ABUNDANCE, SIZE, HABITAT UTILIZATION, AND

INTRASTREAM MOVEMENT OF JUVENILE COHO SALMON IN A SMALL

SOUTHEAST ALASKA STREAM

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A
Thesis

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By

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Abstract

\quatic habitat was measured, and juvenile coho salmon)*ncorhynchus kisutch* abundance and intrastream migrations \ere monitored in Kake Bake Creek, Alaska, between 1985 and .986. Fry densities averaged 0.88, 0.33, and 0.11 fish/m^2 luring August, November, and March, respectively; parr lensities averaged 0.15, 0.09, and 0.05 fish/m^2, during \ugust, November, and March, respectively. Fry were listributed evenly between riffle, glide, and pool habitat .ypes during August, but not during November or March. Parr \ere distributed evenly in riffle and glide habitats during \ugust, November and March. Stream areas containing pools nd large woody debris tended to have higher coho densities; abitat was generally a significant predictor of juvenile bundance despite low R^2 values.

'all immigrants totaled 1,434 coho, with 764 immigrating into eaver ponds. Fall immigrants were bright silver in color nd several had sea-lice *Calugus spp*. attached near their nal fins. Between April 1 and June 2, 1986, 586 coho molts emigrated from Kake Bake Creek; 172 had been fall mmigrants.

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I would especially like to thank my wife, Linda, for her patience, and encouragement, and without whose support, this thesis could not have been completed. I am also grateful to my children, Sumer and Whitney, for their understanding and continued good humor.

INTRODUCTION

Coho salmon (*Oncorhynchus kisutch*) range from central California to Point Hope, Alaska. Kake Bake Creek lies approximately near the center of this range in southeast Alaska (Figure 1). Juvenile coho salmon typically emerge from the gravel in spring (April - May), and generally spend 1 to 3 years rearing in freshwater before outmigrating to sea in the spring as smolts. In the southern one-third of their range, coho salmon typically remain in freshwater about 1 year (Briggs 1953; Smoker 1953) while further north, in Alaska, they remain 1 to 3 years (occasionally 4) in freshwater after emerging from the gravel (International North Pacific Fisheries Commission 1962; and Drucker 1972). The amount of time coho salmon spend in freshwater after emerging from the gravel thus appears to be related to latitude (i.e. colder temperatures) (Crone and Bond 1976). After migrating to the sea as smolts, coho salmon typically spend from 1 to 2 years in the ocean growing to sexual maturity before returning to spawn as adults (Crone and Bond 1976).

Juvenile coho salmon primarily use pools (plunge, backwater, and side channel pools) as freshwater rearing and overwintering areas. During fall, juvenile coho salmon immigrate from stream channels and stream/estuary areas into "riverine" pools, side channels, low velocity tributaries, and beaver ponds (Bustard and Narver 1975; Heifetz et al. 1986; Peterson, 1982; Murphy et al., 1984; Cederholm and Scarlet, 1981; and Tschaplinski and Hartman, 1983). Immigration of juvenile coho salmon into pools is apparently

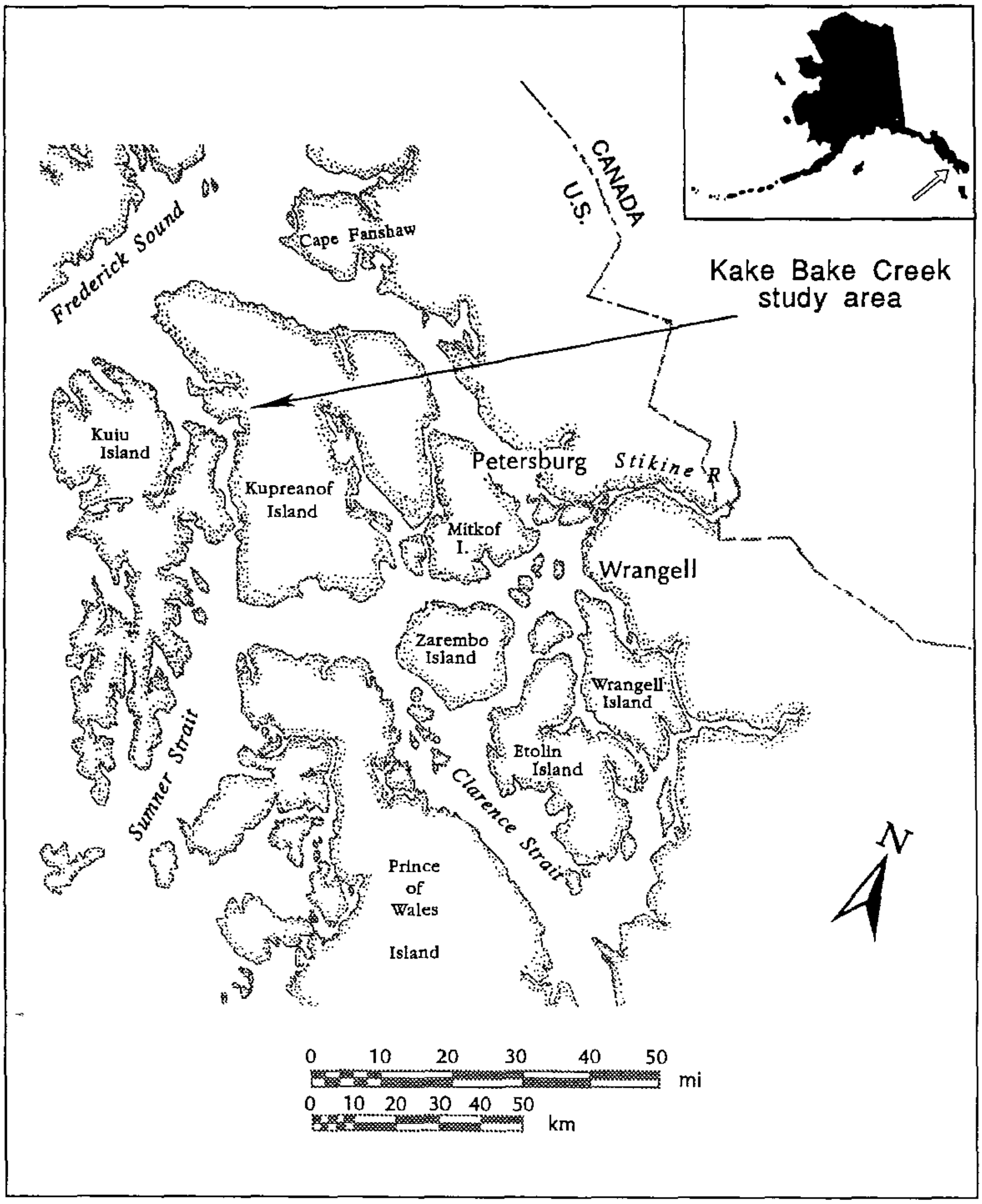


Figure 1. Map of southern southeast Alaska, showing the Kake Bake Creek Study area.

in anticipation of, and a response to, freshets and associated high velocities and turbidity (Scarlett and Cedarholm 1984). Coho salmon immigration may be triggered by cooler temperatures and high water flows during fall months (McMahon and Holtby, 1992).

Pool habitat is known to greatly influence overwinter survival rates of coho salmon (Bustard and Narver 1975; Scarlett and Cedarholm 1984) and suitable overwintering habitat may be the limiting factor in coho salmon production (Beschta et al. 1987). Other studies (Tschaplinski and Hartman, 1983) report that during winter months the abundance of coho salmon in streams is positively and linearly correlated to the volume of pool and debris present. House and Boehne (1986) and Gordon and MacCrimmon (1982) also found strong correlations between the density of juvenile salmonids and pool-forming large woody debris (LWD).

Current forest management practices in southeast Alaska may alter the quantity and quality of pools and pool-forming LWD in streams, possibly limiting coho salmon production (Murphy et al., 1984). Much of the literature (Chapman and Knudsen 1980; Murphy and Hall 1981; Murphy et al. 1981) report that the production of coho salmon in logged watersheds may be greater than in old-growth streams due to increased solar radiation and warmer temperatures that result from logging or canopy removal. However, this may not be the case in areas where streams are exposed to low winter flows and freezing, such as is common in British Columbia and Alaska (Bustard and Narver 1975; Mason 1976; Tschaplinski and Hartman 1983). Beschta et al. (1987) point out that in these areas of canopy removal, coho salmon production may be limited by reduced winter habitat. Recent studies by

Scarlett and Cederholm (1984) also suggest that the critical link in coho salmon production may depend on the overwintering habitat. Streams in southeast Alaska that lack an adequate canopy cover are increasing and already represent a major habitat type.

In 1983-1984 the National Marine Fisheries Service (NMFS), the US Forest Service Forest Sciences Laboratory (FSL), and Alaska Department of Fish and Game (ADF&G), Division of Sport Fish, conducted a cooperative study at Kake Bake Creek, Alaska. The study was designed to investigate overwinter survival rates of juvenile coho salmon in old-growth and clearcut sections of a small southeast Alaska stream. Results from these studies, however, did not account for coho salmon which may have migrated into, overwintered, and survived in Kake Bake Creek (Heifetz et al., *Unpublished*). Therefore, the Alaska Department of Fish and Game continued the study in 1985-1986 to investigate the fall immigration of juvenile coho salmon in Kake Bake Creek (Elliott and Harding 1986). This thesis will report on the 1985-1986 investigation and will describe the juvenile coho salmon immigration, emigration, abundance, and habitat in Kake Bake Creek.

OBJECTIVES

Abundance Estimates

I. Estimate the densities of fry and parr coho salmon in Kake Bake Creek during August and November, 1985 and March 1986.

Test Hypothesis 1): Juvenile fry and parr coho salmon have equal densities throughout Kake Bake Creek.

Test Hypothesis 2): Juvenile fry and parr coho salmon densities are the same over time in Kake Bake Creek.

Habitat

II. Measure and describe the stream habitat throughout Kake Bake Creek, Alaska.

Test Hypothesis 1): The density of fry and parr coho salmon are equal in the three major habitat types: riffle, pool, glide.

Test Hypothesis 2): The density of fry and parr coho salmon remain the same over time in the three major habitat types: riffle, pool, glide.

Movement

III. Measure and describe the magnitude of juvenile coho salmon intrastream migrations in Kake Bake Creek.

1) Describe and measure the magnitude of upstream migrating juvenile coho salmon during fall, 1985.

2) Describe and measure the magnitude of downstream migrating juvenile coho salmon smolt during spring, 1985.

METHODS

Description of Study Site

The Kake Bake Creek study area is located on Kupreanof Island in Southeast Alaska (Figure 1) and lies within the boundaries of the Tongass National Forest, Petersburg Ranger District. Kake Bake Creek is approximately 24 km southeast of the village of Kake, Alaska and drains into Big John Bay. Kake Bake Creek is typical of a small southeast Alaska coho salmon nursery stream, ranging in width from 1 to 10 m and draining a watershed of approximately 5 km^2. Kake Bake Creek is a short stream flowing 2,500 m from the headwaters to the large estuary of Big John Bay. The creek contains resident and anadromous populations of Dolly Varden (*Salvelinus malma*) and cutthroat trout (*O. clarki*) as well as coho (*O. kisutch*), chum (*O. keta*), and pink (*O. gorbuscha*) salmon. Prickly sculpin (*Cottus asper*) and coast range sculpin (*Cottus aleuticus*) also inhabit the study stream.

Kake Bake Creek contains diverse habitat types, including pools, undercut banks, and concentrations of large woody debris. Large woody debris (LWD) is defined as any woody item, such as logs, rootwads, or tree limbs that are in the stream channel and are ≥ 10 cm in diameter and ≥ to 1 m long (Johnson and Heifetz 1985). Approximately 40% of the Kake Bake Creek drainage was clearcut logged in 1981 and intentionally burned following logging to remove the logging slash. The controlled burn escaped the clearcut area and subsequently burned some of the adjacent old-growth forest. The controlled burn is believed to have no effect on this study as the burn did not alter in-stream habitat or overhead cover. The burn did however, influence the future stream cover through damage to the soil which has impaired the revegetation of the young trees (personal communication, Steve Gant, USFS Petersburg Ranger District).

The study stream was divided into estuarine, old-growth, and clearcut areas or "zones". The estuarine zone is defined as the transition zone between the estuary and the furthest upstream point in the creek influenced by tides. It is characteristics by wide, shallow, slow channels with low gradient and water velocity. Vegetation along the stream banks in the estuarine area are mostly salt tolerant grasses. The old-growth zone begins at the upstream end of tidal influence. No logging has occurred in this area and stands of high quality, old-growth Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*) grow adjacent to the stream providing a dense forest canopy. Many of the old-growth trees are an integral part of the stream channel and provide stability to important rearing pools. The clearcut zone is upstream of the old-growth zone and has been clearcut logged; both banks have been clearcut in the upper portion of the clearcut zone while one bank was logged in the lower portion. There is no forest canopy and very little vegetation along the stream banks in the clearcut zone. Old decaying and charred logs and slash are abundant along the stream bank within the clearcut zone. Each zone of the stream was further divided into 50-m subsections, or "reaches" from which coho salmon population estimates and habitat parameters were measured.

A small tributary (<2 m wide) flows into the middle of the clearcut area and is comprised mostly of a series of inactive beaver ponds. This series of beaver ponds form a "slough" which is deep and slow and provides excellent overwintering habitat.

Abundance Estimates

Mark recapture experiments were conducted in August and November, 1985, and March, 1986 to estimate the abundance of juvenile coho salmon in each 50 m sample reach. To prevent fish passage between reaches during the population estimates upstream and downstream boundaries of each reach were blocked with 3 mm stretch mesh seine nets and weighted down with gravel and stones to make a good seal. A Smith-Root type 15-A gasoline powered backpack electroshocker was the principal method used for capturing coho salmon. Beach seines were used to capture fish in the estuarine zone as electroshockers do not work well in areas of high conductivity such as in the saline water of the estuarine area. In areas with heavy debris or in deep pools, 3 mm bar mesh wire minnow traps baited with borax treated salmon roe were used in combination with the electroshocker or beach seine to capture fish.

Captured fish were anaesthetized with diluted methane tricaine methanesulfonate (MS-222) and measured to the nearest 1 mm fork length (FL). During both the initial mark and the subsequent recapture samples of the abundance estimate, 10 coho salmon were selected (representative cross section) and weighed to the nearest 0.1 gm and scale sampled for subsequent age determination. Scales were collected four rows above the lateral line between the posterior edge of the dorsal fin and the anterior edge of the anal fin using forceps. Scale samples were placed between a folded piece of clear plastic and stored inside a coin envelope. All captured fish were given a distinct fin clip or "clip of origin", that corresponded to the particular zone in which they were originally captured. Fish captured in the estuarine were given an upper caudal clip (i.e. small section of the upper caudal lobe was removed) while fish captured in the old-growth and clearcut were given left and right ventral clips (i.e. the entire ventral fin was removed), respectively. This mark also served to distinguish marked from unmarked fish in the recapture sample of the abundance estimates. After the fish had recovered in a holding bucket they were released back into their 50 m reach and given several hours to redistribute themselves before the recapture sample was collected. Each reach was worked thoroughly with the electrofisher. Usually, two passes with the gear was needed until no fish were observed stunned by the electroshocker. Chapman's modification of the Peterson method (Seber 1982) was used to estimate coho salmon fry and parr abundance ($\hat{N}$) within each reach:

$$\hat{N}=\frac{(M+1)(C+1)}{(R+1)}-1$$

where,

M = number of marked fish,

C = number of fish examined for marks, and

R = number of recaptured marked fish,

and the variance ($Var(\hat{N})$) by:

$$Var(\hat{N})=\frac{(M+1)(C+1)(M-1)(C-R)}{(R+1)^{2}(R+2)}$$

Total abundance of coho salmon fry and parr were obtained by summing the abundance estimates from each 50 m stream reach. The variance of the total abundance was obtained by summing the variances from each 50 m stream reach. The probability that fish of different sizes were captured with equal probability during the recapture event was estimated with a

Kolmogorov-Smirnov (K-S) 2-sample test. Plots of cumulative distribution functions will augment the K-S tests.

Density of coho salmon abundance estimates were standardized for each 50 m stream reach by dividing ($\hat{N}$) by the total wetted stream area measured during low flow periods. For some analysis, abundance was expressed as a fraction of habitat type and calculated by dividing ($\hat{N}$) for fry and parr by the area (m^2) of riffle, glide and pool within each 50 m reach.

The ages of the juvenile coho salmon were determined by surface readings of the scale samples using a microfiche reader with a 10 X objective. Age and size structure was estimated for fall immigrants, spring emigrants, and for fish captured in abundance estimates.

Kruskal-Wallis nonparametric tests (Conover 1980) were used to test the hypothesis that coho fry and parr salmon are evenly distributed throughout Kake Bake Creek. Should the hypothesis be rejected the multiple comparison procedure (Conover 1980) would be performed to determine which pairs of populations tend to differ. Coho fry and parr salmon density estimates for August, November, and March were the "samples" while the zone areas of estuarine, old-growth, and clearcut were the different "populations".

Quade nonparametric tests (Conover 1980) were used to test the hypothesis that coho fry and parr salmon densities in Kake Bake Creek remain the same over time. Should the hypothesis be rejected, multiple comparisons would be made. Each 50 m stream reach was the block while coho fry and parr salmon densities in August, November, and March within the stream reach were the treatment. Should multiple comparisons be made, the population densities in each of the three zones during August, November, and March would be tested (i.e. separate analysis for population densities in each zone would be compared over time).

Habitat

Measurement of habitat features was conducted in each reach during August, 1985 and in March, 1986 and follow the methods described in Johnson and Heifetz (1985). A measuring tape was stretched between the upper and lower boundaries of each reach. Linear transects perpendicular to the stream's flow were established using this tape at 5 m intervals within each 50 m reach. The stream width (water width) and channel width (distance between annual highwater marks on each bank) were measured to the nearest 0.1 m along these perpendicular transects. Water depth (nearest 0.1 m) and velocity (nearest m/sec) was measured along these transects at 0.25, 0.50, and 0.75 of the total stream width. The habitat type intersecting each transect line were divided by inspection into riffles, pools, and glides based on criteria in Bisson et al. (1982). Bisson defines riffles as shallow areas with moderate to fast surface turbulence, pools as deeper water with low to moderate current velocities, and glides as areas with even laminar flow over fine-grained substrate, often at transition zones between pools and riffles. The stream bed substrate along each transect line was classified by inspection using methods in Platts et al. (1983) and reported by Johnson and Heifetz (1985). The mean depth, mean velocity, discharge, surface area, volume, and gradient were then calculated for each reach using the transect data.

The volume of pools > $1m^2$ was obtained by measuring the length, width, and five depths. Length and width were measured to the nearest 0.1 m, while the five depths, measured at the center of the pool and at two locations along each length and width axis, were measured to the nearest cm (Johnson and Heifetz 1985). Any LWD, >1 m X 0.1 m associated with any pool was measured, and the total volume of LWD was calculated by summing the volume of the individual pieces. The area of undercut banks (UCB) (>0.5 m long and >0.2 m wide) associated with the pools was measured using methods reported in Johnson and Heifetz (1985). All pools were classified by inspection into one of seven pool types described by Bisson et al. (1982) and adapted by Johnson and Heifetz (1985). Johnson and Heifetz base their pool classification system on what formed the pool (i.e. dammed, backwater, scour etc...).

Regression analysis was used to investigate the relationship between habitat and coho salmon fry and parr density during August, November, and March. The fry and parr density estimates (dependent variables) were regressed with the standardized area of pool, undercut banks, large woody debris, substrate, and mean discharge (independent variables). Graphical plots of the dependent variable with each independent variable were constructed to determine if the relationships were linear. Various methods were used to select the best predictor variables including forward, stepwise, and R-SQUARE (SAS, 1991) selection procedures, and backward elimination, "leaps and bonds" (Becker and Chambers, 1984) and principal component analysis. Regression residual plots were done to assess leverage values or outliers.

Movement

Two immigrant/emigrant traps were constructed in mid-August, 1985 and operated continuously through November, 1985 to catch migrating juveniles. One trap, a "horse and deck" type weir was located in the old-growth area approximately 300 m above the end of the estuarine area (Main weir). The second trap, a "wolf trap", was placed in the clearcut area at the entrance to the beaver pond slough complex (Slough weir)(Figure 2).

In early March, 1986 the two immigrant/emigrant traps were reinstalled and operated continuously until the completion of the study in early June, 1986. In addition, two downstream-only traps were operated from March through early June, 1986. One was a funnel-type fyke net situated between the clearcut and old-growth zones (Lower Clearcut trap). The other was a drop or trough trap (Elliott 1992) placed immediately above the road in the clearcut area (Upper Clearcut trap)(Figure 2).

Coho salmon passing through each migrant trap were given a distinctive fin clip to identify location of capture and direction of movement. Lengths along with representative weights and scale samples were collected and all fish were examined for previous fin clips.

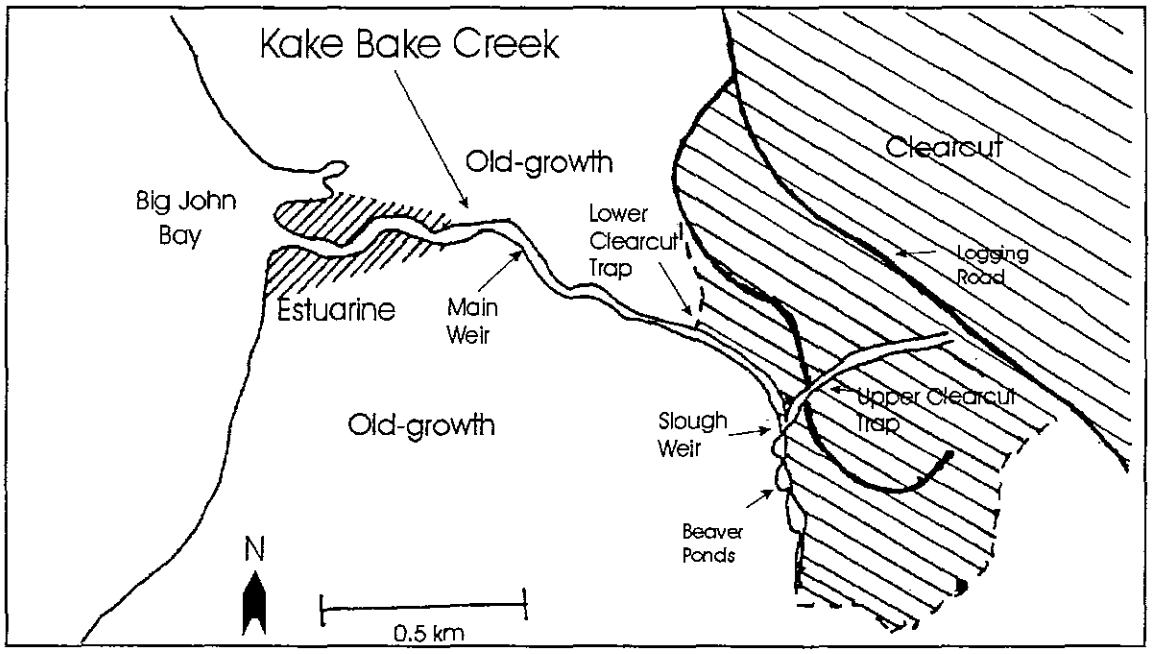


Figure 2. Kake Bake Creek study site showing the general location of the estuarine, old-growth, and clearcut zones, and the location of the immigrant/emigrant weirs and emigrant fish traps.

RESULTS

Abundance Estimates

Age and Length Analysis:

A total of 440 juvenile coho salmon were scale sampled during the August population studies; 202 and 283 were sampled in November and March, respectively. In August, age 0 fish averaged 52.2 mm (SE=0.6 mm) fork length (FL) and age 1^+ fish averaged 87.7 mm (SE=1.2 mm) (Table 1). During November, age 0 fish averaged 53.7 mm (SE=0.8 mm) FL and age 1^+ fish averaged 96.5 mm (SE=2.7 mm) FL. In March, age 0 fish averaged 58.2 mm (SE=0.8 mm) FL while age 1^+ fish averaged 94.1 mm (SE=1.9 mm) FL (Table 1).

Graphical analysis of age and length data suggested separating the population into 2 age/size categories (Figure 3, 4 and 5). In August the break between age 0 (fry) and age 1^+ (parr) occurred at approximately 65 mm (Figure 3); 89% of age 0 fish were ≤65 mm and 100% of age 1^+ were >65 mm. In November and March the break between age 0 and age 1^+ also occurred at approximately 65 mm (Figure 4 and 5). For the purposes of this study fry are described as coho salmon ≤65 mm and age 0; parr are age 1^+ and >65 mm.

The distribution of lengths of coho salmon which were scale sampled for age determination is significantly different from fish not sampled (Kolmogorov-Smirnov [K-S] test, D_{max}=0.3358, P>0.0001) (Figure 6.) Scales were collected from a representative sample selected to provide separation of fry and parr; i.e. scale samples were not randomly selected. Thus, there is a difference in length distribution and mean lengths (Tables 1 and 2) between fish scale sampled (n=440) and those not sampled (n=7,829).

Table 1. Length (mm) analysis of age 0 and 1^+ juvenile coho salmon sampled during August and November, 1985, and March 1986 population studies at Kake Bake Creek, Alaska.

Length (mm)	August		November		March	
	Age 0	Age 1^+	Age 0	Age 1^+	Age 0	Age 1^+
Mean	52.2	87.7	53.7	96.5	58.2	94.1
SE	0.6	1.2	0.8	2.7	0.8	1.9
N	294	146	127	75	198	85
Min	35	66	38	60	42	56
Max	88	150	89	168	111	145
%>65mm	11	100	13	97	22	95
%≤65mm	89	0	87	3	78	5

Table 2. Length (mm) analysis of all coho salmon fry and parr captured (i.e. all fish measured, including scale sampled fish) during population studies during August and November, 1985 and November, 1986 at Kake Bake Creek, Alaska.

Length (mm)	Fry			Parr		
	Aug.	Nov.	March	Aug.	Nov.	March
Mean	47.8	52.6	54.7	84.4	92.4	86.6
SE	0.1	0.1	0.2	0.4	0.8	0.8
N	6699	1882	701	1131	711	370
Min	33	34	41	66	66	66
Max	65	65	65	240	171	145

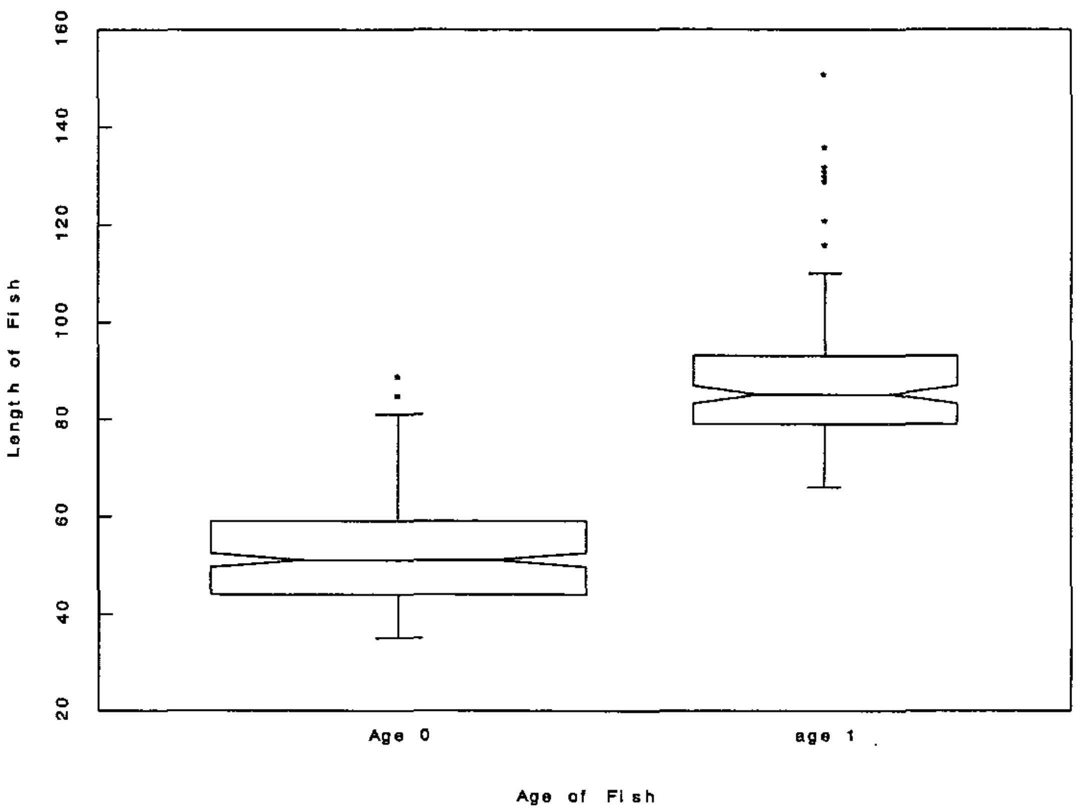


Figure 3. Boxplot of juvenile coho salmon length to determine the separation of fry and parr, by length, during August, 1985 at Kake Bake Creek, Alaska.

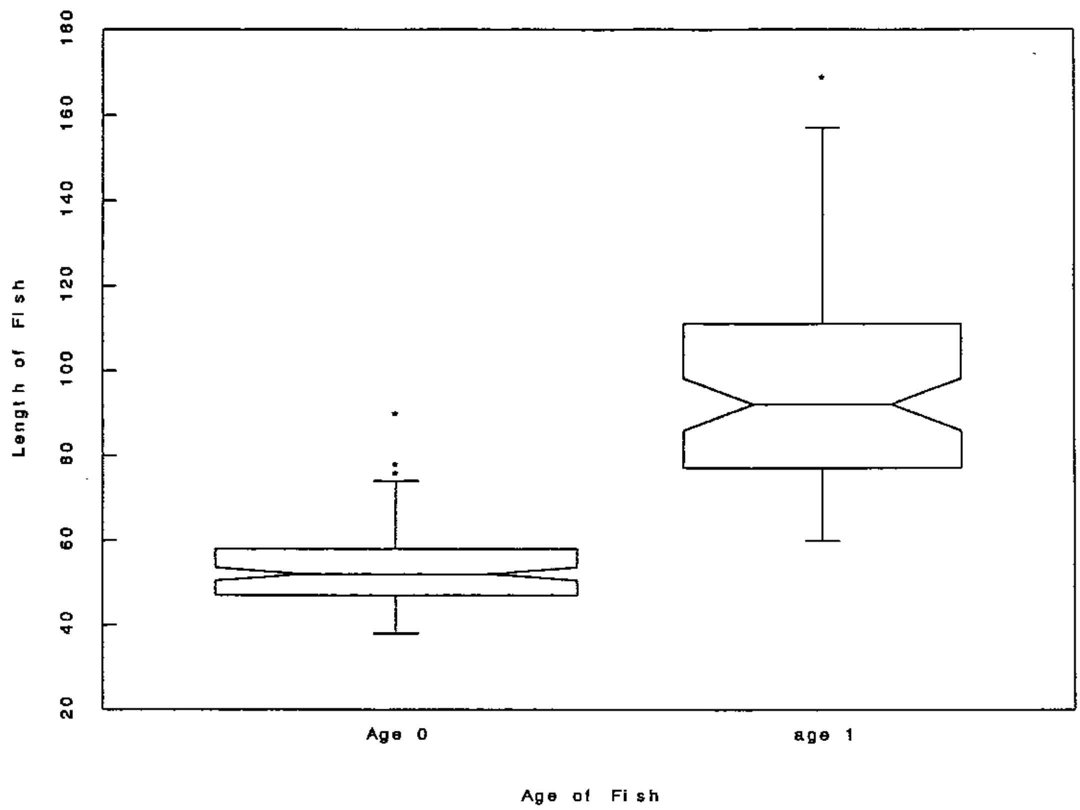


Figure 4. Boxplot of juvenile coho salmon length to determine the separation of fry and parr, by length, during November, 1985 at Kake Bake Creek, Alaska.

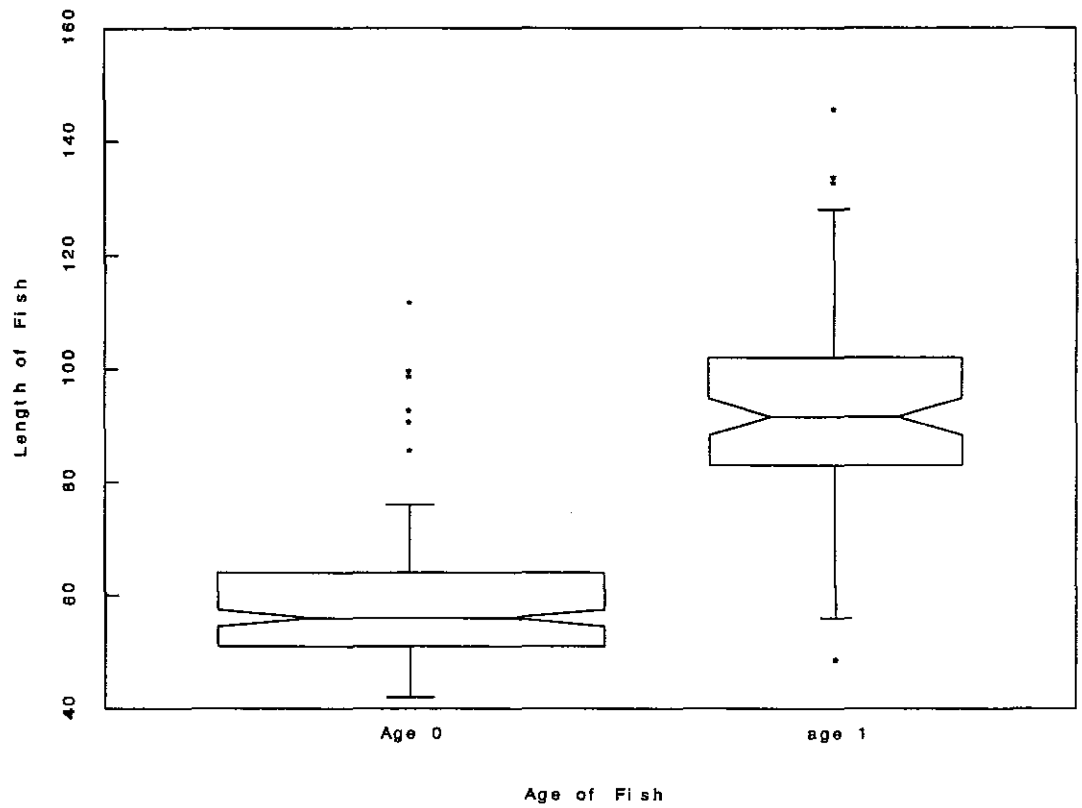


Figure 5. Boxplot of juvenile coho salmon length to determine the separation of fry and parr, by length, during March, 1986 at Kake Bake Creek, Alaska.

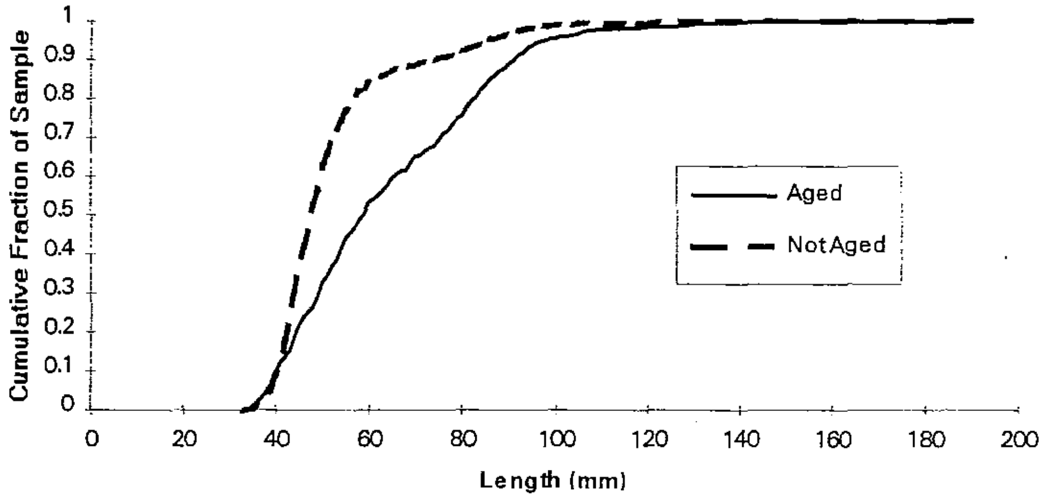


Figure 6. Cumulative histogram of lengths of juvenile coho salmon aged (Aged) versus lengths of coho salmon not aged (Not Aged) during the August, 1985, abundance estimate experiment at Kake Bake Creek, Alaska.

The distribution of lengths of fish recaptured during the abundance estimates was different during August (Kolmogorov-Smirnov [K-S] test, D_{max}=0.0324, P=0.0338) but not during November (D_{max}=0.0348, P=0.4263) or during March (D_{max}=0.0844, P=0.0555). However, the sample sizes for the K-S test during August was large (n=7,828) and one would expect differences to be detected. The cumulative distributions were very similar for all three abundance estimates (Figure 7).

Growth:

The median length of coho salmon fry increased significantly (Kruskal-Wallis test X^2=1,345, P<0.0001) between August, November, and March. The mean fry length increased from 47.8 mm (SE=0.1 mm) in August to 52.6 mm (SE=0.1 mm) in November and to 54.7 mm (SE=0.2 mm) in March (Table 2 and Figure 8). The median length of coho salmon parr also differed significantly (Kruskal-Wallis test X^2=44, P<0.0001) between August, November, and March. Parr lengths averaged 84.4 mm (SE=0.4 mm) in August, 92.4 mm (SE=0.8 mm) in November, and 86.6 mm (SE=0.8 mm) in March (Table 2 and Figure 8).

Density:

The densities of coho salmon fry in August ranged from 2.13 fish/m^2 in the 4th reach of the clearcut zone to 0.21 fish/m^2 in the 9th reach of the estuarine zone (Table 3). The density of coho salmon parr in August ranged from 0.0 fish/m^2 in the 2nd reach of the old-growth and 18th reach in the clearcut zones to 0.45 in the 7th reach of the old-growth zone (Table 3).

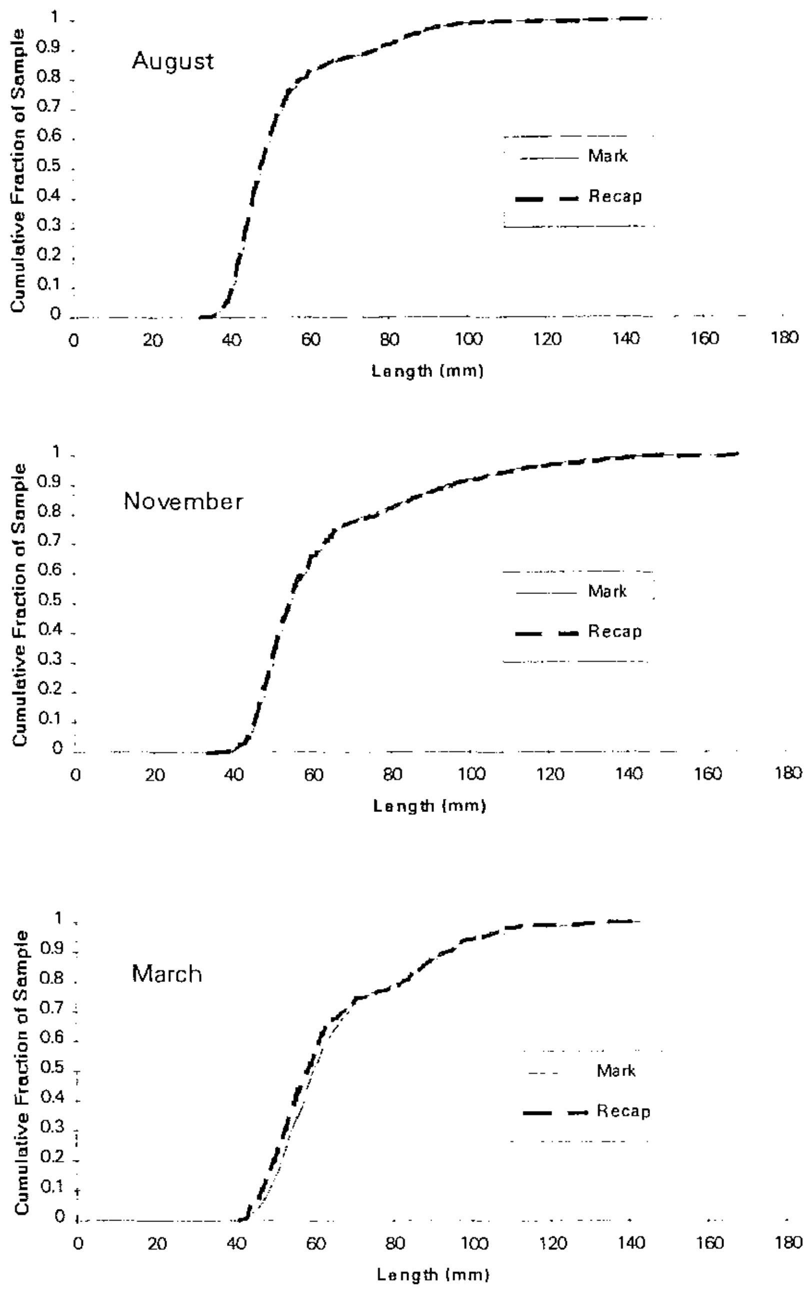


Figure 7. Cumulative histograms of lengths of juvenile coho salmon marked (Mark) versus lengths of coho salmon caught during the recaptured event (Recap) during August and November, 1985, and March, 1986 at Kake Bake Creek, Alaska.

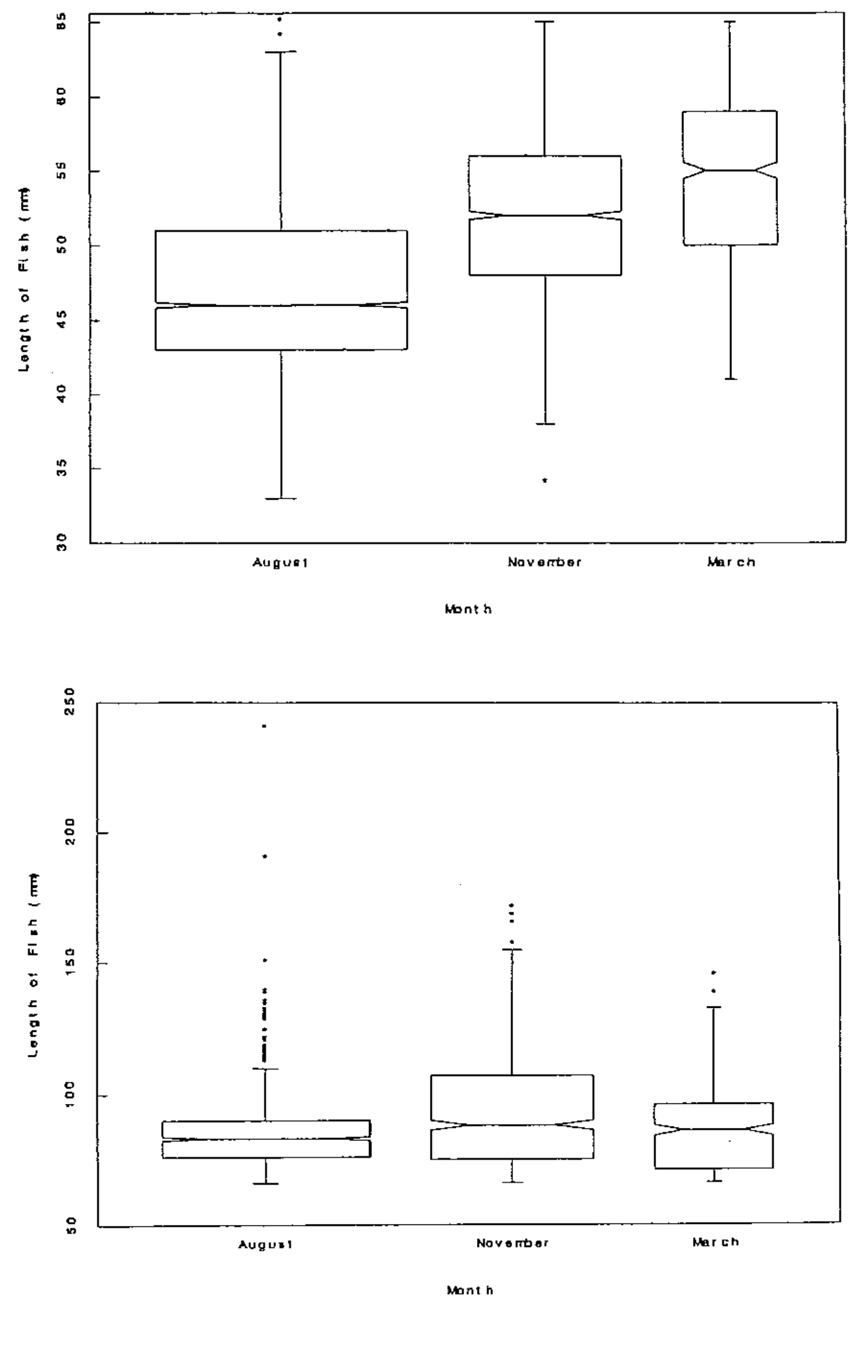


Figure 8. Boxplot of coho salmon fry (top) and parr (bottom) length during population studies during 1985 and 1986 at Kake Bake Creek, Alaska.

Table 3. Coho salmon fry and parr densities (Den.) (fish/m^2) in the estuarine (ET), old-growth (OG), and clearcut (CC) zones during August, 1985 in Kake Bake Creek, Alaska.

Zone	Reach	Total Stream Area (m^2)	Fry Population Est.	Fry Population SE	Fry Den. Est.	Parr Population Est.	Parr Population SE	Parr Den. Est.
ET	1	387.5	149.5	2.2	0.39	11.2	0.5	0.03
ET	2	352.5	152.1	1.6	0.43	5.0	2.5	0.01
ET	3	292.5	96.4	3.3	0.33	5.7	0.0	0.02
ET	4	280.0	158.7	6.0	0.57	22.0	0.0	0.08
ET	5	262.5	145.5	6.0	0.55	39.9	4.3	0.15
ET	6	212.5	131.0	7.6	0.62	14.0	3.0	0.07
ET	7	186.3	166.7	1.5	0.90	3.0	0.0	0.02
ET	8	183.8	100.0	2.1	0.54	9.0	0.0	0.05
ET	9	232.5	49.0	2.8	0.21	31.0	6.8	0.13
ET	10	225.0	113.3	1.3	0.50	27.3	0.0	0.12
ET	11	243.8	126.3	12.4	0.52	12.3	1.6	0.05
OG	1	175.0	216.3	21.0	1.24	13.0	1.4	0.07
OG	2	165.3	174.7	8.6	1.06	0.0	0.0	0.00
OG	3	149.5	289.1	11.3	1.93	9.0	2.2	0.06
OG	4	170.0	129.4	8.7	0.76	24.1	1.4	0.14
OG	5	167.5	180.8	5.0	1.08	17.9	2.6	0.11
OG	6	182.5	101.6	5.4	0.56	24.0	0.0	0.13
OG	7	138.8	112.5	10.6	0.81	62.4	3.8	0.45
OG	8	125.0	98.9	5.9	0.79	23.4	0.7	0.19
OG	9	165.0	121.4	7.8	0.74	6.0	0.0	0.04
OG	10	126.3	73.5	4.4	0.58	19.4	0.7	0.15
OG	11	171.3	69.5	2.9	0.41	22.3	0.6	0.13
OG	12	153.8	90.4	5.2	0.59	41.5	3.4	0.27
OG	13	155.0	91.2	6.1	0.59	18.3	0.6	0.12
OG	14	115.0	84.1	9.5	0.73	46.5	5.0	0.40
OG	15	141.3	123.0	10.6	0.87	12.5	4.0	0.09
CC	1	90.0	92.1	4.4	1.02	29.6	1.6	0.33
CC	2	88.5	110.7	5.4	1.25	15.0	2.1	0.17
CC	3	127.5	271.9	12.1	2.13	37.3	0.6	0.29
CC	4	127.5	228.1	5.4	1.79	33.2	2.6	0.26
CC	5	112.5	143.6	2.9	1.28	23.4	0.8	0.21
CC	6	85.0	124.7	4.0	1.47	27.6	0.9	0.32
CC	7	98.8	138.4	3.2	1.40	10.7	1.1	0.11
CC	8	46.5	41.6	1.6	0.89	19.0	0.0	0.41
CC	9	63.8	87.0	1.2	1.37	18.4	0.8	0.29
CC	10	76.0	43.2	0.5	0.57	10.4	0.8	0.14
CC	11	59.5	87.9	2.9	1.48	6.0	0.0	0.10
CC	12	60.3	69.3	4.7	1.15	10.0	0.0	0.17
CC	13	58.8	37.7	2.2	0.64	7.0	0.0	0.12
CC	14	49.0	35.6	3.5	0.73	15.5	0.9	0.32
CC	15	72.5	56.2	2.8	0.78	2.0	0.0	0.03
CC	16	54.8	51.0	2.9	0.93	3.5	0.9	0.06
CC	17	48.3	26.5	2.3	0.55	2.0	0.0	0.04
CC	18	44.5	36.4	0.8	0.82	0.0	0.0	0.00

Densities of coho salmon fry in November ranged from 1.55 fish/m² to 0.0 fish/m². The areas of highest density included the first and second reach of the clearcut zone; the lowest densities were recorded in the first eight reaches of the estuarine and last four reaches of the clearcut (Table 4). Coho salmon parr density ranged from 0.38 fish/m² to 0.0 fish/m². The highest densities of parr were found between the 7th and 14th reaches of the old-growth; the lowest densities were in the upper nine reaches of the clearcut (Table 4). Ice cover on Kake Bake Creek prevented abundance estimate experiments in the upper 6 reaches of the clearcut zone during November.

The highest density of coho salmon fry in March was estimated at 0.5 fish/m²; there were numerous reaches where no coho salmon fry were found (Table 5). Parr density was highest in the seventh reach of the clearcut zone (0.19 fish/m²). No coho salmon parr were found in eleven reaches of Kake Bake Creek during March (Table 5).

Smoothed plots of fry and parr abundance during August, November, and March are presented in Figures 9, 10, and 11, respectively. Graphically these plots show that coho salmon fry and parr are not evenly distributed in Kake Bake Creek during August, November, or March. Changes in the distribution of abundance of coho salmon fry and parr, between August, November, and March, are also shown in these plots (i.e. abundance does not remain the same over time).

Comparison of Densities Within Stream:

The hypothesis that coho salmon fry were evenly distributed in the estuarine, old-growth, and clearcut zones in Kake Bake Creek during August is rejected (Kruskal-Wallis

Table 4. Coho salmon fry and parr densities (Den.) (fish/m^2) in the estuarine (ET), old-growth (OG), and clearcut (CC) zones during November, 1985 in Kake Bake Creek, Alaska.

		Total Stream Area	Fry			Parr		
			Population		Den.	Population		Den.
Zone	Reach	(m^2)	Est.	SE	Est.	Est.	SE	Est.
ET	1	387.5	5.0	0.0	0.01	1.0	0.0	0.00
ET	2	352.5	1.0	0.0	0.00	0.0	0.0	0.00
ET	3	292.5	2.0	0.0	0.01	0.0	0.0	0.00
ET	4	280.0	1.0	0.0	0.00	0.0	0.0	0.00
ET	5	262.5	2.0	0.0	0.01	1.0	0.0	0.00
ET	6	212.5	4.0	0.0	0.02	0.0	0.0	0.00
ET	7	186.3	0.0	0.0	0.00	0.0	0.0	0.00
ET	8	183.8	8.0	0.0	0.04	0.0	0.0	0.00
ET	9	232.5	7.0	0.0	0.04	0.0	0.0	0.00
ET	10	225.0	72.8	3.9	0.31	11.0	4.0	0.04
ET	11	243.8	20.0	0.0	0.09	0.0	0.0	0.00
OG	1	175.0	33.0	6.5	0.14	0.0	0.0	0.00
OG	2	165.3	16.3	1.5	0.09	0.0	0.0	0.00
OG	3	149.5	50.6	9.0	0.31	1.0	0.0	0.00
OG	4	170.0	67.4	4.8	0.45	4.0	0.0	0.02
OG	5	167.5	71.8	6.1	0.42	8.0	0.0	0.04
OG	6	182.5	119.8	8.0	0.71	39.0	5.0	0.21
OG	7	138.8	152.5	8.9	0.84	18.2	1.5	0.10
OG	8	125.0	114.0	9.8	0.82	30.6	5.8	0.13
OG	9	165.0	56.5	10.1	0.45	12.5	0.9	0.06
OG	10	126.3	27.0	4.3	0.16	5.0	1.4	0.02
OG	11	171.3	58.1	9.7	0.46	40.7	3.7	0.23
OG	12	153.8	34.0	10.3	0.20	8.0	0.0	0.05
OG	13	155.0	44.0	9.5	0.29	46.5	9.3	0.31
OG	14	115.0	35.4	4.4	0.23	15.0	3.6	0.09
OG	15	141.3	95.3	11.0	0.83	29.9	4.9	0.18
CC	1	90.0	49.0	7.6	0.35	4.0	0.0	0.02
CC	2	88.5	62.0	4.4	0.69	44.0	2.4	0.32
CC	3	127.5	137.4	10.5	1.55	40.6	3.0	0.32
CC	4	127.5	119.2	5.6	0.93	56.8	2.7	0.34
CC	5	112.5	90.6	9.5	0.71	31.0	4.7	0.25
CC	6	85.0	87.0	14.0	0.77	65.8	5.3	0.38
CC	7	98.8	58.1	5.7	0.68	35.3	4.7	0.23
CC	8	46.5	0.0	0.0	0.00	25.0	3.8	0.16
CC	9	63.8	31.1	6.1	0.32	0.0	0.0	0.00
CC	10	76.0	32.0	11.5	0.69	31.5	7.0	0.27
CC	11	59.5	32.0	0.0	0.50	9.0	0.0	0.06
CC	12	60.3	10.0	0.0	0.13	9.0	0.0	0.10
CC	13	58.8	5.0	0.0	0.08	3.0	0.0	0.03
CC	14	49.0	3.0	0.0	0.05	1.0	0.0	0.01
CC	15	72.5	NA	NA	NA	NA	NA	NA
CC	16	54.8	NA	NA	NA	NA	NA	NA
CC	17	48.3	NA	NA	NA	NA	NA	NA
CC	18	44.5	NA	NA	NA	NA	NA	NA

Table 5. Coho salmon fry and parr densities (Den.) (fish/m^2) in the estuarine (ET), old-growth (OG), and clearcut (CC) zones during March, 1986 in Kake Bake Creek, Alaska.

		Total Stream Area	Fry			Parr		
			Population		Den.	Population		Den.
Zone	Reach	(m^2)	Est.	SE	Est.	Est.	SE	Est.
ET	1	424.0	0.0	0.0	0.00	0.0	0.0	0.00
ET	2	413.5	0.0	0.0	0.00	0.0	0.0	0.00
ET	3	404.5	0.0	0.0	0.00	0.0	0.0	0.00
ET	4	284.5	0.0	0.0	0.00	1.0	0.0	0.00
ET	5	260.0	0.0	0.0	0.00	3.0	0.0	0.01
ET	6	229.0	0.0	0.0	0.00	0.0	0.0	0.00
ET	7	234.0	0.0	0.0	0.00	0.0	0.0	0.00
ET	8	223.5	0.0	0.0	0.00	0.0	0.0	0.00
ET	9	171.0	1.0	0.0	0.01	0.0	0.0	0.00
ET	10	199.0	4.0	0.0	0.02	1.0	0.0	0.01
ET	11	191.5	0.0	0.0	0.01	1.0	0.0	0.01
OG	1	186.0	0.0	0.0	0.00	0.0	0.0	0.00
OG	2	195.5	0.0	0.0	0.00	0.0	0.0	0.00
OG	3	161.5	0.0	0.0	0.00	0.0	0.0	0.00
OG	4	160.0	8.0	0.0	0.05	0.0	0.0	0.00
OG	5	157.0	8.3	1.5	0.05	1.0	0.0	0.01
OG	6	164.0	12.5	0.8	0.08	2.0	0.0	0.01
OG	7	188.5	29.9	4.1	0.16	1.0	0.0	0.01
OG	8	180.5	30.8	1.2	0.17	3.0	0.0	0.02
OG	9	175.5	16.1	0.0	0.09	5.0	0.0	0.03
OG	10	154.5	43.3	13.3	0.28	4.0	0.0	0.03
OG	11	175.5	31.0	7.3	0.18	8.0	0.0	0.05
OG	12	172.5	21.8	3.1	0.13	11.0	2.2	0.06
OG	13	173.0	18.3	3.4	0.11	15.5	0.8	0.09
OG	14	180.5	21.0	0.0	0.12	12.2	0.0	0.07
OG	15	157.0	31.0	0.0	0.20	18.5	2.4	0.12
CC	1	144.5	8.6	0.8	0.06	4.0	0.0	0.03
CC	2	109.5	21.5	0.0	0.20	15.6	0.5	0.14
CC	3	196.0	89.8	5.2	0.46	33.0	1.9	0.17
CC	4	120.5	31.4	0.0	0.26	21.5	3.1	0.18
CC	5	143.0	40.1	4.0	0.28	14.4	1.3	0.10
CC	6	121.5	19.0	5.5	0.16	7.0	0.0	0.06
CC	7	109.5	38.2	4.5	0.35	20.8	1.2	0.19
CC	8	72.5	10.7	0.9	0.15	9.3	0.4	0.13
CC	9	91.5	16.1	1.1	0.18	14.4	2.0	0.16
CC	10	111.5	16.0	0.0	0.14	10.2	0.9	0.09
CC	11	96.5	17.0	0.0	0.18	7.4	0.5	0.08
CC	12	85.5	9.0	0.0	0.11	7.0	0.0	0.08
CC	13	68.0	2.0	0.0	0.03	0.0	0.0	0.00
CC	14	66.5	8.3	0.0	0.13	1.0	0.0	0.02
CC	15	89.5	12.4	0.0	0.14	8.0	0.0	0.09
CC	16	71.0	4.0	0.0	0.06	2.0	0.0	0.03
CC	17	83.5	1.0	0.0	0.01	2.0	0.0	0.02
CC	18	72.0	8.6	0.0	0.12	2.0	0.0	0.03

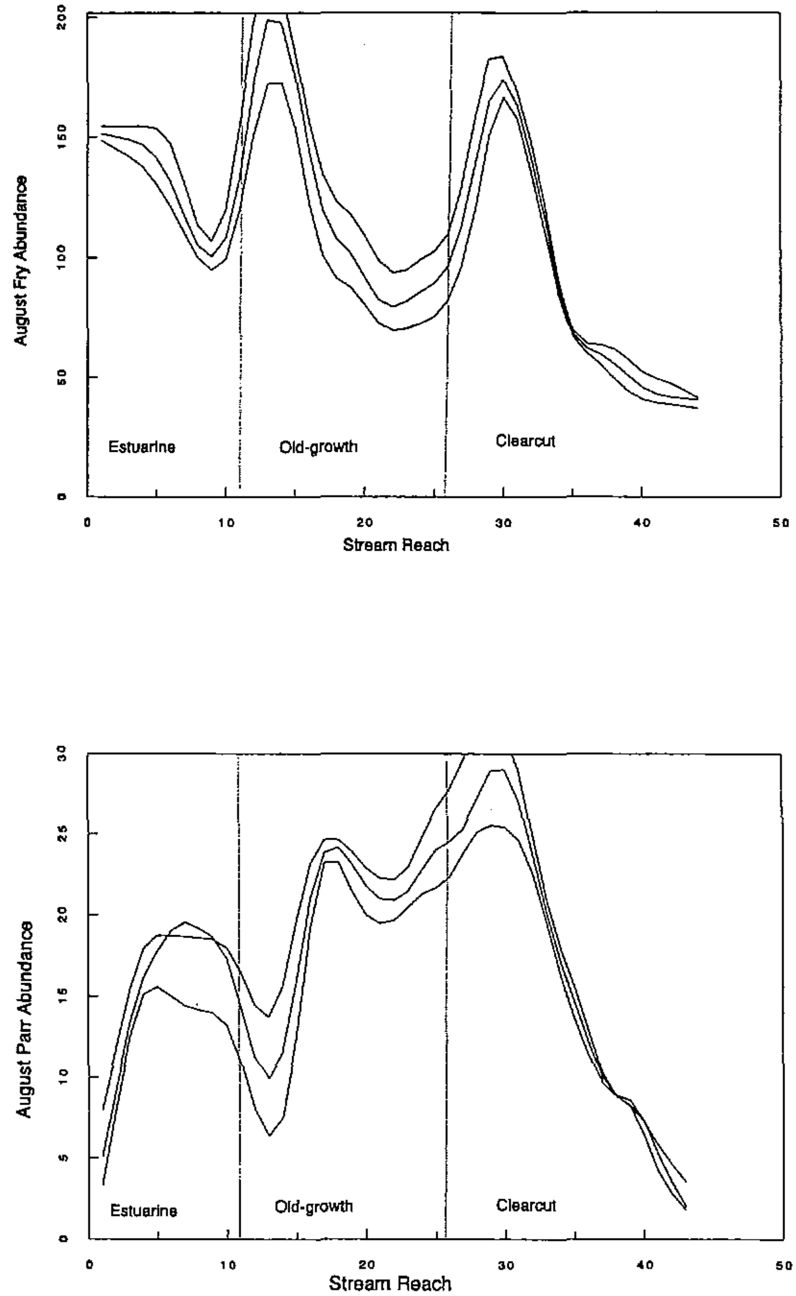


Figure 9. Smoothed plots of coho salmon fry abundance (top) and parr abundance (bottom) during August, 1985 in Kake Bake Creek, Alaska. Stream mouth is at 0 and the furthest upstream reach is to right. The three lines are the smoothed abundance estimate and upper and lower 95% CI for each stream reach.

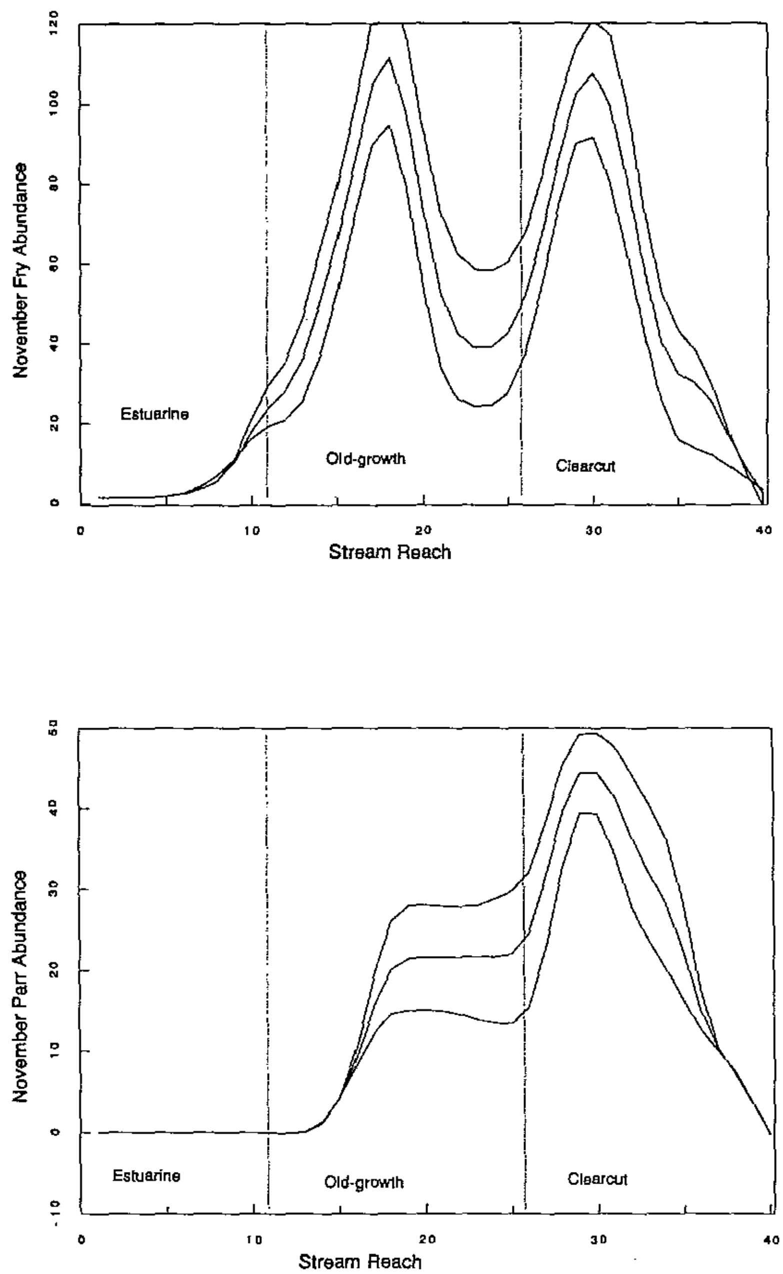
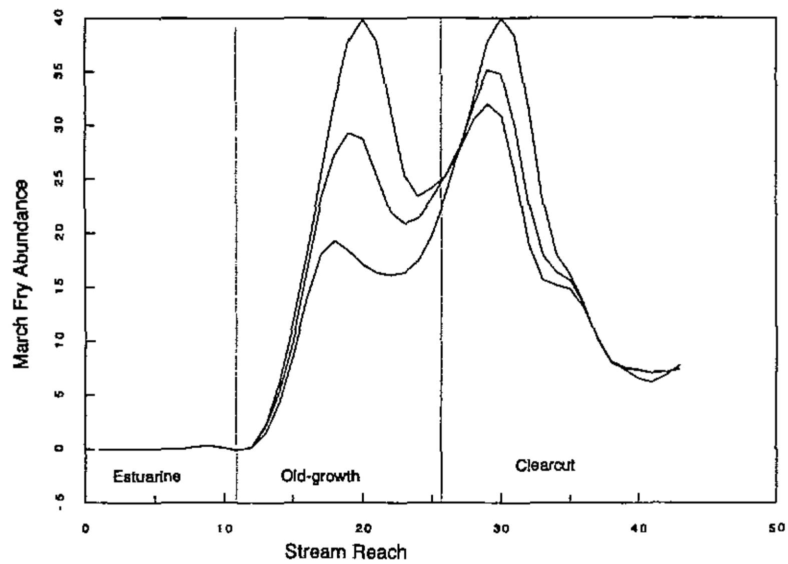


Figure 10. Smoothed plots of coho salmon fry abundance (top) and parr abundance (bottom) during November, 1985 in Kake Bake Creek, Alaska. Stream mouth is at 0 and the furthest upstream reach is to right. The three lines are the smoothed abundance estimate and upper and lower 95% CI for each stream reach.



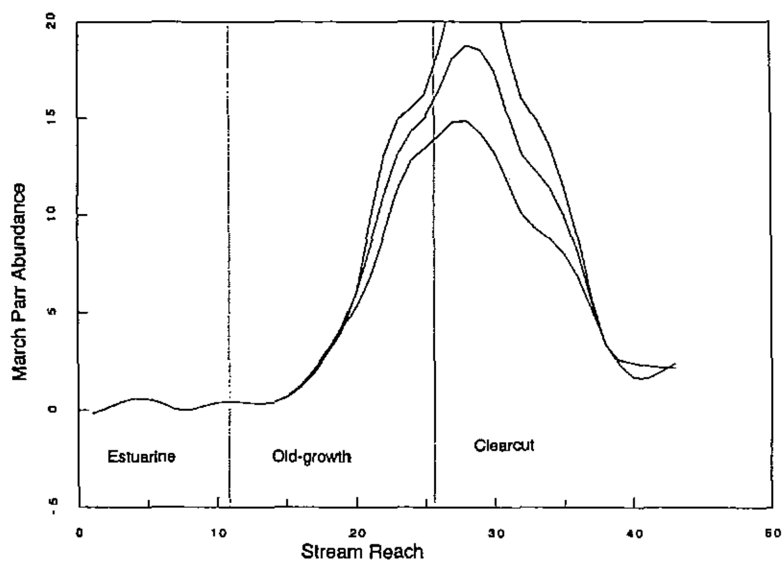


Figure 11. Smoothed plots of coho salmon fry abundance (top) and parr abundance (bottom) during March, 1986 in Kake Bake Creek, Alaska. Stream mouth is at 0 and the furthest upstream reach is to right. The three lines are the smoothed abundance estimate and upper and lower 95% CI for each stream reach.

test X^2=18.9, P<0.0001)(Table 6). The hypothesis is also rejected (Kruskal-Wallis test X^2=10.9; P<0.0001) for fry densities during November; however, the density of coho salmon fry in the estuarine and clearcut (Kruskal-Wallis test X^2=2.0; P=0.16) and in the old-growth and clearcut (Kruskal-Wallis test X^2=1.2; P=0.27), did not tend to differ during November (Table 7). The densities of coho salmon fry throughout Kake Bake in March, 1986 are also significantly different (Kruskal-Wallis test X^2=21.5; P<0.0001) and the hypothesis is rejected (Table 8). However, fry density in the old-growth and clearcut zones during March did not tend to differ (Kruskal-Wallis test X^2=2.5; P=0.11)(Table 8).

The hypotheses that coho salmon parr were evenly distributed in the estuarine, old-growth, and clearcut zones during August, November, and March in Kake Bake Creek are all rejected (Kruskal-Wallis test X^2=9.9, P=0.007; X^2=29.2; P<0.0001; and X^2=21.8, P<0.001), respectively) (Tables 9, 10, and 11). However, the density of coho salmon parr did not tend to differ between the old-growth and clearcut zones in August (Kruskal-Wallis test X^2=1.2, P=0.27) (Table 9).

Comparison of Densities Over Time:

The hypothesis that the density of coho salmon fry were the same between August and November, 1985, and between November, 1985 and March, 1986 is rejected (Quade Test Statistic (T_1) T_1=44.8, P<0.0001)(Table 12). Since the null hypothesis is rejected multiple comparisons can be made. These comparisons demonstrate that the density of coho salmon fry in the old-growth and clearcut zones tended not to differ between August and November (Table 12).

Table 6. Kruskal-Wallis test results on density estimates of coho salmon fry during August, 1985 in Kake Bake Creek, Alaska. Density estimates were grouped into estuarine, old-growth, and clearcut categories, and each density estimate was used as an observation.

	X^2 Statistic	P Value =	df
All (ET vs. OG vs. CC)	18.9[a]	7.7×10^{-5}	2
Estuarine vs. Old-growth	9.5[a]	2.1×10^{-3}	1
Estuarine vs. Clearcut	15.7[a]	7.6×10^{-5}	1
Old-growth vs. Clearcut	4.0[a]	4.5×10^{-2}	1

Conclusions: [a]Fry density in the estuarine, old-growth, and clearcut zones of Kake Bake Creek tended to differ during August, 1985.

Table 7. Kruskal-Wallis test results on density estimates of coho salmon fry during November, 1985 in Kake Bake Creek, Alaska. Density estimates were grouped into estuarine, old-growth, and clearcut categories, and each density estimate was used as an observation.

	X^2 Statistic	P Value =	df
All (ET vs. OG vs. CC)	10.9[a]	4.4×10^{-3}	2
Estuarine vs. old-growth	15.4[a]	8.7×10^{-5}	1
Estuarine vs. Clearcut	2.0[b]	1.6×10^{-1}	1
Old-growth vs. Clearcut	1.2[b]	2.7×10^{-1}	1

Conclusions: [a]Fry density in the estuarine and old-growth zones of Kake Bake Creek tended to differ during November, 1985. [b]Fry densities in the estuarine and clearcut, and in the old-growth and clearcut, did not tend to differ during November, 1985.

Table 8. Kruskal-Wallis test results on density estimates of coho salmon fry during March, 1986 in Kake Bake Creek, Alaska. Density estimates were grouped into estuarine, old-growth, and clearcut categories, and each density estimate was used as an observation.

	X^2 Statistic	P value =	df
All (ET vs. OG vs. CC)	21.5[a]	2.1×10^{-5}	2
Estuarine vs Old-growth	11.9[a]	5.8×10^{-4}	1
Estuarine vs. Clearcut	19.8[a]	8.5×10^{-6}	1
Old-growth vs. Clearcut	2.5[b]	1.1×10^{-1}	1

Conclusions: [a]Fry density in the estuarine and old-growth, and in the estuarine and clearcut zones of Kake Bake Creek tended to differ during March, 1986. [b]Fry densities in the old-growth and clearcut did not tend to differ during March, 1986.

Table 9. Kruskal-Wallis test results on density estimates of coho salmon parr during August, 1985 in Kake Bake Creek, Alaska. Density estimates were grouped into estuarine, old-growth, and clearcut categories, and each density estimate was used as an observation.

	X^2 Statistic	P Value =	df
All (ET vs. OG vs. CC)	9.9[a]	7.1×10^{-3}	2
Estuarine vs Old-growth	4.8[a]	2.9×10^{-2}	1
Estuarine vs. Clearcut	9.2[a]	2.4×10^{-3}	1
Old-growth vs. Clearcut	1.2[b]	2.7×10^{-1}	1

Conclusions: [a]Parr density in the estuarine and old-growth, and in the estuarine and clearcut zones of Kake Bake Creek tended to differ during August, 1985. [b]Parr densities in the old-growth and clearcut did not tend to differ during August, 1985.

Table 10. Kruskal-Wallis test results on density estimates of coho salmon parr during November, 1985 in Kake Bake Creek, Alaska. Density estimates were grouped into estuarine, old-growth, and clearcut categories, and each density estimate was used as an observation.

	X^2 Statistic	P Value =	df
All (ET vs. OG vs. CC)	29.2[a]	4.8×10^{-7}	2
Estuarine vs Old-growth	10.8[a]	1.1×10^{-3}	1
Estuarine vs. Clearcut	9.6[a]	2.0×10^{-3}	1
Old-growth vs. Clearcut	24.4[a]	7.7×10^{-7}	1

Conclusions: [a]Parr density in the estuarine, old-growth, and clearcut zones of Kake Bake Creek tended to differ during November, 1985.

Table 11. Kruskal-Wallis test results on density estimates of coho salmon parr during March, 1986 in Kake Bake Creek, Alaska. Density estimates were grouped into estuarine, old-growth, and clearcut categories, and each density estimate was used as an observation.

	X^2 Statistic	P Value =	df
All (ET vs. OG vs. CC)	21.8[a]	1.9×10^{-5}	2
Estuarine vs Old-growth	7.6[a]	5.9×10^{-3}	1
Estuarine vs. Clearcut	17.7[a]	2.6×10^{-5}	1
Old-growth vs. Clearcut	7.9[a]	4.9×10^{-3}	1

Conclusions: [a]Parr density in the estuarine, old-growth, and clearcut zones of Kake Bake Creek tended to differ during March, 1986.

Table 12. Densities of coho salmon fry tested (using Quade test statistic T_1) for equal densities over time during August and November, 1985, and March, 1986 in Kake Bake Creek, Alaska.

Quade Test Group	T_1 Statistic	P Value	df
Fry in all areas	44.8[a]	> 0.0001	86
Fry in Estuarine	27.8	$= 1.7 \times 10^{-6}$	20
Fry in Old-growth	22.5[b]	$= 2.1 \times 10^{-6}$	26
Fry in Clearcut	17.9[b]	$= 4.1 \times 10^{-6}$	36

Conclusions: [a]Reject the null hypothesis that coho fry density is constant over time; all T_1 exceed the .99 quantile of the F distribution.

Since Ho: is rejected multiple comparisons can be made:
[b]Fry density in the old-growth and clearcut tended not to differ between the August and November sampling periods.

Density of coho salmon parr in Kake Bake Creek also differed between August and November, 1985, and between November, 1985 and March, 1986 and the null hypothesis is rejected (Quade test T_1=15.4, P<0.0001) (Table 13). Multiple comparisons were again made and coho salmon parr densities in the estuarine and old-growth zones did not tend to differ between August and November, 1985.

The differences and magnitude of the changes in coho salmon fry and parr densities between August, November, and March are graphically represented with mixplot graphs (Figure 12). If densities between August, November, and March remained constant all circles would fall into the center of the triangle and all the circles would be the same size (the diameter of the circle corresponds to the magnitude of the density while the location of the circle reflects density differences between August, November, and March).

Habitat

Gradient:

The estuarine zones in Kake Bake Creek is relatively flat with the percent stream gradient ranging from 0.10% to 0.22% (Table 14). The old-growth zone is steeper with gradients ranging from 0.14% to 1.16%. The slope increases in the clearcut zone with gradients ranging from 0.76% to 5.46% (Table 14). The stream gradient was measured only during August, 1985.

Discharge:

Discharge in Kake Bake Creek during August, 1985 ranged from 0.00 to 0.15 m^3/sec (Table 14); however, three measurements in the estuarine (reaches 9, 10, and 11) were taken immediately following a heavy rain when the water level

Table 13. Densities of coho salmon parr tested (using Quade test statistic T_1) for equal densities over time during August and November, 1985, and March, 1986 in Kake Bake Creek, Alaska.

Quade Test Group	T_1 Statistic	P Value	df
Parr in all areas	15.4[a]	> 0.0001	86
Parr in Estuarine	12.7[b]	$= 2.8 \times 10^{-4}$	20
Parr in Old-growth	18.6[b]	$= 9.7 \times 10^{-6}$	26
Parr in Clearcut	28.8	$= 6.0 \times 10^{-8}$	36

Conclusions: [a]Reject the null hypothesis that coho parr density is constant over time; all T_1 exceed the .99 quantile of the F distribution.

Since Ho: is rejected multiple comparisons can be made:
[b]Parr density in the estuarine and old-growth zones tended not to differ between the August and November sampling periods.

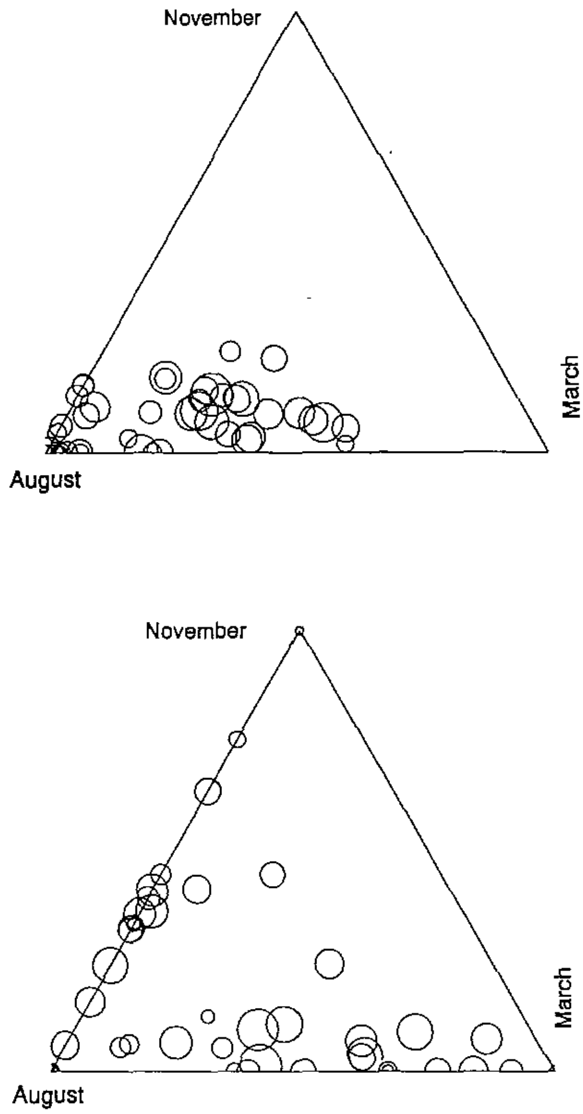


Figure 12. Mixplot graph of coho salmon fry (top) and parr (bottom) density estimates during August and November, 1985, and March, 1986 in Kake Bake Creek, Alaska. The diameter of the circle corresponds to the magnitude of the density while the location of the circle reflects density differences between August, November, and March.

Table 14. Percent stream gradient (cm rise/m) measured during August, 1985 and mean discharge (m^3/sec.) measured during August, 1985 and March, 1986 in Kake Bake Creek, Alaska.

Zone	Reach	Percent Gradient	Mean Discharge (m^3/sec) August	March
Estuarine	1	0.16	0.01	0.08
Estuarine	2	0.12	0.00	0.08
Estuarine	3	0.10	0.01	0.08
Estuarine	4	0.14	0.01	0.03
Estuarine	5	0.10	0.00	0.03
Estuarine	6	0.10	0.01	0.03
Estuarine	7	0.22	0.01	0.04
Estuarine	8	0.22	0.04	0.04
Estuarine	9	0.16	[a]0.10	0.04
Estuarine	10	0.12	[a]0.15	0.03
Estuarine	11	0.15	[a]0.14	0.03
Old-growth	1	0.22	0.01	0.09
Old-growth	2	0.27	0.01	0.06
Old-growth	3	0.16	0.01	0.07
Old-growth	4	0.32	0.04	0.06
Old-growth	5	0.20	0.04	0.08
Old-growth	6	0.31	0.05	0.06
Old-growth	7	0.14	0.04	0.07
Old-growth	8	0.35	0.05	0.06
Old-growth	9	0.18	0.03	0.05
Old-growth	10	0.25	0.03	0.05
Old-growth	11	0.56	0.02	0.04
Old-growth	12	1.16	0.03	0.04
Old-growth	13	0.46	0.02	0.04
Old-growth	14	0.62	0.03	0.04
Old-growth	15	0.47	0.03	0.05
Clearcut	1	0.81	0.02	0.05
Clearcut	2	0.94	0.02	0.06
Clearcut	3	1.20	0.02	0.06
Clearcut	4	0.76	0.02	0.05
Clearcut	5	0.92	0.01	0.05
Clearcut	6	1.08	0.01	0.07
Clearcut	7	0.50	0.01	0.05
Clearcut	8	2.17	0.01	0.04
Clearcut	9	2.50	0.00	0.03
Clearcut	10	2.56	0.01	0.05
Clearcut	11	2.64	0.00	0.04
Clearcut	12	3.26	0.01	0.03
Clearcut	13	5.12	0.01	0.04
Clearcut	14	5.00	0.01	0.03
Clearcut	15	4.12	0.00	0.05
Clearcut	16	4.96	0.01	0.04
Clearcut	17	4.92	0.00	0.04
Clearcut	18	5.46	0.00	0.03

[a] Measured during high water event.

in the creek was higher. Low discharge during August, 1985, in the lower seven estuarine stream reaches may be accounted for by extremely low water velocities; there was no measurable velocity (i.e. velocity <0.00 m/s) at many transect sites. During March, 1986, discharge was typically higher in all areas and ranged from 0.03 to 0.08 m^3/sec (Table 14 and Figure 13).

Stream Area:

During August, 1985, the total stream area per 50 m reach in Kake Bake ranged from 387.5 m^2 in the lowest estuarine reach to 44.5 m^2 in the headwaters of the clearcut zone (Table 15 and Figure 14). In March the total stream area ranged from 424 m^2 in the lowest estuarine reach to 71.0 m^2 in the 15th reach of the clearcut zone (Table 16 and Figure 14).

Area of Riffle, Glide, and Pool:

The stream area in Kake Bake Creek classified as riffle ranged from 0.0 to 105.0 m^2 during August, 1985 (Table 15) and from 0.0 to 68.5 during March, 1986 (Table 16). The area of riffle exceeds the area of glide and pool only in the lower old-growth and upper clearcut zones (Figure 15). During August, 1985, more stream area was classified as riffle in the lower seven old-growth reaches than in March, 1986; however, more stream was classified as riffle in the upper old-growth and clearcut zones during March than during August (Figure 16).

The area of stream classified as glide ranged from 0.0 to 387.5 m^2 during August, 1985, and from 0.0 to 424 m^2 during March, 1986 (Tables 15 and 16). The stream in the estuarine

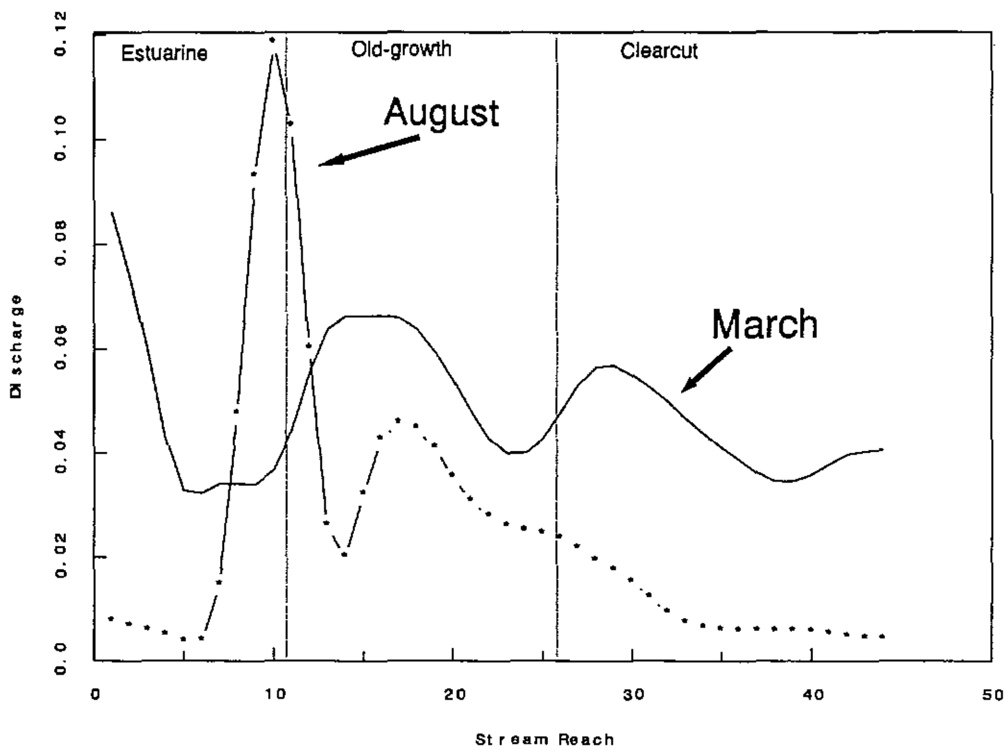


Figure 13. Smoothed plot of the discharge (m^3/sec) for each stream reach during August, 1985, and March 1986, Kake Bake Creek, Alaska.

Table 15. The stream area (m^2), and the area of riffle, glide, pool, and standardized area (habitat area/stream area) of pool, undercut bank (UCB), and large woody debris (LWD), measured in each 50 m stream reach during August, 1985, in Kake Bake Creek, Alaska.

Zone	Reach	Stream Area (m^2)	Area (m^2) Riffle	Glide	Pool	Standardized Area (m^2) Pool	UCB	LWD
ET	1	387.5	0.0	387.5	0.0	0.0000	0.0000	0.0000
ET	2	352.5	0.0	342.5	10.0	0.0000	0.0000	0.0000
ET	3	292.5	30.0	232.5	30.0	0.0047	0.0000	0.0037
ET	4	280.0	0.0	280.0	0.0	0.0000	0.0000	0.0000
ET	5	262.5	0.0	157.5	105.0	0.2011	0.0000	0.0187
ET	6	212.5	0.0	212.5	0.0	0.0000	0.0000	0.0000
ET	7	186.3	17.5	168.7	0.0	0.0000	0.0000	0.0000
ET	8	183.8	18.7	130.0	35.0	0.0769	0.0000	0.0347
ET	9	232.5	0.0	140.0	92.5	0.1782	0.0000	0.0172
ET	10	225.0	12.5	177.5	35.0	0.1997	0.0000	0.0008
ET	11	243.8	106.3	137.5	0.0	0.0000	0.0000	0.0000
OG	1	175.0	0.0	175.0	0.0	0.0000	0.0000	0.0000
OG	2	165.3	31.2	134.0	0.0	0.0058	0.0000	0.0000
OG	3	149.5	13.8	135.7	0.0	0.0025	0.0000	0.0025
OG	4	170.0	62.5	60.0	47.5	0.0372	0.0000	0.0032
OG	5	167.5	105.0	52.5	10.0	0.0187	0.0000	0.0102
OG	6	182.5	77.5	12.5	92.5	0.0934	0.0000	0.0177
OG	7	138.8	72.5	30.0	36.3	0.0871	0.0000	0.0000
OG	8	125.0	90.0	10.0	25.0	0.0994	0.0000	0.0354
OG	9	165.0	45.0	47.5	72.5	0.1256	0.0038	0.0250
OG	10	126.3	58.7	15.0	52.5	0.0938	0.0027	0.0319
OG	11	171.3	11.3	0.0	160.0	0.2318	0.0143	0.0800
OG	12	153.8	26.2	0.0	127.5	0.1730	0.0047	0.0349
OG	13	155.0	27.5	0.0	127.5	0.3051	0.0027	0.0201
OG	14	115.0	51.3	0.0	63.7	0.1043	0.0050	0.0330
OG	15	141.3	31.2	0.0	110.0	0.1384	0.0086	0.0389
CC	1	90.0	38.8	0.0	51.2	0.0869	0.0064	0.0405
CC	2	88.5	40.0	0.0	48.5	0.2528	0.0037	0.0429
CC	3	127.5	42.5	0.0	85.0	0.2373	0.0025	0.0957
CC	4	127.5	12.5	0.0	115.0	0.1508	0.0033	0.0212
CC	5	112.5	13.7	5.0	93.7	0.1250	0.0036	0.0350
CC	6	85.0	31.2	10.0	43.7	0.1114	0.0028	0.0098
CC	7	98.8	32.5	10.0	56.2	0.1233	0.0021	0.0198
CC	8	46.5	30.2	0.0	16.3	0.0477	0.0026	0.0323
CC	9	63.8	10.0	5.0	48.7	0.0896	0.0022	0.0744
CC	10	76.0	38.8	0.0	37.2	0.1325	0.0054	0.0763
CC	11	59.5	15.0	34.5	10.0	0.0431	0.0014	0.0083
CC	12	60.3	34.0	0.0	26.3	0.0314	0.0012	0.0382
CC	13	58.8	35.0	15.0	8.7	0.0539	0.0023	0.0615
CC	14	49.0	36.5	0.0	12.5	0.0489	0.0000	0.0388
CC	15	72.5	10.0	37.5	25.0	0.1106	0.0027	0.0444
CC	16	54.8	42.3	0.0	12.5	0.0314	0.0008	0.0137
CC	17	48.3	23.3	8.7	16.3	0.0745	0.0018	0.0207
CC	18	44.5	34.5	7.5	2.5	0.0365	0.0000	0.0270

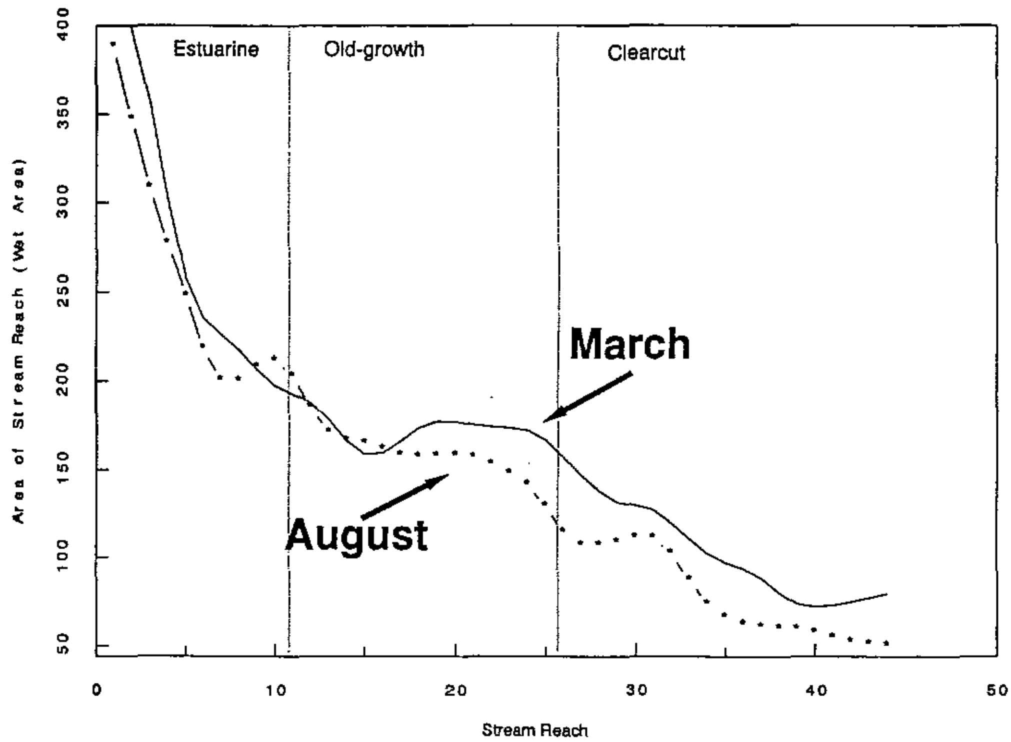


Figure 14. Smoothed plot of the total stream area (m^2) for each stream reach during August, 1985 and March, 1986, Kake Bake Creek, Alaska.

Table 16. The stream area (m^2), and the area of riffle, glide, pool, and standardized area (habitat area/stream area) of pool, undercut bank (UCB), and large woody debris (LWD), measured in each 50 m stream reach during March, 1986, in Kake Bake Creek, Alaska.

Zone	Reach	Stream Area (m^2)	Area (m^2) Riffle	Glide	Pool	Standardized Area (m^2) Pool	U.Bank	LWD
ET	1	424.0	0.0	424.0	0.0	0.0000	0.0000	0.0000
ET	2	413.5	36.0	365.0	12.5	0.0021	0.0000	0.0000
ET	3	404.5	26.0	348.5	30.0	0.0061	0.0000	0.0033
ET	4	284.5	0.0	284.5	0.0	0.0000	0.0000	0.0000
ET	5	260.0	0.0	169.0	91.0	0.1000	0.0000	0.0121
ET	6	229.0	0.0	229.0	0.0	0.0000	0.0000	0.0000
ET	7	234.0	16.0	216.5	1.5	0.0000	0.0000	0.0000
ET	8	223.5	49.0	93.9	80.5	0.0899	0.0000	0.0145
ET	9	171.0	9.0	66.9	95.0	0.2733	0.0000	0.0028
ET	10	199.0	23.0	61.9	114.0	0.3046	0.0000	0.0000
ET	11	191.5	47.5	120.8	23.0	0.0042	0.0000	0.0021
OG	1	186.0	0.0	186.0	0.0	0.0000	0.0000	0.0000
OG	2	195.5	46.0	124.0	25.5	0.0072	0.0000	0.0000
OG	3	161.5	29.0	130.0	2.5	0.0137	0.0000	0.0030
OG	4	160.0	42.0	72.0	46.0	0.0512	0.0032	0.0089
OG	5	157.0	29.0	107.4	20.5	0.0616	0.0069	0.0113
OG	6	164.0	33.5	81.5	49.0	0.0848	0.0000	0.0070
OG	7	188.5	0.0	122.9	65.5	0.0510	0.0000	0.0000
OG	8	180.5	52.0	78.3	50.0	0.0584	0.0171	0.0048
OG	9	175.5	20.0	67.9	87.5	0.1031	0.0225	0.0226
OG	10	154.5	32.5	84.4	37.5	0.1630	0.0074	0.0278
OG	11	175.5	25.0	66.3	84.0	0.1615	0.0547	0.0455
OG	12	172.5	68.5	17.4	86.5	0.2012	0.0389	0.0565
OG	13	173.0	33.0	15.9	124.0	0.3662	0.0197	0.0174
OG	14	180.5	44.5	44.4	91.5	0.1378	0.0328	0.0158
OG	15	157.0	56.5	17.0	83.5	0.1727	0.1139	0.0211
CC	1	144.5	47.0	41.5	56.0	0.0486	0.0195	0.0151
CC	2	109.5	36.5	46.4	26.5	0.1575	0.0408	0.0189
CC	3	196.0	62.0	40.4	93.5	0.2369	0.0088	0.0514
CC	4	120.5	48.5	43.5	28.5	0.1096	0.0309	0.0078
CC	5	143.0	37.0	10.9	95.0	0.1016	0.0200	0.0207
CC	6	121.5	64.5	23.0	34.0	0.1737	0.0297	0.0277
CC	7	109.5	35.5	22.5	51.5	0.0537	0.0132	0.0059
CC	8	72.5	56.5	8.5	7.5	0.0479	0.0123	0.0131
CC	9	91.5	40.5	28.5	22.5	0.1113	0.0124	0.0094
CC	10	111.5	50.0	21.4	40.0	0.0364	0.0113	0.0092
CC	11	96.5	55.0	24.4	17.0	0.0305	0.0079	0.0069
CC	12	85.5	43.0	36.5	6.0	0.0227	0.0034	0.0066
CC	13	68.0	53.5	5.0	9.5	0.0532	0.0117	0.0218
CC	14	66.5	40.0	15.0	11.5	0.0338	0.0192	0.0072
CC	15	89.5	30.5	27.9	31.0	0.0568	0.0148	0.0153
CC	16	71.0	59.0	3.0	9.0	0.0377	0.0140	0.0118
CC	17	83.5	48.0	22.0	13.5	0.0341	0.0056	0.0177
CC	18	72.0	44.5	20.5	7.0	0.0299	0.0000	0.0091

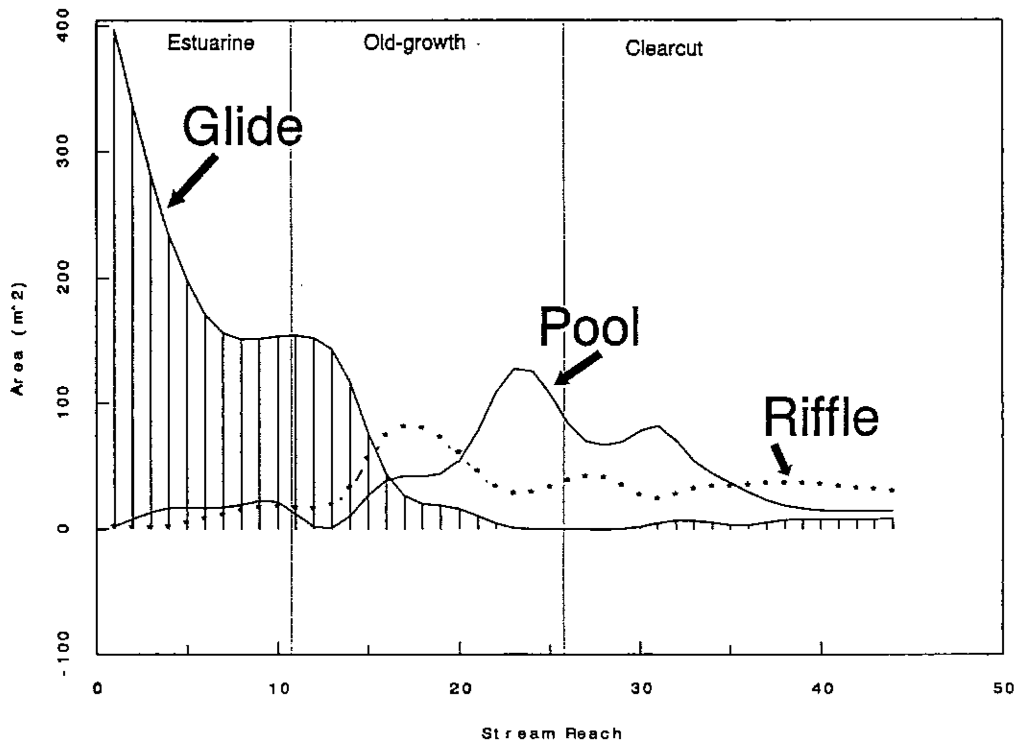


Figure 15. Smoothed plot of the total area (m^2) of pool, glide, and riffle habitat in each 50 m stream reach measured during August, 1985, in Kake Bake Creek, Alaska.

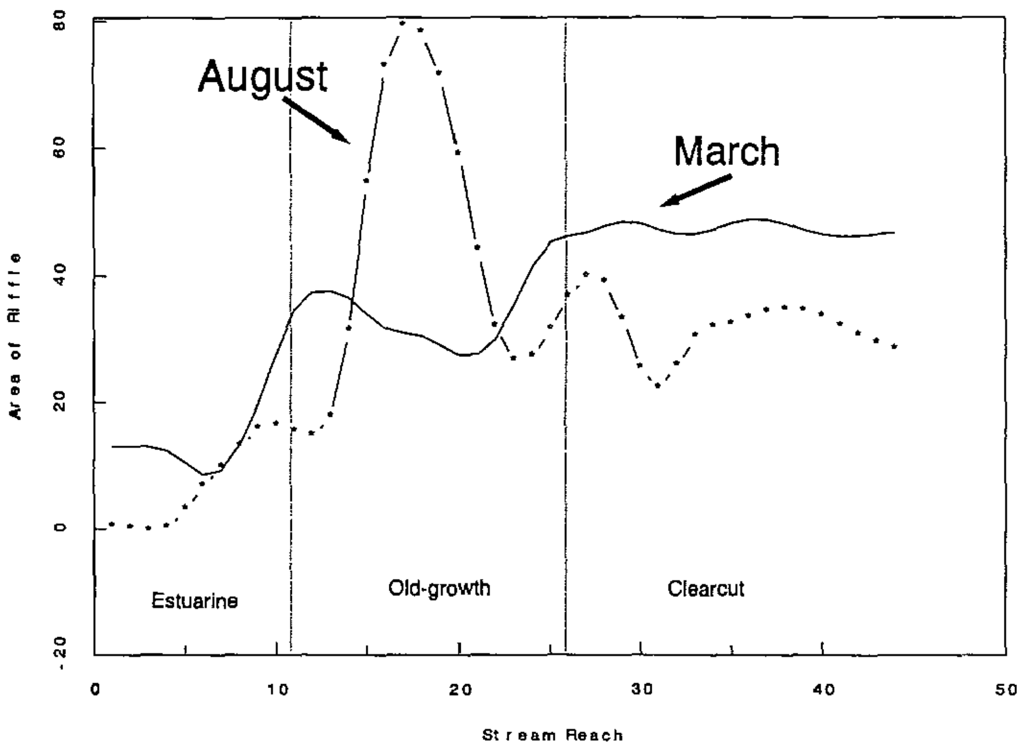


Figure 16. Smoothed plot of the riffle area (m^2) in each 50 m stream reach measured during August, 1985, and March, 1986, in Kake Bake Creek, Alaska.

glide while the remainder of Kake Bake was classified as either pool or riffle (Figure 15). Similar glide areas were measured during August, 1985 and March, 1986 (Tables 15 and 16; and Figure 17).

The stream area classified as pool ranged from 0.0 to 160.0 m^2 during August, 1985 and from 0.0 to 124.0 m^2 in March, 1986 (Tables 15 and 16). Pools were the predominant stream classification in the old-growth and lower clearcut zones (Figure 15). Similar areas were classified as pool during August, 1985, and March, 1986 with the exception of more pool area in the old-growth during August and more pool area in the estuarine during March (Figure 18).

Standardized Area of Pool, UCB and LWD:

The standardized area of pool, UCB, and LWD was calculated by summing up the habitat area (i.e. pool, UCB, and LWD) (Appendix A1 and A2) and dividing by the area of the stream reach.

Similar standardized pool areas were measured during August, 1985 (from 0.0000 to 0.2528 m^2) and during March, 1986 (from 0.0000 to 0.3662 m^2) (Tables 15 and 16; and Figure 19). There was more pool area throughout Kake Bake Creek than either LWD or UCB. There was also more pool area in the upper reaches of the estuarine zones and in the upper old-growth/lower clearcut zones (Figure 20). Very similar standardized pool areas were measured during August, 1985, and March, 1986 (Figure 19).

The standardized area of undercut banks ranged from 0.0000 to 0.0143 m^2 during August, 1985 and from 0.0000 to 0.0547 m^2 in March, 1986 (Tables 15 and 16). Compared to

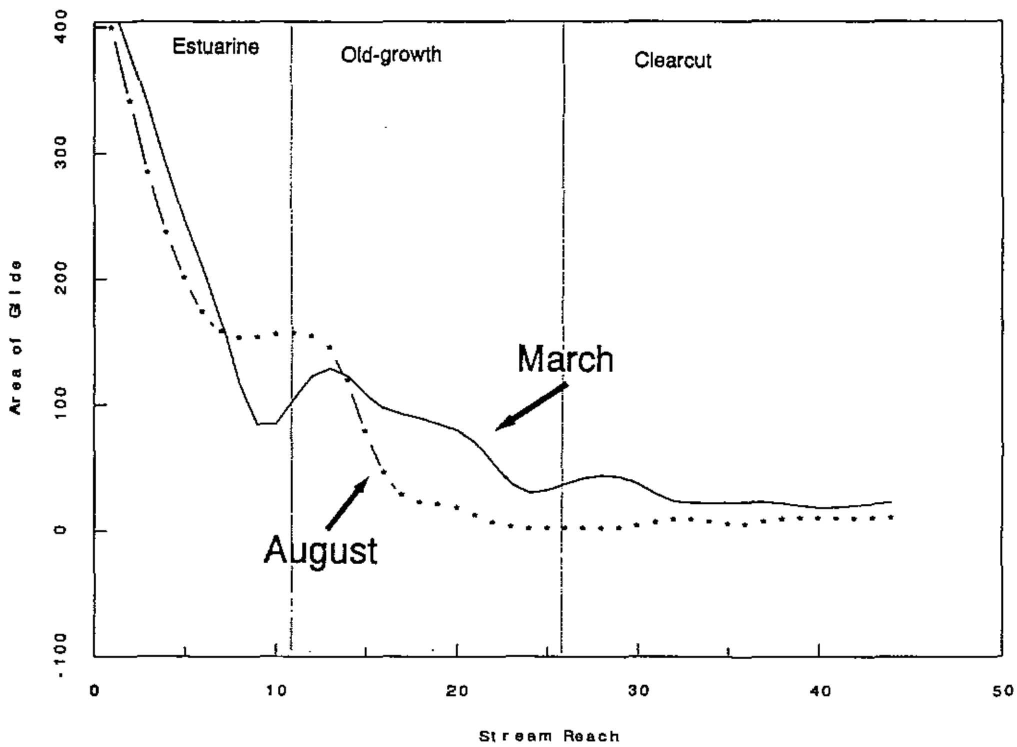


Figure 17. Smoothed plot of the glide area (m^2) in each 50 m stream reach measured during August, 1985, and March, 1986, in Kake Bake Creek, Alaska.

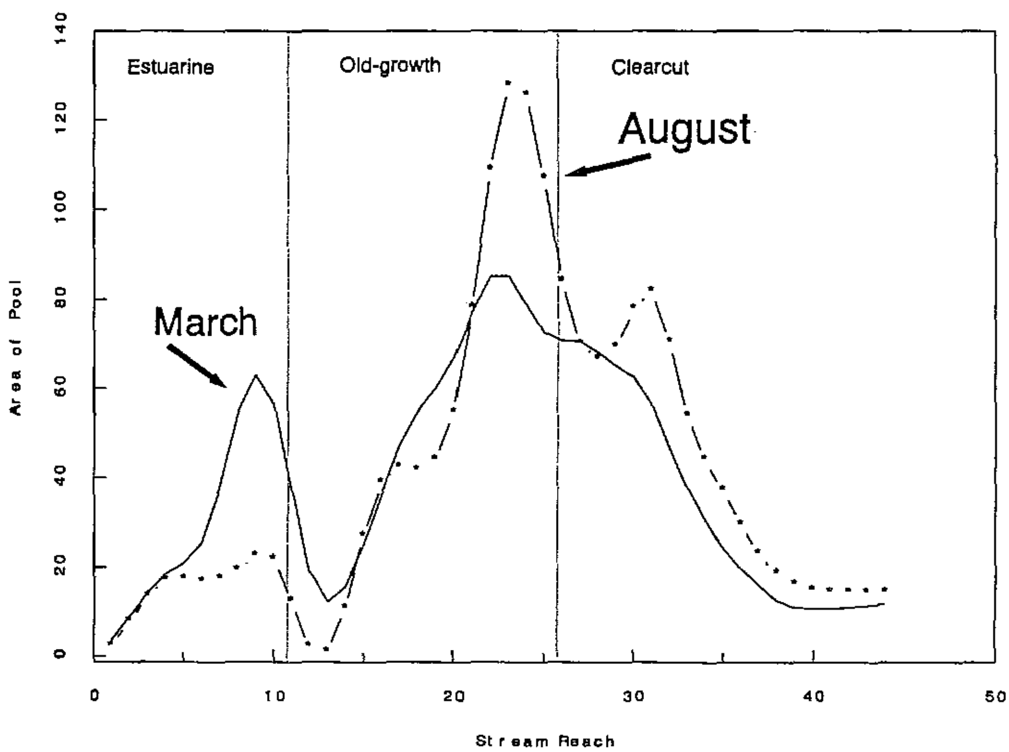


Figure 18. Smoothed plot of the pool area (m^2) in each 50 m stream reach measured during August, 1985, and March, 1986, in Kake Bake Creek, Alaska.

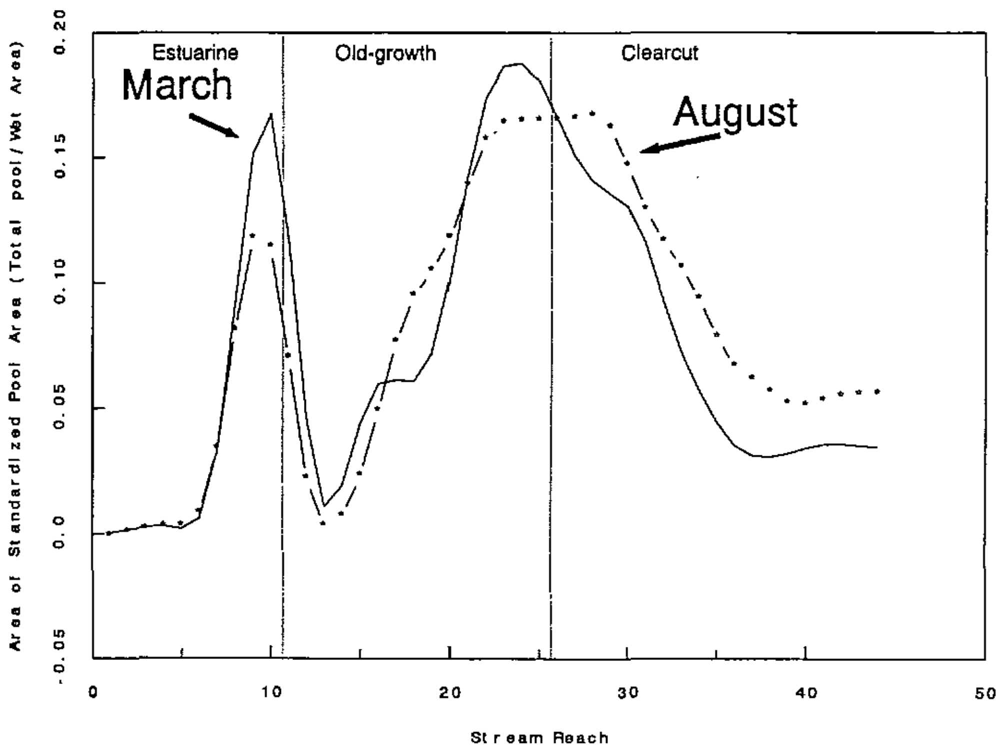


Figure 19. Smoothed plot of standardized pool area (total pool area/stream area) measured for each 50 m stream reach during August, 1985, in Kake Bake Creek, Alaska.

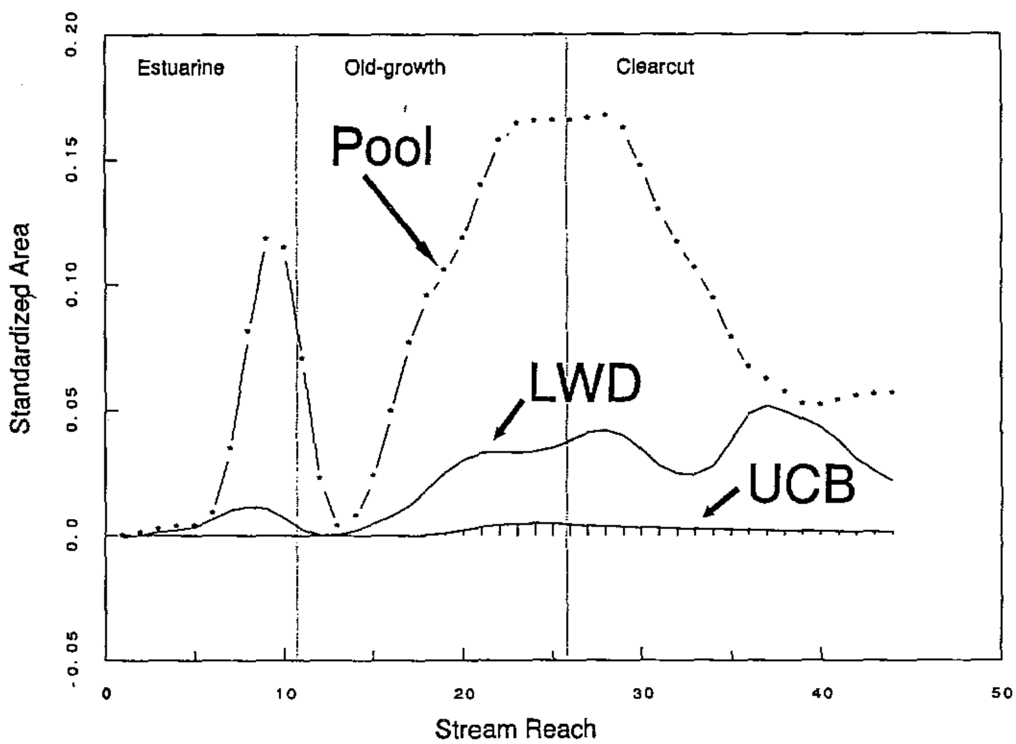


Figure 20. Smoothed plot of standardized area (total area/stream area) of pool, large woody debris (LWD), and undercut banks (UCB) measured for each 50 m stream reach during August, 1985, in Kake Bake Creek, Alaska.

the area of pools UCB make up only a fraction of the habitat per m^2 of stream reach (Figure 20). Undercut banks were found throughout the old-growth and clearcut zones; no undercut banks were found in the estuarine zone (Figure 20). More UCB area was measured in March, 1986, than during August, 1985 (Figure 21).

The standardized area of LWD ranged from 0.0000 to 0.0957 m^2 during August, 1985 and from 0.0000 to 0.0564 m^2 during March, 1986 (Tables 15 and 16). The area of LWD per m^2 of stream reach exceeded the area of UCB but was consistently less than the area of pools (Figure 20). Large woody debris was found throughout Kake Bake but was more predominant in old-growth and clearcut zones (Figure 20). Similar amounts of LWD were measured in the estuarine and old-growth zones during August, 1985, and March, 1986 but more LWD was measured in the clearcut zone during August (Figure 22).

Comparison of Densities Within Riffle, Glide, and Pool:

Coho salmon fry were distributed evenly between riffle, glide, and pool habitat types during August, 1985 (Quade statistic T_1=1.2, P=0.308) (Table 17). During November, 1985 and March, 1986, fry densities were significantly different (Quade statistic T_1=5.3, P=0.0025 and T_1=14.7, P<0.0001, respectively) among the habitat types. However, densities tended not to differ between riffle and pool areas during both November and March (Table 17).

The densities of coho salmon parr were not evenly distributed among riffle, glide, and pool habitat types during August and November, 1985, and March, 1986 (Quade statistic T_1=6.4, P=0.0025; T_1=10.8, P=0.0066; and T_1=11.6,

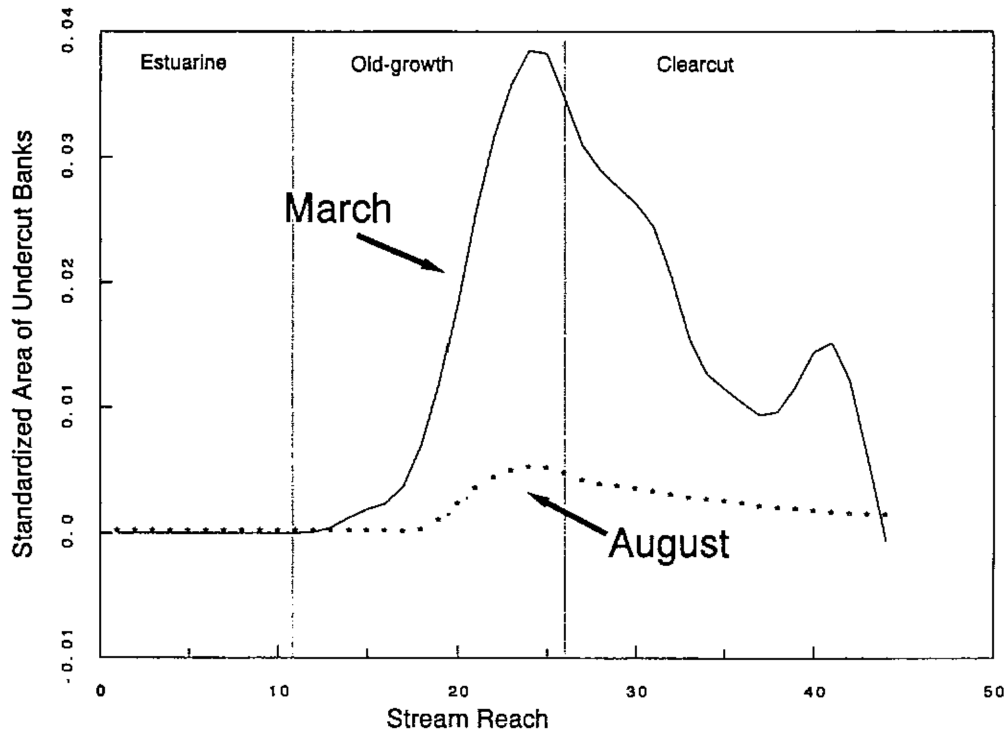


Figure 21. Smoothed plot of standardized undercut banks (total undercut bank area/stream area) measured for each 50 m stream reach during August, 1985, and March, 1986, in Kake Bake Creek, Alaska.

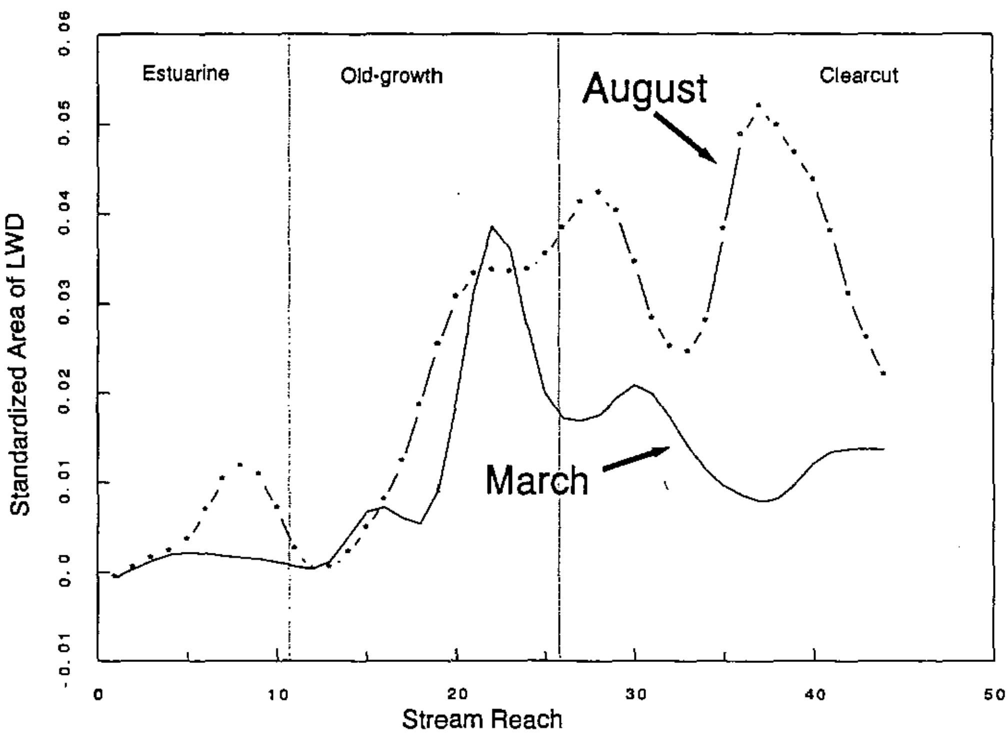


Figure 22. Smoothed plot of standardized large woody debris (total LWD area/stream area) measured for each 50 m stream reach during August, 1985, and March, 1986, in Kake Bake Creek, Alaska.

Table 17. The density of coho salmon fry tested (using Quade test statistic T_1) for equal densities by habitat type (riffle, glide, and pool) during August and November, 1985, and March, 1986, Kake Bake Creek, Alaska.

Quade Test Group	T_1 Statistic	P Value =	df
Fry during August	1.2[a]	0.3084	2 and 86
Fry during November	5.3[b]	6.6×10^{-3}	2 and 86
Fry during March	14.7[c]	3.3×10^{-6}	2 and 86

Conclusions: [a]Accept the hypothesis that coho fry densities are distributed evenly between riffle, glide and pool habitat types during August, 1985. [b]Reject the hypothesis that coho fry densities are distributed evenly between riffle, glide and pool habitat types during November, 1985; however multiple comparisons reveal that fry densities did not differ between riffle and pool habitat types. [c]Reject the hypothesis that coho fry densities are distributed evenly between riffle, glide and pool habitat types during March, 1986; however multiple comparisons reveal that fry densities did not differ between riffle and pool habitat types.

$P<0.0001$, respectively) (Table 18). However, multiple comparisons revealed that parr densities in the riffle and glide habitat types were not different during August and November, 1985, and March, 1986.

Comparison of Densities Within Habitat Types Over Time:

Coho salmon fry densities did not remain the same over time (August, November, and March) in either the riffle, glide, or pool habitat types (Quade statistic $T_1=43.7$, $P<0.0001$; $T_1=46.4$, $P<0.0001$; and $T_1=53.8$, $P<0.0001$, respectively) (Table 19). Multiple comparisons reveal that fry densities were different in all three habitat types between August and November, 1985 and March, 1986.

The densities of coho salmon parr also did not remain the same over time in the riffle, glide, or pool habitat types (Quade statistic $T_1=18.2$, $P<0.0001$; $T_1=15.6$, $P<0.0001$; and $T_1=16.0$, $P<0.0001$, respectively) (Table 20). However, multiple comparisons revealed: 1) no difference in densities in the riffle habitat between August and November; 2) no difference in densities in the glide habitat between November and March; and 3) no difference in densities in the pool habitat between August and November.

Relationships Between Density and Habitat:

The R^2 values (index of association between dependent and independent variables) from the regression of coho salmon fry and parr densities against habitat variables are presented in Table 21. The R^2 values from the best models (i.e. selected models containing habitat variables which appear to contribute significantly to the predictive power of the model) range from 0.0863 to 0.3132. The regression models for November and March (fry and parr) are significant

Table 18. The density of coho salmon parr tested (using Quade test statistic T_1) for equal densities by habitat type (riffle, glide, and pool) during August and November, 1985, and March, 1986, Kake Bake Creek, Alaska.

Quade Test Group	T_1 Statistic	P Value =	df
Parr during August	6.4[a]	2.5×10^{-3}	2 and 86
Parr during November	10.8[b]	6.4×10^{-3}	2 and 86
Parr during March	11.6[c]	3.3×10^{-5}	2 and 86

Conclusions: [a]Reject the hypothesis that coho parr densities are distributed evenly between riffle, glide and pool habitat types during August, 1985; however multiple comparisons reveal that parr densities did not differ between riffle and pool habitat types. [b]Reject the hypothesis that coho parr densities are distributed evenly between riffle, glide and pool habitat types during November, 1985; however multiple comparisons reveal that parr densities did not differ between riffle and pool habitat types. [c]Reject the hypothesis that coho parr densities are distributed evenly between riffle, glide and pool habitat types during March, 1986; however multiple comparisons reveal that parr densities did not differ between riffle and pool habitat types.

Table 19. The density of coho salmon fry tested (using Quade test statistic T_1) for equal densities by habitat type (riffle, glide, and pool) over time (between August and November, 1985, and March, 1986) in Kake Bake Creek, Alaska.

Quade Test Group	T_1 Statistic	P Value =	df
Fry Density in Riffle	43.7[a]	8.2×10^{-14}	2 and 86
Fry Density in Glide	46.4[a]	2.2×10^{-14}	2 and 86
Fry Density in Pool	53.8[a]	6.6×10^{-16}	2 and 86

Conclusions: [a]Reject the hypothesis that coho fry densities are distributed evenly between riffle, glide and pool habitat over time. Multiple comparisons reveal that fry densities did differ between riffle and pool habitat types between August, November, and March.

Table 20. The density of coho salmon parr tested (using Quade test statistic T_1) for equal densities by habitat type (riffle, glide, and pool) over time (between August and November, 1985, and March, 1986) in Kake Bake Creek, Alaska.

Quade Test Group	T_1 Statistic	P Value =	df
Parr Density in Riffle	18.2[a]	2.7×10^{-7}	2 and 86
Parr Density in Glide	15.6[a]	1.6×10^{-6}	2 and 86
Parr Density in Pool	16.0[a]	1.3×10^{-6}	2 and 86

Conclusions: [a]Reject the hypothesis that coho fry densities are distributed evenly between riffle, glide and pool habitat over time. However, multiple comparisons reveal that: 1) parr densities did not differ between August and November in the riffle habitat; 2) parr densities did not differ between November and March in the glide habitat; and 3) parr densities did not differ between August and November in the pool habitat.

Table 21. Results from regression analysis of coho salmon fry and parr densities with habitat variables for August (Aug.), and November (Nov.), 1985 and March (Mar.), 1986, Kake Bake Creek, Alaska.

Model	Predictor Values[a]	C(p)[b]	R^2	F[c]	P Value =
Aug.Fry	D	2.09	0.0863	3.97	0.0529
	D S	1.85	0.1350	3.20	0.0511
	D S R	2.13	0.1722	2.77	0.0538
	D S R W	3.91	0.1772	2.10	0.0994
	D S R W B	5.09	0.1950	1.84	0.1282
Aug. Parr	W	-1.05	0.1172	5.57	0.0229*
	W P	-0.10	0.1409	3.36	0.0444*
	W P S	1.41	0.1520	2.39	0.0830
	W P S R	5.01	0.1611	1.46	0.2260
Nov. Fry	P	0.59	0.1737	8.83	0.0049*
	P S	-0.46	0.2359	6.33	0.0040*
	P W S	1.20	0.2428	4.28	0.0104*
	P W R S	3.09	0.2451	3.17	0.0240*
Nov. Parr	P	3.16	0.2147	11.48	0.0015*
	P S	2.51	0.2629	7.31	0.0019*
	P S D	2.67	0.2964	5.62	0.0026*
	P S D R	5.27	0.3219	3.61	0.0091*
Mar. Fry	W	-0.09	0.2817	16.47	0.0002*
	W R	1.90	0.2818	8.05	0.0011*
	W P B	2.16	0.3132	6.08	0.0016*
	W P B D	4.01	0.3158	4.50	0.0044*
Mar. Parr	B	1.65	0.2101	11.17	0.0018*
	B W	1.18	0.2571	7.09	0.0023*
	B P R	2.41	0.2715	4.97	0.0050*
	B P R D	4.09	0.2775	3.75	0.0113*

[a] P= Standardized area of pool; B=Standardized area of undercut banks; W= Standardized area of large woody debris; R= Standardized area of root wads; S= Standardized area of substrate; and D= Mean Discharge.

[b] Statistic which is a measure of the total squared error for a subset model containing *p* independent variables; larger C(p) values indicate equations with larger error mean squares. For any specified model if $C(p) > (p+1)$ there is evidence of bias due to an incompletely specified model; conversely if $C(p) < (p+1)$ the model contains too many variables (SAS, 1991).

[c] Test statistic used to determine whether or not all of the independent variables taken together significantly contribute to the prediction of the dependent variable.

* Reject the null hypothesis that the independent variables do NOT explain a significant amount of variation in coho density at $\alpha < 0.05$.

($P<0.05$) indicating that some relationship exists between the habitat variables (standardized area of pool, undercut banks, large woody debris, rootwads, substrate, and mean discharge) and juvenile coho salmon density. Habitat was generally a significant predictor of juvenile coho salmon density despite low R^2 values and considerable residual variation.

Individual comparisons (by stream reach) of coho salmon densities and habitat variables also indicate a relationship between density and habitat. The stream reach with highest density of coho salmon fry during August (clearcut # 3 with 2.13 fry/m^2) also had the highest standardized area of LWD (0.0957 m^2) and the third highest standardized pool area (0.2373 m^2) (Table 15). This reach also had the highest density of coho salmon fry during March, 1986 and the second highest density during November, 1985. Coho salmon fry abundance in this reach (clearcut # 3) declined by 77% between August and March, while the total Kake Bake Creek coho salmon fry abundance declined by 87%; between August and November the density of fry declined by only 27% compared to 64% for Kake Bake Creek overall.

<u>Movement</u>

Fall Immigrants:

Two immigrant/emigrant weirs were operated at Kake Bake Creek during fall 1985 (Figure 2). The Main weir was continuously operated from August 18 through November 7 and the Slough weir from September 6 through November 5, 1985.

A total of 1,434 juvenile coho salmon (485 fry and 949 parr) immigrated through the Main weir and 58 emigrated downstream (46 fry and 12 parr) (Table 22). The first immigrant juvenile coho salmon passed through the Main weir

Table 22. The number and length (mm) of immigrant and emigrant juvenile coho salmon passed through the Main and Slough weirs during fall, 1985, at Kake Bake Creek, Alaska.

Weir/ Direction	Stage	Mean Length	Standard Deviation	N	Max. Length	Min. Length
Main	Fry	58.0	5.2	485	65	38
Upstream	Parr	95.9	22.7	949	235	66
	Overall	83.1	25.9	1,434	235	38
Downstream	Fry	48.0	8.7	46	65	37
	Parr	98.0	20.6	12	133	68
	Overall	58.2	23.5	58	133	37
Slough	Fry	57.7	6.0	161	65	38
Upstream	Parr	96.2	20.5	603	221	66
	Overall	88.1	24.2	764	221	38
Downstream	Fry	46.9	7.2	67	65	38
	Parr	96.6	23.6	42	208	66
	Overall	66.1	28.9	109	208	38

on August 18, 1985; the mean of the immigration occurred on September 25 (SD=12.7 days) (Appendix B1). Peak immigration through the Main weir was strongly related to high water and high tide events (Figure 23). Juvenile coho salmon immigrating through the Main weir averaged 83.1 mm in length (SD=25.9 mm) and ranged from 38 to 235 mm (Table 22).

Two hundred and twelve of the juvenile coho salmon immigrating through the Main weir had been captured and marked during the August population study in the estuarine zone; 112 had been marked in the old-growth zone during August (Table 23). Seventy two percent of the coho salmon immigrants through the Main weir (1,038) were unmarked (Table 18 and Appendix B2).

Seven hundred and sixty four juvenile coho salmon (161 fry and 603 parr) immigrated through the Slough weir and 109 emigrated downstream (67 fry and 42 parr) (Table 22). On September 6, 1985 the first juvenile coho salmon immigrated through the Slough weir; the mean of the immigration occurred on October 1 (SD=11.3 days). The mean length of immigrant juvenile coho salmon through the Slough weir was 66.1 mm and ranged from 38 to 208 mm (Table 22). The pattern of immigration was similar at both the Slough and Main weirs (Figure 24 and Appendix B1).

A total of 420 immigrants through the Slough weir had earlier passed upstream through the Main weir (Table 23). One hundred and ten Slough weir immigrants had been captured and marked during the August population experiment in the clearcut zone and 100 had been marked in the old-growth zone during August (Table 23). Twenty one percent (163) of the

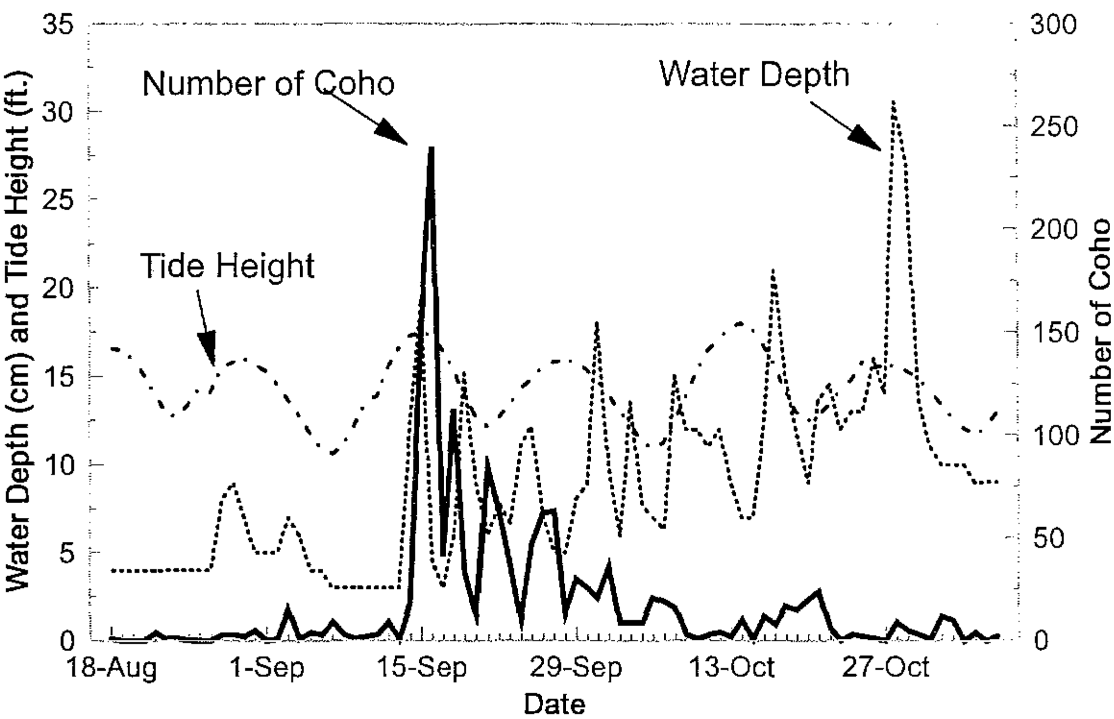


Figure 23. Water depth, tide height, and migration timing of juvenile coho salmon immigrating through the Main weir during fall, 1985 at Kake Bake Creek, Alaska.

Table 23. The number of marked and unmarked immigrant and emigrant juvenile coho salmon passed through the Main and Slough weirs during fall, 1985 at Kake Bake Creek, Alaska. Fish with multiple clips are reported once for each clip type (i.e. totals not given); a complete listing of clip combinations may be found in Appendix B2.

Significance	Main		Slough	
Of Clip[1]	Upstream	Downstream	Upstream	Downstream
1983-1984 Clips	73	1	26	4
Aug ET or Main Up	212	22	420	14
Aug OG	112	7	100	3
Aug CC	9	2	110	4
Slu	NA	NA	5	13
Unmarked	1,038	26	161	64

[1] 1983-1984 Clips = Fish marked during prior studies; Aug = Fish marked during August, (1985) population study; ET= Estuarine zone; OG = Old-growth zone; CC = Clearcut zone; Main Up = Fish passed upstream through Main weir; Slu = Fish passed downstream through Slough weir.

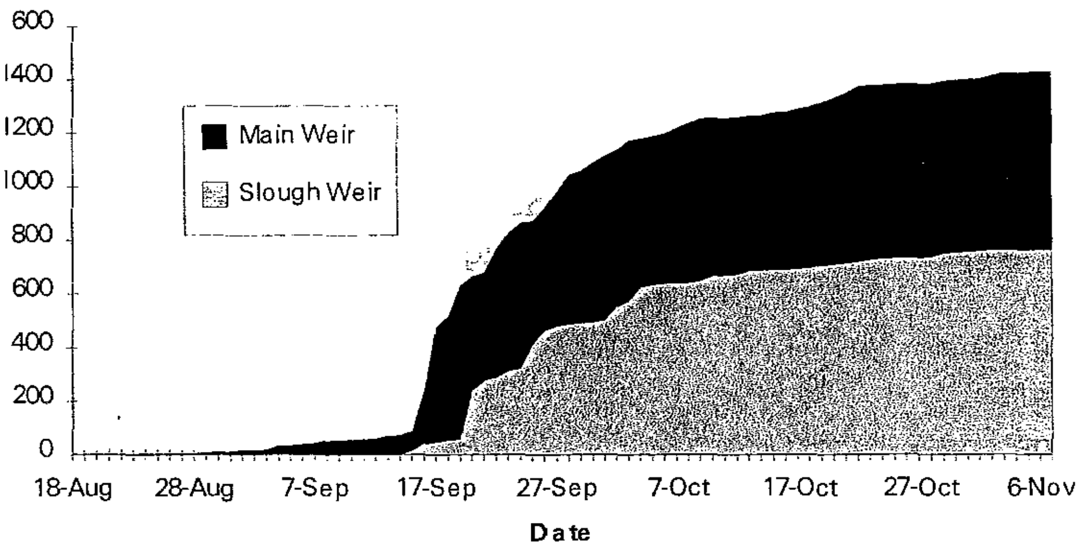


Figure 24. Cumulative number of immigrant juvenile coho salmon passed through the Main and Slough weirs during fall, 1985, in Kake Bake Creek, Alaska.

coho salmon immigrants through the Slough weir were unmarked (Table 18 and Appendix B2).

Spring Emigrants:

Four emigrant weir/traps were operated in Kake Bake Creek during spring (April 1 through June 2), 1986 (Figure 2). The mean of emigration occurred on May 15 (SD=11.8 days), May 15 (SD=11.8 days), May 14 (SD=10.2 days), and May 21 (SD=89. days) at the Main, Lower Clearcut, Upper Clearcut, and Slough weirs/traps, respectively (Figure 25 and Appendix B3).

Five hundred and eighty six juvenile coho salmon (141 fry and 445 parr) emigrated through the Main weir between April 1 through June 2, 1986. The coho salmon ranged in length from 45 to 145 mm and averaged 82.6 mm (SD = 20.4) (Table 24). Three hundred and eighty of the Main weir emigrants had previously emigrated through the Lower Clearcut trap; 49 had emigrated through the Slough weir, and 4 had emigrated through the Upper Clearcut trap (Table 25). One hundred and seventy two of the emigrants had immigrated through the Main Weir during Fall 1985; 366 had previously been marked during population studies (255 during August in the old-growth and clearcut zones, 53 during November, 58 during March) (Table 25 and Appendix B2).

The Lower Clearcut emigrant trap was operational between April 1 through June 2 and 476 emigrant juvenile coho salmon (116 fry and 360 parr) were marked and passed downstream (Table 24). The emigrants ranged in length from 44 to 161 mm and had a mean size of 82.8 mm (SD = 20.6). Forty eight of the Lower Clearcut emigrants had previously emigrated through the Slough weir and 17 had emigrated through the Upper

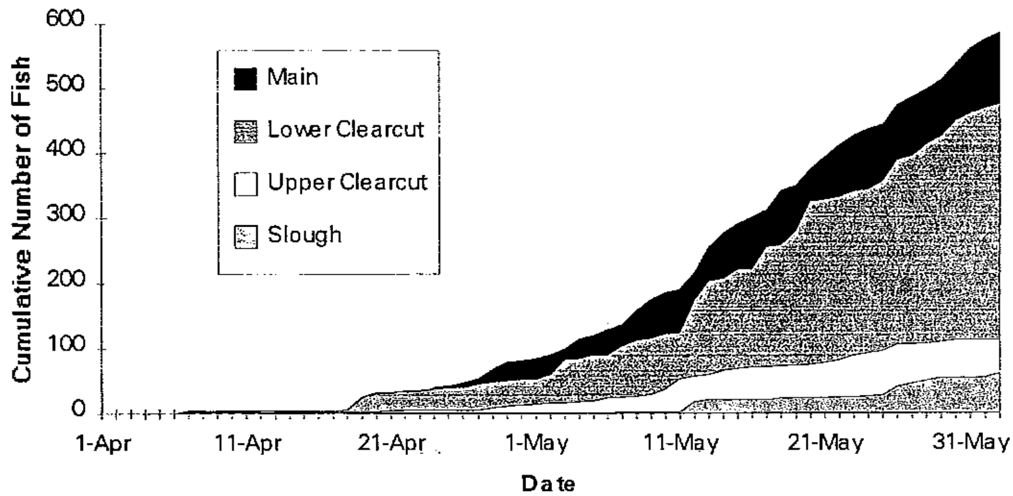


Figure 25. Cumulative number of emigrant juvenile coho salmon counted through the four weirs during spring, 1986, at Kake Bake Creek, Alaska.

Table 24. The number and length (mm) of emigrant juvenile coho salmon passed through the Main, Lower Clearcut, Slough, and Upper Clearcut weirs during spring, 1986, at Kake Bake Creek, Alaska.

Emigrant Weir	Stage	Mean	SD	N	Max	Min
Main	fry	57.0	5.5	141	65	45
	par	90.6	16.3	445	155	66
	Total	82.6	20.4	586	155	45
Lower Clearcut	fry	58.3	5.0	116	65	44
	par	90.7	17.2	360	161	66
	Total	82.8	20.6	476	161	44
Slough	fry	60.0	5.3	4	65	53
	par	95.3	16.7	58	144	66
	Total	93.1	18.8	62	144	53
Upper Clearcut	fry	59.6	4.1	38	65	52
	par	86.6	16.6	75	155	66
	Total	77.5	18.8	113	155	52
Overall Total		82.7	20.4	1,237	161	44

Table 25. The number of marked and unmarked emigrant juvenile coho salmon passed through the Main, Lower Clearcut (Low CC), Slough, and Upper Clearcut (Upper CC) weirs during spring 1986 at Kake Bake Creek, Alaska. Fish with multiple clips are reported once for each clip type (i.e. totals not given); a complete listing of clip combinations may be found in Appendix B2.

Significance Of Clip[1]	Downstream Weir			
	Main	Lower CC	Slough	Upper CC
Aug ET or Main Up	172	132	16	16
Aug OG	87	32	4	1
Aug CC	168	172	13	80
Nov Pop	53	52	3	5
Mar Pop	58	43		2
Upper CC	4	17		
Slu	49	48	19	2
Lower CC	380	4		
Unmarked	73	148	31	25

[1] Aug, Nov, Mar = Fish marked during August, November, (1985) or March (1986) population studies; ET= Estuarine zone; OG = Old-growth zone; CC = Clearcut zone; Lower CC = fish passed downstream through Lower Clearcut weir; Main Up = Fish passed upstream through Main weir; Slu = Fish passed downstream through Slough weir; Upper CC = Fish passed downstream through Upper Clearcut weir;

Clearcut weir (Table 25). One hundred and thirty two of the Lower Clearcut emigrants had immigrated through the Main weir during fall, 1985; 299 had previously been marked during population studies (204 during August in the old-growth and clearcut zones; 52 during November, and 43 during March) (Table 25 and Appendix B2).

The Slough weir was operational April 3 through June 2, 1986 and 62 coho salmon emigrants (4 fry and 58 parr) were marked and passed downstream. The emigrants ranged in length from 53 to 144 mm and averaged 93.1 mm (SD = 18.8 mm) (Table 24). Nineteen of the emigrants had immigrated through the Slough weir and sixteen had immigrated through the Main weir during fall, 1985; 20 had been previously marked during population studies (13 during August in the clearcut zone, 4 during August in the old-growth zone, and 3 during November) (Table 25 and Appendix B2).

One hundred and thirteen juvenile coho salmon (38 fry and 75 parr) emigrated through the Upper Clearcut trap between April 2 and May 30. The emigrants ranged in length from 52 to 155 mm and averaged 77.5 mm (SD = 18.8 mm) (Table 24). Sixteen of the Upper Clearcut emigrants had immigrated through the Main weir and 2 through the Slough weir during fall, 1985; 88 had previously been marked during population studies (80 during August in the clearcut, 1 during August in the old-growth zone, 5 during November, and 2 during March) (Table 25 and Appendix B2).

DISCUSSION

Abundance Estimates

The estimated number of juvenile coho salmon in Kake Bake Creek decreased from 5,816 (SE=46.0) in August to 2,441 (SE=128.5) in November, and to 895 (SE=20.0) in March (Table 26). This represents an overall survival of juvenile coho salmon of 42% between August and November, 1985, and 15% between August, 1985 and March, 1986. Abundance of coho salmon in the estuarine zone decreased by over 99%; the juvenile coho salmon either emigrating or dying. Coho salmon in the clearcut zone decreased by 73% between August, 1985 and March, 1986; coho salmon in the old-growth decreased by 85%. The decrease in the number of juvenile coho salmon, between August, 1985 and March, 1986, in the clearcut and old-growth zones may have been greater, as fall immigrants moved into these areas between August and November. The November, 1985 population study was conducted after the juvenile coho salmon immigration was completed.

The 37% survival rate of juvenile coho salmon in Kake Bake Creek between November, 1985 and March, 1986 is similar to survival rates reported in comparable studies, but substantially lower than the 96% survival rate reported by Bryant (*Unpublished*) for coho salmon in the Kake Bake Creek slough ponds between August, 1983 and February, 1984. Bustard and Narver (1975) estimated a 35% survival rate for juvenile coho salmon in a small, unlogged, west coast Vancouver Island Stream. Scarlett and Cederholm (1984) report a "69 to 78% reduction" (31 to 22% survival) in resident coho salmon in two small tributaries of the Clearwater River in Washington (population decrease not all due to mortality as some coho salmon emigrated downstream).

Table 26. The estimated number of fry, parr, and total juvenile coho salmon (SE) in the estuarine, old-growth, and clearcut stream zones during August and November, 1985 and March, 1986, in Kake Bake Creek, Alaska.

Population	Stream Zone			
Estimate	Estuarine	Old-growth	Clearcut	Total Pop.
Aug. 1985				
Fry	1,388 (17.9)	1,956 (35.7)	1,682 (18.2)	5,026 (44.0)
Parr	180 (9.0)	340 (9.2)	270 (4.4)	790 (13.6)
Total	1,568 (20.0)	2,296 (36.9)	1,952 (18.8)	5,816 (46.0)
Nov. 1985				
Fry	122 (3.9)	976 (31.3)	716 (26.6	1,814 (41.2)
Parr	13 (4.0)	258 (101.3)	356 (67.4)	627 (20.7)
Total	135 (5.6)	1,234 (106.0)	1,072 (72.5)	2,441 (128.5)
Mar. 1986				
Fry	5 (0.0)	272 (16.5)	353 (9.7)	630 (19.2)
Parr	6 (0.0)	81 (3.3)	178 (4.7)	265 (56.3)
Total	11 (0.0)	353 (16.9)	531 (10.8)	895 (20.0)

Tschaplinski and Hartman (1983) report a "rough overwinter survival" of 72.2% (prelogging) and 67.4% (postlogging) in Carnation Creek, British Columbia. Peterson (1982b) reports an overall survival rate of 78% and 28% in less-productive and more productive ponds, respectively. Thedinga et al. (1989) reports an average survival rate of 20% for coho salmon fry between summer and winter in 18 streams in southeast Alaska. Possible explanations for the lower survival rate of coho salmon in Kake Bake Creek between November and March include predation and weather.

Habitat

Areas in Kake Bake Creek with the highest density of coho salmon fry during August, 1985 contained the highest concentrations of pools and LWD. Coho salmon parr were also found in higher abundance in stream reaches containing the highest concentration of pools and LWD. Regression analysis shows a relationship between juvenile coho salmon density and habitat, however, habitat was not a good predictor of coho salmon density. Numerous other studies (Bustard and Narver (1975), Tschaplinski and Hartman, 1983, Heifetz et al. (1986), and Murphy and Koski (1989)) also report on the important relationship between LWD and pools to rearing and overwintering coho salmon.

The stream reaches in Kake Bake Creek which had the lowest density of fry and parr were located in the estuarine zone. The stream in the estuarine zone may be characterized as shallow and wide with slow moving water (glide) and almost no pools, undercut banks, or LWD. The population of fry and parr in the estuarine declined by over 99% between August, 1985 and March, 1986. Some of this decline, however, may be accounted for through immigration of coho salmon into upstream reaches. Murphy et al. (1984), Bustard and Narver (1975), and Heifetz et al. (1986) report that juvenile coho salmon prefer to overwinter in pools with LWD and avoid overwintering in areas with riffles and glides.

Movement

Between August 18 and November 7, 1985 1,434 juvenile coho salmon immigrated through the Main weir; between September 6 and November 5, 1985, 764 juveniles immigrated through the Slough weir. Fifty five percent (420) of the juvenile coho salmon immigrating into the Slough weir had previously immigrated through the Main weir. The majority of the immigrants which passed through the Main weir, and subsequently the Slough weir, typically moved between the two weirs within several days. These immigrants were different in appearance than the juvenile coho salmon previously observed in Kake Bake Creek. The immigrants were bright silver (resembling smolts) in color and several fish had sea-lice (*Caligus* spp.) attached near the anal fin. Several of the largest coho salmon immigrants (>200 mm) were dissected to determine sexual maturity and to confirm that the fish were not precocious males. Examination of scales collected from these immigrants revealed widely spaced circuli, indicating a recent period of accelerated growth, probably marine growth (Craig Farrington, Alaska Department of Fish and Game, Juneau, Alaska, Personal communication). The presence of sea-lice indicate a recent (<6 days) (McLean et al. 1990) immigration from marine water.

Kake Bake Creek drains into Big John Bay, a large (6.5 km^2) wetland or estuary/salt marsh with numerous sloughs and ponds. Rearing salmonids were observed surface feeding in these sloughs and ponds during early September, 1985 (personal observation). Other studies (Murphy et al. 1984; Tschaplinski, 1982, 1988; and McMahon and Holtby, 1992) describe the use and the importance of estuaries to rearing coho salmon fry, smolt, and parr.

The fall immigration of juvenile coho salmon from the estuarine zone in Kake Bake, and from Big John Bay, into upstream areas is similar to findings in other studies. McMahon and Holtby (1992) report that parr left a 500-m-long "riverine-type" estuary and returned upstream with the onset of cooler temperatures and higher water flows during fall. Murphy et al. (1984) report that juvenile coho salmon moved out of stream/estuarine areas to upstream freshwater areas. There were, however, no studies which describe the magnitude of juvenile coho salmon immigration from a large estuary such as Big John Bay. Hartman and Scrivener (1990) report that 15% ($n \approx 120$) of juvenile coho salmon remaining in the Carnation Creek estuary during October entered an adjacent stream (which had been dry during the summer); the remaining 85% migrated to sea. Atlantic salmon (*Salmo Salar*) parr are known to emigrate downstream in the spring, rear in the estuary during the summer, with the larger fish smolting and migrating to sea while the smaller parr returned to the river for overwintering (Cunjak and Chadwick, 1989). There are isolated cases of a coho salmon smolt leaving a large river system (Berner's River), traveling approximately 50 km, and immigrating into a stream drainage with a lake (Auke Lake) (Leon Shaul, Alaska Department of Fish and Game, Douglas, unpublished data). While no references were found which describe how and at what salinity sea lice are acquired by juvenile coho salmon, it is assumed that the presence of sea lice indicates some type of "marine exposure".

Of the 62 juvenile coho salmon which emigrated from the Slough weir between April 3 and June 2, 1986 only 19 had immigrated through the Slough weir during fall, 1985. This reflects a decrease in abundance of approximately 98% for the Slough weir immigrants. No population studies or habitat measurements were conducted upstream of the Slough weir during this study. Population estimates were, however, estimated by Bryant (*Unpublished*) for the beaver ponds upstream of the Kake Bake Creek Slough weir during 1983 and 1984; 673 (SE=104) in August; 1,119 (SE=48) in October/November; 370 (SE=45) in February; and 129 (SE=5) in June. Bryant states that the population decline in June reflected smolt emigration and the decline in February did not necessarily reflect proportional mortality; in fact Bryant estimated a 96% survival rate of coho salmon in the Kake Bake Creek ponds between August, 1983 and February, 1984.

There are no good explanations for the 98% decrease (1985-1986) in coho salmon abundance upstream of the slough weir (in the beaver ponds). The Slough weir was operational for 16 days before the first coho emigrated and 39 days before the first significant emigration (16 emigrants) occurred. Thus, it is believed that large numbers of coho emigrants were not missed. However, some coho did emigrate from the beaver ponds prior to weir installation as 49 coho emigrants through the Main weir had been fall Slough immigrants. Juvenile coho remaining in the beaver ponds after June 3, 1986 could have subsequently emigrated from Kake Bake Creek and would not have been captured and counted. To assess the magnitude of juvenile coho remaining in the beaver ponds, two overnight sets of six baited minnow traps were randomly set in the beaver ponds prior to removal of the Slough weir. No juvenile coho were subsequently caught in any of these traps. Assuming that emigration timing of juvenile coho at Kake Bake Creek was similar to other areas in southeast Alaska, the number of juvenile coho remaining in the beaver ponds after June 3, 1986 would have comprised only a small percentage of the total Slough weir emigration. At Auke Creek (near Juneau, Alaska) less than 6% of the total 1986 juvenile smolt emigration (5,666 smolts) occurred after June 3, 1986 (Taylor *Unpublished*). In a coho smolt population abundance experiment conducted at Vallenar Creek (near Ketchikan, Alaska) in 1988, less than 1% of the emigrating coho were captured after June 3, 1988 (Elliott et al. 1989).

Mortality is probably the best explanation for the large decrease of coho salmon upstream of the Slough weir. Possible causes of mortality include predation, low oxygen levels, or an unusually cold winter. River otters (*Lutra canadensis*) are known to feed on juvenile coho salmon. Dolloff (1993) counted the number of juvenile coho salmon otoliths found in otter scats and reports that between defecations, up to 204 juvenile coho salmon may be eaten by an otter. Other coho salmon predators observed in the area include Dolly Varden, (Armstrong, 1965) cutthroat trout (Swales and Levings, 1989), mink (*Mustela vison*) (Heggenes and Borgstrom, 1988), and common mergansers (*Mergus merganser*) (Wood, 1987). The beaver ponds in Kake Bake Creek had been inactive for several years i.e. no beavers present and no fresh mud or branches (Woo and Waddington, 1990). Neff (1957), states that (in Colorado) abandonment of a colony by beavers means the loss of habitat necessary for trout survival. The beaver ponds had silted in creating a "bathtub" type structure with minimal cover (LWD or undercut banks) available to aid in predator avoidance. The ambient temperature dropped to and remained between -10 and -17°C for 10 days in early November, 1985; nearly all of Kake Bake Creek froze over within days (personal observation). The sudden onset and severity of this cold weather may have contributed to the population decline. Inadequate oxygen may also have contributed to the population decline as dissolved oxygen levels may have dropped below lethal limits; low winter flows may have isolated the ponds creating a stagnant environment i.e. no water movement combined with an organic mud bottom (Bryant, 1984).

The fall immigration of juvenile coho salmon out of the main Kake Bake Creek and into more suitable overwintering habitat strongly concurs with the literature. Studies by Bustard and Narver (1975), Peterson (1982), Murphy et al. (1984), Cederholm and Scarlett (1981), and Tschaplinski and Hartman (1983) report fall migrations of juvenile coho salmon from streams and rivers into spring-fed riverine ponds, into low velocity tributaries, or into beaver ponds.

General Discussion

The standard error (SE) for several of the coho salmon population estimates for individual stream reaches is reported as zero, primarily coho salmon parr population estimates. A SE of 0 is reported because the number of marked fish recaptured exceeded the number of marked fish put out. Two explanations for this are: 1) measurement error i.e. fish were measured <65 mm when marked (therefore fry) and measured >65 mm when recaptured (therefore parr); or 2) marked fish moved into stream reaches (from previous downstream mark/recapture studies) prior to mark/recapture studies.

During the Kake Bake Creek study, juvenile coho salmon were not tagged with unique tags, therefore no individual growth rates may be calculated. The overall increase in the mean length of coho salmon fry between August, 1985 and March, 1986 may not be growth but rather higher mortality rates of smaller fish. Likewise, the increase in the mean length of coho salmon parr may have been from higher mortality rates of small fish or from immigration of larger fish.

CONCLUSIONS

Abundance Estimates

1) Juvenile coho salmon fry and parr were not evenly distributed in the estuarine, old growth and clearcut zones during August and November, 1985 and March, 1986.

Exceptions:

a) The density of fry in the estuarine and clearcut zone and in the old-growth and clearcut zones did not differ during November, 1985.

b) The density of fry in the old-growth and clearcut zones did not differ during March, 1986.

c) The density of parr did not differ between the old-growth and clearcut zones during August, 1985.

2) The density of coho salmon fry and parr did not remain the same between August and November, 1985 and between November, 1985 and March, 1986.

Exceptions:

a) Fry densities in the old-growth and clearcut zones did not differ between August and November, 1985.

b) Parr densities did not differ in the estuarine and old-growth zones between August and November, 1985.

Habitat

1a) Juvenile coho fry were distributed evenly between riffle, glide, and pool habitat types during August, 1985.

1b) Juvenile coho fry were not distributed evenly between riffle, glide, and pool habitat types during November, 1985 and March, 1986.

Exceptions:

a) Fry were distributed evenly between riffle and pool habitat types during both November, 1985, and March, 1986.

1c) Parr were not distributed evenly between riffle, glide, and pool habitat types during August, November, and March.

Exceptions:

a) Parr were evenly distributed in the riffle and glide habitat types during August, November, and March.

2) Fry densities did not remain the same between August, November, and March in either the riffle, glide, or pool habitat type.

2a) Parr densities did not remain the same between August, November, and March in either the riffle, glide, or pool habitat type.

Exceptions:

a) no difference in parr densities in the riffle habitat between August and November.

b) no difference in parr densities in the glide habitat between November and March.

c) no difference in parr densities in the pool habitat between August and November.

<u>Movement</u>

1) There was a significant immigration of juvenile coho salmon (n=1,434) into Kake Bake Creek between August and November, 1985.

2) Juvenile coho salmon smolt emigrated (n=586) from Kake Bake Creek between April and June, 1986.

RECOMMENDATIONS

1) The occurrence, magnitude, and scope of juvenile coho salmon immigrating into small rearing streams during the fall, from areas outside of the creek, needs further investigations.

2) Any model used to predict or forecast the abundance, production, or standing crop of juvenile coho salmon in any small southeast Alaska stream should consider the possibility of immigrations of juvenile coho from outside the stream.

3) Any study designed to estimate the overwinter survival of juvenile coho salmon, should consider the possibility of fall immigrations.

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APPENDIX A

Appendix A1. Summary of pool volume, and area of undercut banks (UCB), large woody debris (LWD), rootwads (RW), and substrate (Sub) by zone, reach and pool type during August, 1985, Kake Bake Creek.

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)	Sub Area (m^2)
Estuarine	3	Lateral Scour	1.4	0.0	1.1	0.0	0.0
Estuarine	5	Lateral Scour	52.8	0.0	4.9	6.0	0.0
Estuarine	8	Lateral Scour	5.9	0.0	0.7	0.0	0.0
Estuarine	8	Upsurge	8.2	0.0	5.7	0.0	0.0
Estuarine	9	Lateral Scour	41.4	0.0	4.0	20.1	0.6
Estuarine	10	Lateral Scour	44.9	0.0	0.2	0.0	0.0
Old-growth	2	Lateral Scour	1.0	0.0	0.0	0.0	0.0
Old-growth	3	Lateral Scour	0.4	0.0	0.4	0.0	0.0
Old-growth	4	Dammed	0.2	0.0	0.0	0.0	0.0
Old-growth	4	Lateral Scour	1.4	0.0	0.0	0.0	0.0
Old-growth	4	Plunge	4.7	0.0	0.6	0.0	0.0
Old-growth	5	Plunge	3.1	0.0	1.7	0.0	0.0
Old-growth	6	Backwater	16.4	0.0	0.4	0.0	0.0
Old-growth	6	Plunge	0.7	0.0	2.8	0.0	0.0
Old-growth	7	Backwater	1.5	0.0	0.0	0.0	0.0
Old-growth	7	Lateral Scour	10.6	0.0	0.0	0.0	0.0
Old-growth	8	Dammed	4.9	0.0	0.0	0.0	0.0
Old-growth	8	2nd Channel	0.1	0.0	0.0	0.0	0.0
Old-growth	8	Upsurge	7.4	0.0	4.4	0.0	0.1
Old-growth	9	Lateral Scour	15.3	0.5	0.9	8.0	0.0
Old-growth	9	Plunge	5.3	0.1	3.2	0.0	0.0
Old-growth	9	2nd Channel	0.1	0.0	0.0	0.0	0.0
Old-growth	10	Dammed	0.0	0.0	1.7	0.0	0.0
Old-growth	10	Lateral Scour	9.8	0.3	1.2	0.0	0.0
Old-growth	10	Plunge	2.0	0.0	1.1	0.0	0.0

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Appendix A1. (page 2 of 4)

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)	Sub Area (m^2)
Old-growth	11	Dammed	5.8	0.0	5.2	0.0	0.0
Old-growth	11	Lateral Scour	33.0	2.5	7.9	0.0	0.0
Old-growth	11	Plunge	0.9	0.0	0.6	0.0	0.0
Old-growth	12	Lateral Scour	18.4	0.7	3.6	0.0	0.0
Old-growth	12	Plunge	4.2	0.1	0.3	0.0	0.0
Old-growth	12	Upsurge	4.1	0.0	1.4	0.0	0.0
Old-growth	13	Dammed	14.9	0.3	1.4	12.0	0.0
Old-growth	13	Lateral Scour	5.4	0.1	0.0	0.0	0.0
Old-growth	13	Upsurge	27.0	0.0	1.7	0.0	0.0
Old-growth	14	Lateral Scour	11.7	0.6	2.3	0.0	0.0
Old-growth	14	2nd Channel	0.3	0.0	1.5	0.0	0.0
Old-growth	15	Dammed	1.4	0.0	0.7	0.0	0.0
Old-growth	15	Lateral Scour	17.3	1.2	3.0	0.0	0.0
Old-growth	15	Plunge	0.8	0.0	1.8	0.0	0.0
Clearcut	1	Lateral Scour	2.7	0.5	1.6	2.0	0.0
Clearcut	1	Plunge	1.8	0.0	0.5	0.0	0.0
Clearcut	1	2nd Channel	0.2	0.0	0.3	0.0	0.0
Clearcut	1	Upsurge	3.2	0.0	1.3	0.0	0.0
Clearcut	2	Lateral Scour	6.3	0.3	0.2	9.0	0.0
Clearcut	2	Upsurge	16.1	0.1	3.6	20.0	0.0
Clearcut	3	Dammed	0.8	0.0	0.0	0.0	0.0
Clearcut	3	Lateral Scour	3.1	0.0	3.0	0.0	0.0
Clearcut	3	Plunge	17.3	0.1	4.6	0.0	0.0
Clearcut	3	2nd Channel	1.0	0.2	0.0	12.0	0.0
Clearcut	3	Upsurge	8.2	0.0	4.6	0.0	0.0
Clearcut	4	Dammed	6.9	0.0	0.3	0.0	0.0
Clearcut	4	Lateral Scour	5.8	0.3	0.6	0.0	0.0
Clearcut	4	Plunge	1.0	0.0	0.4	0.0	0.0
Clearcut	4	Upsurge	5.6	0.1	1.4	0.0	0.0
Clearcut	5	Backwater	0.2	0.1	0.2	0.0	0.0

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Appendix A1. (page 3 of 4)

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)	Sub Area (m^2)
Clearcut	5	Dammed	0.6	0.0	0.0	0.0	0.0
Clear ut	5	Lateral Scour	11.5	0.4	1.8	0.0	0.0
Clearcut	5	Upsurge	1.8	0.0	2.0	0.0	0.0
Clearcut	6	Dammed	3.2	0.0	0.4	0.0	0.0
Clearcut	6	Lateral Scour	5.9	0.2	0.2	1.0	0.0
Clearcut	6	Plunge	0.4	0.0	0.2	0.0	0.0
Clearcut	7	Lateral Scour	12.2	0.2	2.0	5.0	0.0
Clearcut	8	Lateral Scour	0.7	0.1	0.0	4.0	0.0
Clearcut	8	Plunge	1.6	0.0	1.5	0.0	0.0
Clearcut	9	Dammed	0.2	0.0	0.3	0.0	0.0
Clearcut	9	Lateral Scour	2.1	0.1	0.3	0.0	0.0
Clearcut	9	Plunge	3.5	0.0	4.1	3.8	0.0
Clearcut	10	Lateral Scour	2.0	0.2	2.0	0.0	0.0
Clearcut	10	Plunge	8.1	0.2	3.8	0.0	0.0
Clearcut	11	Lateral Scour	1.3	0.0	0.0	0.0	0.0
Clearcut	11	Plunge	0.9	0.1	0.5	0.0	0.0
Clearcut	11	2nd Channel	0.4	0.0	0.0	0.0	0.0
Clearcut	12	Lateral Scour	0.9	0.1	1.2	2.3	0.0
Clearcut	12	Plunge	0.5	0.0	1.1	0.0	0.0
Clearcut	12	Trench	0.5	0.0	0.0	0.0	0.0
Clearcut	13	Lateral Scour	1.2	0.1	1.7	0.0	0.0
Clearcut	13	Plunge	1.6	0.0	1.9	0.0	0.0
Clearcut	13	Trench	0.3	0.0	0.0	0.0	0.0
Clearcut	14	Dammed	1.0	0.0	0.0	0.0	0.0
Clearcut	14	Plunge	1.4	0.0	1.9	0.0	0.0
Clearcut	15	Dammed	1.3	0.1	0.1	8.0	0.0
Clearcut	15	Lateral Scour	1.9	0.2	1.4	0.0	0.0
Clearcut	15	Plunge	1.1	0.0	0.0	0.0	0.0
Clearcut	15	Upsurge	3.7	0.0	1.7	0.0	0.0
Clearcut	16	Lateral Scour	0.6	0.0	0.0	0.0	0.0

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Appendix A1. (page 4 of 4)

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)	Sub Area (m^2)
Clearcut	16	Plunge	1.1	0.0	0.8	0.0	0.0
Clearcut	17	Lateral Scour	1.0	0.1	0.0	0.0	0.0
Clearcut	17	Plunge	2.5	0.0	1.0	0.0	0.1
Clearcut	17	Upsurge	0.2	0.0	0.0	0.0	0.0
Clearcut	18	Plunge	0.9	0.0	0.9	0.0	0.0
Clearcut	18	Trench	0.1	0.0	0.3	0.0	0.0
Clearcut	18	Upsurge	0.6	0.0	0.0	4.5	0.0

Appendix A2. Summary of pool volume, and area of undercut banks (UCB), large woody debris (LWD), and rootwads (RW) by zone, reach and pool type during March, 1986, Kake Bake Creek.

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)
Estuarine	2	Dammed	0.9	0.0	0.0	0.0
Estuarine	3	Upsurge	2.5	0.0	1.3	0.0
Estuarine	5	Upsurge	26.0	0.0	3.2	0.3
Estuarine	5	Backwater	3.7	0.0	0.8	0.0
Estuarine	5	Plunge	6.2	0.0	0.6	0.0
Estuarine	5	Upsurge	10.1	0.0	1.9	0.0
Estuarine	9	Backwater	0.8	0.0	0.2	0.0
Estuarine	9	Lateral Scour	45.9	0.0	0.3	1.2
Estuarine	10	Lateral Scour	60.6	0.0	0.0	0.0
Estuarine	11	Backwater	0.3	0.0	0.3	0.0
Estuarine	11	Lateral Scour	0.5	0.0	0.1	0.0
Old-growth	2	Backwater	1.0	0.0	0.0	0.0
Old-growth	2	Lateral Scour	0.4	0.0	0.0	0.0
Old-growth	3	Backwater	1.1	0.0	0.0	0.0
Old-growth	3	Upsurge	1.1	0.0	0.5	0.0
Old-growth	4	Backwater	3.2	0.0	0.0	0.0
Old-growth	4	Lateral Scour	2.3	0.3	0.8	0.0
Old-growth	4	2nd Channel	0.7	0.0	0.0	0.0
Old-growth	4	Upsurge	2.0	0.2	0.6	0.0
Old-growth	5	Backwater	0.7	0.4	0.0	0.0
Old-growth	5	Lateral Scour	0.4	0.0	0.1	0.0
Old-growth	5	Plunge	1.4	0.0	0.1	0.0
Old-growth	6	Backwater	1.5	0.0	0.0	0.0
Old-growth	6	Lateral Scour	12.4	0.0	1.1	0.0
Old-growth	7	Backwater	1.3	0.0	0.0	0.0
Old-growth	7	Lateral Scour	8.4	0.0	0.0	0.0

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Appendix A2. (page 2 of 4)

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)
Estuarine	2	Dammed	0.9	0.0	0.0	0.0
Old-growth	8	Dammed	1.3	0.8	0.5	0.0
Old-growth	8	Lateral Scour	4.7	1.6	0.2	0.0
Old-growth	8	Plunge	0.6	0.0	0.1	0.0
Old-growth	8	2nd Channel	0.7	0.0	0.0	0.0
Old-growth	8	Trench	3.4	0.7	0.0	0.0
Old-growth	9	Lateral Scour	2.4	1.4	0.9	0.0
Old-growth	9	Plunge	7.3	1.1	2.3	0.1
Old-growth	9	2nd Channel	0.7	0.0	0.6	0.3
Old-growth	9	Trench	7.8	1.4	0.2	0.0
Old-growth	10	Dammed	20.1	1.1	2.6	0.0
Old-growth	10	Lateral Scour	2.5	0.0	0.3	0.0
Old-growth	10	Plunge	2.6	0.0	1.4	0.0
Old-growth	11	Backwater	0.8	1.4	0.7	0.0
Old-growth	11	Dammed	3.6	0.3	2.7	0.0
Old-growth	11	Lateral Scour	18.2	7.2	1.6	0.0
Old-growth	11	Plunge	5.8	0.8	3.0	0.0
Old-growth	12	Dammed	24.9	4.5	5.5	1.8
Old-growth	12	Lateral Scour	0.3	0.0	0.2	0.0
Old-growth	12	Plunge	1.4	0.0	0.9	0.0
Old-growth	12	Trench	8.2	2.2	3.1	0.0
Old-growth	13	Dammed	9.2	2.3	0.1	0.0
Old-growth	13	Lateral Scour	2.4	0.0	0.3	0.0
Old-growth	13	Plunge	51.7	1.2	2.6	0.0
Old-growth	14	Dammed	1.1	0.0	0.5	0.0
Old-growth	14	Lateral Scour	1.5	0.0	0.2	0.0
Old-growth	14	Plunge	2.0	2.2	0.2	0.0
Old-growth	14	Upsurge	20.3	3.7	1.9	0.5

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Appendix A2. (page 3 of 4)

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)
Estuarine	2	Dammed	0.9	0.0	0.0	0.0
Old-growth	15	Dammed	4.2	1.7	1.5	0.0
Old-growth	15	Lateral Scour	22.9	16.2	1.8	0.0
Clearcut	1	Lateral Scour	0.6	0.0	0.0	0.0
Clearcut	1	2nd Channel	2.6	1.5	0.3	0.0
Clearcut	1	Upsurge	3.9	1.4	1.9	0.0
Clearcut	2	Upsurge	17.2	4.5	2.1	0.4
Clearcut	3	Dammed	3.3	0.0	1.5	0.5
Clearcut	3	Lateral Scour	22.6	0.0	2.0	0.0
Clearcut	3	Plunge	3.5	1.4	3.4	0.0
Clearcut	3	Trench	1.8	0.0	0.3	0.0
Clearcut	3	Upsurge	15.2	0.4	2.9	0.0
Clearcut	4	Lateral Scour	12.9	3.7	0.9	0.0
Clearcut	4	2nd Channel	0.3	0.0	0.0	0.0
Clearcut	5	Dammed	0.6	0.0	0.0	0.0
Clearcut	5	Lateral Scour	11.3	2.9	2.6	0.0
Clearcut	5	Plunge	2.6	0.0	0.4	0.0
Clearcut	6	Dammed	2.8	0.5	0.5	0.0
Clearcut	6	Lateral Scour	6.2	2.2	0.2	0.3
Clearcut	6	Plunge	0.9	0.5	0.8	0.0
Clearcut	6	2nd Channel	0.8	0.0	0.2	0.0
Clearcut	6	Trench	10.4	0.5	1.7	1.1
Clearcut	7	Lateral Scour	5.9	1.4	0.6	0.6
Clearcut	8	Dammed	1.6	0.0	0.3	0.8
Clearcut	8	Plunge	1.0	0.6	0.5	0.0
Clearcut	8	Upsurge	0.9	0.3	0.1	0.0
Clearcut	9	Dammed	0.1	0.0	0.0	0.0
Clearcut	9	Lateral Scour	2.3	0.7	0.4	0.0

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Appendix A2. (page 4 of 4)

Zone	Reach	Pool Type	Pool Vol. (m^3)	UCB Area (m^2)	LWD Area (m^2)	RW Area (m^2)
Estuarine	2	Dammed	0.9	0.0	0.0	0.0
Clearcut	9	Plunge	7.7	0.4	0.4	0.0
Clearcut	10	Lateral Scour	4.1	1.3	1.0	0.0
Clearcut	11	Lateral Scour	2.8	0.8	0.6	0.0
Clearcut	11	Plunge	0.2	0.0	0.1	0.0
Clearcut	12	Plunge	1.9	0.3	0.6	0.0
Clearcut	13	Dammed	1.4	0.3	0.8	0.0
Clearcut	13	Lateral Scour	0.1	0.0	0.0	0.0
Clearcut	13	Plunge	2.1	0.5	0.7	0.1
Clearcut	14	Backwater	0.7	0.3	0.2	0.0
Clearcut	14	Lateral Scour	0.4	0.5	0.0	0.0
Clearcut	14	Plunge	1.1	0.6	0.3	0.0
Clearcut	15	Dammed	2.0	1.0	0.5	0.4
Clearcut	15	Lateral Scour	1.0	0.1	0.3	0.0
Clearcut	15	Plunge	2.1	0.2	0.6	0.0
Clearcut	16	Plunge	1.0	0.6	0.3	0.0
Clearcut	16	2nd Channel	0.3	0.0	0.0	0.0
Clearcut	16	Trench	0.6	0.4	0.0	0.0
Clearcut	16	Upsurge	0.8	0.0	0.5	0.0
Clearcut	17	Lateral Scour	0.3	0.0	0.0	0.0
Clearcut	17	Plunge	2.6	0.5	1.5	0.0
Clearcut	18	Dammed	0.6	0.0	0.1	0.5
Clearcut	18	Lateral Scour	0.8	0.0	0.5	0.0
Clearcut	18	Plunge	0.7	0.0	0.0	0.0

APPENDIX B

Appendix B1. The daily and cumulative (Cum.) number of immigrant and emigrant juvenile coho salmon passed through the Main and Slough weirs during fall, 1985, at Kake Bake Creek, Alaska.

	Main Weir				Slough Weir			
	Upstream		Downstream		Upstream		Downstream	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
18-Aug-85	1	1	0	0	NA[1]	0	NA[1]	0
19-Aug-85	0	1	2	2	NA[1]	0	NA[1]	0
20-Aug-85	0	1	0	2	NA[1]	0	NA[1]	0
21-Aug-85	0	1	0	2	NA[1]	0	NA[1]	0
22-Aug-85	4	5	4	6	NA[1]	0	NA[1]	0
23-Aug-85	1	6	0	6	NA[1]	0	NA[1]	0
24-Aug-85	0	6	0	6	NA[1]	0	NA[1]	0
25-Aug-85	1	7	1	7	NA[1]	0	NA[1]	0
26-Aug-85	0	7	0	7	NA[1]	0	NA[1]	0
27-Aug-85	0	7	0	7	NA[1]	0	NA[1]	0
28-Aug-85	0	7	0	7	NA[1]	0	NA[1]	0
29-Aug-85	3	10	0	7	NA[1]	0	NA[1]	0
30-Aug-85	3	13	0	7	NA[1]	0	NA[1]	0
31-Aug-85	2	15	0	7	NA[1]	0	NA[1]	0
1-Sep-85	5	20	0	7	NA[1]	0	NA[1]	0
2-Sep-85	0	20	0	7	NA[1]	0	NA[1]	0
3-Sep-85	1	21	0	7	NA[1]	0	NA[1]	0
4-Sep-85	15	36	2	9	NA[1]	0	NA[1]	0
5-Sep-85	1	37	1	10	NA[1]	0	NA[1]	0
6-Sep-85	4	41	1	11	3	3	0	0
7-Sep-85	3	44	1	12	0	3	0	0
8-Sep-85	9	53	0	12	0	3	0	0
9-Sep-85	3	56	1	13	0	3	0	0
10-Sep-85	1	57	0	13	0	3	0	0
11-Sep-85	2	59	0	13	0	3	0	0
12-Sep-85	3	62	0	13	0	3	0	0
13-Sep-85	9	71	0	13	0	3	0	0
14-Sep-85	1	72	0	13	0	3	1	1
15-Sep-85	18	90	0	13	13	16	1	2
16-Sep-85	148	238	1	14	25	41	1	3
17-Sep-85	240	478	0	14	7	48	1	4
18-Sep-85	41	519	1	15	7	55	4	8
19-Sep-85	113	632	3	18	4	59	2	10
20-Sep-85	34	666	6	24	183	242	1	11
21-Sep-85	13	679	0	24	37	279	0	11
22-Sep-85	85	764	2	26	12	291	0	11
23-Sep-85	63	827	4	30	24	315	0	11

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Appendix B1. (page 2 of 3)

	Main Weir				Slough Weir			
	Upstream		Downstream		Upstream		Downstream	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
24-Sep-85	37	864	6	36	8	323	1	12
25-Sep-85	10	874	1	37	87	410	3	15
26-Sep-85	47	921	0	37	55	465	2	17
27-Sep-85	62	983	0	37	18	483	4	21
28-Sep-85	63	1046	0	37	5	488	9	30
29-Sep-85	14	1060	2	39	4	492	2	32
30-Sep-85	30	1090	0	39	3	495	0	32
1-Oct-85	26	1116	0	39	9	504	3	35
2-Oct-85	21	1137	0	39	50	554	13	48
3-Oct-85	36	1173	1	40	20	574	0	48
4-Oct-85	9	1182	0	40	52	626	0	48
5-Oct-85	9	1191	0	40	10	636	5	53
6-Oct-85	9	1200	0	40	3	639	0	53
7-Oct-85	21	1221	6	46	1	640	0	53
8-Oct-85	19	1240	0	46	2	642	0	53
9-Oct-85	16	1256	3	49	7	649	1	54
10-Oct-85	3	1259	0	49	17	666	2	56
11-Oct-85	1	1260	0	49	4	670	8	64
12-Oct-85	3	1263	0	49	3	673	6	70
13-Oct-85	4	1267	0	49	13	686	11	81
14-Oct-85	2	1269	1	50	2	688	2	83
15-Oct-85	10	1279	2	52	3	691	2	85
16-Oct-85	1	1280	0	52	0	691	0	85
17-Oct-85	12	1292	2	54	2	693	1	86
18-Oct-85	8	1300	0	54	4	697	3	89
19-Oct-85	17	1317	0	54	10	707	3	92
20-Oct-85	15	1332	0	54	3	710	1	93
21-Oct-85	20	1352	0	54	6	716	0	93
22-Oct-85	24	1376	1	55	5	721	1	94
23-Oct-85	6	1382	0	55	7	728	0	94
24-Oct-85	0	1382	0	55	4	732	0	94
25-Oct-85	3	1385	0	55	1	733	3	97
26-Oct-85	2	1387	0	55	0	733	0	97
27-Oct-85	1	1388	0	55	2	735	1	98
28-Oct-85	0	1388	0	55	3	738	0	98
29-Oct-85	9	1397	1	56	14	752	7	105
30-Oct-85	5	1402	0	56	3	755	0	105
31-Oct-85	3	1405	0	56	4	759	0	105
1-Nov-85	1	1406	0	56	1	760	0	105
2-Nov-85	12	1418	0	56	3	763	1	106

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Appendix B1. (page 3 of 3)

	Main Weir				Slough Weir			
	Upstream		Downstream		Upstream		Downstream	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
3-Nov-85	10	1428	0	56	0	763	3	109
4-Nov-85	0	1428	2	58	0	763	0	109
5-Nov-85	4	1432	0	58	1	764	0	109
6-Nov-85	0	1432	0	58	NA[1]	764	NA[1]	109
7-Nov-85	2	1434	0	58	NA[1]	764	NA[1]	109

[1] Weir not operable.

Appendix B2. The number and tagging history of immigrant and emigrant coho salmon passed through the weirs during fall, 1985 and spring, 1986, at Kake Bake Creek, Alaska.

Significance of Clip[1]	Fall 1985 Main Weir Up	Fall 1985 Main Weir Down	Fall 1985 Slough Weir Up	Fall 1985 Slough Weir Down	Spring 1986 Weir (Downstream Only) Main	Spring 1986 Lower CC	Spring 1986 Slough	Spring 1986 Upper CC
1983-1984 Clips	73	1	26	4		8		
Aug ET or Main Up	203	22	374	12	24	68	5	2
Aug OG	105	7	44	1	24	7	1	
Aug CC	5	2	96	2	9	86	2	57
Aug OG/Aug CC	1		12	1	3	3		1
Aug OG/Aug CC/Low CC					1			
Aug OG/Aug CC/Mar Pop/Low CC					1			
Aug OG/Aug CC/Nov Pop						3		
Aug OG/Aug CC/Nov Pop/Mar Pop					1			
Aug OG/Aug CC/Slu						1	1	
Aug OG/Aug CC/Slu/Low CC					2			
Aug OG/Low CC					8			
Aug OG/Mar Pop					9	2		
Aug OG/Nov Pop					5	6		
Aug OG/Nov Pop/Low CC					1			
Aug OG/Nov Pop/Mar Pop					2	1		
Aug OG/Nov Pop/Mar Pop/Low CC					2			
Aug OG/Nov Pop/Slu/Low CC					1			
Aug OG/Slu							2	
Aug OG/Slu/Low CC					1			
Aug CC/Low CC					81	1		
Aug CC/Nov Pop					2	14		1
Aug CC/Nov Pop/Low CC					9			
Aug CC/Nov Pop/Mar Pop					1	4		
Aug CC/Nov Pop/Mar Pop/Low CC					2			
Aug CC/Nov Pop/Slu/Low CC					1			
Aug CC/Nov Pop/Slu/Mar Pop						1		
Aug CC/Nov Pop/Upper CC						1		
Aug CC/Mar Pop					2	12		10
Aug CC/Mar Pop/Low CC					8	1		
Aug CC/Mar Pop/Upper CC						4		
Aug CC/Slu				5		4	4	
Aug CC/Slu/Low CC					6			
Aug CC/Upper CC						7		
Aug CC/Upper CC/Low CC					1			
Main Up/Aug CC	3		2	1	2	17	1	6
Main Up/Aug CC/Low CC					18			

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Appendix B2. (page 2 of 3)

Significance of Clip[1]	Fall 1985 Main Weir Up	Fall 1985 Main Weir Down	Fall 1985 Slough Weir Up	Fall 1985 Slough Weir Down	Spring 1986 Weir (Downstream Only) Main	Lower CC	Slough	Upper CC
Main Up/Aug CC/Mar Pop						1		2
Main Up/Aug CC/Mar Pop/Low CC					1			
Main Up/Aug CC/Mar Pop/Upper CC						1		
Main Up/Aug CC/Nov Pop					2	3	1	1
Main Up/Aug CC/Nov Pop/Low CC					1			
Main Up/Aug CC/Nov Pop/Slu/Low CC					1			
Main Up/Aug CC/Slu						4	2	1
Main Up/Aug CC/Slu/ Nov Pop						1		1
Main Up/Aug CC/Slu/Low CC					5			
Main Up/Aug CC/Upper CC						1		
Main Up/Aug CC/Upper CC/Low CC					1			
Main Up/Aug OG	6		44	1	4	5	1	
Main Up/Aug OG/Aug CC					2	2		
Main Up/Aug OG/Aug CC/Low CC					3			
Main Up/Aug OG/Aug CC/Mar Pop					1			
Main Up/Aug OG/Aug CC/Nov Pop					1			
Main Up/Aug OG/Low CC					6			
Main Up/Aug OG/Mar Pop					3			
Main Up/Aug OG/Nov Pop					1			
Main Up/Aug OG/Nov Pop/Mar Pop					1			
Main Up/Aug OG/Slu					1	2	1	
Main Up/Aug OG/Slu/Low CC					3			
Main Up/Nov Pop					1	4		1
Main Up/Nov Pop/Low CC					3			
Main Up/Nov Pop/Mar Pop						2		
Main Up/Nov Pop/Mar Pop/Low CC					2			
Main Up/Nov Pop/Upper CC						1		
Main Up/Mar Pop					4	4		2
Main Up/Mar Pop/Low CC					4			
Main Up/Low CC					62			
Main Up/Slu				5	1	15	5	
Main Up/Slu/Low CC					14			
Main Up/Slu/Mar Pop/Upper CC						1		
Nov Pop/Low CC					6			
Nov Pop/Mar Pop					1	2		
Nov Pop/Slu						1	1	
Nov Pop/Slu/Low CC					3			
Nov. Pop.					3		1	1
Mar Pop					10	6		2

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Appendix B2. (page 3 of 3)

Significance of Clip[1]	Fall 1985 Main Weir Up	Fall 1985 Main Weir Down	Fall 1985 Slough Weir Up	Fall 1985 Slough Weir Down	Spring 1986 Weir (Downstream Only) Main	Spring 1986 Weir (Downstream Only) Lower CC	Spring 1986 Weir (Downstream Only) Slough	Spring 1986 Weir (Downstream Only) Upper CC
Mar Pop/Low CC					1			
Mar Pop/Upper CC						1		
Mar Pop/Upper CC/Low CC					2			
Low CC					112	2		
Slu			5	13	3	18	3	
Slu/Low CC					17			
Unmarked	1038	26	161	64	73	148	31	25
Total Number of fish	1434	58	764	109	586	476	62	113

[1] 1983-1984 Clips = Marked during prior studies; Aug, Nov, Mar = Fish marked during August, November, (1985) or March (1986) population studies; ET= Estuarine zone; OG = Old-growth zone; CC = Clearcut zone; Low CC = fish passed downstream through Lower Clearcut weir; Main Up = Fish passed upstream through Main weir; Slu = Fish passed downstream through Slough weir; Upper CC = Fish passed downstream through Upper Clearcut weir.

Appendix B3. The daily and cumulative number of emigrant juvenile coho salmon passed through each weir during spring, 1986, at Kake Bake Creek, Alaska.

	Main		Lower Clearcut		Slough		Upper Clearcut	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
4/1/86	0	0	0	0	NA[1]	0	NA[1]	0
4/2/86	0	0	0	0	NA[1]	0	0	0
4/3/86	0	0	0	0	0	0	0	0
4/4/86	0	0	0	0	0	0	0	0
4/5/86	0	0	0	0	0	0	0	0
4/6/86	0	0	0	0	0	0	0	0
4/7/86	5	5	1	1	0	0	0	0
4/8/86	0	5	1	2	0	0	0	0
4/9/86	0	5	1	3	0	0	0	0
4/10/86	0	5	1	4	0	0	0	0
4/11/86	0	5	1	5	0	0	0	0
4/12/86	0	5	0	5	0	0	0	0
4/13/86	0	5	0	5	0	0	2	2
4/14/86	0	5	0	5	0	0	0	2
4/15/86	0	5	0	5	0	0	0	2
4/16/86	0	5	0	5	0	0	0	2
4/17/86	0	5	0	5	0	0	0	2
4/18/86	0	5	2	7	0	0	0	2
4/19/86	8	13	19	26	1	1	0	2
4/20/86	2	15	7	33	0	1	1	3
4/21/86	0	15	0	33	0	1	1	4
4/22/86	4	19	3	36	0	1	1	5
4/23/86	0	19	0	36	0	1	0	5
4/24/86	22	41	3	39	0	1	0	5
4/25/86	2	43	2	41	0	1	0	5
4/26/86	5	48	0	41	0	1	0	5
4/27/86	6	54	5	46	0	1	0	5
4/28/86	15	69	3	49	0	1	4	9
4/29/86	11	80	2	51	0	1	2	11
4/30/86	2	82	2	53	0	1	2	13
5/1/86	3	85	0	53	0	1	1	14
5/2/86	6	91	8	61	0	1	2	16
5/3/86	9	100	23	84	0	1	0	16
5/4/86	16	116	1	85	0	1	2	18
5/5/86	5	121	6	91	0	1	1	19
5/6/86	9	130	0	91	0	1	5	24
5/7/86	8	138	14	105	2	3	1	25
5/8/86	21	159	9	114	0	3	1	26
5/9/86	17	176	3	117	0	3	3	29

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	Main		Lower Clearcut		Slough		Upper Clearcut	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
5/10/86	11	187	7	124	0	3	9	38
5/11/86	5	192	1	125	0	3	15	53
5/12/86	25	217	51	176	16	19	4	57
5/13/86	39	256	29	205	3	22	2	59
5/14/86	22	278	4	209	0	22	7	66
5/15/86	14	292	14	223	0	22	3	69
5/16/86	10	302	0	223	0	22	2	71
5/17/86	11	313	34	257	0	22	1	72
5/18/86	30	343	3	260	2	24	1	73
5/19/86	8	351	22	282	1	25	1	74
5/20/86	25	376	45	327	0	25	1	75
5/21/86	18	394	3	330	0	25	3	78
5/22/86	19	413	4	334	1	26	4	82
5/23/86	15	428	9	343	0	26	7	89
5/24/86	10	438	3	346	2	28	4	93
5/25/86	7	445	13	359	1	29	3	96
5/26/86	30	475	32	391	13	42	11	107
5/27/86	12	487	6	397	5	47	0	107
5/28/86	12	499	18	415	4	51	1	108
5/29/86	14	513	12	427	4	55	2	110
5/30/86	25	538	25	452	0	55	3	113
5/31/86	24	562	10	462	0	55	NA[1]	113
6/1/86	14	576	8	470	1	56	NA[1]	113
6/2/86	10	586	6	476	6	62	NA[1]	113

[1] Weir not operable.