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Origins of Sockeye Salmon in East Side Bristol Bay Fisheries in 1987 Based on Linear Discriminant Function Analysis of Scale Patterns

by
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and
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State of Alaska

Steve Cowper, Governor

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ORIGINS OF SOCKEYE SALMON IN EAST SIDE BRISTOL BAY FISHERIES IN 1987 BASED ON LINEAR DISCRIMINANT FUNCTION ANALYSIS OF SCALE PATTERNS

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ABSTRACT

Stock compositions of the 1987 commercial harvest of sockeye salmon (*Oncorhynchus nerka*) in the Naknek-Kvichak, Egegik, and Ugashik Districts of Bristol Bay were estimated using analysis of scale patterns and age composition. Scale measurements from age-1.2, -1.3, and -2.3 fish from escapements were used to build discriminant functions which allowed commercial catches to be proportioned by river of origin. Catches of fish from other age groups were proportioned by combining results from analysis of scale patterns with escapement age composition.

The majority of sockeye salmon harvested in each fishing district originated from rivers within the district; however we did find interceptions of outside stocks in every area. Of the estimated 4,949,015 sockeye salmon caught in the Naknek-Kvichak District, 62% were from the Kvichak River, 27% from the Naknek River, 3% from the Egegik River, and 8% from the Ugashik River. An estimated 5,386,845 sockeye salmon caught in the Egegik District were comprised of 74% Egegik River, 9% Kvichak River, 5% Naknek River, and 12% Ugashik River. The Ugashik District harvest of 2,119,188 sockeye salmon was 81% Ugashik River, 3% Kvichak River, 11% Naknek River, and 5% Egegik River.

The Ugashik River run experienced the highest (30.1%) interception rate outside the district followed by the Naknek River run (17.4%). Runs to Kvichak River (5.4%) and Egegik River (4.5%) were intercepted at much lower rates outside their districts of origin. Overall (inside and outside the district) exploitation rates by stock were: 37.1% for Kvichak River, 63.8% for Naknek River, 77% for Egegik River, and 80.4% for Ugashik River.

KEY WORDS: Sockeye salmon (*Oncorhynchus nerka*), Bristol Bay, scale pattern analysis, linear discriminant analysis, estimates of stock composition, exploitation rates

INTRODUCTION

A basic principle of Pacific salmon management is that harvest of any stock should not occur unless its basic spawning escapement can be ensured. The sockeye salmon (*Oncorhynchus nerka*) fishery within Bristol Bay has been limited to districts and sections located near the mouths of spawning streams to minimize problems associated with mixed stock fisheries (Figure 1). However, the relatively close proximity of spawning rivers to each other and annual variations in migration routes causes some stock mixing even in areas close to river mouths.

The Bristol Bay Management Area can be divided into two general regions, the West and East Side fisheries. The East Side fishery is composed of three districts: Naknek-Kvichak, Egegik, and Ugashik Districts (Figure 1). The Naknek-Kvichak District is subdivided into the Naknek and Kvichak Sections. A tagging study conducted by Straty (1975) during 1955-57 documented that sockeye salmon from Kvichak, Naknek, Egegik, and Ugashik Rivers were intermixed to some degree in all three districts.

The amount of intermixing of sockeye salmon within the East Side districts was not quantified until 1986. Prior to 1986 (1956-85), total runs of sockeye salmon to Kvichak, Naknek, Egegik, and Ugashik Rivers were estimated by adding the catch in the district to the escapement into each respective river within the district. Harvests within the Naknek-Kvichak District were assigned to river of origin based on the age composition of the contributing rivers (Naknek, Kvichak, and Branch Rivers). This method, referred to as the standard method, of estimating sockeye salmon runs by river for Bristol Bay assumed that all fish harvested in a district were returning to rivers within the district and that interception of fish from other districts was not occurring (Yuen and Nelson 1987, Cross and Stratton 1988).

Decreased catches of sockeye salmon in the Kvichak Section in 1985 and 1986, accompanied by large increases in catches in Egegik and Ugashik Districts have prompted concerns about interceptions within East Side districts. In 1985, Fried and Yuen (1985) found scale pattern analysis useful in identifying sockeye salmon stocks within the East Side Bristol Bay fisheries. Bue (1986) expanded the use of scale pattern analysis in 1986 and estimated contributions by river to the three district catches.

Increased accuracy in estimates of catch composition should allow managers to affect more effective stock-specific harvest goals. More accurate estimates may also result in better preseason forecasts, spawner-return relationships, and escapement goals.

The objectives of this ongoing investigation are: (1) to estimate stock composition of the 1987 commercial harvests of sockeye salmon in the Naknek-Kvichak, Egegik, and Ugashik Districts; (2) to estimate total runs by river; (3) to compare estimates of run by river obtained from scale pattern analysis with those developed from the standard method.

METHODS

Estimation of Catch and Escapement

Commercial catch statistics were taken from final operation reports prepared by fish processors as documented by Cross and Stratton (1988). These numbers may differ slightly from final catch statistics that will be compiled by Alaska Department of Fish and Game (ADF&G), Commercial Fisheries Division, as errors are detected and corrected. Sockeye salmon escapement estimates were based on counts made from towers on the banks of the Kvichak, Naknek, Egegik and Ugashik Rivers (Cross and Stratton, 1988). Counts were made on each bank of the river for 10 min during every hour. Counts were made according to a set schedule in which fish were counted from one bank on the hour and counting from the opposite bank immediately followed. Each 10-min count was expanded into an hourly estimate to calculate the total daily escapement.

Estimation of Age Composition

Ages were determined by examining scales (Mosher, 1968). Scales were collected from the left side of the fish approximately two rows above the lateral line in an area crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Scales were mounted on gummed cards, and impressions were made in cellulose acetate (Clutter and Whitesel 1956). To record ages we used European notation (Koo 1962) in which numerals preceding the decimal refer to the number of freshwater annuli and numerals following the decimal refer to the number of marine annuli. Total age from time of egg deposition (brood year) is the sum of these two numbers plus one to account for the incubation time.

Age composition of sockeye salmon harvests by district was estimated with stratified systematic sampling design (Cochran 1977). Thompson's (1987) work on the "worst case" parameter value for the multinomial distribution, shows that a sample size of 510 would result in simultaneously estimating the true percentage for each major age group within 5 percentage points 95% of the time. We set the desired sample size for each strata at 600 scales to account for unageable scales due to scale reabsorption and regeneration. Catch sampling was stratified by district and through time. The number of time strata sampled from each district depended on the number of fishing periods. From 23 June through 17 July, each district catch of sockeye salmon was sampled every fishing period unless fishing periods were continuous and then samples were taken at least every 3 d. Prior to 23 June and after 17 July, district sockeye catches were sampled only once. For dates not sampled, the age composition of sockeye salmon harvests was assumed to be the same as that estimated for the most recent date. Methods and results of sampling sockeye catches in Bristol Bay for age composition in 1987 are reported by Cross and Stratton (1988).

Escapement samples were taken from sockeye salmon captured by beach seine at the tower counting sites. The goal for sampling escapements was set at 200 fish per day. This goal was selected so that 600 samples were available every three days. In practice this daily goal could only be obtained during the peak of the

run. Successive daily age composition estimates were compared using chi-square tests. Successive dates were placed in the same strata if significant ($P < 0.05$) differences were not found. Detailed age, sex, and size data for the escapement into each river are reported by Cross and Stratton (1988).

Estimation of Age Composition

Linear discriminant analysis (Fisher 1936) of scale patterns combined with age composition data were used to determine the rivers of origin of sockeye salmon harvested within East Side Bristol Bay fishing districts in 1987.

Measurement Of Scale Patterns

Scale impressions were projected at 100X magnification using equipment similar to that described by Ryan and Christie (1976). Scale images were measured on a Talos digitizing tablet and processed by a microcomputer. To standardize each scale, measurements were taken along the anterior-posterior axis. Distances between growth rings (circuli) were measured and the numbers of circuli were counted from the following scale growth zones: (1) scale focus to the outside edge of the first freshwater annulus (first freshwater annular zone), (2) outside edge of the last freshwater annulus to the end of freshwater growth (freshwater plus growth zone), and (3) the last circulus of the freshwater plus growth zone to the outer edge of the first ocean annulus (first marine annular zone). For age-2.3 sockeye salmon, distances between circuli were also measured from the outside edge of the first freshwater annulus to the outside edge of the second freshwater annulus (second freshwater annular zone). In addition, the total distance from the outside edge of the first ocean annulus to the outside edge of the second ocean annulus (second marine annular zone) was recorded for age-1.3, and -2.3 sockeye salmon (Figure 2). From the distance measurements and circuli counts, we computed 75 variables for age-1.2 and -1.3 samples and 109 variables for age-2.3 samples (Table 1). We measured scale patterns of age-1.2, -1.3, and -2.3 sockeye salmon because these age groups made up 83% of the commercial catch.

Discriminant Analysis

Escapement samples providing scales of known origin from Kvichak, Naknek, Egegik, and Ugashik Rivers were used to build the linear discriminant functions (LDF). Commercial catch samples providing scales of mixed origin were classified with the discriminant functions to estimate the contribution of each river to the age-1.2 ,-1.3, and -2.3 harvests.

Major scale variables were plotted to review their distributions. Differences between mean number of circuli and size of growth zones for males and females were investigated using independent t-tests. The selection of scale variables for each discriminant model was made by a forward stepping procedure using partial F statistics as the criteria for entry/removal of variables (Enslein et al. 1977). Variables were added until model accuracy ceased to improve. We tested the equality of variance-covariance matrices using a F-statistic as described

by Box (1949). A nearly unbiased estimate of classification accuracy for each LDF was determined using a "leaving-one-out procedure" (Lachenbruch 1967).

Construction of Age-1.2 Models. A four-way linear discriminant model was constructed from scale measurements of age-1.2 fish entering the Kvichak, Naknek, Egegik, and Ugashik Rivers. Models for the Kvichak, Egegik, and Ugashik Rivers were constructed from 200 scales weighted through time based on tower counts. All (125) available age-1.2 scales from Naknek River were used for the model.

Classification of Age-1.2 Scales. Linear discriminant models were used to assign unknown samples (age-1.2 scales from the commercial catches) to stream of origin. Model estimates of proportions by stock in the catch were adjusted for misclassification errors using the procedure of Cook and Lord (1978). The adjusted proportions are presumed to accurately reflect the true stock composition. The variance and 90% confidence intervals for the adjusted estimates were computed using the procedure of Pella and Robertson (1979). A catch sample was reclassified with a model representing fewer stocks if the adjusted proportion was less than or equal to zero for the stock in question.

Initially, we measured 50 age-1.2 scales from each sample date for each fishery and classified the samples with the discriminant model. We compared successive stock composition estimates with chi-squared tests. If significant ($P < 0.05$) differences were not found between stock estimates, we combined scale measurements from consecutive fishing periods to make the desired sample size of 100. If the estimated stock proportions for consecutive fishing periods were significantly different, we measured an additional 50 age-1.2 samples from the fishing period.

We calculated the numbers of age-1.2 fish by stock in a specific catch stratum by multiplying the estimated stock proportion from scale pattern analysis with the estimated proportion of age-1.2 catch with the total catch:

$$\hat{C}_{i1.2} = C\hat{P}_{1.2}\hat{S}_{i1.2} \quad (1)$$

where:

$\hat{C}_{i1.2}$ = estimated catch of fish aged 1.2 returning to stock i;

C = catch of sockeye salmon in a fishery at a given time;

$\hat{P}_{1.2}$ = estimated proportion of fish aged 1.2 in the catch; and

$\hat{S}_{i1.2}$ = estimated proportion of stock i aged 1.2 in the catch.

The variance of the estimated catch of age-1.2 sockeye salmon ($V[\hat{C}_{i1.2}]$) from each stock in a specific fishery at a given time was calculated as an exact variance of a product according to Goodman (1960):

$$V[\hat{C}_{i1.2}] = C^2 V[\hat{P}_{1.2}\hat{S}_{i1.2}] \quad (2)$$

$$V[\hat{P}_{1.2}\hat{S}_{i1.2}] = V[\hat{P}_{1.2}]\hat{S}^2_{i1.2} + V[\hat{S}_{i1.2}]\hat{P}^2_{1.2} - V[\hat{S}_{i1.2}]V[\hat{P}_{1.2}] \quad (3)$$

The contributions by stock through time for a specific fishery were added to estimate the contribution to that fishery for the entire year; the variance of the yearly contribution was calculated as the sum of the variances for each time period. Finally, the contributions by stock to each fishery were added to produce the total contribution by stock to the East Side Bristol Bay age-1.2 sockeye salmon harvest, and the variance of the total contribution by stock was calculated as the sum of the variances for each fishery.

Construction of Age-1.3 Models. Initially a three-way linear discriminant model was constructed from measurements of age-1.3 scales from fish escaping into the Naknek, Egegik, and Ugashik Rivers. The Kvichak River was not included in the initial model because there were only 11 age-1.3 scales from the escapement which were usable for digitizing (the 1.3-age group only comprised 3% of the Kvichak escapement). Models for the Naknek, Egegik, and Ugashik Rivers were constructed from 200 age-1.3 scales weighted through time by tower counts. The three-way model could not discriminate between Naknek and Ugashik Rivers. An estimated 24% of the Naknek River samples were misclassified as belonging Ugashik River, while an estimated 31% of the Ugashik River samples were misclassified as Naknek River. Frequency distributions of the width of the first freshwater annular zone for samples from Naknek and Ugashik Rivers were similar (Figure 3). The three-way model of age-1.3 samples was very accurate in identifying Egegik River samples (92% of the Egegik samples were correctly classified). Because the three-way model could not discriminate Naknek River from Ugashik River, we decided to combine samples from Kvichak, Naknek and Ugashik Rivers and compare them to Egegik River. For the pooled sample, we randomly selected 100 of the 200 samples initially measured from Naknek and Ugashik Rivers and added the 11 usable scales from Kvichak River. Growth patterns of Kvichak River age-1.3 scales were similar to those of Naknek and Ugashik Rivers. Although we were unable to include Kvichak River in the initial analysis because of insufficient age-1.3 scales, we decided to include it in the combined model.

Classification of Age-1.3 Scales. The two-way linear discriminant model of Kvichak-Naknek-Ugashik pooled versus Egegik was used to classify age-1.3 sockeye salmon caught in the Egegik District. Procedures used to adjust for the age-1.3 model misclassification and to compute variances and 90% confidence intervals for the age-1.3 stock estimates for Egegik District were the same as those used in the age-1.2 analysis. We initially measured 50 age-1.3 scales from each sample date and classified the samples with the discriminant model. We then compared estimated stock proportions with chi-squared tests and combined successive sample dates if stock estimates were the same or measured an additional 50 scales if successive stock estimates were significantly different.

A variance for each stock's (Egegik versus combined rivers) contribution to the total season catch at Egegik District was computed using equations (2) and (3).

We did not classify age-1.3 sockeye salmon harvested in Naknek-Kvichak or Ugashik Districts with the two-way model because the model could only estimate the contribution of Egegik River. The other rivers were combined in one group. Catches of age-1.3 sockeye salmon from Naknek-Kvichak and Ugashik Districts were assigned to river of origin based on the age-1.2 and -2.3 stock estimates (from scale pattern analysis) and the age composition of the escapements.

Construction of Age-2.3 Models. A three-way linear discriminant model was constructed from scale measurements of age-2.3 fish entering Naknek, Egegik, and Ugashik Rivers. Kvichak River was not included in the model because age-2.3 fish only comprised 1% of the escapement. Models for Naknek, Egegik and Ugashik Rivers were built from 200 age-2.3 scales weighted through time based on tower counts.

Classification of Age-2.3 Scales. The three-way linear discriminant model (Naknek/Egegik/ Ugashik) was used to classify age-2.3 sockeye salmon caught in the three east side districts . Procedures used for the age-2.3 scale pattern analysis were the same as those used for the age-1.2 analysis.

Separation Of Kvichak-Naknek-Ugashik Age-1.3 Catch

Because the age-1.3 model could not accurately discriminate Kvichak, Naknek and Ugashik Rivers, samples from these rivers were pooled. Scale patterns were used to estimate the contributions of combined Kvichak-Naknek-Ugashik Rivers and Egegik River to the Egegik District catch of age-1.3 sockeye salmon. Proportions of age-1.3 fish classified to pooled Kvichak-Naknek-Ugashik were separated to each respective river based on the scale pattern estimates for age-1.2 and -2.3 fish and the age composition in the escapements:

$$(4)\quad \hat{S}_{i1.3} = \hat{S}_{p1.3}\ \frac{\hat{S}_{i(1.2,2.3)}(\hat{E}_{i1.3}/\hat{E}_{i(1.2,2.3)})}{\sum_{i=1}^{n} \hat{S}_{i(1.2,2.3)}(\hat{E}_{i1.3}/\hat{E}_{i(1.2,2.3)})}$$

$$(5)\quad \hat{S}_{i(1.2,2.3)} = \frac{\hat{C}_{i1.2} + \hat{C}_{i2.3}}{\hat{C}_{1.2} + \hat{C}_{2.3}}$$

$$(6)\quad \hat{E}_{i(1.2,2.3)} = \frac{\hat{E}_{i1.2} + \hat{E}_{i2.3}}{E_i}$$

where:

$\hat{S}_{i1.3}$ = estimated proportion of stock i (Kvichak, Naknek or Ugashik) in Egegik catches of fish aged 1.3;

$\hat{S}_{p1.3}$ = estimated proportion of pooled Kvichak-Naknek-Ugashik in Egegik catches of fish aged 1.3;

$\hat{S}_{i(1.2,2.3)}$ = estimated proportion of stock i in Egegik catches of age-1.2 and -2.3 fish;

$\hat{E}_{i1.3}$ = estimated proportion of fish aged 1.3 in the escapement of stock i;

$\hat{E}_{i(1.2,2.3)}$ = estimated combined proportion of fish aged 1.2 and 2.3 in the escapement of stock i;

$\hat{C}_{i1.2}$ = estimated numbers of fish aged 1.2 in stock i caught in a fishery;

$\hat{C}_{i2.3}$ = estimated numbers of fish aged 2.3 in stock i caught in a fishery;

$\hat{C}_{1.2}$ = estimated numbers of fish aged 1.2 caught in a fishery;

$\hat{C}_{2.3}$ = estimated numbers of fish aged 2.3 caught in a fishery;

$\hat{E}_{i1.2}$ = estimated numbers of fish aged 1.2 in the escapement of stock i;

$\hat{E}_{i2.3}$ = estimated numbers of fish aged 2.3 in the escapement of stock i;

E_i = numbers of fish escaping in stock i; and

n = number of stocks.

Two assumptions were necessary: (1) the age compositions of Kvichak, Naknek, and Ugashik Rivers escapements represented the overall proportions available in the Egegik District catch; (2) the exploitation rates for the 1.3-age group within the Kvichak, Naknek, and Ugashik Rivers were equal to the average exploitation rates for the combined 1.2- and 2.3-age groups in each river. If the proportion of age-1.3 fish for a stock was actually higher in the district than in the escapement, we would under-estimate the contribution of that stock to the age-1.3 catch. Conversely, if the proportion of age-1.3 fish for a stock was actually lower in the district than in the escapement, we would over-estimate that stock's contribution to the age-1.3 catch. If the exploitation rate for a stock's 1.3-age group was greater than the average exploitation rate for the stock's 1.2- and 2.3- age groups, we would under-estimate that stock's contribution. On the other hand, if the age-1.3 exploitation rate for a stock was actually less than the average age-1.2 and age-2.3 exploitation rate, we would over-estimate that stock's contribution to the age-1.3 catch.

Estimation Of Stock Composition For Minor Age Groups

Estimates of stock composition for fish of minor ages (other than age-1.2 and -2.3) harvested in Naknek-Kvichak and Ugashik Districts were based on the combined scale pattern estimates for age-1.2 and -2.3 fish and the combined ratio of age-1.2 and -2.3 fish to fish of minor age groups in respective escapements. The equations used to estimate the stock compositions for fish of other ages were basically the same as equations (4), (5), and (6) above with the following exceptions: $\hat{S}_{ij}$ (estimated proportion of stock i in the catches of fish aged j) replaced $\hat{S}_{i1.3}$ and there was no pooled proportion ($\hat{S}_{p1.3}$).

Scale patterns were analyzed for the 1.2-, 1.3-, and 2.3-age groups for catches from Egegik District. Estimates of stock compositions for sockeye salmon of other ages (other than age-1.2, -1.3, -2.3) were computed as explained above except they were based on the combined scale pattern estimates for age-1.2, -1.3, and -2.3 fish and the escapement age composition.

Estimation of Run Size

We estimated the size of each river's sockeye salmon run by adding estimates of catch by stock to estimates of escapements. For each river, we computed the percentage that was: (1) harvested within its natal district, (2) harvested outside the district, and (3) escaped into the river. Finally, we compared run sizes estimated from scale pattern analysis with those estimated with the standard method which assumes that all fish caught in a district originate from rivers within the district.

RESULTS

Catch and Escapement

Commercial fishermen harvested an estimated 12,455,048 sockeye salmon in East Side Bristol Bay Districts in 1987 (Table 2), compared to an average catch from 1977-86 of 16.1 million. Sockeye salmon caught in the Egegik District (5,386,845) accounted for 43% of the East Side Bristol Bay catch, while catches in the Naknek-Kvichak (4,949,015) and Ugashik (2,119,188) Districts comprised 40% and 17%, respectively. Peak catches occurred in the Naknek-Kvichak District during 6-16 July, in the Egegik District during 27 June through 9 July, and in the Ugashik District from 2-13 July.

An estimated 6,065,800 sockeye salmon escaped into the Kvichak River in 1987 with 84% of the fish being counted during 2-11 July (Table 3). Escapement into the Naknek River was estimated at 1,061,806 sockeye salmon and 85% of it occurred during 1-9 July. An estimated 1,272,978 sockeye salmon escaped into the Egegik River. Approximately 80% of the escapement into the Egegik River was obtained from 26 June through 11 July. Escapement into Ugashik River was estimated at 668,964 sockeye salmon and 70% of them passed the tower in three days (15-17 July).

Age Composition

Table 4 shows that four age groups made up most (99.8%) of the East Side Bristol Bay catch: age-1.2 (38%), age-1.3 (25%), age-2.2 (17%), and age-2.3 (20%). Percentages by age differed among district catches. The Naknek-Kvichak District catch was comprised mostly of age-1.2 (60%) and age-1.3 (22%) fish. The Egegik District catch had similar percentages of age-1.2 (26%), age-1.3 (27%), age-2.2 (25%), and age-2.3 (21%) sockeye salmon. Age-2.3 sockeye salmon predominated (35%) in the Ugashik District catch, followed by age-1.3 (25%), age-2.2 (21%), and age-1.2 (18%) fish.

Age compositions of sockeye salmon escaping into the rivers varied considerably among runs (Table 5). Escapement into the Kvichak River was largely (90%) comprised of age-1.2 sockeye salmon, while the escapement into the Naknek River was mostly (39% each) fish aged 1.3 and 2.3. Similar to the catch in Egegik District, all four age groups were well represented in the escapement into Egegik River. The age composition of Egegik River escapement was 25% age-1.2, 27% age-1.3, 29% age-2.2, and 19% age-2.3. Sockeye salmon escapement into Ugashik River was comprised of higher percentages of younger fish than the district catch. Age composition of the Ugashik River escapement was 36% age-1.2, 20% age-1.3, 21% age-2.2, and 22% age-2.3.

Classification Models

Age 1.2

Variables which provided the greatest discrimination among stocks of age-1.2 fish were: variable 28 (number of circuli in the first 3/4 of the first freshwater zone), variable 5 (distance from the focus to circulus 6), and variable 61 (number of circuli in the plus growth zone). Freshwater growth of Egegik River fish was greatest, followed by freshwater growth of Ugashik, Naknek, and Kvichak Rivers fish (Table 6 and Figure 4). There was little overlap between distributions of freshwater growth variables for samples from Egegik and Kvichak Rivers (Figure 4). Naknek River fish showed a wide variation in freshwater growth which substantially overlapped the distribution of freshwater growth of Ugashik River fish.

We computed t-statistics for mean values of the number of circuli and size of each growth zone for males and females by stock (Table 7). We found significant differences between sexes for: (1) number of circuli and size of plus growth zone for Kvichak River age-1.2 fish, and (2) number of circuli and size of freshwater growth zone for Naknek and Ugashik Rivers age-1.2 fish. Because we did not find any growth zones which were consistently different between sexes for all stocks, we combined samples of males and females to build our models.

Catches of age-1.2 fish from all districts were initially classified to natal stream with a four-way model (Kvichak, Naknek, Egegik, Ugashik Rivers). The mean proportion correctly classified by the four-way model was 0.72 (Table 8). Correct classifications for Kvichak (0.88) and Egegik (0.86) Rivers were extremely high. Proportions correctly classified were lower for Ugashik (0.60) and Naknek (0.54) Rivers. Samples from Ugashik River misclassified predominately to Naknek River, while Naknek River samples misclassified equally to the three other rivers. The range of classification accuracies were 0.72 to 0.87 for three-way models and 0.72 to 0.99 for two-way models.

Age 1.3

The three-way model (Naknek, Egegik, and Ugashik) of age-1.3 samples could not differentiate Naknek River fish from Ugashik River fish; however, Egegik River fish were very distinct. Mean values of scale variables were similar among age-1.3 samples from Naknek and Ugashik Rivers (Table 9). We pooled age-1.3 samples from Kvichak, Naknek, and Ugashik Rivers (Kvi-Nak-Uga pooled) and compared them to Egegik River age-1.3 samples. Scale variables which provided the greatest separation between Kvi-Nak-Uga pooled and Egegik River were: variable 14 (the distance from circulus 2 to the end of first freshwater) and variable 89 (the distance from circulus 15 to the end of the first ocean). The mean value of variable 14 for age-1.3 fish from Egegik River was 1.5 times as large as the mean value for the other pooled systems (Table 9 and Figure 5).

The sizes of the first and second ocean zones (S1OZ and S2OZ) for age-1.3 fish from Egegik River were different between males and females (Table 10). Growth zones of fish from Naknek and Ugashik Rivers did not differ between sexes. We did not use measurements from the second ocean zone in the age-1.3 analysis. The overall classification accuracy of the two-way model Kvi-Nak-Uga pooled versus Egegik was 0.95 (Table 11). Because we could only separate Egegik River

fish from the other stocks, we limited age-1.3 catch classification to those catches from the Egegik District.

Age 2.3

Scale characters which differed the most among stocks of age-2.3 fish were: variable 66 (total size of the first and second freshwater and the plus growth) and variable 57 (average interval between circuli in the second freshwater). Mean values of variable 66 were greatest for samples from Egegik River and smallest for samples from Ugashik River (Table 12 and Figure 6).

Age-2.3 samples from the Naknek River showed significant differences between sexes for the following growth zones: size of second freshwater zone (S2FW), size plus growth zone (SPGZ), and size second ocean zone (S2OZ) (Table 13). Age-2.3 samples from Egegik River had significantly different mean values between males and females for the size of the first ocean zone (S1OZ), while samples from Ugashik River differed in the size of the second ocean zone. We did not include measurements from the second ocean zone in the age-2.3 analysis.

The mean proportion correctly classified by the three-way model of Naknek, Egegik and Ugashik Rivers was 0.76 (Table 14). Correct classifications for Egegik and Ugashik Rivers were high (0.81 and 0.82, respectively); while the classification accuracy for Naknek River was lower (0.66). Classification accuracies for two-way models ranged from 0.83 to 0.95 (Table 14).

Estimates of Catch Composition

Age 1.2

We found the majority of age-1.2 sockeye salmon harvested in each district originated from rivers within the district (Table 15). Of the 2,995,754 age-1.2 fish caught in the Naknek-Kvichak district, 94.4% originated within the district and 5.6% were from outside the district (Figure 7). An estimated 1,397,720 age-1.2 sockeye salmon were caught in the Egegik District of which 64.6% originated from the Egegik River and 35.4% were produced outside the district (Figure 8). The catch of age-1.2 sockeye salmon in the Ugashik District was 388,607 fish of which 74.6% originated in the Ugashik River and 25.4% from stocks outside the district (Figure 9). Towards the end of the season an increase in percent contribution of Ugashik River age-1.2 fish occurred in all three districts.

The 90% confidence intervals around the point estimates for stock composition of age-1.2 fish varied because the accuracies of the classification models by stock differed (Table 15). Estimates for age-1.2 catch contributions for Kvichak and Egegik Rivers were more precise than other rivers with 90% confidence intervals ranging from $\pm$0.10 to $\pm$0.15. The 90% confidence intervals for catch estimates of Ugashik River stocks ranged from $\pm$0.15 to $\pm$0.20; while confidence intervals around estimates for Naknek River were the widest and ranged from $\pm$0.15 to $\pm$0.25.

Coefficients of variation for estimated stock proportions were lowest for the two major contributors: 0.03 for the Kvichak River, 0.05 for the Egegik River (Table 16). Coefficients of variation were much larger for age-1.2 proportions

from the Ugashik River (0.20) and Naknek Rivers (0.88) because their contributions were much less and the model accuracies for these systems was lower.

Age 1.3

Estimates of age-1.3 catch composition from scale pattern analysis was limited to the Egegik District. An estimated 1,450,744 age-1.3 sockeye salmon were caught in the Egegik District of which 76.9% originated in the Egegik River and 23.1% were from other rivers (Figure 10). We found no temporal trends in stock composition for age-1.3 catch in Egegik District (Table 17 and Figure 10). The 90% confidence intervals around the age-1.3 point estimates ranged from $\pm$0.06 to $\pm$0.11 (Table 17). The coefficient of variation was 0.04 for the estimated numbers of age-1.3 fish caught from Egegik River and 0.09 for the harvest of other stocks (Table 18).

Age 2.3

The majority of age-2.3 sockeye salmon harvested in each district originated from rivers within the district (Table 19). Of the 576,071 age-2.3 fish caught in the Naknek-Kvichak district, 81.3% originated within the district and 18.7% were from outside the district (Figure 11). An estimated 1,145,320 age-2.3 sockeye salmon were caught in the Egegik District of which 69.8% originated from the Egegik River and 30.1% were produced outside the district (Figure 12). The catch of age-2.3 sockeye salmon in the Ugashik District was 738,435 fish with 86.2% of them originating in the Ugashik River and 13.8% from stocks outside the district (Figure 13). As in the age-1.2 analysis, the only temporal trend in the age-2.3 catch composition was an increase towards the end of the season in the percent contribution of Ugashik River to catches in all three districts.

The 90% confidence intervals around the age-2.3 point estimates ranged from $\pm$0.10 to $\pm$0.25 (Table 19). Coefficients of variation for estimated numbers of age-2.3 fish by stock in the harvest were 0.05 for the Ugashik River, 0.06 for Egegik River, and 0.10 for Naknek River (Table 20).

All Ages

The Naknek-Kvichak District sockeye salmon harvest was comprised of 3,056,295 fish from the Kvichak River, 1,358,763 fish from the Naknek River, 134,102 fish from the Egegik River and 399,855 fish from the Ugashik River (Table 21). An estimated 4,016,003 sockeye salmon caught in the Egegik District were from the Egegik River, while 473,258 fish were from the Kvichak River, 268,838 fish were from the Naknek River, and 628,745 fish were from the Ugashik River (Table 22). Ugashik River sockeye salmon predominated (1,716,207 fish) in the Ugashik District catch, followed by 239,654 Naknek River fish, 112,389 Egegik River fish, and 50,938 Kvichak River fish (Table 23).

Stock Interceptions by District

Of the total Kvichak River fish harvested in 1987, 85.4% were taken in the Naknek-Kvichak District, 13.2% were taken in the Egegik District and 1.4% were taken in the Ugashik District (Table 24). The majority (72.8%) of the Naknek River fish were harvested in the Naknek-Kvichak District, followed by 14.4% caught in the Egegik District, and 13% caught in the Ugashik District. Most (94.2%) of the Egegik River fish were harvested in Egegik District, while 6% were taken in the Naknek-Kvichak (3%) and Ugashik (3%) Districts. The largest (62.5%) harvest of Ugashik River fish occurred in the Ugashik District, followed by the Egegik District (22.9%) and the Naknek-Kvichak District (15%).

An estimated 1,032,688 sockeye salmon destined for the Kvichak and Naknek Rivers were intercepted in districts outside their natal district. Conversely, fishermen in the Naknek-Kvichak District intercepted 533,957 sockeye salmon which were headed for other rivers; thus, the Naknek-Kvichak District realized a net loss of 498,731 fish. The number of Egegik River fish intercepted in outside districts was 246,491 sockeye salmon, while fishermen in the Egegik District caught 1,370,841 sockeye salmon which originated in other districts. Therefore, in 1987 the fishermen in Egegik District realized a net gain of 1,124,350 sockeye salmon. An estimated 1,028,600 Ugashik River fish were intercepted outside the district, and 402,981 sockeye salmon from other rivers were caught in the Ugashik District. This resulted in a net loss to Ugashik District fishermen of 625,619 fish.

Runs by River System

The 1987 sockeye salmon run to the Kvichak River was estimated at 9,646,372 fish; of which 62.9% escaped into the river, 31.7% were harvested within the Naknek-Kvichak District, and 5.4% were harvested in other districts (Tables 25-26 and Figure 14). Of the 2,929,062 sockeye salmon run to the Naknek River, 36.3% escaped into the river, 46.4% were caught in the Naknek-Kvichak District, and 17.4% were caught in other districts (Figure 15). Distribution of the 5,535,471 sockeye salmon run to the Egegik River was 23% to the escapement, 72.6% to the Egegik District harvest, and 4.5% to the other districts harvests (Figure 16). Ugashik River had a sockeye salmon run estimated at 3,413,772 fish; of which 19.6% escaped into the river, 50.3% were harvested within the Ugashik District, and 30.1% were harvested in other districts (Figure 17).

Exploitation Rates

The Ugashik River run experienced the highest (30.1%) rate of exploitation outside the district followed by the Naknek River which had an outside exploitation rate of 17.4%. Runs to Kvichak River (5.4%) and Egegik River (4.5%) were exploited at much lower rates outside their districts of origin. Overall (inside and outside the district) exploitation rates by stock were: 37.1% for Kvichak River, 63.8% for Naknek River, 77% for Egegik River, and 80.4% for Ugashik River (Tables 25 and 26).

Comparison of Run Estimates

Interceptions of outside stocks within a district were not considered in past procedures used to estimate total runs for East Side Bristol Bay rivers. One of the objectives of this investigation was to determine the level of interceptions by district and to estimate run size by river. Run estimates developed from the standard method (STD) can not be compared directly to those developed with scale pattern analysis (SPA) because Branch River was included in the STD method and not in SPA. Therefore, we adjusted the run estimates developed by the STD method so that the Naknek-Kvichak District catch was proportioned only Kvichak, Naknek, Egegik, and Ugashik Rivers. Run estimates for Kvichak River were basically the same between the two methods, they differed by 2,529 fish (Table 27). Based on SPA, the run to Naknek River was under-estimated by 496,203 sockeye salmon by the STD method. Conversely, the STD run estimate for the Egegik River was 1,124,352 fish greater than the SPA estimate. The STD and SPA estimates of Ugashik River run size differed by 625,620 fish, with the STD estimate being lower. Comparisons of run estimates developed from SPA with those developed by STD, indicate that by not including interceptions of stocks outside their natal districts in 1987 we would over-estimate the run to Egegik River and under-estimate the runs to Naknek and Ugashik Rivers.

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Table 1. Scale variables screened for linear discriminant function analysis of ages-1.2, -1.3, and -2.3 sockeye salmon for the East Side of Bristol Bay, 1987.

Variable Number	Variable Name	Zone
		First Freshwater Annular Zone
1	NC1FW	Number of circuli first freshwater
2	S1FW	Size (width) of first freshwater
3 (16)	C0-C2	Distance, scale focus (C0) to circulus 2 (C2)
4 (17)	C0-C4	Distance, scale focus to circulus 4
5 (18)	C0-C6	Distance, scale focus to circulus 6
6 (19)	C0-C8	Distance, scale focus to circulus 8
7 (20)	C2-C4	Distance, circulus 2 to circulus 4
8 (21)	C2-C6	Distance, circulus 2 to circulus 6
9 (22)	C2-C8	Distance, circulus 2 to circulus 8
10 (23)	C4-C6	Distance, circulus 4 to circulus 6
11 (24)	C4-C8	Distance, circulus 4 to circulus 8
12 (25)	C(NC-4)-E1FW	Distance, circulus (number circuli first freshwater minus 2) to end first freshwater
13 (26)	C(NC-2)-E1FW	Distance, circulus (number circuli first freshwater minus 4) to end first freshwater
14	C2-E1FW	Distance, circulus 2 to end first freshwater
15	C4-E1FW	Distance, circulus 4 to end first freshwater
16 thru	C0-C2/S1FW ...	Relative widths, (variables 3-13)/S1FW
26	C(NC-2)-E1FW/S1FW	
27	S1FW/NC1FW	Average interval between circuli in first freshwater
28	NC 1ST 3/4	Number of circuli in first 3/4 of first freshwater
29	MAX DIST	Maximum distance between 2 consecutive circuli in first freshwater
30	MAX DIST/S1FW	Relative width, (variable 29)/S1FW

-Continued-

Table 1. (p 2 of 3).

Variable Number	Variable Name	Zone
		Second Freshwater Annular Zone
31	NC2FW	Number of circuli second freshwater
32	S2FW	Size (width) of second freshwater
33 (46)	E1FW-C2	Distance, end of first freshwater to circulus 2 (C2) in second freshwater
34 (47)	E1FW-C4	Distance, end of first freshwater to circulus 4
35 (48)	E1FW-C6	Distance, end of first freshwater to circulus 6
36 (49)	E1FW-C8	Distance, end of first freshwater to circulus 8
37 (50)	C2-C4	Distance, circulus 2 to circulus 4
38 (51)	C2-C6	Distance, circulus 2 to circulus 6
39 (52)	C2-C8	Distance, circulus 2 to circulus 8
40 (53)	C4-C6	Distance, circulus 4 to circulus 6
41 (54)	C4-C8	Distance, circulus 4 to circulus 8
42 (55)	C(NC-4)-E2FW	Distance, circulus (number circuli second freshwater minus 4) to end second freshwater
43 (56)	C(NC-2)-E2FW	Distance, circulus (number circuli second freshwater minus 2) to end second freshwater
44	C2-E2FW	Distance, circulus 2 to end second freshwater
45	C4-E2FW	Distance, circulus 4 to end second freshwater
46 thru	E1FW-C2/S2FW ...	Relative widths, (variables 33-43)/S2FW
56	C(NC-2)-E2FW/S2FW	
57	S2FW/NC2FW	Average interval between circuli in second freshwater
58	NC 1ST 3/4	Number of circuli in first 3/4 of second freshwater
59	MAX DIST	Maximum distance between 2 consecutive circuli in second freshwater
60	MAX DIST/S2FW	Relative width, (variable 59)/S2FW
		Plus Growth Zone
61	NCPG	Number of circuli in plus growth
62	SPGZ	Size (width) plus growth zone
		Freshwater and Plus Growth Zones
63	NC1FW + NC2FW	Total number of circuli first and second freshwater
64	S1FW + S2FW	Total size (width) of first and second freshwater
65	NC1FW+NC2FW+NCPG	Total number of circuli first and second freshwaters and plus growth
66	S1FW+S2FW+SPGZ	Total size (width) first and second freshwaters and plus growth
67	S1FW/S1FW+S2FW+SPGZ	Relative width, (variable 2)/S1FW+S2FW+SPGZ
68	SPGZ/S1FW+S2FW+SPGZ	Relative width, (variable 62)/S1FW+S2FW+SPGZ
69	S2FW/S1FW+S2FW+SPGZ	Relative width, (variable 32)/S1FW+S2FW+SPGZ

-Continued-

Table 1. (p 3 of 3).

Variable Number	Variable Name	Zone
		First Marine Annular Zone
70	NC1OZ	Number of circuli in first ocean zone
71	S1OZ	Size (width) first ocean zone
72 (90)	EFW-C3	Distance, end of freshwater growth to circulus 3
73 (91)	EFW-C6	Distance, end of freshwater growth to circulus 6
74 (92)	EFW-C9	Distance, end of freshwater growth to circulus 9
75 (93)	EFW-C12	Distance, end of freshwater growth to circulus 12
76 (94)	EFW-C15	Distance, end of freshwater growth to circulus 15
77 (95)	C3-C6	Distance, circulus 3 to circulus 6
78 (96)	C3-C9	Distance, circulus 3 to circulus 9
79 (97)	C3-C12	Distance, circulus 3 to circulus 12
80 (98)	C3-C15	Distance, circulus 3 to circulus 15
81 (99)	C6-C9	Distance, circulus 6 to circulus 9
82 (100)	C6-C12	Distance, circulus 6 to circulus 12
83 (101)	C6-C15	Distance, circulus 6 to circulus 15
84 (102)	C9-C15	Distance, circulus 9 to circulus 15
85 (103)	C(NC-6)-E1OZ	Distance, circulus (number circuli first ocean minus 6) to end first ocean
86 (104)	C(NC-3)-E1OZ	Distance, circulus (number circuli first ocean minus 3) to end first ocean
87	C3-E1OZ	Distance, circulus 3 to end of first ocean
88	C9-E1OZ	Distance, circulus 9 to end of first ocean
89	C15-E1OZ	Distance, circulus 15 to end of first ocean
90 thru	EFW-C3/S1OZ ...	Relative widths, (variables 72-86)/S1OZ
104	C(NC-3)-E13OZ/S1OZ	
105	S1OZ/NC1OZ	Average interval between circuli in first ocean
106	NC 1ST 1/2	Number of circuli in first 1/2 of first ocean
107	MAX DIST	Maximum distance between 2 consecutive circuli in first ocean
108	MAX DIST/S1OZ	Relative width, (variable 107)/S1OZ
		Second Marine Annular Zone
109	S2OZ	Size (width) of second ocean zone

Table 2. Sockeye salmon commercial catch in numbers of fish by district and date for the East Side of Bristol Bay, 1987.

Date	Catch (Nos. of Fish)[a]			
	Naknek/Kvichak	Egegik	Ugashik	East Side
6/01-6/20	17,555	164,969	43,606	226,130
6/22	19,308		5,920	25,228
6/23			11,900	11,900
6/25		79[b]		79
6/26			120[b]	120
6/27		626,251		626,251
6/28			709[b]	709
6/29	129,738	248,184		377,922
6/30		801,181		801,181
7/01-7/02	117,129	542,970	244,364[c]	904,463
7/04		755,400	319,328	1,074,728
7/06-7/07	250,679	570,765		821,444
7/08-7/09	312,439	328,061	349,591[d]	990,091
7/10	471,392	295,836	200,753	967,981
7/11	740,724	24,734		765,458
7/12	695,125	261,562	324[b]	957,011
7/13	708,485	208,246	334,378	1,251,109
7/14	478,441			478,441
7/15	225,974	189,145		415,119
7/16	249,366	28,188	77,317	354,871
7/17	178,585	117,130	172,673	468,388
7/18	91,747	69,353	53,504	214,604
7/20	87,984	38,259	130,225	256,468
7/21	76,068	63,498	61,635	201,201
7/22	24,101	17,273	39,656	81,030
7/23	39,951	16,616	24,389	80,956
7/24	14,783	11,132	19,505	45,420
7/25	13,700	2,565		16,265
7/27-8/01	4,927	4,294	27,513	36,734
8/03-end	814	1,154	1,778	3,746
Totals	4,949,015	5,386,845	2,119,188	12,455,048

[a] Blanks indicate a district was closed.

[b] Represents fish caught by an ADF&G test fishery.

[c] Includes 30 fish caught on 7/01 by an ADF&G test fishery.

[d] Includes 749 fish caught on 7/08 by an ADF&G test fishery.

Table 3. Escapement of sockeye salmon by river and date for the East Side of Bristol Bay, 1987.

Date	Kvichak Escapement		Naknek Escapement		Egegik Escapement		Ugashik Escapement	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
6/21			0	0				
6/22			60	60				
6/23			24	84	174	174		
6/24			0	84	18,786	18,960		
6/25	0	0	0	84	5,622	24,582		
6/26	0	0	0	84	60,750	85,332		
6/27	0	0	216	300	110,226	195,558		
6/28	0	0	186	486	51,132	246,690		
6/29	0	0	24	510	53,718	300,408		
6/30	36	36	30,660	31,170	28,188	328,596		
7/01	30,138	30,174	265,752	296,922	83,100	411,696		
7/02	506,616	536,790	59,190	356,112	18,702	430,398		
7/03	581,382	1,118,172	15,024	371,136	52,986	483,384		
7/04	428,826	1,546,998	13,980	385,116	37,236	520,620	4,218	4,218
7/05	155,970	1,702,968	33,600	418,716	51,618	572,238	1,332	5,550
7/06	78,786	1,781,754	121,608	540,324	67,446	639,684	918	6,468
7/07	85,398	1,867,152	193,326	733,650	80,304	719,988	6	6,474
7/08	769,230	2,636,382	104,520	838,170	124,248	844,236	2,514	8,988
7/09	1,022,298	3,658,680	86,442	924,612	122,718	966,954	29,172	38,160
7/10	867,432	4,526,112	9,888	934,500	64,302	1,031,256	27,996	66,156
7/11	610,434	5,136,546	45,720	980,220	34,734	1,065,990	2,424	68,580
7/12	267,528	5,404,074	26,682	1,006,902	10,626	1,076,616	468	69,048
7/13	250,356	5,654,430	10,860	1,017,762	10,842	1,087,458	198	69,246
7/14	118,890	5,773,320	7,416	1,025,178	19,932	1,107,390	3,030	72,276
7/15	105,150	5,878,470	5,010	1,030,188	21,930	1,129,320	120,300	192,576
7/16	67,524	5,945,994	2,328	1,032,516	33,144	1,162,464	310,194	502,770
7/17	24,576	5,970,570	1,082	1,033,598	47,244	1,209,708	45,252	548,022
7/18	14,592	5,985,162	503	1,034,101	7,134	1,216,842	5,874	553,896
7/19	15,072	6,000,234	6,000	1,040,101	20,946	1,237,788	4,308	558,204
7/20	12,486	6,012,720	12,882	1,052,983	9,642	1,247,430	4,596	562,800
7/21	19,122	6,031,842	5,243	1,058,226	16,938	1,264,368	5,736	568,536
7/22	22,950	6,054,792	3,580	1,061,806	6,672	1,271,040	7,626	576,162
7/23	8,508	6,063,300			2,154	1,273,194	11,802	587,964
7/24	2,580	6,065,880			-216[a]	1,272,978	6,858	594,822

-Continued-

Table 3. (p 2 of 2).

Date	Kvichak Escapement Daily	Kvichak Escapement Cumulative	Naknek Escapement Daily	Naknek Escapement Cumulative	Egegik Escapement Daily	Egegik Escapement Cumulative	Ugashik Escapement Daily	Ugashik Escapement Cumulative
7/25							4,590	599,412
7/26							11,172	610,584
7/27							18,756	629,340
7/28							6,120	635,460
7/29							11,142	646,602
7/30							8,604	655,206
7/31							7,242	662,448
8/01							6,516	668,964
Total		6,065,800		1,061,806		1,272,978[b]		668,964[c]

[a] Fish were counted swimming downstream past the tower.

[b] An additional 575 sockeye salmon were counted in tributaries of the King Salmon River bringing the Egegik District sockeye escapement total to 1,273,553.

[c] An additional 2,075 sockeye salmon were counted in the Dog Salmon River, and 15,855 in the King Salmon River drainage, bringing the Ugashik District sockeye escapement total to 686,894.

Table 4. Age composition by brood year of sockeye salmon commercial catches for the East Side of Bristol Bay, 1987.

District	Sample Size		1984 1.1	1983 0.3	1983 1.2	1982 0.4	1982 1.3	1982 2.2	1981 1.4	1981 2.3	1981 3.2	1980 2.4	Total
Naknek/	4,685	Numbers		6,141	2,995,754		1,095,930	268,445	6,217	576,071		457	4,949,015
Kvichak		Percent		0.1	60.5		22.1	5.4	0.1	11.6		0.0[a]	100.0
		SE		3,547	44,911		38,800	20,131	3,206	28,424		477	N/A
Egegik	3,655	Numbers	1,263		1,397,720		1,450,744	1,374,814	10,552	1,145,320	6,432		5,386,845
		Percent	0.0[a]		26.0		26.9	25.5	0.2	21.3	0.1		100.0
		SE	1,258		39,717		39,971	39,003	3,960	37,021	3,268		N/A
Ugashik	3,142	Numbers		8,033	388,607	1,394	536,313	441,121	2,993	738,435	1,005	1,287	2,119,188
		Percent		0.4	18.3	0.1	25.3	20.8	0.1	34.9	0.1	0.1	100.0
		SE		2,432	14,967	1,031	17,097	15,954	1,370	18,802	1,106	907	N/A
Total	11,482	Numbers	1,263	14,174	4,782,081	1,394	3,082,987	2,084,380	19,762	2,459,826	7,437	1,744	12,455,048
East Side		Percent	0.0[a]	0.1	38.4	0.0[a]	24.8	16.7	0.2	19.8	0.0[a]	0.0[a]	100.0

[a] Fish present, but represent less than 0.1%.

Table 5. Age composition by brood year of sockeye salmon escapement for the East Side of Bristol Bay, 1987.

River	Sample Size		1984 0.2	1984 1.1	1983 0.3	1983 1.2	1983 2.1	1982 1.3	1982 2.2	1981 1.4	1981 2.3	1981 3.2	1980 2.4	Total
Kvichak	2,100	Numbers				5,487,957	3,089	193,699	308,188		72,947			6,065,880
		Percent				90.5	0.1	3.2	5.1		1.2			100.0
Naknek	1,590	Numbers		619		104,183	6,640	418,445	113,571	6,109	411,489		750	1,061,806
		Percent		0.1		9.8	0.6	39.4	10.7	0.6	38.8		0.1	100.0
Egegik	3,410	Numbers				318,217	7,240	339,084	366,890	195	240,395	957		1,272,978
		Percent				25.0	0.6	26.6	28.8	0.0[a]	18.9	0.1		100.0
Ugashik	2,870	Numbers	45	57	1,284	238,692	5,575	135,868	137,827	643	148,879		94	668,964
		Percent	0.0[a]	0.0[a]	0.2	35.7	0.8	20.3	20.6	0.1	22.3		0.0[a]	100.0

[a] Fish present, but represent less than 0.1%.

Table 6. Mean and standard error of age-1.2 scale variables used to construct linear discriminant functions for the East Side of Bristol Bay, 1987.

Variable Number	Variable Name	Kvichak Mean[a]	Kvichak SE	Naknek Mean[a]	Naknek SE	Egegik Mean[a]	Egegik SE	Ugashik Mean[a]	Ugashik SE
First Freshwater Annular Zone									
1	NC1FW	11.08	0.092	13.88	0.228	16.53	0.100	14.38	0.107
2	S1FW	142.50	1.074	167.54	2.403	203.54	1.244	171.36	1.259
5	C0-C6	96.87	0.552	93.62	0.737	99.93	0.489	92.91	0.461
7	C2-C4	25.72	0.253	25.68	0.358	26.56	0.243	23.96	0.245
8	C2-C6	49.15	0.395	47.78	0.539	50.35	0.354	45.76	0.339
10	C4-C6	23.43	0.247	22.10	0.346	23.79	0.219	21.80	0.239
11	C4-C8	44.27	0.372	43.12	0.495	45.71	0.315	43.14	0.357
12	C(NC-4)-E1FW	34.09	0.310	34.00	0.434	35.37	0.399	32.87	0.307
13	C(NC-2)-E1FW	14.55	0.193	15.34	0.255	15.61	0.223	15.04	0.197
15	C4-E1FW	69.06	0.999	96.02	2.467	127.40	1.111	100.25	1.157
28	NC 1ST 3/4	6.42	0.068	8.54	0.164	10.51	0.076	8.82	0.074
Plus Growth Zone									
61	NCPG	2.85	0.087	3.68	0.130	2.09	0.062	2.76	0.070
Freshwater and Plus Growth Zones									
65	NC1FW+NCPG	13.92	0.103	17.56	0.220	18.62	0.106	17.14	0.103
66	S1FW+SPGZ	171.15	1.098	204.60	2.469	224.25	1.195	199.05	1.226
First Marine Annular Zone									
71	S1OZ	364.44	2.440	360.42	3.616	345.40	2.145	365.36	2.736
73	EFW-C6	115.40	1.091	112.15	1.752	116.90	0.973	121.25	1.006
76	EFW-C15	287.40	1.484	279.79	2.176	282.67	1.304	292.44	1.501
77	C3-C6	63.25	0.647	59.65	1.072	65.78	0.577	65.32	0.625
78	C3-C9	122.49	0.928	118.30	1.543	125.97	0.845	125.58	0.914
85	C(NC-6)-E1OZ	77.84	0.706	76.03	0.871	71.15	0.553	79.29	0.752
86	C(NC-3)-E1OZ	36.85	0.413	36.70	0.523	34.02	0.351	38.17	0.427
106	NC 1ST 1/2	8.89	0.085	9.00	0.136	8.30	0.069	8.62	0.082

[a] Scale images projected at 100x magnification and measured in .01 inches, therefore variable means represent .0001 of inches.

Table 7. Mean, variance, and t-statistic comparing males and females for selected scale variables of age-1.2 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1987.

River	Sex	Sample Size		NC1FW	S1FW	NCPGZ	SPGZ	NC1OZ	S1OZ
Kvichak River	Male	96	Mean	11.17	142.59	2.59	26.41	21.08	370.70
			Variance	1.55	220.56	1.21	163.78	4.73	1296.66
	Female	104	Mean	10.99	142.40	3.08	30.73	20.83	358.65
			Variance	1.85	241.89	1.66	160.08	3.50	1033.82
	Combined	200	Mean	11.08	142.50	2.85	28.66	20.95	364.44
			Variance	1.71	230.50	1.50	165.73	4.09	1190.49
	T-Statistic			-0.95	-0.09	2.84[a]	2.40[a]	-0.90	-2.50[a]
Naknek River	Male	84	Mean	13.45	162.45	3.75	37.81	21.32	361.25
			Variance	6.20	683.94	2.53	308.06	7.47	1763.08
	Female	41	Mean	14.76	177.98	3.54	35.51	21.20	358.73
			Variance	6.09	652.67	1.25	169.71	4.31	1398.75
	Combined	125	Mean	13.88	167.54	3.68	37.06	21.28	360.42
			Variance	6.49	721.88	2.11	262.12	6.40	1632.75
	T-Statistic			-2.92[a]	-3.32[a]	0.82	0.79	0.28	0.35
Egegik River	Male	101	Mean	16.36	201.74	2.02	20.77	20.34	346.18
			Variance	2.37	306.01	0.76	123.34	3.77	834.89
	Female	99	Mean	16.71	205.37	2.15	20.64	20.48	344.60
			Variance	1.62	309.28	0.76	65.40	3.88	1015.53
	Combined	200	Mean	16.53	203.54	2.09	20.71	20.41	345.40
			Variance	2.02	309.40	0.76	94.19	3.81	920.28
	T-Statistic			-1.75	-1.46	-1.07	0.10	-0.54	0.37
Ugashik River	Male	85	Mean	14.64	175.49	2.62	26.35	20.55	370.41
			Variance	2.31	293.40	0.98	112.90	4.51	1309.67
	Female	115	Mean	14.19	168.30	2.86	28.69	20.59	361.63
			Variance	2.19	314.74	0.98	115.76	5.21	1616.34
	Combined	200	Mean	14.38	171.36	2.76	27.70	20.58	365.36
			Variance	2.28	316.87	0.99	115.31	4.89	1497.73
	T-Statistic			2.07[a]	2.88[a]	-1.68	-1.52	-0.12	1.59

[a] Significant, alpha = 0.05.

Table 8. Classification matrices from discriminant analyses of age-1.2 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1987.

Actual Group Of Origin	Sample Size	Classified Group of Origin			
		Kvichak	Naknek	Egegik	Ugashik
Kvichak	199	0.885	0.050	0.000	0.065
Naknek	125	0.176	0.536	0.128	0.160
Egegik	200	0.000	0.055	0.860	0.085
Ugashik	200	0.065	0.235	0.095	0.605

Mean proportion correctly classified = 0.722
Variables used: 28,5,61,76,8,106,1,85,12,10
Box's Test of Variance-Covariance Equality [a]
F-statistic = 2.62
df = 198, 828123

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Naknek	Egegik
Kvichak	199	0.915	0.085	0.000
Naknek	125	0.168	0.648	0.184
Egegik	200	0.010	0.100	0.890

Mean proportion correctly classified = 0.818
Variables used: 28,61,2,11,77,71,13,65
Box's Test of Variance-Covariance Equality
F-statistic = 4.38
df = 72, 529905

-Continued-

Table 8. (p 2 of 4).

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Egegik	Ugashik
Kvichak	199	0.915	0.000	0.085
Egegik	200	0.000	0.870	0.130
Ugashik	200	0.075	0.100	0.825

Mean proportion correctly classified = 0.870
Variables used: 28,5,76,65,85,12,61,8,78,11
Box's Test of Variance-Covariance Equality
F-statistic = 2.29
df = 110, 961415

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Naknek	Ugashik
Kvichak	200	0.875	0.055	0.070
Naknek	125	0.152	0.600	0.248
Ugashik	200	0.090	0.245	0.665

Mean proportion correctly classified = 0.713
Variables used: 65,73,61,8,85,10,12
Box's Test of Variance-Covariance Equality
F-statistic = 3.46
df = 56, 542286

-Continued-

Table 8. (p 3 of 4).

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvichak	Egegik
Kvichak	199	0.990	0.010
Egegik	200	0.015	0.985

Mean proportion correctly classified = 0.987
Variables used: 28,66,11,2,71,13
Box's Test of Variance-Covariance Equality
F-statistic = 2.98
df = 21, 579655

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Naknek	Ugashik
Naknek	125	0.712	0.288
Ugashik	200	0.280	0.720

Mean proportion correctly classified = 0.716
Variables used: 61,73,15,7
Box's Test of Variance-Covariance Equality
F-statistic = 8.84
df = 10, 324979

-Continued-

Table 8. (p 4 of 4).

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvichak	Ugashik
Kvichak	200	0.915	0.085
Ugashik	200	0.080	0.920

Mean proportion correctly classified = 0.918
Variables used: 28,65,86,10,15
Box's Test of Variance-Covariance Equality
F-statistic = 2.09
df = 15, 637784

[a] The equality of the variance -covariance matrices tested with a procedure described by Box (1949).

Table 9. Mean and standard error of age-1.3 scale variables used to construct linear discriminant functions for the East Side of Bristol Bay, 1987.

Variable Number	Variable Name	Kvichak Mean[a]	Kvichak SE	Naknek Mean[a]	Naknek SE	Egegik Mean[a]	Egegik SE	Ugashik Mean[a]	Ugashik SE
First Freshwater Annular Zone									
2	S1FW	157.91	5.411	149.79	1.879	212.99	1.340	147.13	1.294
11	C4-C8	45.27	1.532	40.46	0.364	45.35	0.290	40.68	0.358
14	C2-E1FW	110.46	4.929	101.82	1.847	162.26	1.290	98.18	1.250
18	C0-C6/S1FW	0.63	0.019	0.64	0.007	0.48	0.003	0.64	0.005
22	C2-C8/S1FW	0.46	0.014	0.44	0.004	0.34	0.002	0.44	0.003
24	C4-C8/S1FW	0.29	0.011	0.27	0.003	0.21	0.002	0.28	0.002
28	NC 1ST 3/4	7.55	0.282	7.41	0.119	11.06	0.083	7.15	0.084
First Marine Annular Zone									
73	EFW-C6	105.55	3.627	89.83	1.418	114.13	1.063	103.85	1.297
81	C6-C9	55.91	2.692	56.02	0.795	60.30	0.559	58.47	0.642
89	C15-E1OZ	148.27	9.200	171.18	3.316	124.30	2.359	157.71	3.144
91	EFW-C6/S1OZ	0.25	0.011	0.21	0.004	0.28	0.003	0.24	0.004

[a] Scale images projected at 100x magnification and measured in .01 inches, therefore variable means are in .0001 inches.

Table 10. Mean, variance, and t-statistic comparing males and females for selected scale variables of age-1.3 sockeye salmon sampled from the Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1987.

River	Sex	Sample Size		NC1FW	S1FW	NCPGZ	SPGZ	NC1OZ	S1OZ	S2OZ
Naknek River	Male	87	Mean	12.47	152.00	2.82	28.05	26.24	436.74	303.90
			Variance	5.81	788.00	2.62	289.79	6.95	1511.78	1590.65
	Female	113	Mean	12.10	148.08	2.42	24.14	26.27	428.92	293.41
			Variance	4.59	642.40	2.62	324.21	7.77	1760.18	1441.03
	Combined	200	Mean	12.26	149.79	2.60	25.84	26.26	432.32	297.97
			Variance	5.13	705.89	2.64	311.47	7.38	1659.07	1525.63
	T-Statistic			1.16	1.03	1.70	1.56	-0.08	1.35	1.90
Egegik River	Male	102	Mean	17.40	214.64	2.02	20.30	23.99	418.12	295.36
			Variance	2.18	357.34	0.91	98.23	4.50	1668.96	1305.10
	Female	98	Mean	17.24	211.28	2.08	20.58	24.10	405.89	284.34
			Variance	2.45	358.45	1.00	110.10	4.79	1059.09	1335.52
	Combined	200	Mean	17.33	212.99	2.05	20.44	24.05	412.13	289.96
			Variance	2.31	358.92	0.95	103.54	4.63	1400.86	1343.91
	T-Statistic			0.73	1.26	-0.45	-0.19	-0.37	2.34[a]	2.15[a]
Ugashik River	Male	92	Mean	11.95	145.64	2.74	28.95	25.47	434.45	312.71
			Variance	2.56	357.99	2.46	363.24	7.06	1891.59	1722.23
	Female	107	Mean	12.07	148.36	2.65	28.36	25.23	431.59	304.68
			Variance	2.63	318.04	2.04	287.89	6.75	1453.89	1280.46
	Combined	200[b]	Mean	12.01	147.13	2.69	28.58	25.35	433.18	308.6
			Variance	2.58	335.06	2.23	320.22	6.85	1656.09	1493.86
	T-Statistic			-0.52	-1.04	0.40	0.23	0.63	0.49	1.46

[a] Significant, alpha = 0.05.

[b] Includes one unsexed sampled.

Table 11 . Classification matrices from discriminant analyses of age-1.3 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1987.

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Naknek	Egegik	Ugashik
Naknek	199	0.673	0.085	0.241
Egegik	200	0.035	0.925	0.040
Ugashik	199	0.312	0.025	0.663

Mean proportion correctly classified = .754
Variables used: 2,73,91,81,11,24,22,28,18
Box's Test Variance-Covariance Equality [a]
F-Statistic = 11.63
df = 90, 969828

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvi-Nak-Uga[b]	Egegik
Kvi-Nak-Uga	211	0.945	0.055
Egegik	200	0.035	0.965

Mean proportion correctly classified = .954
Variables used: 14,89
Box's Test Variance-Covariance Equality
F Statistic = 9.49
df = 3, greater than 1000000

[a] The equality of the variance -covariance matrices were tested with a procedure described by Box (1949).

[b] Samples from Kvichak, Naknek, and Ugashik were pooled.

Table 12. Mean and standard error of age-2.3 scale variables used to construct linear discriminant functions for the East Side of Bristol Bay, 1987.

Variable Number	Variable Name	Naknek Mean[a]	Naknek SE	Egegik Mean[a]	Egegik SE	Ugashik Mean[a]	Ugashik SE
First Freshwater Annular Zone							
1	NC1FW	9.01	0.118	10.82	0.150	8.62	0.084
14	C2-E1FW	66.87	1.287	90.44	1.730	58.14	0.930
21	C2-C6/S1FW	0.38	0.003	0.33	0.003	0.37	0.003
27	S1FW/NC1FW	12.69	0.075	13.08	0.074	12.15	0.072
30	MAX DIST/S1FW	0.13	0.002	0.11	0.002	0.13	0.001
Second Freshwater Annular Zone							
31	NC2FW	10.57	0.137	11.40	0.173	9.13	0.080
38	C2-C6	43.75	0.403	43.78	0.435	45.44	0.425
44	C2-E2FW	85.01	1.375	95.46	2.041	72.43	0.953
55	C(NC-4)-E2FW/S2FW	0.35	0.008	0.33	0.007	0.38	0.005
57	S2FW/NC2FW	10.16	0.069	10.32	0.075	10.49	0.074
Plus Growth Zone							
61	NCPG	1.95	0.067	1.56	0.053	1.69	0.053
Freshwater and Plus Growth Zones							
64	S1FW+S2FW	220.46	1.612	258.65	2.392	199.83	1.433
65	NC1FW+NC2FW+NCPG	21.53	0.136	23.77	0.193	19.44	0.109
66	S1FW+S2FW+SPGZ	238.95	1.461	273.00	2.275	216.14	1.405
68	SPGZ/S1FW+S2FW+SPGZ	0.08	0.003	0.06	0.002	0.078	0.002
First Marine Annular Zone							
71	S1OZ	407.41	3.194	395.55	2.687	424.03	2.875
77	C3-C6	62.78	0.573	65.82	0.567	63.86	0.599
94	EFW-C15/S1OZ	0.72	0.005	0.74	0.005	0.69	0.005
95	C3-C6/S1OZ	0.16	0.002	0.17	0.002	0.15	0.002
107	MAX DIST	27.69	0.243	27.28	0.211	27.52	0.276
108	MAX DIST/S1OZ	0.07	0.001	0.07	0.001	0.07	0.001

[a] Scale images were projected at 100x magnification and measured in .01 inches, therefore variable means represent .0001 inches.

Table 13. Mean, variance, and t-statistic comparing males and females for selected scale variables of age-2.3 sockeye salmon sampled from the Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1987.

River	Sex	Sample Size		S1FW	S2FW	SPGZ	S1FW+S2FW+SPGZ	S1OZ	S2OZ
Naknek River	Male	74	Mean	114.93	111.41	17.66	244.00	412.43	294.49
			Variance	390.83	423.40	99.65	421.37	1939.78	1488.09
	Female	126	Mean	112.68	104.32	18.98	235.98	404.46	280.62
			Variance	339.74	355.42	130.78	409.32	2092.25	1439.42
	Combined	200	Mean	113.52	106.94	18.49	238.95	407.41	285.75
			Variance	357.96	390.34	119.11	426.77	2040.70	1495.09
	T-Statistic			1.05	3.25[a]	-1.29	3.14[a]	1.75	3.52[a]
Egegik River	Male	92	Mean	142.12	118.47	13.85	274.43	401.67	271.74
			Variance	671.69	844.98	58.44	988.80	1606.73	1731.69
	Female	108	Mean	138.90	118.09	15.50	272.49	390.33	266.80
			Variance	545.79	900.85	61.64	1081.90	1258.88	1267.29
	Combined	200	Mean	140.38	118.27	14.74	273.39	395.55	269.07
			Variance	603.21	870.81	60.55	1034.83	1443.73	1479.38
	T-Statistic			0.92	0.09	-1.50	0.43	2.12[a]	0.91
Ugashik River	Male	102	Mean	103.19	94.59	17.11	214.88	428.88	310.32
			Variance	199.90	165.65	65.98	420.76	1677.67	2087.41
	Female	97	Mean	105.58	96.51	15.42	217.51	418.60	289.80
			Variance	218.56	191.52	53.71	371.71	1597.95	1998.35
	Combined	200[b]	Mean	104.35	95.48	16.31	216.14	424.03	300.46
			Variance	208.32	177.75	60.22	394.67	1653.62	2132.49
	T-Statistic			-1.17	-1.01	1.53	-0.93	1.79	3.20[a]

[a] Significant, alpha = 0.05.

[b] Includes one unsexed sample.

Table 14. Classification matrices from discriminant analyses of age-2.3 sockeye salmon sampled from the Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1987.

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Naknek	Egegik	Ugashik
Naknek	200	0.655	0.150	0.195
Egegik	200	0.190	0.810	0.000
Ugashik	200	0.140	0.035	0.825

Mean proportion correctly classified = .763
Variables used: 66,57,21,55,31,14,61,30,1,71,108,77,94
Box's Test Variance-Covariance Equality [a]
F-Statistic = 2.62
df = 182, 944681

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Naknek	Egegik
Naknek	200	0.845	0.155
Egegik	200	0.180	0.820

Mean proportion correctly classified = .832
Variables used: 64,57,27,21,107,95,30
Box's Test Variance-Covariance Equality
F-Statistic = 2.89
df = 28, 551970

-Continued-

Table 14. (p 2 of 2).

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Egegik	Ugashik
Egegik	199	0.950	0.050
Ugashik	200	0.045	0.955

Mean proportion correctly classified = .952
Variables used: 66,27,57,38,68
Box's Test Variance-Covariance Equality
F-Statistic = 6.74
df = 15, 634549

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Naknek	Ugashik
Naknek	200	0.820	0.180
Ugashik	200	0.155	0.845

Mean proportion correctly classified = .832
Variables used: 65,27,55,31,44,21
Box's Test Variance-Covariance Equality
F-Statistic = 5.38
df = 21, 582609

[a] The equality of the variance -covariance matrices were tested with a procedure described by Box (1949).

Table 15. Run composition estimates and 90% confidence intervals (C.I.) calculated from scale pattern analyses of age-1.2 sockeye salmon by fishery and date for the East Side of Bristol Bay, 1987.

Fishery	Sample Date	Kvichak		Naknek		Egegik		Ugashik	
		Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.
Naknek/ Kvichak	6/22	0.869	(.720,1.00)	0.032	(0,.218)	0.022	(0,.078)	0.077	(0,.256)
	6/29,7/01	0.903	(.757,1.00)	0.055	(0,.238)	0.025	(0,.081)	0.017	(0,.179)
	7/07	0.813	(.659,.967)	0.002	(0,.192)	0.029	(0,.093)	0.156	(0,.355)
	7/09	0.809	(.654,1.00)	0.039	(0,.233)	0.040	(0,.110)	0.112	(0,.301)
	7/10	1.000	(.968,1.00)	0.000	Trace[a]	0.000	Trace	0.000	Trace
	7/12-7/13	0.901	(.772,1.00)	0.046	(0,.200)	0.000	Trace	0.053	(0,.206)
	7/15	0.903	(.775,1.00)	0.019	(0,.169)	0.000	Trace	0.078	(0,.235)
Egegik	6/21	0.470	(.231,.709)	0.082	(0,.335)	0.448	(.202,.694)	0.000	Trace
	6/27,6/30	0.314	(.204,.424)	0.000	Trace	0.651	(.515,.787)	0.035	(0,.151)
	7/02,7/04	0.210	(.139,.281)	0.000	Trace	0.790	(.719,.861)	0.000	Trace
	7/07,7/10	0.290	(.154,.426)	0.072	(0,.257)	0.628	(.463,.792)	0.010	(0,.175)
	7/13	0.425	(.302,.548)	0.000	Trace	0.371	(.243,.500)	0.204	(.067,.341)

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Table 15. (p 2 of 2).

Fishery	Sample Date	Kvichak Pt. Est.	Kvichak 90% C.I.	Naknek Pt. Est.	Naknek 90% C.I.	Egegik Pt. Est.	Egegik 90% C.I.	Ugashik Pt. Est.	Ugashik 90% C.I.
Ugashik	7/02	0.095	(0,.206)	0.000	Trace	0.194	(.046,.341)	0.711	(.527,.895)
	7/04	0.151	(.046,.256)	0.000	Trace	0.163	(.043,.283)	0.686	(.528,.844)
	7/08,7/09	0.174	(.032,.315)	0.117	(0,.426)	0.154	(.012,.295)	0.555	(.265,.845)
	7/10,7/12	0.000	Trace	0.028	(0,.246)	0.000	Trace	0.972	(.754,1.00)
	7/13	0.169	(.056,.282)	0.000	Trace	0.083	(0,.193)	0.748	(.589,.907)
	7/17	0.076	(0,.182)	0.000	Trace	0.040	(0,.155)	0.884	(.721,1.00)

[a] Trace was recorded for systems which were originally included in the classification model but whose point estimates were less than zero and the upper bounds of the 90% confidence interval was positive.

Table 16. Estimated numbers of age-1.2 sockeye salmon by river of origin harvested in the East Side of Bristol Bay, 1987.

District	River	Estimated Proportion	Estimated Numbers	Standard Error of Estimate	Coefficient of Variation
Naknek/	Kvichak	0.919	2,754,027	93,206	0.03
Kvichak	Naknek	0.025	75,116	92,929	1.24
	Egegik	0.005	13,895	6,442	0.46
	Ugashik	0.051	152,715	92,840	0.61
	Total	1.000	2,995,753		
Egegik	Kvichak	0.297	415,373	38,499	0.09
	Naknek	0.018	24,883	23,271	0.94
	Egegik	0.646	902,429	49,899	0.06
	Ugashik	0.039	55,035	36,070	0.66
	Total	1.000	1,397,720		
Ugashik	Kvichak	0.119	46,087	8,331	0.18
	Naknek	0.025	9,874	10,673	1.08
	Egegik	0.110	42,580	9,029	0.21
	Ugashik	0.746	290,066	18,576	0.06
	Total	1.000	388,607		
Total	Kvichak	0.672	3,215,487	101,188	0.03
East Side	Naknek	0.023	109,873	96,391	0.88
	Egegik	0.201	958,904	51,117	0.05
	Ugashik	0.104	497,816	101,318	0.20
	Total	1.000	4,782,080		

Table 17. Run composition estimates and 90% confidence intervals (C.I.) calculated from scale pattern analysis of age-1.3 sockeye salmon by date for Egegik District of Bristol Bay, 1987.

Fishery	Sample Date	Egegik		Other[a]	
		Pt. Est.	90% C.I.	Pt. Est.	90% C.I.
Egegik	6/21	0.752	(.638,.866)	0.248	(.134,.362)
	6/27	0.943	(.885,1.00)	0.057	(0,.115)
	6/30	0.642	(.553,.731)	0.358	(.269,.447)
	7/02	0.788	(.705,.872)	0.212	(.128,.295)
	7/04	0.836	(.758,.914)	0.164	(.086,.242)
	7/07	0.813	(.730,.896)	0.187	(.104,.270)
	7/10	0.940	(.873,1.00)	0.060	(0,.127)
	7/13	0.590	(.489,.690)	0.410	(.310,.511)

[a] Other represents samples from Kvichak, Naknek, and Ugashik Rivers.

Table 18. Estimated numbers of age-1.3 sockeye salmon by river of origin harvested in Egegik District of Bristol Bay, 1987.

District	River	Estimated Proportion	Estimated Numbers	Standard Error of Estimate	Coefficient of Variation
Egegik	Egegik	0.769	1,116,044	42,055	0.04
	Other[a]	0.231	334,700	30,726	0.09
	Total	1.000	1,450,744		

[a] Other represents samples from Kvichak, Naknek, and Ugashik Rivers.

Table 19. Run composition estimates and 90% confidence intervals (C.I.) calculated from scale pattern analyses of age-2.3 sockeye salmon by fishery and date for the the East Side of Bristol Bay, 1987.

Fishery	Sample Date	Naknek Pt. Est.	Naknek 90% C.I.	Egegik Pt. Est.	Egegik 90% C.I.	Ugashik Pt. Est.	Ugashik 90% C.I.
Naknek/ Kvichak	6/22	0.847	(.555,1.00)	0.118	(0,.303)	0.035	(0,.223)
	6/29,7/02	0.783	(.536,1.00)	0.135	(0,.290)	0.082	(0,.244)
	7/07	0.830	(.674,.986)	0.170	(.014,.326)	0.000	Trace[a]
	7/09	0.808	(.545,1.00)	0.065	(0,.220)	0.126	(0,.311)
	7/10	0.745	(.238,1.00)	0.048	(0,.331)	0.207	(0,.582)
	7/12	1.000	(.700,1.00)	0.000	Trace	0.000	Trace
	7/13	0.808	(.473,1.00)	0.131	(0,.344)	0.062	(0,.280)
	7/15	0.738	(.560,.917)	0.000	Trace	0.262	(.083,.440)
Egegik	6/27	0.000	Trace	0.857	(.779,.934)	0.143	(.066,.221)
	6/30	0.000	Trace	0.724	(.622,.826)	0.276	(.174,.378)
	7/02	0.144	(0,.396)	0.788	(.588,.988)	0.068	(0,.180)
	7/04	0.077	(0,.284)	0.658	(.484,.830)	0.265	(.131,.400)
	7/07,7/10	0.061	(0,.267)	0.772	(.601,.942)	0.167	(.055,.280)
	7/13	0.233	(.021,.445)	0.455	(.291,.618)	0.312	(.163,.461)

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Table 19. (p 2 of 2).

Fishery	Sample Date	Naknek Pt. Est.	Naknek 90% C.I.	Egegik Pt. Est.	Egegik 90% C.I.	Ugashik Pt. Est.	Ugashik 90% C.I.
Ugashik	7/02	0.000	Trace	0.028	(0,.081)	0.972	(.919,1.00)
	7/04	0.218	(.013,.424)	0.001	(0,.085)	0.781	(.604,.958)
	7/09	0.116	(0,.235)	0.000	Trace	0.884	(.765,1.00)
	7/10	0.012	(0,.124)	0.000	Trace	0.988	(.876,1.00)
	7/13	0.212	(.087,.337)	0.000	Trace	0.788	(.663,.913)
	7/17	0.162	(.040,.284)	0.000	Trace	0.838	(.716,.960)

[a] Trace was recorded for systems which were originally included in the classification model used to classify the catch and whose point estimates were less than zero, but the upper bound of the 90% confidence interval was positive.

Table 20. Estimated numbers of age-2.3 sockeye salmon by river of origin harvested in the East Side of Bristol Bay, 1987.

District	River	Estimated Proportion	Estimated Numbers	Standard Error of Estimate	Coefficient of Variation
Naknek/	Naknek	0.813	468,600	43,333	0.09
Kvichak	Egegik	0.071	40,831	19,979	0.49
	Ugashik	0.116	66,640	25,468	0.38
	Total	1.000	576,071		
Egegik	Naknek	0.087	99,940	45,626	0.46
	Egegik	0.699	799,744	46,878	0.06
	Ugashik	0.214	245,636	30,745	0.13
	Total	1.000	1,145,320		
Ugashik	Naknek	0.134	98,618	23,849	0.24
	Egegik	0.004	3,226	5,468	1.69
	Ugashik	0.862	636,591	28,442	0.04
	Total	1.000	738,435		
Total	Naknek	0.271	667,158	67,292	0.10
East Side	Egegik	0.343	843,801	51,250	0.06
	Ugashik	0.386	948,867	49,019	0.05
	Total	1.000	2,459,826		

Table 21. Run composition estimates of sockeye salmon catch by age group and date for the Naknek/Kvichak District of Bristol Bay, 1987.

Catch Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	2.4 %	2.4 Number	Total %	Total Number
6/01[a]	Kvichak	0.0	0	86.9	13,810	6.2	655	20.4	414	0.0	0	0.0	0	0.0	0	40.4	14,879
thru	Naknek	0.0	0	3.2	509	76.8	8,086	42.8	869	96.6	89	84.7	6,808	0.0	0	44.4	16,361
6/22	Egegik	0.0	0	2.2	350	10.2	1,073	22.6	460	0.6	1	11.8	948	0.0	0	7.7	2,832
	Ugashik	100.0	277	7.7	1,224	6.8	718	14.2	289	2.8	3	3.5	281	0.0	0	7.6	2,791
	Total	100.0	277	100.0	15,892	100.0	10,532	100.0	2,032	100.0	92	100.0	8,038	0.0	0	100.0	36,863
6/29	Kvichak	0.0	0	90.3	54,246	7.2	2,185	23.2	2,752	0.0	0	0.0	0	0.0	0	45.6	59,183
	Naknek	0.0	0	5.5	3,304	76.4	23,143	41.7	4,952	97.4	246	78.3	21,345	0.0	0	40.8	52,989
	Egegik	0.0	0	2.5	1,502	12.0	3,641	26.2	3,104	0.8	2	13.5	3,680	0.0	0	9.2	11,928
	Ugashik	0.0	0	1.7	1,021	4.4	1,321	8.9	1,056	1.8	5	8.2	2,235	0.0	0	4.3	5,638
	Total	0.0	0	100.0	60,073	100.0	30,289	100.0	11,864	100.0	252	100.0	27,260	0.0	0	100.0	129,738
7/01	Kvichak	0.0	0	90.3	50,882	9.2	2,904	28.0	3,013	0.0	0	0.0	0	0.0	0	48.5	56,800
thru	Naknek	0.0	0	5.5	3,099	74.0	23,255	38.1	4,099	97.3	205	78.3	14,377	0.0	0	38.4	45,035
7/02	Egegik	0.0	0	2.5	1,409	12.3	3,871	25.3	2,718	0.8	2	13.5	2,479	0.0	0	8.9	10,478
	Ugashik	0.0	0	1.7	958	4.5	1,416	8.7	933	1.9	4	8.2	1,506	0.0	0	4.1	4,816
	Total	0.0	0	100.0	56,348	100.0	31,446	100.0	10,763	100.0	211	100.0	18,361	0.0	0	100.0	117,129
7/06	Kvichak	0.0	0	81.3	118,638	11.0	5,418	25.2	6,232	0.0	0	0.0	0	0.0	0	52.0	130,288
thru	Naknek	0.0	0	0.2	292	53.0	26,182	20.7	5,116	87.5	799	83.0	24,299	92.8	424	22.8	57,112
7/07	Egegik	0.0	0	2.9	4,232	14.9	7,337	23.1	5,711	1.2	11	17.0	4,977	0.0	0	8.9	22,268
	Ugashik	0.0	0	15.6	22,764	21.2	10,468	30.9	7,643	11.3	103	0.0	0	7.2	33	16.4	41,012
	Total	0.0	0	100.0	145,926	100.0	49,404	100.0	24,702	100.0	914	100.0	29,276	100.0	457	100.0	250,679

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Table 21. (p 2 of 3).

Catch Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	2.4 %	2.4 Number	Total %	Total Number
7/08	Kvichak	0.0	0	80.9	129,507	7.2	4,758	20.9	6,009	0.0	0	0.0	0	0.0	0	44.9	140,274
thru	Naknek	0.0	0	3.9	6,243	68.7	45,128	33.7	9,682	93.1	514	80.9	46,445	0.0	0	34.6	108,011
7/09	Egegik	0.0	0	4.0	6,403	9.9	6,496	19.3	5,551	0.7	4	6.5	3,732	0.0	0	7.1	22,186
	Ugashik	0.0	0	11.2	17,929	14.2	9,308	26.0	7,462	6.2	34	12.6	7,234	0.0	0	13.4	41,968
	Total	0.0	0	100.0	160,083	100.0	65,690	100.0	28,704	100.0	552	100.0	57,410	0.0	0	100.0	312,439
7/10	Kvichak	0.0	0	100.0	822,590	35.6	86,476	69.9	49,622	0.0	0	0.0	0	0.0	0	79.1	958,689
thru	Naknek	0.0	0	0.0	0	55.1	133,884	18.4	13,050	96.0	2,200	74.5	54,625	0.0	0	16.8	203,759
7/11	Egegik	0.0	0	0.0	0	2.7	6,455	3.5	2,506	0.2	5	4.8	3,519	0.0	0	1.0	12,486
	Ugashik	0.0	0	0.0	0	6.6	16,067	8.2	5,852	3.7	85	20.7	15,178	0.0	0	3.1	37,182
	Total	0.0	0	100.0	822,590	100.0	242,882	100.0	71,031	100.0	2,291	100.0	73,322	0.0	0	100.0	1,212,116
7/12	Kvichak	0.0	0	90.1	411,128	13.4	16,603	42.1	12,921	0.0	0	0.0	0	0.0	0	63.4	440,652
	Naknek	0.0	0	4.6	20,990	78.7	97,644	42.1	12,908	0.0	0	100.0	82,721	0.0	0	30.8	214,264
	Egegik	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	Ugashik	100.0	1,334	5.3	24,184	7.9	9,834	15.8	4,858	0.0	0	0.0	0	0.0	0	5.8	40,210
	Total	100.0	1,334	100.0	456,302	100.0	124,081	100.0	30,687	0.0	0	100.0	82,721	0.0	0	100.0	695,125
7/13	Kvichak	0.0	0	90.1	583,691	11.2	35,224	33.0	17,931	0.0	0	0.0	0	0.0	0	53.7	636,847
thru	Naknek	0.0	0	4.6	29,800	73.0	229,904	36.6	19,881	0.0	0	80.8	133,606	0.0	0	34.8	413,191
7/14	Egegik	0.0	0	0.0	0	7.2	22,632	14.3	7,796	0.0	0	13.0	21,496	0.0	0	4.4	51,924
	Ugashik	100.0	4,530	5.3	34,335	8.6	27,094	16.1	8,755	0.0	0	6.2	10,252	0.0	0	7.2	84,965
	Total	100.0	4,530	100.0	647,826	100.0	314,853	100.0	54,363	0.0	0	100.0	165,354	0.0	0	100.0	1,186,926

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Table 21. (p 3 of 3).

Catch Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	2.4 %	2.4 Number	Total %	Total Number
7/15[b]	Kvichak	0.0	0	90.3	569,535	15.8	35,743	39.1	13,407	0.0	0	0.0	0	0.0	0	61.4	618,685
thru	Naknek	0.0	0	1.9	11,984	62.2	140,991	26.2	8,983	89.7	1,709	73.8	84,375	0.0	0	24.6	248,041
8/22	Egegik	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	Ugashik	0.0	0	7.8	49,196	22.1	50,019	34.7	11,909	10.3	196	26.2	29,954	0.0	0	14.0	141,274
	Total	0.0	0	100.0	630,714	100.0	226,753	100.0	34,299	100.0	1,905	100.0	114,329	0.0	0	100.0	1,008,000
Total	Kvichak	0.0	0	91.9	2,754,027	17.3	189,965	41.8	112,303	0.0	0	0.0	0	0.0	0	61.8	3,056,295
	Naknek	0.0	0	2.5	76,220	66.4	728,216	29.6	79,541	92.7	5,762	81.3	468,600	92.8	424	27.5	1,358,763
	Egegik	0.0	0	0.5	13,895	4.7	51,505	10.4	27,846	0.4	24	7.1	40,831	0.0	0	2.7	134,102
	Ugashik	100.0	6,141	5.1	151,611	11.5	126,245	18.2	48,755	6.9	430	11.6	66,640	7.2	33	8.1	399,855
	Total	100.0	6,141	100.0	2,995,754	100.0	1,095,930	100.0	268,445	100.0	6,217	100.0	576,071	100.0	457	100.0	4,949,015

[a] Scale samples were collected on 22 June. Stock composition estimates calculated for 22 June were applied to 1 June through 22 June catches.

[b] Scale samples were collected on 15 July. Stock composition estimates calculated for 15 July were applied to 15 July through 22 August catches.

Table 22. Run composition estimates of sockeye salmon catch by age group and date for the Egegik District of Bristol Bay, 1987.

Catch		1.1		1.2		1.3		2.2		1.4		2.3		3.2		Total	
Date	System	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number
6/03[a]	Kvichak	0.0	0	47.0	14,837	3.5	3,406	2.0	228	0.0	0	0.0	0	0.0	0	11.2	18,471
thru	Naknek	0.0	0	8.2	2,589	14.3	13,854	4.1	463	73.0	3,715	0.0	0	0.0	0	12.5	20,621
6/21	Egegik	0.0	0	44.8	14,142	75.2	72,749	88.6	9,919	19.0	968	85.7	17,455	0.0	0	69.9	115,233
	Ugashik	0.0	0	0.0	0	7.0	6,732	5.3	591	8.0	409	14.3	2,912	0.0	0	6.5	10,644
	Total	0.0	0	100.0	31,568	100.0	96,741	100.0	11,201	100.0	5,092	100.0	20,367	0.0	0	100.0	164,969
6/25	Kvichak	0.0	0	31.4	56,304	1.1	2,147	1.8	2,548	0.0	0	0.0	0	0.0	0	9.7	61,000
thru	Naknek	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
6/27	Egegik	0.0	0	65.1	116,732	94.3	179,808	93.4	130,908	0.0	0	85.7	98,480	0.0	0	84.0	525,928
	Ugashik	100.0	1,263	3.5	6,276	4.6	8,721	4.8	6,710	0.0	0	14.3	16,432	0.0	0	6.3	39,402
	Total	100.0	1,263	100.0	179,312	100.0	190,677	100.0	140,166	0.0	0	100.0	114,912	0.0	0	100.0	626,330
6/29	Kvichak	0.0	0	31.4	103,397	5.5	20,281	2.3	4,213	0.0	0	0.0	0	0.0	0	12.2	127,891
thru	Naknek	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
6/30	Egegik	0.0	0	65.1	214,368	64.2	238,149	82.0	148,032	42.5	1,684	72.4	119,203	0.0	0	68.7	721,436
	Ugashik	0.0	0	3.5	11,525	30.3	112,518	15.7	28,270	57.5	2,283	27.6	45,442	0.0	0	19.1	200,037
	Total	0.0	0	100.0	329,291	100.0	370,948	100.0	180,514	100.0	3,967	100.0	164,645	0.0	0	100.0	1,049,365
7/02	Kvichak	0.0	0	21.0	32,815	1.7	1,871	1.5	2,812	0.0	0	0.0	0	0.0	0	6.9	37,498
	Naknek	0.0	0	0.0	0	16.2	17,603	3.0	5,636	0.0	0	14.4	13,245	0.0	0	6.7	36,484
	Egegik	0.0	0	79.0	123,449	78.8	85,728	93.4	173,579	0.0	0	78.8	72,479	0.0	0	83.8	455,235
	Ugashik	0.0	0	0.0	0	3.3	3,590	2.1	3,908	0.0	0	6.8	6,255	0.0	0	2.5	13,753
	Total	0.0	0	100.0	156,264	100.0	108,792	100.0	185,936	0.0	0	100.0	91,978	0.0	0	100.0	542,970

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Table 22. (p 2 of 3).

Catch Date	System	1.1 %	1.1 Number	1.2 %	1.2 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	3.2 %	3.2 Number	Total %	Total Number
7/04	Kvichak	0.0	0	21.0	47,104	1.0	1,685	1.3	2,386	0.0	0	0.0	0	0.0	0	6.8	51,175
	Naknek	0.0	0	0.0	0	6.2	10,967	1.5	2,659	0.0	0	7.7	13,149	0.0	0	3.5	26,774
	Egegik	0.0	0	79.0	177,200	83.6	147,595	89.1	162,551	0.0	0	65.8	112,360	100.0	1,447	79.6	601,153
	Ugashik	0.0	0	0.0	0	9.2	16,302	8.1	14,744	0.0	0	26.5	45,251	0.0	0	10.1	76,297
	Total	0.0	0	100.0	224,304	100.0	176,549	100.0	182,340	0.0	0	100.0	170,760	100.0	1,447	100.0	755,400
7/07	Kvichak	0.0	0	29.0	59,927	1.0	1,941	1.6	4,452	0.0	0	0.0	0	0.0	0	7.4	66,321
thru	Naknek	0.0	0	7.2	14,879	11.1	21,301	2.9	8,028	0.0	0	6.1	13,323	0.0	0	6.4	57,530
7/09	Egegik	0.0	0	62.8	129,774	81.3	155,711	89.1	248,396	0.0	0	77.2	168,609	100.0	3,360	78.5	705,850
	Ugashik	0.0	0	1.0	2,066	6.6	12,573	6.5	18,011	0.0	0	16.7	36,474	0.0	0	7.7	69,125
	Total	0.0	0	100.0	206,646	100.0	191,526	100.0	278,888	0.0	0	100.0	218,406	100.0	3,360	100.0	898,826
7/10	Kvichak	0.0	0	29.0	29,868	0.3	390	1.2	2,247	0.0	0	0.0	0	0.0	0	5.6	32,505
thru	Naknek	0.0	0	7.2	7,415	3.4	4,923	1.8	3,528	53.9	805	6.1	8,741	0.0	0	4.4	25,412
7/12	Egegik	0.0	0	62.8	64,679	94.0	134,696	91.6	175,012	32.5	486	77.2	110,623	0.0	0	83.4	485,496
	Ugashik	0.0	0	1.0	1,030	2.3	3,285	5.4	10,272	13.6	202	16.7	23,930	0.0	0	6.7	38,719
	Total	0.0	0	100.0	102,992	100.0	143,294	100.0	191,059	100.0	1,493	100.0	143,294	0.0	0	100.0	582,132

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Table 22. (p 3 of 3).

Catch Date	System	1.1 %	1.1 Number	1.2 %	1.2 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	3.2 %	3.2 Number	Total %	Total Number
7/13[b]	Kvichak	0.0	0	42.5	71,121	1.3	2,175	2.5	5,102	0.0	0	0.0	0	0.0	0	10.2	78,397
thru	Naknek	0.0	0	0.0	0	21.3	36,699	6.8	13,834	0.0	0	23.3	51,483	0.0	0	13.3	102,017
8/27	Egegik	0.0	0	37.1	62,084	59.0	101,608	68.3	139,819	0.0	0	45.5	100,536	100.0	1,625	52.9	405,672
	Ugashik	0.0	0	20.4	34,138	18.4	31,735	22.4	45,955	0.0	0	31.2	68,939	0.0	0	23.6	180,767
	Total	0.0	0	100.0	167,343	100.0	172,217	100.0	204,710	0.0	0	100.0	220,958	100.0	1,625	100.0	766,853
Total	Kvichak	0.0	0	29.7	415,373	2.3	33,897	1.7	23,988	0.0	0	0.0	0	0.0	0	8.8	473,258
	Naknek	0.0	0	1.8	24,883	7.3	105,347	2.5	34,149	42.8	4,520	8.7	99,940	0.0	0	5.0	268,838
	Egegik	0.0	0	64.6	902,429	76.9	1,116,044	86.4	1,188,216	29.7	3,138	69.8	799,744	100.0	6,432	74.6	4,016,003
	Ugashik	100.0	1,263	3.9	55,035	13.5	195,456	9.3	128,461	27.4	2,894	21.4	245,636	0.0	0	11.7	628,745
	Total	100.0	1,263	100.0	1,397,720	100.0	1,450,744	100.0	1,374,814	100.0	10,552	100.0	1,145,320	100.0	6,432	100.0	5,386,845

[a] Scales were collected on 21 June. Stock composition estimates calculated for 21 June were applied to 3-21 June catches.

[b] Scales were collected on 13 July. Stock composition estimates calculated for 13 July were applied to 13 July to 27 August catches.

Table 23. Run composition estimates of sockeye salmon catch by age group and date for the Ugashik District of Bristol Bay, 1987.

Catch Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	0.4 %	0.4 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	Other[a] %	Other[a] Number	Total %	Total Number
6/08[b]	Kvichak	0.0	0	9.5	5,031	3.1	43	0.3	279	0.5	192	0.0	0	0.0	0	0.0	0	1.8	5,545
thru	Naknek	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
7/02	Egegik	0.0	0	19.4	10,274	8.1	114	13.7	12,960	14.4	6,031	2.4	17	2.8	3,122	0.0	0	10.6	32,517
	Ugashik	100.0	2,788	71.1	37,655	88.8	1,238	86.0	81,535	85.1	35,590	97.6	680	97.2	108,374	100.0	697	87.6	268,558
	Total	100.0	2,788	100.0	52,961	100.0	1,394	100.0	94,774	100.0	41,812	100.0	697	100.0	111,496	100.0	697	100.0	306,619
7/04	Kvichak	0.0	0	15.1	11,565	0.0	0	0.5	447	1.0	568	0.0	0	0.0	0	0.0	0	3.9	12,579
	Naknek	0.0	0	0.0	0	0.0	0	25.1	20,483	8.1	4,424	54.2	335	21.8	22,755	0.0	0	15.0	47,998
	Egegik	0.0	0	16.3	12,484	0.0	0	10.4	8,480	13.4	7,296	1.1	7	0.1	104	0.0	0	8.9	28,371
	Ugashik	100.0	1,853	68.6	52,541	0.0	0	63.9	52,121	77.4	42,066	44.6	276	78.1	81,523	0.0	0	72.1	230,379
	Total	100.0	1,853	100.0	76,590	0.0	0	100.0	81,530	100.0	54,354	100.0	618	100.0	104,383	0.0	0	100.0	319,328
7/08	Kvichak	0.0	0	17.4	12,983	0.0	0	0.6	532	1.2	890	0.0	0	0.0	0	0.0	0	4.1	14,405
thru	Naknek	0.0	0	11.7	8,730	0.0	0	23.7	20,501	7.6	5,828	52.1	360	11.6	12,743	0.0	0	13.8	48,161
7/09	Egegik	0.0	0	15.4	11,491	0.0	0	9.5	8,210	12.1	9,297	1.0	7	0.0	0	0.0	0	8.3	29,004
	Ugashik	100.0	1,382	55.5	41,412	0.0	0	66.1	57,120	79.1	60,674	46.9	324	88.4	97,108	0.0	0	73.8	258,020
	Total	100.0	1,382	100.0	74,616	0.0	0	100.0	86,362	100.0	76,689	100.0	691	100.0	109,851	0.0	0	100.0	349,591
7/10	Kvichak	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
thru	Naknek	0.0	0	2.8	1,144	0.0	0	4.1	1,952	1.1	566	11.8	47	1.2	757	0.0	0	2.2	4,465
7/12	Egegik	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	Ugashik	0.0	0	97.2	39,706	0.0	0	95.9	45,243	98.9	49,009	88.2	350	98.8	62,303	0.0	0	97.8	196,612
	Total	0.0	0	100.0	40,850	0.0	0	100.0	47,195	100.0	49,575	100.0	397	100.0	63,060	0.0	0	100.0	201,077

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Table 23. (p 2 of 2).

Catch Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	0.4 %	0.4 Number	1.3 %	1.3 Number	2.2 %	2.2 Number	1.4 %	1.4 Number	2.3 %	2.3 Number	Other[a] %	Other[a] Number	Total %	Total Number
7/13	Kvichak	0.0	0	16.9	10,166	0.0	0	0.5	385	1.0	810	0.0	0	0.0	0	0.0	0	3.4	11,361
	Naknek	0.0	0	0.0	0	0.0	0	27.9	21,423	9.3	7,652	56.0	330	21.2	24,254	68.2	402	16.2	54,063
	Egegik	0.0	0	8.3	4,993	0.0	0	4.3	3,300	5.7	4,696	0.4	3	0.0	0	0.0	0	3.9	12,991
	Ugashik	0.0	0	74.8	44,994	0.0	0	67.2	51,557	83.9	68,815	43.6	257	78.8	90,154	31.8	188	76.5	255,964
	Total	0.0	0	100.0	60,152	0.0	0	100.0	76,665	100.0	81,973	100.0	590	100.0	114,408	0.0	590	100.0	334,378
7/16[c] thru 9/07	Kvichak	0.0	0	7.6	6,341	0.0	0	0.2	258	0.3	450	0.0	0	0.0	0	0.0	0	1.2	7,049
	Naknek	0.0	0	0.0	0	0.0	0	24.1	36,156	7.8	10,702	0.0	0	16.2	38,108	0.0	0	14.0	84,967
	Egegik	0.0	0	4.0	3,338	0.0	0	1.6	2,370	2.0	2,794	0.0	0	0.0	0	100.0	1,005	1.6	9,506
	Ugashik	100.0	2,010	88.4	73,759	0.0	0	74.1	111,003	89.8	122,772	0.0	0	83.8	197,129	0.0	0	83.3	506,673
	Total	100.0	2,010	100.0	83,438	0.0	0	100.0	149,787	100.0	136,718	0.0	0	100.0	235,237	100.0	1,005	100.0	608,195
Total	Kvichak	0.0	0	11.9	46,087	3.1	43	0.4	1,900	0.7	2,909	0.0	0	0.0	0	0.0	0	2.4	50,938
	Naknek	0.0	0	2.5	9,874	0.0	0	18.7	100,516	6.6	29,172	35.8	1,072	13.4	98,618	17.5	402	11.3	239,654
	Egegik	0.0	0	11.0	42,580	8.1	114	6.6	35,318	6.8	30,113	1.1	33	0.4	3,226	43.9	1,005	5.3	112,389
	Ugashik	100.0	8,033	74.6	290,067	88.8	1,238	74.3	398,579	85.9	378,927	63.1	1,888	86.2	636,591	38.6	885	81.0	1,716,207
	Total	100.0	8,033	100.0	388,607	100.0	1,394	100.0	536,313	100.0	441,121	100.0	2,993	100.0	738,435	100.0	2,292	100.0	2,119,188

[a] Includes age-3.2, and age-2.4.

[b] Scales were collected on 2 July. Stock composition estimates calculated for 2 July were applied to 8 June through 2 July catches.

[c] Scales were collected on 17 July. Stock composition estimates calculated for 17 July were applied to 16 July through 7 September catches.

Table 24. Catch of sockeye salmon by run and district for the East Side of Bristol Bay, 1987.

Run		District Nak/Kvi	Egegik	Ugashik	Total
Kvichak	Numbers	3,056,295	473,258	50,938	3,580,491
	Percent	85.4	13.2	1.4	100.0
Naknek	Numbers	1,358,763	268,838	239,654	1,867,255
	Percent	72.8	14.4	12.8	100.0
Egegik	Numbers	134,102	4,016,003	112,389	4,262,494
	Percent	3.1	94.2	2.6	100.0
Ugashik	Numbers	399,855	628,745	1,716,207	2,744,807
	Percent	14.6	22.9	62.5	100.0
Total East Side	Numbers	4,949,015	5,386,844	2,119,188	12,455,047
	Percent	39.7	43.3	17.0	100.0

Table 25. Percentages of sockeye salmon by run and age group for the East Side of Bristol Bay, 1987.

Run		0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	1.4	2.3	3.2	2.4	Total
Kvichak	Escapement				56.89	0.03		2.01	3.19		0.76			62.88
	In District Catch				28.55			1.97	1.16					31.68
	Other Dist. Catch				4.78		0.00[a]	0.37	0.28					5.43
	Total Return				90.23	0.03	0.00[a]	4.35	4.64		0.76			100.00
Naknek	Escapement		0.02		3.56	0.23		14.29	3.88	0.21	14.05		0.03	36.25
	In District Catch				2.60			24.86	2.72	0.20	16.00		0.01	46.39
	Other Dist. Catch				1.19			7.03	2.16	0.19	6.78		0.01	17.36
	Total Return		0.02		7.35	0.23		46.18	8.75	0.60	36.83		0.05	100.00
Egegik	Escapement				5.75	0.13		6.13	6.63	0.00[a]	4.34	0.02		23.00
	In District Catch				16.30			20.16	21.47	0.06	14.45	0.12		72.55
	Other Dist. Catch				1.02		0.00[a]	1.57	1.05	0.00[a]	0.80	0.02		4.45
	Total Return				23.07	0.13	0.00[a]	27.86	29.14	0.06	19.59	0.15		100.00
Ugashik	Escapement	0.00[a]	0.00[a]	0.04	6.99	0.16		3.98	4.04	0.02	4.36		0.00[a]	19.60
	In District Catch			0.24	8.50		0.04	11.68	11.10	0.06	18.65		0.03	50.27
	Other Dist. Catch		0.04	0.18	6.05			9.42	5.19	0.10	9.15		0.00[a]	30.13
	Total Return	0.00[a]	0.04	0.45	21.54	0.16	0.04	25.08	20.33	0.17	32.16		0.03	100.00

[a] Fish present, but represent less than .01%.

Table 26. Numbers of sockeye salmon by run and age group for the East Side of Bristol Bay, 1987.

Run		0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	1.4	2.3	3.2	2.4	Total
Kvichak	Escapement				5,487,957	3,089		193,699	308,188		72,947			6,065,880
	In District Catch				2,754,027			189,965	112,303					3,056,295
	Other Dist. Catch				461,460		43	35,797	26,897					524,197
	Total Return				8,703,444	3,089	43	419,461	447,388		72,947			9,646,372
Naknek	Escapement		619		104,183	6,640		418,445	113,571	6,109	411,489		750	1,061,806
	In District Catch				76,220			728,216	79,541	5,762	468,600		424	1,358,763
	Other Dist. Catch				34,757			205,863	63,321	5,592	198,558		402	508,493
	Total Return		619		215,160	6,640		1,352,524	256,433	17,463	1,078,647		1,576	2,929,062
Egegik	Escapement				318,217	7,240		339,084	366,890	195	240,395	957		1,272,978
	In District Catch				902,429			1,116,044	1,188,216	3,138	799,744	6,432		4,016,003
	Other Dist. Catch				56,475		114	86,823	57,959	57	44,057	1,005		246,490
	Total Return				1,277,121	7,240	114	1,541,951	1,613,065	3,390	1,084,196	8,394		5,535,471
Ugashik	Escapement	45	57	1,284	238,692	5,575		135,868	137,827	643	148,879		94	668,964
	In District Catch			8,033	290,067		1,238	398,579	378,927	1,888	636,591		885	1,716,208
	Other Dist. Catch		1,263	6,141	206,646			321,701	177,216	3,324	312,276		33	1,028,600
	Total Return	45	1,320	15,458	735,405	5,575	1,238	856,148	693,970	5,855	1,097,746		1,012	3,413,772

Table 27. Comparison of sockeye salmon run estimates for the East Side of Bristol Bay, 1987.

Stock	Estimated Run		Difference
	Standard Method[a]	Scale Pattern Analysis	
Kvichak	9,643,843	9,646,372	-2,529
Naknek	2,432,859	2,929,062	-496,203
Egegik	6,659,823	5,535,471	1,124,352
Ugashik	2,788,152	3,413,772	-625,620
Total East Side	21,524,677	21,524,677	

[a] Standard method assumes fish harvested in a district originated within the district, and divides the Naknek-Kvichak District catch to the Naknek and Kvichak Rivers based of escapement age composition (Cross and Stratton, 1988). These numbers have been adjusted to include Branch River return.

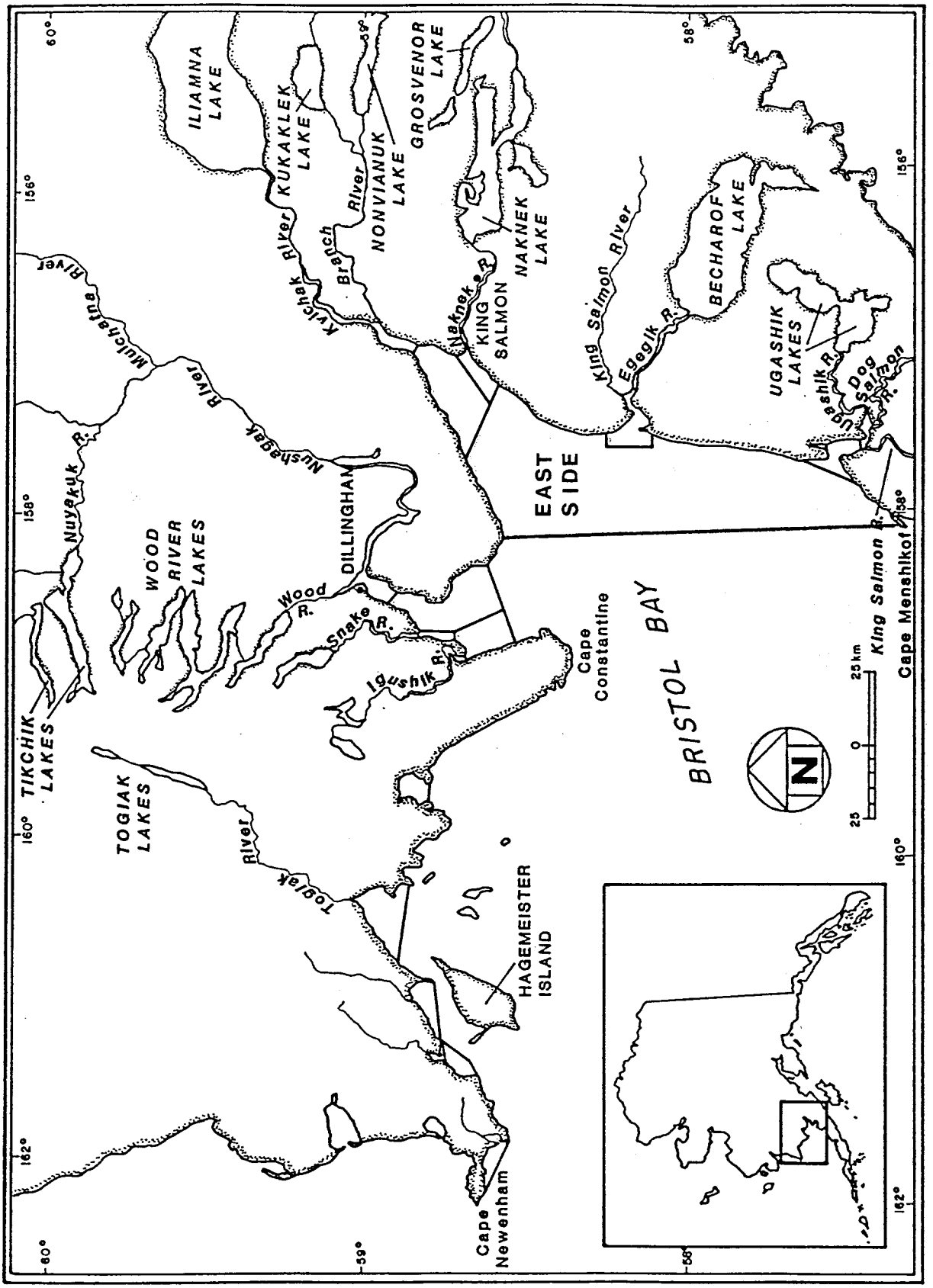


Figure 1. Map of Bristol Bay showing fishing districts and major rivers.

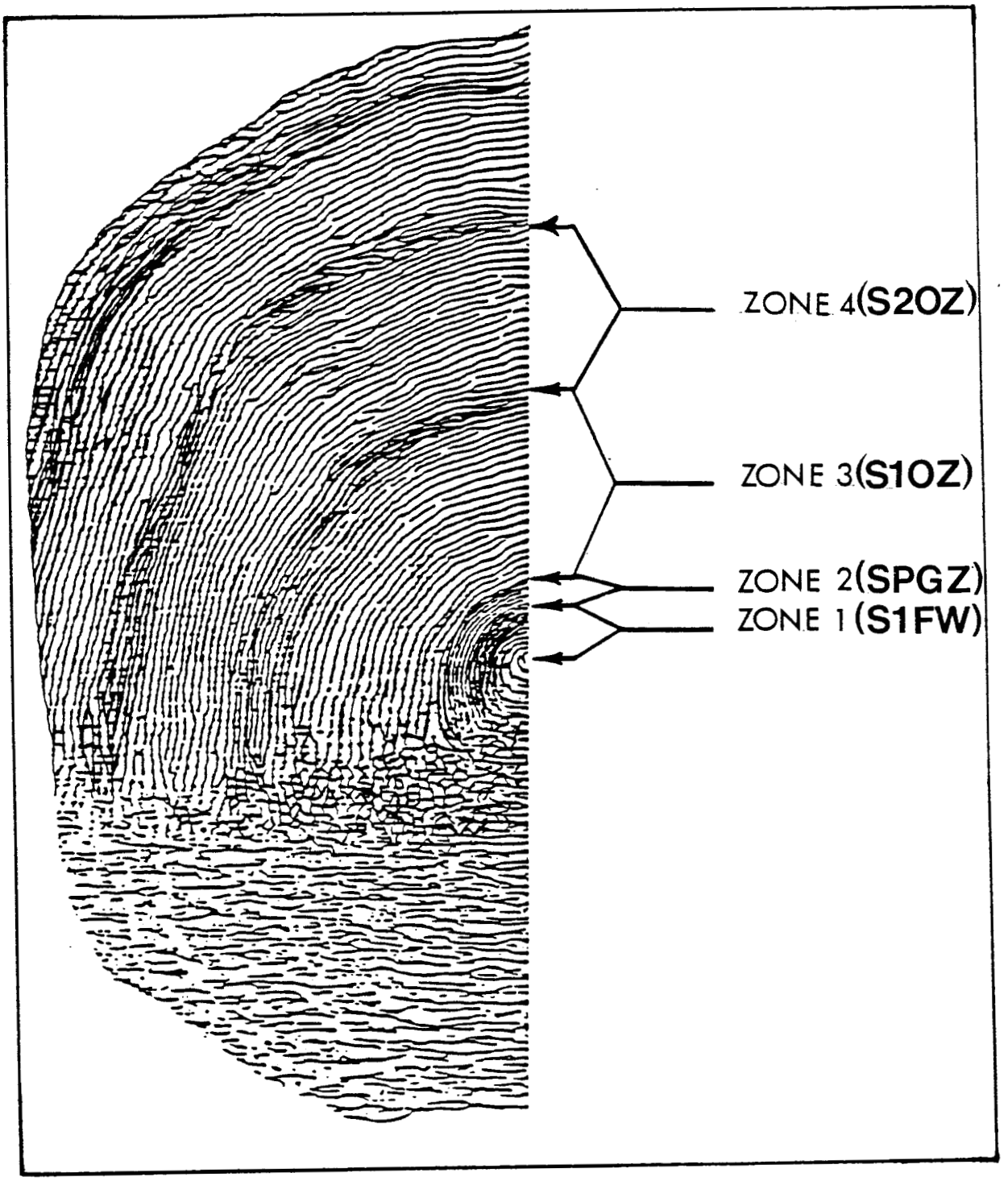


Figure 2. Age-1.3 sockeye salmon scale showing the growth zones measured to generate variables to build linear discriminant functions.

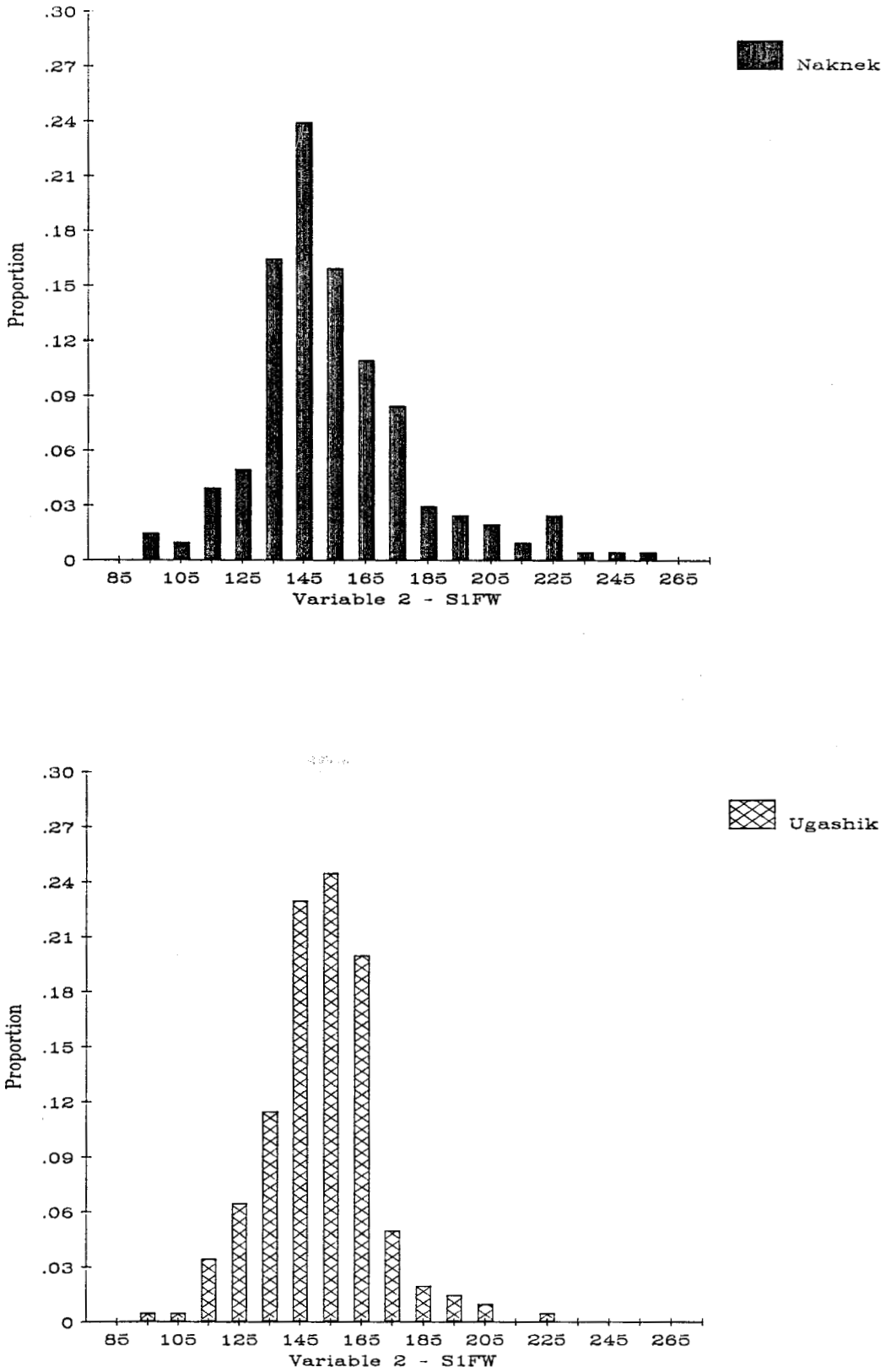


Figure 3. Size of the first freshwater (S1FW) growth zone measured from age-1.3 scales taken from escapements of sockeye salmon in the Naknek and Ugashik Rivers in 1987.

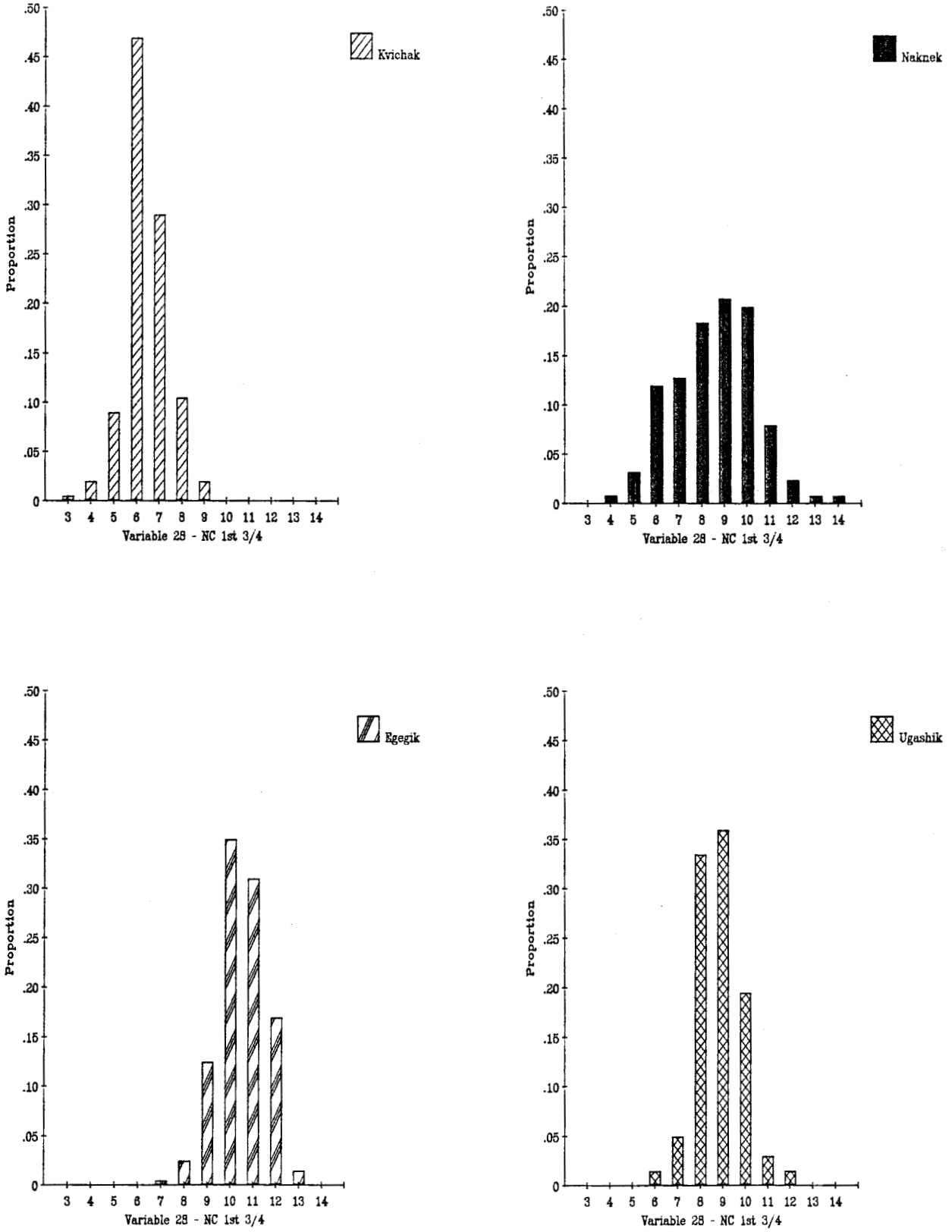


Figure 4. Number of circuli in the first 3/4 of the freshwater (NC 1st 3/4) growth zone measured from age-1.2 scales taken from escapements of sockeye salmon in the Kvichak, Naknek, Egegik, and Ugashik Rivers in 1987.

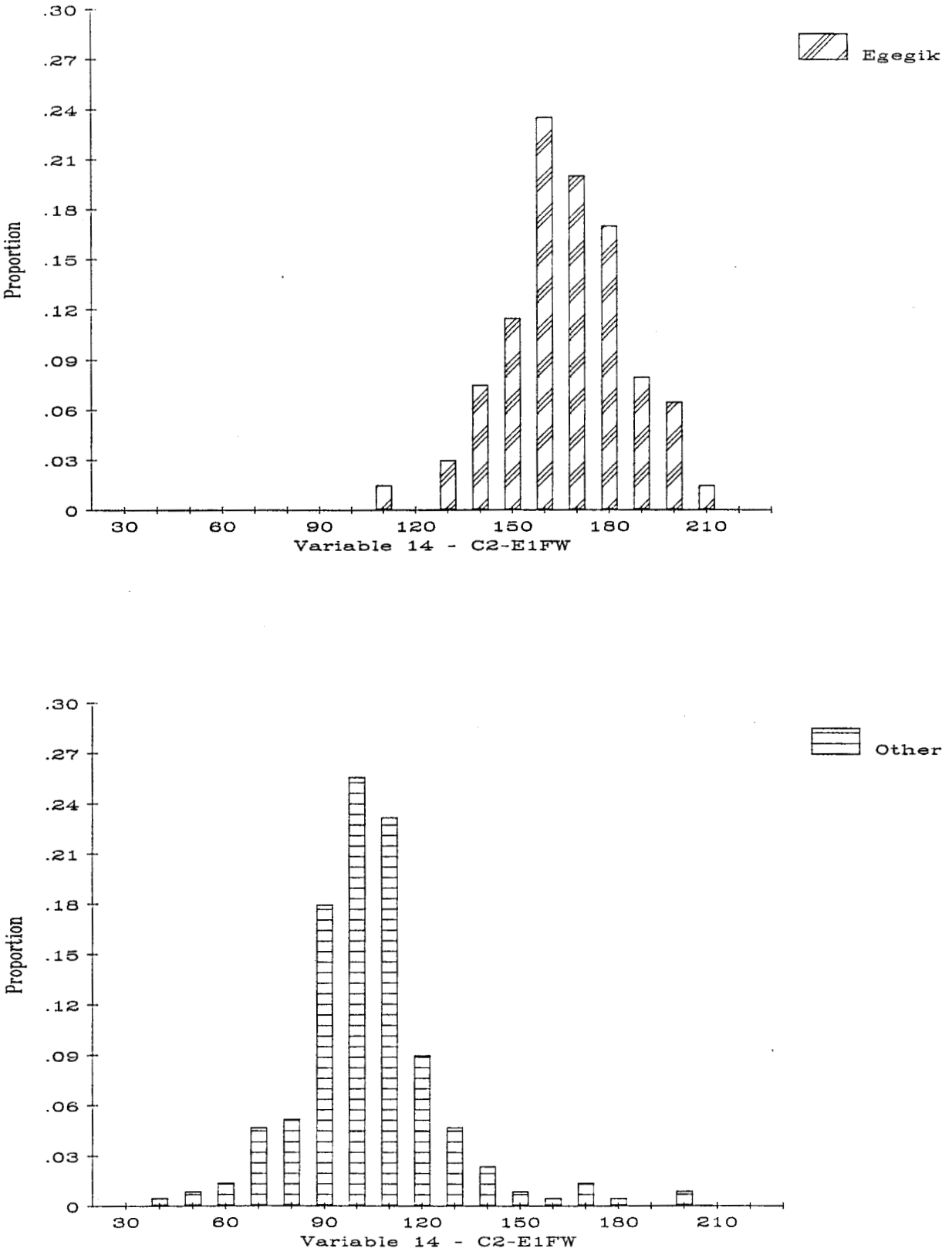


Figure 5. Distance from circulus 2 to the end of the first freshwater (C2-E1FW) growth zone measured from age-1.3 scales taken from escapements of sockeye salmon in Egegik River and Kvichak-Naknek-Ugashik pooled (other) in 1987.

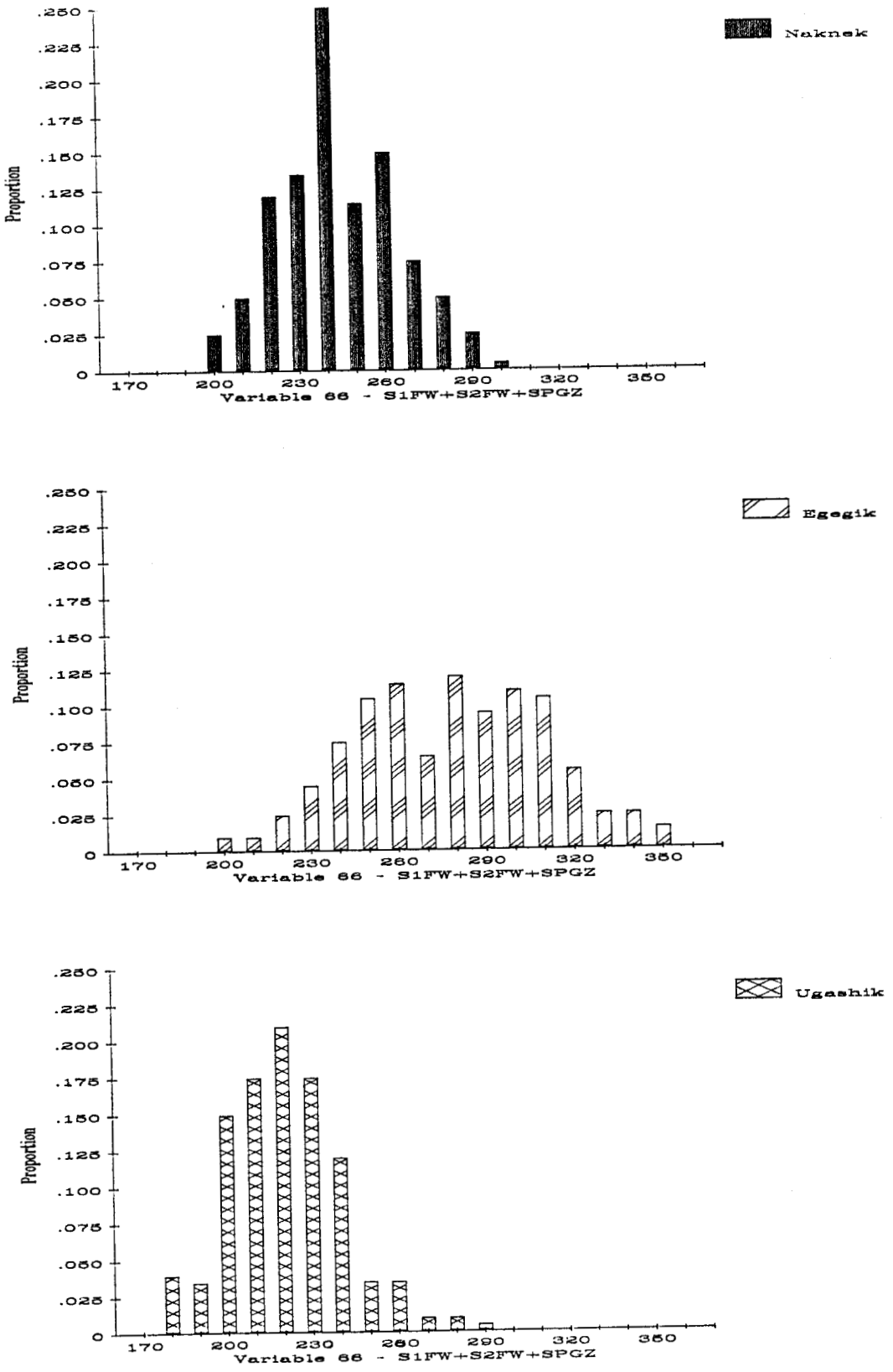
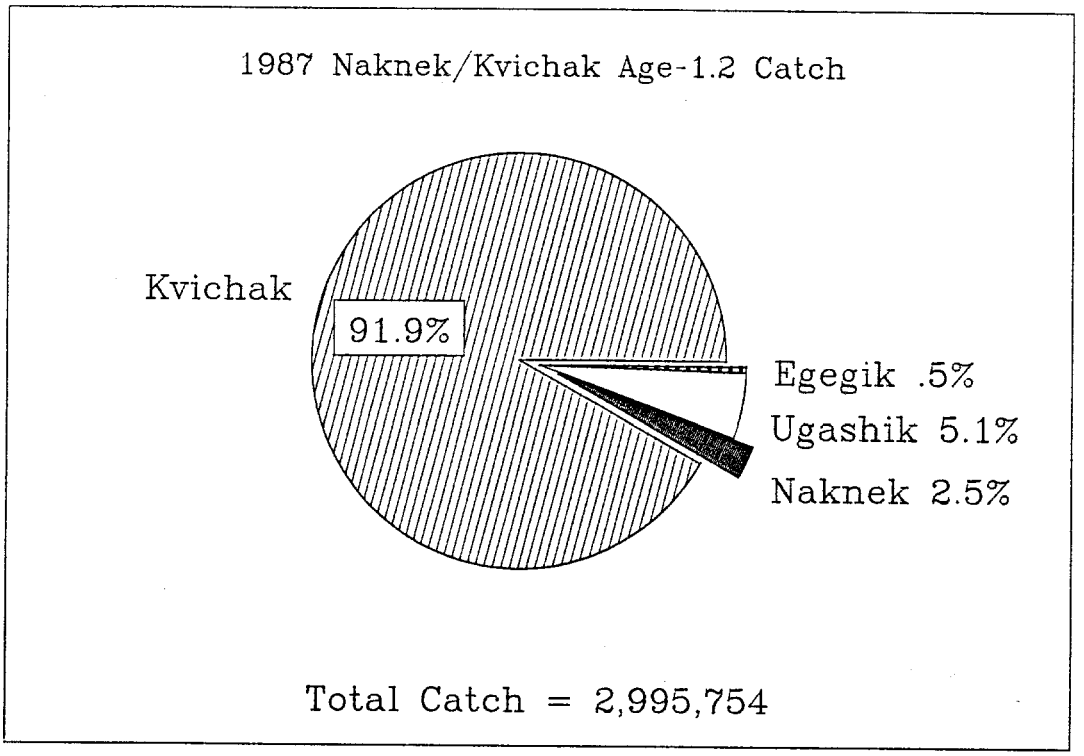


Figure 6. Size of the first and second freshwater and plus growth zones (S1FW+S2FW+SPGZ) measured from age-2.3 scales taken from escapements of sockeye salmon in Naknek, Egegik, and Ugashik Rivers in 1987.



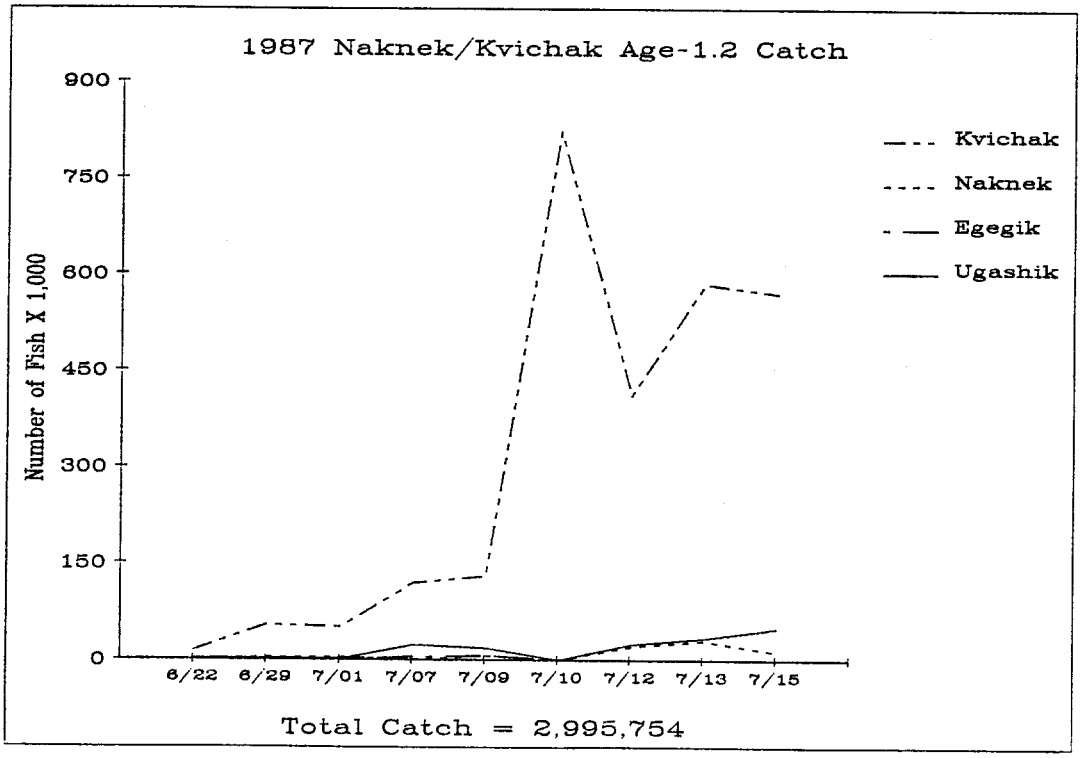
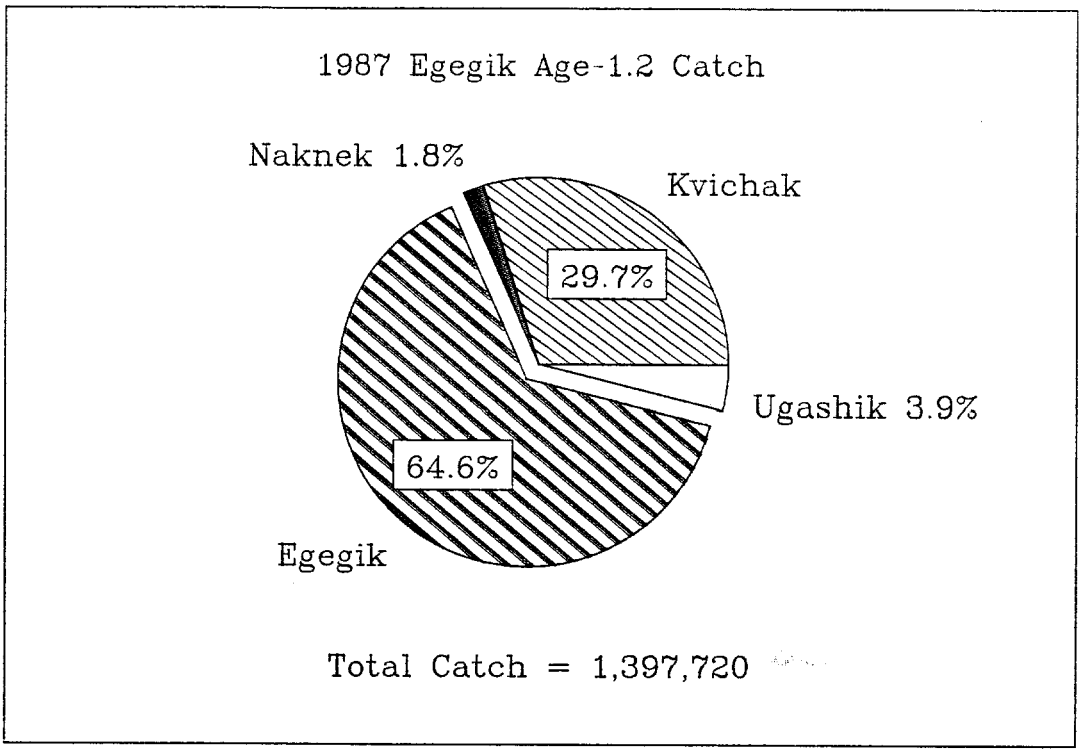


Figure 7. Estimates of stock composition for the 1987 catch of age-1.2 sockeye salmon in the Naknek-Kvichak District in percent and numbers of fish through time.



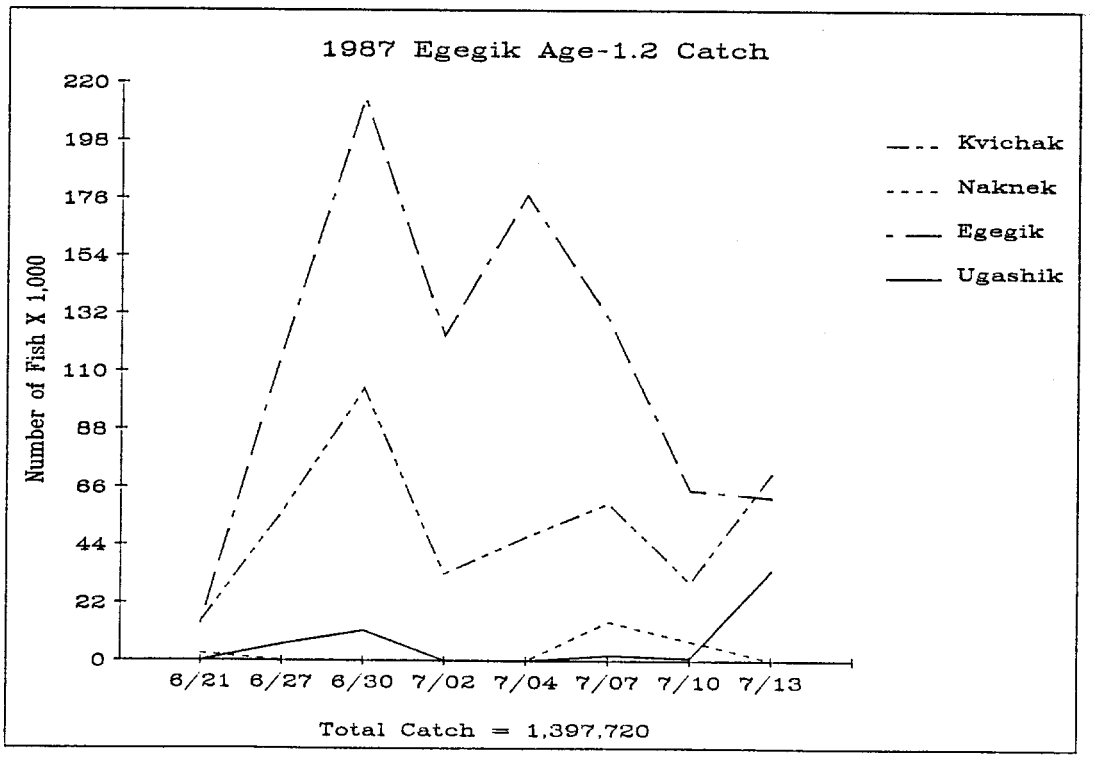
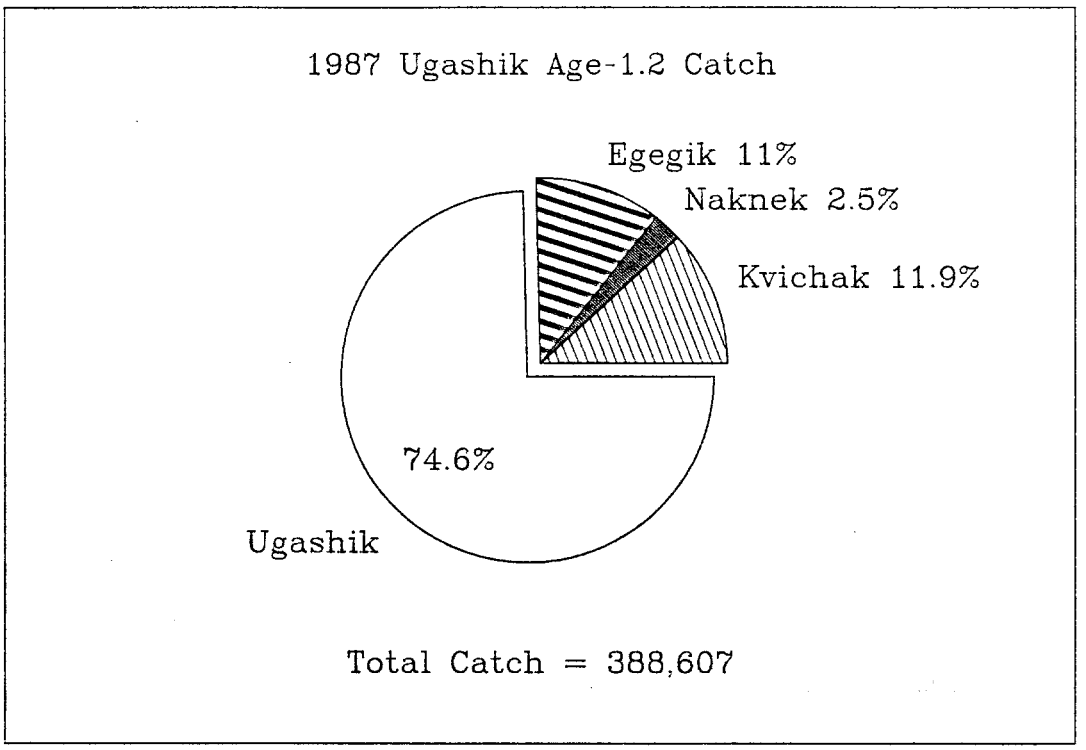


Figure 8. Estimates of stock composition for the 1987 catch of age-1.2 sockeye salmon in the Egegik District in percent and numbers of fish through time.



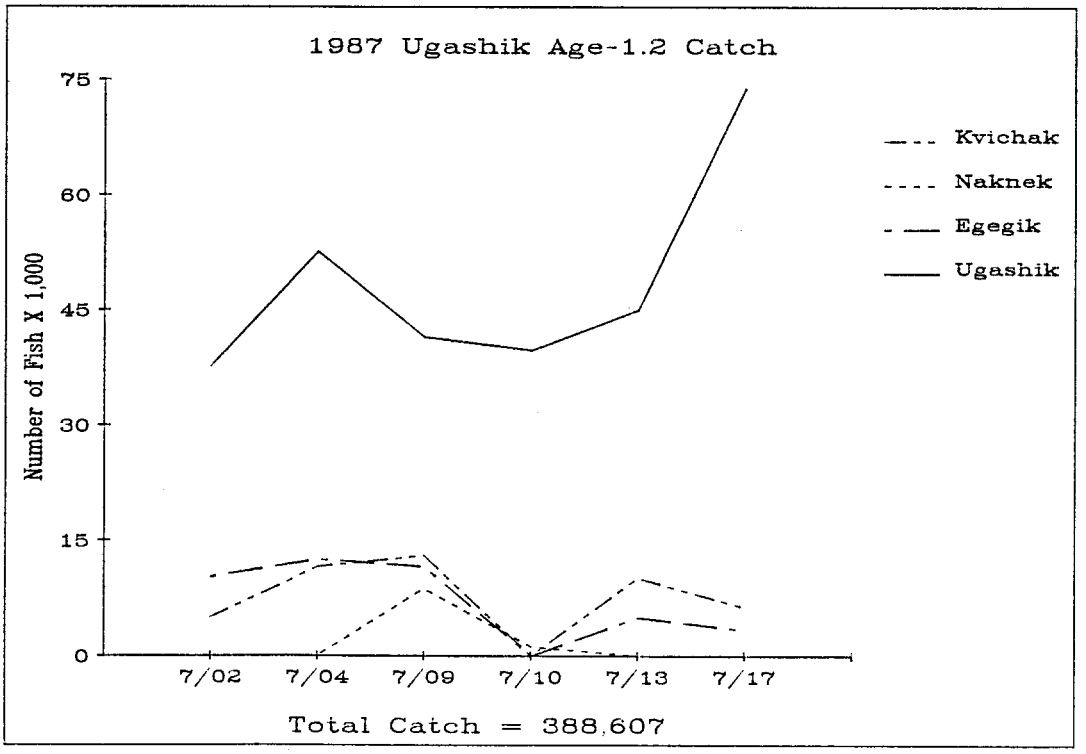
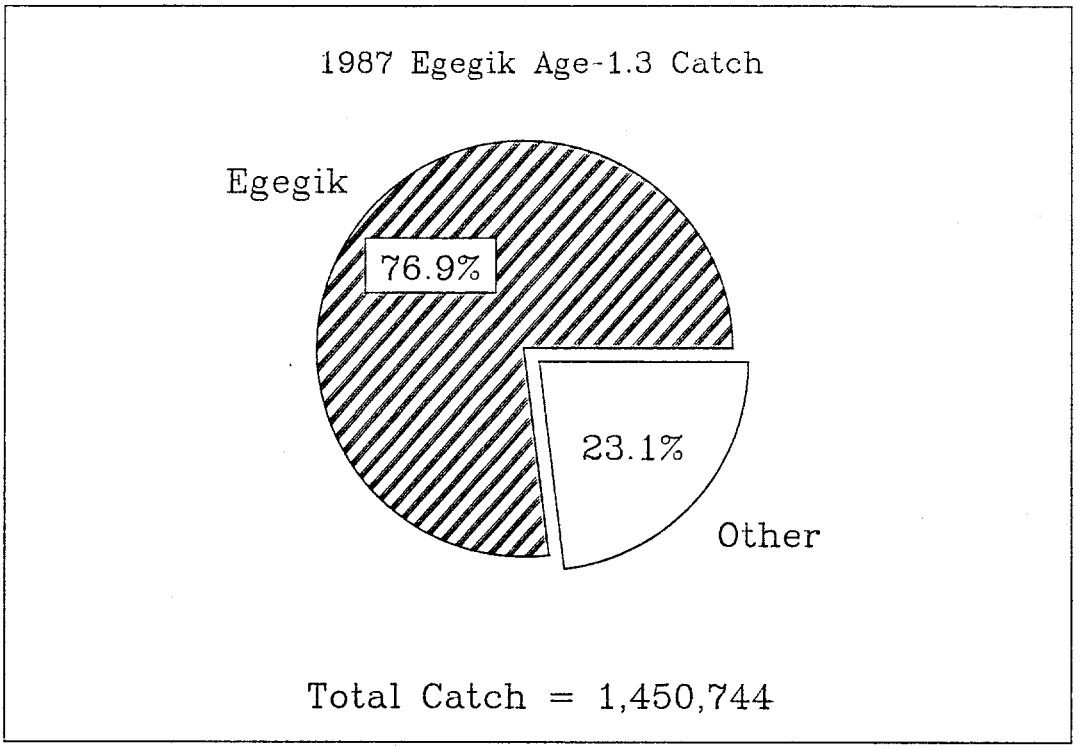


Figure 9. Estimates of stock composition for the 1987 catch of age-1.2 sockeye salmon in the Ugashik District in percent and numbers of fish through time.



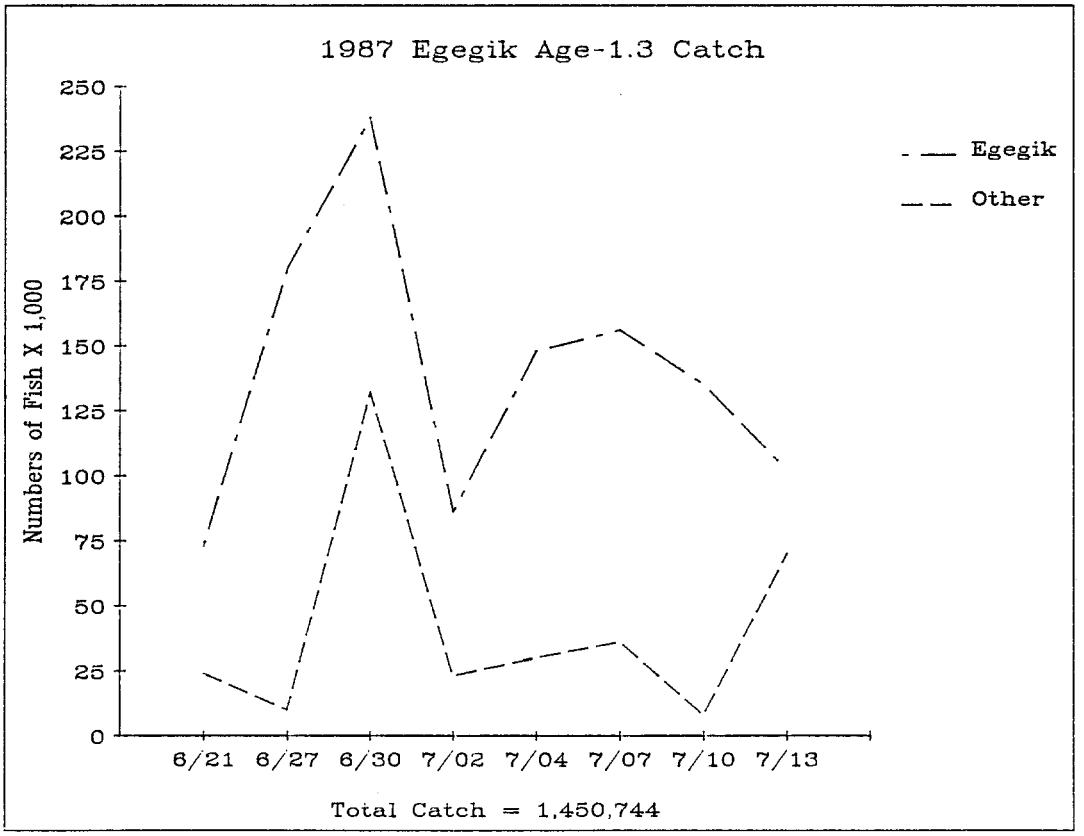
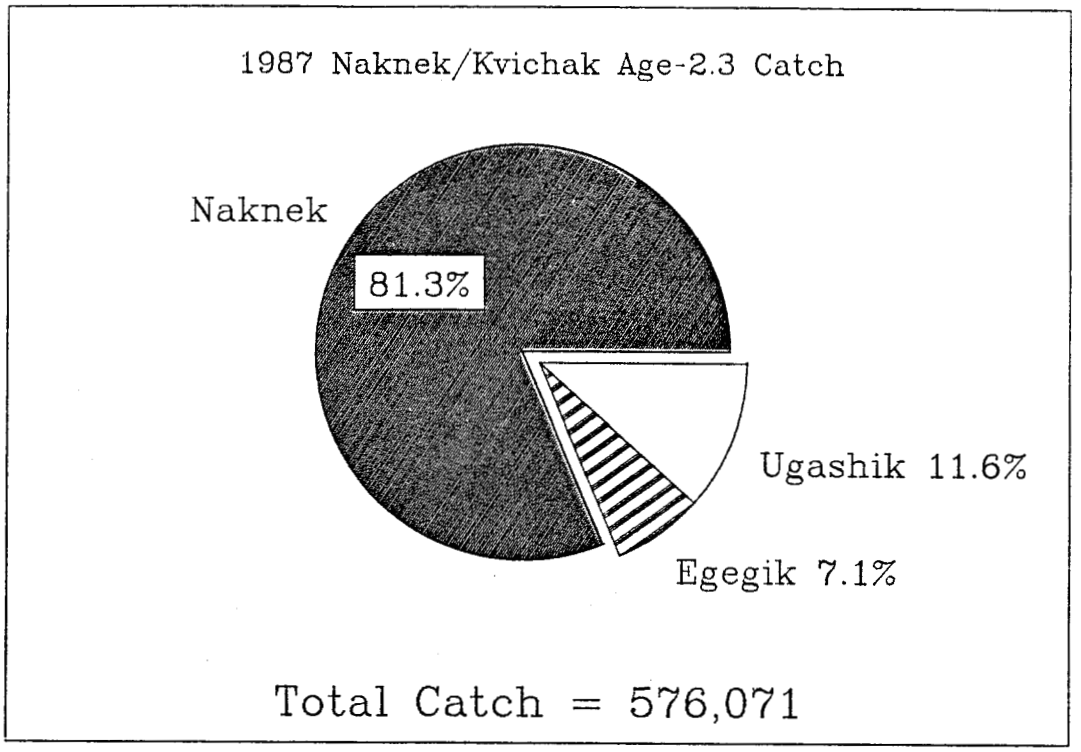


Figure 10. Estimates of stock composition for the 1987 catch of age-1.3 sockeye salmon in the Egegik District in percent and numbers of fish through time.



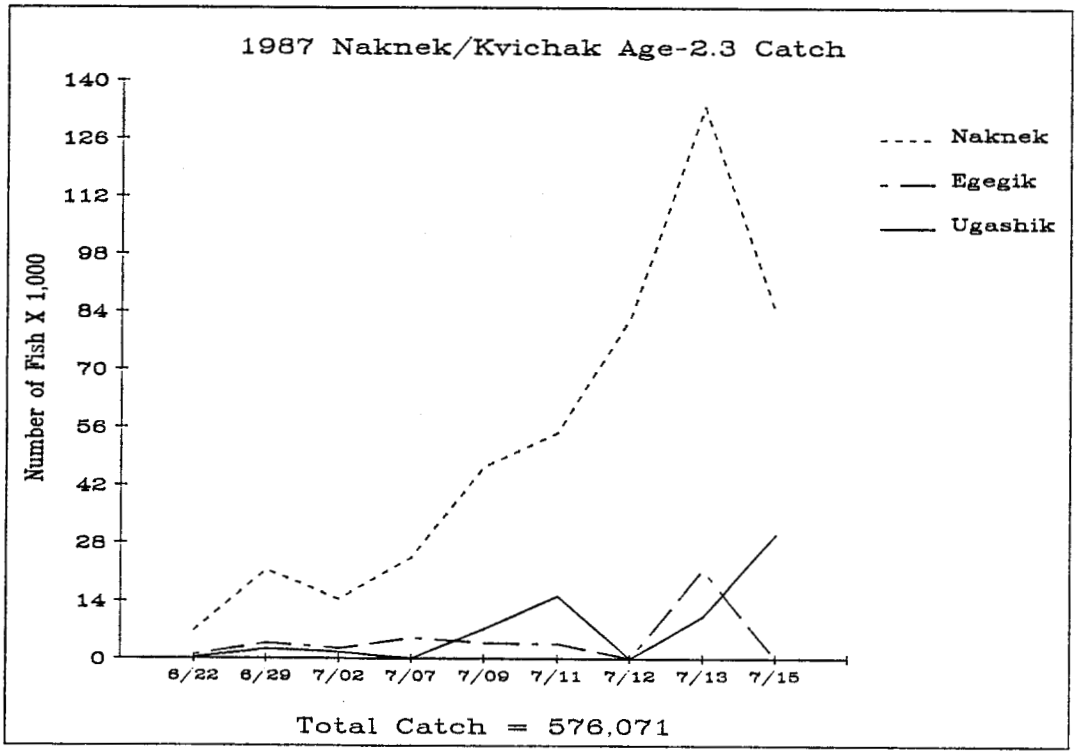
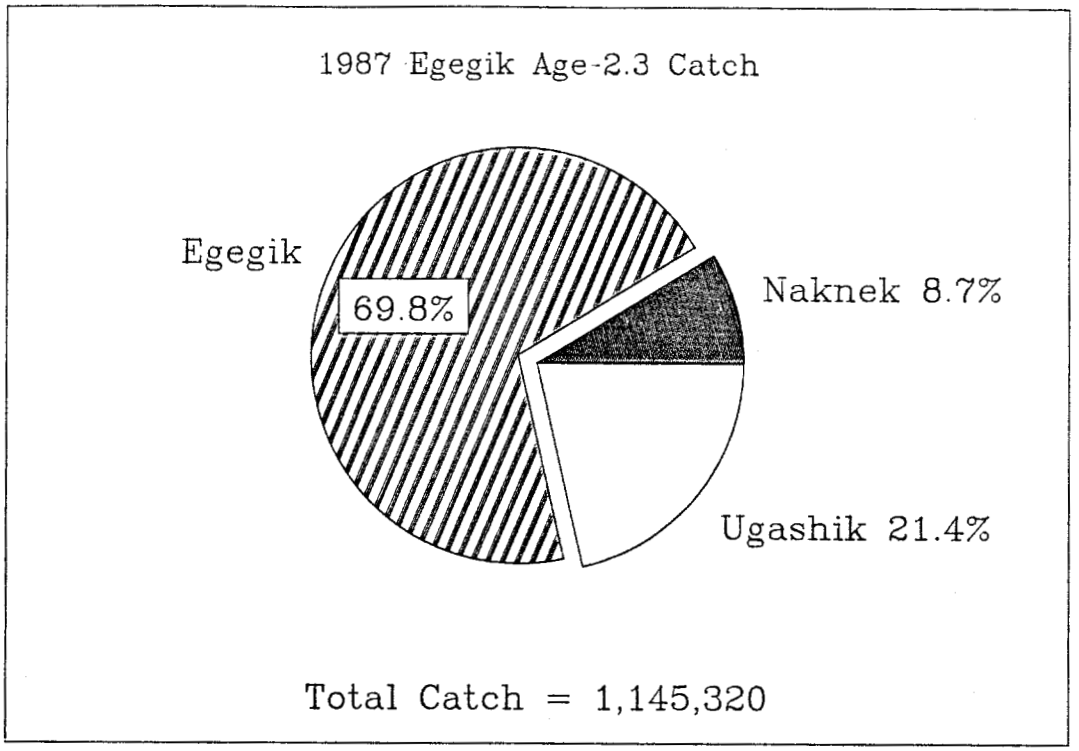


Figure 11. Estimates of stock composition for the 1987 catch of age-2.3 sockeye salmon in the Naknek-Kvichak District in percent and numbers of fish through time.



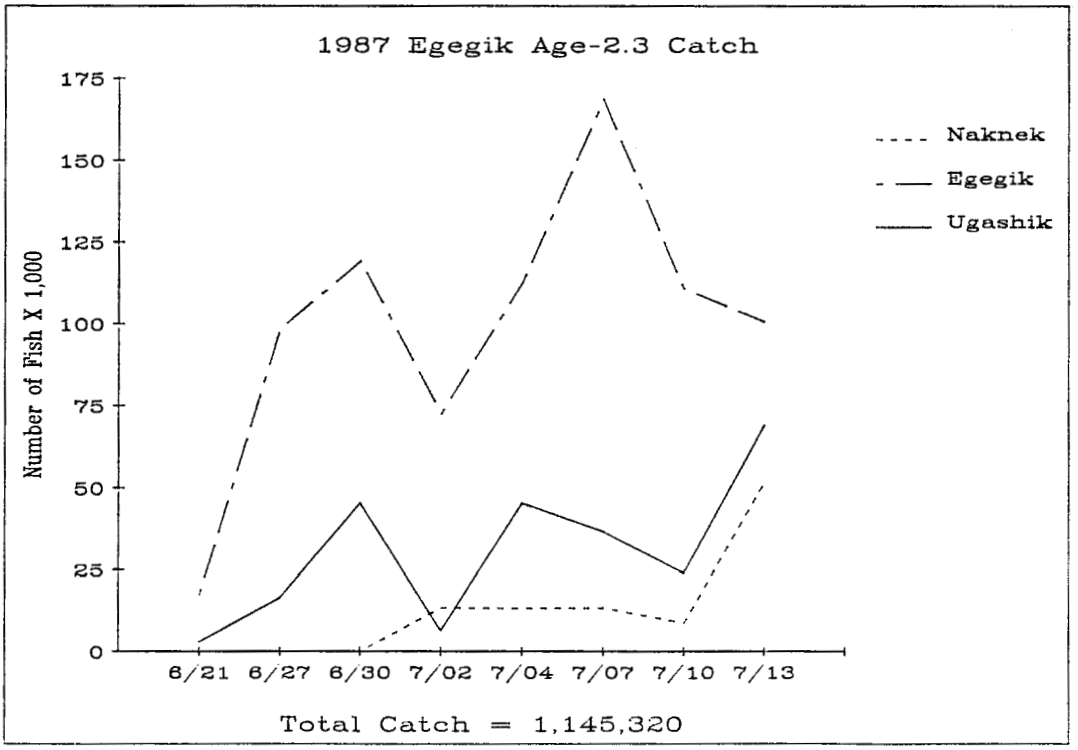
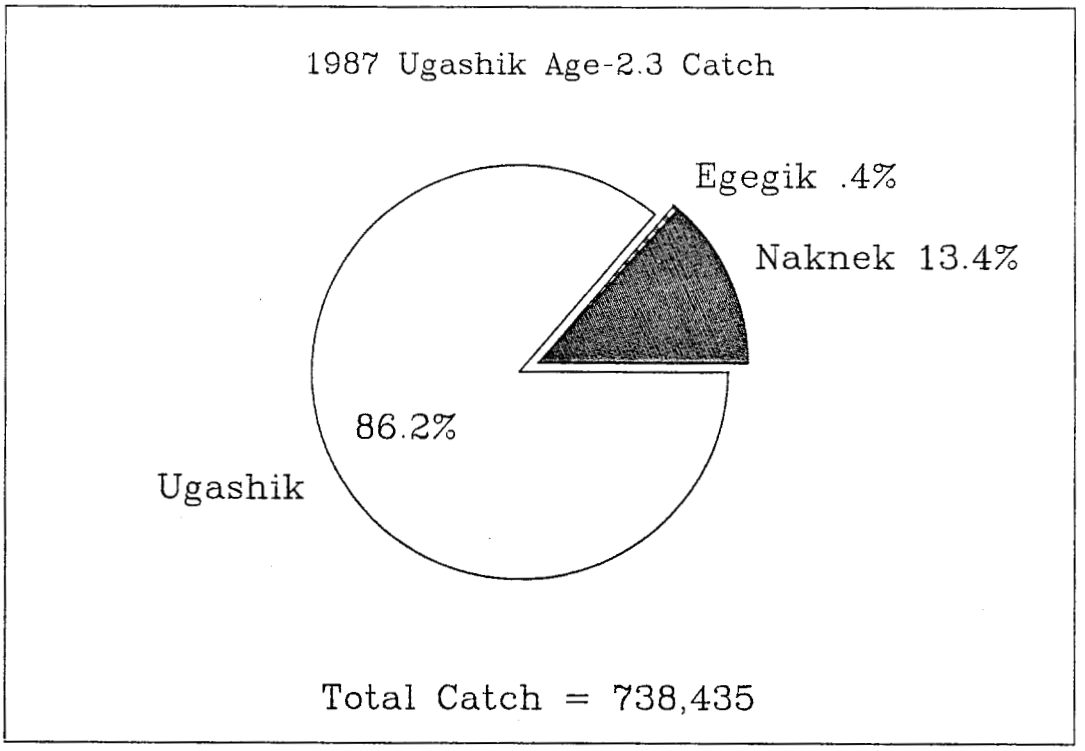


Figure 12. Estimates of stock composition for the 1987 catch of age-2.3 sockeye salmon in the Egegik District in percent and numbers of fish through time.



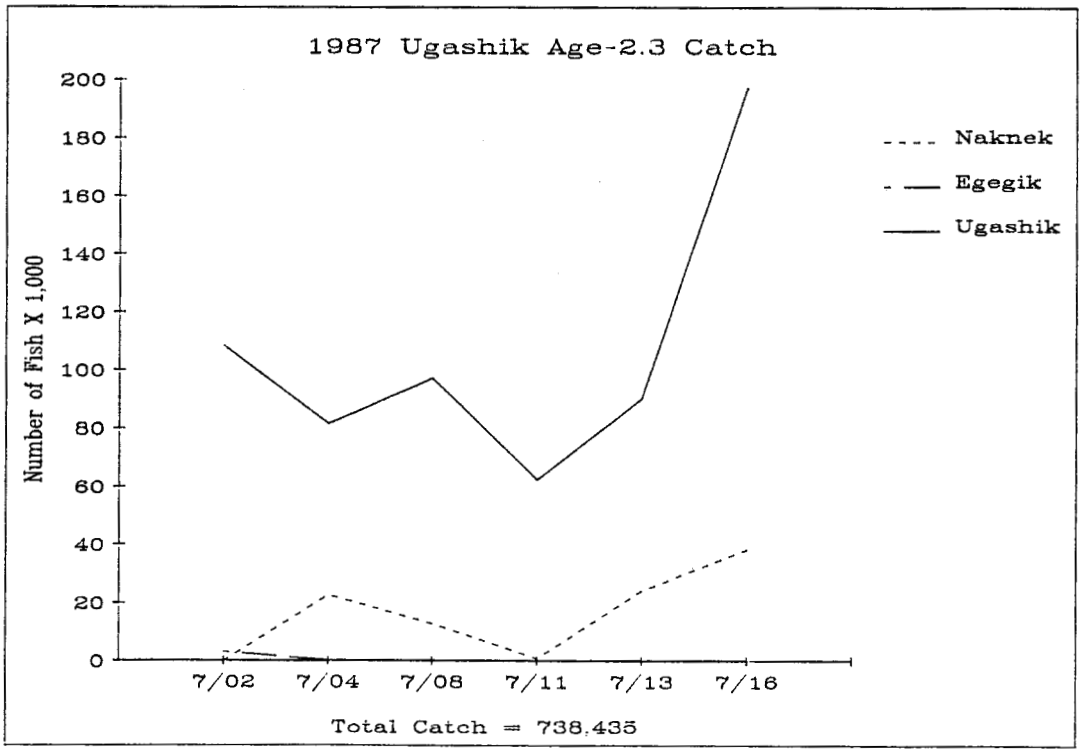
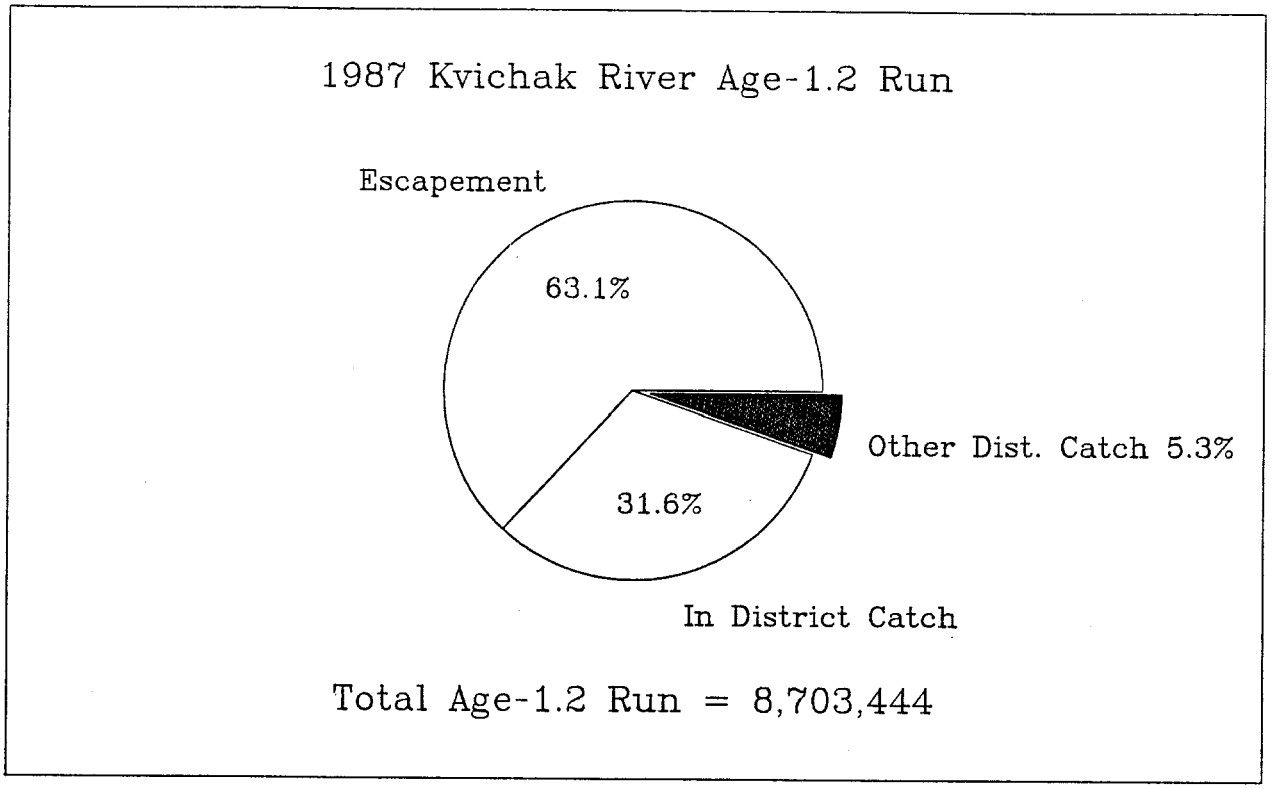


Figure 13. Estimates of stock composition for the 1987 catch of age-2.3 sockeye salmon in the Ugashik District in percent and numbers of fish through time.



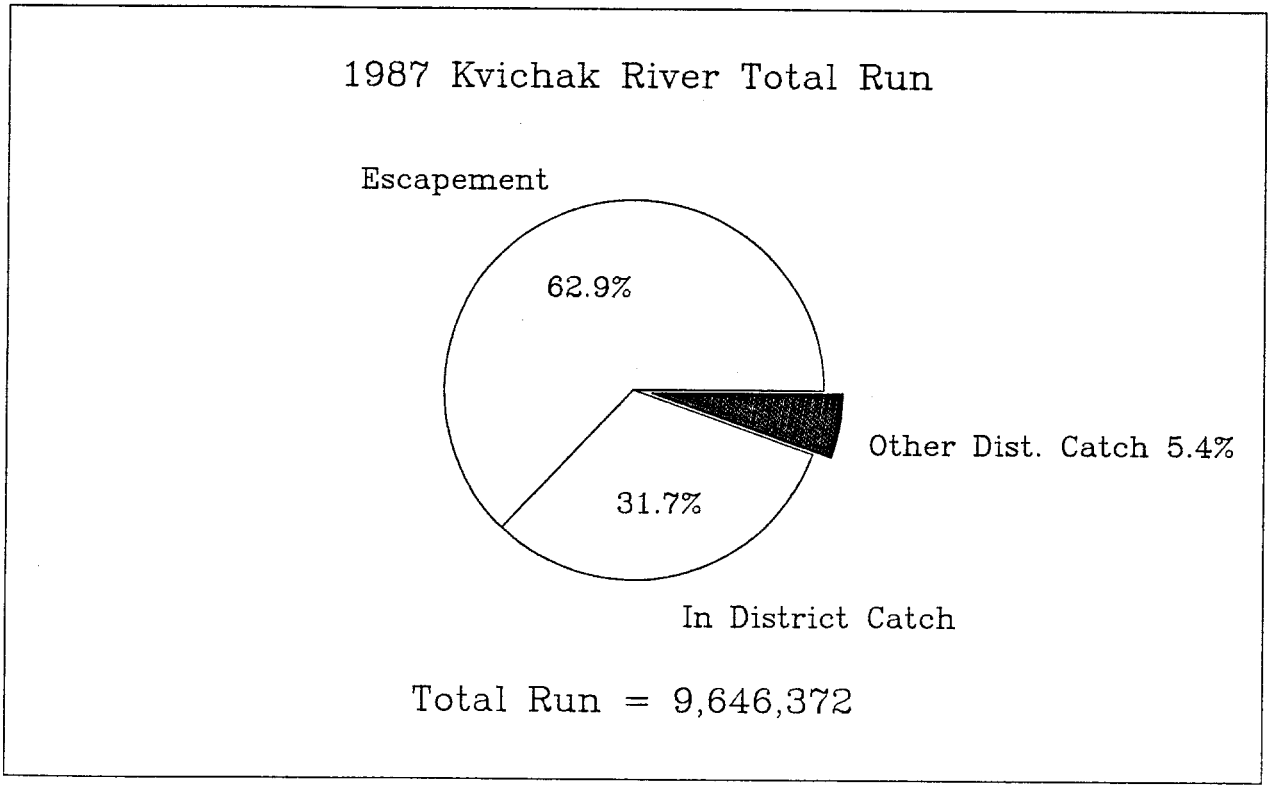
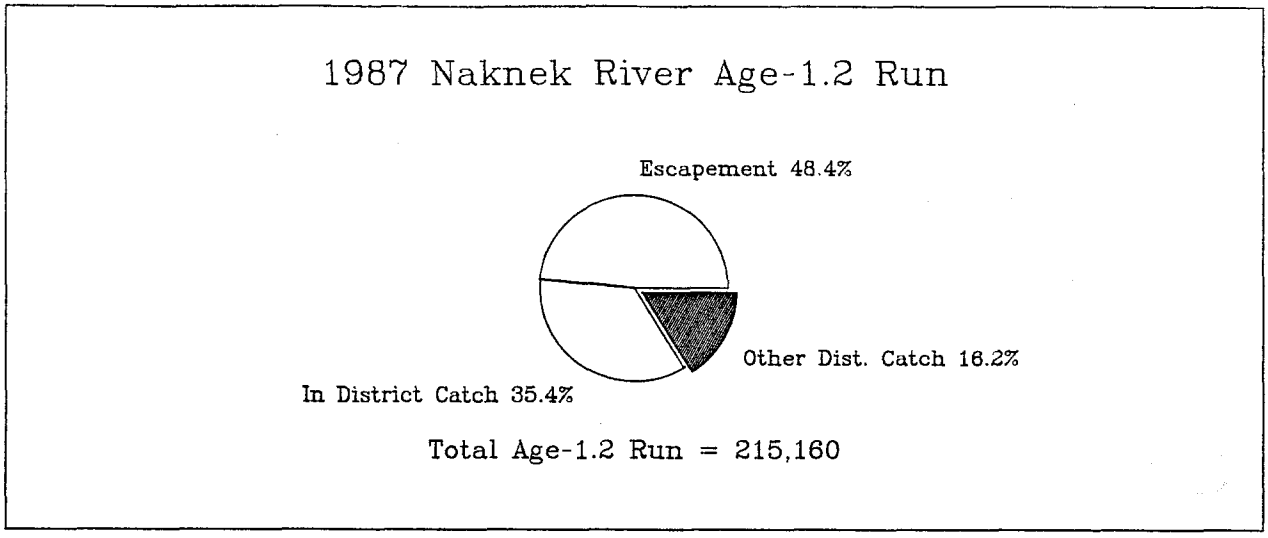
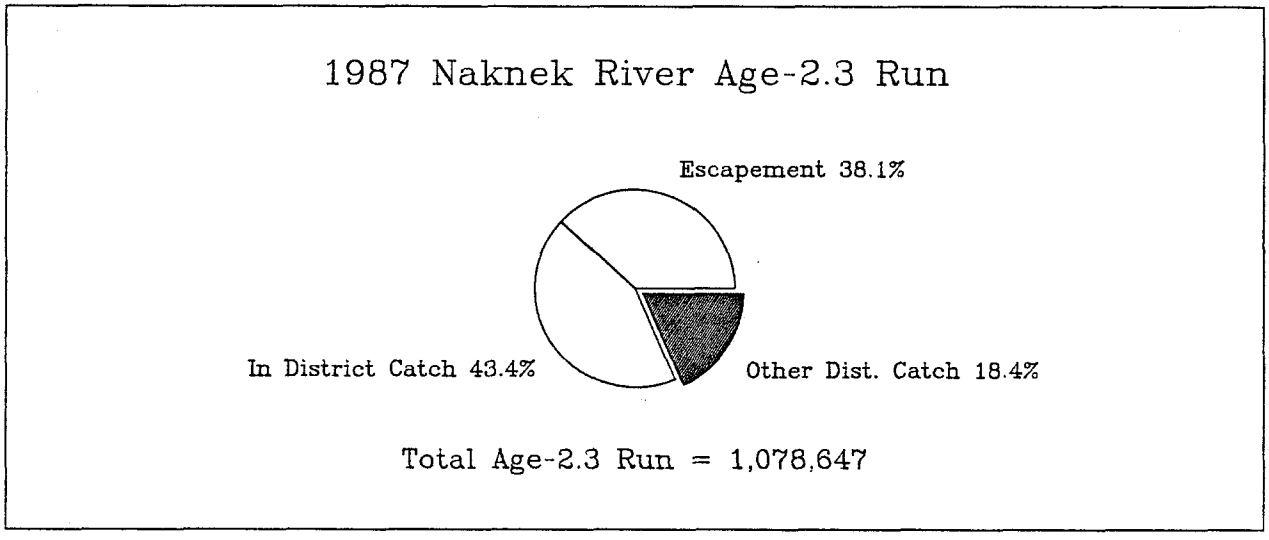


Figure 14. Age-1.2 and total run percentages to the Kvichak River in 1987 and the breakdown of run to escapement, in district catch, and other district catch.





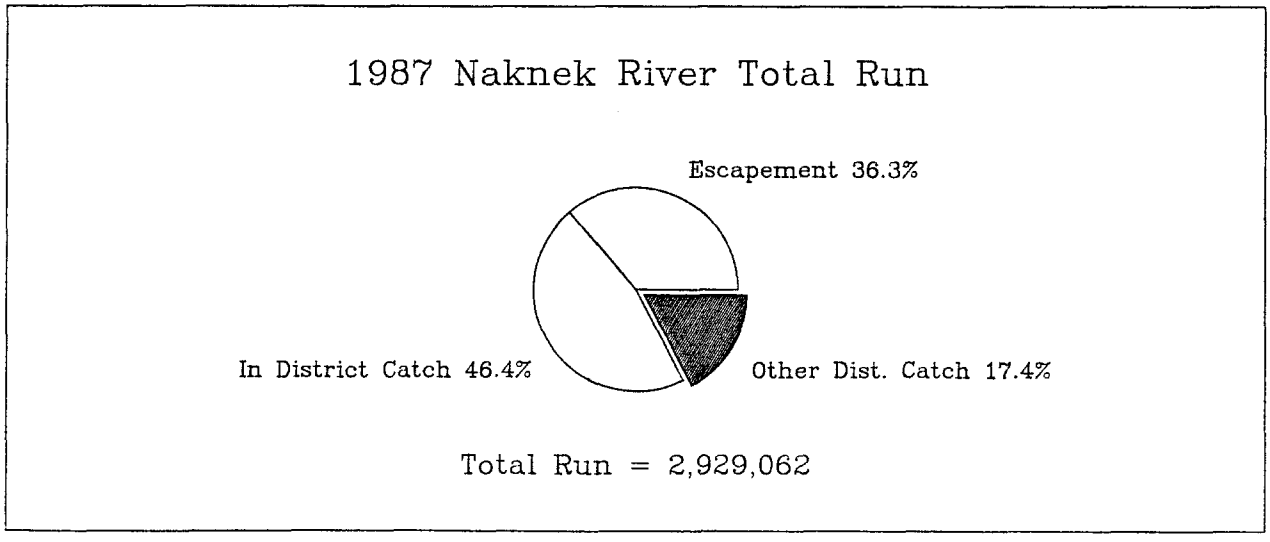
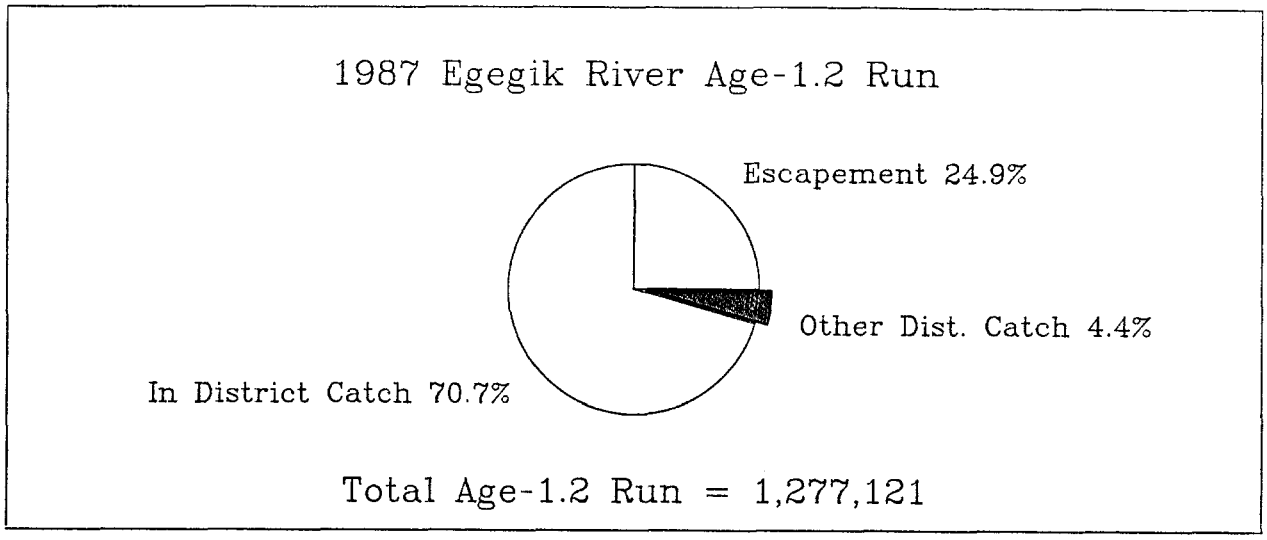
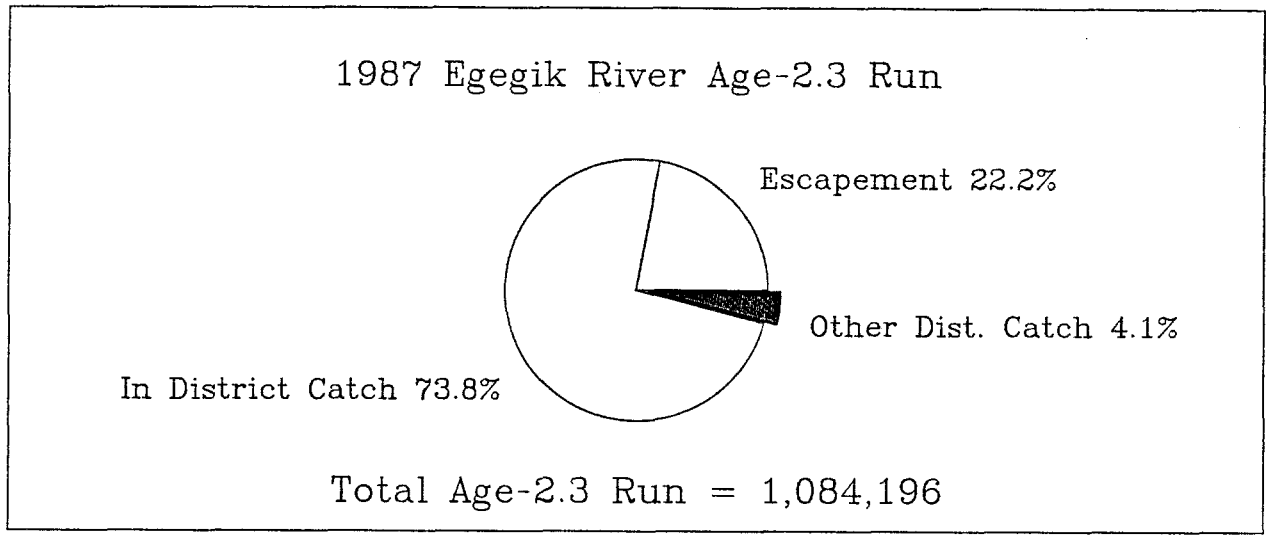


Figure 15. Age-1.2, age-2.3, and total run percentages to the Naknek River in 1987 and the breakdown of run to escapement, in district catch, and other district catch.





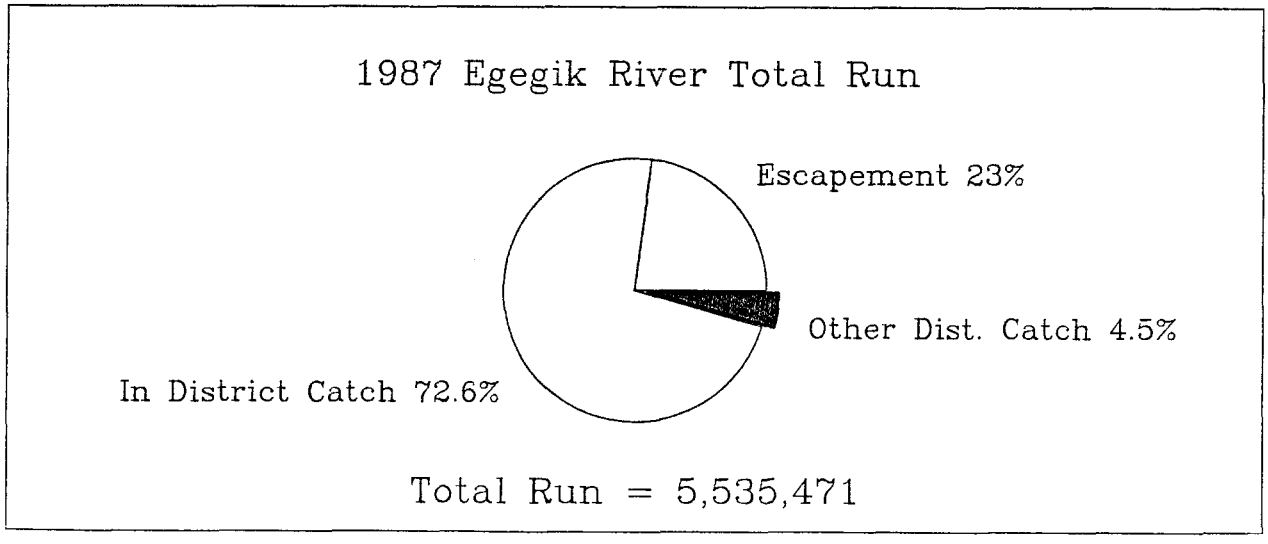
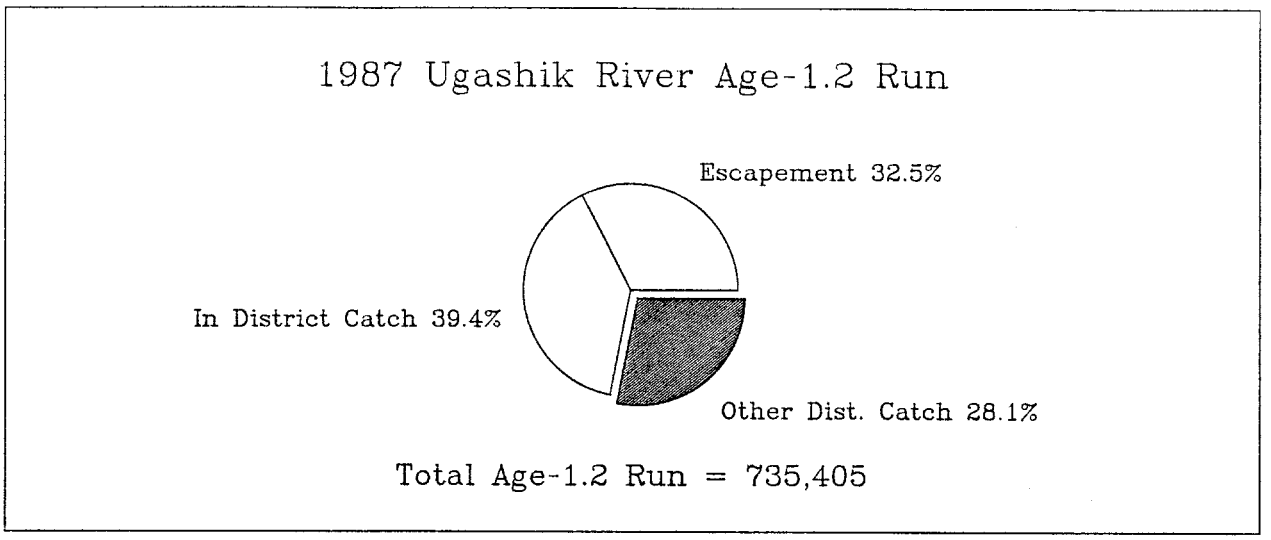
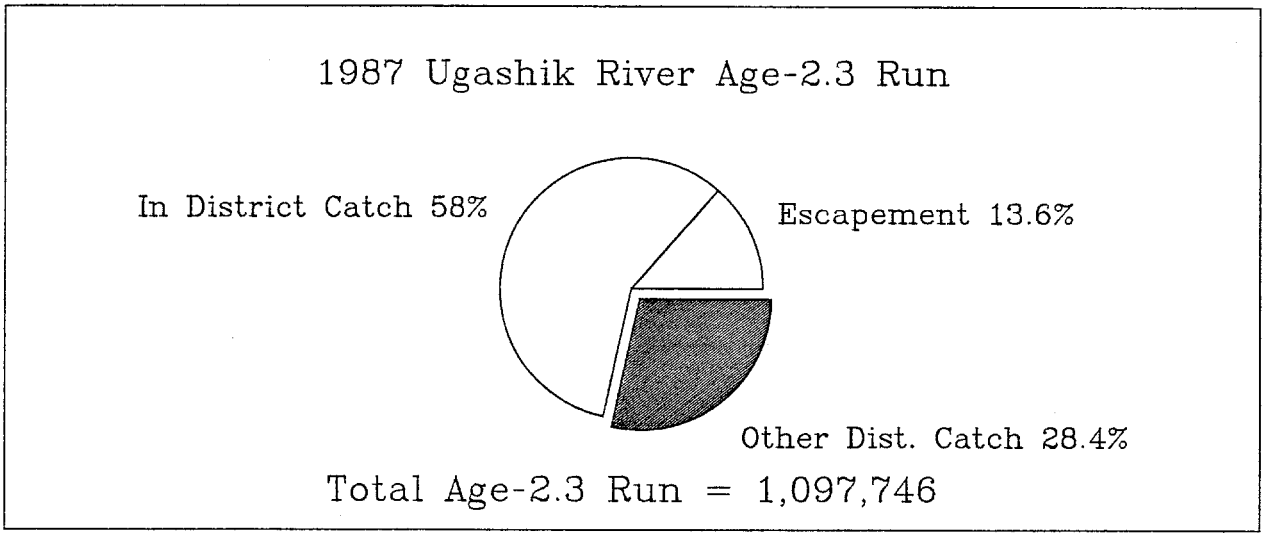


Figure 16. Age-1.2, age-2.3, and total run percentages to Egegik River in 1987 and the breakdown of run to escapement, in district catch, and other district catch.





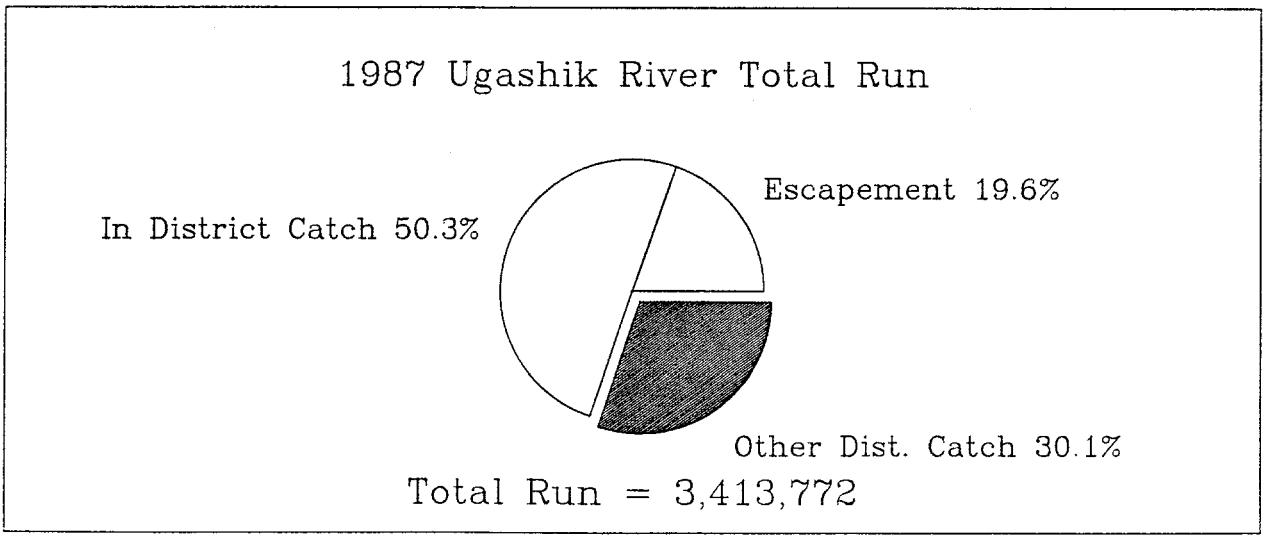


Figure 17. Age-1.2, age-2.3, and total run percentages to the Ugashik River in 1987 and the breakdown of run to escapement, in district catch, and other district catch.

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