were adjusted to maximize catches and minimize mortalities. All juvenile fish captured were anesthetized using MS-222 (Tricaine methanesulfonate). Field specimens were identified using the guidelines set forth by McConnel and Snyder (1972), Trautman (1973), and Morrow (1980). Juvenile chinook and coho salmon collected at the traps were checked for a cold brand mark and all recovered marks were recorded. Chum and sockeye salmon juveniles with a clipped adipose fin were passed through a detector to verify the presence of a coded wire tag. All coded wire tagged fish recovered at the traps were preserved and tags were late removed and decoded using a reading jig and a binocular microscope. All other fish recovered at the traps were held until anesthetic recovery was complete and then released downstream of the traps.

Scales were collected from a representative sub-sample of fish captured for comparison to length frequency data for final age class determination. Biological and habitat data were entered directly into an Epson HX-20 microcomputer.

Length and weight relationship data were also collected from samples of juvenile chinook, coho, and sockeye salmon collected in the outmigrant traps at Talkeetna Station. Total length was recorded to the nearest millimeter and live weights were determined to the nearest 0.1 grain.

2.2.5 Coded wire tagging

The coded wire tagging was conducted at Slough 11 (RM 135.3) from May 16 through June 20, 1984. The fish were transported from the collection areas to Slough 11 in an aerated tub, tagged, held for at least 24 hours, and then returned to the collection areas. The fish were also held overnight at the collection areas prior to release.

The primary fish collection techniques were beach seines which were used to weir off the downstream end of the collection area. These weirs were checked at least once each day to collect fish and remove debris. Beach seining and dip netting supplemented the weir catches at sites where weiring alone did not provide enough fish for the tagging operation.

The coded wire tagging equipment and implantation procedures are similar to those outlined by Roth et al. (1984) using the guidelines provided by Koerner (1977) and Moberly et al. (1977). One-half length binary coded wire tags measuring 0.02 inches (0.533 mm) in length and 0.01 inches (0.254 mm) in diameter were used in the study. The captured fish were separated by species and length prior to tagging. Physical differences between fish required the use of separate head molds for each species and length class. Fifty fish of each group were measured for total length to determine the proper head molds for the tagging procedure.

The adipose fin was clipped from each fish prior to tagging to provide a visual indicator of the presence of a coded wire tag. At the end of each tagging day, a subsample of 100 tagged fish were anesthetized and passed through the quality control device to determine the tag retention rate. Mortalities were recorded the following day and just prior to release. A single tag code was used for each species tagged and for each collection site. Six distince tag codes were used for juvenile sockeye salmon and fourteen distinct tag codes were used for juvenile chum salmon.

Coded wire tagging data recorded at each site included date tagged, tag code, species, number of fish tagged, percent tag retention, mortality, and date and time of release. Total numbers of fish tagged by species, collection site, and release date as well as final tag retention and mortality were tabulated for each tag code.

2.2.6 Cold branding

Mark-recapture studies using cold branding were conducted from July through mid October. Sites in Indian River were sampled twice a month and fish were captured, branded, and released continually throughout the field season. Sampling in the sloughs and side channels of the Susitna River was conducted for five consecutive days and captured fish were either branded and released the same day or held until the end of the five day period before release.

Primary collection techniques were minnow traps, beach seines, and dip nets. Captured fish were transported from the areas of collection to the Gold Creek field camp for cold brand marking. Cold branded fish from all sites except Indian River were held for 24 hours to determine marking mortality before being released at the area of collection. Fish collected in Indian River were marked, held for 24 hours, and then released at a side slough at TRM 7.2.

The brands consisted of single brass letters or symbols measuring approximately three millimeters in height which were soldered onto threaded brass caps. Liquid nitrogen was used as the cooling agent and the branding procedures were similar to those outlined by Raleigh et al. (1973). The cold branding equipment is described in ADF&G (1985).

Juvenile chinook and coho salmon were marked with a distinctive brand to signify the collection site and date of their capture. Fish were marked on one side of the body at one of three target branding areas (Fig. 5), and a branding time of two seconds was used.

Date, collection site, gear type, fishing effort, species, number of fish captured, and brand symbol were recorded for each site. The number of recaptures by species and the symbols for previously marked fish were also recorded. Total length was measured for 50 fish of each species during each sampling trip.

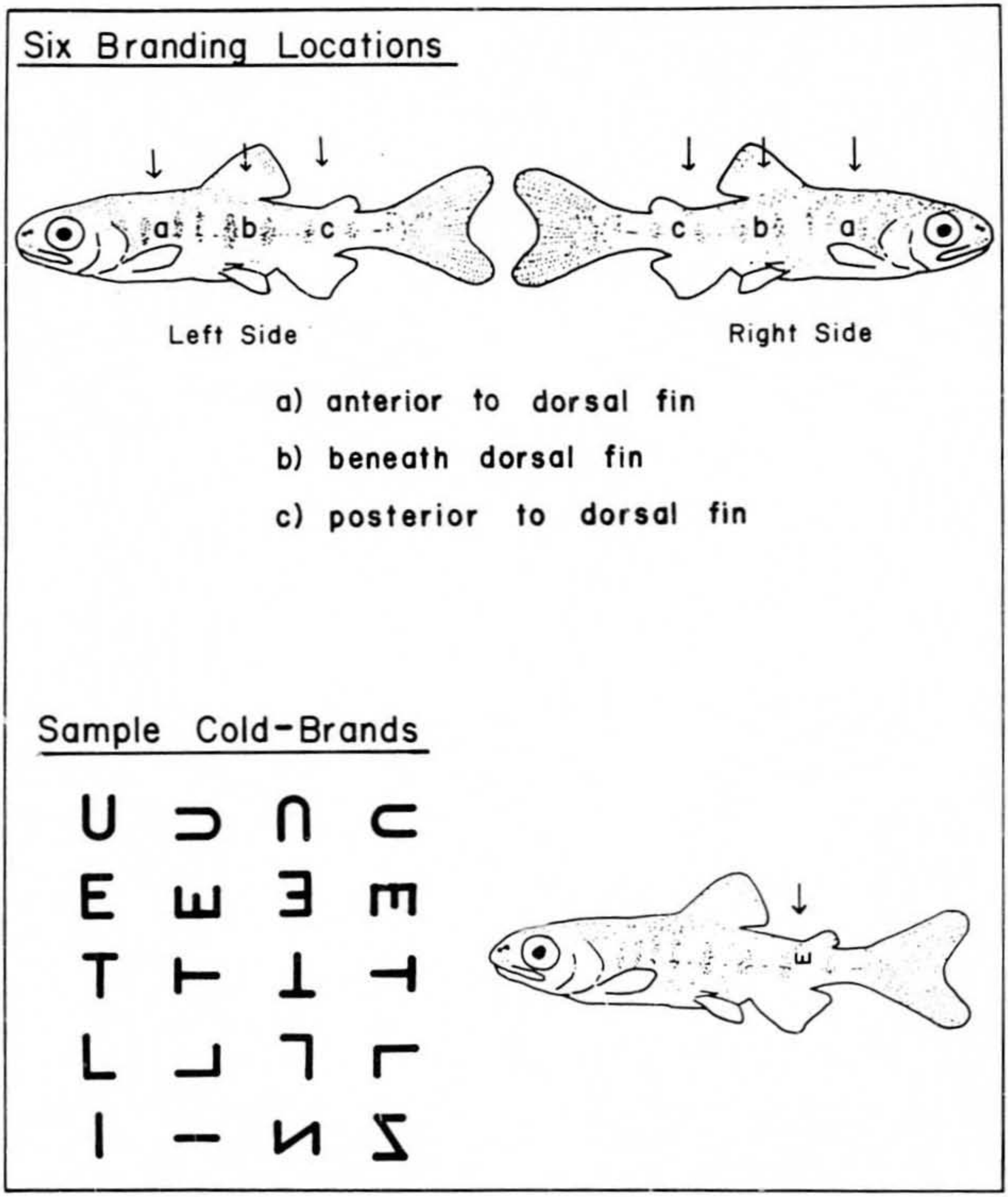

Figure 5. Branding locations and sample brands used for cold branding chinook and coho salmon juveniles, 1984.

2.3 Data Analysis

2.3.1 Juvenile salmon catch per unit effort

The catch per unit effort (CPUE) data collected for juvenile salmon at the stationary outmigrant traps are presented as the average catch per hour for each calendar day of sampling effort. The catch was expanded to 24 hour intervals by dividing the number of hours fished on a given day into 24 and then multiplying this ratio by the catch for each species and age class.

The catch rates plotted for each species and age class of juvenile salmon collected at the stationary traps were smoothed using the von Hann linear filter (Dixon et al. 1981). The equation is:

$$Z_{(t)} = \tfrac{1}{4}Y_{(t-1)} + \tfrac{1}{2}Y_{(t)} + \tfrac{1}{4}Y_{(t+1)}$$

where: $Z_{(t)}$ = smoothed catch per hour for day (t) and

$Y_{(t)}$ = observed catch per hour for day (t)

This is similar to a three day moving average except that the current day is weighted twice as heavily as the preceding and subsequent days.

The cumulative catch totals were adjusted for days not fished by tabulating the mean of the total catches recorded for the three days preceding and the three days following an unsampled day.

Length frequency distribution and scale analysis data were used to determine the age class composition of chinook, coho, and sockeye salmon juveniles.

Weights were converted to grams and the data entered into a linear regression computer program to provide the length/weight relationship for each species. These data were used to provide estimates of the total biomass passing the Talkeetna and Flathorn station outmigrant traps by sampling period through the season.

2.3.2 Population and survival estimates

Potential egg deposition for chum and sockeye salmon was calculated by multiplying the average fecundity for each species by the estimated number of female spawners that passed Curry Station in 1983 (Barrett et al. 1984). The chum, sockeye, and chinook salmon adult population estimates were reduced by 40%, 39%, and 7% respectively, to account for milling fish which eventually spawned below the Chulitna River confluence (Barrett 1984; Barrett et al. 1984). The following formula was used to determine egg deposition:

Total potential egg deposition = (E) x (1-M) x (P) x (F)

where:

E = Adult population estimate at Curry Station

M = Percent milling

P = Percent females

F = Average fecundity

Population estimates for chum and sockeye outmigrants were calculated by the Schaefer (1951) method. Estimates of survival for both species were determined by dividing the population estimates by the calculated potential egg deposition for each species. Only valid tagged fish were used in the calculations. The total number of valid tagged fish was determined by subtracting the mortalities for each day of tagging from the total number of fish tagged and then multiplying this by the tag retention rate. Total tag recoveries at the Talkeetna Station outmigrant traps include only those fish with a coded wire tag. Fish having a clipped adipose fin but no tag were not considered in the population estimates.

Population estimates for chinook and coho salmon were calculated from the data collected during the cold branding study using the Petersen (Chapman 1951) or Schaefer (1951) methods, or by comparing catch per unit efforts. Egg-to-fry survival for chinook salmon in Indian River was extrapolated using the technique listed above for determination of chum and sockeye survival except that the estimate of egg deposition was reduced to represent the percentage of chinook (determined from peak spawning counts) which spawned in Indian River. Fecundities used were those measured by Healy and Heard (1984) for Kenai River and Cook Inlet chinook salmon.

2.3.3 Environmental variables

Results of a statistical time series analysis of discharge, turbidity, and age 0+ chinook and sockeye salmon outmigration are presented in Part 4 of this report.

3.0 RESULTS

The results of the juvenile salmon outmigration studies are presented by species. The catch per unit effort (CPUE) data are presented as a percentage of the highest CPUE (after smoothing) recorded at the stationary traps during 1984. The cumulative catch data are presented as a percentage of the total adjusted cumulative catch after application of the smoothing functions. Juvenile salmon length data collected at Flathorn Station are from both the stationary and mobile traps and the length information presented for Talkeetna Station is from both the stationary traps located at this site.

3.1 Chinook Salmon

3.1.1 Catch per unit effort

3.1.1.1 Age 0+

Chinook salmon fry were collected incidentally during the coded wire tagging study in May and June. As chum and sockeye fry were targeted in the coded wire tagging study, chinook catch rates were not recorded. Chinook fry were observed to be most abundant at Slough 22 and Indian River.

The cold branding study captured 26,823 chinook salmon fry in Indian River from July 1 through October 15. Fifty eight percent of this catch was recorded near the mouth of the river (section I), 30% in the lower portion (section II) and 12% in the upper portion (section III). Beach seining of sections II and III during July captured 3,280 chinook salmon fry; 66% in section III and 34% in section II. Minnow trapping begun in Indian River in late July collected a total of 23,543 chinook fry during 947 minnow trap days (defined as one trap day for each overnight minnow trap set) for a season average of 24.9 fish per trap day.

Catch rates in Indian River (Fig. 6) were generally highest in section II except during late August when high and turbid water conditions reduced trapping effectiveness. The CPUE for chinook fry in Indian River for all sections combined was highest during late July (average of 36 fish per trap day) and steadily declined through the season to a low of 15 fish per trap day in early October.

A total of 11,875 chinook salmon fry were captured in sloughs and side channels in the middle reach of the Susitna River during the cold branding study from July 1 through October 15. Sloughs accounted for 84% of the catch while the remaining 16% were collected in side channels. Beach seining during July and August collected 39% of the total catch at these sites while minnow trapping begun in early September captured 61% of the chinook fry.

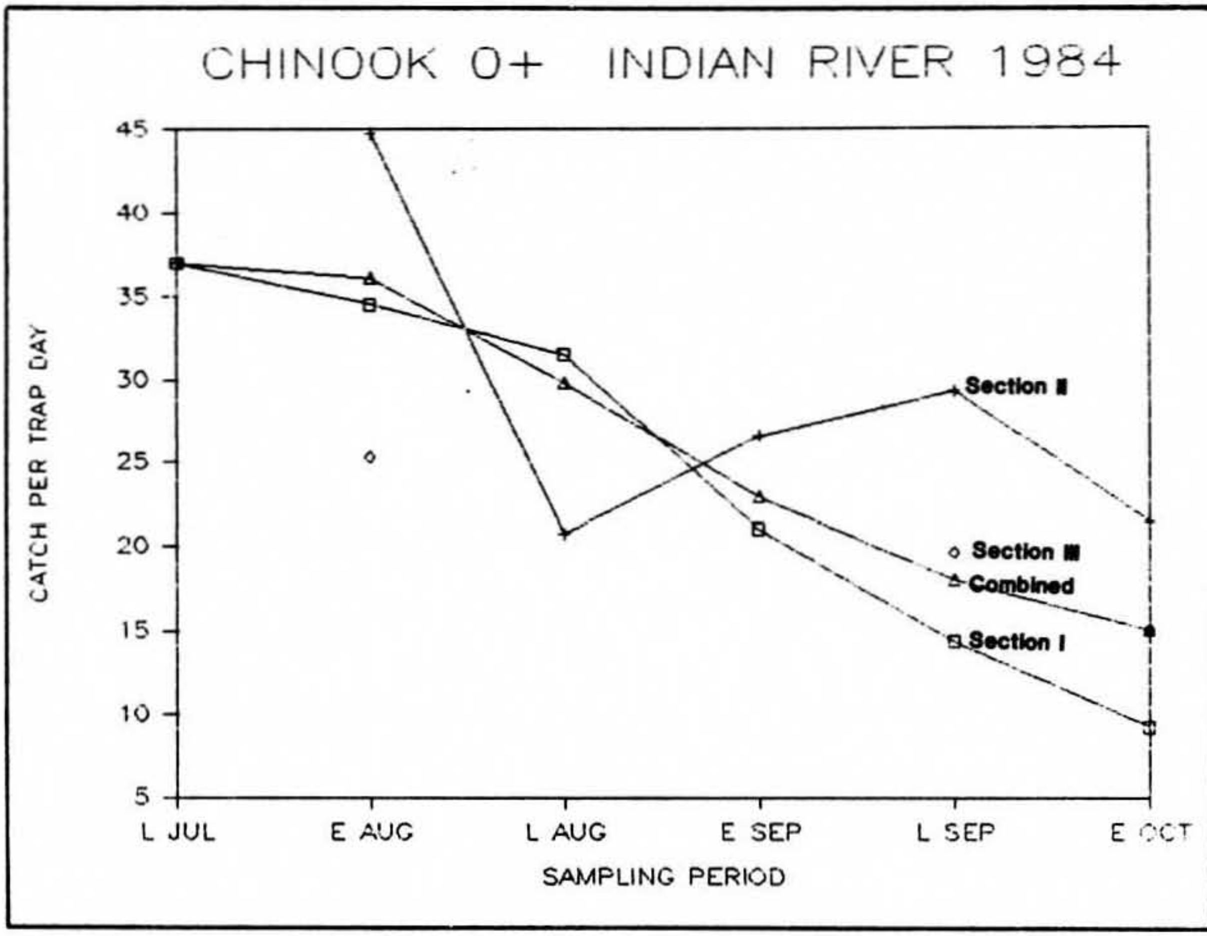

Figure 6. Chinook salmon (age 0+) average catch per minnow trap by sampling period and survey section in Indian River, 1984.

The 7,291 chinook salmon fry captured by minnow trapping at slough and side channel sites in the middle river were collected during 378 minnow trap days for an average of 19 fish per trap day. Mean CPUE by study site ranged from a high of 48 fish per trap day at Slough 22 during early October to a low of 3 fish per trap day at Side Channel 21 in late September.

A total of 14,110 chinook salmon fry were collected at the Talkeetna Station outmigrant traps. Peak catches were recorded from late June through early August and the highest catch rate of 17.3 chinook fry per hour was recorded on July 26 (Fig. 7). Fifty percent of the catch was recorded by July 20. Catches decreased after early August and the last capture of chinook fry at this site was recorded on September 29.

A total of 2,118 chinook salmon fry were captured in the stationary outmigrant trap at Flathorn Station. Catch rates were greatest between late June and late August (Fig. 8). The chinook fry catch rate at this site peaked at 7.8 fish per hour on July 23, 50% of the captures were recorded by July 13, and the last capture was recorded on September 30.

The highest catch rate of the Flathorn Station mobile trap was 16.2 fish per hour, recorded on July 23 (Fig. 9). Of the 189 chinook fry collected in the mobile trap during 1984, 60% were captured at bank transect sampling points and the remaining captures occurred at center channel sampling sites (Fig. 10).

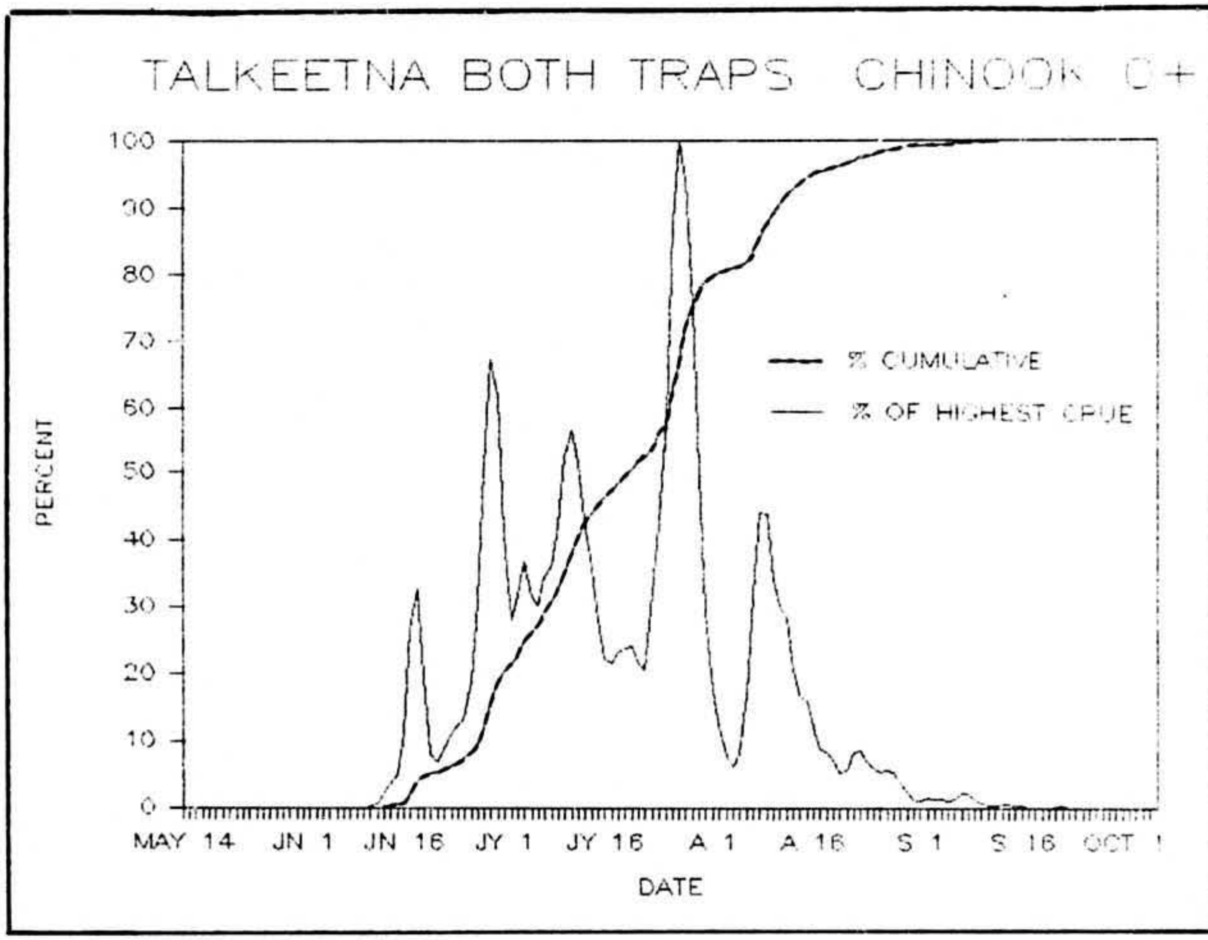

Figure 7. Chinook salmon (age 0+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

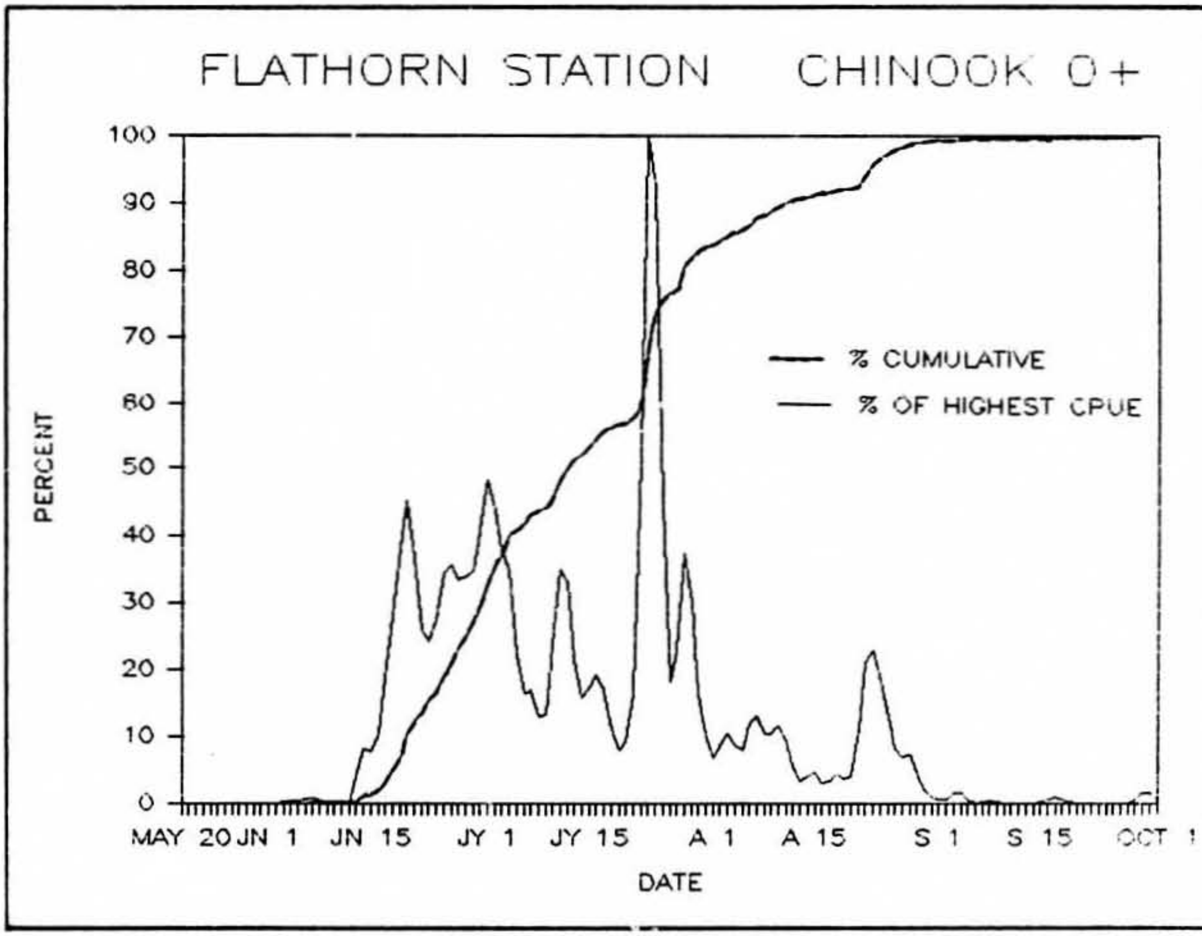

Figure 8. Chinook salmon (age 0+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant trap, May 20 through October 1, 1984.

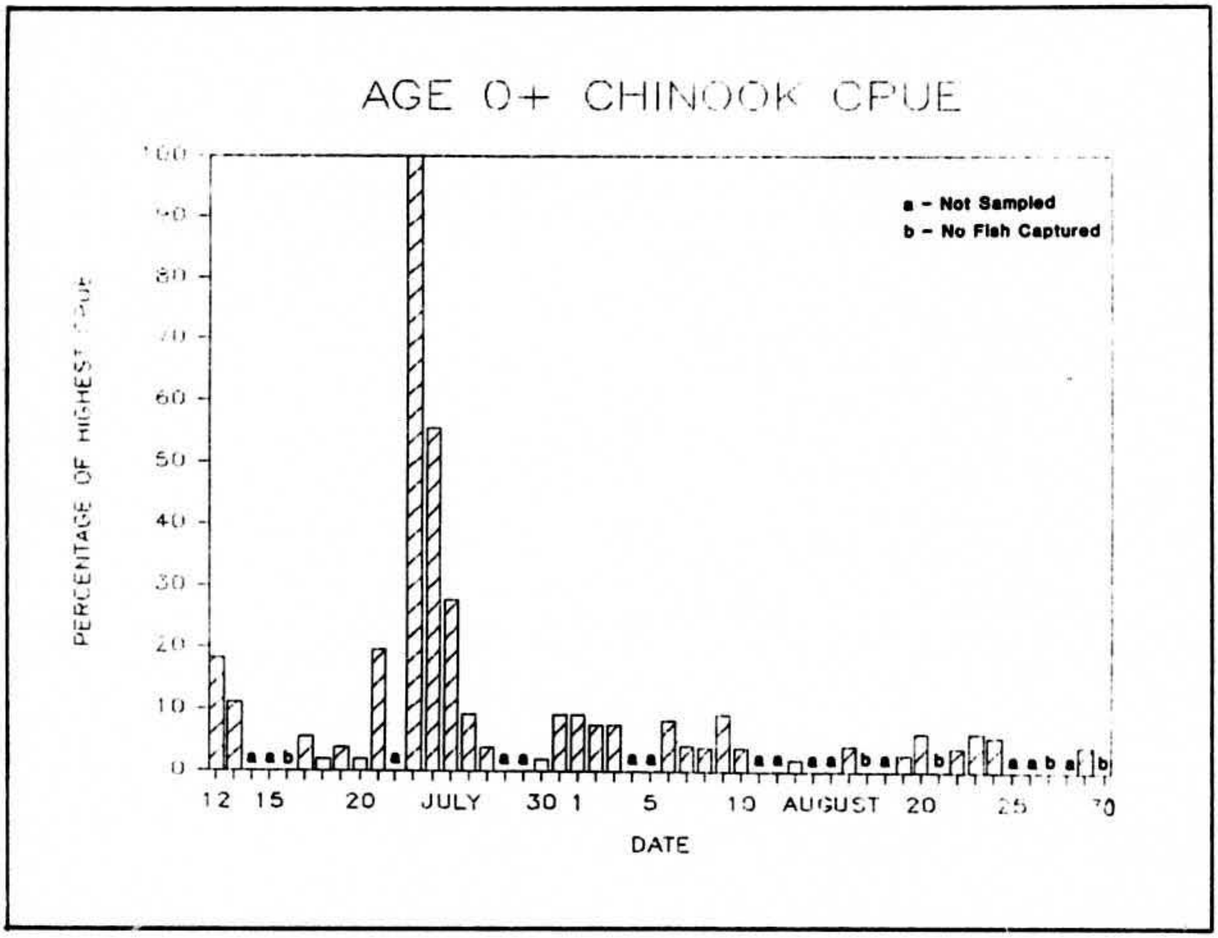

Figure 9. Chinook salmon (age 0+) daily catch per unit effort recorded at the Flathorn mobile outmigrant trap, July 12 through August 30, 1984.

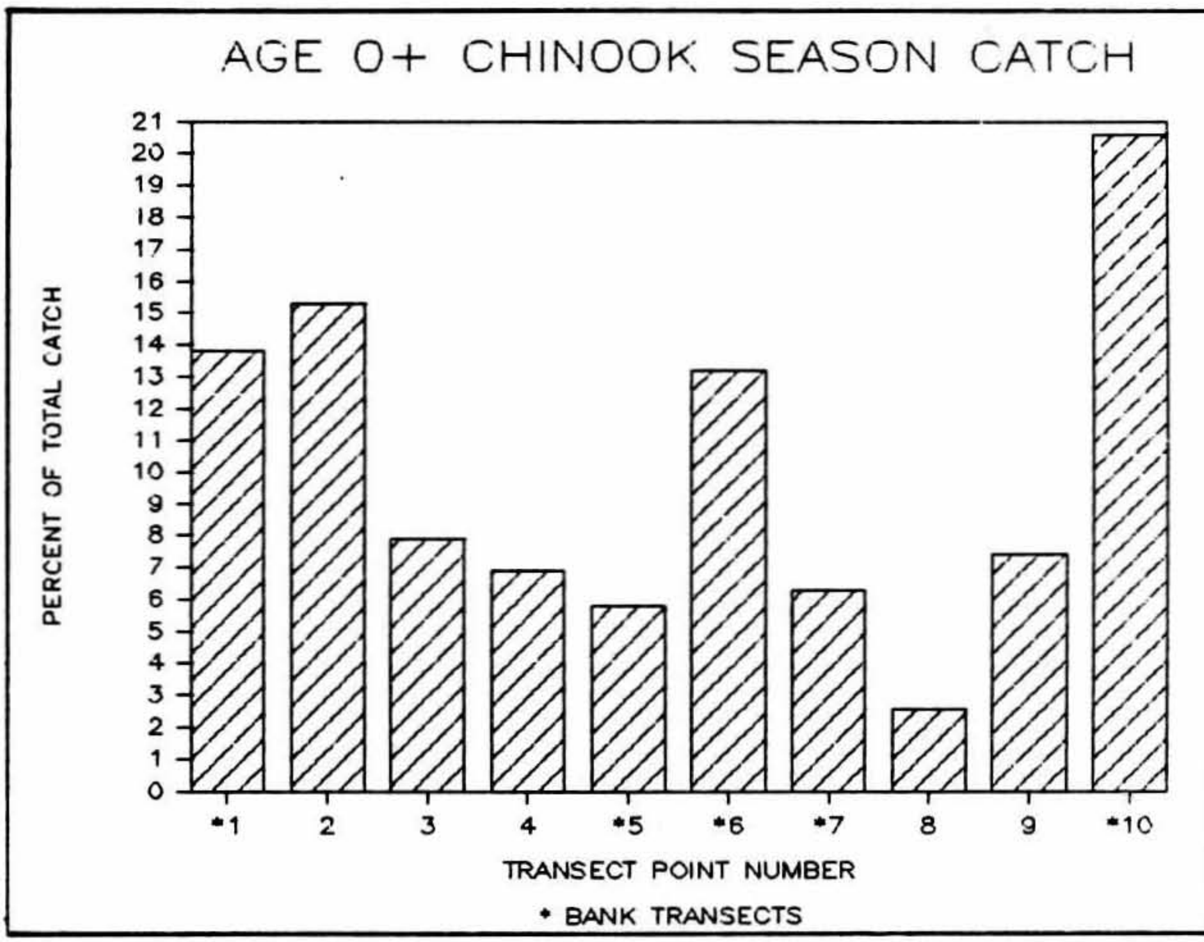

Figure 10. Chinook salmon (age 0+) percent of total catch by sampling point recorded at the Flathorn mobile outmigrant trap, 1984.

The Deshka River weir captured 1,808 chinook salmon during 1984 (Appendix Table A-1). Eighty-eight percent of the captures were recorded during July and the peak catch rate of 21.2 fish per hour was recorded on July 25. Minnow trap catches at this site were highest during late June at 8.7 fish per trap (Appendix Table A-2).

A total of 1,356 chinook salmon fry were collected in the lower reach of the Susitna River by the Juvenile Aquatic Habitat Studies (JAHS) surveys from June through early October (see Part 2 of this report). Catch rates for all sites combined peaked in August and then decreased through early October (Fig. 11).

3.1.1.2 Age 1+

Age 1+ chinook salmon were captured incidentally during the coded wire tagging study in May and June and were most abundant at Indian River and Slough 11. No age 1+ chinook were captured during the cold branding study begun in July, as most of these fish had outmigrated by that time.

Peak catch rates of the 1,321 age 1+ chinook captured at the Talkeetna Station outmigrant traps were recorded during the deployment of the traps in mid May and again in mid and late June (Fig. 12). Fifty percent of the season catches occurred by June 23. The highest catch rate for this age class was 3.6 fish per hour recorded on May 15 and the last age 1+ chinook was captured in the traps on August 7.

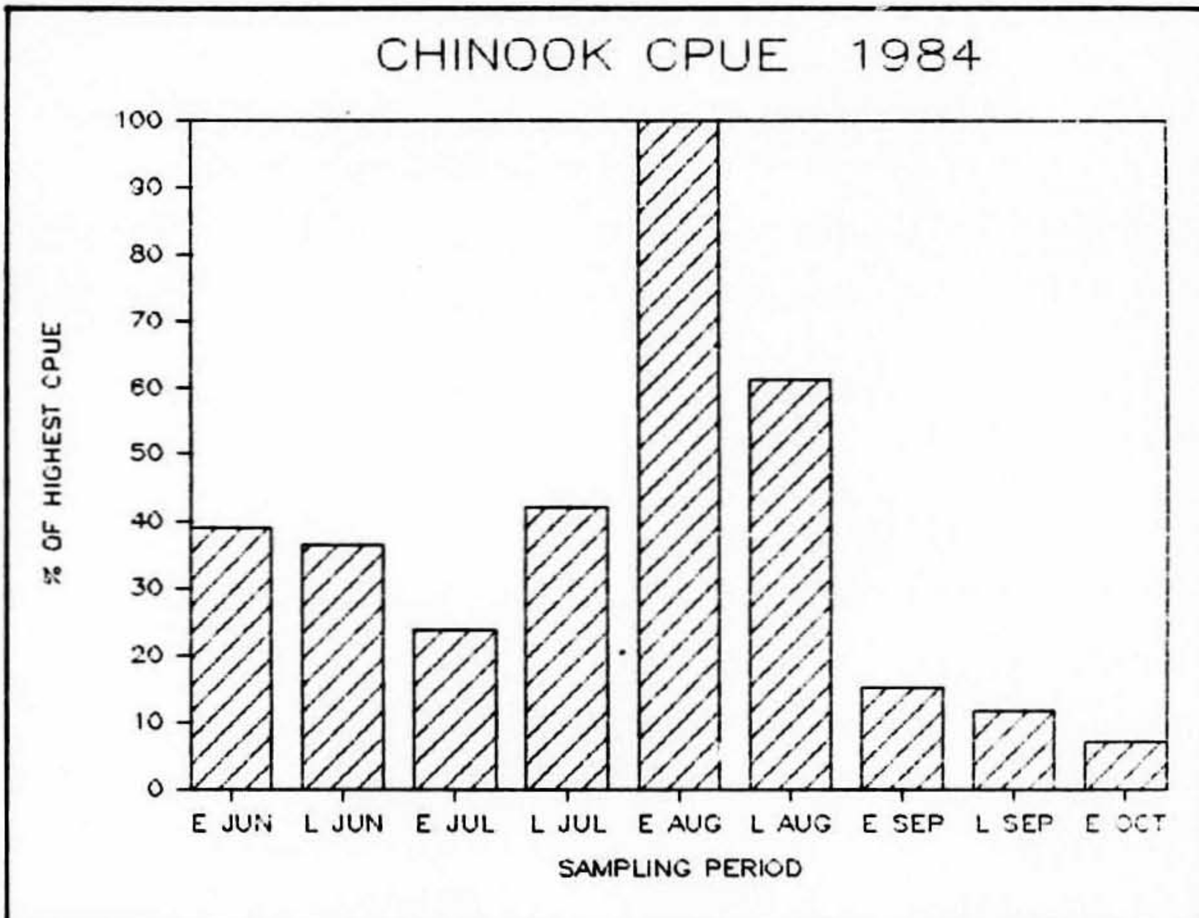

Figure 11. Chinook salmon (age 0+) catch per unit effort by sampling period recorded at JAHS sites in the lower reach of the Susitna River, 1984.

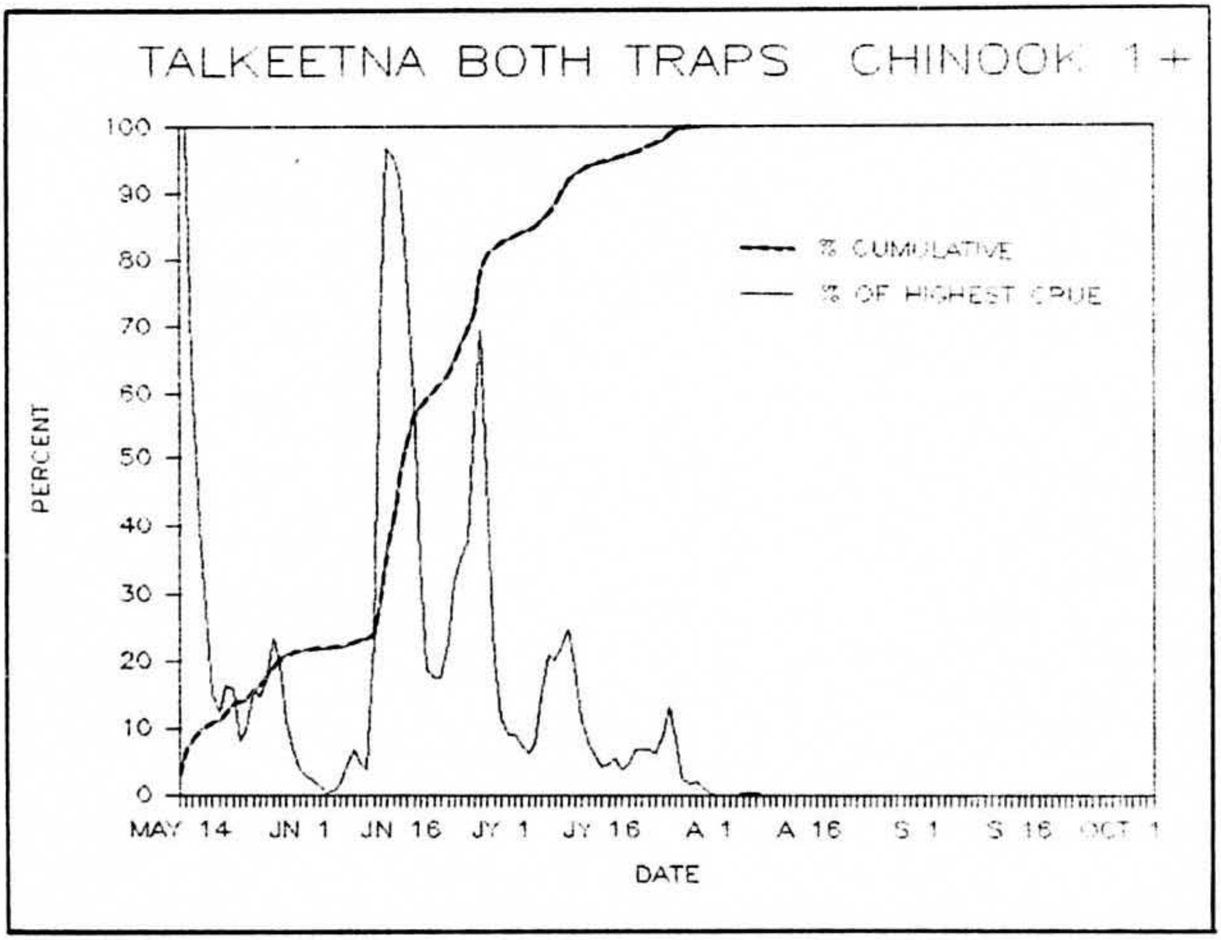

Figure 12. Chinook salmon (age 1+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

Catch rates for the 346 age 1+ chinook salmon captured at Flathorn Station were highest during early June (Fig. 13). The highest CPUE of 6.4 fish per hour was recorded on June 14 (50% of the season total by this date) and the last age 1+ chinook was collected at this site on August 23.

Nine age 1+ chinook salmon were collected in the Deshka River during weir and minnow trap sampling, with the last capture recorded on October 10.

3.1.2 Growth

3.1.2.1 Age 0+

Chinook fry collected between Talkeetna and Devil Canyon (middle river) averaged 43 mm during late May and showed a steady growth through the season to a mean length of 64 mm by early October (Fig. 14). Age 0+ chinook collected between Cook Inlet and Talkeetna (lower river) during the same period averaged consistently larger than fry collected in the middle river. Chinook fry in the lower river increased from a mean length of 41 mm in late May to 75 mm in early October. The number of fish measured, mean length, and range of lengths by sampling period for chinook salmon fry are presented for each data collection area in Appendix Table A-3 and A-4.

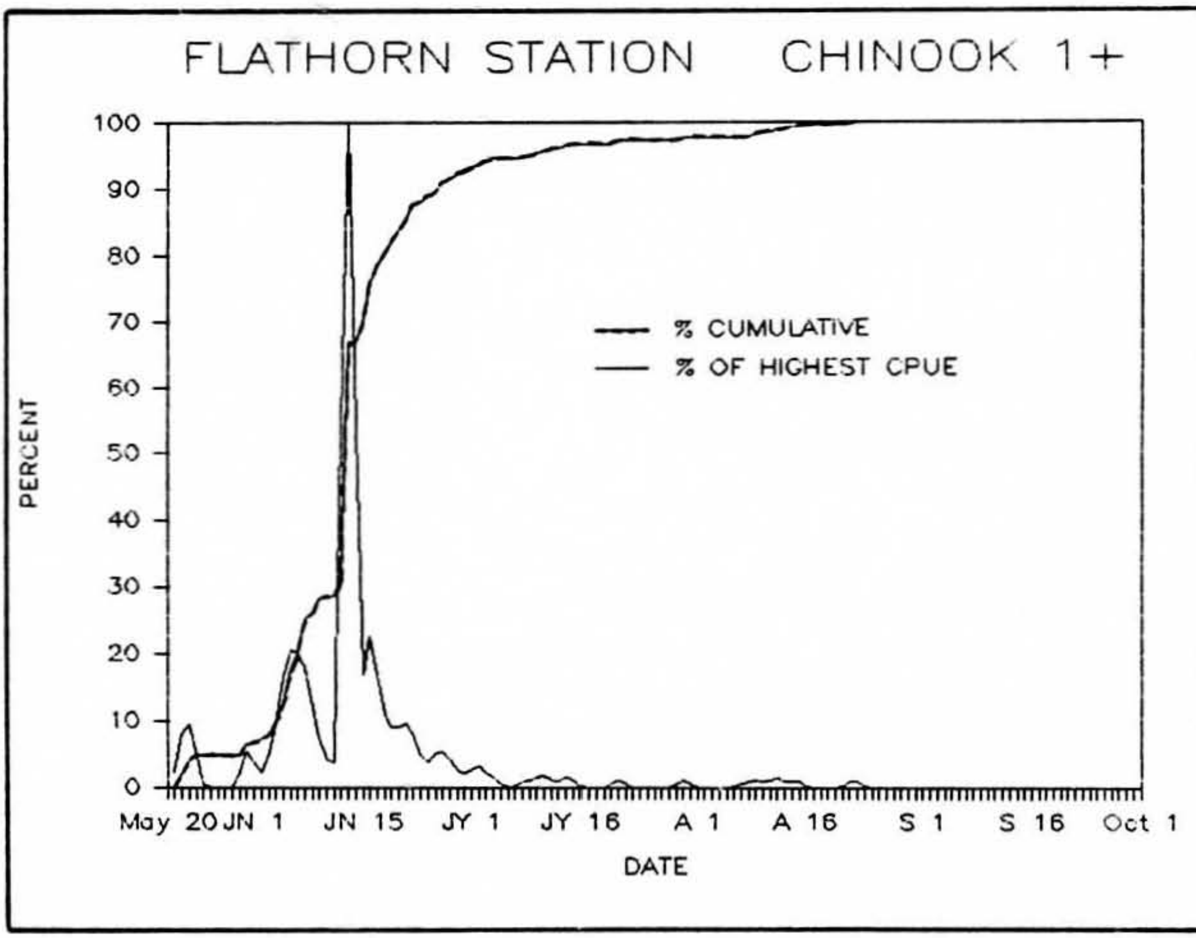

Figure 13. Chinook salmon (age 1+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant trap, May 20 through October 1, 1984.

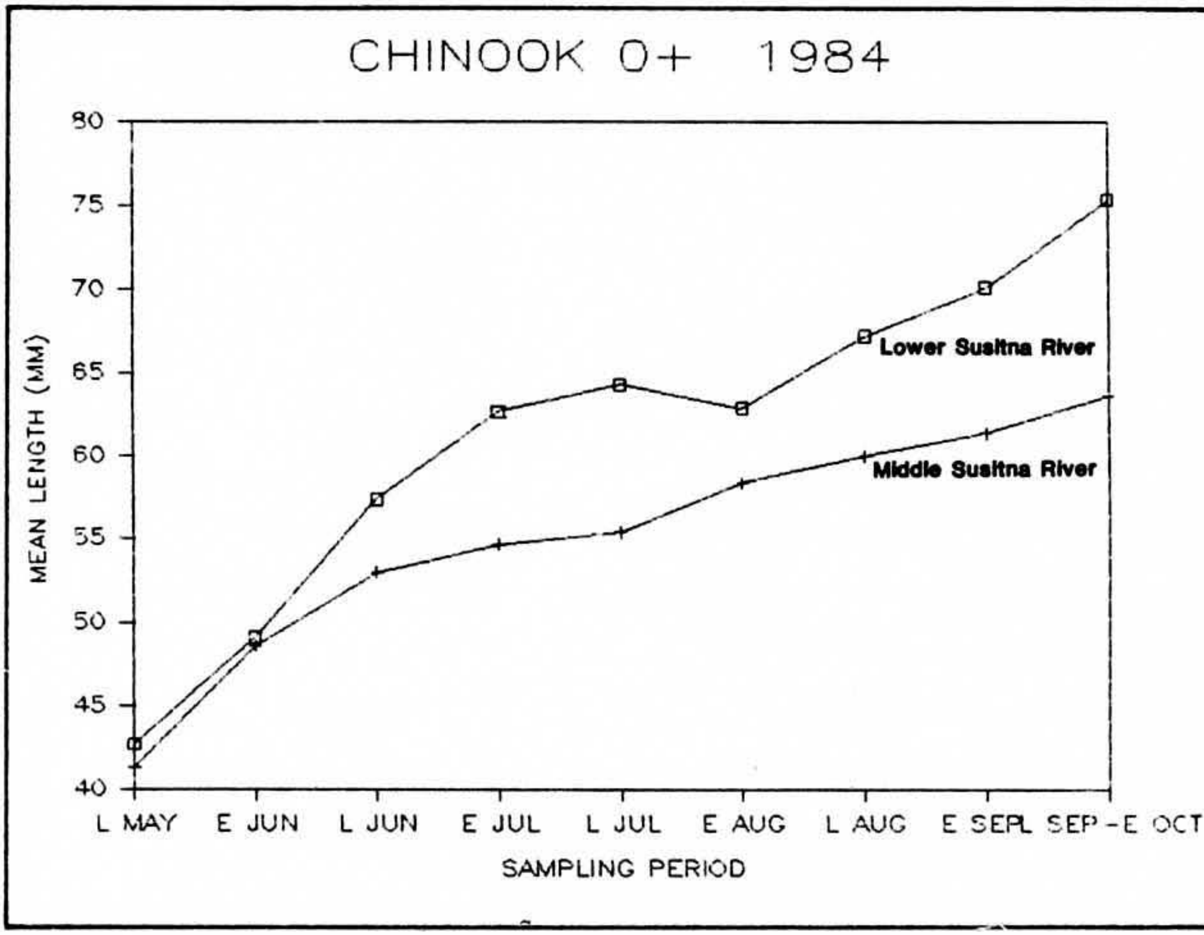

Figure 14. Chinook salmon (age 0+) mean length and range of lengths by sampling period for fish collected in the lower and middle reach of the Susitna River, 1984.

3.1.2.2 Age 1+

Age 1+ chinook salmon for all sites sampled averaged 78 mm during May and the mean length increased to 90 mm during early June. Average lengths for this age class stayed the same through late July by which time most of the age 1+ chinook had migrated out of the Susitna River.

A sample of juvenile chinook was measured at Talkeetna Station to provide a relationship between length and weight for fish passing this site (Fig. 15).

3.1.3 Cold branding

A total of 23,406 chinook salmon fry were cold branded in Indian River between July 1 and October 15, 1984 (Table 1). One hundred forty-seven of these marked fish were later recaptured in Indian River, five were captured in the Talkeetna Station outmigrant traps, and five were captured below Indian River in side channels and sloughs associated with the mainstem Susitna River. The time between release of marked chinook fry in Indian River at TRM 7.2 and their subsequent recapture at the mouth of this tributary ranged from nine to 70 days with a mean of 30 days. The five chinook fry branded in Indian River which were collected in the outmigrant traps at Talkeetna Station averaged 17 days between release and recapture with a range from 8 to 26 days.

A total of 9,802 chinook salmon fry were cold branded in sloughs and side channels in the middle river between July 1 and October 15. Of

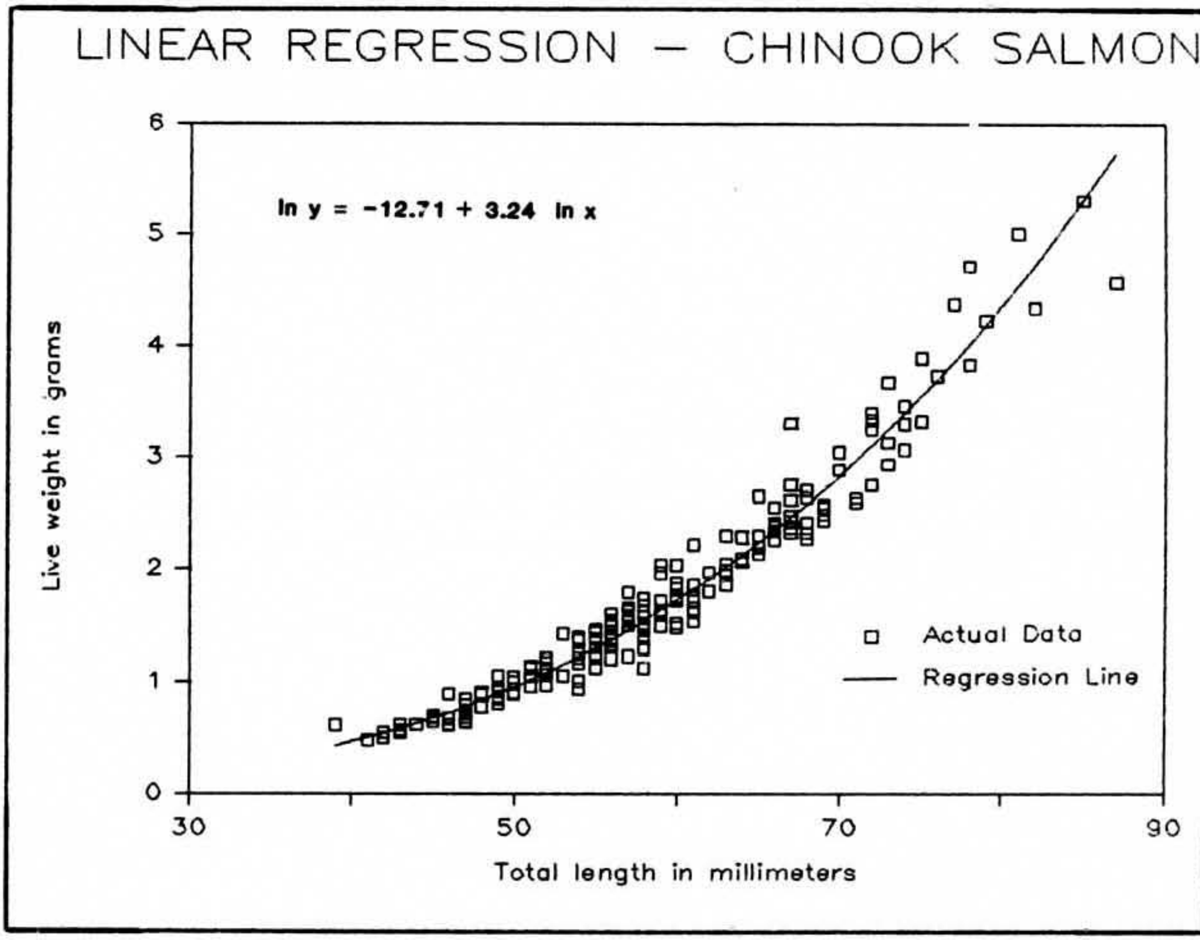

Figure 15. The linear regression of the weight/length relationship for juvenile chinook salmon collected at the Talkeetna stationary outmigrant traps, 1984.

Table 1. The number of chinook salmon fry marked and recovered in Indian River by sampling period, 1984.

Marking Period	Number of Fish Marked	Recapture Period						Total
		July 16-31	August 1-15	August 16-31	Sept. 1-15	Sept. 16-30	Oct 1-15	
July 1-15	2,093	26	10	5	2	3	3	49
July 16-31	1,924	-	5	4	5	5	2	21
August 1-15	6,735	-	-	8	17	8	8	41
August 16-31	3,806	-	-	-	4	5	2	11
September 1-15	5,492	-	-	-	-	17	7	24
September 16-30	3,356	-	-	-	-	-	1	1
TOTALS	23,406	26	15	17	28	38	23	147

these fish, 643 (6.6%) were later recaptured; 631 in the same slough they were originally marked and released, six fish in sloughs and side channels downstream from their release sites, four fish in the Talkeetna Station traps and two fish at sites upstream from their points of release. The branded chinook fry collected in the Talkeetna outmigrant traps averaged 12 days between release and recapture with a range from 8 to 17 days.

3.1.4 Population estimates

Females comprised 43.9% of the estimated population of 8,450 adult chinook salmon (greater than 350 mm) which passed Curry Station in 1983 (confidence intervals (C.I.) of 5,700 to 13,150 fish). Indian River chinook comprised 26.9% of the peak spawning survey counts (Barrett et al. 1984). An estimated 10,635,000 eggs were deposited in Indian River during 1983 which provided a total production of 3,211,000 chinook salmon fry during 1984, a survival rate of 30.2% (C.I. - 19.4 to 44.8%). The calculations used in the Schaefer estimate of population for chinook fry in Indian River are provided in Appendix B.

Population estimate experiments were conducted at four sloughs and three side channels in the middle river during the cold branding study (Table 2). Populations were estimated at a high of 47,050 chinook fry in Slough 22 to a low of 3,420 in Upper Side Channel 11.

Table 2. Chinook salmon fry, population estiamtes by site for sloughs and side channels surveyed in the Susitna River above the Chulitna River confluence, 1984.

Sampling Site	Branding Dates	Recapture Dates	Estimate Method	Population Estimate
Upper Side Channel 11	7/19 - 8/1	7/30 - 8/2	Schaefer	3,420
Side Channel 10	7/16 - 7/19	7/17 - 7/20	Schaefer	7,630
Moose Slough	8/8 - 8/11	8/9 - 8/12	Schaefer	4,990
Slough 22	9/8 - 9/13	10/8	Petersen	47,050
Slough 19	8/29	9/26	Petersen	4,550
Side Channel 21	9/24 - 9/26		CPUE Index	3,700
Slough 20	10/8 - 10/12		CPUE Index	13,800

3.2 Coho Salmon

3.2.1 Catch per unit effort

3.2.1.1 Age 0+

Juvenile coho salmon were observed during the coded wire tagging study to be most abundant at Indian River. Catch rates were not recorded. The cold branding study collected 1,548 coho salmon fry in Indian River from July 1 through October 15. Of this catch, 31% of the coho were captured in Section I, 44% in section II and 26% in section III. Beach seining of sections II and III during July captured 444 juvenile coho salmon; 76% in section II and 24% in section III. Minnow trapping begun in late July captured 1,129 juvenile coho salmon during 947 minnow trap days for a season average of 1.2 coho per trap day. Of these catches, 43% were recorded in the lower section, 31% in the middle section, and 26% in the upper section.

The catch per unit effort for all Indian River sections combined was steady through the season ranging from 1.1 to 1.5 fish per trap day (Fig. 16). Catches of coho fry were always highest in section III which averaged 5.0 coho per trap day over the season. Season average CPUE in section II was 1.4 coho per trap day and Section I averaged 0.8 coho per trap day.

A total of 90 coho salmon fry were captured during the cold branding study in sloughs and side channels in the middle Susitna River.

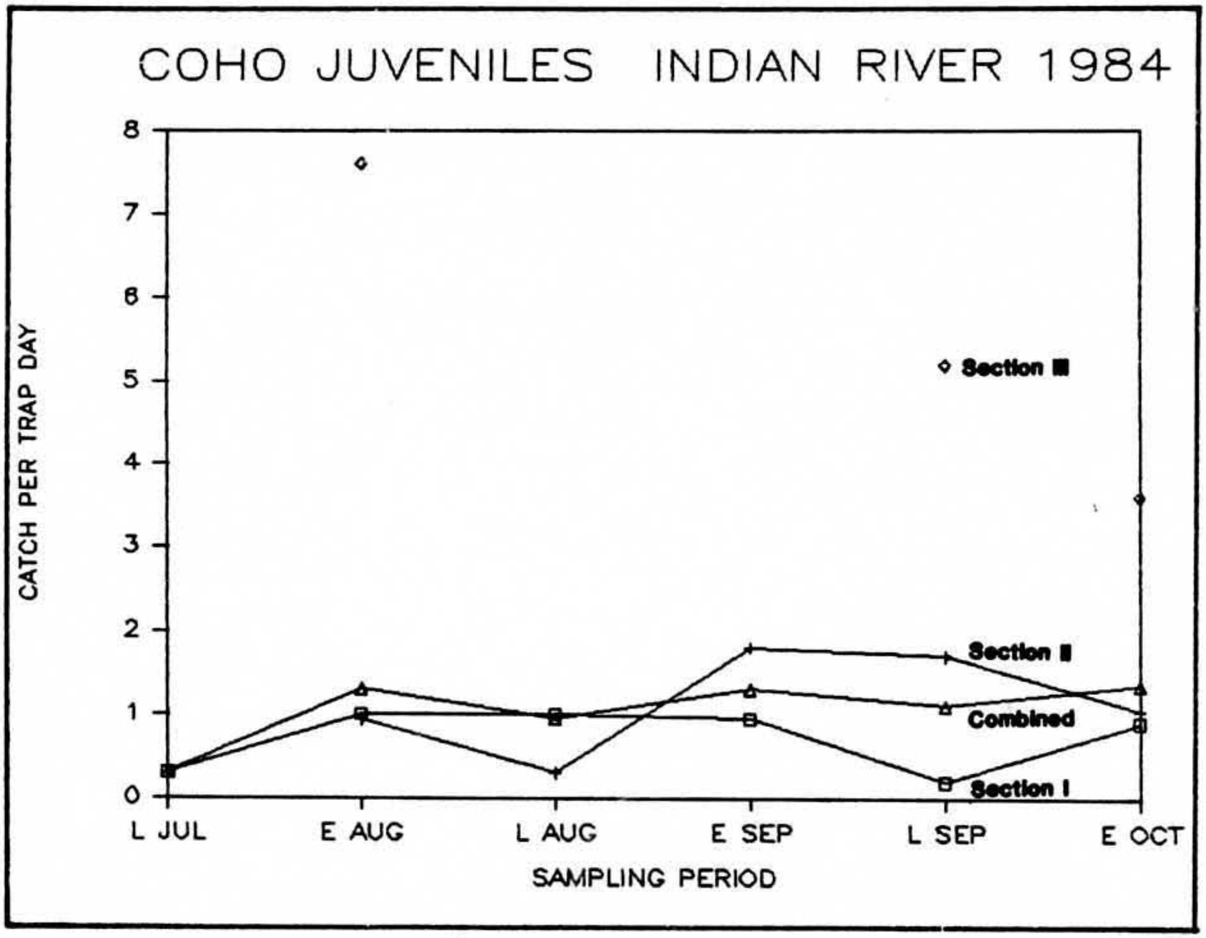

Figure 16. Coho salmon (age 0+) average catch per minnow trap by sampling period and survey section in Indian River, 1984.

Ninety-five percent of the coho catch was recorded in slough habitats in this reach. Beach seining during July and August captured 40% of the season's total catch while minnow trapping during September and early October collected the remaining 60% (average of 0.2 coho per trap day). Daily minnow trap CPUE ranged from a low of 0.01 at Slough 22 and Side Channel 21 in September to a high of 7.6 coho per trap day at Slough 14 on September 10.

Peak catches for the 1,830 age 0+ coho salmon collected at the Talkeetna Station outmigrant traps were recorded during late July and August, and the highest catch rate of 2.9 coho fry per hour was recorded on July 30, by which time 50% of the season total had been recorded (Fig. 17). The last coho fry was captured in the traps on October 4.

A total of 441 age 0+ coho salmon were captured at the Flathorn stationary outmigrant trap during 1984. Catch rates were highest during late August and late September and the peak catch rate of 1.5 fish per hour was recorded in the trap on September 30 (Fig. 18). Fifty percent of the catch at this site occurred by August 26. Only 16 age 0+ coho were captured in the mobile trap at Flathorn Station.

A total of 380 age 0+ coho salmon were captured in the lower Susitna River during the JAHS study (see Part 2 of this report). Catch rates were highest during the late summer sampling and the peak catch rates were recorded in early October (Fig. 19).

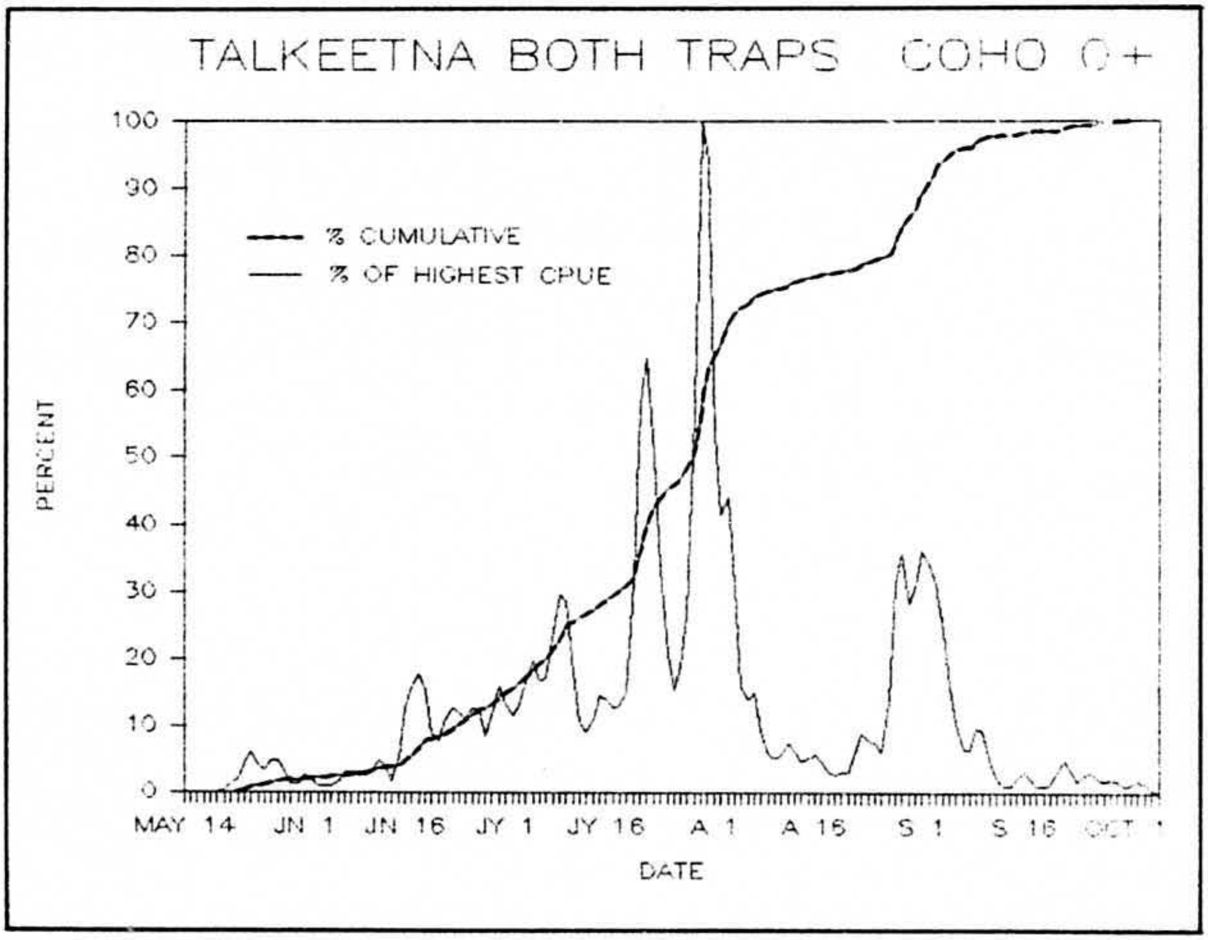

Figure 17. Coho salmon (age 0+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

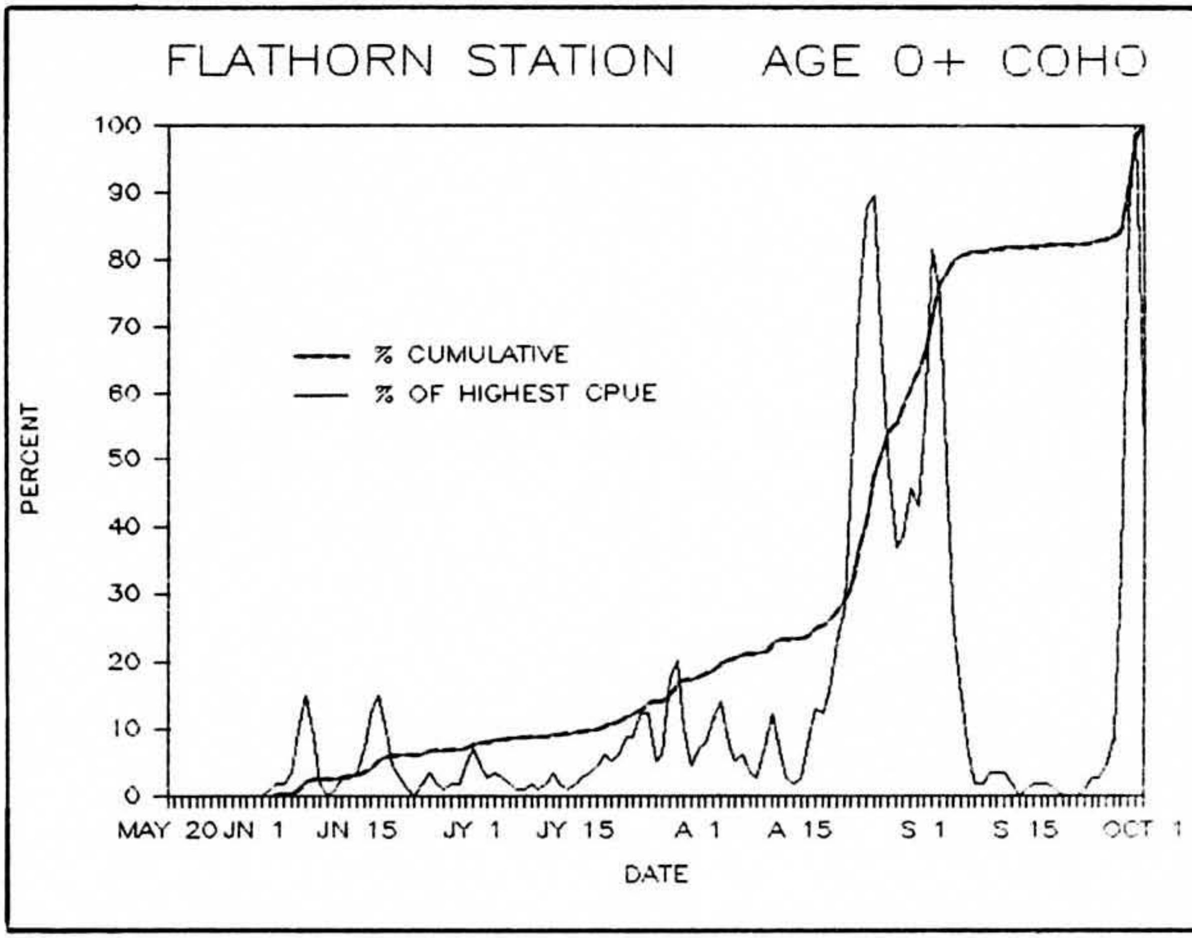

Figure 18. Coho salmon (age 0+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant trap, May 20 through October 1, 1984.

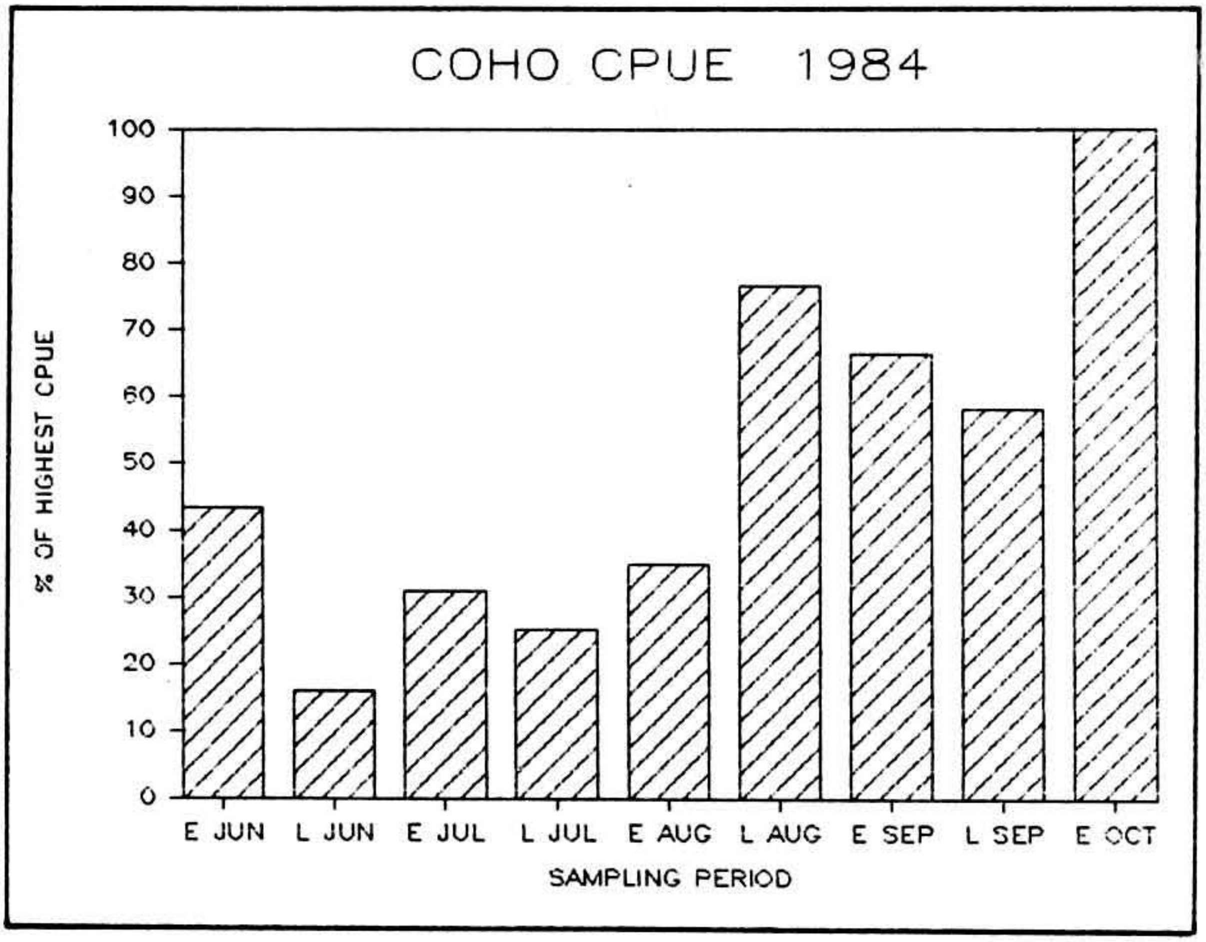

Figure 19. Coho salmon juveniles catch per unit effort by sampling period recorded at JAHS sites in the lower reach of the Susitna River, 1984.

The Deshka River weir captured 95 coho salmon fry during 1984; the peak catch rate of 1.3 fish per hour was recorded on July 25 (Appendix Table A-1). Minnow trap catches at this site were highest during late August at 2.6 coho per trap (Appendix Table A-2).

3.2.1.2 Age 1+ and older

Age 1+ coho salmon were collected sporadically during the coded wire tagging study in May and June with the highest concentrations observed in Slough 11 and Indian River. The cold branding study from July through early October captured 25 age 1+ coho at Indian River and 18 at middle river slough and side channel sites during the season.

Peak catches for the 1,425 age 1+ coho salmon juveniles captured at the Talkeetna Station outmigrant traps were observed in mid June and were again high in late July and late August (Fig. 20). Fifty percent of the catch was recorded by June 25. The highest catch rate for these age classes was 1.6 fish per hour recorded on June 18 and the last capture was on October 2.

Catch rates for the 291 age 1+ coho salmon juveniles captured at the Flathorn stationary outmigrant trap were highest during late August and September (Fig. 21) and the highest CPUE of 0.8 coho per hour was recorded on September 3. Fifty percent of the total catch was recorded by August 30 and the last capture of these age classes was October 1. The mobile outmigrant trap captured 10 age 1+ coho salmon during the season.

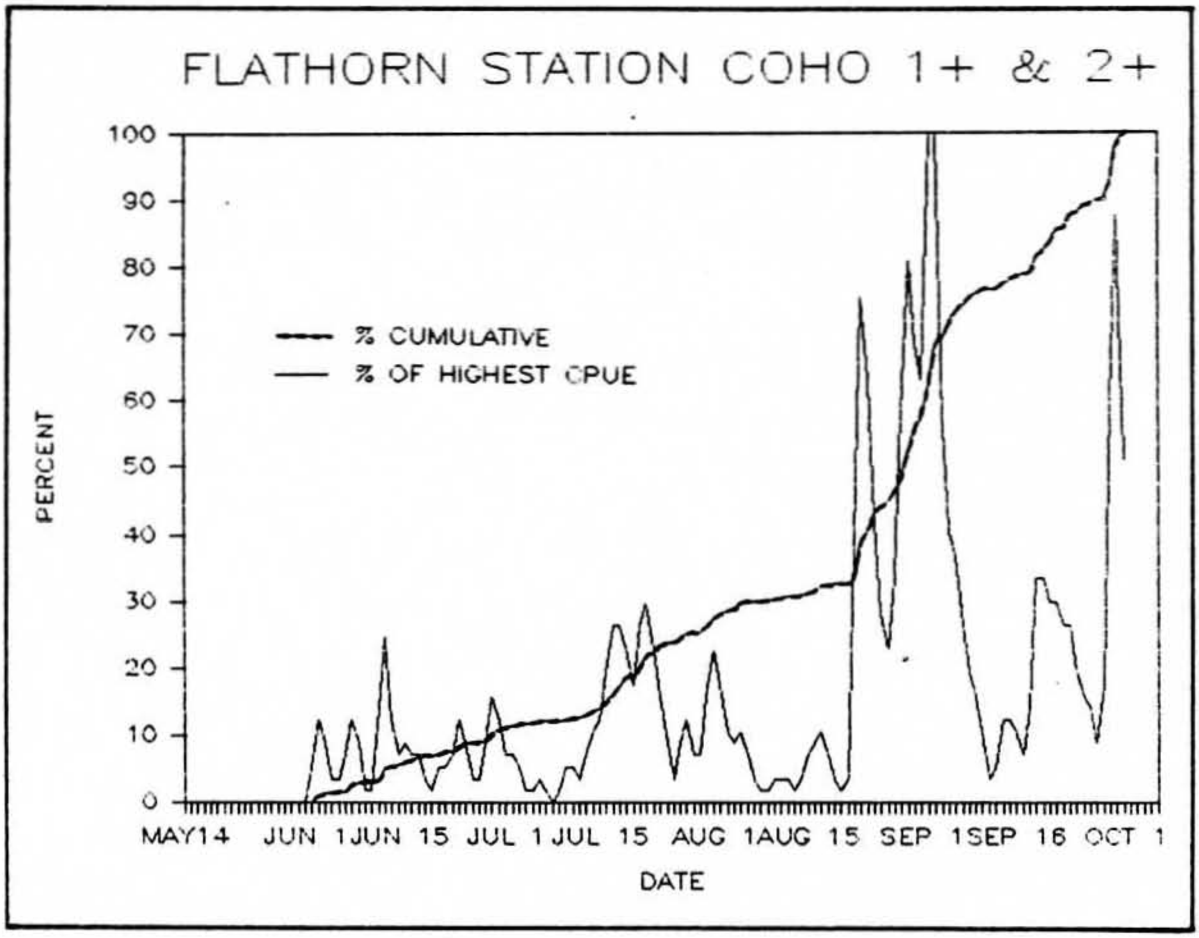

Figure 20. Coho salmon (age 1+ and older) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

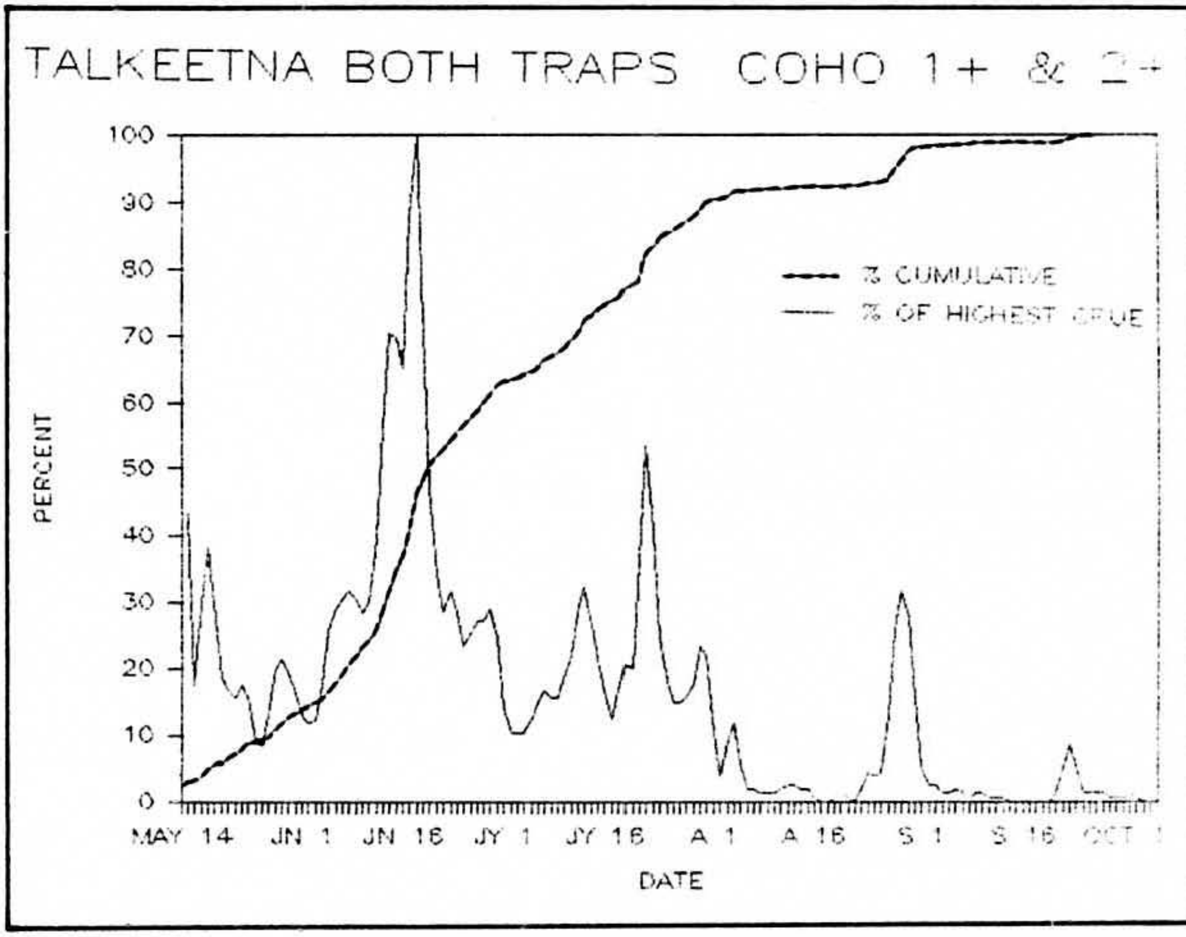

Figure 21. Coho salmon (age 1+ and older) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant trap, May 20 through October 1, 1984.

The JAHS study in the lower river collected 62 age 1+ coho salmon juveniles with most of the captures being recorded at tributary sites in this reach.

The Deshka River weir collected 26 age 1+ coho while minnow trapping at this site captured 119 fish. Catches were observed throughout the season with a peak rate of 6.2 coho per trap recorded in late August.

A total of 44 age 2+ coho salmon juveniles were collected during the 1984 studies. Talkeetna Station, Flathorn Station and the Deshka River accounted for 95% of the captures of this age class.

3.2.2 Growth

3.2.2.1 Age 0+

Coho fry collected in the lower river were consistently larger than the fry collected in the middle river throughout the season (Fig. 22). Coho fry collected between Talkeetna and Devil Canyon averaged 40 mm total length during late May and showed a steady growth to a mean of 58 mm by late August. Coho fry in the lower river averaged 42 mm in early June and had grown to a mean length of 71 mm by late September. The number of fish measured, mean length, and range of lengths by sampling period for coho fry are presented for each data collection area in Appendix Table A-5 and A-6.

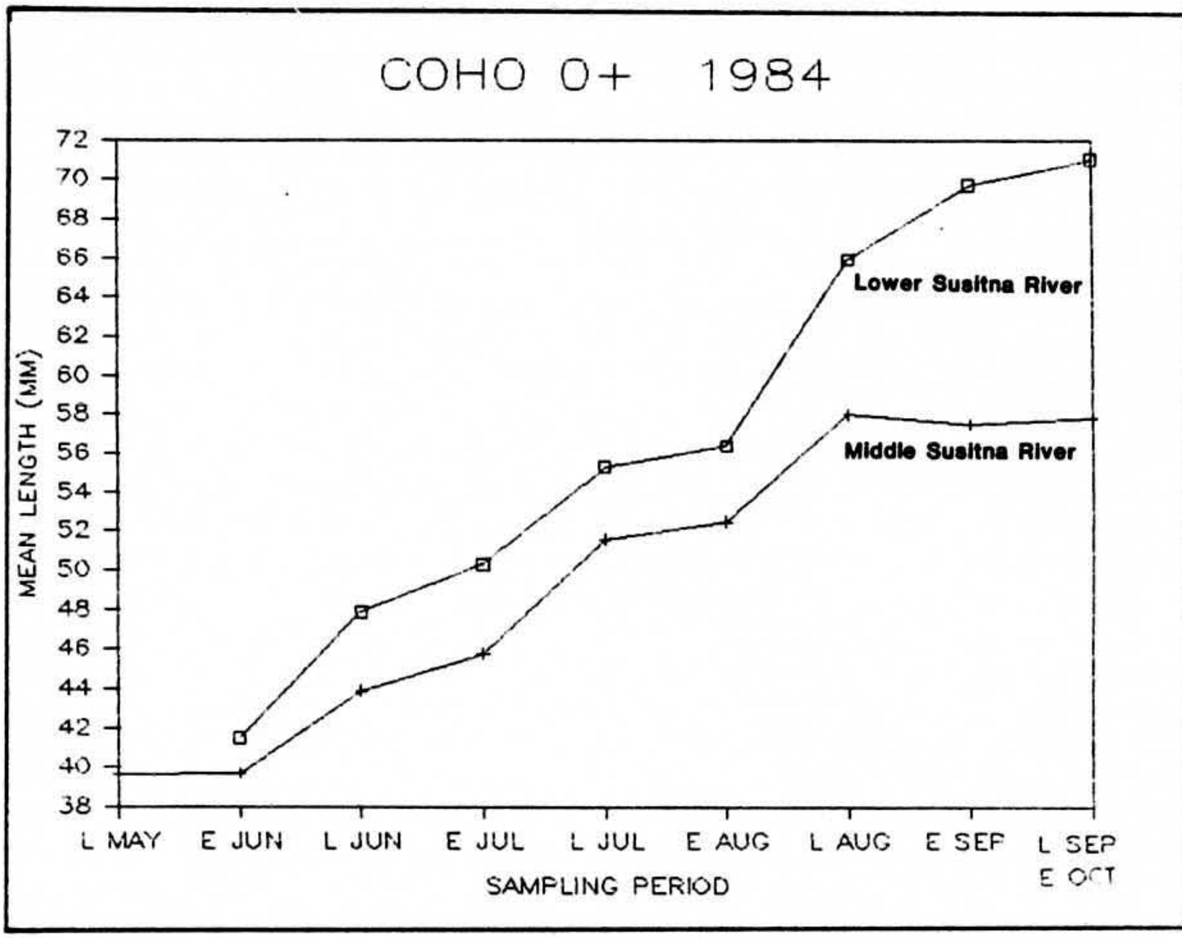

Figure 22. Coho salmon (age 0+) mean length and range of lengths by sampling period for fish collected in the lower and middle reach of the Susitna River, 1984.

3.2.2.2 Age 1+ and older

Age 1+ coho salmon juveniles collected in the lower river also averaged larger through the season than fish of the same age class collected in the middle river (Fig. 23). Age 1+ coho averaged 70 mm total length in both reaches during May and increased to 104 mm in the middle river and 111 mm in the lower river by early October. Length data by collection area and sampling period are provided in Appendix Table A-7 and A-8.

Age 2+ coho salmon juveniles collected during the 1984 studies averaged 137.1 mm and ranged from 114 to 176 mm (Appendix Table A-9).

A sample of juvenile coho salmon were measured at Talkeetna Station to provide a relationship between length and weight for fish passing this site (Fig. 24).

3.2.3 Cold branding

A total of 1,480 juvenile coho salmon were cold branded in Indian River from July 1 through October 15. Of these fish, five were recaptured in Indian River and two were recovered at the Talkeetna Station outmigrant traps. The marked coho recaptured in Indian River were branded and released at TRM 11.5 on July 17 and recaptured at TRM 2.2 between September 9 and 11, for an average of 55 days between release and recovery. The two branded coho recovered at Talkeetna Station were released in Indian River on August 12 and were recovered in the outmi-

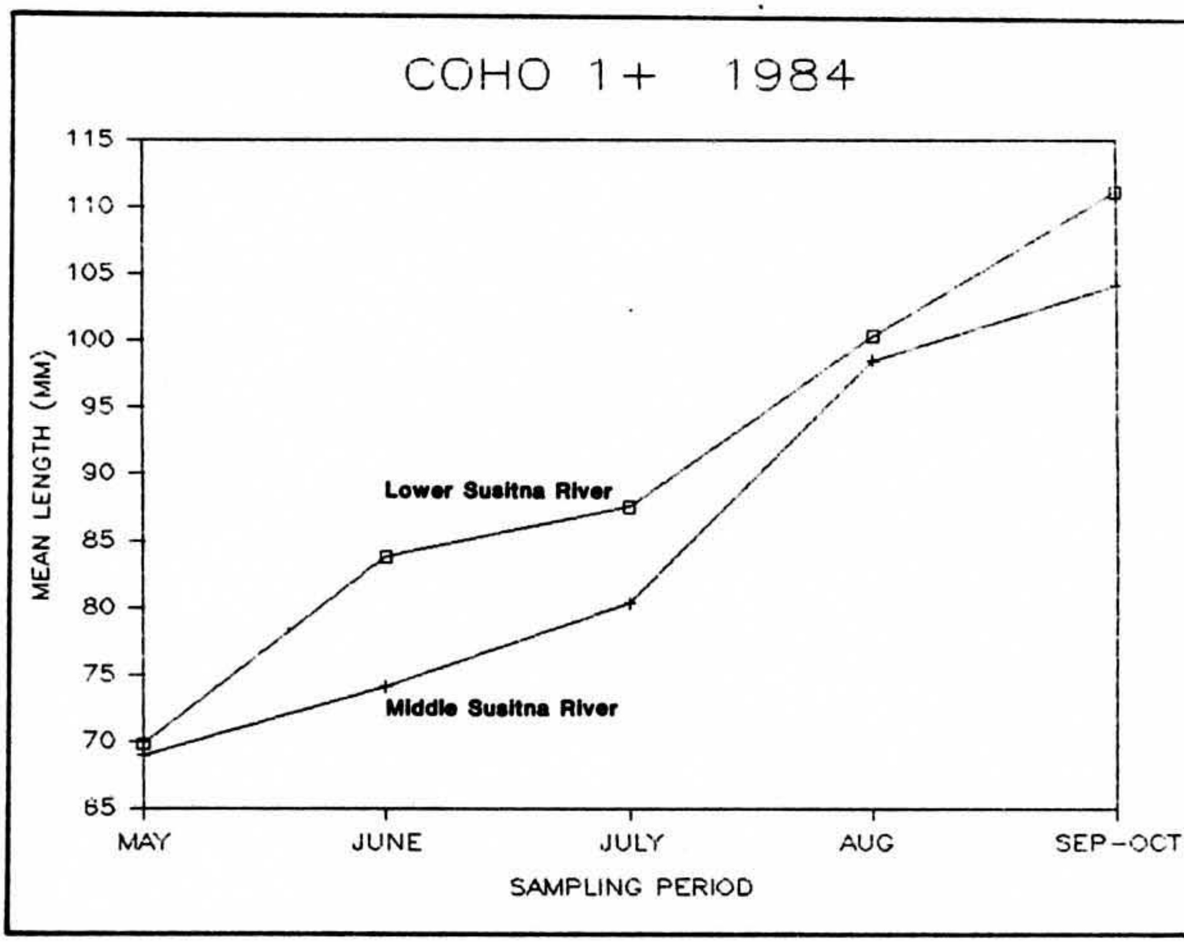

Figure 23. Coho salmon (age 1+) mean length by month for fish collected in the lower and middle reach of the Susitna River, 1984.

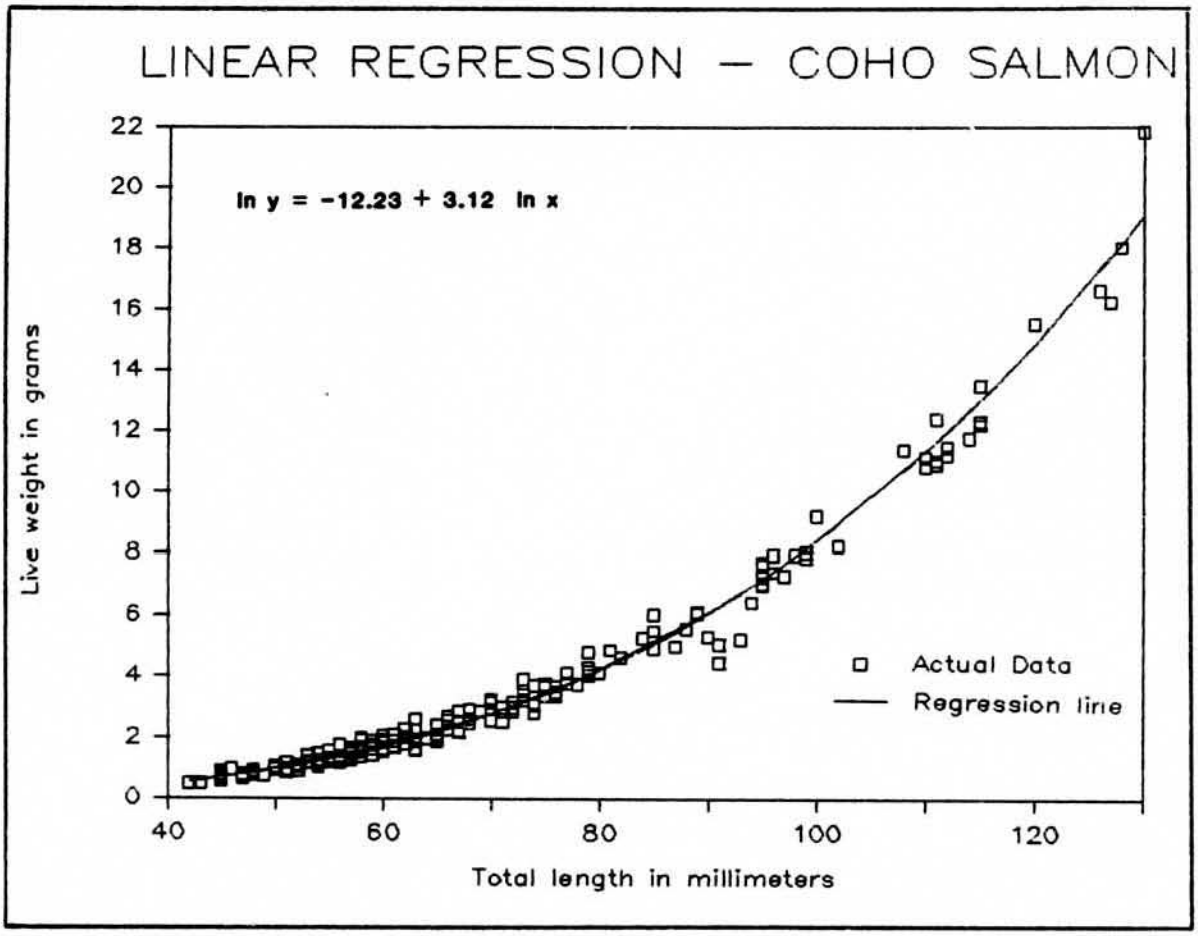

Figure 24. The linear regression of the weight/length relationship for juvenile coho salmon collected at the Talkeetna stationary outmigrant traps, 1984.

grant traps on August 31 and September 22; 19 days and 41 days, respectively, between release and recovery.

A total of 106 juvenile coho salmon were cold branded at slough and side channel sites, and the only recapture was recorded at Talkeetna Station. The recaptured fish was marked and released at Slough 14 on September 10 and was recovered in the traps on September 16.

3.2.4 Population estimates

Since only 100 to 200 of the estimated 750 adult coho passing Curry Station in 1983 entered Indian River, and since juvenile coho of the same brood year outmigrate as age 0+, 1+, and 2+ fish, few juvenile coho salmon were captured for marking during the 1984 cold branding studies. Too few branded coho salmon were recaptured to provide population estimates for any of the sites surveyed.

3.3 Sockeye Salmon

3.3.1 Catch per unit effort

3.3.1.1 Age 0+

Sockeye salmon fry were collected during the coded wire tagging study in May and June at sloughs 8A, 9, 11, and 21 but catch rates were recorded only for Slough 21. These data were determined from 24 hour fyke net catches and are presented in Appendix Table A-10.

A total of 248 sockeye salmon fry were captured at slough and side channel sites in the middle river and in Indian River during beach seine sampling conducted in July and August. Of these fish, 94% were collected in sloughs and the remaining 6% were collected in Indian River and at mainstem side channels.

Peak catch rates for the 7,484 age 0+ sockeye salmon fry collected at the Talkeetna Station outmigrant traps were recorded in mid June and early July with the highest daily catch rate of 13.0 sockeye fry per hour occurring on June 18 (Fig. 25). The major downstream redistribution of sockeye fry in this reach had occurred by mid July (50% by July 4). The last sockeye fry at Talkeetna Station was observed on October 4.

Juvenile sockeye catches at the Flathorn stationary outmigrant trap were greatest during May and June but the downstream movement of sockeye fry continued through the open water season (Fig. 26). A total of 2,315 sockeye fry were collected in the trap during 1984, and the peak catch rate of 4.6 fish per hour was recorded on June 8. Fifty percent of the catches had occurred by June 29 and the last capture was October 1.

Mobile trap catches of sockeye fry at Flathorn Station were highest during June and the peak catch rate of 5.4 fish per hour was recorded on July 12 (Fig. 27). Of the 114 sockeye collected in the mobile trap during 1984, 59% were captured at bank transect points (Fig. 28).

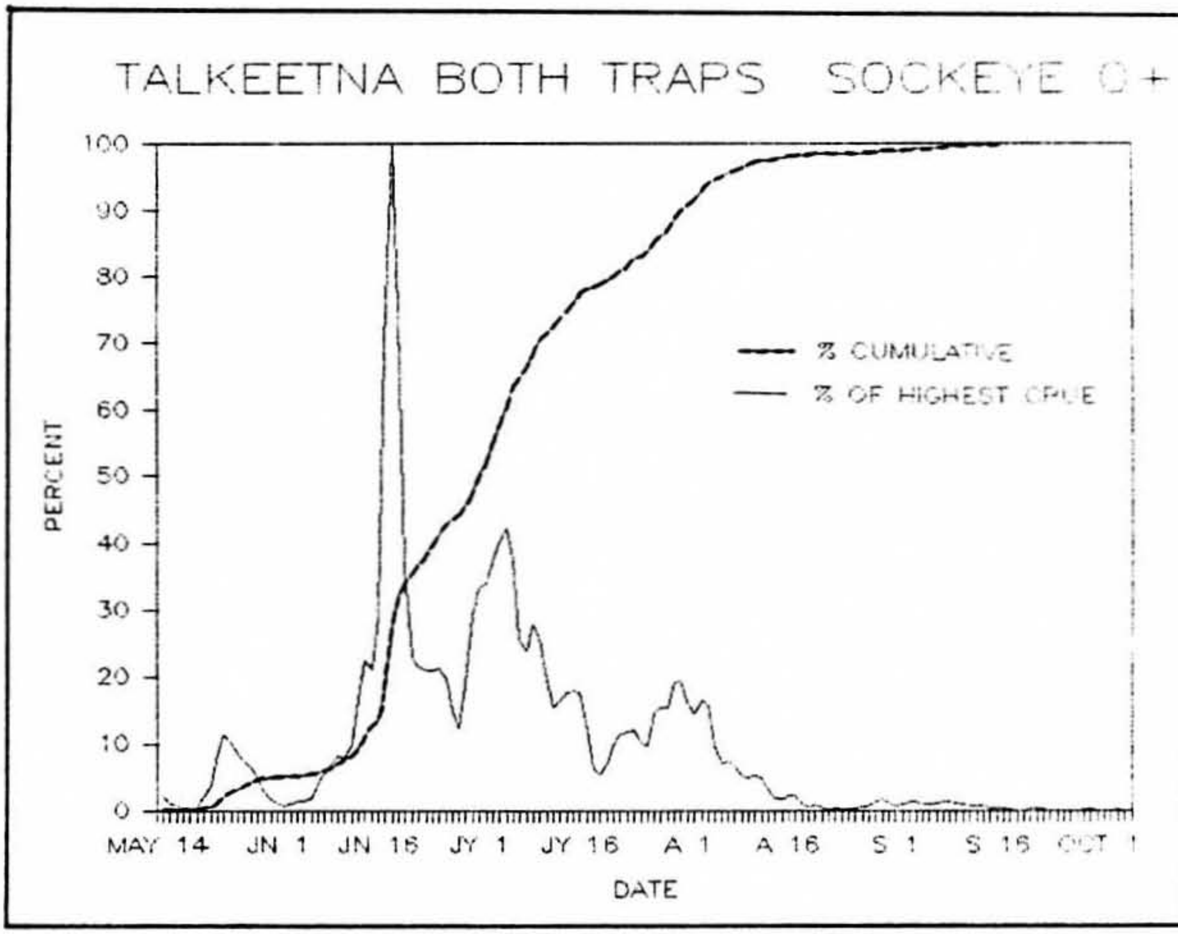

Figure 25. Sockeye salmon (age 0+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

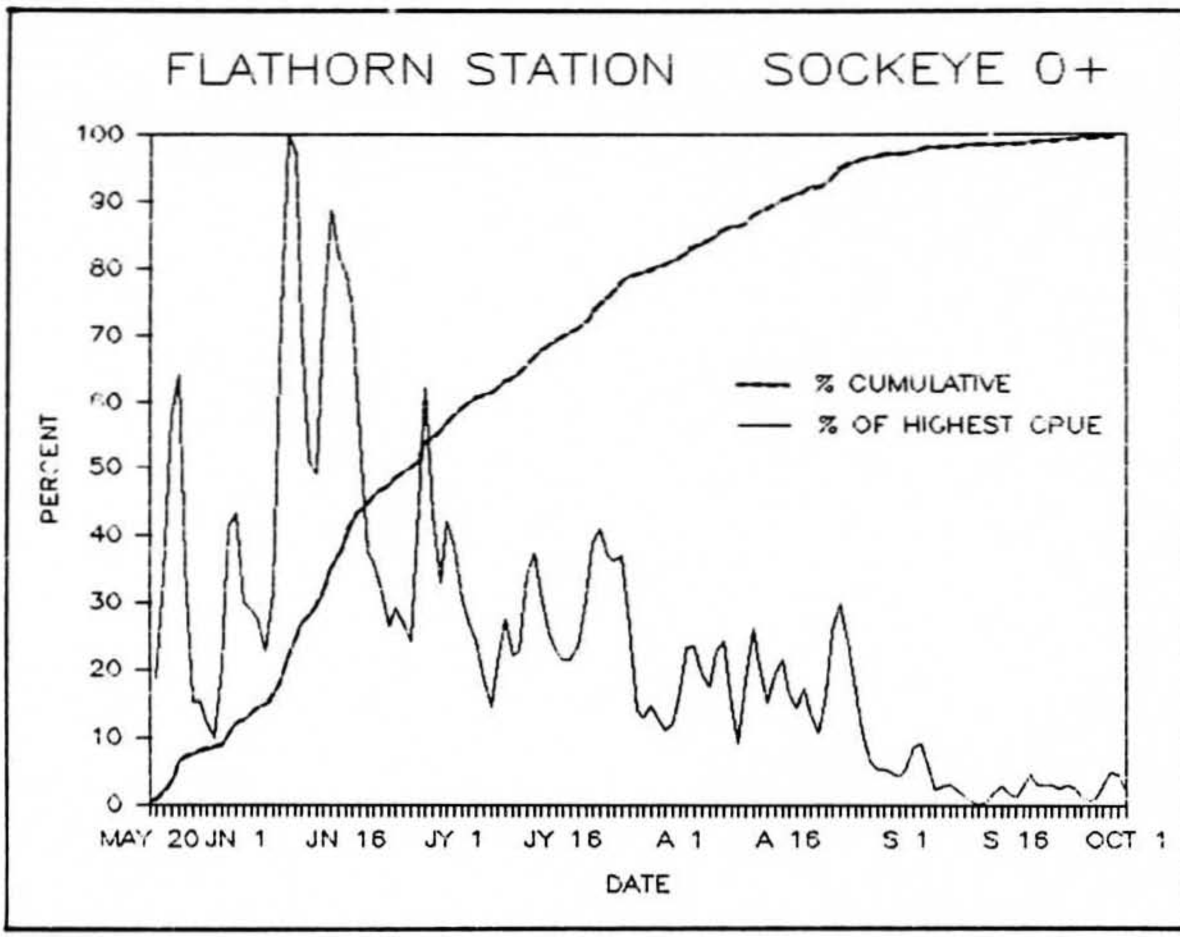

Figure 26. Sockeye salmon (age 0+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant trap, May 20 through October 1, 1984.

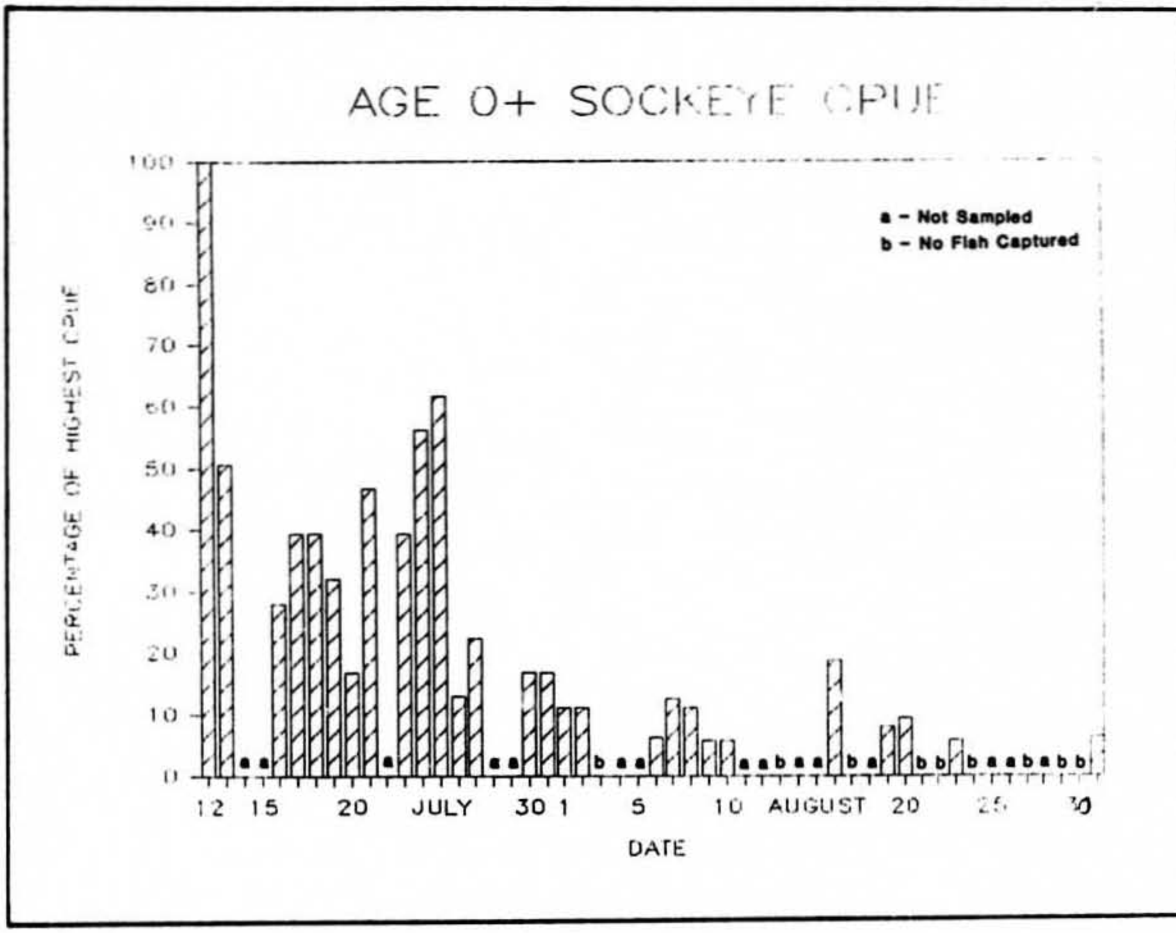

Figure 27. Sockeye salmon (age 0+) daily catch per unit effort recorded at the Flathorn mobile outmigrant trap, July 12 through August 31, 1984.

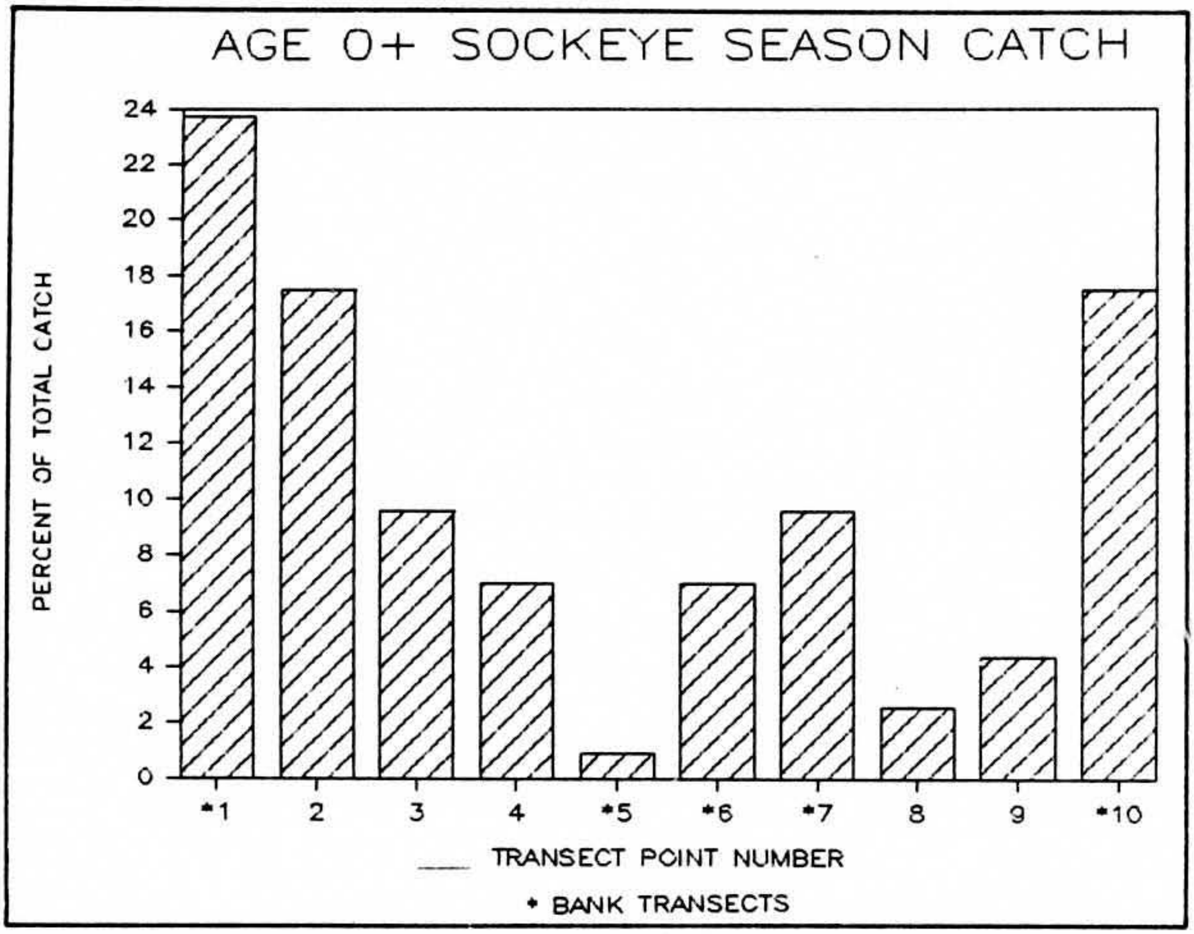

Figure 28. Sockeye salmon (age 0+) percent of the total catch by sampling point recorded at the Flathorn mobile outmigrant trap, 1984.

A total of 412 sockeye salmon fry were collected in the lower river during JAHS surveys from June through October (see Part 2 of this report). Catch rates at JAHS sites peaked in late June and then were low throughout the remainder of the season (Fig. 29). An increase in catch rates was recorded at some sites including Rolly Creek (RM 39.0) and Beaver Dam Slough (RM 86.3) in late August and September, indicating the movement of sockeye into these sites during late summer.

3.3.1.2 Age 1+

A total of 90 age 1+ sockeye salmon juveniles were collected. Nineteen were captured at Talkeetna Station and 63 were collected at Flathorn Station.

Ninety-six percent of the catch for age 1+ sockeye collected at the outmigrant traps (Talkeetna and Flathorn combined) was recorded during May and June (Fig. 30). The last age 1+ sockeye was captured at Talkeetna Station on July 29.

3.3.2 Growth

The mean length and range of lengths for age 0+ sockeye salmon by reach of river and sampling period is presented in Fig. 31. During May and June, sockeye fry collected in the middle river reach had a smaller mean length than the same age class sockeye collected in the lower river. By early July, sockeye fry averaged the same length (49 mm) in both

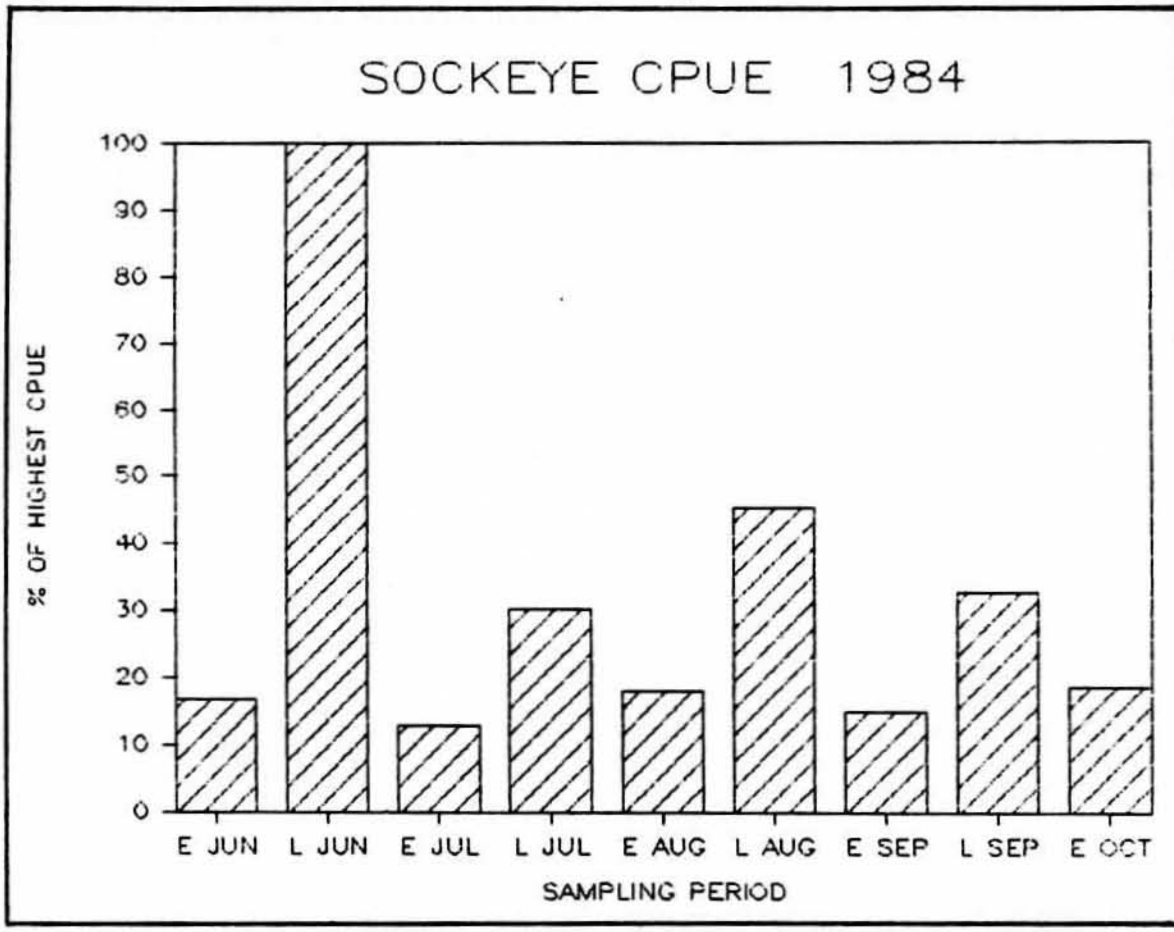

Figure 29. Sockeye salmon juveniles catch per unit effort by sampling period recorded at JAHS sites in the lower reach of the Susitna River, 1984.

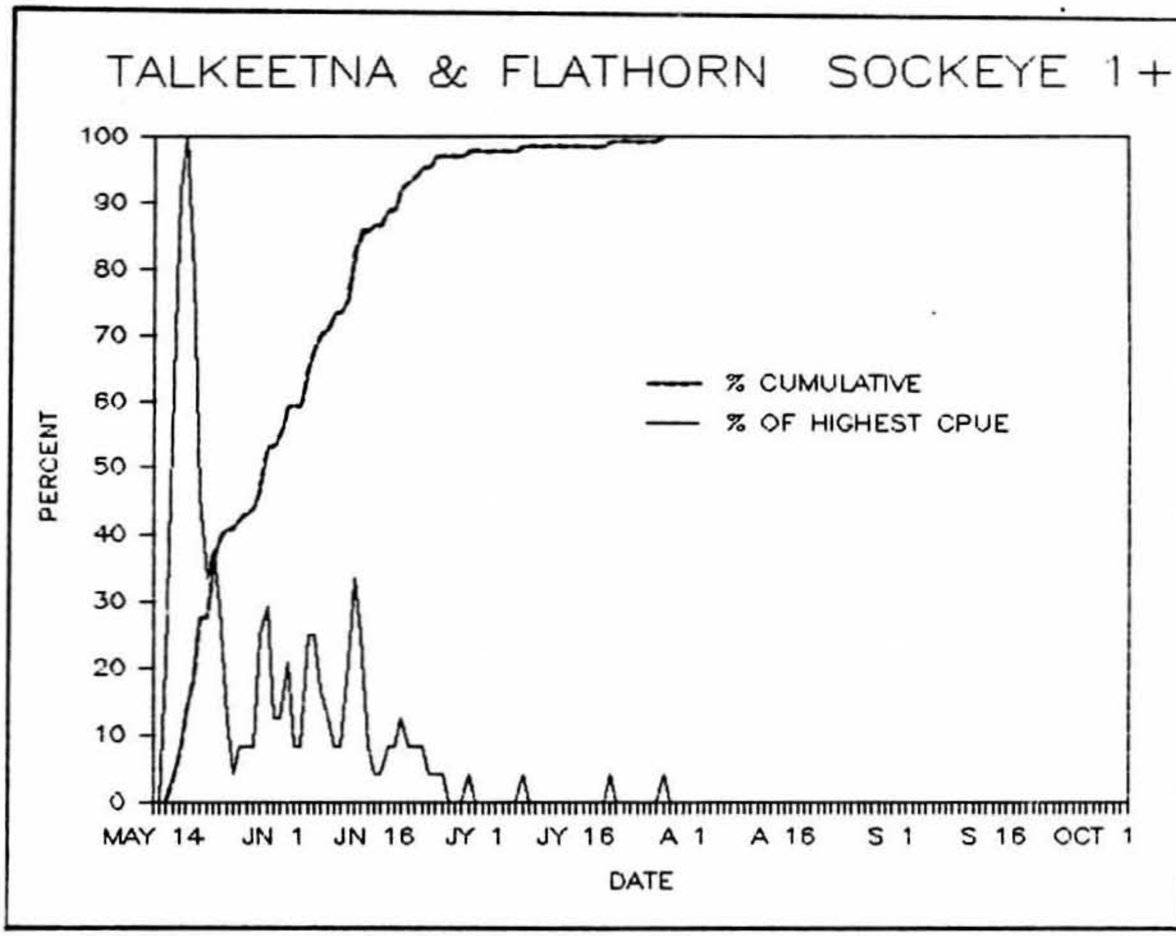

Figure 30. Sockeye salmon (age 1+) smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn and Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

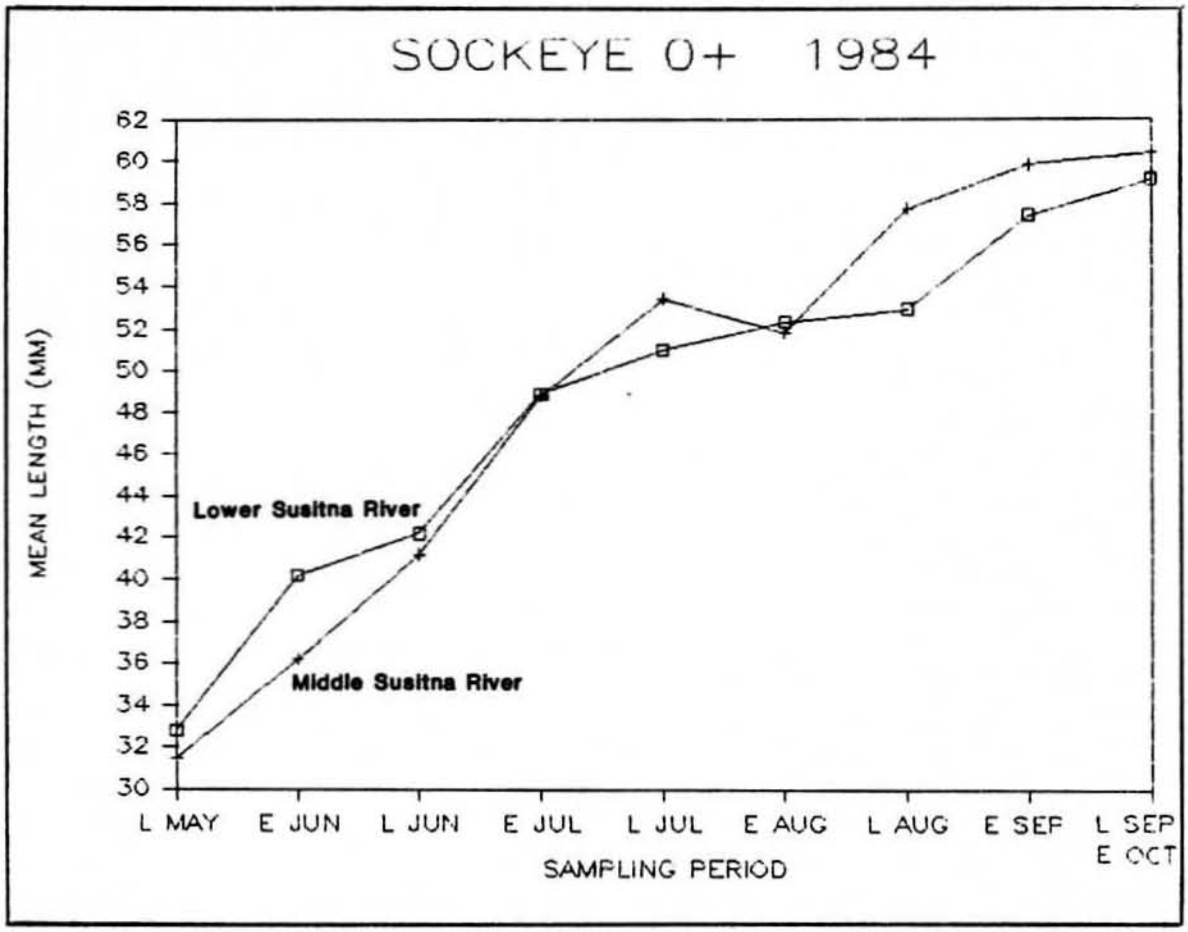

Figure 31. Sockeye salmon (age 0+) mean length and range of lengths by sampling period for fish collected in the lower and middle reach of the Susitna River, 1984.

reaches, and by late August; middle river sockeye fry were averaging larger than fish collected in the lower river. This trend continued through the remainder of the season. The number of fish measured, the mean length and range of lengths by sampling period for sockeye salmon fry are presented for each of the data collection areas in Appendix Table A-11.

The 90 age 1+ sockeye salmon collected during 1984 averaged 73 mm total length and ranged from 56 to 102 mm (Appendix Table A-12). A coded wire tagged sockeye fry released in 1983 and recaptured in 1984 had increased from 32 mm to 81 mm.

A sample of juvenile sockeye were measured at Talkeetna Station to provide a relationship between length and weight for fish passing this site (Fig. 32).

3.3.3 Coded wire tagging and recovery

A total of 14,532 tagged sockeye salmon fry averaging 33 mm total length were released between May 22 and June 22, 1984 (Table 3). Tag retention rates for sockeye fry averaged 97.1% and ranged from 92.3 to 99.0%. Tagging mortality ranged from 0.6 to 2.6% and averaged 1.3%.

A total of 366 tagged sockeye salmon fry (2.5% of the total tagged sockeye released) were recovered from the 7,484 age 0+ sockeye captured and examined for tags at the Talkeetna Station outmigrant traps during

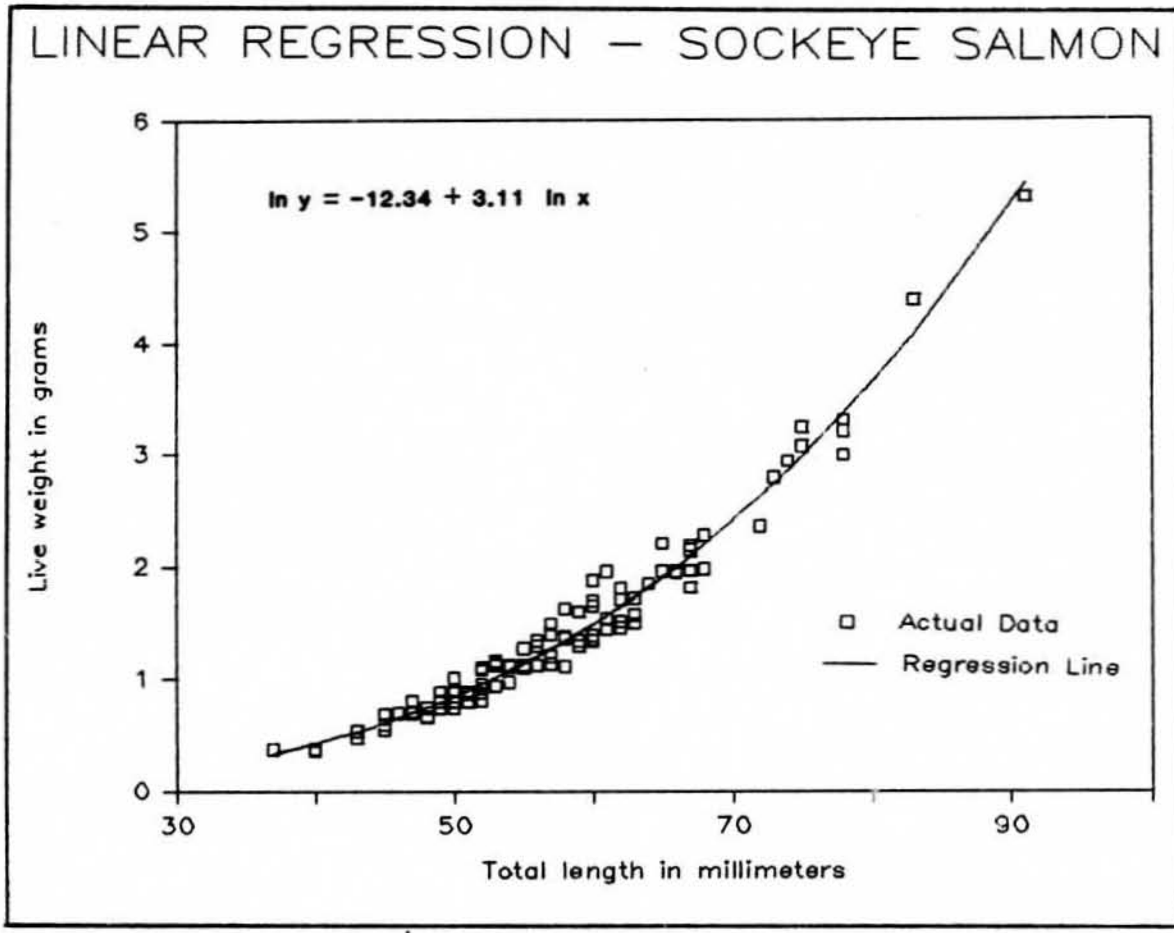

Figure 32. The linear regression of the weight/length relationship for juvenile sockeye salmon collected at the Talkeetna stationary outmigrant traps, 1984.

Table 3. Coded wire tag release data for sockeye salmon fry on the Susitna River by tagging site and release date, 1984.

Tagging Site (River Mile)	Number of Fish Tagged	Date of Release	Percent Tag Retention	Percent Mortality
Slough 21 (RM 142.0)	3,736	5/28	97.9	2.6[a]
Slough 11 (RM 135.3)	2,327	5/22	92.3	1.1
	2,732	5/24	97.7	0.7
	1,537	6/22	96.6	1.1
Slough 9 (RM 128.3)	2,052	6/9	99.0	1.0
Slough 8A (RM 125.3)	2,148	6/19	99.0	0.6
TOTAL - ALL SITES	14,532	5/22-6/22	97.1	1.3

[a] Mortality due to handling, thermal, and anesthetic stresses.

1984. In addition, 15 sockeye fry with clipped adipose fins but no coded wire tags were recovered in the traps. When compared to the total tagged sockeye salmon fry recovered, this provides a tag retention rate at the traps of 96.1%.

Trap recoveries of coded wire tagged sockeye fry were made from 0 to 109 days (mean = 35 days) following their release at the tagging sites (Fig. 33). In addition, one tagged sockeye fry which was released from Slough 21 on May 28 was recaptured at Flathorn Station on July 7. Seven coded wire tagged sockeye fry were recovered during the cold branding study in early August (Table 4). Six of these fish were recovered at Moose Slough (RM 123.2) and one tagged sockeye fry was recovered at a side channel below Slough 11 (RM 135.2).

A single coded wire tagged sockeye salmon marked and released during 1983 was recovered during the 1984 sampling season. This fish was released June 8, 1983 at Slough 11 and was recovered at Talkeetna Station on July 21, 1984.

The ratio of coded wire tagged sockeye fry to total sockeye fry was the same (0.05:1.00) in both traps at Talkeetna Station. This indicates that the coded wire tagged fish were uniformly mixed in the total population by the time they migrated past the traps.

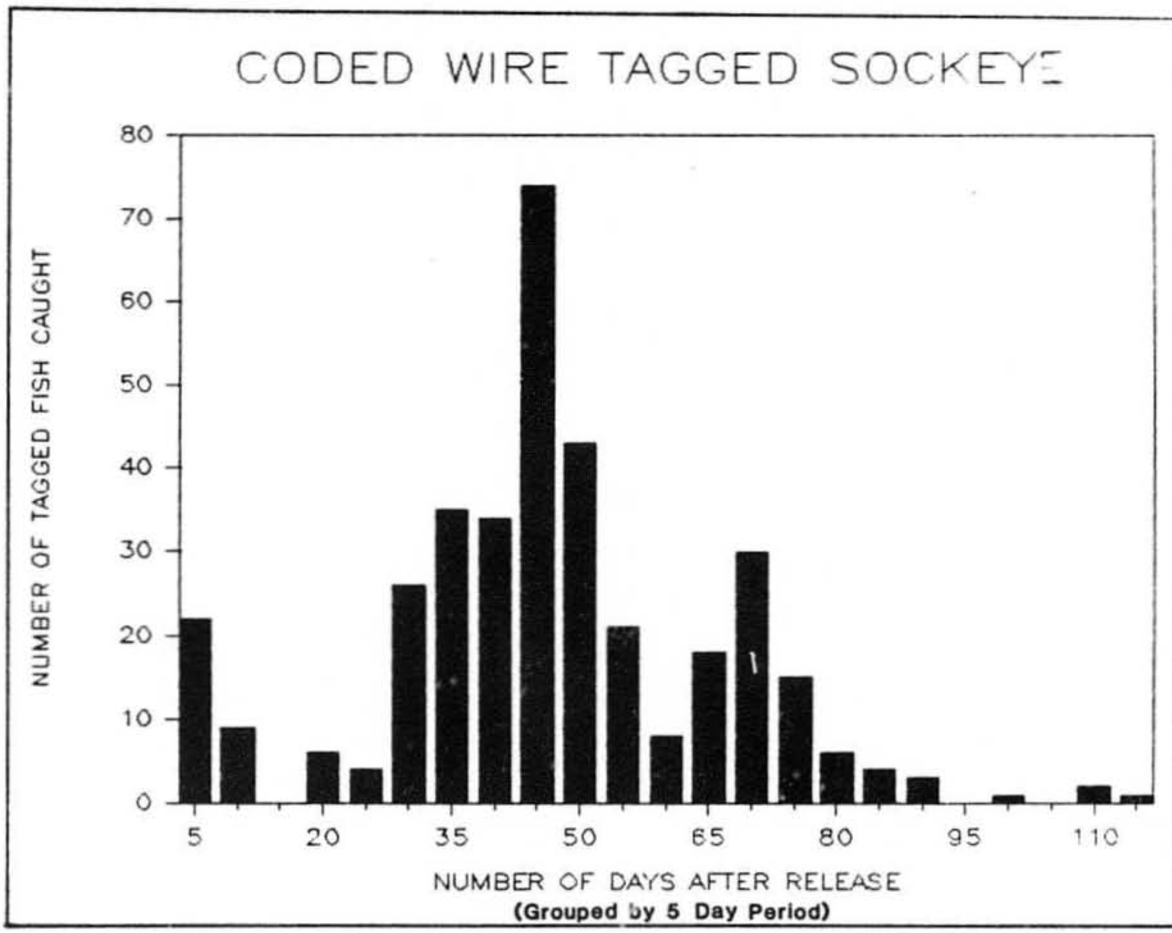

Figure 33. Length of time between the mark and recapture of coded wire tagged sockeye salmon juveniles in the middle reach of tne Susitna River, 1984.

Table 4. Recoveries of coded wire tagged sockeye salmon fry at mainstem river sites between Talkeetna and Devil Canyon, 1984.

Collection Site	Collection Date	Release Site	Release Date
Moose Slough[1]	8/8	Slough 21	5/28
Moose Slough	8/8	Slough 21	5/28
Moose Slough	8/8	Slough 11	6/22
Moose Slough	8/8	Slough 9	6/9
Moose Slough	8/8	Slough 8A	6/19
Moose Slough	8/8	Slough 8A	6/19
Slough 11 Side Channel[2]	8/3	Slough 21	5/28

[1] River Mile 123.2

[2] River Mile 134.9

3.3.4 Population estimates and survival rates of outmigrants

Females comprised 38.5% of the population of 1,900 adult sockeye salmon estimated past Curry Station in 1983 (C.I. - 1,600 to 2,300 adults) and the fecundity of Susitna River sockeye averaged 3,350 eggs per female (Barrett et al. 1984). Milling activity was estimated at 30% (Barrett 1984). These data provided a calculation of total potential egg deposition for sockeye salmon of 1,715,000 eggs during 1983.

Using the method outlined by Schaefer (1951), a population of 299,000 sockeye salmon fry was estimated to have outmigrated past the Talkeetna Station traps during 1984 (Appendix Table B-1 and B-2). A comparison of the population estimate to the calculated potential egg deposition (dividing the estimated number of fry by the number of eggs) gave an egg-to-outmigrant survival rate of 17.4%. The survival rates ranged from 14.4 to 20.7% using the confidence intervals from the adult population estimate at Curry Station.

3.4 Chum Salmon

3.4.1 Catch per unit effort

Chum salmon were collected during the coded wire tagging study in May and June and during beach seine sampling of Indian River in July. Catch rates were not generally recorded during these studies except for 24 hour fyke net sets at Slough 21 (Appendix Table A-10).

Peak catches of chum fry collected at the Talkeetna Station outmigrant traps were recorded during late May and mid June, with the highest daily catch rate of 8.0 fish per hour occurring on June 14 (Fig. 34). Ninety-five percent of the 3,590 chum fry captured at Talkeetna Station were recorded by July 15. The major outmigration had occurred by the end of June (50% by June 13), although the migration continued until September 11.

Chum salmon fry catches at Flathorn Station were greatest during June with a peak catch rate of 10.9 fish per hour recorded on June 14 by which time 50% of the season catch had occurred (Fig. 35). Of the 783 chum fry collected at this site, 97% were captured by July 1 and the last chum fry was captured at Flathorn Station on July 22.

Beach seining and electrofishing at side channel, slough, and tributary sites in the lower river reach collected chum salmon fry during June and July (see Part 2 of this report). Chum fry were abundant in this reach during early June but catches steadily decreased through July (Fig. 36).

3.4.2 Growth

Chum fry in the middle river reach averaged 40 mm during May, 45 mm during June, and 46 mm during July ~~(Table 6)~~. During June, Indian River chum fry averaged the smallest at 40 mm while Slough 8B fish had the largest mean length of 49 mm. Indian River chum fry had increased to a mean length of 48 mm by early July.

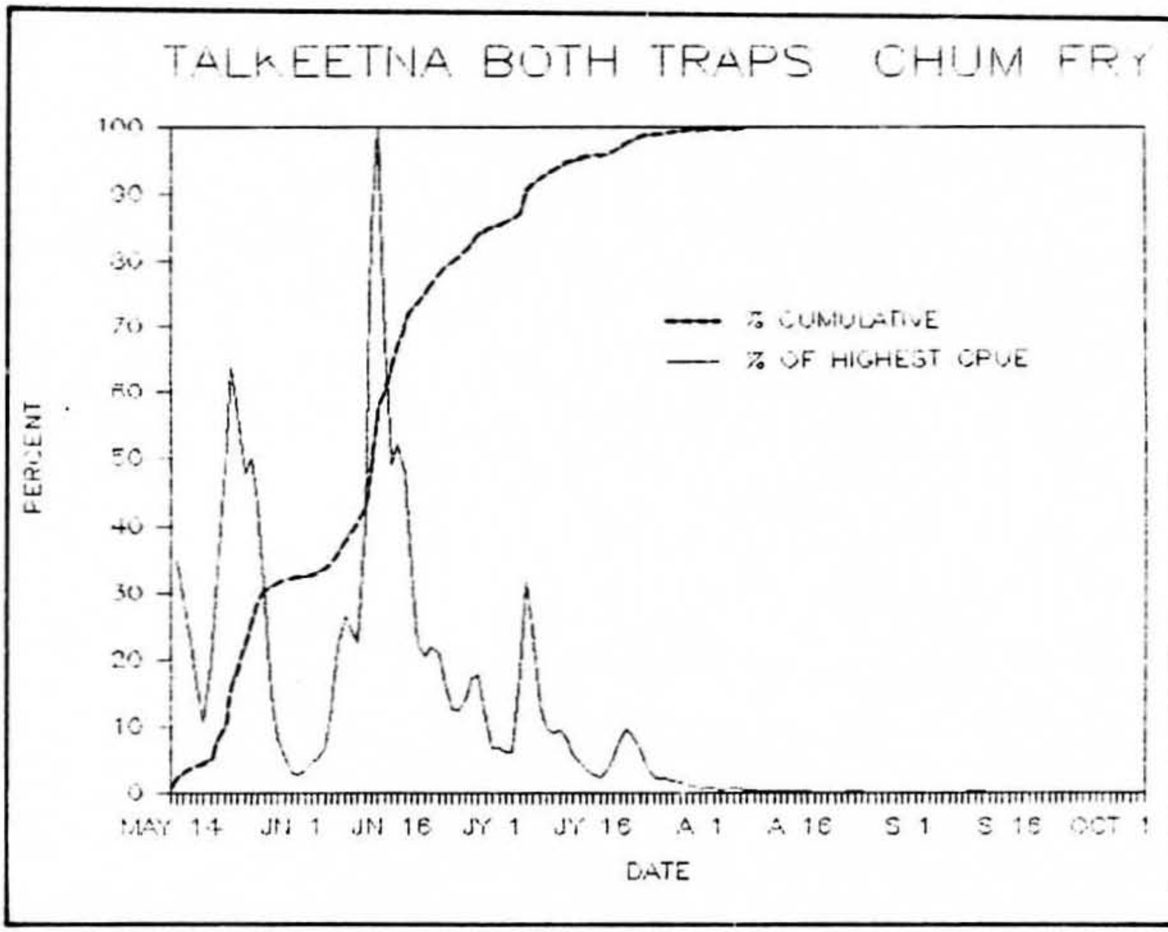

Figure 34. Chum salmon fry smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

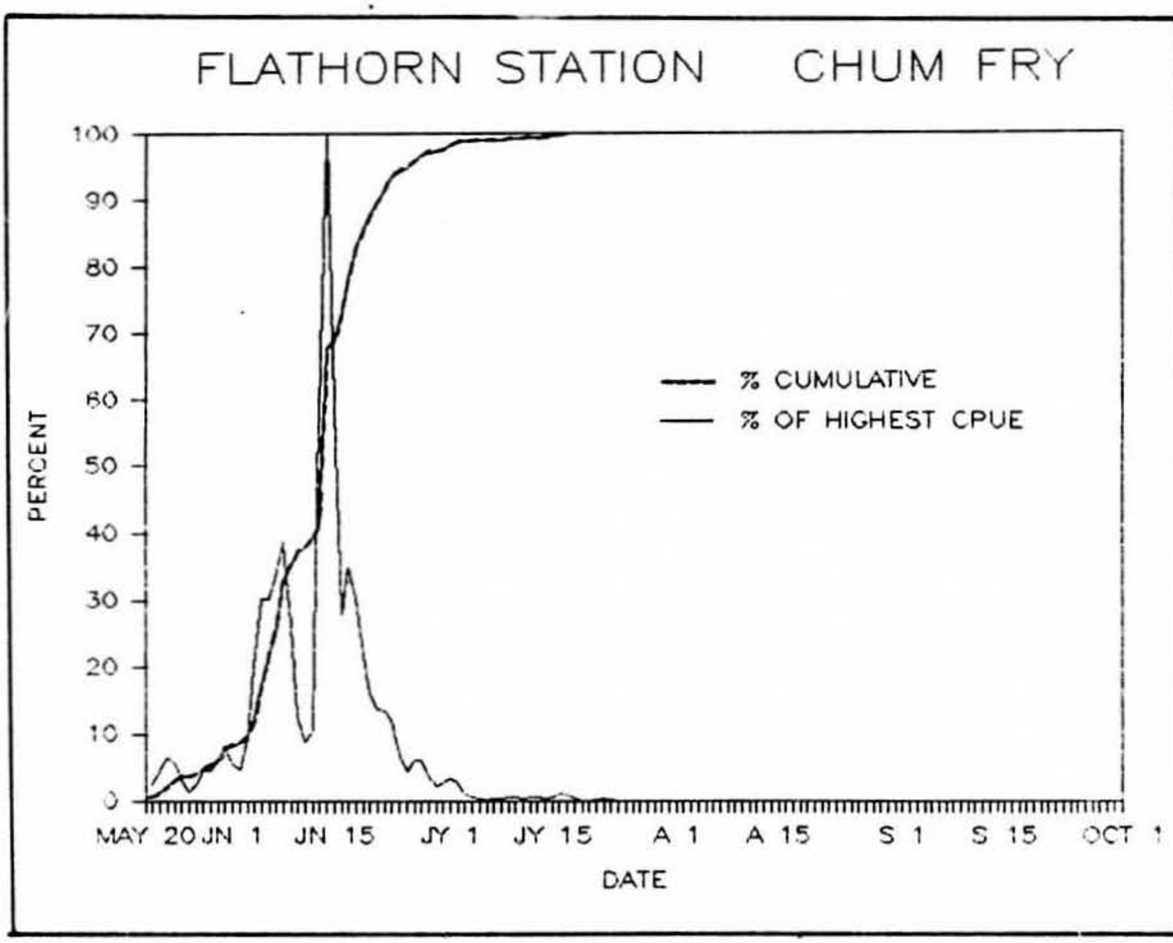

Figure 35. Chum salmon fry smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant trap, May 20 through October 1, 1984.

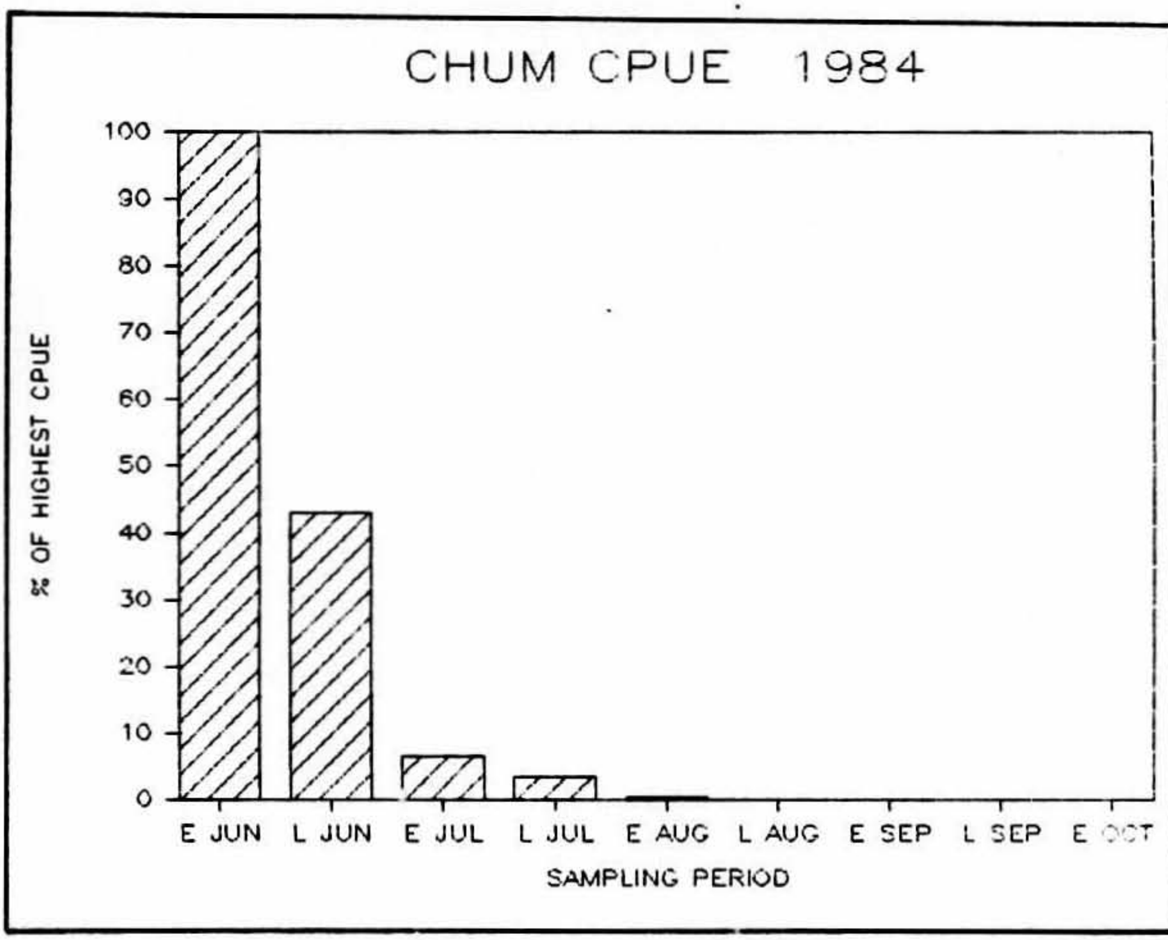

Figure 36. Chum salmon fry catch per unit effort by sampling period recorded at JAHS sites in the lower reach of the Susitna River, 1984.

Chum salmon fry collected at Talkeetna Station showed an increase of six millimeters in mean length between May (40 mm) and early June (46 mm) and averaged 43 to 45 mm after this period. Talkeetna Station outmigrant trap recoveries of coded wire tagged chum fry showed a two millimeter increase in mean length between release and recovery (mean time interval of eight days). Tagged chum fry which were captured 11 or more days after release averaged 48 mm, an increase of five millimeters between release and recovery.

Limited sampling of the Talkeetna River during June and July indicated a mean length of 43 mm for chum fry outmigrating from this tributary.

Below the Chulitna River confluence, growth was less apparent as chum fry averaged 40 to 43 mm at the sites sampled in this reach throughout the period of outmigration. The mean length and range of lengths for chum fry by sampling period for each of the areas surveyed are presented in Appendix Table A-13.

3.4.3 Coded wire tagging and recovery

A total of 31,396 tagged chum fry averaging 43 mm total length were released between May 22 and June 22, 1984 (Table 5). Tag retention rates ranged from 93.0 to 100% and averaged 96.4%. Mortality rates between tagging and release averaged 0.9% and ranged from 0.0 to 2.7%.

Table 5. Coded wire tag release data for chum salmon fry on the Susitna River by tagging site and release date, 1984.

Tagging Site (River Mile)	Number of Fish Tagged	Date of Release	Percent Tag Retention	Percent Mortality
Slough 22 (RM 144.3)	2,383	6/7	98.0	0.5
Slough 21 (RM 142.0)	2,201	6/3	96.6	1.4
Slough 20 (RM 140.1)	1,255	6/11	96.9	0.6
Slough 15 (RM 137.3)	351	6/14	100.0	0.0
Indian River (RM 138.6)	4,612	6/1	94.5	0.7
	341	6/1	93.0	0.0
	4,592	6/21	93.8	2.7[a]
	2,511	6/22	95.0	0.4
Slough 11 (RM 135.3)	2,031	5/22	97.7	0.1
	2,203	5/24	93.9	0.3
	572	5/24	99.0	0.2
	1,916	6/16	98.0	0.4
Slough 9 (RM 128.3)	5,122	6/6	99.4	0.7
Slough 8B (RM 122.4)	1,306	6/13	98.0	0.8
TOTAL - ALL SITES	31,396	5/22-6/22	96.4	0.9

[a] High mortality due to injury from improper headmold.

Fifty-one tagged chum salmon fry (0.2% of the total tagged chum released) were recovered from the 3,590 chum salmon fry captured and examined for tags at the Talkeetna Station outmigrant traps during 1984. In addition, two chum fry with clipped adipose fins but no coded wire tags were recovered in the traps. When compared to the total tagged chum salmon fry recovered, this provides a tag retention rate at the traps of 96.2%.

Trap recoveries of tagged chum fry were made from 0 to 29 days (mean = 8 days) following their release at the tagging sites (Fig. 37).

The ratio of coded wire tagged chum fry to the total number of fish caught at each trap at Talkeetna Station was 0.016:1 at Trap 1 and 0.013:1 at Trap 2, indicating that the tagged chum fry were randomly distributed with the untagged population by the time they migrated past the traps.

3.4.4 Population estimates and survival rates of outmigrants

Adult population estimates at Curry Station during 1983 were 21,100 chum salmon with confidence intervals of 19,200 to 23,500 adults and females comprised 34.5% of these fish (Barrett et al. 1984). Fecundities of Susitna River chum salmon were determined during 1983 to be 2,850 eggs per female. Chum salmon milling was estimated at 40% (Barrett 1984). These data provided an estimate of total potential egg deposition of 12,448,000 eggs.

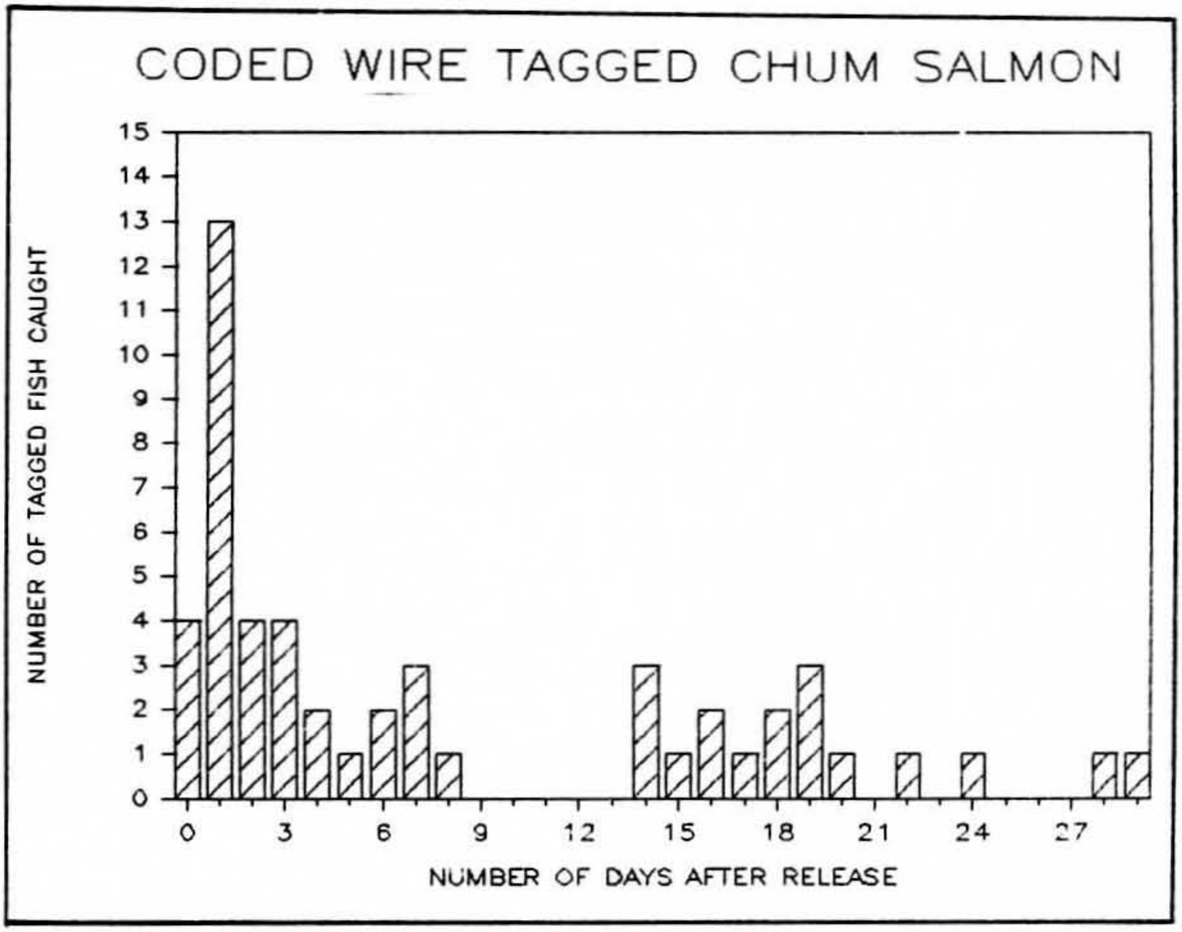

Figure 37. Length of time between the mark and recapture of coded wire tagged chum salmon juveniles in the middle reach of the Susitna River, 1984.

The population estimated using the Schaefer (1951) method was 2,039,000 chum salmon fry outmigrating past Talkeetna Station during 1984 (Appendix Table B-3 and B-4).

Using the above data, an egg-to-outmigrant survival rate of 16.4% was calculated for chum salmon with a confidence interval (from the adult population estimate) of 14.7 to 18.0%.

3.5 Pink Salmon

Sixty-eight pink salmon fry were captured between May 15 and July 18 at the Talkeetna Station outmigrant traps during 1984, with the peak catch rate of 0.8 fish per hour being recorded on June 18 (Fig. 38). Pink fry migrating past Talkeetna Station averaged 36 mm total length with a range from 29 to 53 mm.

A total of 405 pink salmon fry were collected in the stationary outmigrant trap at Flathorn Station. Catches occurred from May 21 through July 6 and the peak catch rate of 4.0 fish per hour was recorded on June 5 (Fig. 39). Fifty percent of the catches at this site were recorded by June 11. Pink fry collected at Flathorn Station averaged 34 mm and ranged in length from 25 to 46 mm.

No pink salmon fry were collected during the cold branding studies in the middle river, during sampling of the Deshka River, or at JAHS sites in the lower river during 1984.

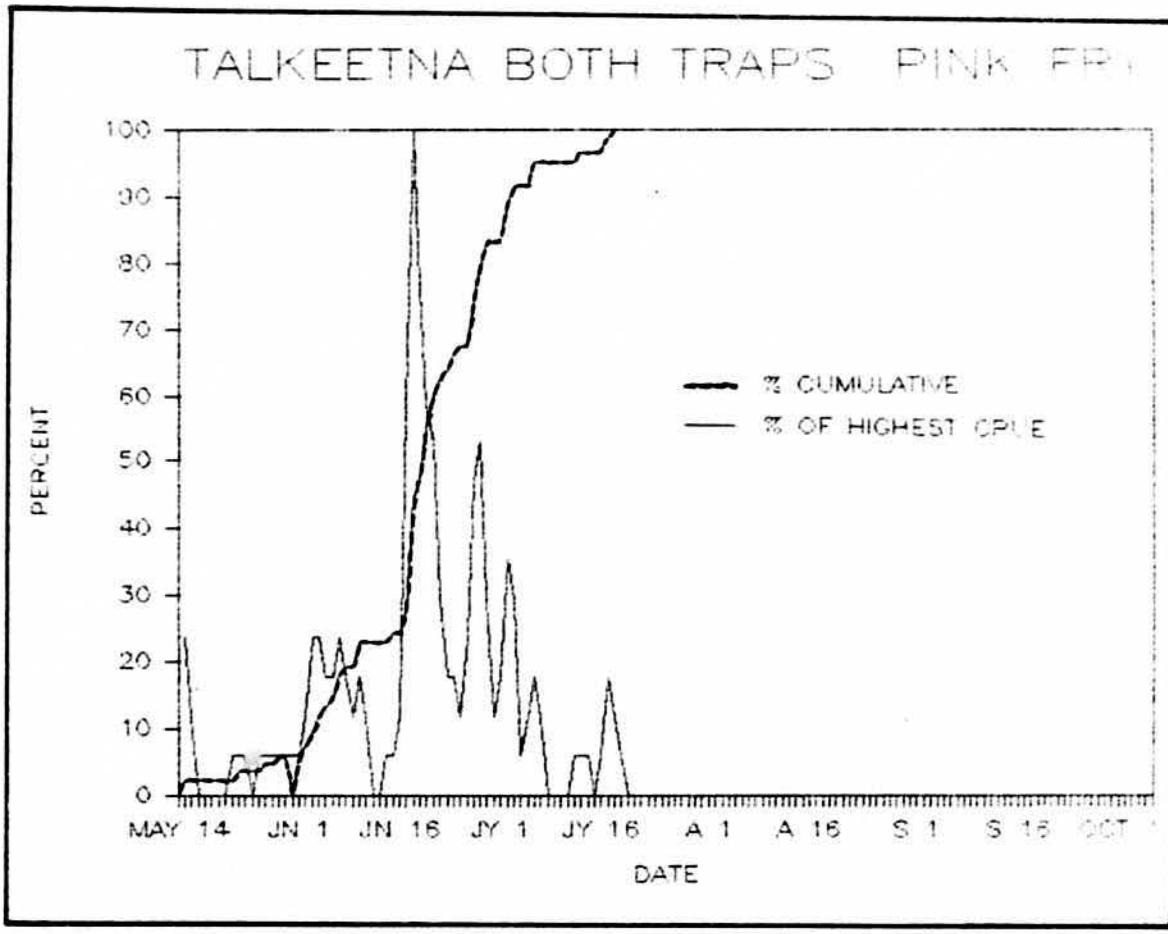

Figure 38. Pink salmon fry smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, May 14 through October 6, 1984.

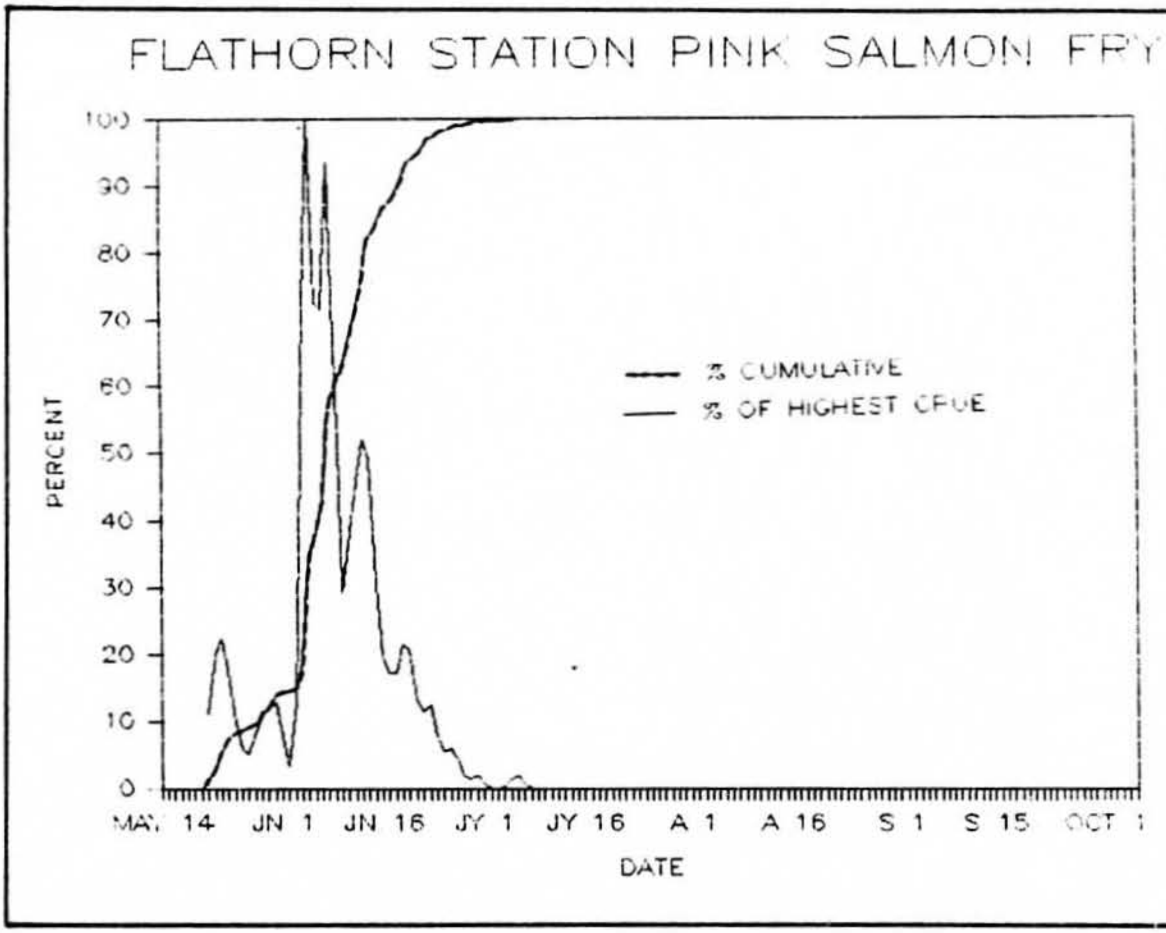

Figure 39. Pink salmon fry smoothed daily catch per unit effort and adjusted cumulative catch recorded at the Flathorn stationary outmigrant traps, May 20 through October 1, 1984.

3.6 Descriptive Statistics for Catch and Environmental Variables

Summary statistics for Talkeetna Station catch are given in Table 6 and for environmental variables in Table 7. Flathorn data are summarized in Table 8. The influence of discharge peaks on the level of outmigration can be seen by comparing the seasonal discharge level (Fig. 39A; Fig. 39B) with the outmigration plots presented earlier.

Table 6. Summary statistics for juvenile salmon catch per hour by species and age class recorded at the Talkeetna Station outmigrant traps, May 14 through October 6, 1984.

	Catch Per Hour, Both Traps[a]			
	Min	Max	Mean	Std. Dev.
Chinook 0+	0.0	17.2	2.2	3.2
Chinook 1+	0.0	3.5	0.3	0.6
Coho 0+	0.0	2.9	0.3	0.4
Coho 1+[b]	0.0	1.7	0.3	0.3
Sockeye 0+	0.0	13.0	1.2	1.8
Sockeye 1+	0.0	0.3	0.0	0.0
Chum	0.0	8.0	0.7	1.2

[a] N = 146

[b] includes all juvenile coho age 1+ or older.

Table 7. Summary statistics for habitat variables recorded on the Susitna River between the Chulitna River confluence and Devil Canyon, May 14 through October 6, 1984.

	Min	Max	Mean	Std. Dev.	n
Discharge (ft^3/sec)[a]	6,780	52,000	19,405	8160.0	146
Water Temperature (°C)[b]	2.0	13.5	8.8	3.0	145
Turbidity (NTU)[b]	13	400	115	92.0	145

[a] USGS provisional data at Gold Creek, 1984.

[b] ADF&G data at Talkeetna Station outmigrant traps, 1984.

Table 8. Summary statistics for juvenile salmon catch per hour by species and age class recorded at the Flathorn Station outmigrant traps, May 20 through October 1, 1984.

Catch Per Hour[a]	Min	Max	Mean	Std. Dev.
Chinook 0+	0.0	7.8	0.7	1.1
Chinook 1+	0.0	6.5	0.1	0.6
Coho 0+	0.0	1.5	0.1	0.3
Coho 1+[b]	0.0	0.8	0.1	0.1
Sockeye 0+	0.0	4.6	0.8	0.8
Sockeye 1+	0.0	0.4	0.0	0.1
Chum	0.0	10.9	0.3	1.1
Pink	0.0	4.0	0.2	0.5
Discharge (ft^3/sec)[c]	40,800	166,000	93,122	28,887.5

[a] n = 134.

[b] Includes all juvenile coho age 1+ or older.

[c] USGS provisional data at Susitna Station, 1984.

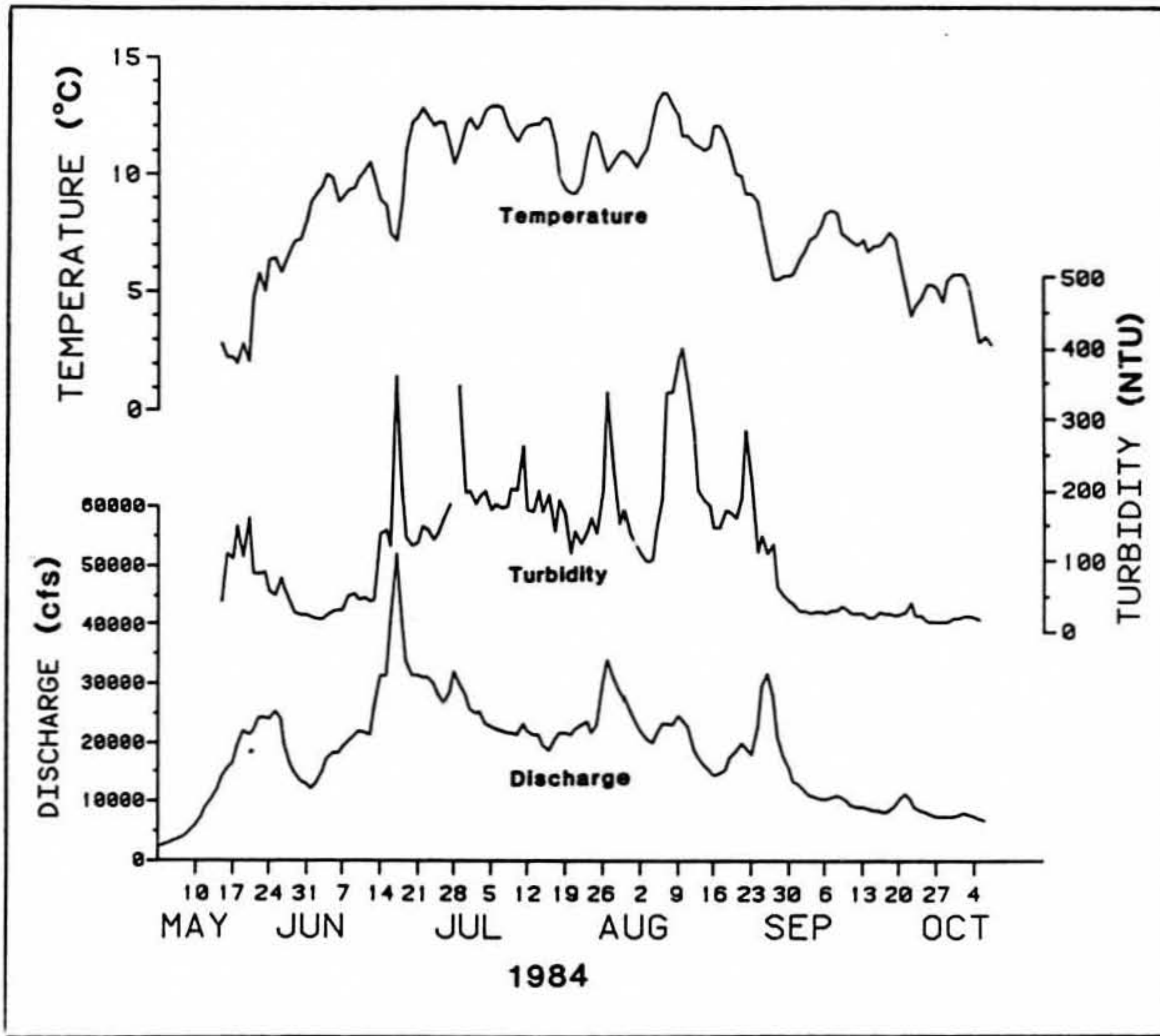

Figure 39A. Mainstem discharge, water temperature, and turbidity in the middle reach of the Susitna River, 1984. Discharge was measured at the USGS gaging station at Gold Creek. Water temperature and turbidity were measured at Talkeetna Station.

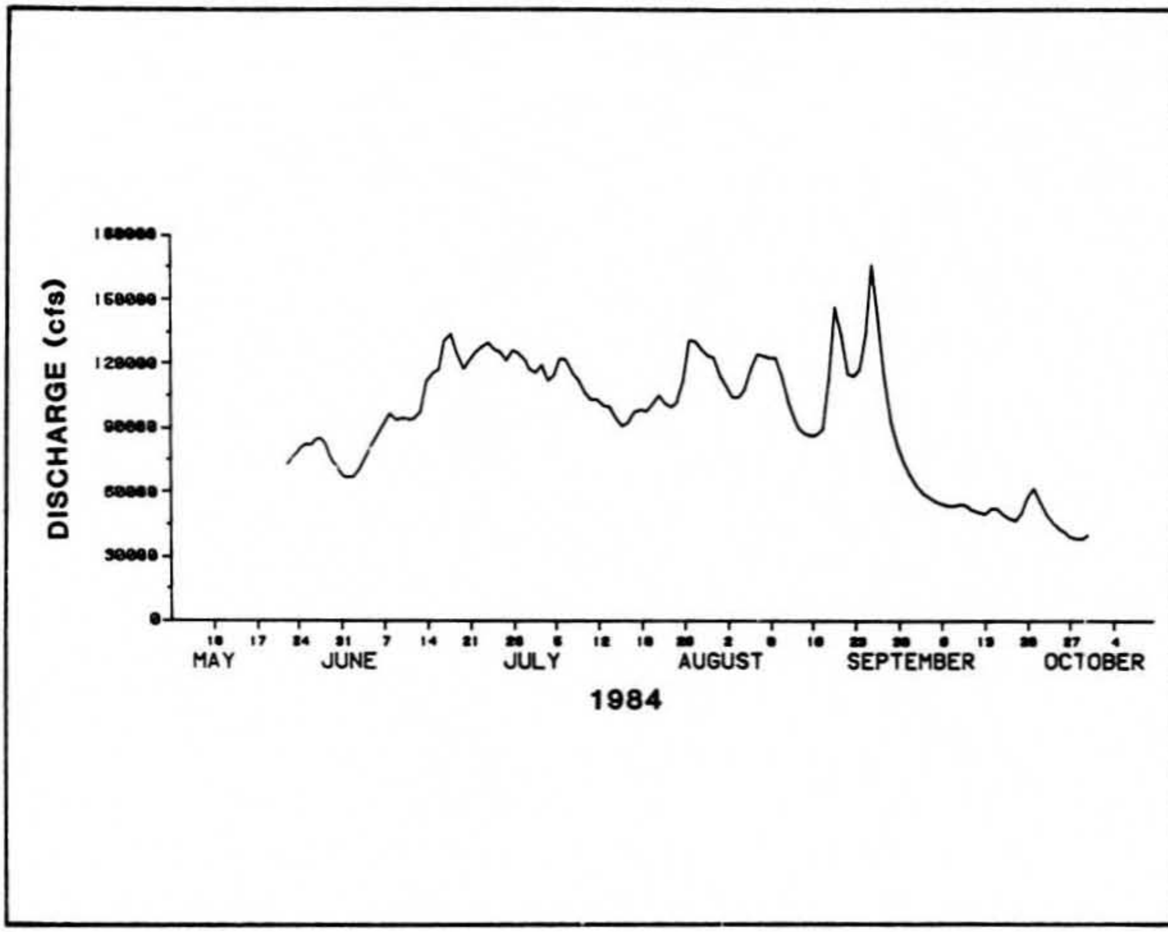

Figure 39B. Mainstem discharge in the lower reach of the Susitna River measured at the USGS gaging station at Susitna Station, 1984.

4.0 DISCUSSION

4.1 Chinook Salmon

4.1.1 Outmigration

Fifty percent of the outmigration of age 0+ chinook salmon past Talkeetna Station during both 1983 and 1984 had occurred by mid July, but the rates and timing were different between the two years (Fig. 40). During 1983, two pulses of chinook fry movement were recorded, one in late June and the second in mid August. Conversely, the 1984 outmigration did not start until mid June and was then relatively steady through late August.

Low tributary flows during July of 1983 trapped chinook fry in pools and side channels in Indian River until high tributary flows from heavy rainfall in mid August allowed access or flushed fry to the Susitna River (Roth et al. 1984). In 1984, minnow trap catches of marked and unmarked chinook in Indian River during the cold branding study showed the movement of chinook fry out of this tributary continued from July through early October.

In 1984, age 0+ chinook salmon in the middle river that had outmigrated from the tributaries were found predominately in shallow, turbid, rocky bottom areas in breached sloughs and side channels during July and August. Not until mid August, when mainstem flows had decreased and

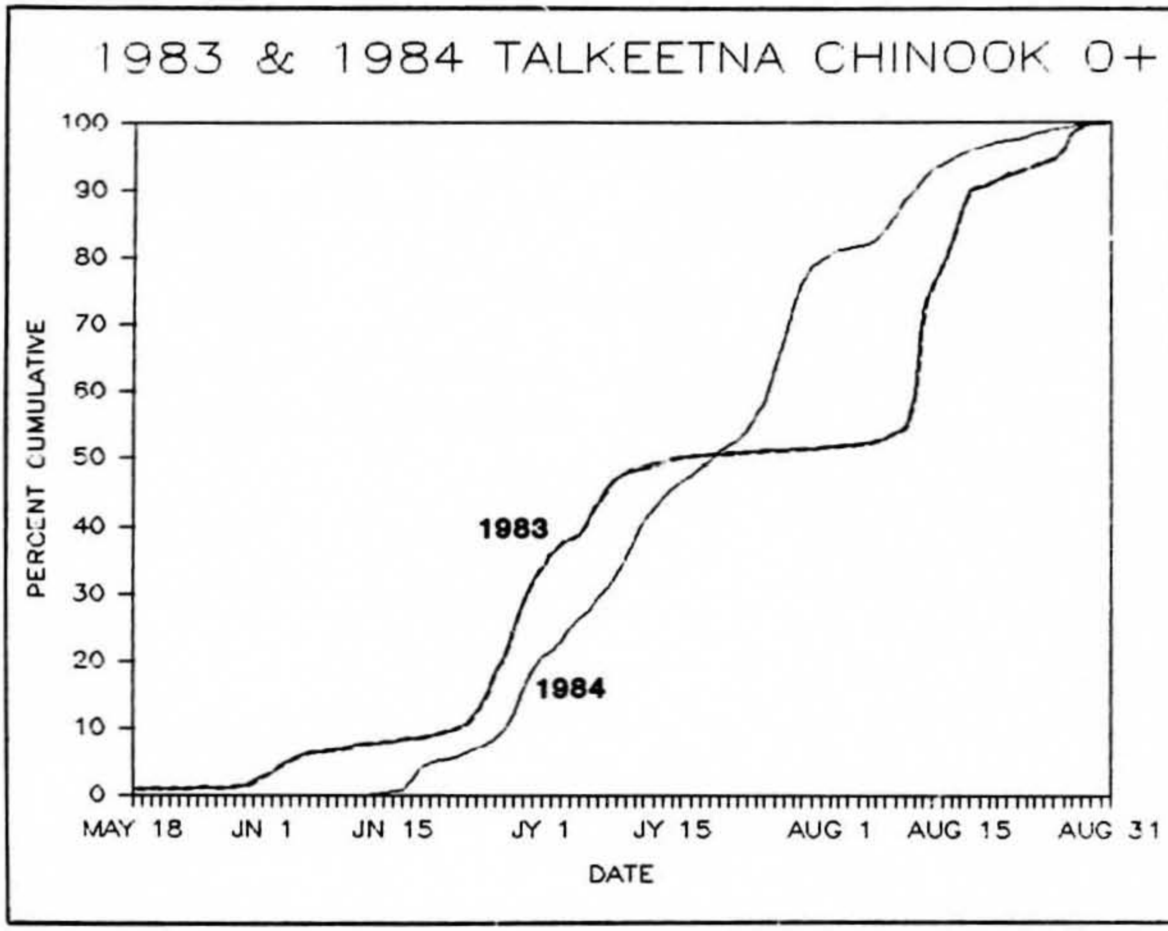

Figure 40. Chinook salmon (age 0+) adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

many of these sloughs and side channels were no longer breached, did catches of juvenile chinook increase at clear water sloughs and side channels. In early September, juvenile chinook were concentrated at the mouths of clearwater sloughs and side channels, but as water temperatures and stage continued dropping through September and early October, these fish slowly dispersed throughout these sites with the major concentrations being found in areas with non-imbedded substrate and a groundwater source.

The rates of outmigration of age 1+ chinook salmon past Talkeetna Station were similar in 1983 and 1984 (Fig. 41), but the date by which half of the total seasonal outmigration occurred was ten days earlier in 1983 than in 1984, primarily because of the late start of outmigration in 1984.

The chinook fry appear to associate with the banks of the river during their downstream movement. Although juvenile chinook were captured across the entire river at Flathorn Station, 60% of the total mobile trap captures were recorded at bank transect sites.

4.1.2 Freshwater life history

Chinook salmon juveniles in the middle river appear to group into at least two separate categories. The first group are those juveniles which rear and overwinter in their natal tributaries and outmigrate to the ocean as age 1+ fish during the spring of their second year. The second group of chinook juveniles spend a portion of their first summer

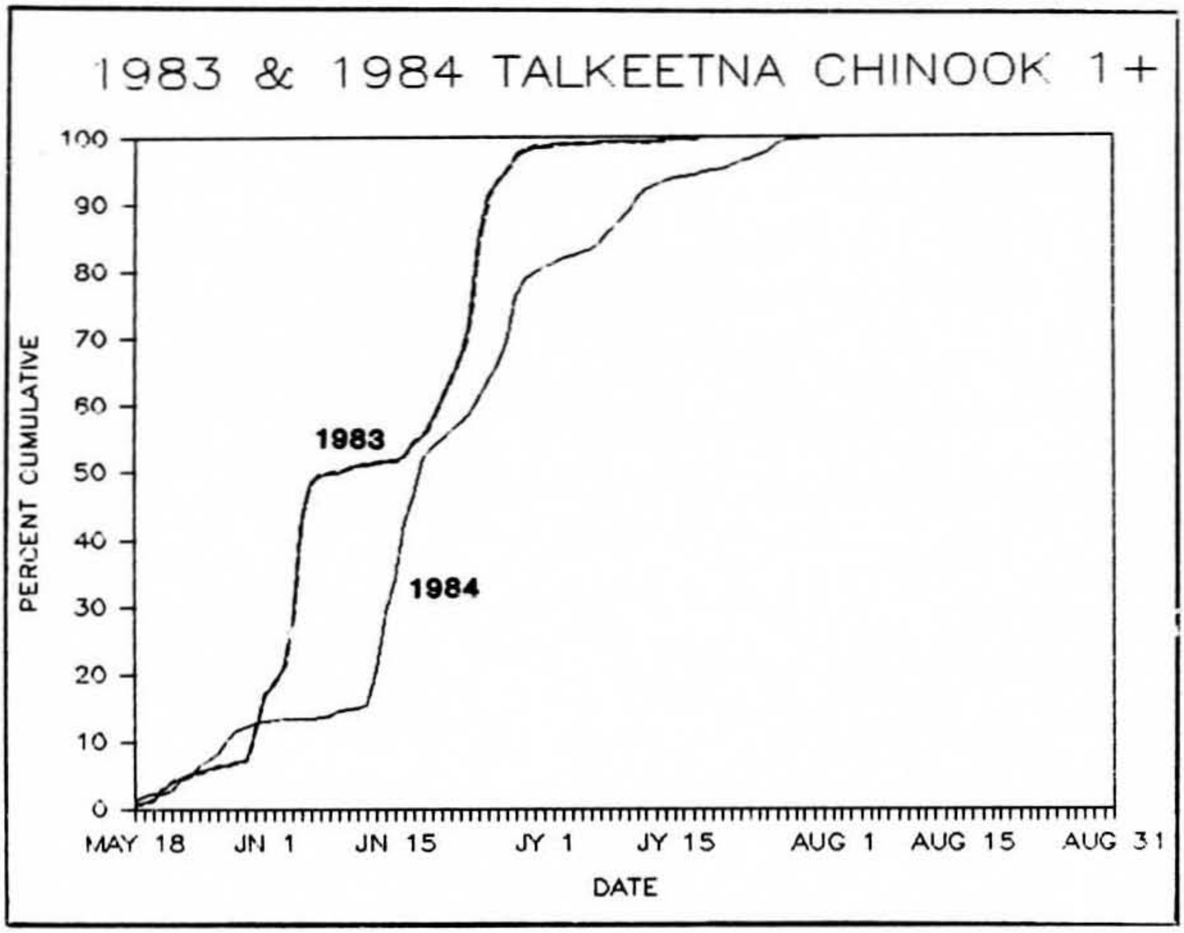

Figure 41. Chinook salmon (age 1+) adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

in their natal tributaries and then, probably because of density dependent interaction of flushing by high flows, enter the mainstem river. These fish actively search out suitable habitats as they move downstream. Many of the fish enter sloughs and side channels in the middle river to overwinter while others continue downstream to the lower river.

Since 80% of the Talkeetna Station trap catch had occurred by August 1, and high catches were recorded at Indian River and selected sloughs above Talkeetna Station in August, September, and October, it appeared that a significant percentage of 1983 brood year chinook salmon were going to overwinter in the middle river. Previous winter sampling has not been successful in locating large concentrations of juvenile chinooks in this reach (ADF&G 1982). Possible reasons are: 1) the much higher adult chinook escapement in 1983 than in 1980, 2) the winter sampling during 1981 was conducted in January, February, and March when water temperatures approach 0°C, and the behavior of the fish may change in that they go into the substrate and are less susceptible to capture, and 3) the sampling methods and intensity at selected sites were limited during the 1981 sampling. (Ed. Note: Sampling during the winter of 1984-1985 has confirmed the presence of large numbers of chinook fry in this reach).

A third group of chinook salmon juveniles may be present in the Susitna River. Data collected at the Flathorn Station outmigrant trap showed that a portion of the age 0+ chinook were moving downstream past this site. Although it is possible that these fish may overwinter in freshwater habitats below Flathorn Station, it appears that many of these fish would enter the ocean as age 0+ fish. Scale samples collected from returning adults indicated that this age class of outmigrants represented less than 3% of the middle river returning chinook during 1983 (Barrett et al. 1984) and less than 1% in 1984 (Barrett et al. 1985).

Intermittent operation of an outmigrant weir on the Deshka River during 1984 showed that a large number of chinook fry were outmigrating from this tributary during July and August. Similar data were collected in 1980 by Delaney et al. (1981), who postulated that the observed outmigration was a size related response as the fish reached approximately 80 mm and that the chinook fry were able to reach this critical size during even numbered years of high pink salmon escapement and related abundant food supplies. It is not known whether these fish remain in habitats associated with the mainstem river or if they continue to the ocean as age 0+ fish, but data collected at JAHS sites below the Deshka River during 1984 indicated that very few chinook fry were rearing in this area.

If it is assumed that a large percentage of Susitna River chinook salmon do migrate to the ocean as age 0+ fish, then either (1) the marine survival of this age class is very low or (2) the adult scales were not interpreted correctly. Age 0+ outmigrants may possibly form a transition check or other similar tightening of the circuli on their scales during their entry into the ocean in the summer of their first year, and this check may be interpreted as a freshwater annulus on the scales of returning adults. This could reduce the percentage of adults determined to have outmigrated as age 0+ fish and would result in underestimation of the importance of this age class to the total population of returning adults.

Richards (1979) showed that a major portion (72%) of the adult scales analyzed from the Deshka River during 1978 showed that the fish had migrated to the ocean during their first summer as age 0+ fish. Scale analysis from creel census samples collected in the Deshka River have classed these fish as predominantly age 1+ outmigrants (Kubik 1967; Kubik and Wadman 1978; Kubik and Delaney 1980).

These data indicate that a reevaluation of the criteria used to determine the period of freshwater residence from adult salmon scales is needed. Additional tests would be helpful in verifying the age of chinook outmigrants from the Susitna River and in determining the contribution of each age class to the population of returning adults. A comparison of freshwater growth recorded on juvenile scales collected at the mouth of the Susitna River to the scales of returning adults would be beneficial. Also, the collection of chinook juveniles in the Cook Inlet estuary would allow the comparisons of circuli formation during the period of transition from freshwater to ocean growth. Additionally, a comparison of ages determined from scales and otoliths may provide insight into the freshwater histories of chinook salmon in the Susitna River.

4.1.3 Estimates of population and survival

Population estimates for Indian River chinook salmon juveniles (3,211,000 in 1984) and the estimated survival rate of 30.2% are much higher than what we believe to be the true values. This is due to the late start of sampling (mid July), intermittent sampling throughout the season, and the presence of two separate populations; those fish which overwinter in the middle river and those fish which migrate to habitats in the lower river. More valid population estimates would be obtained if sampling was conducted throughout the open-water season at these sites and if a method of distinguishing the sub-populations was developed.

Attempts were made during July and early August to estimate the juvenile chinook populations and residence times in selected sloughs and side channels of the middle river using the Jolly-Seber model (Ricker 1975). Both population estimates and residence timing varied so greatly day to day and site to site, due mostly to differences in individual site habitat, fluctuating flow conditions, and the resultant changes in gear effectiveness, that these estimates were deemed invalid. Studies of residence time did show, however, that at the majority of the sites sampled, large breaching flows had a flushing effect in that branded fish were displaced out of the site but, at the same time, new fish migrated in to replace these outmigrants.

4.1.4 Growth

The increase in mean length of age 0+ chinook by sampling period for the combined data collected at the Talkeetna Station outmigrant traps during 1982, 1983 and 1984 is presented in Fig. 42. Chinook fry which emerge from the gravel at an average length of approximately 37 mm have, by early June, increased to an average of 44 mm. By the end of the open-water season, chinook fry in the middle river had a mean length of 63 mm. Chinook fry collected in the lower river in 1984 averaged from two to ten mm larger than their counterparts in the middle river through the season (Fig. 14).

Outmigrating age 1+ fish, after overwintering in the middle reach, increased 10 mm in length during June and July and averaged 90 mm during the peaks of outmigration.

Examination of the downstream redistribution of juvenile chinook salmon in the Susitna River by age class during 1984 as the percent cumulative of the total catches recorded at Talkeetna and Flathorn Stations compared to the calculated percent cumulative biomass moving past these sites shows that chinook fry in the middle river averaged approximately the same length (50 to 55 mm) throughout the period of peak outmigration (late June through early August), resulting in very little separation between cumulative movements recorded for catch and biomass at Talkeetna Station (Fig. 43). The outmigration of chinook fry in the middle river appears to be triggered, in part, by the fish reaching a critical size.

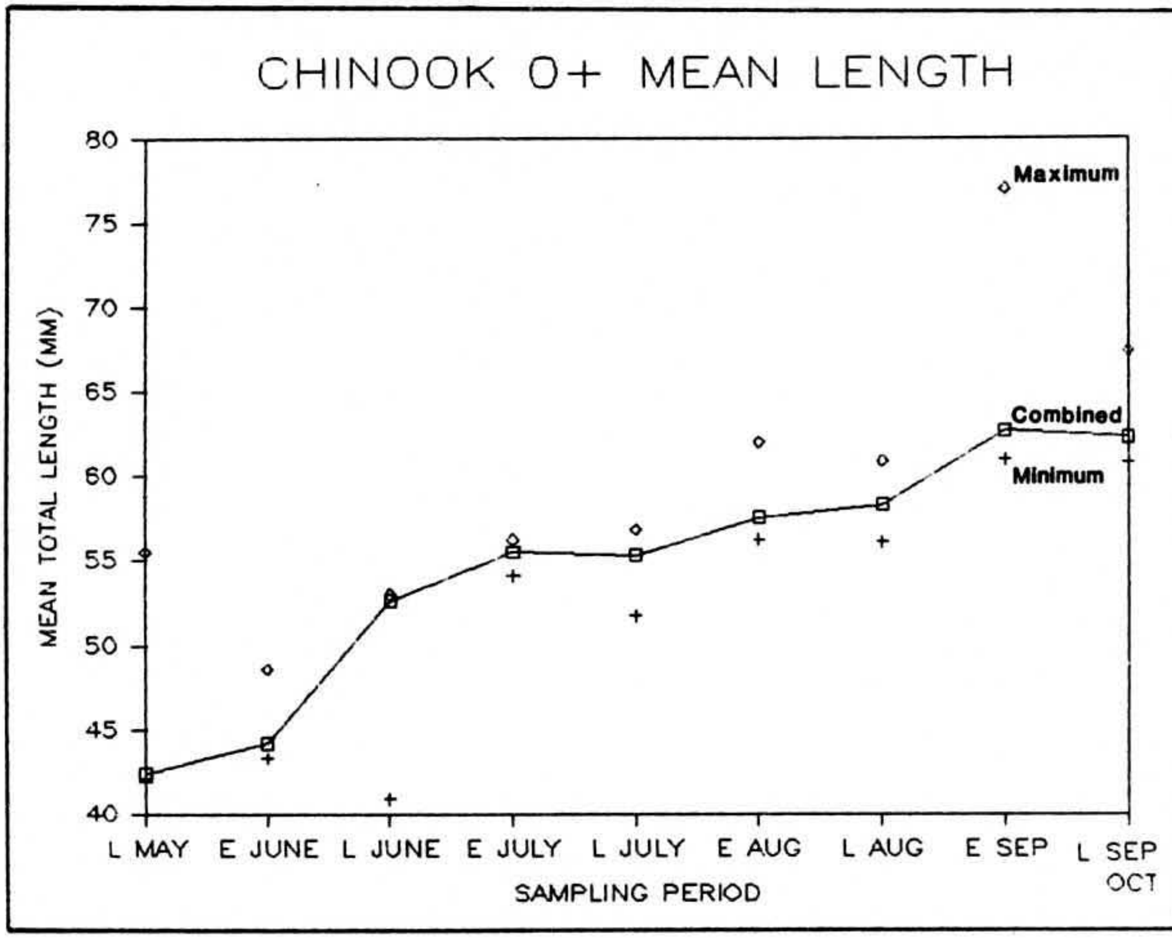

Figure 42. Chinook salmon (age 0+) mean length and range of mean lengths by sampling period recorded at the Talkeetna stationary outmigrant traps during 1982, 1983, and 1984.

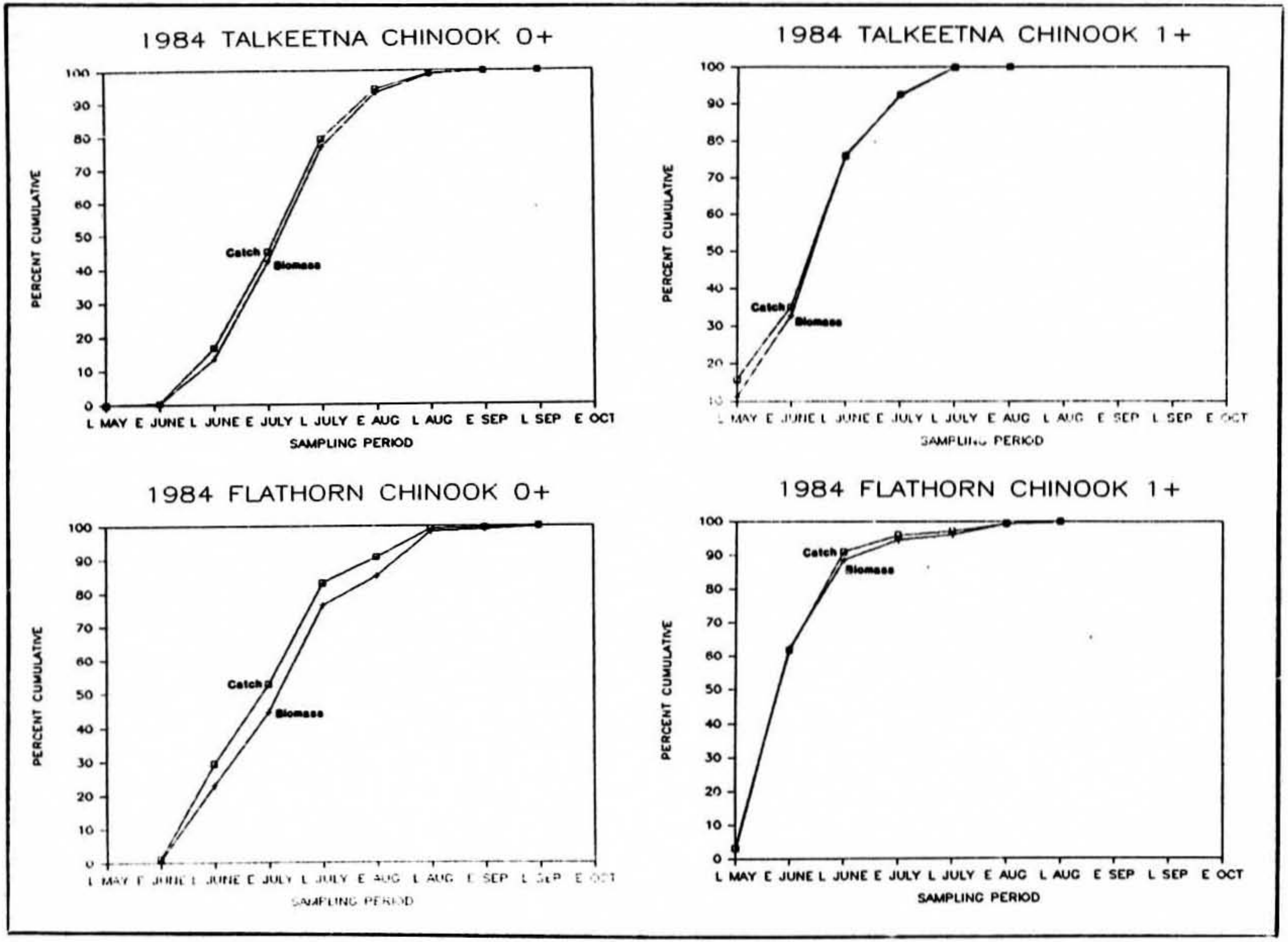

Figure 43. Chinook salmon adjusted cumulative catch and biomass by age class recorded at Talkeetna and Flathorn stations, 1984.

As they reach this critical size, chinook fry which have not found suitable habitat conditions, redistribute downstream to other rearing areas.

In the lower river, total biomass movements were delayed in comparison to the total number of chinook fry moving past Flathorn Station (Fig. 44). This was due to the growth occurring in the lower river and because of the mixed stocks present in this reach.

4.2 Coho Salmon

4.2.1 Outmigration

The downstream movement of coho salmon fry past Talkeetna Station is compared for 1983 and 1984 in Fig. 44. Although the outmigration from May through early July was slower during 1984, 50% of the total season outmigration was recorded ten days earlier in 1984 than in 1983. The delay in downstream movement observed during July of 1983 was due in part to low tributary water levels during this period, and the high rates of downstream movement recorded in mid August corresponded to a period of heavy rainfall and high tributary discharges.

The downstream movement of age 1+ coho salmon past Talkeetna Station was approximately two weeks later in 1984 than in 1983 while the rates of movement were fairly stable throughout both seasons (Fig. 45).

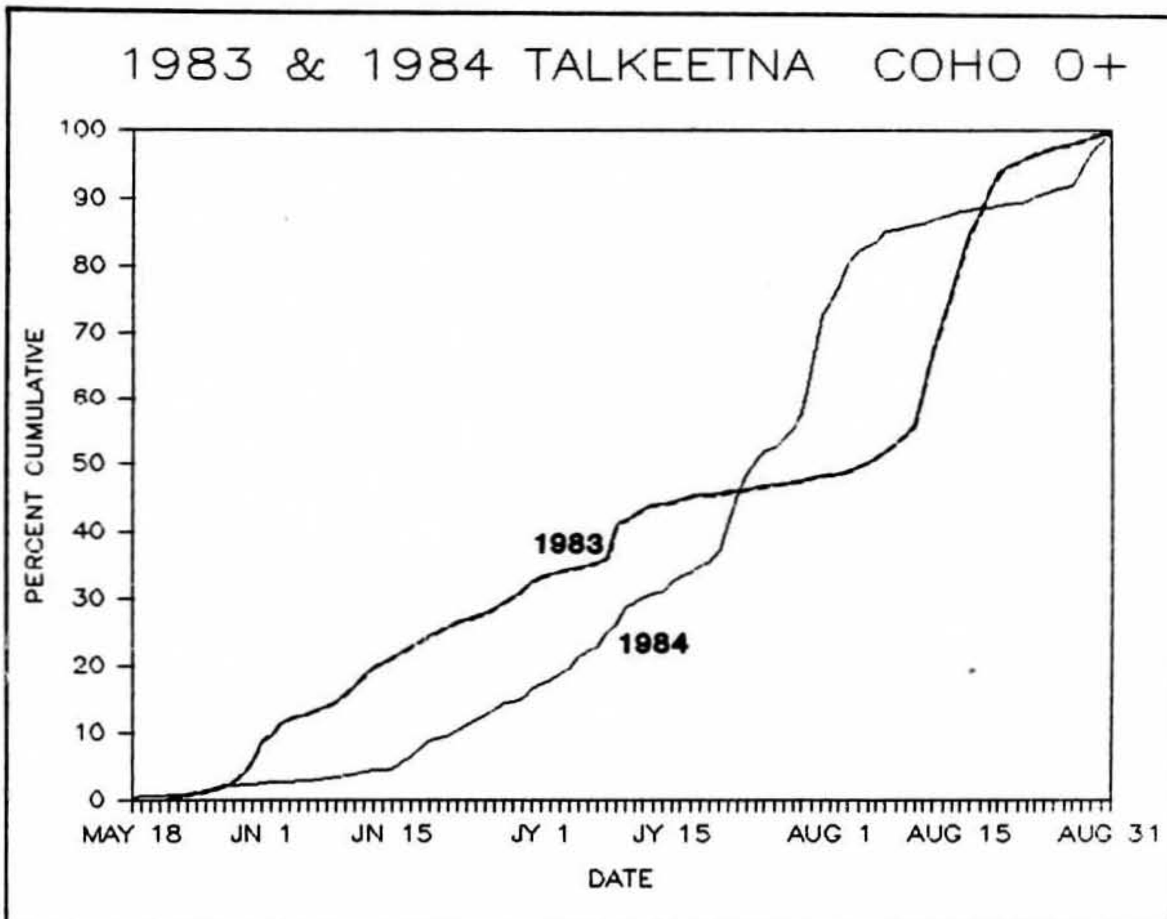

Figure 44. Coho salmon (age 0+) adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

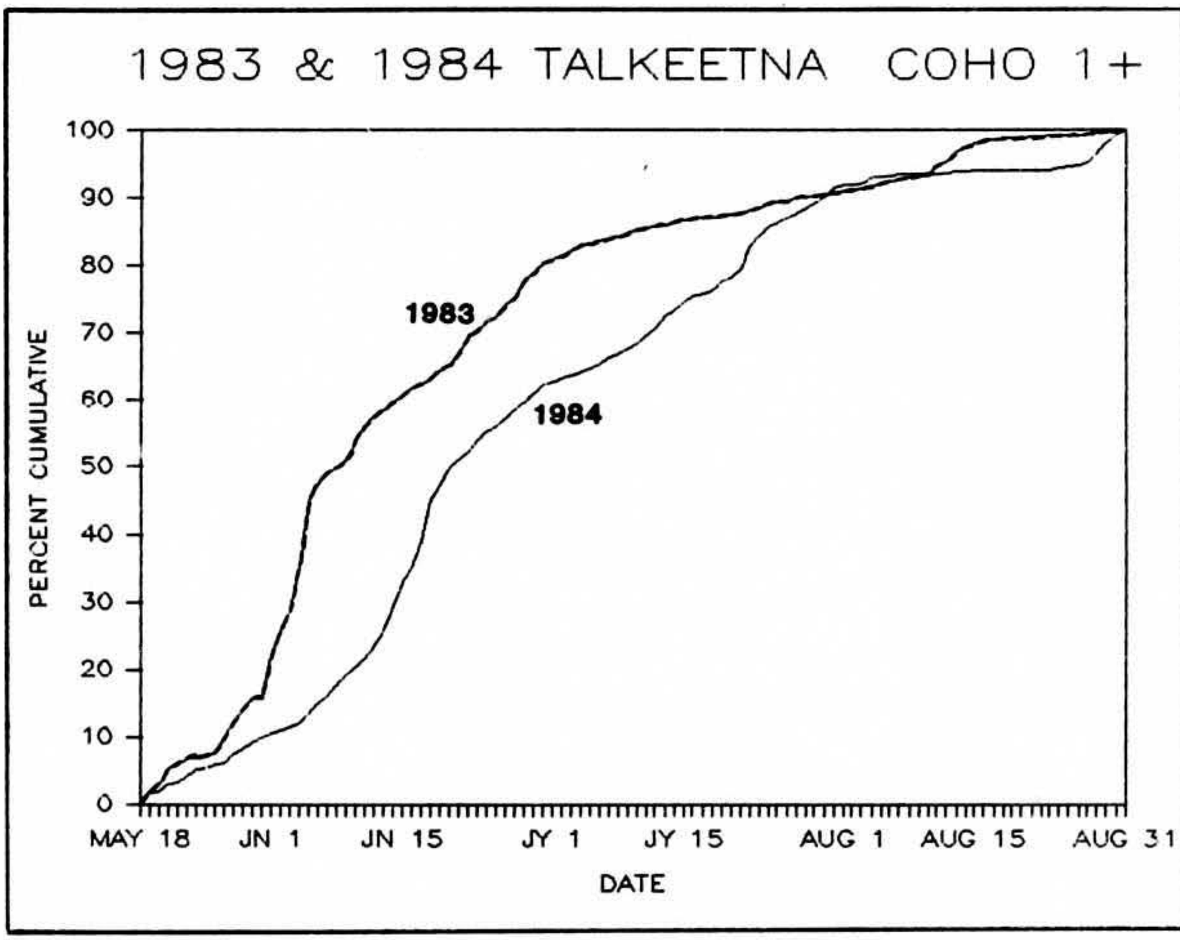

Figure 45. Coho salmon (age 1+) adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

4.2.2 Freshwater life history

Most coho salmon juveniles spend one or more years in the Susitna River before migrating to the ocean. Analysis of scales from returning adults indicate that most juvenile coho outmigrate as either age 1+ or age 2+ but the proportion of each age class has varied between years (ADF&G 1982; ADF&G 1983; Barrett et al. 1984; Barrett et al. 1985).

Coho salmon in the middle Susitna River spawn almost exclusively in the tributaries and the fry, after emergence, rear in their natal tributaries or enter the mainstem river in search of suitable habitats. Outmigrant trap data collected at Talkeetna Station have shown a downstream redistribution of juvenile coho occurring throughout the open-water season. These coho then move into tributaries, sloughs, beaver ponds, or other habitats to overwinter. Similar redistributions of juvenile coho were observed by Delaney and Wadman (1979) and by Tschaplinski and Hartman (1983).

Trap catches recorded at Talkeetna Station during 1982 and 1984 showed that high pulses of juvenile coho catches occurred during September or early October. It was presumed these fish were redistributing to habitats in the lower river to overwinter, but the data collected at Flathorn Station in 1984 indicate that a portion of these fish may be migrating to the ocean during the fall (Fig. 18). This fall outmigration of juvenile coho may be an adaptive response to deteriorating freshwater habitat conditions. Considering the high mortalities which would be expected if the fish overwintered in freshwater, ocean conditions (though less than optimum) may provide more favorable and abundant habitat through the winter resulting in an increased survival for these fish.

4.2.3 Growth

The change in mean length for age 0+ coho by sampling period for the combined data collected at the Talkeetna Station outmigrant traps during 1982, 1983, and 1984 is presented in Fig. 46. Coho salmon in the middle river emerge from the gravel at approximately 35 mm and have increased to 45 mm by early July. By the end of the open-water season, coho fry have obtained a mean length of approximately 68 mm. Throughout the season, age 0+ coho in the lower river averaged at least five millimeters larger than fish collected in the middle river (Fig. 22).

Age 1+ coho salmon in the middle river also showed a steady growth through the season (Fig. 47) increasing approximately 45 mm between late May and early October. Similar to age 0+ coho, age 1+ coho collected in the lower river averaged larger than fish captured in the middle river reach (Fig. 23).

The downstream redistribution (as shown by the cumulative biomass) of juvenile coho salmon in the Susitna River by age class during 1984 averaged one to two weeks later than the redistribution of the total number of individuals recorded at both the Talkeetna and Flathorn Station outmigrant traps (Fig. 48). The difference between the

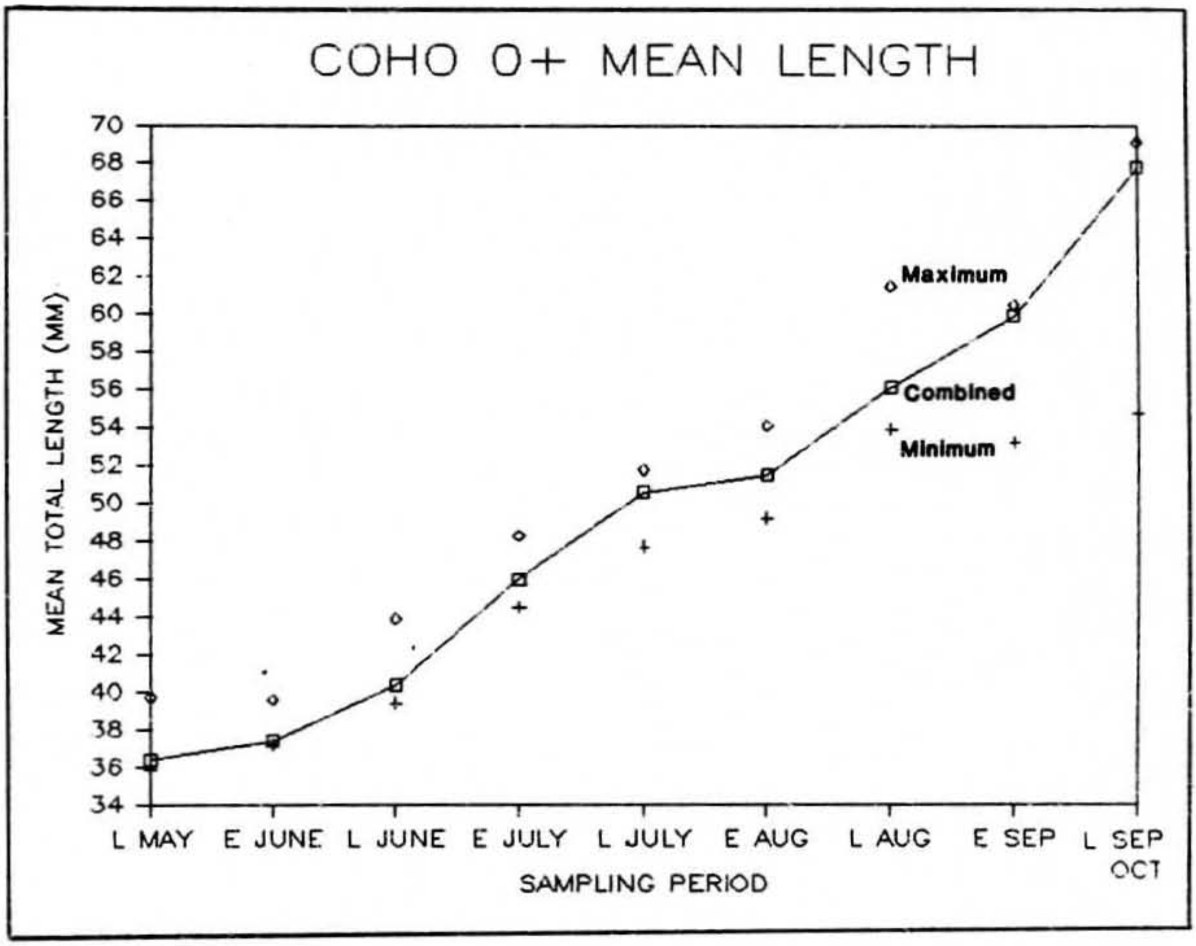

Figure 46. Coho salmon (age 0+) mean length and range of mean lengths by sampling period recorded at the Talkeetna stationary outmigrant traps during 1982, 1983, and 1984.

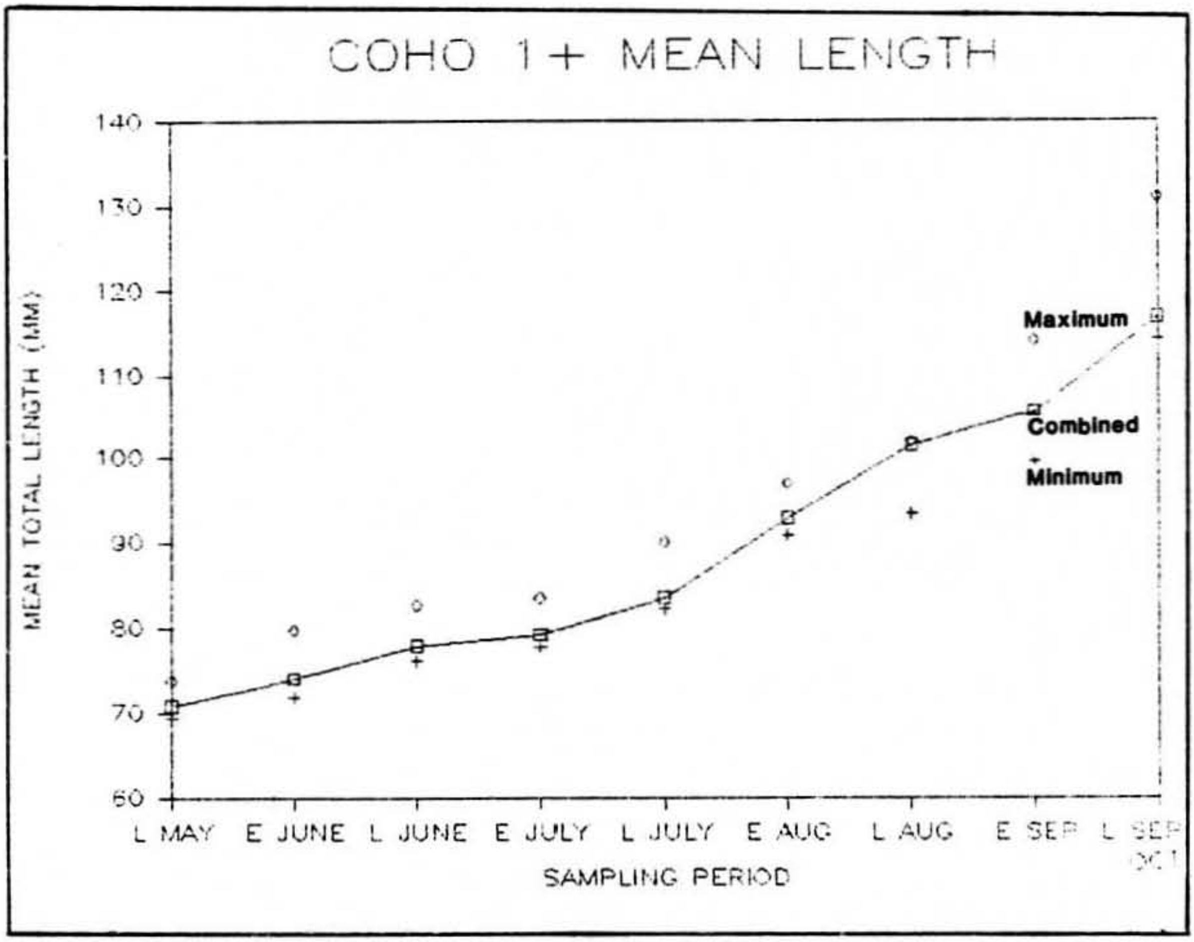

Figure 47. Coho salmon (age 1+) mean length and range of mean lengths by sampling period recorded at the Talkeetna stationary outmigrant traps during 1982, 1983, and 1984.

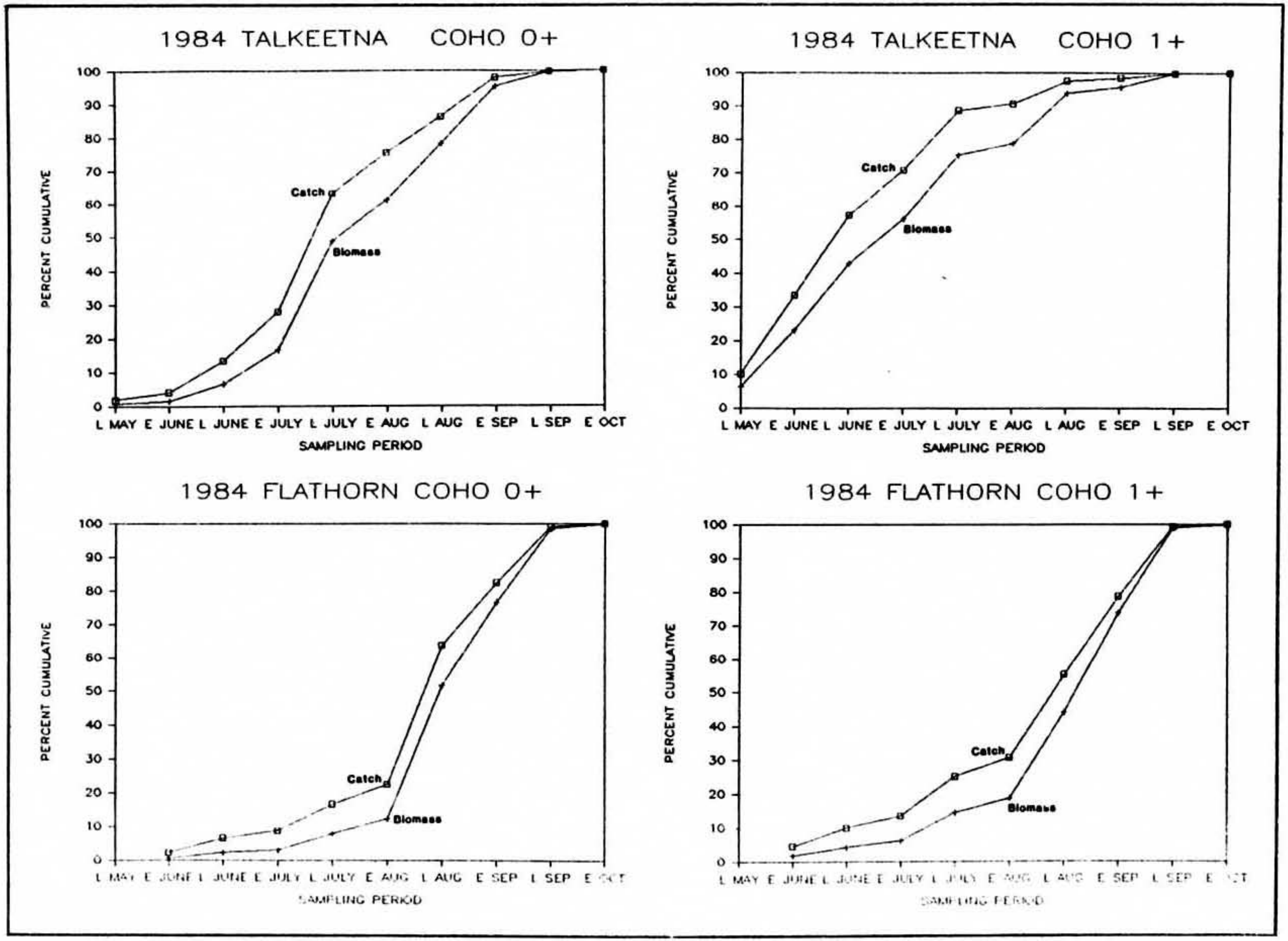

Figure 48. Coho salmon adjusted cumulative catch and biomass by age class recorded at Talkeetna and Flathorn stations, 1984.

cumulative biomass movement and the movement of total numbers of fish results from the growth of juvenile coho occurring during the open-water season. It if is presumed that larger fish have a greater chance of surviving due to their comparatively larger size and increased mortality, then fish which have spent more time in the river (and are thus larger) are of more value than those fish which outmigrated earlier. Any determinations made concerning mitigation activities for these fish should then consider the timing of movement of total biomass in the river rather than formulating actions only from the catch data.

4.3 Sockeye Salmon

4.3.1 Outmigration

The migration of sockeye salmon fry past Talkeetna Station during 1984 was similar to the timing recorded during 1983 (Fig. 49). Fifty percent of the total outmigration was recorded by the end of June during both seasons. Sockeye fry were steadily redistributing to areas below the sampling site from break-up through late August. Sampling of sloughs and side channels in the middle river during the cold branding study showed that sockeye fry were not actively outmigrating but were entering habitats along the margins of the river as they moved downstream. The fry probably remain at these sites until (1) they are displaced by flows or density interactions, (2) adequate food supplies are no longer available, or (3) the habitats become otherwise unsuitable.

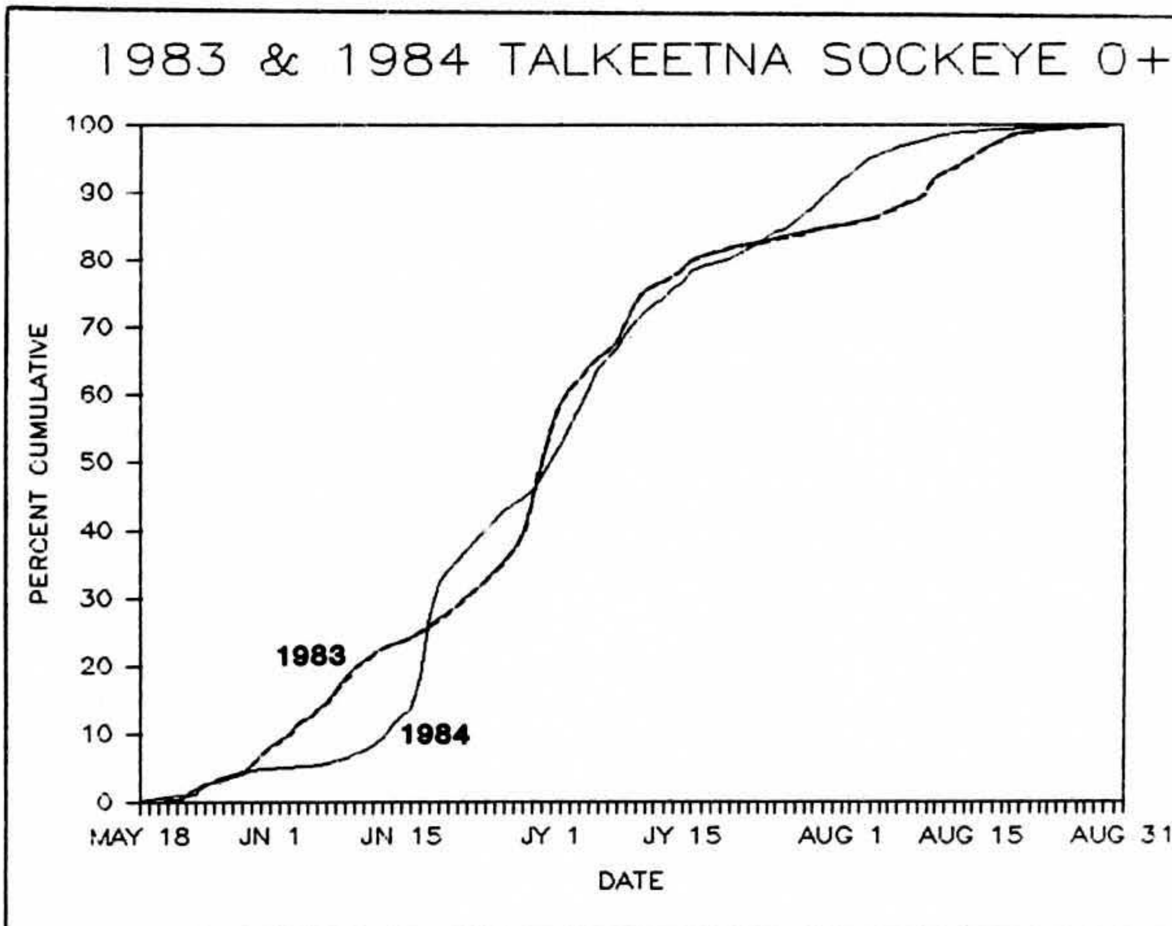

Figure 49. Sockeye salmon (age 0+) adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

The tendency of sockeye fry to orient along the banks of the river during their downstream migration is shown by the outmigrant trap recoveries of sockeye at Talkeetna Station. The Susitna River at this site is approximately 600 feet wide during mean summer flows (USGS provisional data). The two bank traps combined sampled approximately 1.5% of the total river width at this site but captured 2.5% of the total sockeye fry estimated (from coded wire tag recoveries) to be migrating past the traps during 1984, indicating that these fish orient near the banks during their downstream migration. This was also observed at Flathorn Station where 59% of the total sockeye fry collected in the mobile trap were captured at bank transect points.

The rates of downstream movement for coded wire tagged sockeye fry during 1984 showed that fry in the middle river, after tagging, spent an average of 35 days (range from 0 to 109 days) in the middle river before migrating past Talkeetna Station.

4.3.2 Freshwater life history

Outmigrant trap data collected at Talkeetna Station during the past three seasons (1982-1984) show that a large number of sockeye fry migrate out of this reach as age 0+ fish, but scale analysis of adult sockeye collected at Curry Station showed that this age class represented only 6.4% of the returning adults during 1984 (Barrett et al. 1985). The largest percentage of returning adults were comprised of fish which had spent one winter in freshwater before going to the ocean.

The apparent discrepancy in these data leads to confusion about the early life history of sockeye salmon in the middle reach of the Susitna River.

Bernard et al. (1983) analyzed scale patterns from samples of adult sockeye salmon collected from four different sites in the Susitna River watershed in an attempt to delineate the differences in scale patterns for the period of freshwater growth for each of the sites. Samples were collected from escapements of sockeye salmon at Curry and Talkeetna stations on the Susitna River, from the outlet of Larson Lake on the Talkeetna River, and from the Tokositna River which is a tributary to the Chulitna River. This study found that sockeye salmon samples collected from the Susitna River sites could not be distinguished from those of Tokositna or Larson Lake fish.

Six hypotheses were suggested by Bernard et al. (1983) for the lack of unique differences in the scale patterns between Susitna River fish and those collected from the other sites. In general, these hypotheses can be separated into two groups: 1) The Susitna River fish are a unique stock but the fry rear in environments similar to those found in Larson Lake and the Tokositna River, or 2) the sockeye salmon spawning in the Susitna River are strays from either the Talkeetna or Chulitna watersheds and their fry move into these watersheds to rear or are displaced downstream and enter the ocean as age 0+ fish. If these fish enter the ocean as age 0+ fish, scale analysis of returning adults indicates that survival of these fish is very low.

The study conducted by Bernard et al. (1983) was based on the assumption that sockeye fry did not rear in the middle Susitna River, but the data collected at the Talkeetna Station outmigrant traps during the past three years has shown that substantial sockeye rearing occurs in this reach.

Three problems exist with the studies conducted by Bernard et al. (1983). First, they analyzed scales from only 1.3 age fish (European formula). Barrett et al. (1984) has shown that multiple age classes are present in the middle Susitna River escapements. Juvenile sockeye salmon outmigrating from Larson Lake predominantly spend two winters in freshwater before outmigrating from the lake as smolts (Marcuson 1985) so this factor alone would make it possible to accurately separate most of the Susitna River fish from the Larson Lake stocks.

Secondly, a small sample size was used in the study. Only 43 of the 104 scale samples collected at Curry Station met the age criteria for the study which is an insufficient sample size for this type of analysis.

The third and probably most significant item is that the Susitna River samples were collected at the fishwheel sites rather than at the spawning grounds. Barrett (1984) has pointed out that a high percentage of these fish (30% estimated in 1983) are milling fish which eventually spawned in areas other than the middle Susitna River. Comparisons of the scales of fish collected at the spawning grounds in these rivers may provide more accurate differentiation of Susitna River fish from those observed in the Talkeetna and Chulitna rivers.

Although it is possible that sockeye salmon which spawn in the middle reach of the Susitna River are strays from the stocks originating from the Talkeetna and Chulitna rivers, it is more likely that the Susitna sockeye are a separate and viable stock. The age 0+ fish which outmigrate from the middle reach of the Susitna probably imprint to their natal areas in the early stages after hatching and then later distribute to suitable habitats throughout the expanse of the lower river to overwinter. These fish then enter the ocean during their second year of life and finally return to their natal areas as adults to spawn.

More definitive information on the viability of middle Susitna River sockeye may be obtained through the continued monitoring of returning adults at the fishwheel sites and during spawning ground surveys to collect returning fish which were marked with coded wire tags as fry.

Outmigrant data collected for the Susitna River suggest that juvenile sockeye salmon life histories in the middle Susitna River can be grouped into three categories. The first group are those fish which spend their entire freshwater period rearing in the middle river, overwintering in this reach and then migrating to the ocean during the spring of their second year (age 1+). The second group includes those fish which rear for a portion (one to four months) of their first summer in the middle river and then migrate to areas below the Chulitna River confluence to overwinter and then enter the ocean during the spring of their second year. The third group of juvenile sockeye spend a portion of their first summer rearing in the middle river and then begin a downstream migration, eventually entering the marine environment during their first summer or fall as age 0+ fish.

Presently, it is not known what contribution each group provides to the total outmigration of juvenile sockeye from the middle Susitna River. Outmigrant trap data collected at Flathorn Station during 1984 collected a large number of age 0+ sockeye and most of these fish were probably destined for the ocean as 0+ fish (group 3).

Although trap catches of age 1+ sockeye at Talkeetna Station have been low (only 19 fish during 1984), it is possible that this age class (group 1) migrates out of the middle river prior to the initiation of spring sampling or that they differ from their age 0+ counterparts in that they migrate further from shore and are not intercepted by the bank traps in proportion to their relative abundance. Also, data collected in 1983 (Roth et al. 1984) showed that the bank traps were less effective at capturing these larger fish.

Data collected at the Talkeetna Station outmigrant traps indicate that the largest percentage of juvenile sockeye in the middle reach belong to the second group. These fish spend a portion of their first summer in the middle river and then redistribute to habitats in the lower river to overwinter. Data collected during tne JAHS sampling in the lower river during 1984 showed rearing sockeye at lower river sites including the mouth of Rolly Creek (RM 39.0) and at Beaver Dam Slough (RM 86.3).

Numerous other rearing sites such as Sunshine Creek (RM 85.7) and Whitsol Lake (RM 35.2) exist in the lower river and the large amount of available habitat in this reach probably provides the overwintering sites for a large percentage of the middle river sockeye juveniles.

4.3.3 Estimate of population and survival

An estimated 299,000 sockeye fry were produced during 1984 from the approximately 1,900 adults which migrated past Curry Station in 1983 for an egg-to-outmigrant survival rate of 17.4%. Comparatively, the 1,300 adult sockeye which passed Curry Station during 1983 produced an estimated 575,000 fry for a survival rate during 1983 of 42.0%.

The substantial differences between the estimates of survival in 1983 and 1984 are due in part to the data used in the calculations. During both years, survival rates were calculated by dividing the number of fry produced by the estimated number of eggs carried by adults past Curry Station during the previous season. Barrett et al. (1984) pointed out that the estimates provided at Curry Station represent only the fish which passed this site but do not necessarily reflect the number of fish which actually spawned in the middle river reach. As sockeye salmon in this reach are almost strictly slough spawners, more reasonable estimates were calculated by Barrett et al. (1984) by comparing slough escapement counts to observation life data to estimate the total slough escapement in the middle river. During 1983, this comparison provided an estimate that 1,060 adult sockeye had spawned in sloughs in the middle river. The observation life data were then used to provide comparable estimates for 1982 showing approximately 1,500 sockeye had spawned in the sloughs that year. These data were then used to recalculate the sockeye egg-to-outmigrant survival rates. A survival rate of 21.9% was estimated for 1984 and a rate of 35.3% was calculated for 1983. These rates are probably representative of the survival of sockeye in the middle river during the past two years.

Many factors may have caused the reduced survival of sockeye between 1983 and 1984:

1) Natural variations in the habitat conditions present at the spawning sites during the incubation periods caused the between year differences in survival.

2) Mainstem discharges (and thus slough water levels) were lower during the 1982 spawning season resulting in less eggs deposited in areas which would later dewater and freeze during the winter. Conversely, the higher flows during the 1983 spawning period may have resulted in many of the eggs being deposited in areas which later dewatered and froze. Vining et al. (1985) reported that dewatering and freezing were the primary factors contributing to the high embryonic mortalities for incubating chum salmon in the Susitna River.

3) As Slough 11 is the primary sockeye salmon spawning site in the middle river (average of 66% from 1981-1983) (Barrett et al. 1984), a detrimental change in incubating conditions at this site such as decreased intragravel flows or silting may have increased egg mortality.

4) The calculation of survival rates is based on the estimated number of parent spawners and are dependent on the precision of this estimate.

4.3.4 Growth

The weekly growth rate for sockeye fry which were coded wire tagged in 1983 and 1984 (Fig. 50) most accurately represent the growth rates for sockeye salmon fry in the middle river because the dates of release and recovery and the mean lengths for the for each period were known.

The coded wire tagged sockeye fry grew approximately three millimeters each week until they reached a critical size and then the growth rates stagnated (Fig. 50). Schmidt (1984) postulated that the cessation of sockeye growth after reaching a certain size was associated with evolved behavioral patterns and morphological changes. Schmidt (1984) suggested that the sockeye fry were able to rear in the middle river habitats for part of the summer but began a downstream migration in search of plankton rich environments after reaching a critical size. The small number of habitats which provide this type of environment in areas

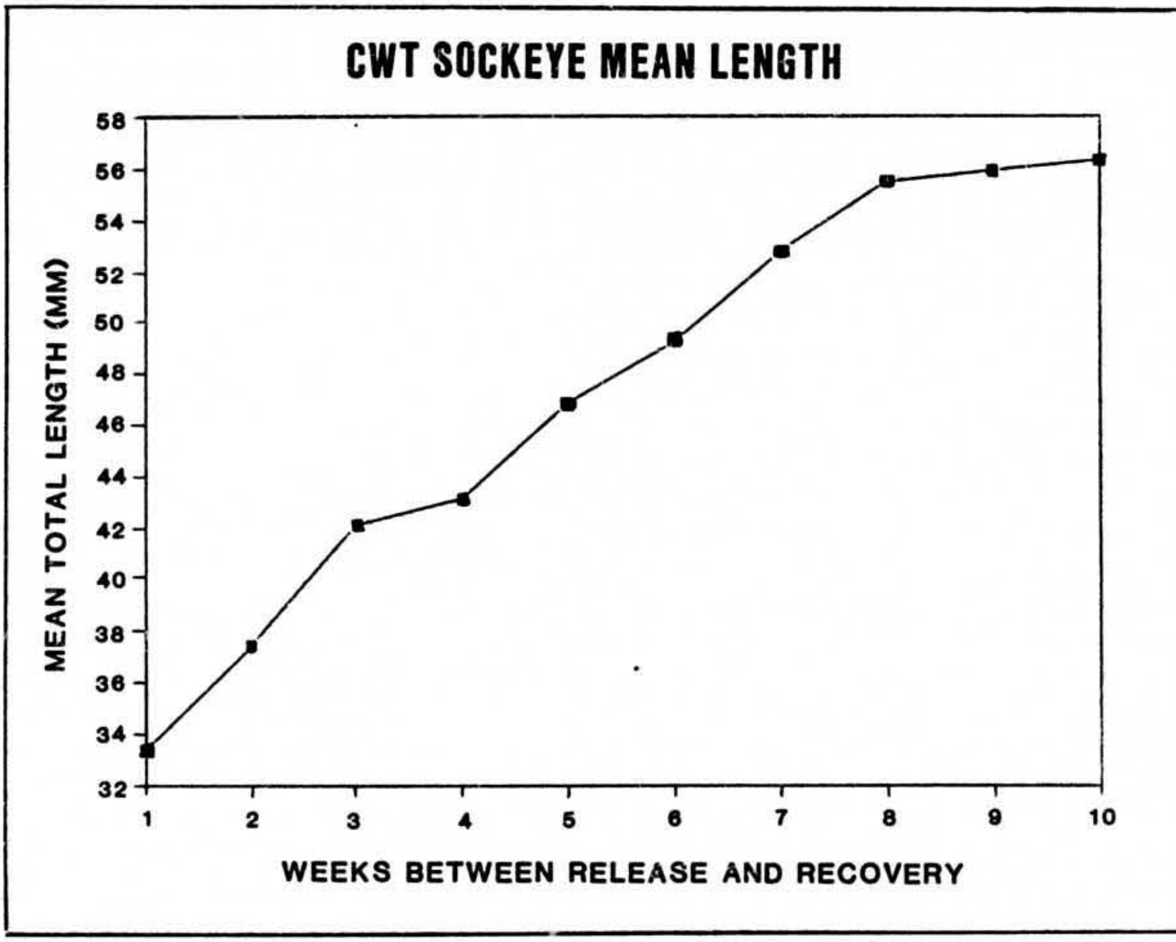

Figure 50. Mean length of coded wire tagged sockeye salmon fry at recovery sites in the middle reach of the Susitna River by week, 1984.

associated with the Susitna River is a major factor in controlling the production of sockeye in the middle river.

A comparison of the length data collected at Talkeetna Station during 1982, 1983, and 1984 and during the previous winter studies show that Susitna River sockeye average approximately 32 mm total length at emergence, 35 mm by early June, and have increased to approximately 50 mm by late July (Fig. 51). From late July through August, no significant growth was observed for sockeye fry collected at Talkeetna Station, indicating that the critical size postulated by Schmidt (1984) may be 50 to 55 mm in the middle river. The apparent growth of sockeye fry after late August (Fig. 51) is due to the collection of fish which had continued rearing in the small number of sites in the middle river which provide the necessary food and habitat requirements. These fish were probably forced to migrate out of these areas as water levels and available habitat decreased. The number of sockeye collected after late August represent less than 2% of the total outmigration of age 0+ fish from this reach.

A comparison of the downstream redistribution of sockeye salmon in the Susitna River by age class during 1984 as the percent cumulative of the total catches recorded at Talkeetna and Flathorn stations compared to the calculated percent cumulative biomass moving past these sites, indicated that the redistribution by weight of sockeye in the Susitna River was up to two weeks later than the redistribution observed when comparing only total numbers of fish (Fig. 52).

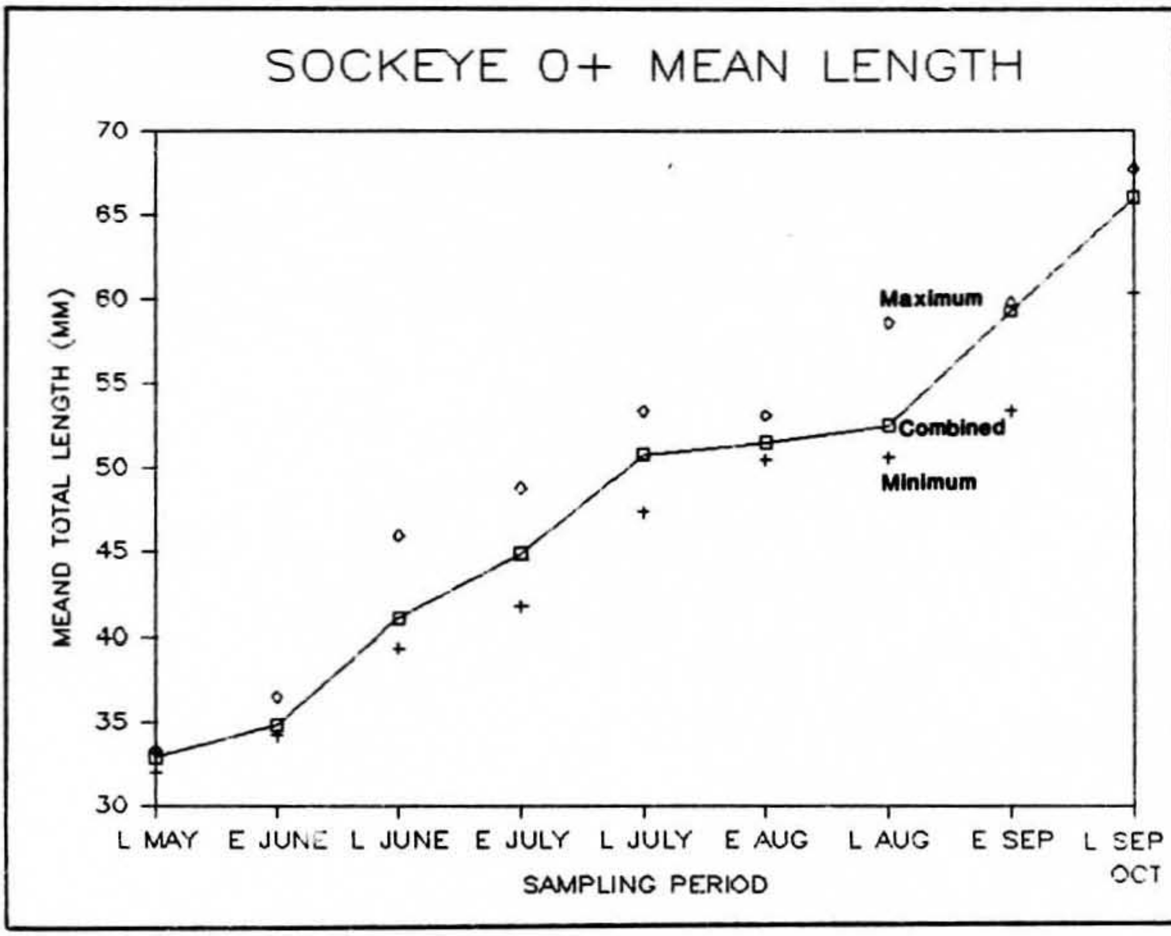

Figure 51. Sockeye salmon (age 0+) mean length and range of mean lengths by sampling period recorded at the Talkeetna stationary outmigrant traps during 1982, 1983, and 1984.

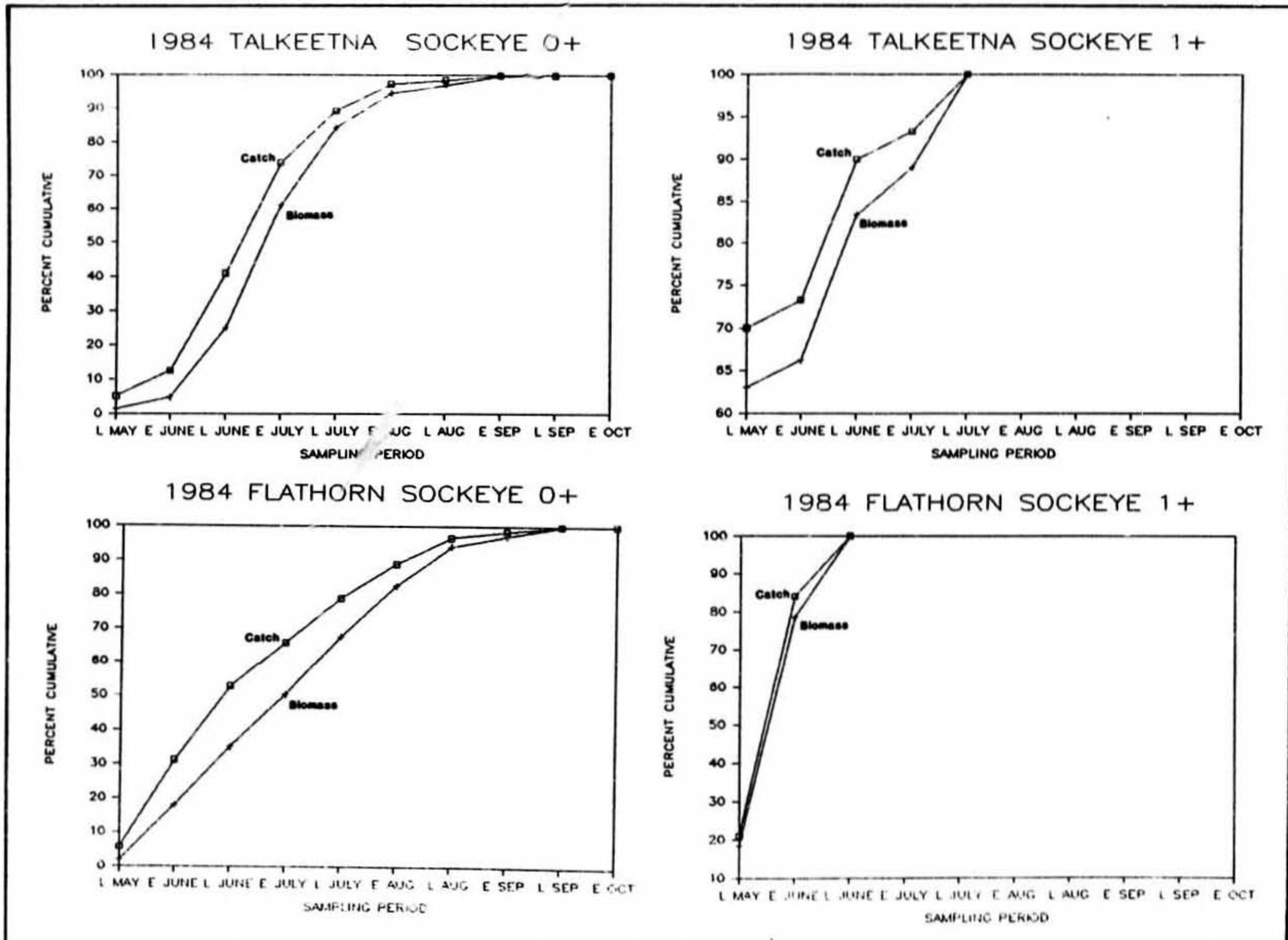

Figure 52. Sockeye salmon adjusted cumulative catch and biomass by age class recorded at Talkeetna and Flathorn stations, 1984.

Age 1+ sockeye salmon collected during 1984 averaged approximately 75 mm. This is approximately 10 mm smaller than the average length of sockeye fry collected at the end of the open-water season indicating that the fry are growing through the winter and early spring prior to outmigrating as smolts. The average length of age 1+ sockeye migrating out of the Susitna River was approximately 10 mm smaller than the same age fish outmigrating during 1984 from Larson Lake, a major spawning site in the Talkeetna River (Marcuson 1985).

4.4 Chum Salmon

4.4.1 Outmigration

The migration of chum salmon fry past Talkeetna Station during 1984 was similar to the timing recorded during 1983 (Fig. 53). Fifty percent of the total outmigration past this site had occurred by mid June and over 95% of the chum fry had migrated out of the middle river by mid July. At Flathorn Station, the peak chum fry outmigration also occurred in mid June during 1984.

Outmigrant trap recoveries of chum fry at Talkeetna Station indicate that these fish migrate primarily in areas associated with the center channel and higher velocities. The two bank traps combined sampled approximately 1.5% of the total river surface area at this site (USGS provisional data) but captured only 0.2% of the total chum fry estimated to be migrating past the traps during 1984. No comparable data were

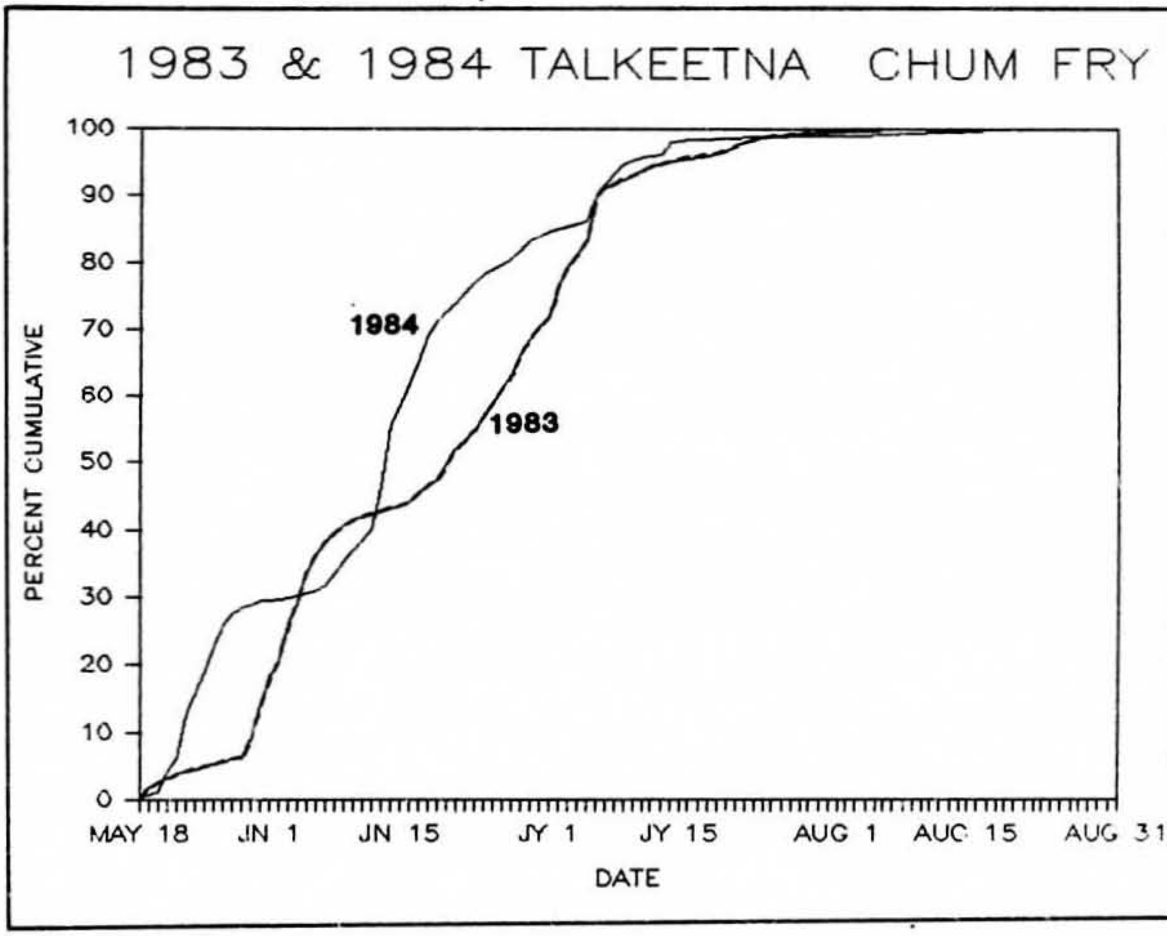

Figure 53. Chum salmon fry adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

collected at Flathorn Station during 1984 due to the late startup of the mobile trap. The earlier sampling at Flathorn Station expected during 1984 coupled with the addition of a mobile trap at Talkeetna Station will provide more definition information on the horizontal distribution of chum salmon fry during their outmigration from the Susitna River.

Coded wire tagged chum fry during 1984 spent an average of 8 days (range from 0 to 29 days) in the middle river before migrating past Talkeetna Station.

4.4.2 Freshwater life history

Chum salmon fry spend from one to eight weeks in the Susitna River before outmigrating to the ocean. A portion of the population of chum fry probably migrates out of the Susitna River shortly after hatching while the remaining group of fish stay in the river to rear for a period of time before outmigrating. It is not possible to determine the percentage which each group provides due to the difficulty in sampling outmigrant fishes prior to or during breakup.

4.4.3 Estimates of population and survival

An estimated 2,039,000 chum salmon fry were produced during 1984 from the approximately 21,100 adults past Curry Station in 1983 for an egg-to-outmigrant survival rate of 16.4%. Comparatively, the 17,600 adult chum which passed Curry Station during 1982 produced an estimated 3,322,000 fry for a survival rate of 14.1%.

The calculation of survival rates is based upon the estimated number of parent spawners which is difficult to obtain because of the extent of tributary spawning by chum salmon. Also a substantial percentage of chum salmon passing Curry Station are milling fish which eventually spawn below this site, and although estimates have been provided for 1982 and 1983 (Barrett 1984), these percentages are, at best, only indicators of the amount of chum salmon milling occurring. As these estimates have a large influence on the calculated rates of survival, the rates presented for 1983 and 1984 should be used to compare differences between years rather than absolute values of middle river chum salmon survival.

4.4.4 Growth

The mean length by one week periods of recovery after release for coded wire tagged chum fry which were tagged and recaptured during 1983 and 1984 (Fig. 54) most accurately represent the growth rates of chum fry in the middle river because the dates of release and recovery and the lengths for the fish for each period were known.

These data indicate that the chum fry in the middle river are actively rearing after emergence. Chum fry rearing was also shown from the analysis of stomach samples from tagged fish recovered at Talkeetna Station during 1983. The samples analyzed showed that these fish had been eating various life stages of mayfly, diptera, stonefly, blackfly, midges, and dancefly.

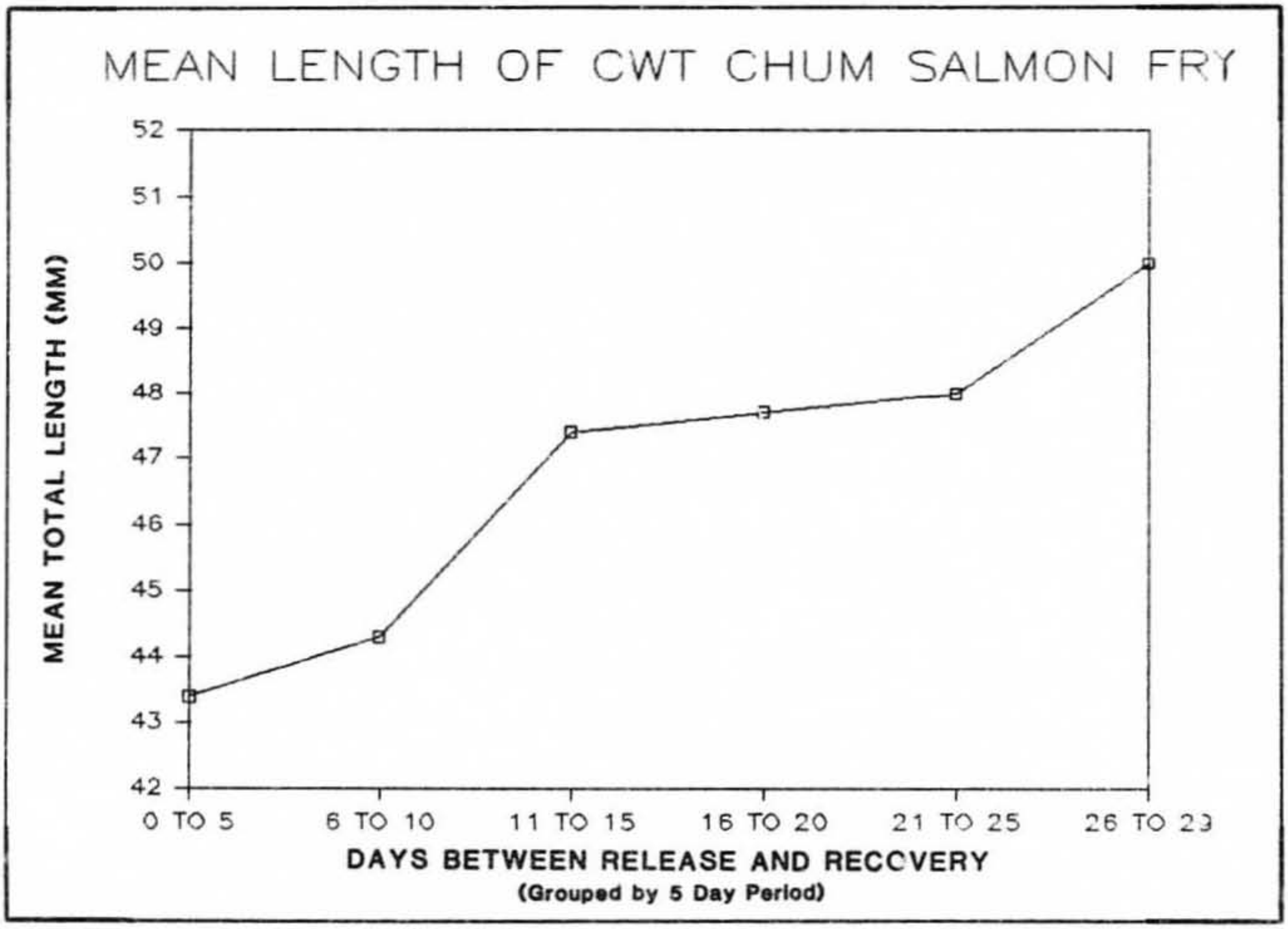

Figure 54. Mean length of coded wire tagged chum salmon fry at recovery sites in the middle reach of the Susitna River by 5 day period, 1984.

4.5 Pink Salmon

4.5.1 Outmigration

The rates of downstream migration of pink salmon fry past Talkeetna Station for 1983 and 1984 were very similar between the two years but the timing was approximately two weeks later in 1984 than in 1983 (Fig. 55). Differences in spawning times, winter temperatures, and spring breakup account for the differences in timing between the two years.

The low catches of juvenile pink salmon recorded at Talkeetna Station during the past three seasons is due to the pattern and timing of outmigration. Pink salmon fry outmigrate shortly after emergence and most of the fry probably have migrated past the traps prior to the initiation of sampling. Those fish which are still in the middle river after breakup appear to outmigrate in association with center channels and high velocities. The inclusion of mobile outmigrant trap sampling at Talkeetna Station during 1984 will assist in defining the horizontal distribution of outmigrating pink fry past this site during the open-water season.

4.5.2 Freshwater life history

Pink salmon fry in the Susitna River outmigrate to the ocean shortly after emergence during a relatively short timing window whose boundaries

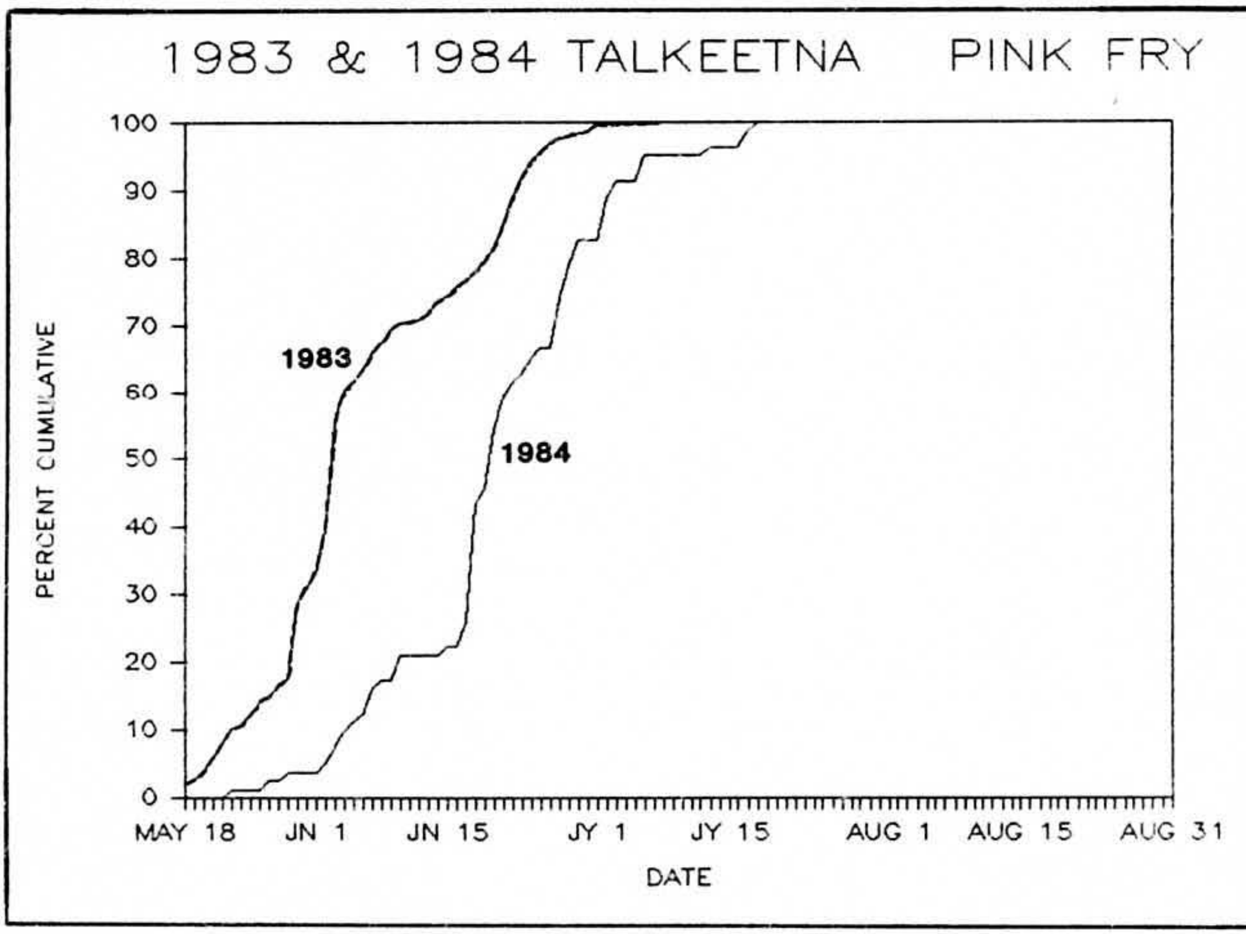

Figure 55. Pink salmon fry adjusted cumulative catch recorded at the Talkeetna stationary outmigrant traps, 1983 and 1984.

are determined by the timing of spawning the previous season, the incubation temperatures, and the availability of access to the Susitna River after emergence. Changes in any of these factors would subsequently change the timing of outmigration for this species.

4.5.3 Growth

Pink salmon in the Susitna River spend little or no time rearing in the system before outmigrating. The pink fry collected during 1984 averaged approximately 35 mm which is similar to their mean length at emergence. A few pink fry which ranged in length from 40 to 50 mm were collected, indicating that a small percentage of fry may be feeding for a short period of time in freshwater before outmigrating to the ocean.

5.0 CONTRIBUTORS

Fisheries Technicians Chuck Blaney (crew leader - Talkeetna Station), Albert Badgley, Patricia Harris, Diana Roche, James Gruber and Fishery Biologists Larry Dugan (Task Manager) Roger Harding (crew leader - Flathorn Station) Linda Soquet, Jeff Bigler, Tom Crowe, and Jim Anderson operated the outmigrant traps.

Fishery Biologists Dan Sharp and Linda Soquet and Fishery Technicians Doug Patrick and Anne Wiseman assisted in the coded wire tagging efforts.

Dan Gray (Fishery Biologist) helped with the cold branding study.

John McDonald and David Sterrit collected the data at the Deshka River weir.

Stephen Hale assisted with the statistical analyses of the habitat variables.

Allen Bingham and staff, and especially Kathrin Zosel, did the data processing; Skeers Word Processing typed the report; and Carol Hepler and Drew Crawford drafted the figures.

Tim Hansen and Craig Richards analyzed stomach samples of chum salmon fry.

Paul Suchanek, Drew Crawford, and Stephen Hale reviewed this draft.

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APPENDIX A

JUVENILE SALMON CATCH AND LENGTH DATA, 1984

Appendix Table A-1. Weir catches of juvenile chinook and coho salmon on the Deshka River, May 10 through September 19, 1984.

Date	Tributary River Mile	Hours Fished	Chinook Total Catch	Chinook Catch Per Hour	Coho Total Catch	Coho Catch Per Hour
May 10	2.0	21.5	2	0.1	0	0.0
12	2.0	15.0	9	0.6	1	0.1
13	2.0	21.0	3	0.1	0	0.0
27	5.0	12.0	50	4.2	1	0.1
28	5.0	12.5	7	0.6	0	0.0
29	4.5	12.5	3	0.2	0	0.0
31	5.0	12.0	4	0.3	0	0.0
June 1	5.0	12.5	21	1.7	0	0.0
21	5.0	11.5	1	0.1	0	0.0
22	5.0	21.5	3	0.1	0	0.0
July 11	2.5	14.5	209	14.4	5	0.3
12	2.5	24.0	144	6.0	2	0.1
13	2.5	24.0	268	11.2	3	0.1
14	2.5	23.5	186	7.9	4	0.2
15	2.5	24.0	27	1.1	0	0.0
16	2.5	24.0	130	5.4	1	0.0
25	2.5	15.0	318	21.2	21	1.4
26	2.5	24.0	149	6.2	8	0.3
31	2.5	20.0	168	8.4	4	0.2
August 13	2.5	14.0	45	3.2	15	1.1
14	2.5	23.0	4	0.2	2	0.1
15	2.5	23.0	5	0.2	5	0.2
16	2.5	23.0	27	1.2	12	0.5
31	2.0	21.5	5	0.2	22	1.0
September 11	1.5	13.5	1	0.1	0	0.0
12	1.5	23.0	6	0.3	0	0.0
13	1.5	23.0	8	0.3	1	0.0
14	1.5	23.0	2	0.1	0	0.0
15	2.5	18.0	1	0.1	2	0.1
16	2.5	24.0	0	0.0	6	0.3
17	2.5	24.0	1	0.0	0	0.0
18	2.5	23.0	1	0.0	2	0.1
Season Totals		621.0	1,808	2.9	117	0.2

Appendix Table A-2. Results of incidental minnow trapping in the Deshka River, 1984.

Date	Tributary River Mile	Hours Fished	Number of Traps	Chinook Catch	Catch Per Trap	Coho Catch	Catch Per Trap
June 21	5.5	16	6	56	9.3	14	2.3
August 28	2.5	9	6	15	2.5	48	8.0
29	2.7	7	7	23	3.3	50	7.1
September 17	5.5	24	4	20	5.0	4	1.0
October 10	2.2	24	2	1	0.5	2	1.0
10	6.0	24	4	30	7.5	4	1.0
11	5.0	27	7	23	3.3	21	3.0
13	2.0 to 6.0	54	5	2	0.4	10	2.0
14	2.0 to 6.0	28	5	1	0.2	4	0.8
15	4.0	24	5	41	8.2	9	1.8
Season Totals			51	212	4.2	166	3.3

Appendix Table A-3. Number of fish, mean length, and range of lengths for age 0+ chinook salmon by sampling period on the Susitna River between Cook Inlet and Talkeetna, 1984.

Sampling Period	Flathorn Station			Deshka River			Mainstem Susitna River[a]		
	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	0	-	-	77	42.7	36-49	*	-	-
June 1-15	24	56.6	40-67	21	42.4	40-46	74	48.5	34-63
June 16-30	374	58.5	39-74	56	55.7	46-69	63	52.0	36-70
July 1-15	357	62.0	40-84	236	66.8	52-83	84	54.5	39-74
July 16-31	436	64.3	43-88	201	69.7	52-93	171	58.1	39-80
August 1-15	189	66.6	47-89	53	74.4	60-91	330	58.9	40-82
August 16-31	193	72.7	46-94	65	71.7	55-89	238	61.5	42-94
September 1-15	8	77.3	68-84	15	77.9	69-88	52	66.8	52-95
September 16 - October 15	10	78.7	68-95	102	76.0	68-85	53	73.2	51-92

* Not sampled.

[a] Includes all mainstem, slough and side channel sites sampled during the JAHS study in the lower reach of the Susitna River.

Appendix Table A-4. Number of fish, mean length, and range of lengths for age 0+ chinook salmon by sampling period on the Susitna River between Talkeetna and Devil Canyon, 1984.

Sampling Period	Talkeetna River			Talkeetna Station			Mainstem Susitna River[a]			Indian River		
	n	Mean	Range	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	*	-	-	2	55.5	53-58	60	40.8	35-45	*	-	-
June 1-15	0	-	-	54	48.6	36-66	*	-	-	*	-	-
June 16-30	26	52.2	43-64	475	53.0	37-70	*	-	-	*	-	-
July 1-15	159	56.0	44-70	538	56.2	38-75	100	47.8	38-67	50	48.9	42-64
July 16-31	155	56.1	40-74	1131	55.5	37-80	50	52.2	42-69	50	54.9	47-67
August 1-15	257	60.7	44-84	748	57.9	40-90	50	52.4	40-77	100	58.8	47-90
August 16-31	114	65.2	51-84	612	59.5	39-95	100	56.1	43-72	100	61.1	49-80
September 1-15	0	-	-	119	62.7	45-91	100	57.6	47-88	100	63.8	47-90
September 16 - October 15	*	-	-	13	60.8	51-90	200	61.0	45-90	300	65.5	50-89

* Not sampled.

[a] Includes all mainstem, slough, and side channel sites sampled during the coded wire tagging and cold branding studies in the middle reach of the Susitna River.

Appendix Table A-5. Number of fish, mean length, and range of lengths for age 0+ coho salmon by sampling period on the Susitna River between Cook Inlet and Talkeetna, 1984.

Sampling Period	Flathorn Station			Deshka River			Mainstem Susitna River[a]		
	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	0	-	-	0	-	-	*	-	-
June 1-15	10	42.7	32-60	0	-	-	18	40.9	33-50
June 16-30	19	48.7	32-64	0	-	-	9	46.2	34-61
July 1-15	11	49.3	36-65	0	-	-	26	50.7	35-65
July 16-31	38	58.6	44-73	21	57.3	47-65	33	50.2	37-65
August 1-15	30	62.1	49-79	19	63.6	53-72	45	49.6	41-68
August 16-31	181	66.8	40-89	59	71.2	51-89	71	59.1	40-85
September 1-15	84	75.0	55-94	2	68.0	67-69	59	62.2	49-86
September 15 - October 15	67	75.1	57-94	29	77.0	60-95	105	66.7	49-95

* Not sampled.

[a] Includes all mainstem, slough, and side channel sites sampled during the JAHS study in the lower reach of the Susitna River.

Appendix Table A-6. Number of fish, mean length, and range of lengths for age 0+ coho salmon by sampling period on the Susitna River between Talkeetna and Devil Canyon, 1984.

Sampling Period	Talkeetna Station			Mainstem Susitna River[a]			Indian River		
	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	35	39.7	35-46	*	-	-	*	-	-
June 1-15	40	39.6	30-51	*	-	-	*	-	-
June 16-30	156	43.9	31-58	*	-	-	*	-	-
July 1-15	242	47.8	32-63	0	-	-	62	38.0	34-51
July 16-31	439	51.8	33-69	0	-	-	10	44.1	42-49
August 1-15	221	54.1	41-74	0	-	-	80	48.0	39-58
August 16-31	198	61.5	42-80	38	50.8	39-62	46	49.0	42-61
September 1-15	212	60.5	42-85	41	56.8	40-70	90	50.9	44-64
September 16 - October 15	39	69.1	51-90	5	59.4	48-76	166	55.1	44-73

* Not sampled.

[a] Includes all mainstem, slough, and side channel sites sampled during the coded wire tagging and cold branding studies in the middle reach of the Susitna River.

Appendix Table A-7. Number of fish, mean length, and range of lengths for age 1+ coho salmon by sampling period on the Susitna River between Cook Inlet and Talkeetna, 1984.

Sampling Period	Flathorn Station			Deshka River			Mainstem Susitna River[a]		
	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	0	-	-	5	69.8	58-89	*	-	-
June 1-15	7	87.4	62-110	0	-	-	1	70	70
June 16-30	15	78.1	65-96	14	78.6	58-108	11	97.4	62-111
July 1-15	12	84.9	70-111	13	79.0	62-95	6	81.3	72-101
July 16-31	39	89.8	75-120	6	101.7	65-118	4	85.3	73-92
August 1-15	16	92.8	80-112	2	97.5	83-112	4	102.0	98-109
August 16-31	68	103.4	91-122	68	98.2	90-123	11	105.2	90-123
September 1-15	68	109.4	95-129	1	118.0	118	3	105.3	104-108
September 16 - October 15	53	112.9	95-133	31	111.8	92-134	4	112.0	99-110

* Not sampled.

[a] Includes all mainstem, slough, and side channel sites sampled during the JAHS study in the lower reach of the Susitna River.

Appendix Table A-8. Number of fish, mean length, and range of lengths for age 1+ coho salmon by sampling period on the Susitna River between Talkeetna and Devil Canyon, 1984.

Sampling Period	Talkeetna Station			Mainstem Susitna River[a]			Indian River		
	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	139	69.4	51-105	18	63.0	52-85	*	-	-
June 1-15	332	71.8	52-102	*	-	-	*	-	-
June 16-30	340	76.1	59-115	*	-	-	*	-	-
July 1-15	192	77.8	64-118	0	-	-	2	67.0	64-70
July 16-31	252	82.2	70-125	0	-	-	7	85.7	79-90
August 1-15	28	93.5	79-120	0	-	-	17	86.1	74-99
August 16-31	96	101.9	81-131	2	103.5	102-105	0	-	-
September 1-15	14	99.6	86-127	10	93.2	83-101	0	-	-
September 16 - October 15	21	114.4	93-135	4	93.5	90-99	0	-	-

* Not sampled.

[a] Includes all mainstem, slough, and side channel sites sampled during the coded wire tagging and cold branding studies in the middle reach of the Susitna River.

Appendix Table A-9. Number of fish, mean length, and range of lengths for age 2+ coho salmon by sampling period on the Susitna River between Cook Inlet and Devil Canyon, 1984.

Sampling Period	Number of Fish	Mean Length	Range of Lengths
May	5	133.2	120 - 160
E. June	7	135.6	114 - 157
L. June	1	136.0	136
E. July	2	130.0	130
L. July	0	-	-
E. August	1	126.0	126
L. August	13	138.0	125 - 176
E. September	2	134.0	134
L. September - E. October	13	141.0	135 - 150
All Season	44	137.1	114 - 176

Appendix Table A-10. Daily catches of outmigrant chum and sockeye salmon fry in a fyke net located at the mouth of Slough 21, May 23 to June 12, 1984.

Check Date	Sockeye	Chum	Check Date	Sockeye	Chum
May 23	1,005	74	June 3	155	8
24	694	83	4	140	8
25	810	60	5	164	10
26	2,150	355	6	419	12
27	1,479	399	7	1,024	82
28	400	83	8	570	85
29	1,777	198	9	761	59
30	253	89	10	31	34
June 1	156	44	11	23	8
2	344	33	12	29	8
			13[1]	2	1

[1] Slough breached allowing fish passage around net. Net pulled.

Appendix Table A-11. Number of fish, mean length, and range of lengths for age 0+ sockeye salmon by sampling period on the Susitna River between Cook Inlet and Devil Canyon, 1984.

Sampling Period	Flathorn Station			Mainstem Susitna River[a] Below Talkeetna			Talkeetna Station			Mainstem Susitna River[b] Above Talkeetna		
	n	Mean	Range	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	134	32.8	27-45	*	-	-	213	32.0	26-41	100	30.5	25-37
June 1-15	284	40.4	29-60	15	36.0	26-52	305	36.5	28-60	100	35.2	29-49
July 16-30	343	42.7	25-70	80	40.1	26-66	509	41.9	25-71	50	34.2	28-44
July 1-15	313	49.2	25-80	20	43.6	30-65	570	48.8	30-75	0	-	-
July 16-31	337	52.2	30-85	54	43.5	28-76	748	53.4	35-87	8	53.1	47-68
August 1-15	239	53.0	29-85	38	47.9	30-76	547	51.8	33-88	49	51.4	43-62
August 16-31	185	52.8	30-93	106	53.0	28-86	90	58.6	42-79	50	56.2	36-69
September 1-15	41	55.6	42-75	20	61.2	45-71	95	59.8	40-91	0	-	-
September 16 - October 15	37	57.2	38-81	62	60.3	35-79	15	60.4	48-90	0	-	-

* Not sampled.

[a] Includes all mainstem, slough, and side channel sites sampled during the JAHS study in the lower reach of the Susitna River.

[b] Includes all mainstem slough, and side channel sites sampled during the coded wire tagging and cold branding studies in the middle reach of the Susitna River.

Appendix Table A-12. Number of fish, mean length, and range of lengths for age 1+ sockeye salmon by sampling period on the Susitna River between Cook Inlet and Devil Canyon, 1984.

Sampling Period	Number of Fish	Mean Length	Range of Lengths
May	32	71.3	56 - 99
June 1-15	40	71.3	61 - 100
June 16-30	15	77.8	71 - 91
July	3	91.7	81 - 102
Season	90	73.1	56 - 102

Appendix Table A-13. Number of fish, mean length, and range of lengths for chum salmon fry by sampling period on the Susitna River between Cook Inlet and Devil Canyon, 1984.

Sampling Period	Flathorn Station			Mainstem Susitna River Below Talkeetna[a]			Talkeetna Station			Mainstem Susitna River Above Talkeetna[b]		
	n	Mean	Range	n	Mean	Range	n	Mean	Range	n	Mean	Range
May	35	42.7	36-62	*	-	-	367	40.1	32-52	150	39.9	33-47
June 1-15	198	41.9	30-55	298	43.2	31-58	357	45.6	35-68	300	44.5	36-60
June 16-30	209	42.7	32-63	109	39.4	31-50	427	42.9	36-62	50	40.2	36-48
July 1-15	17	42.5	30-59	37	42.3	33-57	337	44.0	35-65	50	48.2	39-54
July 16-31	3	43.3	31-52	21	40.4	36-47	172	44.6	36-59	10	46.5	40-51

* Not sampled.

a Includes all mainstem, slough, and side channel sites sampled coded wire tagging and cold branding studies in the middle reach of the Susitna River.

b Includes all mainstem, slough, and side channel sites sampled during the coded wire tagging and cold branding studies in the middle reach of the Susitna River.

APPENDIX B

THE SCHAEFER ESTIMATE OF POPULATION SIZE

One of the assumptions of a mark-recapture program which must be met to provide a valid population estimate is that, during tagging and recovery, the marked individuals are randomly distributed within the unmarked population. A biased Petersen estimate would result if the marking and recapture efforts were selective. Schaefer (1951) pointed out that when generating a population estimate for migrating fishes, the fact that some fish do not always migrate as a single population should be considered, so that the mixing of marked and unmarked fish between the time of tagging and recovery may be incomplete.

Schaefer (1951) provided a method for estimating the population, when using numbered tags, by estimating the relation between time of tagging and recovery when migration extends over a considerable period of time. By using numbered tags, both the date of tagging and date of recovery is known for each fish recovered and the population can be divided into a series of distinct units.

Specific to the coded wire tag mark-recapture program conducted on the Susitna River during 1983 and 1984 there may be a tendency for fish which emerge earliest to outmigrate earliest, resulting in a positive correlation between time of tagging at the emergence sites and the time of migration past the recovery site. When such a correlation exists, the recovery during any single period would not be a random sample of the whole population.

The method proposed by Schaefer uses the summation of populations for individual periods of tagging and recovery to estimate the total population. A table is first generated which shows the number of fish tagged and recovered during each time interval. Using these data, a second table can be formed which estimates the population for each period; the sum of these being the total population estimate.

The population estimate (N) was determined from the formula from Ricker's (1975) modification of Schaefer's (1951) equation:

$$N = N_{ij} = R_{ij} \cdot \frac{M_i}{R_i} \cdot \frac{C_j}{R_j}$$

where: R_{ij} = the number of fish which were marked during a tagging period (i) and subsequently recaptured during a recovery period (j).

M_i = the number of fish marked during a single tagging period.

R_i = the total marked fish recaptured from a single tagging period.

C_j = the number of fish captured and examined for marks during a recovery period.

R_j = the number of marked fish which were recaptured during a recovery period.

N_{ij} = the estimate of the number of fish available for marking during a period (i) and the number available for recovery in a period (j).

Tagging and recovery periods for the Susitna River study were grouped by eight day intervals. The data collected for the estimate of the population of sockeye salmon outmigrants is tabulated by the Schaefer method in Appendix Table B-1. The computation of these data and the resulting population estimate are presented in Appendix Table B-2.

The mark-recovery data for chum salmon are presented in Appendix Table B-3, and the computations and final population estimate are provided in Appendix Table B-4.

With the use of distinct marks, successive groups of tagged fish maintain a separate identify and can be treated as separate populations. Using the methods provided by Schaefer (1951), it is possible to generate population estimates for each time interval both at tagging and recovery. This allows the comparison of population estimates not only between years, but between given time periods of the outmigration during a single year.

Appendix Table B-1. Data collected on the coded wire tag, mark-recapture experiment for sockeye salmon fry to provide a population estimate using the methods outlined by Schaefer (1951). Tagging and recovery periods are by eight day intervals, May 22 through September 18, 1984.

Period of Recovery (j)	Period of Tagging (i) 1	2	3	4	Tagged Fish Recovered (Rj)	Total Fish Recovered (Cj)	Cj/Rj
1	27	-	-	-	27	339	12.6
2	4	-	-	-	4	71	17.8
3	7	-	-	-	7	414	59.1
4	26	-	6	5	37	1,293	34.9
5	21	-	5	24	50	931	18.6
6	70	-	16	15	101	1,627	16.1
7	32	-	9	7	48	976	20.3
8	16	-	1	3	20	428	21.4
9	29	-	5	10	44	693	15.8
10	6	-	2	4	12	360	30.0
11	6	-	-	-	7	173	24.7
12	-	-	1	-	1	20	20.0
13	1	-	-	-	1	46	46.0
14	2	-	-	-	2	60	30.0
15	1	-	-	-	1	31	31.0
Total Tagged Fish Recovered (Ri)	248	0	45	69	362	7,462	
Total Fish Tagged (Mi)	8,795	0	2,052	3,685	14,532		
Mi/Ri	35.5	-	45.6	53.4			

Appendix Table B-2. Computation of the sockeye salmon for outmigrant population from the data presented in Appendix Table B-1.

Period of Recovery (j)	Period of Tagging (i) 1	2	3	4	Total
1	12,077	-	-	-	12,077
2	2,528	-	-	-	2,528
3	14,686	-	-	-	14,686
4	32,213	-	9,549	9,318	51,080
5	13,866	-	4,241	23,838	41,945
6	40,009	-	11,747	12,896	64,652
7	23,061	-	8,331	7,588	38,980
8	12,155	-	976	3,428	16,559
9	16,266	-	3,602	8,437	28,305
10	6,390	-	2,736	6,408	15,534
11	5,261	-	-	1,319	6,580
12	-	-	912	-	912
13	1,633	-	-	-	1,633
14	2,130	-	-	-	2,130
15	1,101	-	-	-	1,101
TOTAL	183,376	-	42,094	73,232	298,702

Appendix Table B-3. Data collected on the coded wire tag, mark-recapture experiment for chum salmon fry to provide a population estimate using the methods outlined by Schaefer (1951). Tagging and recovery periods are by eight day intervals, May 22 through July 24, 1984.

Period of Recovery (j)	Period of Tagging (i) 1	2	3	4	Tagged Fish Recovered (Rj)	Total Fish Recovered (Cj)	Cj/Rj
1	11	-	-	-	11	932	84.7
2	-	1	-	-	1	104	104.0
3	3	4	2	-	9	860	95.6
4	-	3	3	6	12	526	43.8
5	1	3	-	8	12	361	30.1
6	-	-	-	1	1	334	334.9
7	-	-	-	4	4	154	38.5
8	-	-	-	1	1	132	132.0
Total Tagged Fish Recovered (Ri)	15	11	5	20	51		
Total Fish Tagged (Mi)	4,806	12,276	5,295	9,019	31,396		
Mi/Ri	320.4	1,116.0	1,059.0	451.0			

Appendix Table B-4. Computation of the chum salmon for outmigrant population from the data presented in Appendix Table B-3.

Period of Recovery (j)	Period of Tagging (i) 1	2	3	4	Total
1	298,517	-	-	-	298,517
2	-	116,064	-	-	116,064
3	91,891	426,758	202,481	-	721,130
4	-	146,642	139,153	118,523	404,318
5	9,644	100,775	-	108,601	219,020
6	-	-	-	150,634	150,634
7	-	-	-	69,454	69,454
8	-	-	-	59,532	59,532
TOTAL	400,052	790,239	341,634	506,744	2,038,669