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Origins of Sockeye Salmon in East Side Bristol Bay Fisheries in 1988 Based on Linear Discriminant Function Analysis of Scale Patterns

by

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and

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State of Alaska

Walter J. Hickel, Governor

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ORIGINS OF SOCKEYE SALMON IN EAST SIDE BRISTOL BAY FISHERIES IN 1988 BASED ON LINEAR DISCRIMINANT FUNCTION ANALYSIS OF SCALE PATTERNS

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF APPENDICES

ABSTRACT

We estimated stock compositions of the 1988 commercial harvest of sockeye salmon *Oncorhynchus nerka* in the Naknek-Kvichak, Egegik, and Ugashik Districts of Bristol Bay using analysis of scale patterns and age composition. Scale measurements from age-1.3 and age-2.2 fish from escapements were used to build discriminant functions, allowing commercial catches to be assigned to river of origin. Catches of sockeye salmon from other age groups were assigned to rivers by combining results from scale pattern analysis with escapement age composition.

Most sockeye salmon harvested in each fishing district originated from rivers within the district; however interceptions of outside stocks occurred in every area. Of the estimated 3,549,422 sockeye salmon caught in Naknek-Kvichak District, 82% were from Kvichak River, 14% from Naknek River, 3% from Egegik River, and 1% from Ugashik River. The estimated 6,400,126 sockeye salmon caught in Egegik District were comprised of the following rivers: 68% Egegik, 15% Kvichak, 7% Naknek, and 10% Ugashik. The Ugashik District harvest of 1,531,615 sockeye salmon was 78% Ugashik River, 3% Kvichak River, 10% Naknek River, and 9% Egegik River.

Sockeye runs to Naknek and Ugashik Rivers experienced the highest (27% and 26%) interception rates outside their districts. Runs to Kvichak (13%) and Egegik Rivers (4%) were intercepted outside their district at much lower rates. Total exploitation rates (inside and outside the district) by stock were 49% for Kvichak River, 51% for Naknek River, 74% for Egegik River, and 74% for Ugashik River.

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

INTRODUCTION

In mixed-stock fishery situations it is always the weaker stock that has the greatest risk of overexploitation. To minimize problems associated with mixed stock fisheries, the sockeye salmon *Oncorhynchus nerka* fishery within Bristol Bay has been constrained within districts and sections located near the mouths of spawning streams (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 fisheries, the West and East Side fisheries. The East Side fishery is composed of three districts: Naknek-Kvichak, Egegik, and Ugashik (Figure 1). Naknek-Kvichak District is subdivided into 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 degree of sockeye intermixing within the East Side districts was not quantified until 1986. From 1956 to 1985 total runs of sockeye salmon to Kvichak, Naknek, Egegik, and Ugashik Rivers were estimated by adding district catch to the escapement into each respective river within the district. Harvests within Naknek-Kvichak District were assigned to rivers of origin based on the age composition of contributing rivers (Naknek, Kvichak, and Branch Rivers). This method of estimating sockeye salmon runs by river for Bristol Bay, referred to as the standard method, operates under the assumption that all fish harvested in a district were returning to rivers within the district and that interception of fish from other districts did not occur (Yuen and Nelson 1987, Cross and Stratton 1988, Stratton and Cross 1990). Bernard (1983) evaluated the biases inherent with this procedure.

Decreased catches of sockeye salmon in Kvichak Section in 1985 and 1986, accompanied by large catch increases in Egegik and Ugashik Districts, 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 fisheries. Scale pattern studies were expanded and contributions by river to East Side district catches were estimated in 1986 (Bue et al. 1986) and 1987 (Cross and Stratton 1989).

The objectives of this ongoing investigation are to: (1) estimate stock composition of the 1988 commercial harvests of sockeye salmon in Naknek-Kvichak, Egegik, and Ugashik Districts; (2) estimate total run by river; and (3) compare estimates of run by river obtained from scale pattern analysis with those developed from the standard method. Increased accuracy in estimates of catch composition should allow managers to more effectively regulate for stock-specific harvest goals. More accurate estimates may also result in better preseason forecasts, more accurate spawner-return relationships, and optimal escapement goals.

METHODS

Estimation Of Catch and Escapement

Commercial catch statistics documented in ADF&G (1989) were taken from final operation reports prepared by fish processors. These numbers may differ slightly from final Alaska Department of Fish and Game (ADF&G) catch statistics because minor errors may be detected and corrected. Sockeye salmon escapement estimates were based on visual counts made from towers on the banks of Kvichak, Naknek, Egegik and Ugashik Rivers (ADF&G 1989). Counts were made on each river bank for 10 min every hour. Counts were made according to a set schedule in which fish were counted from one bank on the hour and from the opposite bank immediately following. 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). We used European notation (Koo 1962) to record ages; 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 a 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 scales which could not be aged 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, in which case samples were taken at least once every 3 d. Prior to 23 June and after 17 July, district sockeye catches were sampled 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. Fish were measured to the nearest millimeter from the middle of the eye to the fork of the tail. Sex was determined from morphometric characteristics. Methods and results of sampling sockeye catches in Bristol Bay for age composition in 1988 are reported by Stratton and Cross (1990).

Escapement samples were taken from sockeye salmon captured by beach seine at the counting tower sites. The goal for sampling escapements was set at 200 fish per day. This goal was selected so that 600 samples were available every 3 d. 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 Stratton and Cross (1990).

Estimation Of Catch 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 the East Side fishing districts in 1988.

Measurement Of Scale Patterns

Scale impressions were projected onto a digitizing tablet at 100X magnification using equipment similar to that described by Ryan and Christie (1976). To standardize each scale, measurements were taken along the anterior-posterior axis. This axis is approximately 20 degrees ventral of the long axis and perpendicular to the sculptured (anterior) field (Figure 2). Distances between growth rings (circuli) were measured, and the numbers of circuli were counted from the following scale growth zones: (1) center of 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-2.2 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 sockeye salmon (Figure 2). A total of 75 variables for age-1.3 and age-1.2 samples and 108 variables for age-2.2 samples were computed from the distance measurements and circuli counts (Table 1). We measured scale patterns of age-1.3 and age-2.2 sockeye salmon because these age groups comprised 64% of the commercial catch. In addition, we measured scale patterns of age-1.2 sockeye salmon from the escapements, however the age-1.2 discriminant model could not accurately identify the stocks.

Discriminant Analysis

Escapement samples from Kvichak, Naknek, Egegik, and Ugashik Rivers provided scales of known origin used to build the linear discriminant functions (LDF). Branch River, which is a tributary of the Kvichak River, was not included in the Kvichak River standard because it is numerically small compared to the numbers of sockeye salmon returning to Kvichak River (in 1988 Kvichak escapement was

8,317,500 and Branch escapement was 194,630). Commercial catch samples provided scales of mixed origin and were classified with the discriminant functions to estimate the contribution of each river to the age-1.3 and age-2.2 harvests. Escapement samples collected in 1988 were used to classify 1988 catches in the age-specific LDF models.

We examined frequency distribution plots for the principal scale variables (width and number of circuli for each growth zone). Differences between mean number of circuli and size of selected 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-1.3 Models. A four-way linear discriminant model was constructed from scale measurements of age-1.3 fish entering the Kvichak, Naknek, Egegik, and Ugashik Rivers. Approximately 200 scale samples weighted by run strength through time from each of the four rivers were used to build the discriminant models. The four-way (Kvichak, Naknek, Egegik, Ugashik) discriminant model was used to classify district catches of age-1.3 fish. In addition, we constructed a five-way model which included samples from West Side escapements to test the feasibility of estimating the possible interception of West Side stocks in the three East Side districts. We combined 50 samples from each of the four West Side escapements (Nushagak, Wood, Igushik, Togiak) into a pooled West Side group. We then built a five-way discriminant model which included the West Side group and Kvichak, Naknek, Egegik, and Ugashik Rivers.

Classification of Age-1.3 Fish. Linear discriminant models were used to assign unknown samples (age-1.3 fish from the commercial catches) to their rivers 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 were assumed 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 ≤ 0 for one or more stocks in the original model.

Initially, 50 age-1.3 scales from each sample date for each fishery were measured and classified with the discriminant model. Successive stock composition estimates were compared with chi-squared tests. If significant ($P < 0.05$) differences were not found between stock estimates, scale measurements from consecutive fishing periods were combined to achieve the desired sample size of 100. If the estimated stock proportions for consecutive fishing periods were significantly different, we measured an additional 50 age-1.3 samples from the fishing period.

We calculated the numbers of age-1.3 fish by stock in a specific catch stratum by multiplying the estimated stock proportion from scale pattern analysis with the estimated proportion of age-1.3 catch with the total catch:

$$\hat{C}_{i1.3} = C\hat{P}_{1.3}\hat{S}_{i1.3} \ , \tag{1}$$

where:

$\hat{C}_{i1.3}$ = estimated catch of age-1.3 fish returning to stock i;

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

$\hat{P}_{1.3}$ = estimated proportion of age-1.3 fish in the catch; and

$\hat{S}_{i1.3}$ = estimated proportion of age-1.3 fish of stock i in the catch.

The variance of the estimated catch of age-1.3 sockeye salmon, $V[\hat{C}_{i1.3}]$, from each stock in a specific fishery at a given time was calculated as an exact variance of a product according to Goodman (1960):

$$V[\hat{C}_{i1.3}] = C^2V[\hat{P}_{1.3}\hat{S}_{i1.3}], \text{ and} \tag{2}$$

$$V[\hat{P}_{1.3}\hat{S}_{i1.3}] = V[\hat{P}_{1.3}]\hat{S}^2_{i1.3} + V[\hat{S}_{i1.3}]\hat{P}^2_{1.3} - V[\hat{S}_{i1.3}]V[\hat{P}_{1.3}]. \tag{3}$$

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 period. Finally, the contributions by stock to each fishery were added to produce the total contribution by stock to the East Side age-1.3 sockeye salmon harvest, and the variance of the total contribution by stock was calculated as the sum of the variances for each fishery.

In addition to classifying age-1.3 samples from East Side district catches to river of origin, we also classified age-1.3 samples taken from West Side escapements (Nushagak, Wood, Igushik, Togiak) with the four-way East Side model (Kvichak, Naknek, Egegik, Ugashik). We did this to understand which East Side rivers the West Side systems would misclassify as if they were intercepted in the East Side district catches but not included in the analysis.

Construction of Age-2.2 Models. A four-way linear discriminant model was constructed from scale measurements of age-2.2 fish entering Kvichak, Naknek, Egegik, and Ugashik Rivers. Models were built from 200 age-2.2 scales from each river's escapement and were weighted through time based on tower counts.

Classification of Age-2.2 Fish. The four-way linear discriminant model (Kvichak/Naknek/Egegik/Ugashik) was used to classify age-2.2 sockeye salmon caught in the three East Side districts. Procedures used for the age-2.2 scale pattern analysis were the same as those used for the age-1.3 analysis.

Construction of Age-1.2 Models. A four-way linear discriminant model was constructed from scale measurements of age-1.2 fish entering Kvichak, Naknek, Egegik, and Ugashik Rivers. Models were built from 100 age-1.2 scales from each river's escapement and were weighted through time based on tower counts.

Estimation Of Stock Composition For Minor Age Groups

Estimates of stock composition for sockeye salmon of minor ages (other than age-1.3 and age-2.2) harvested in the three East Side districts were based on the combined scale pattern estimates for age-1.3 and age-2.2 fish. In addition, the combined ratio of age-1.3 and age-2.2 fish to sockeye salmon of minor age groups within respective escapements was used. Scale pattern estimates and age composition information were combined as follows:

$$\hat{S}_{ij} = \frac{\hat{S}_{i(1.3,2.2)}(\hat{E}_{ij}/\hat{E}_{i(1.3,2.2)})}{\sum_{i=1}^{n}\hat{S}_{i(1.3,2.2)}(\hat{E}_{ij}/\hat{E}_{i(1.3,2.2)})}, \tag{4}$$

$$\hat{S}_{i(1.3,2.2)} = \frac{\hat{C}_{i1.3} + \hat{C}_{i2.2}}{\hat{C}_{1.3} + \hat{C}_{2.2}}, \tag{5}$$

$$\hat{E}_{i(1.3,2.2)} = \frac{\hat{E}_{i1.3} + \hat{E}_{i2.2}}{E_i}, \tag{6}$$

where:

$\hat{S}_{ij}$ = estimated proportion of stock i in the catches of age-j fish;

$\hat{S}_{i(1.3,2.2)}$ = estimated proportion of stock i in the combined catches of age-1.3 and -2.2 fish;

$\hat{E}_{ij}$ = estimated proportion of age-j fish in the escapement of stock i;

$\hat{E}_{i(1.3,2.2)}$ = estimated combined proportion of age-1.3 and -2.2 fish in the escapement of stock i;

$\hat{C}_{i1.3}$ = estimated numbers of age-1.3 fish in stock i caught in a fishery;

$\hat{C}_{i2.2}$ = estimated numbers of age-2.2 fish in stock i caught in a fishery;

$\hat{C}_{1.3}$ = estimated numbers of age-1.3 fish caught in a fishery;

$\hat{C}_{2.2}$ = estimated numbers of age-2.2 fish caught in a fishery;

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

$\hat{E}_{i2.2}$ = estimated numbers of age-2.2 fish in the escapement of stock i;

E_i = numbers of fish escaping in stock i; and

n = number of stocks.

Estimation Of Run Size

The size of the sockeye salmon run to each river was estimated 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.

RESULTS

Catch and Escapement

In 1988 commercial fishermen harvested an estimated 11,481,163 sockeye salmon in the East Side districts (Table 2), compared to an average catch from 1978-87 of 17.0 million. Sockeye salmon caught in the Egegik District (6,400,126) accounted for 56% of the East Side catch, while catches in Naknek-Kvichak (3,549,422) and Ugashik (1,531,615) Districts comprised 31% and 13%, respectively. Peak catches

occurred in Naknek-Kvichak District during 1-16 July, in Egegik District during 20 June through 13 July, and in Ugashik District from 9-14 July.

In 1988 an estimated 4,065,216 sockeye salmon escaped into Kvichak River, 83% of the sockeye salmon were counted during 2-13 July (Table 3). Escapement into Naknek River was estimated at 1,037,862 sockeye salmon, with 80% occurring during 30 June through 10 July. An estimated 1,612,680 sockeye salmon escaped into Egegik River. Approximately 83% of the escapement into Egegik River was obtained from 28 June through 11 July. Escapement into Ugashik River was estimated at 642,972 sockeye salmon; 73% passed the counting tower in 7 d (14-20 July).

Age Composition

Four age groups made up most (99.2%) of the East Side catch: age-1.2 (16.6%), age-1.3 (35.7%), age-2.2 (28.1%), and age-2.3 (18.8%) (Table 4). Percentages by age differed among district catches. Naknek-Kvichak District catch was mostly comprised of age-1.3 (44.2%) and age-1.2 (31.8%) sockeye salmon. Egegik District catch had similar percentages of age-1.3 (35.4%) and age-2.2 (35.2%) sockeye salmon. Age-2.3 sockeye salmon predominated (35.2%) in Ugashik District catch, followed by age-2.2 (26.4%).

Age composition of sockeye salmon escaping into rivers varied considerably among runs (Table 5). Escapement into Kvichak River was predominantly age-1.3 (41.3%) and age-1.2 (38.3%) sockeye salmon, while the escapement into Naknek River was divided among ages 1.2 (27.6%), 1.3 (26%), 2.2 (18.9%), and 2.3 (23.7%). Sockeye salmon escaping into Egegik River were mostly age-2.2 (48%) and age-1.3 (26.5%). The escapement into Ugashik River was comprised of higher percentages of younger fish than the district catch. Age composition of the Ugashik River escapement was 24.4% age-1.2, 10.1% age-1.3, 29.6% age-2.2, and 27.9% age-2.3.

Classification Models

Age 1.3

Variables which provided the greatest discrimination among stocks of age-1.3 sockeye salmon in the four-way East Side model were variable 2 (size of first freshwater zone), variable 19 (relative width among circuli from scale focus to circulus 8), and variable 6 (distance from scale focus to circulus 8). Freshwater growth of Egegik River fish was greatest, followed by freshwater growth of Ugashik, Naknek, and Kvichak fish (Table 6). Frequency distribution plots of the size of the freshwater growth zone show Egegik samples to be the most distinctive and Naknek and Kvichak samples to be the most similar (Figure 3).

We computed t-statistics to test for differences in the mean values of the number of circuli and size of each growth zone for males and females by stock for Kvichak, Naknek, Egegik, and Ugashik Rivers (Table 7). We found significant differences between sexes for (1) size of first freshwater growth zone for Naknek

River age-1.3 fish, (2) size of first ocean growth zone for Egegik River age-1.3 fish, and (3) the size of the second ocean growth zone for Ugashik River age-1.3 fish. Because there were no growth zones which were consistently different between sexes for all stocks, we combined samples of males and females to build the models.

Variables which provided the greatest discrimination among stocks of age-1.3 sockeye salmon in the five-way model (West Side combined/ Kvichak/ Naknek/ Egegik/ Ugashik) were variable 2 (size of first freshwater growth zone), variable 22 (relative width among circuli from circulus 2 to circulus 8 in first freshwater), and variable 9 (distance from circulus 2 to circulus 8 in first freshwater). Mean proportion correctly classified in the five-way model was 0.66 (Appendix A.1). Classification accuracies were fairly high for Egegik (0.86), Kvichak (0.72), Ugashik (0.65), and West Side combined (0.61); while classification accuracy for Naknek River was low (0.48). Because the inclusion of the West Side group reduced the ability of the discriminant model to identify Naknek sockeye salmon, and results from earlier tagging studies (Straty, 1975) indicated that West Side stocks were not present in large numbers in East Side districts, the four-way model, which only included East Side stocks, was used to estimate the catch composition of the East Side districts.

Catches of age-1.3 sockeye salmon from East Side districts were initially classified to natal streams with a four-way model (Kvichak, Naknek, Egegik, Ugashik Rivers). The mean proportion correctly classified by the four-way model was 0.735 (Table 8). The correct classification for Egegik River (0.875) was extremely high, while those for Kvichak (0.755) and Ugashik (0.710) were similar. Proportions correctly classified were lower for Naknek River (0.601). Samples from Naknek River misclassified equally to Kvichak and Ugashik Rivers. The range of classification accuracies was 0.720 to 0.847 for three-way models and 0.796 to 0.993 for two-way models.

Age 2.2

Scale characters which differed the most among stocks of age-2.2 sockeye salmon were: variable 2 (size of first freshwater growth zone), variable 31 (number of circuli in the second freshwater growth zone), and variable 5 (distance from scale focus to circulus 6). Mean values of variable 2 were greatest for samples from Egegik River and smallest for samples from Ugashik River (Table 9 and Figure 4).

Only samples from Ugashik River showed significant differences for scale variables between sexes. Differences between sexes were found for variable 65 (the size of first freshwater zone plus size of second freshwater growth zone plus size of plus growth zone) and for variable 71 (the size first ocean growth zone; Table 10).

The mean proportion correctly classified for age-2.2 samples by the four-way model of Kvichak, Naknek, Egegik and Ugashik Rivers was 0.734 (Table 11). Correct classifications for Ugashik River was the highest (0.800), followed by Egegik (0.740) and Kvichak (0.730) Rivers. Classification accuracy for Naknek River was lowest (0.667). Classification accuracies for three-way models ranged

from 0.793 to 0.832. Classification accuracies for two-way models ranged from 0.819 to 0.940 (Table 11).

Age 1.2

Scale characters which differed the most among stocks of age-1.2 sockeye salmon were variable 19 (relative width among circuli from the scale focus to circulus 8), variable 14 (distance from circulus 2 to end of first freshwater), and variable 78 (distance from circulus 3 to circulus 9 in first ocean). The mean proportion correctly classified by the four-way age-1.2 model of Kvichak, Naknek, Egegik and Ugashik Rivers was only 0.604 (Appendix A.2). Correct classifications for Kvichak River were the highest (0.788), followed by Ugashik (0.710) and Egegik (0.690) Rivers. Classification accuracy for Naknek River was extremely low (0.230), with a higher proportion of Naknek samples misclassifying to other rivers than correctly classifying to Naknek River. Due to the high misclassification of Naknek River samples, we felt the age-1.2 model was not sufficiently accurate for catch identification and did not use it in the analysis.

Estimates Of Catch Composition

Age 1.3

Most age-1.3 sockeye salmon harvested in each district originated from rivers within the district (Table 12). Of the 1,566,865 age-1.3 sockeye salmon caught in Naknek-Kvichak District, 97.9% originated within the district and 2.1% were from outside the district (Figure 5). There were no strong temporal trends (nonstatistical comparison=NSC) in the age-1.3 stock proportions in Naknek-Kvichak District catches. Of the estimated 2,264,798 age-1.3 sockeye salmon caught in Egegik District, 64.1% originated from Egegik River and 35.9% were produced outside the district (Figure 6). The percentages of Egegik age-1.3 fish harvested in Egegik District were lower early in the season, increased during the peak of the season, then decreased towards the end of the season. The catch of age-1.3 sockeye salmon in Ugashik District was 271,043 fish, 76.2% originated in Ugashik River and 23.8% from stocks outside the district (Figure 7). The contribution of Ugashik River age-1.3 sockeye salmon to Ugashik District catch was low prior to 9 July, then increased greatly.

The 90% confidence intervals around stock composition point estimates of age-1.3 fish varied because the accuracies of the classification models differed by stock (Table 12). Estimates for age-1.3 catch contributions for Kvichak and Egegik Rivers were more precise than other rivers, with 90% confidence intervals ranging from $\pm$0.06 to $\pm$0.20. 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, ranging 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 Kvichak River, 0.04 for Egegik River (Table 13).

Coefficients of variation were much larger for age-1.3 proportions from Ugashik River (0.17) and Naknek River (0.19) because their contributions were much less and the model accuracies for these systems were lower.

Age 2.2

Most age-2.2 sockeye salmon harvested in each district originated from rivers within the district (Table 14). Of the 568,786 age-2.2 sockeye salmon caught in Naknek-Kvichak District, 91.8% originated within the district, and 8.2% were from outside the district (Figure 8). An estimated 2,253,463 age-2.2 sockeye salmon were caught in Egegik District, 82.5% originating from Egegik River and 17.5% originating outside the district (Figure 9). The catch of age-2.2 sockeye salmon in Ugashik District was 403,976 fish, 67.1% originating in Ugashik River and 32.9% from stocks outside the district (Figure 10). Temporal changes in the contribution of age-2.2 Kvichak River fish to the catch in Naknek-Kvichak District and the contribution of age-2.2 Ugashik River fish to the catch in Ugashik District were similar to those of the age-1.3 catch contributions by river. The contribution of Egegik River to the age-2.2 catch in Egegik District was high throughout the season.

The 90% confidence intervals around age-2.2 stock composition estimates ranged from $\pm$0.10 to $\pm$0.25 (Table 14). Coefficients of variation for estimated numbers of age-2.2 sockeye salmon by stock in the harvest were 0.03 for the Egegik River, 0.08 for Kvichak River, 0.10 for Ugashik River, and 0.19 for Naknek River (Table 15).

All Ages

The Naknek-Kvichak District sockeye salmon harvest was comprised of 2,912,462 fish from Kvichak River, 516,444 fish from Naknek River, 95,322 fish from Egegik River and 25,194 fish from Ugashik River (Table 16). Percent contribution by stock to the Naknek-Kvichak District total catch was 82.1% Kvichak, 14.6% Naknek, 2.7% Egegik, and 0.7% Ugashik Rivers (Figure 11). An estimated 4,379,166 sockeye salmon caught in Egegik District were from Egegik River, 975,062 were from Kvichak River, 413,540 were from Naknek River, and 632,358 were from Ugashik River (Table 17). Percent catch contributions by stock in Egegik District were 68.4% Egegik, 15.2% Kvichak, 9.9% Ugashik, and 6.5% Naknek Rivers (Figure 12). Ugashik River sockeye salmon predominated (1,193,490 fish) in Ugashik District catch, followed by 150,745 Naknek River fish, 141,983 Egegik River fish, and 45,397 Kvichak River fish (Table 18). The total Ugashik District sockeye catch was comprised of 77.9% Ugashik River fish, 9.8% Naknek River fish, 9.3% Egegik River fish, and 3% Kvichak River fish (Figure 13).

Stock Interceptions By District

Of the 3,932,921 Kvichak River sockeye salmon harvested in 1988, 74% were taken in Naknek-Kvichak District, 24.8% were taken in Egegik District, and 1.2% were taken in Ugashik District (Table 19). Approximately 47.8% of Naknek River

sockeye salmon were harvested in Naknek-Kvichak District, followed by 38.3% caught in Egegik District and 13.9% caught in Ugashik District. Most (94.8%) Egegik River fish were harvested in Egegik District, while 5.2% were taken in Naknek-Kvichak (2.1%) and Ugashik (3.1%) Districts. The largest (64.4%) harvest of Ugashik River sockeye salmon occurred in Ugashik District, followed by Egegik District (34.2%) and Naknek-Kvichak District (1.4%).

An estimated 1,584,744 sockeye salmon destined for Kvichak and Naknek Rivers were intercepted in districts outside their natal district. Conversely, fishermen in Naknek-Kvichak District intercepted 120,516 sockeye salmon which were headed for other rivers; thus, Naknek-Kvichak District realized a net loss of 1,464,228 fish. The number of Egegik River sockeye salmon intercepted in other districts was 237,305, while fishermen in Egegik District caught 2,020,960 sockeye salmon which originated in other districts. Therefore, in 1988 Egegik District fishermen realized a net gain of 1,783,655 sockeye salmon. An estimated 657,552 Ugashik River sockeye salmon were intercepted outside Ugashik District and 338,125 sockeye salmon from other rivers were caught in Ugashik District. This resulted in a net loss to Ugashik District fishermen of 319,427 sockeye salmon.

Misclassification Of West Side Rivers

When treated as unknowns and classified with a four-way discriminant model, age-1.3 samples from Nushagak, Wood, Igushik, and Togiak Rivers classified primarily to Naknek and Kvichak Rivers (Appendix A.3). Samples from Nushagak River classified in similar proportions to Kvichak (0.44) and Naknek (0.56) Rivers. Wood River samples classified to Kvichak (0.48), Naknek (0.41), and Ugashik (0.10) Rivers. All samples from Igushik and Togiak Rivers classified to Naknek River. Based on these results, it appears that if West Side stocks are caught within East Side districts, they are misclassified as Kvichak and Naknek stocks. Consequently, the presence of West Side stocks in East Side districts would inflate estimates of Kvichak and Naknek contributions to the catch.

Runs By River System

The 1988 sockeye salmon run to Kvichak River was estimated at 7,998,137 fish; 50.8% escaped into the river, 36.4% were harvested within Naknek-Kvichak District, and 12.8% were harvested in other districts (Tables 20-21 and Figure 14). Of the 2,118,591 sockeye salmon returning to Naknek River, 49% escaped into the river, 24.4% were caught in Naknek-Kvichak District, and 26.6% were caught in other districts (Figure 15). Distribution of the 6,229,153 sockeye salmon returning to Egegik River was 25.9% to the escapement, 70.3% to Egegik District harvest, and 3.8% to other districts harvests (Figure 16). Ugashik River had a sockeye salmon run estimated at 2,494,014 fish; 25.8% escaped into the river, 47.8% were harvested within Ugashik District, and 26.4% were harvested in other districts (Figure 17).

Exploitation Rates

Naknek River (26.6%) and Ugashik River (26.4%) runs experienced the highest rates of exploitation outside their natal districts, followed by Kvichak River (12.8%) and Egegik River (3.8%) runs. Overall (inside and outside the district) exploitation rates by stock were: 49.2% for Kvichak River, 51.0% for Naknek River, 74.1% for Egegik River, and 74.2% for Ugashik River (Tables 20 and 21).

Comparison Of Run Estimates

Interception of outside stocks within a district was not considered in past procedures used to estimate total runs for East Side 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 to Kvichak and Naknek Rivers . The greatest differences in numbers of fish between the STD and SPA were for runs returning to Egegik and Kvichak Rivers (Table 22). Based on SPA, the Egegik River run was over-estimated by 1,783,653 sockeye salmon by STD. Conversely, the STD run estimate for Kvichak River was 1,119,307 fish less than the SPA estimate. The STD and SPA estimates for Naknek River differed by 344,919 fish, with the STD estimate being lower. The STD estimate of run size for Ugashik River was also lower by 319,427 fish than that estimated by SPA. 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 1988 we would over-estimate the run to Egegik River and under-estimate the runs to Kvichak, Naknek and Ugashik Rivers.

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Table 1. Scale variables screened for linear discriminant function analysis of age-1.3, and -2.2 sockeye salmon for the East Side of Bristol Bay, 1988.

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 26	C0-C2/S1FW ... C(NC-2)-E1FW/S1FW	Relative widths, (variables 3-13)/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 4).

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 56	E1FW-C2/S2FW ... C(NC-2)-E2FW/S2FW	Relative widths, (variables 33-43)/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

-Continued-

Table 1. (p 3 of 4).

Variable Number	Variable Name	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
		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)-E13OZ	Distance, circulus (number circuli first ocean minus 3) to end first ocean

-Continued-

Table 1. (p 4 of 4).

Variable Number	Variable Name	Zone
		First Marine Annular Zone
87	C3-E10Z	Distance, circulus 3 to end of first ocean
88	C9-E10Z	Distance, circulus 9 to end of first ocean
89	C15-E10Z	Distance, circulus 15 to end of first ocean
90 thru 104	EFW-C3/S10Z ... C(NC-3)-E13OZ/S10Z	Relative widths, (variables 72-86)/S10Z
105	S10Z/NC10Z	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/S10Z	Relative width, (variable 107)/S10Z
		Second Marine Annular Zone
109	S20Z	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, 1988.

Date	Catch (Nos. of Fish)[a]			
	Naknek-Kvichak	Egegik	Ugashik	East Side
6/01-6/17	18,824	147,403	4,796	171,023
6/18	3,970			3,970
6/20	34,689	292,350	6,288	333,327
6/21	64,340	215,591	17,120	297,051
6/22	99,478	259,472	22,578	381,528
6/23	43,707	244,216	13,672	301,595
6/26			144[a]	144
6/27	361,061	519,225	3[b]	880,289
6/29		938,322	324[b]	938,646
7/01	675,222	1,007,728	285[b]	1,683,235
7/03-7/04	153,892	145,767[c]	36,789	336,448
7/05	376,000	229,893		605,893
7/06		327,356		327,356
7/07		104,687		104,687
7/08		354,901	1,045[b]	355,946
7/09		306,276	215,221	521,497
7/10	149,658	462		150,120
7/11-7/12	544,163	429,193	437,165	1,410,521
7/13	82,250	264,725	424,741	771,716
7/14	374,888	92,229	196,132	663,249
7/15	190,920	164,399	28,975	384,294
7/16	158,472	119,563	99,510	377,545
7/17	69,548	52,318		121,866
7/18	42,321	69,980		112,301
7/19	31,196	41,532		72,728
7/20	15,184	19,157		34,341
7/21	16,015	21,271		37,286
7/22	13,439	14,536		27,975
7/23	7,545			7,545
7/24-7/31	18,709	14,237	24,409	57,355
8/01-9/09	3,931	3,337	2,418	9,686
Totals	3,549,422	6,400,126	1,531,615	11,481,163

[a] Blanks indicate a district was closed.

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

[c] Includes 2,017 fish caught on 7/03 by an ADF&G test fishery.

Table 3. Escapement of sockeye salmon by river and date for the East Side of Bristol Bay, 1988.

	Kvichak Escapement		Naknek Escapement		Egegik Escapement		Ugashik Escapement	
Date	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
06/22			618	618	10,032	10,032		
06/23			252	870	6,768	16,800		
06/24			1,062	1,932	5,964	22,764		
06/25	1,068	1,068	15,492	17,424	2,256	25,020		
06/26	3,378	4,446	9,564	26,988	6,636	31,656		
06/27	71,958	76,404	39,540	66,528	17,100	48,756		
06/28	188,070	264,474	8,718	75,246	96,108	144,864		
06/29	48,396	309,378	9,528	84,774	111,444	256,308		
06/30	14,730	312,870	67,272	152,046	66,288	322,596		
07/01	36,204	363,804	140,556	292,602	39,348	361,944		
07/02	414,204	778,008	47,586	340,188	58,164	420,108		
07/03	414,504	1,192,512	120,600	460,788	109,584	529,692		
07/04	405,258	1,597,770	56,448	517,236	126,168	655,860	3,792	3,792
07/05	303,438	1,901,208	24,906	542,142	158,940	814,800	1,968	5,760
07/06	178,062	2,079,270	14,988	557,130	135,216	950,016	1,296	7,056
07/07	109,842	2,189,112	31,806	588,936	81,666	1,031,682	312	7,368
07/08	42,528	2,231,640	71,262	660,198	115,896	1,147,578	360	7,728
07/09	40,224	2,271,864	111,612	771,810	64,506	1,212,084	3,240	10,968
07/10	117,084	2,388,948	134,046	905,856	78,918	1,291,002	750	11,718
07/11	385,602	2,774,550	23,280	929,136	104,148	1,395,150	642	12,360
07/12	698,280	3,472,830	21,666	950,802	42,048	1,437,198	504	12,864
07/13	279,762	3,752,592	28,170	978,972	53,796	1,490,994	11,694	24,558
07/14	87,486	3,840,078	21,720	1,000,692	79,578	1,570,572	66,366	90,924
07/15	107,856	3,947,934	6,696	1,007,388	9,804	1,580,376	96,690	187,614
07/16	41,706	3,989,640	20,232	1,027,620	5,466	1,585,842	130,008	317,622
07/17	30,636	4,020,276	5,202	1,032,822	8,328	1,594,170	35,340	352,962
07/18	25,224	4,045,500	2,286	1,035,108	10,938	1,605,108	53,004	405,966
07/19	11,742	4,057,242	1,764	1,036,872	4,662	1,609,770	54,756	460,722
07/20	4,276	4,061,538	990	1,037,862	1,986	1,611,756	36,426	497,148
07/21	3,078	4,064,616			924	1,612,680	29,826	526,974
07/22	600	4,065,216					25,806	552,780
07/23							21,198	573,978
07/24							11,016	584,994
07/25							14,778	599,772
07/26							25,980	625,752
07/27							6,126	631,878
07/28							2,334	634,212
07/29							2,220	636,432
07/30							2,718	639,150
07/31							2,070	641,220
08/01							1,056	642,276
08/02							696	642,972
Total		4,065,216		1,037,862		1,612,680		642,972[a]

[a] An additional 11,440 sockeye were counted in the drainages of the Dog Salmon and King Salmon Rivers, bringing the Ugashik District sockeye salmon escapement total to 654,412.

Table 4. Age composition by brood year of sockeye salmon commercial catches for the East Side of Bristol Bay, 1988.

District	Sample Size		1985		1984			1983			1982			1981		Total
			0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	1.4	2.3	3.2	2.4	3.3	
Naknek-Kvichak	6,350	Numbers		1,170	2,735	1,126,540	4,329		1,566,865	568,786	11,411	267,586				3,549,422
		Percent		0.0[a]	0.1	31.8	0.1		44.2	16.0	0.3	7.5				100.0
		SE		897	1,401	20,761	1,980		21,945	16,084	2,424	12,229				
Egegik	7,416	Numbers	3,420		7,542	483,157	9,777	704	2,264,798	2,253,463	8,383	1,355,103	7,606		6,173	6,400,126
		Percent	0.0[a]		0.1	7.6	0.2	0.0[a]	35.4	35.2	0.1	21.2	0.1		0.1	100.0
		SE	2,042		2,416	20,495	4,180	728	35,908	36,898	3,414	31,397	2,416		2,416	
Ugashik	3,024	Numbers	679		1,720	296,979	7,350	810	271,043	403,976	8,409	539,551		609	489	1,531,615
		Percent	0.0[a]		0.1	19.4	0.5	0.1	17.7	26.4	0.6	35.2		0.0[a]	0.0[a]	100.0
		SE	627		1,512	10,826	2,305	874	10,826	12,456	1,950	12,931		509	460	
Total East Side	16,790	Numbers	4,099	1,170	11,997	1,906,676	21,456	1,514	4,102,706	3,226,225	28,203	2,162,240	7,606	609	6,662	11,481,163
		Percent	0.1	0.0[a]	0.1	16.6	0.2	0.0[a]	35.7	28.1	0.2	18.8	0.1	0.0[a]	0.1	100.0
		SE	2,136	897	3,176	31,117	5,168	1,137	43,453	42,134	4,619	36,090	2,416	509	2,459	

[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, 1988.

River	Sample Size		1985		1984			1983		1982			1981		Total
			0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	
Kvichak	2,366	Numbers	3,485	5,909	1,162	1,557,148	40,309	1,679,241	700,039	3,446	74,447				4,065,216
		Percent	0.1	0.2	0.0[a]	38.3	1.0	41.3	17.2	0.1	1.8				100.0
Naknek	1,933	Numbers		1,749		286,579	21,061	270,194	196,517	13,194	246,005		2,564		1,037,862
		Percent		0.2		27.6	2.0	26.0	18.9	1.3	23.7		0.3		100.0
Egegik	3,276	Numbers	461	341.0		98,856	74,089	427,507	774,308	816	232,060	3,085		1,157	1,612,680
		Percent	0.0[a]	0.0[a]		6.1	4.6	26.5	48.0	0.1	14.4	0.2		0.1	100.0
Ugashik	2,714	Numbers	1,046	506	3,451	156,897	45,466	65,096	190,502	540	179,319		149		642,972
		Percent	0.2	0.1	0.5	24.4	7.1	10.1	29.6	0.1	27.9		0.0[a]		100.0

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

Table 6. Mean and standard error of age-1.3 scale variables used to construct linear discriminant functions for the East Side of Bristol Bay, 1988.

Variable Number	Variable Name	Kvichak		Naknek		Egegik		Ugashik	
		Mean[a]	SE	Mean[a]	SE	Mean[a]	SE	Mean[a]	SE
First Freshwater Annular Zone									
1	NC1FW	11.17	0.085	11.93	0.144	16.76	0.091	13.86	0.115
2	S1FW	143.72	0.995	146.87	1.414	211.90	1.200	162.61	1.423
5	C0-C6	96.31	0.516	94.40	0.456	102.59	0.481	90.43	0.521
6	C0-C8	117.26	0.576	113.84	0.541	125.12	0.535	111.00	0.636
11	C4-C8	44.05	0.302	40.96	0.330	46.86	0.298	40.79	0.355
12	C(NC-4)-E1FW	34.86	0.322	33.71	0.321	36.52	0.335	32.66	0.310
15	C4-E1FW	70.51	0.902	73.95	1.426	133.64	1.092	92.40	1.312
16	C0-C2/S1FW	0.34	0.003	0.33	0.004	0.24	0.002	0.29	0.003
17	C0-C4/S1FW	0.51	0.004	0.51	0.005	0.37	0.002	0.44	0.004
18	C0-C6/S1FW	0.67	0.004	0.65	0.006	0.49	0.002	0.56	0.004
19	C0-C8/S1FW	0.82	0.005	0.78	0.007	0.59	0.003	0.69	0.005
24	C4-C8/S1FW	0.31	0.002	0.28	0.002	0.22	0.001	0.25	0.002
25	C(NC-4)-E1FW/S1FW	0.25	0.003	0.23	0.003	0.17	0.002	0.20	0.002
27	S1FW/NC1FW	12.91	0.066	12.43	0.074	12.67	0.052	11.76	0.064
Plus Growth Zone									
61	NCPG	2.15	0.068	2.15	0.101	1.41	0.046	1.80	0.061
62	SPGZ	20.79	0.654	19.76	1.112	12.79	0.583	15.91	0.668
Freshwater and Plus Growth Zones									
65	NC1FW+NCPG	13.32	0.096	14.07	0.172	18.17	0.088	15.66	0.116
66	S1FW+SPGZ	164.51	1.071	166.63	1.767	224.68	1.165	178.52	1.458
67	S1FW/S1FW+SPGZ	0.88	0.004	0.89	0.006	0.94	0.003	0.91	0.004
First Marine Annular Zone									
70	NC1OZ	21.68	0.152	23.71	0.231	20.91	0.146	21.65	0.164
78	C3-C9	121.31	0.950	105.88	1.523	134.07	0.940	121.10	1.116
88	C9-E1OZ	90.02	2.410	126.23	3.785	73.84	2.021	88.17	2.545
91	EFW-C6/S1OZ	0.29	0.004	0.24	0.005	0.32	0.004	0.29	0.004
92	EFW-C9/S1OZ	0.45	0.005	0.38	0.007	0.50	0.004	0.46	0.005
95	C3-C9/S1OZ	0.33	0.003	0.28	0.005	0.37	0.003	0.33	0.003
99	C6-C9/S1OZ	0.16	0.002	0.15	0.003	0.18	0.002	0.16	0.002
108	MAX DIST/S1OZ	0.08	0.001	0.07	0.001	0.08	0.001	0.07	0.001
Sample Size		200		200		200		200	

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

Table 7. Mean, variance, and t-statistic comparing males and females for selected scale variables of age-1.3 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1988.

River	Sex	Sample Size		NC1FW	S1FW	NCPGZ	SPGZ	NC1OZ	S1OZ	S2OZ
Kvichak River	Male	74	Mean	11.18	143.38	2.15	21.00	21.80	374.19	350.54
			Variance	1.43	248.21	0.79	78.27	5.31	1623.50	1844.42
	Female	126	Mean	11.17	143.92	2.15	20.67	21.61	368.83	350.92
			Variance	1.44	170.39	0.99	90.56	4.26	1094.54	1863.43
	Combined	200	Mean	11.17	143.72	2.15	20.79	21.68	370.82	350.78
			Variance	1.43	198.15	0.91	85.62	4.63	1289.80	1847.13
	T-Statistic			0.23	-0.10	-1.30	-0.84	1.53	1.64	-0.46
Naknek River	Male	84	Mean	12.10	150.37	2.19	21.65	23.45	390.88	333.48
			Variance	4.69	525.59	2.23	277.02	10.13	1853.29	2732.52
	Female	116	Mean	11.80	144.33	2.11	18.39	23.89	392.21	328.05
			Variance	3.78	297.16	1.93	223.46	11.07	1917.82	1654.61
	Combined	200	Mean	11.93	146.87	2.15	19.76	23.71	391.65	330.33
			Variance	4.16	399.88	2.04	247.29	10.67	1881.70	2103.08
	T-Statistic			1.17	2.03[a]	0.08	1.01	-0.35	0.35	1.09
Egegik River	Male	97	Mean	16.73	213.31	1.42	12.56	20.80	373.23	351.63
			Variance	1.68	315.20	0.39	63.19	3.70	1140.11	2114.38
	Female	102	Mean	16.78	210.65	1.40	13.05	21.00	364.16	339.38
			Variance	1.66	263.42	0.46	73.75	4.83	904.39	2457.78
	Combined	200[b]	Mean	16.76	211.90	1.41	12.79	20.91	368.58	345.26
			Variance	1.65	288.01	0.42	68.09	4.25	1029.57	2306.58
	T-Statistic			-0.29	1.10	0.22	-0.42	-0.67	2.00[a]	1.80
Ugashik River	Male	105	Mean	13.90	163.65	1.82	16.31	21.71	370.55	363.06
			Variance	3.11	442.69	0.71	91.20	4.84	1246.37	2693.92
	Female	95	Mean	13.81	161.46	1.77	15.45	21.57	364.80	343.74
			Variance	2.16	364.68	0.78	87.68	6.01	987.01	2720.13
	Combined	200	Mean	13.86	162.61	1.80	15.92	21.65	367.82	353.88
			Variance	2.64	404.81	0.74	89.26	5.38	1125.89	2786.32
	T-Statistic			0.41	0.77	0.42	0.64	0.44	1.21	2.62[a]

[a] Significant, alpha = 0.05.

[b] Includes one unsexed sampled.

Table 8. Classification matrices from discriminant analyses of age-1.3 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1988.

Actual Group Of Origin	Sample Size	Classified Group of Origin			
		Kvichak	Naknek	Egegik	Ugashik
Kvichak	200	0.755	0.130	0.000	0.115
Naknek	200	0.192	0.601	0.015	0.192
Egegik	200	0.000	0.000	0.875	0.125
Ugashik	200	0.070	0.155	0.065	0.710

Mean proportion correctly classified = 0.735
Variables used: 2,19,6,17,61,15,18,108,99,88,78
Box's Test of Variance-Covariance Equality[a]
F-statistic = 13.53
D.F. = 198, 1356426

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Naknek	Egegik
Kvichak	200	0.810	0.190	0.000
Naknek	200	0.222	0.753	0.025
Egegik	200	0.025	0.030	0.945

Mean proportion correctly classified = 0.836
Variables used: 2,24,11,61,108,99,88,78
Box's Test of Variance-Covariance Equality
F-statistic = 19.56
D.F. = 72, 986267

-Continued-

Table 8. (p 2 of 3).

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Naknek	Ugashik
Kvichak	200	0.795	0.120	0.085
Naknek	198	0.157	0.641	0.202
Ugashik	200	0.115	0.115	0.725

Mean proportion correctly classified = 0.720
Variables used: 95,62,24,5,67,92,108,18,15,17,70,65
Box's Test of Variance-Covariance Equality
F-statistic = 5.88
D.F. = 156, 943163

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Egegik	Ugashik
Kvichak	200	0.850	0.000	0.150
Egegik	200	0.000	0.880	0.120
Ugashik	200	0.130	0.060	0.810

Mean proportion correctly classified = 0.847
Variables used: 2,19,6,17,18,27,25
Box's Test of Variance-Covariance Equality

F-statistic = 26.12
D.F. = 56, 1018034

-Continued-

Table 8. (p 3 of 3).

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvichak	Naknek
Kvichak	200	0.815	0.185
Naknek	200	0.222	0.778

Mean proportion correctly classified = 0.796
Variables used: 95,24,65,18,99,108,91
Box's Test of Variance-Covariance Equality
F-statistic = 4.81
D.F. = 28, 546322

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvichak	Egegik
Kvichak	200	0.995	0.005
Egegik	200	0.010	0.990

Mean proportion correctly classified = 0.993
Variables used: 1,12,66,16
Box's Test of Variance-Covariance Equality
F-statistic = 8.79
D.F. = 10, 757309

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

Table 9. Mean and standard error of age-2.2 scale variables used to construct linear discriminant functions for the East Side of Bristol Bay, 1988.

Variable Number	Variable Name	Kvichak		Naknek		Egegik		Ugashik	
		Mean[a]	SE	Mean[a]	SE	Mean[a]	SE	Mean[a]	SE
First Freshwater Annular Zone									
2	S1FW	120.26	0.906	118.16	1.479	162.69	1.508	112.90	1.187
5	C0-C6	90.22	0.522	89.84	0.546	96.21	0.507	80.92	0.481
8	C2-C6	45.01	0.386	43.07	0.412	47.94	0.361	37.99	0.000
10	C4-C6	21.43	0.227	19.44	0.237	22.12	0.223	17.37	0.187
16	C0-C2/S1FW	0.38	0.003	0.41	0.005	0.30	0.003	0.39	0.004
18	C0-C6/S1FW	0.76	0.005	0.77	0.008	0.60	0.005	0.73	0.006
23	C4-C6/S1FW	0.18	0.002	0.17	0.002	0.14	0.001	0.16	0.002
27	S1FW/NC1FW	12.67	0.074	12.60	0.080	12.55	0.065	11.35	0.061
Second Freshwater Annular Zone									
31	NC2FW	8.64	0.096	10.83	0.108	8.71	0.096	9.53	0.087
34	E1FW-C4	46.90	0.416	45.71	0.432	47.49	0.410	49.46	0.433
35	E1FW-C6	67.62	0.498	68.96	0.548	70.27	0.520	73.34	0.526
40	C4-C6	20.72	0.264	23.25	0.286	22.79	0.259	23.88	0.251
53	C4-C6/S2FW	0.23	0.003	0.21	0.003	0.24	0.003	0.23	0.002
Freshwater and Plus Growth Zones									
63	NC1+NC2	18.17	0.124	20.29	0.164	21.72	0.141	19.51	0.116
66	S1FW+S2FW+SPGZ	223.06	1.356	245.96	1.857	269.30	1.689	231.33	1.432
67	S1FW/S1FW+S2FW+SPGZ	0.54	0.003	0.48	0.004	0.60	0.004	0.49	0.004
69	S2FW/S1FW+S2FW+SPGZ	0.40	0.004	0.47	0.004	0.35	0.004	0.46	0.004
First Marine Annular Zone									
86	C(NC-3)-E1OZ	39.86	0.390	39.30	0.403	38.47	0.350	41.58	0.382
96	C3-C9/S1OZ	0.33	0.002	0.34	0.002	0.34	0.002	0.32	0.002
99	C6-C9/S1OZ	0.16	0.001	0.17	0.001	0.16	0.001	0.16	0.001
100	C6-C12/S1OZ	0.31	0.002	0.32	0.002	0.32	0.002	0.31	0.002
Sample Size		200		198		200		200	

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

Table 10. Mean, variance, and t-statistic comparing males and females for selected scale variables of age-2.2 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1988.

River	Sex	Sample Size		S1FW	S2FW	SPGZ	S1FW+S2FW+ SPGZ	S1OZ
Kvichak River	Male	87	Mean	121.68	91.24	12.57	225.49	415.95
			Variance	148.10	305.19	60.01	423.04	1633.65
	Female	113	Mean	119.16	89.37	12.65	221.18	407.19
			Variance	175.14	225.81	64.45	320.22	1841.25
	Combined	200	Mean	120.26	90.19	12.62	223.06	411.01
			Variance	164.14	259.84	62.21	367.65	1761.23
	T-Statistic			1.38	0.81	-0.06	1.58	1.47
Naknek River	Male	116	Mean	117.23	115.40	13.31	245.94	399.85
			Variance	339.01	306.34	75.39	602.23	773.24
	Female	82	Mean	119.96	112.85	13.62	246.44	398.30
			Variance	516.28	334.62	61.96	761.17	1259.10
	Combined	200[a]	Mean	118.16	114.33	13.47	245.96	399.60
			Variance	437.73	320.47	67.60	689.96	1058.46
	T-Statistic			-0.93	0.99	-0.26	-0.13	0.34
Egegik River	Male	78	Mean	164.72	93.51	12.96	271.19	401.69
			Variance	506.94	257.37	62.47	556.31	1151.57
	Female	121	Mean	161.50	94.98	11.65	268.13	403.50
			Variance	416.96	223.07	27.27	584.20	1334.34
	Combined	200[b]	Mean	162.69	94.47	12.15	269.30	402.55
			Variance	454.93	237.13	42.77	570.44	1253.76
	T-Statistic			1.04	-0.66	1.41	0.88	-0.35
Ugashik River	Male	67	Mean	113.67	108.51	13.28	235.46	413.64
			Variance	297.94	277.49	64.22	466.18	1230.73
	Female	133	Mean	112.51	104.66	12.07	229.24	398.36
			Variance	266.55	212.74	37.69	368.27	1131.12
	Combined	200	Mean	112.90	105.95	12.48	231.33	403.48
			Variance	281.71	244.05	49.67	409.88	1179.54
	T-Statistic			0.47	1.68	1.19	2.07[c]	2.99[c]

[a] Includes two unsexed samples.

[b] Includes one unsexed sample.

[c] Significant, alpha = 0.05.

Table 11. Classification matrices from discriminant analyses of age-2.2 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1988.

Actual Group Of Origin	Sample Size	Classified Group of Origin			
		Kvichak	Naknek	Egegik	Ugashik
Kvichak	200	0.730	0.105	0.015	0.150
Naknek	198	0.121	0.667	0.081	0.131
Egegik	200	0.125	0.085	0.740	0.050
Ugashik	200	0.105	0.080	0.015	0.800

Mean proportion correctly classified = 0.734
Variables used: 2,31,5,35,18,23
Box's Test of Variance-Covariance Equality[a]
F-statistic = 17.64
D.F. = 63, 1476989

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Naknek	Egegik
Kvichak	200	0.795	0.180	0.025
Naknek	198	0.126	0.768	0.106
Egegik	200	0.095	0.090	0.815

Mean proportion correctly classified = 0.793
Variables used: 2,10,53,100,67,31
Box's Test of Variance-Covariance Equality
F-statistic = 3.33
D.F. = 42, 1050851

-Continued-

Table 11. (p 2 of 4).

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Kvichak	Egegik	Ugashik
Kvichak	200	0.825	0.050	0.125
Egegik	200	0.120	0.815	0.065
Ugashik	200	0.120	0.025	0.855

Mean proportion correctly classified = 0.832
Variables used: 2,48,27,35,66,23,86
Box's Test of Variance-Covariance Equality
F-statistic = 2.57
D.F. = 56, 1018034

Actual Group Of Origin	Sample Size	Classified Group of Origin		
		Naknek	Egegik	Ugashik
Naknek	198	0.742	0.126	0.131
Egegik	200	0.080	0.830	0.090
Ugashik	200	0.125	0.030	0.845

Mean proportion correctly classified = 0.806
Variables used: 2,18,31,69,34,96,86
Box's Test of Variance-Covariance Equality
F-statistic = 3.88
D.F. = 56, 1011057

-Continued-

Table 11. (p 3 of 4).

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvichak	Naknek
Kvichak	200	0.825	0.175
Naknek	198	0.187	0.813

Mean proportion correctly classified = 0.819
Variables used: 23,100,67,63,16
Box's Test of Variance-Covariance Equality
F-statistic = 5.20
D.F. = 15, 631253

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Kvichak	Egegik
Kvichak	200	0.945	0.055
Egegik	200	0.130	0.870

Mean proportion correctly classified = 0.908
Variables used: 2,23,40,35
Box's Test of Variance-Covariance Equality
F-statistic = 7.79
D.F. = 10, 757309

-Continued-

Table 11. (p 4 of 4).

Actual Group Of Origin	Sample Size	Classified Group of Origin	
		Egegik	Ugashik
Egegik	200	0.930	0.070
Ugashik	200	0.050	0.950

Mean proportion correctly classified = 0.940
Variables used: 2,8,35,27,86,99
Box's Test of Variance-Covariance Equality
F-statistic = 1.95
D.F. = 21, 582609

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

Table 12. Run composition estimates and 90% confidence intervals (C.I.) calculated from scale pattern analyses of age-1.3 sockeye salmon by fishery and date for the East Side of Bristol Bay, 1988.

		Kvichak		Naknek		Egegik		Ugashik	
Fishery	Date	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.
Naknek-Kvichak	6/06-6/23	0.885	(.659,1.00)	0.090	(0,.324)	0.009	(0,.041)	0.016	(0,.191)
	6/24-7/01	0.975	(.945,1.00)	0.000	Trace[a]	0.025	(0,.055)	0.000	Trace
	7/02-7/04	0.528	(.336,.720)	0.409	(.212,.606)	0.063	(.003,.123)	0.000	Trace
	7/05-7/07	0.975	(.945,1.00)	0.000	Trace	0.025	(0,.055)	0.000	Trace
	7/08-7/10	0.568	(.334,.800)	0.391	(.119,.663)	0.014	(0,.059)	0.027	(0,.214)
	7/11-7/12	0.921	(.740,1.00)	0.059	(0,.243)	0.020	(0,.052)	0.000	Trace
	7/13-7/14	0.840	(.699,.980)	0.160	(.020,.301)	0.000	Trace	0.000	Trace
	7/15-9/03	0.775	(.584,.966)	0.220	(.025,.416)	0.005	(0,.029)	0.000	Trace
Egegik	6/06-6/17	0.383	(.207,.560)	0.039	(0,.190)	0.533	(.380,.686)	0.045	(0,.217)
	6/18-6/23	0.351	(.178,.525)	0.068	(0,.224)	0.557	(.404,.710)	0.024	(0,.192)
	6/24-6/27	0.153	(.091,.215)	0.000	Trace	0.847	(.785,.909)	0.000	Trace
	6/28-6/29	0.160	(.033,.288)	0.024	(0,.146)	0.716	(.559,.872)	0.100	(0,.289)
	6/30-7/02	0.241	(.094,.387)	0.001	(0,.125)	0.643	(.487,.799)	0.115	(0,.303)
	7/03-7/05	0.069	(0,.165)	0.062	(0,.188)	0.781	(.629,.933)	0.088	(0,.277)
	7/06	0.327	(.197,.458)	0.000	Trace	0.481	(.350,.611)	0.192	(.044,.341)
	7/07-7/08	0.074	(0,.178)	0.095	(0,.237)	0.747	(.592,.900)	0.084	(0,.273)
	7/09	0.110	(0,.245)	0.238	(.048,.428)	0.635	(.479,.790)	0.017	(0,.195)
	7/10-7/11	0.145	(0,.301)	0.239	(.030,.448)	0.563	(.399,.728)	0.053	(0,.246)
	7/12	0.238	(.077,.399)	0.164	(0,.342)	0.585	(.430,.740)	0.013	(0,.185)
	7/13	0.308	(.125,.491)	0.124	(0,.312)	0.499	(.338,.661)	0.069	(0,.259)
	7/14-7/16	0.131	(0,.293)	0.179	(0,.393)	0.585	(.401,.768)	0.105	(0,.328)
	7/17-9/08	0.299	(.094,.504)	0.169	(0,.394)	0.451	(.277,.626)	0.081	(0,.293)

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Table 12. (p 2 of 2).

		Kvichak		Naknek		Egegik		Ugashik	
Fishery	Date	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.
Ugashik	6/07-6/23	0.160	(.029,.291)	0.036	(0,.176)	0.626	(.468,.784)	0.178	(0,.378)
	6/24-7/04	0.341	(.093,.593)	0.049	(0,.330)	0.113	(0,.257)	0.497	(.182,.810)
	7/05-7/09	0.115	(0,.289)	0.000	Trace	0.071	(0,.188)	0.814	(.599,1.00)
	7/10-7/13	0.044	(0,.185)	0.082	(0,.334)	0.002	(0,.091)	0.872	(.613,1.00)
	7/14-9/07	0.166	(.004,.329)	0.227	(0,.455)	0.000	Trace	0.607	(.378,.836)

[a] Trace was recorded for systems that were originally included in the model used to classify the catch and their point estimates were zero, but the upper bounds of the 90% confidence interval was greater than zero.

Table 13. Estimated numbers of age-1.3 sockeye salmon by river of origin harvested in the East Side of Bristol Bay, 1988.

District	River	Estimated Proportion	Estimated Numbers	Standard Error of Estimate	Coefficient of Variation
Naknek-Kvichak	Kvichak	0.886	1,388,294	41,039	0.03
	Naknek	0.093	145,233	34,489	0.24
	Egegik	0.018	28,878	11,303	0.39
	Ugashik	0.003	4,469	12,921	2.89
	Total	1.000	1,566,874		
Egegik	Kvichak	0.230	521,199	49,570	0.10
	Naknek	0.060	135,514	43,545	0.32
	Egegik	0.641	1,451,916	56,208	0.04
	Ugashik	0.069	156,169	55,515	0.36
	Total	1.000	2,264,798		
Ugashik	Kvichak	0.089	24,185	10,409	0.43
	Naknek	0.092	24,968	17,319	0.69
	Egegik	0.057	15,336	6,285	0.41
	Ugashik	0.762	206,554	20,632	0.10
	Total	1.000	271,043		
Total East Side	Kvichak	0.471	1,933,678	65,190	0.03
	Naknek	0.075	305,715	58,186	0.19
	Egegik	0.365	1,496,130	57,677	0.04
	Ugashik	0.089	367,192	60,618	0.17
	Total	1.000	4,102,715		

Table 14. Run composition estimates and 90% confidence intervals (C.I.) calculated from scale pattern analyses of age-2.2 sockeye salmon by fishery and date for the East Side of Bristol Bay, 1988.

		Kvichak		Naknek		Egegik		Ugashik	
Fishery	Date	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.	Pt. Est.	90% C.I.
Naknek-Kvichak	6/06-6/23	0.803	(.525,1.00)	0.089	(0,.309)	0.088	(0,.220)	0.020	(0,.215)
	6/24-7/01	0.763	(.540,.988)	0.123	(0,.306)	0.080	(0,.181)	0.034	(0,.193)
	7/02-7/04	0.547	(.357,.738)	0.280	(.082,.478)	0.173	(.043,.303)	0.000	Trace[a]
	7/05-7/07	0.927	(.757,1.00)	0.023	(0,.196)	0.050	(0,.130)	0.000	Trace
	7/08-7/10	0.444	(.257,.632)	0.556	(.368,.743)	0.000	Trace	0.000	Trace
	7/11-7/12	0.808	(.640,.977)	0.076	(0,.243)	0.116	(.019,.212)	0.000	Trace
	7/13-7/14	0.736	(.565,.906)	0.202	(.023,.380)	0.063	(0,.150)	0.000	Trace
	7/15-9/03	0.817	(.684,.950)	0.183	(.050,.316)	0.000	Trace	0.000	Trace
Egegik	6/06-6/23	0.057	(0,.186)	0.000	Trace	0.928	(.790,1.00)	0.015	(0,.102)
	6/24-6/27	0.000	Trace	0.000	Trace	0.943	(.875,1.00)	0.057	(0,.125)
	6/28-6/29	0.061	(0,.151)	0.000	Trace	0.939	(.849,1.00)	0.000	Trace
	6/30-7/02	0.213	(.067,.358)	0.000	Trace	0.734	(.587,.881)	0.053	(0,.152)
	7/03-7/05	0.075	(0,.199)	0.079	(0,.209)	0.846	(.699,.994)	0.000	Trace
	7/06	0.119	(0,.250)	0.058	(0,.185)	0.823	(.675,.971)	0.000	Trace
	7/07-7/08	0.093	(0,.269)	0.057	(0,.214)	0.789	(.592,.984)	0.061	(0,.181)
	7/09	0.147	(.051,.244)	0.000	Trace	0.853	(.756,.949)	0.000	Trace
	7/10-7/11	0.046	(0,.211)	0.042	(0,.194)	0.789	(.594,.985)	0.123	(0,.256)
	7/12	0.179	(0,.363)	0.055	(0,.207)	0.623	(.433,.812)	0.144	(0,.287)
	7/13	0.014	(0,.137)	0.000	Trace	0.981	(.847,1.00)	0.005	(0,.090)
	7/14-9/08	0.097	(0,.267)	0.110	(0,.275)	0.631	(.440,.823)	0.162	(.016,.308)
Ugashik	6/07-6/23	0.000	Trace	0.000	Trace	0.875	(.797,.953)	0.125	(.047,.203)
	6/24-7/04	0.040	(0,.207)	0.072	(0,.241)	0.318	(.142,.493)	0.570	(.360,.781)
	7/05-7/09	0.000	Trace	0.000	Trace	0.193	(.112,.274)	0.807	(.726,.888)
	7/10-7/13	0.000	Trace	0.121	(0,.266)	0.211	(.093,.328)	0.668	(.515,.823)
	7/14-9/07	0.033	(0,.183)	0.134	(0,.304)	0.119	(.004,.233)	0.714	(.518,.911)

[a] Trace was recorded for systems that were originally included in the model used to classify the catch and their point estimates were zero, but the upper bounds of the 90% confidence interval was greater than zero.

Table 15. Estimated numbers of age-2.2 sockeye salmon by river of origin harvested in the East Side of Bristol Bay, 1988.

District	River	Estimated Proportion	Estimated Numbers	Standard Error of Estimate	Coefficient of Variation
Naknek-Kvichak	Kvichak	0.777	442,049	24,503	0.06
	Naknek	0.141	80,309	18,428	0.23
	Egegik	0.070	39,880	9,236	0.23
	Ugashik	0.012	6,548	11,211	1.71
	Total	1.000	568,786		
Egegik	Kvichak	0.093	209,502	44,497	0.21
	Naknek	0.032	72,053	27,381	0.38
	Egegik	0.825	1,859,242	58,413	0.03
	Ugashik	0.050	112,666	29,420	0.26
	Total	1.000	2,253,463		
Ugashik	Kvichak	0.010	3,944	6,475	1.64
	Naknek	0.100	40,200	15,877	0.39
	Egegik	0.219	88,634	13,082	0.15
	Ugashik	0.671	271,198	19,943	0.07
	Total	1.000	403,976		
Total East Side	Kvichak	0.203	655,494	51,208	0.08
	Naknek	0.060	192,562	36,625	0.19
	Egegik	0.616	1,987,756	60,728	0.03
	Ugashik	0.121	390,412	37,269	0.10
	Total	1.000	3,226,225		

Table 16. Run composition estimates of sockeye salmon catch by age group and date for the Naknek-Kvichak District of Bristol Bay, 1988.

		1.1		0.3		1.2		2.1		1.3		2.2		1.4		2.3		Total	
Date	System	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number
6/06[a]	Kvichak	0.0	0	0.0	0	89.4	37,437	0.0	0	88.5	151,704	80.3	31,644	31.9	158	29.9	3,540	84.7	224,483
thru	Naknek	0.0	0	0.0	0	8.7	3,627	0.0	0	9.0	15,428	8.9	3,507	66.7	329	52.1	6,157	11.0	29,047
6/23	Egegik	0.0	0	0.0	0	0.3	129	0.0	0	0.9	1,543	8.8	3,468	0.4	2	5.0	597	2.2	5,738
	Ugashik	0.0	0	0.0	0	1.6	676	0.0	0	1.6	2,743	2.0	788	0.9	5	12.9	1,528	2.2	5,740
	Total	0.0	0	0.0	0	100.0	41,869	0.0	0	100.0	171,417	100.0	39,407	100.0	493	100.0	11,822	100.0	265,008
6/24	Kvichak	0.0	0	80.9	2,088	95.9	237,239	75.4	525	97.5	529,974	76.3	129,267	59.8	1,250	50.4	35,560	90.3	935,903
thru	Naknek	0.0	0	0.0	0	2.8	7,035	6.4	44	0.0	0	12.3	20,839	38.2	799	26.9	18,929	4.6	47,646
7/01	Egegik	0.0	0	0.0	0	0.5	1,228	11.3	79	2.5	13,589	8.0	13,554	1.2	26	12.8	9,032	3.6	37,508
	Ugashik	0.0	0	19.1	493	0.8	1,944	6.9	48	0.0	0	3.4	5,760	0.8	16	9.9	6,965	1.5	15,226
	Total	0.0	0	100.0	2,581	100.0	247,446	100.0	697	100.0	543,563	100.0	169,419	100.0	2,091	100.0	70,486	100.0	1,036,283
7/02	Kvichak	0.0	0	0.0	0	60.2	21,820	0.0	0	52.8	30,528	54.7	17,465	6.7	39	7.3	2,007	46.7	71,859
thru	Naknek	0.0	0	0.0	0	38.3	13,899	0.0	0	40.9	23,648	28.0	8,940	92.6	532	84.0	22,954	45.5	69,974
7/04	Egegik	0.0	0	0.0	0	1.4	524	0.0	0	6.3	3,643	17.3	5,524	0.6	4	8.7	2,365	7.8	12,059
	Ugashik	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
	Total	0.0	0	0.0	0	100.0	36,243	0.0	0	100.0	57,818	100.0	31,929	100.0	575	100.0	27,327	100.0	153,892
7/05	Kvichak	0.0	0	0.0	0	98.8	112,011	0.0	0	97.5	152,407	92.7	75,062	84.5	1,190	73.9	17,685	95.3	358,356
thru	Naknek	0.0	0	0.0	0	0.8	860	0.0	0	0.0	0	2.3	1,862	14.0	197	10.2	2,438	1.4	5,358
7/07	Egegik	0.0	0	0.0	0	0.4	493	0.0	0	2.5	3,908	5.0	4,049	1.5	21	15.9	3,816	3.3	12,286
	Ugashik	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
	Total	0.0	0	0.0	0	100.0	113,364	0.0	0	100.0	156,315	100.0	80,973	100.0	1,408	100.0	23,940	100.0	376,000
7/08	Kvichak	0.0	0	0.0	0	56.2	20,336	0.0	0	56.8	36,316	44.4	8,039	5.9	33	6.5	2,014	44.6	66,738
thru	Naknek	0.0	0	0.0	0	41.6	15,082	0.0	0	39.1	24,999	55.6	10,067	93.7	531	87.0	26,815	51.8	77,494
7/10	Egegik	0.0	0	0.0	0	0.1	52	0.0	0	1.4	895	0.0	0	0.1	0	0.8	251	0.8	1,198
	Ugashik	0.0	0	0.0	0	2.0	742	0.0	0	2.7	1,726	0.0	0	0.3	2	5.7	1,757	2.8	4,228
	Total	100.0	0	100.0	0	100.0	36,212	100.0	0	100.0	63,937	100.0	18,106	100.0	566	100.0	30,837	100.0	149,658

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Table 16. (p 2 of 2).

		1.1		0.3		1.2		2.1		1.3		2.2		1.4		2.3		Total	
Date	System	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number
7/11	Kvichak	90.0	914	0.0	0	93.2	195,849	72.8	1,109	92.1	200,563	80.8	61,523	40.6	206	39.9	14,776	87.3	474,941
thru	Naknek	9.5	96	0.0	0	6.2	13,064	13.8	210	5.9	12,848	7.6	5,787	58.4	297	47.7	17,692	9.2	49,994
7/12	Egegik	0.5	6	0.0	0	0.6	1,239	13.4	203	2.0	4,355	11.6	8,832	1.0	5	12.4	4,587	3.5	19,228
	Ugashik	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
	Total	100.0	1,016	0.0	0	100.0	210,152	100.0	1,523	100.0	217,767	100.0	76,142	100.0	508	100.0	37,055	100.0	544,163
7/13	Kvichak	75.8	117	100.0	154	83.1	147,945	60.5	186	84.0	140,299	73.5	51,962	18.8	285	21.1	8,303	76.4	349,251
thru	Naknek	23.9	37	0.0	0	16.6	29,600	34.4	106	16.0	26,724	20.2	14,281	81.0	1,230	75.9	29,820	22.3	101,797
7/14	Egegik	0.2	0	0.0	0	0.2	431	5.1	16	0.0	0	6.3	4,454	0.2	3	3.0	1,187	1.3	6,091
	Ugashik	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
	Total	100.0	154	100.0	154	100.0	177,976	100.0	307	100.0	167,023	100.0	70,697	100.0	1,518	100.0	39,309	100.0	457,138
7/15[b]	Kvichak	0.0	0	0.0	0	80.1	210,754	58.0	1,046	77.5	146,494	81.7	67,086	15.7	669	18.2	4,883	76.0	430,932
thru	Naknek	0.0	0	0.0	0	19.9	52,406	41.0	740	22.0	41,586	18.3	15,027	84.2	3,582	81.3	21,794	23.8	135,134
9/03	Egegik	0.0	0	0.0	0	0.0	117	0.9	17	0.5	945	0.0	0	0.0	1	0.5	133	0.2	1,214
	Ugashik	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
	Total	0.0	0	0.0	0	100.0	263,278	100.0	1,802	100.0	189,025	100.0	82,113	100.0	4,252	100.0	26,810	100.0	567,280
Total	Kvichak	88.1	1,031	82.0	2,242	87.3	983,391	66.2	2,866	88.6	1,388,286	77.7	442,048	33.6	3,830	33.2	88,768	82.1	2,912,462
	Naknek	11.4	133	0.0	0	12.0	135,574	25.4	1,100	9.3	145,232	14.1	80,309	65.7	7,496	54.8	146,600	14.6	516,444
	Egegik	0.5	6	0.0	0	0.4	4,213	7.3	315	1.8	28,878	7.0	39,880	0.5	63	8.2	21,968	2.7	95,322
	Ugashik	0.0	0	18.0	493	0.3	3,362	1.1	48	0.3	4,469	1.2	6,548	0.2	23	3.8	10,250	0.7	25,194
	Total	100.0	1,170	100.0	2,735	100.0	1,126,540	100.0	4,329	100.0	1,566,865	100.0	568,786	100.0	11,411	100.0	267,586	100.0	3,549,422

[a] Scale samples were collected on 21 June. Stock composition estimates calculated for 21 June were applied to 6 June through 23 June catches.

[b] Scale samples were collected from 15 and 17 July. Stock composition estimates calculated from those dates were applied to 15 July through 3 September catches.

Table 17. Run composition estimates of sockeye salmon catch by age group and date for the Egegik District of Bristol Bay, 1988.

		0.3		1.2		2.1		1.3		2.2		1.4		2.3		Other[a]		Total	
Date	System	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number
6/06[b]	Kvichak	23.3	204	68.6	4,804	0.0	0	38.3	33,538	5.7	1,414	24.0	280	5.6	1,465	0.0	0	28.3	41,706
thru	Naknek	0.0	0	6.3	441	0.0	0	3.9	3,415	0.0	0	48.3	564	9.3	2,413	0.0	0	4.6	6,833
6/17	Egegik	0.0	0	17.2	1,204	0.0	0	53.3	46,673	92.8	23,024	23.4	273	69.5	18,043	0.0	0	60.5	89,216
	Ugashik	76.7	672	7.9	556	0.0	0	4.5	3,940	1.5	372	4.3	51	15.6	4,057	0.0	0	6.5	9,648
	Total	100.0	876	100.0	7,005	0.0	0	100.0	87,566	100.0	24,810	100.0	1,168	100.0	25,978	0.0	0	100.0	147,403
6/18	Kvichak	30.3	720	61.9	30,856	0.0	0	35.1	174,207	5.7	17,732	0.0	0	4.2	6,310	0.0	0	22.7	229,825
thru	Naknek	0.0	0	10.2	5,092	0.0	0	6.8	33,749	0.0	0	0.0	0	12.3	18,705	0.0	0	5.7	57,546
6/23	Egegik	0.0	0	22.9	11,421	0.0	0	55.7	276,447	92.8	288,690	0.0	0	75.5	114,737	0.0	0	68.3	691,295
	Ugashik	69.7	1,655	5.0	2,500	0.0	0	2.4	11,912	1.5	4,666	0.0	0	8.0	12,230	0.0	0	3.3	32,963
	Total	100.0	2,375	100.0	49,869	0.0	0	100.0	496,315	100.0	311,088	0.0	0	100.0	151,982	0.0	0	100.0	1,011,629
6/24	Kvichak	0.0	0	39.8	12,871	0.0	0	15.3	33,659	0.0	0	15.9	166	1.5	1,545	0.0	0	9.3	48,241
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
6/27	Egegik	0.0	0	50.1	16,188	0.0	0	84.7	186,334	94.3	150,428	77.8	811	89.7	95,439	0.0	0	86.5	449,201
	Ugashik	0.0	0	10.1	3,262	0.0	0	0.0	0	5.7	9,093	6.3	66	8.8	9,363	0.0	0	4.2	21,783
	Total	0.0	0	100.0	32,321	0.0	0	100.0	219,993	100.0	159,521	100.0	1,043	100.0	106,347	0.0	0	100.0	519,225
6/28	Kvichak	7.4	125	40.8	27,666	0.0	0	16.0	57,451	6.1	18,804	13.3	225	1.7	3,462	0.0	0	11.5	107,733
thru	Naknek	0.0	0	4.3	2,934	0.0	0	2.4	8,618	0.0	0	31.0	524	3.3	6,595	0.0	0	2.0	18,672
6/29	Egegik	0.0	0	36.8	24,928	0.0	0	71.6	257,093	93.9	289,453	46.6	789	76.7	153,225	0.0	0	77.3	725,488
	Ugashik	92.6	1,569	18.0	12,221	0.0	0	10.0	35,907	0.0	0	9.2	155	18.3	36,577	0.0	0	9.2	86,429
	Total	100.0	1,694	100.0	67,749	0.0	0	100.0	359,069	100.0	308,257	100.0	1,694	100.0	199,859	0.0	0	100.0	938,322
6/30	Kvichak	0.0	0	57.5	43,989	0.0	0	24.1	93,255	21.3	58,620	32.5	673	3.6	9,204	9.0	742	20.5	206,483
thru	Naknek	0.0	0	0.1	105	0.0	0	0.1	387	0.0	0	1.7	35	0.2	395	0.0	0	0.1	923
7/02	Egegik	0.0	0	21.4	16,414	0.0	0	64.3	248,810	73.4	202,005	47.2	977	65.2	168,712	81.9	6,780	63.9	643,698
	Ugashik	0.0	0	21.0	16,054	0.0	0	11.5	44,499	5.3	14,586	18.6	384	31.1	80,346	9.1	755	15.5	156,624
	Total	0.0	0	100.0	76,562	0.0	0	100.0	386,952	100.0	275,211	100.0	2,069	100.0	258,657	100.0	8,277	100.0	1,007,728

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Table 17. (p 2 of 4).

Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	2.1 %	2.1 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
7/03	Kvichak	0.0	0	26.2	3,855	0.0	0	6.9	7,696	7.5	11,878	3.6	19	1.0	890	3.8	100	6.5	24,438
thru	Naknek	0.0	0	24.4	3,590	0.0	0	6.2	6,915	7.9	12,511	73.8	388	16.9	14,889	0.0	0	10.2	38,294
7/05	Egegik	0.0	0	37.2	5,474	0.0	0	78.1	87,113	84.6	133,978	19.9	105	70.6	62,073	91.2	2,398	77.5	291,140
	Ugashik	0.0	0	12.3	1,813	0.0	0	8.8	9,816	0.0	0	2.7	14	11.4	10,013	5.0	132	5.8	21,788
	Total	0.0	0	100.0	14,732	0.0	0	100.0	111,540	100.0	158,367	100.0	526	100.0	87,865	100.0	2,630	100.0	375,660
7/06	Kvichak	8.1	116	52.6	17,640	0.0	0	32.7	34,982	11.9	13,494	0.0	0	3.2	2,215	0.0	0	20.9	68,447
	Naknek	0.0	0	6.7	2,246	0.0	0	0.0	0	5.8	6,577	0.0	0	7.3	5,065	0.0	0	4.2	13,888
	Egegik	0.0	0	19.8	6,623	0.0	0	48.1	51,457	82.3	93,327	0.0	0	59.0	40,845	100.0	2,852	59.6	195,104
	Ugashik	91.9	1,310	20.9	7,011	0.0	0	19.2	20,540	0.0	0	0.0	0	30.4	21,055	0.0	0	15.2	49,916
	Total	100.0	1,426	100.0	33,520	0.0	0	100.0	106,980	100.0	113,398	0.0	0	100.0	69,180	100.0	2,852	100.0	327,356
7/07	Kvichak	0.0	0	27.6	15,461	0.0	0	7.4	7,754	9.3	18,954	0.0	0	1.1	1,063	9.3	153	9.4	43,384
thru	Naknek	0.0	0	20.9	11,719	0.0	0	9.5	9,955	5.7	11,617	0.0	0	15.5	14,470	0.0	0	10.4	47,761
7/08	Egegik	0.0	0	31.0	17,398	0.0	0	74.7	78,277	78.9	160,801	0.0	0	63.0	58,746	71.5	1,180	68.8	316,402
	Ugashik	0.0	0	20.6	11,531	0.0	0	8.4	8,802	6.1	12,432	0.0	0	20.3	18,959	19.2	318	11.3	52,041
	Total	0.0	0	100.0	56,108	0.0	0	100.0	104,789	100.0	203,804	0.0	0	100.0	93,237	100.0	1,651	100.0	459,588
7/09	Kvichak	41.6	487	40.5	9,953	4.1	24	11.0	9,469	14.7	18,250	0.0	0	2.0	1,382	0.0	0	12.9	39,565
	Naknek	0.0	0	28.1	6,904	8.0	47	23.8	20,488	0.0	0	0.0	0	24.7	17,223	0.0	0	14.6	44,662
	Egegik	0.0	0	29.5	7,247	85.7	502	63.5	54,664	85.3	105,900	0.0	0	71.0	49,445	0.0	0	71.1	217,758
	Ugashik	58.4	684	2.0	493	2.3	13	1.7	1,463	0.0	0	0.0	0	2.3	1,637	0.0	0	1.4	4,291
	Total	100.0	1,171	100.0	24,596	100.0	586	100.0	86,085	100.0	124,150	0.0	0	100.0	69,688	0.0	0	100.0	306,276
7/10	Kvichak	0.0	0	22.4	4,387	2.1	7	14.5	6,345	4.6	3,324	2.8	19	1.0	439	0.0	0	7.9	14,521
thru	Naknek	0.0	0	29.4	5,745	7.8	26	23.9	10,459	4.2	3,035	80.8	536	22.9	10,330	0.0	0	16.5	30,130
7/11	Egegik	0.0	0	23.8	4,657	64.5	214	56.3	24,637	78.9	57,021	11.6	77	50.8	22,898	100.0	1,327	60.6	110,831
	Ugashik	0.0	0	24.4	4,770	25.6	85	5.3	2,319	12.3	8,889	4.8	32	25.3	11,420	0.0	0	15.0	27,515
	Total	0.0	0	100.0	19,559	100.0	332	100.0	43,760	100.0	72,270	100.0	663	100.0	45,087	100.0	1,327	100.0	182,998

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Table 17. (p 3 of 4).

Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	2.1 %	2.1 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
7/12	Kvichak	0.0	0	44.8	12,234	5.7	27	23.8	17,732	17.9	16,070	0.0	0	2.7	1,466	0.0	0	19.3	47,529
	Naknek	0.0	0	21.3	5,820	7.8	36	16.4	12,219	5.5	4,938	0.0	0	23.2	12,540	0.0	0	14.4	35,560
	Egegik	0.0	0	16.6	4,524	61.6	285	58.5	43,586	62.2	55,841	0.0	0	49.2	26,621	100.0	463	53.2	131,319
	Ugashik	0.0	0	17.3	4,718	24.9	115	1.3	969	14.4	12,928	0.0	0	25.0	13,519	0.0	0	13.1	32,249
	Total	0.0	0	100.0	27,304	100.0	463	100.0	74,506	100.0	89,776	0.0	0	100.0	54,145	100.0	463	100.0	246,657
7/13	Kvichak	0.0	0	42.2	9,371	3.6	19	30.8	20,662	1.4	1,532	8.2	42	1.9	1,257	0.0	0	12.4	32,883
	Naknek	0.0	0	14.9	3,296	3.6	19	12.4	8,319	0.0	0	63.5	328	12.2	7,942	0.0	0	7.5	19,903
	Egegik	0.0	0	33.7	7,473	83.8	433	49.9	33,475	98.1	107,319	25.5	132	75.7	49,243	0.0	0	74.8	198,075
	Ugashik	0.0	0	9.2	2,050	8.9	46	6.9	4,629	0.5	547	2.8	15	10.1	6,578	0.0	0	5.2	13,864
	Total	0.0	0	100.0	22,190	100.0	516	100.0	67,085	100.0	109,398	100.0	516	100.0	65,020	0.0	0	100.0	264,725
7/14 thru 7/16	Kvichak	0.0	0	24.0	7,432	2.5	123	13.1	8,952	9.7	18,519	3.2	23	1.1	899	10.6	75	9.6	36,022
	Naknek	0.0	0	27.2	8,438	8.1	397	17.9	12,232	11.0	21,001	80.9	570	23.0	18,327	12.8	90	16.2	61,054
	Egegik	0.0	0	17.6	5,457	53.1	2,616	58.5	39,975	63.1	120,468	9.3	65	40.7	32,411	61.9	436	53.5	201,429
	Ugashik	0.0	0	31.2	9,670	36.4	1,794	10.5	7,175	16.2	30,928	6.6	46	35.1	27,969	14.7	103	20.7	77,687
	Total	0.0	0	100.0	30,997	100.0	4,931	100.0	68,334	100.0	190,916	100.0	704	100.0	79,605	100.0	704	100.0	376,191
7/17[c] thru 9/08	Kvichak	0.0	0	33.4	6,889	4.0	118	29.9	15,495	9.7	10,912	0.0	0	1.8	871	0.0	0	14.5	34,286
	Naknek	0.0	0	25.1	5,174	8.5	251	16.9	8,758	11.0	12,375	0.0	0	24.3	11,755	0.0	0	16.2	38,313
	Egegik	0.0	0	15.0	3,095	51.9	1,530	45.1	23,373	63.1	70,986	0.0	0	39.7	19,226	0.0	0	50.0	118,209
	Ugashik	0.0	0	26.6	5,487	35.6	1,050	8.1	4,198	16.2	18,225	0.0	0	34.3	16,601	0.0	0	19.3	45,560
	Total	0.0	0	100.0	20,645	100.0	2,949	100.0	51,824	100.0	112,497	0.0	0	100.0	48,453	0.0	0	100.0	236,368

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Table 17. (p 4 of 4).

Date	System	0.3 %	0.3 Number	1.2 %	1.2 Number	2.1 %	2.1 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
Total	Kvichak	21.9	1,652	42.9	207,408	3.2	317	23.0	521,199	9.3	209,502	17.3	1,447	2.4	32,468	6.0	1,070	15.2	975,062
	Naknek	0.0	0	12.7	61,511	7.9	776	6.0	135,514	3.2	72,053	35.1	2,945	10.4	140,650	0.5	90	6.5	413,540
	Egegik	0.0	0	27.3	132,102	57.1	5,581	64.1	1,451,916	82.5	1,859,241	38.5	3,229	67.3	911,663	86.2	15,436	68.4	4,379,166
	Ugashik	78.1	5,890	17.0	82,136	31.7	3,104	6.9	156,169	5.0	112,666	9.1	763	19.9	270,323	7.3	1,308	9.9	632,358
	Total	100.0	7,542	100.0	483,157	100.0	9,777	100.0	2,264,798	100.0	2,253,463	100.0	8,383	100.0	1,355,103	100.0	17,904	100.0	6,400,126

[a] Includes age-0.2, age-0.4, age-3.2, and age-3.3.

[b] Scale samples were collected on 17 June. Stock composition estimates calculated for 17 June were applied to 6 June through 17 June catches.

[c] Scale samples were collected on 17 July. Stock composition estimates calculated for 17 July were applied to 17 July through 8 September catches.

Table 18. Run composition estimates of sockeye salmon catch by age group and date for the Ugashik District of Bristol Bay, 1988.

		0.3		1.2		2.1		0.4		1.3		2.2		1.4		2.3		Other[a]		Total	
Date	System	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number
6/07[b]	Kvichak	1.9	17	23.5	1,518	0.0	0	7.8	16	16.0	3,009	0.0	0	7.5	63	0.9	160	0.0	0	7.4	4,783
thru	Naknek	0.0	0	5.0	320	0.0	0	1.7	4	3.6	677	0.0	0	34.2	286	3.5	607	0.0	0	2.9	1,895
6/23	Egegik	0.0	0	28.7	1,853	0.0	0	75.4	158	62.6	11,772	87.5	17,432	36.5	306	55.4	9,596	0.0	0	63.8	41,115
	Ugashik	98.1	878	42.8	2,762	0.0	0	15.1	32	17.8	3,347	12.5	2,490	21.9	183	40.2	6,969	0.0	0	25.9	16,661
	Total	100.0	895	100.0	6,453	0.0	0	100.0	209	100.0	18,805	100.0	19,922	100.0	838	100.0	17,332	0.0	0	100.0	64,454
6/24	Kvichak	1.1	4	20.8	1,729	2.3	23	15.7	18	34.1	2,217	4.0	408	0.0	0	1.1	118	0.0	0	12.0	4,515
thru	Naknek	0.0	0	7.8	651	2.4	25	6.3	7	4.9	319	7.2	734	0.0	0	7.2	794	0.0	0	6.7	2,529
7/04	Egegik	0.0	0	4.0	329	12.6	127	23.8	27	11.3	735	31.8	3,243	0.0	0	9.9	1,100	0.0	0	14.8	5,560
	Ugashik	98.9	332	67.3	5,586	82.7	833	54.2	61	49.7	3,231	57.0	5,813	0.0	0	81.9	9,083	0.0	0	66.4	24,940
	Total	100.0	336	100.0	8,295	100.0	1,008	100.0	112	100.0	6,500	100.0	10,199	0.0	0	100.0	11,095	0.0	0	100.0	37,545
7/05	Kvichak	0.2	1	5.2	2,634	0.5	9	4.3	21	11.5	4,051	0.0	0	3.2	16	0.2	152	0.0	0	3.2	6,884
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	0.0	0
7/09	Egegik	0.0	0	2.3	1,139	5.9	116	14.7	72	7.1	2,501	19.3	11,426	5.5	27	4.8	3,217	100.0	489	8.8	18,987
	Ugashik	99.8	488	92.5	46,624	93.6	1,832	81.0	396	81.4	28,676	80.7	47,778	91.2	446	95.0	64,155	0.0	0	88.0	190,395
	Total	100.0	489	100.0	50,397	100.0	1,957	100.0	489	100.0	35,229	100.0	59,204	100.0	489	100.0	67,523	100.0	489	100.0	216,266
7/10	Kvichak	0.0	0	2.3	3,628	0.2	3	0.0	0	4.4	7,226	0.0	0	0.6	27	0.1	326	0.0	0	1.3	11,210
thru	Naknek	0.0	0	11.6	18,169	3.2	39	0.0	0	8.2	13,467	12.1	25,106	63.3	2,909	9.0	29,269	55.6	339	10.4	89,298
7/13	Egegik	0.0	0	1.8	2,785	5.0	61	0.0	0	0.2	328	21.1	43,780	1.8	82	3.8	12,261	0.0	0	6.9	59,298
	Ugashik	0.0	0	84.4	132,700	91.6	1,117	0.0	0	87.2	143,207	66.8	138,603	34.3	1,577	87.2	284,627	44.4	270	81.5	702,101
	Total	0.0	0	100.0	157,283	100.0	1,219	0.0	0	100.0	164,228	100.0	207,489	100.0	4,595	100.0	326,483	100.0	609	100.0	861,906

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Table 18. (p 2 of 2).

		0.3		1.2		2.1		0.4		1.3		2.2		1.4		2.3		Other[a]		Total	
Date	System	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number
7/14[c]	Kvichak	0.0	0	8.4	6,230	0.9	29	0.0	0	16.6	7,683	3.3	3,536	1.7	41	0.4	460	3.7	25	5.1	18,005
thru	Naknek	0.0	0	17.4	12,954	5.4	171	0.0	0	22.7	10,506	13.4	14,360	74.2	1,846	14.7	17,187	0.0	0	16.2	57,024
9/07	Egegik	0.0	0	1.2	890	3.8	120	0.0	0	0.0	0	11.9	12,752	0.9	23	2.8	3,229	1.1	8	4.8	17,023
	Ugashik	0.0	0	73.1	54,477	89.9	2,845	0.0	0	60.7	28,093	71.4	76,514	23.2	576	82.2	96,241	95.1	646	73.8	259,392
	Total	0.0	0	100.0	74,551	100.0	3,166	0.0	0	100.0	46,281	100.0	107,162	100.0	2,487	100.0	117,118	100.0	679	100.0	351,444
Total	Kvichak	1.2	21	5.3	15,739	0.9	64	6.8	55	8.9	24,185	1.0	3,944	1.7	147	0.2	1,216	1.4	25	3.0	45,397
	Naknek	0.0	0	10.8	32,094	3.2	235	1.3	11	9.2	24,968	10.0	40,200	60.0	5,041	8.9	47,858	19.1	339	9.8	150,745
	Egegik	0.0	0	2.4	6,996	5.8	423	31.7	256	5.7	15,336	21.9	88,634	5.2	438	5.4	29,402	28.0	497	9.3	141,983
	Ugashik	98.8	1,699	81.5	242,149	90.2	6,628	60.3	488	76.2	206,554	67.1	271,198	33.1	2,783	85.5	461,076	51.5	916	77.9	1,193,490
	Total	100.0	1,720	100.0	296,979	100.0	7,350	100.0	810	100.0	271,043	100.0	403,976	100.0	8,409	100.0	539,551	100.0	1,777	100.0	1,531,615

[a] Other includes age-0.2, age-2.4, and age-3.3.

[b] Scale samples were collected from 17 and 23 June. Stock composition estimates calculated from those dates were applied to 7 June through 23 June catches.

[c] Scale samples were collected from 14 and 15 July. Stock composition estimates calculated from those dates were applied to 14 July through 7 September catches.

Table 19. Catch of sockeye salmon by run and district for the East Side of Bristol Bay, 1988.

Run		District			Total
		Nak-Kvi	Egegik	Ugashik	
Kvichak	Numbers	2,912,462	975,062	45,397	3,932,921
	Percent	74.0	24.8	1.2	100.0
Naknek	Numbers	516,444	413,540	150,745	1,080,729
	Percent	47.8	38.3	13.9	100.0
Egegik	Numbers	95,322	4,379,166	141,983	4,616,471
	Percent	2.1	94.8	3.1	100.0
Ugashik	Numbers	25,194	632,358	1,193,490	1,851,042
	Percent	1.4	34.2	64.4	100.0
Total East Side	Numbers	3,549,422	6,400,126	1,531,615	11,481,163
	Percent	30.9	55.8	13.3	100.0

Table 20. Percentages of sockeye salmon by run and age group for the East Side of Bristol Bay, 1988.

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	3.3	Total
Kvichak	Escapement	0.04	0.07	0.01	19.47	0.50		21.00	8.75	0.04	0.93				50.83
	In District Catch		0.01	0.03	12.30	0.04		17.36	5.53	0.05	1.11				36.41
	Other Dist. Catch	0.01		0.02	2.79	0.00[a]	0.00[a]	6.82	2.67	0.02	0.42				12.76
	Total Return	0.06	0.09	0.06	34.55	0.54	0.00[a]	45.17	16.95	0.11	2.46				100.00
Naknek	Escapement		0.08		13.53	0.99		12.75	9.28	0.62	11.61		0.12		48.99
	In District Catch		0.01		6.40	0.05		6.86	3.79	0.35	6.92				24.38
	Other Dist. Catch				4.42	0.05	0.00[a]	7.57	5.30	0.38	8.90		0.02		26.63
	Total Return		0.09		24.34	1.09	0.00[a]	27.18	18.36	1.35	27.43		0.14		100.00
Egegik	Escapement	0.01	0.01		1.59	1.19		6.86	12.43	0.01	3.73	0.05		0.02	25.89
	In District Catch	0.02			2.12	0.09	0.01	23.31	29.85	0.05	14.64	0.12		0.10	70.30
	Other Dist. Catch	0.00[a]	0.00[a]		0.18	0.01	0.00[a]	0.71	2.06	0.01	0.82			0.01	3.81
	Total Return	0.03	0.01		3.89	1.29	0.01	30.88	44.34	0.07	19.19	0.17		0.13	100.00
Ugashik	Escapement	0.04	0.02	0.14	6.29	1.82		2.61	7.64	0.02	7.19		0.01		25.78
	In District Catch	0.03		0.07	9.71	0.27	0.02	8.28	10.87	0.11	18.49		0.01		47.85
	Other Dist. Catch	0.05		0.26	3.43	0.13	0.00[a]	6.44	4.78	0.03	11.25				26.37
	Total Return	0.12	0.02	0.46	19.43	2.22	0.02	17.33	23.29	0.16	36.93		0.02		100.00

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

Table 21. Numbers of sockeye salmon by run and age group for the East Side of Bristol Bay, 1988.

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	3.3	Total
Kvichak	Escapement	3,485	5,909	1,162	1,557,148	40,309		1,679,241	700,039	3,446	74,477				4,065,216
	In District Catch		1,031	2,242	983,391	2,866		1,388,286	442,048	3,830	88,768				2,912,462
	Other Dist. Catch	1,020		1,673	223,147	381	130	545,384	213,446	1,594	33,684				1,020,459
	Total Return	4,505	6,940	5,077	2,763,686	43,556	130	3,612,911	1,355,533	8,870	196,929				7,998,137
Naknek	Escapement		1,748		286,579	21,061		270,194	196,517	13,194	246,005		2,564		1,037,862
	In District Catch		133		135,574	1,100		145,232	80,309	7,496	146,600				516,444
	Other Dist. Catch				93,605	1,011	101	160,482	112,253	7,986	188,508		339		564,285
	Total Return		1,881		515,758	23,172	101	575,908	389,079	28,676	581,113		2,903		2,118,591
Egegik	Escapement	461	341		98,856	74,089		427,507	774,308	816	232,060	3,085		1,157	1,612,680
	In District Catch	1,221			132,102	5,581	436	1,451,916	1,859,241	3,229	911,663	7,606		6,173	4,379,168
	Other Dist. Catch	8	6		11,209	738	256	44,214	128,514	501	51,370			489	237,305
	Total Return	1,690	347		242,167	80,408	692	1,923,637	2,762,063	4,546	1,195,093	10,691		7,819	6,229,153
Ugashik	Escapement	1,046	506	3,451	156,897	45,466		65,096	190,502	540	179,319		149		642,972
	In District Catch	646		1,699	242,149	6,628	488	206,554	271,198	2,783	461,076		270		1,193,491
	Other Dist. Catch	1,204		6,383	85,498	3,152	103	160,638	119,214	786	280,573				657,551
	Total Return	2,896	506	11,533	484,544	55,246	591	432,288	580,914	4,109	920,968		419		2,494,014

Table 22. Comparison of sockeye salmon run estimates for the East Side of Bristol Bay, 1988.

Stock	Estimated Return		
	Standard Method[a]	Scale Pattern Analysis	Difference
Kvichak	6,878,830	7,998,137	-1,119,307
Naknek	1,773,672	2,118,591	-344,919
Egegik	8,012,806	6,229,153	1,783,653
Ugashik	2,174,587	2,494,014	-319,427
Total East Side	18,839,895	18,839,895	

[a] Standard method assumes fish harvested in a district originated within that district, and divides the Naknek-Kvichak District catch to the Naknek and Kvichak Rivers based on escapement age composition (Stratton and Cross, 1990). These numbers have been adjusted to include Branch River return.

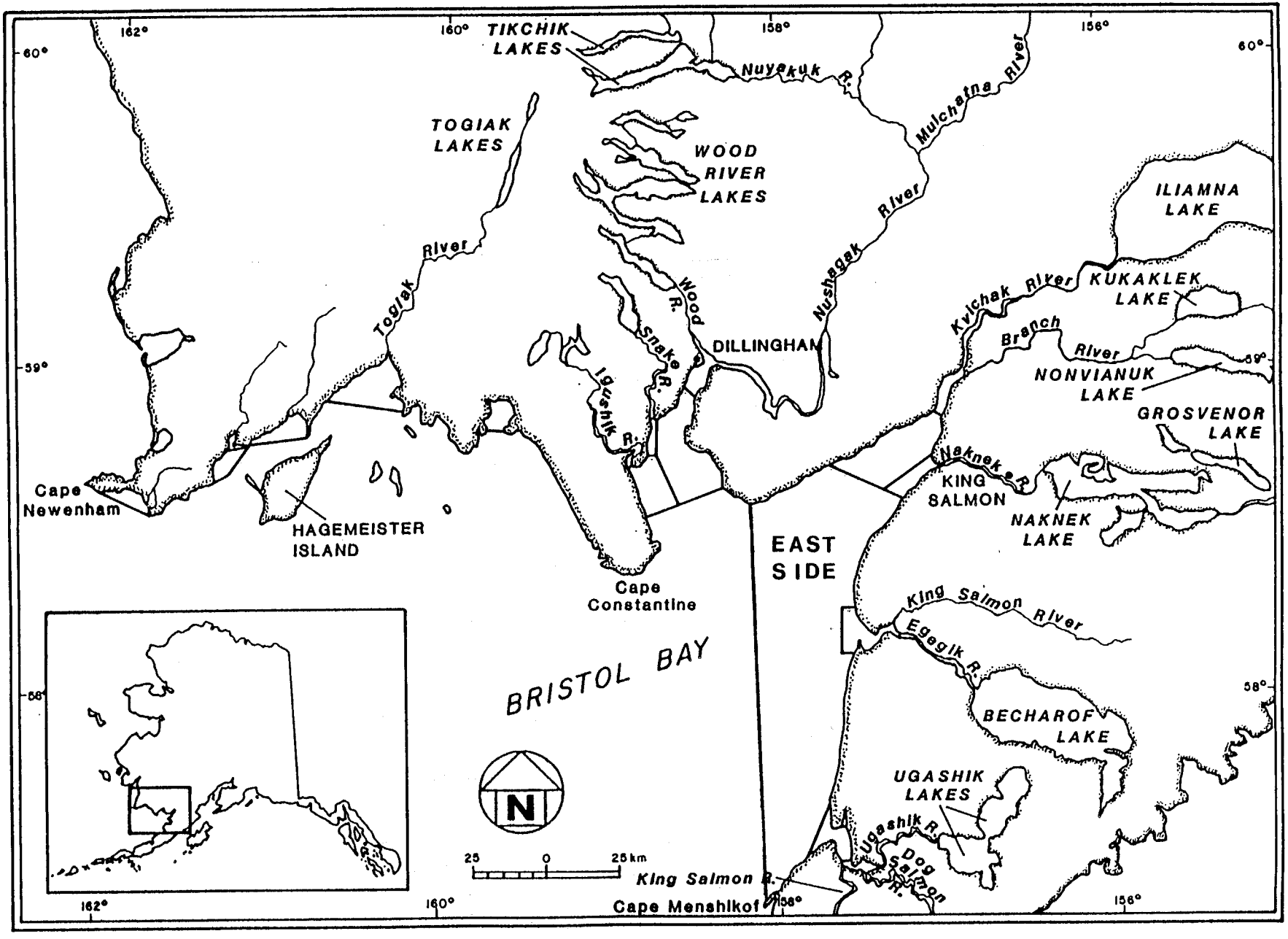


Figure 1. Map of Bristol Bay showing fishing districts and major rivers.

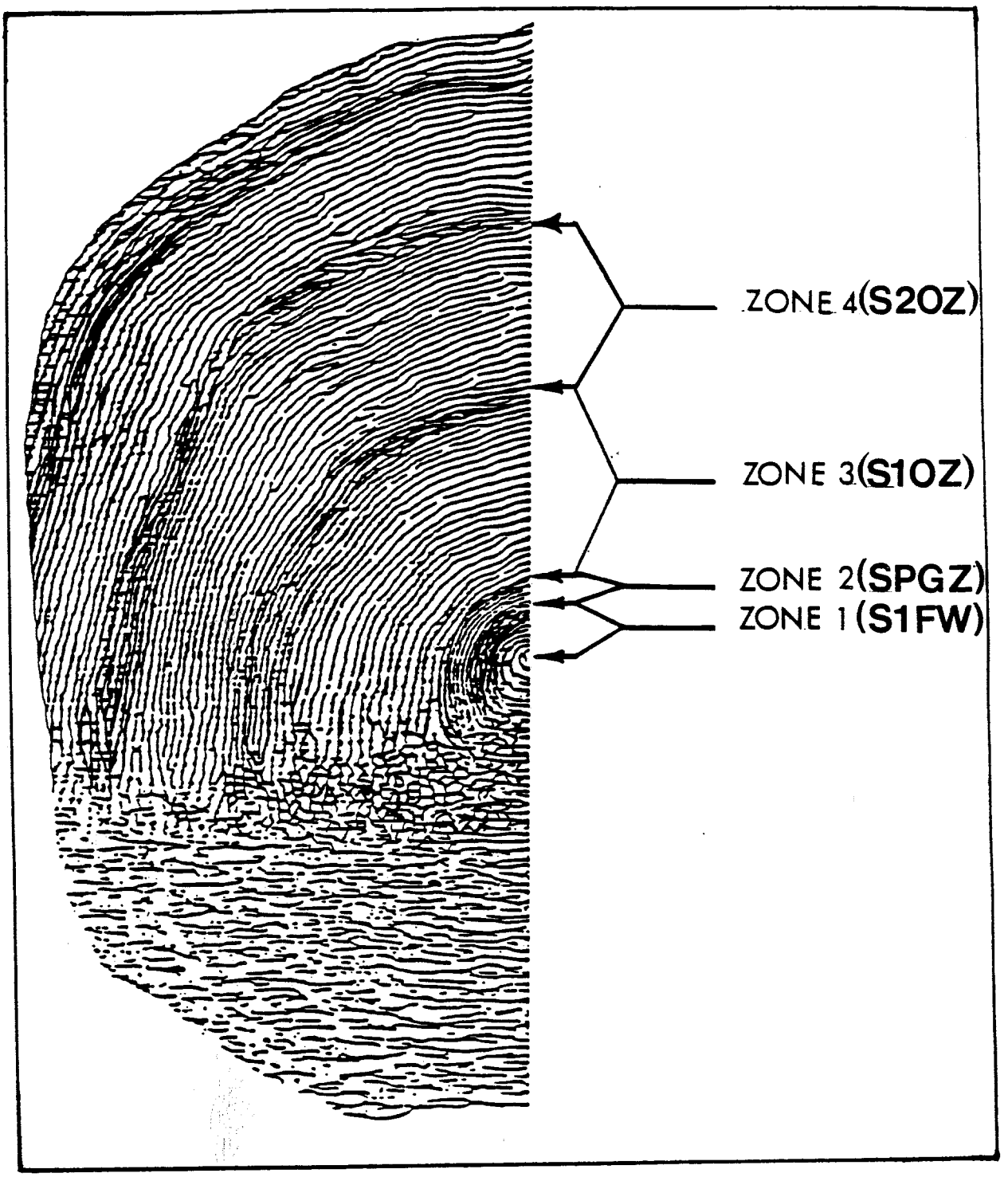


Figure 2. Age 1.3 sockeye salmon scale showing the growth zones measured to generate variables to build linear discriminant functions.

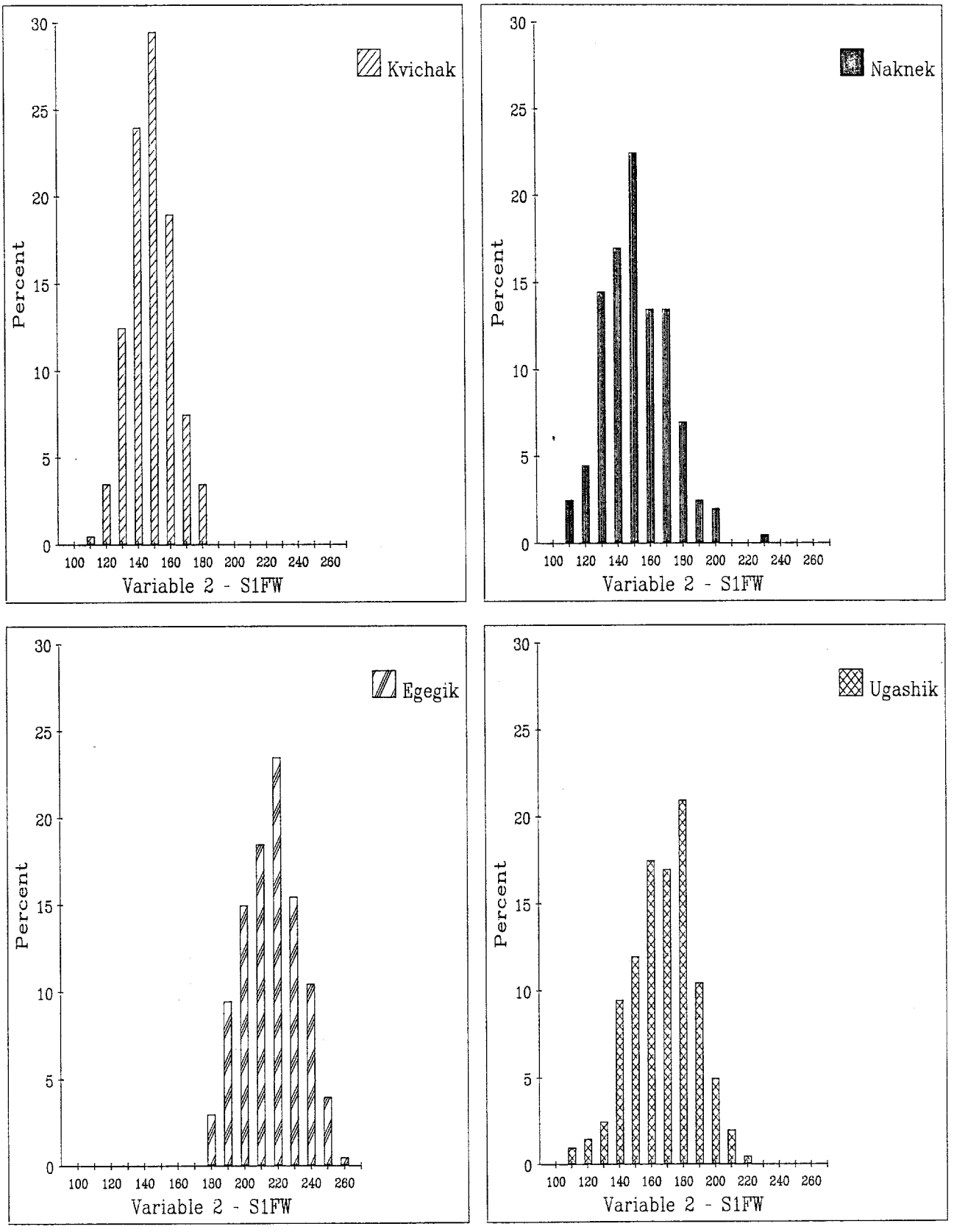


Figure 3. Size of the first freshwater (S1FW) growth measured from age-1.3 scales taken from escapements of sockeye salmon in the Kvichak, Naknek, Egegik, and Ugashik Rivers in 1988.

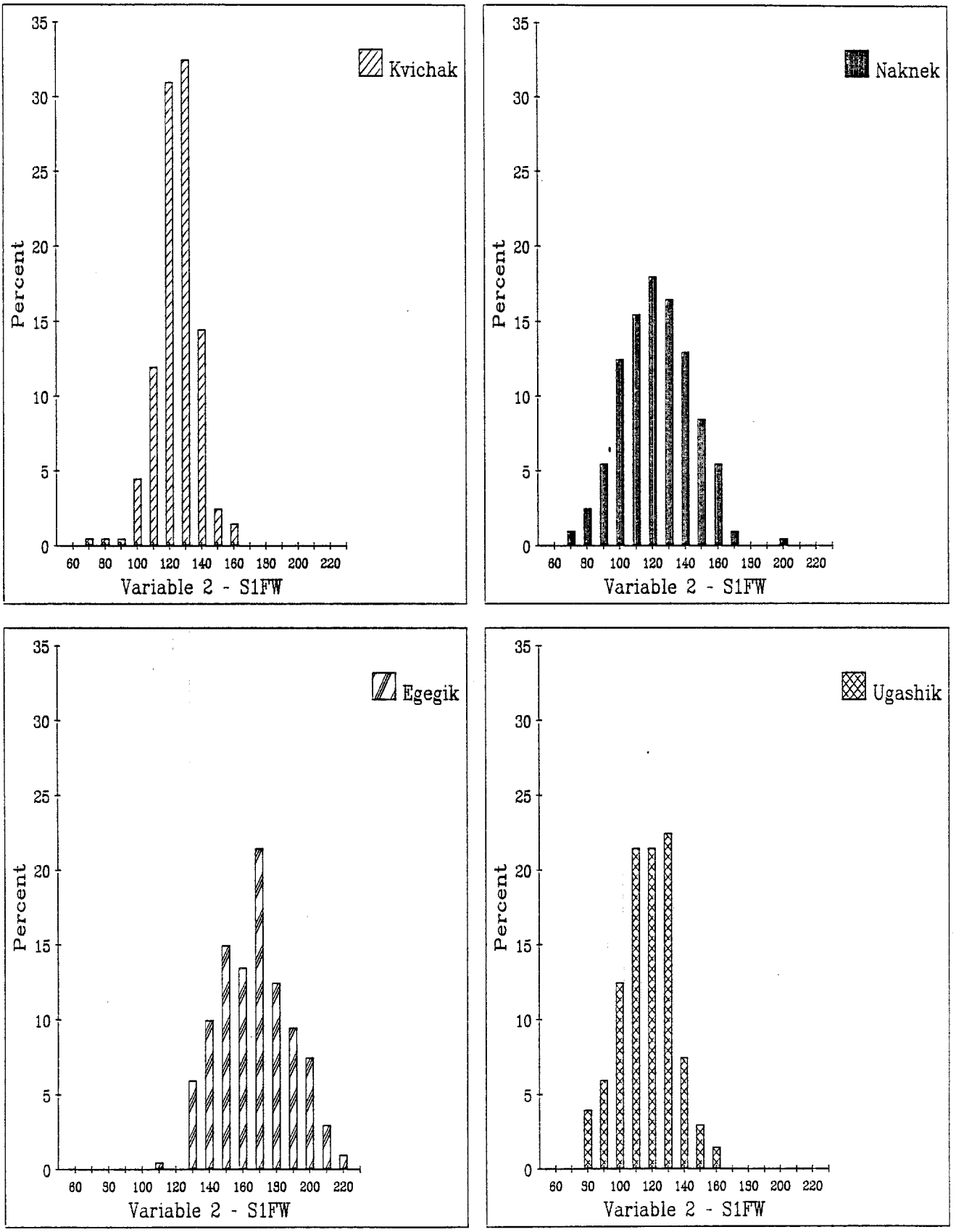
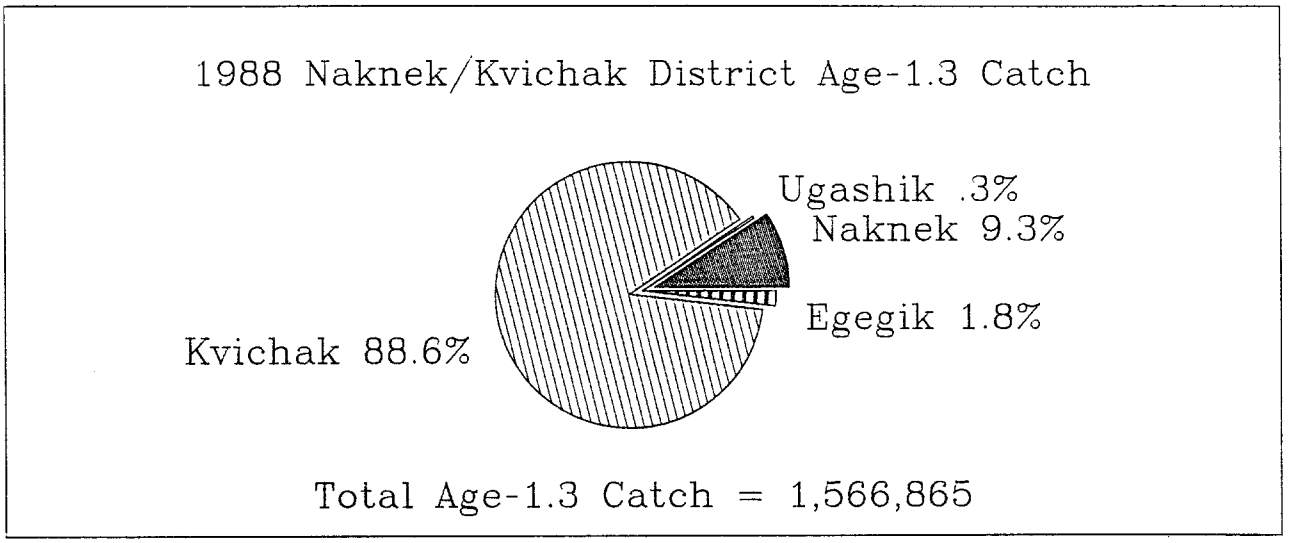
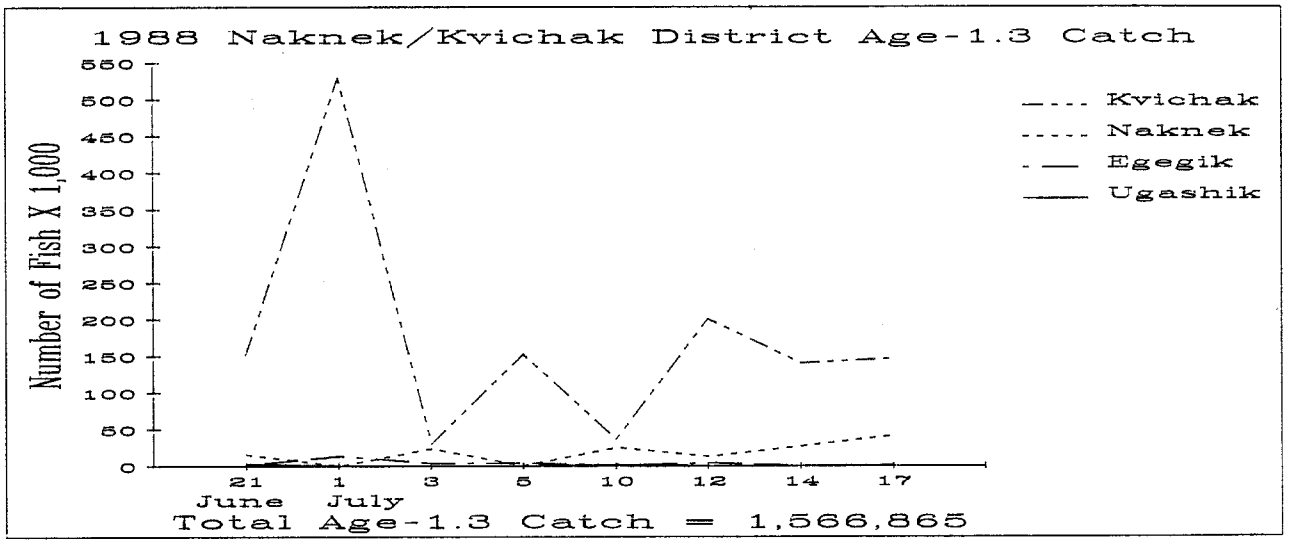


Figure 4. Size of the first freshwater (S1FW) growth measured from age-2.2 scales taken from escapements of sockeye salmon in the Kvichak, Naknek, Egegik, and Ugashik Rivers in 1988.





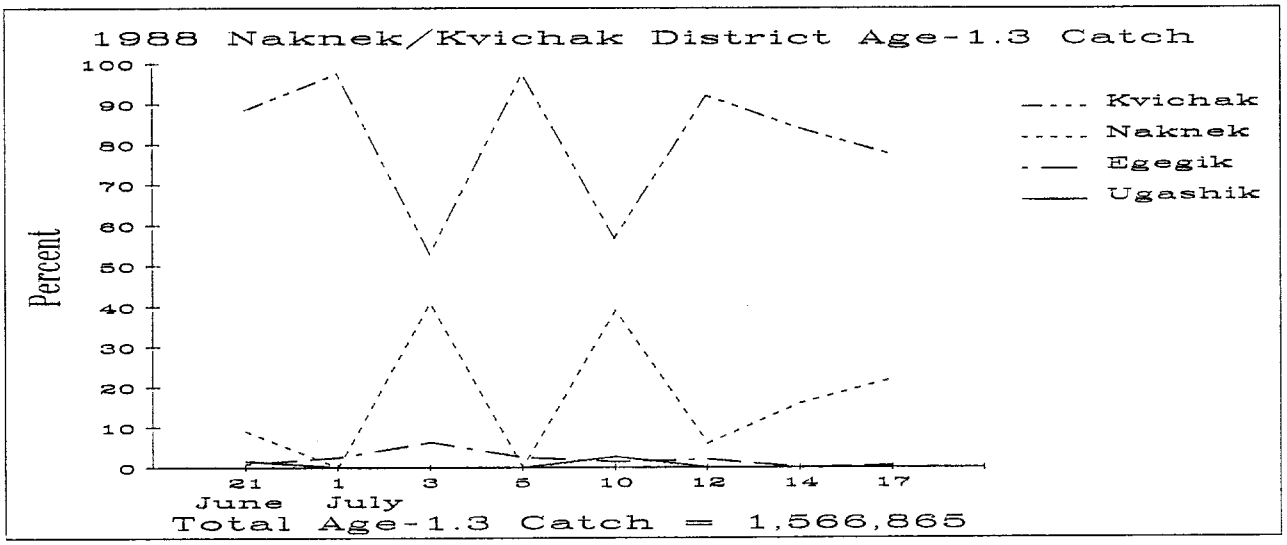
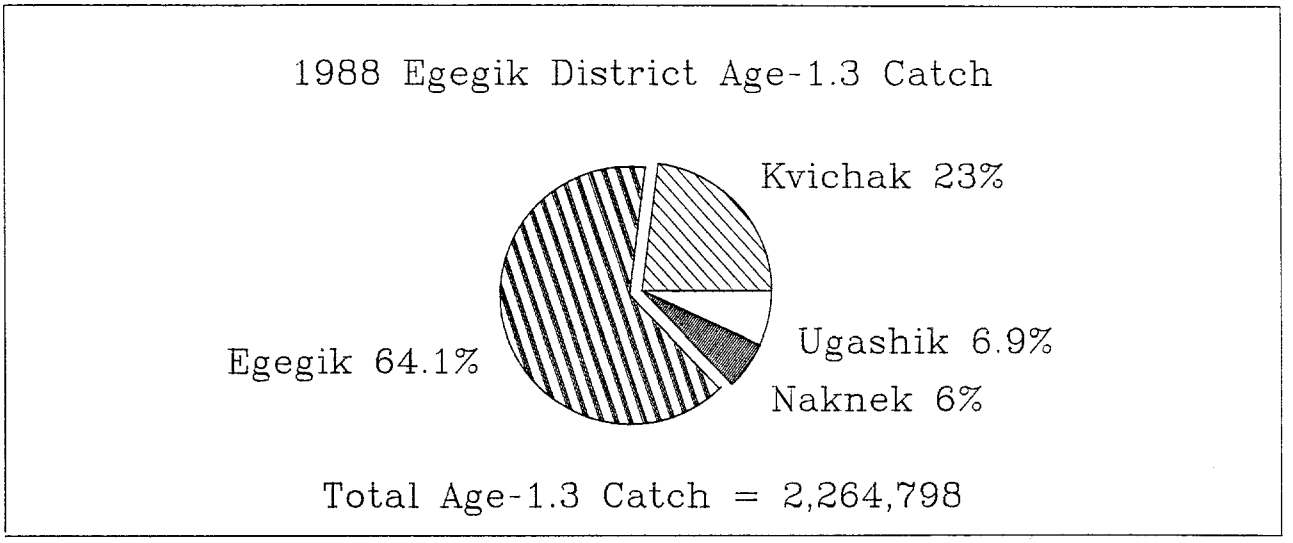
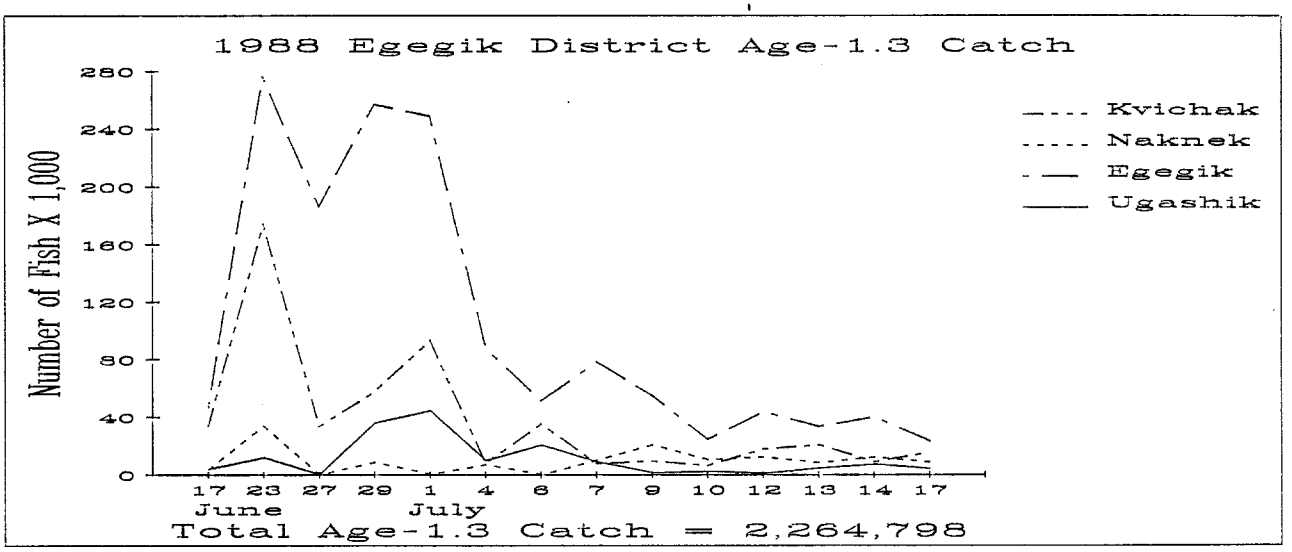


Figure 5. Estimates of stock composition for the 1988 catch of age-1.3 sockeye salmon in the Naknek-Kvichak District in percent and numbers of fish through time.





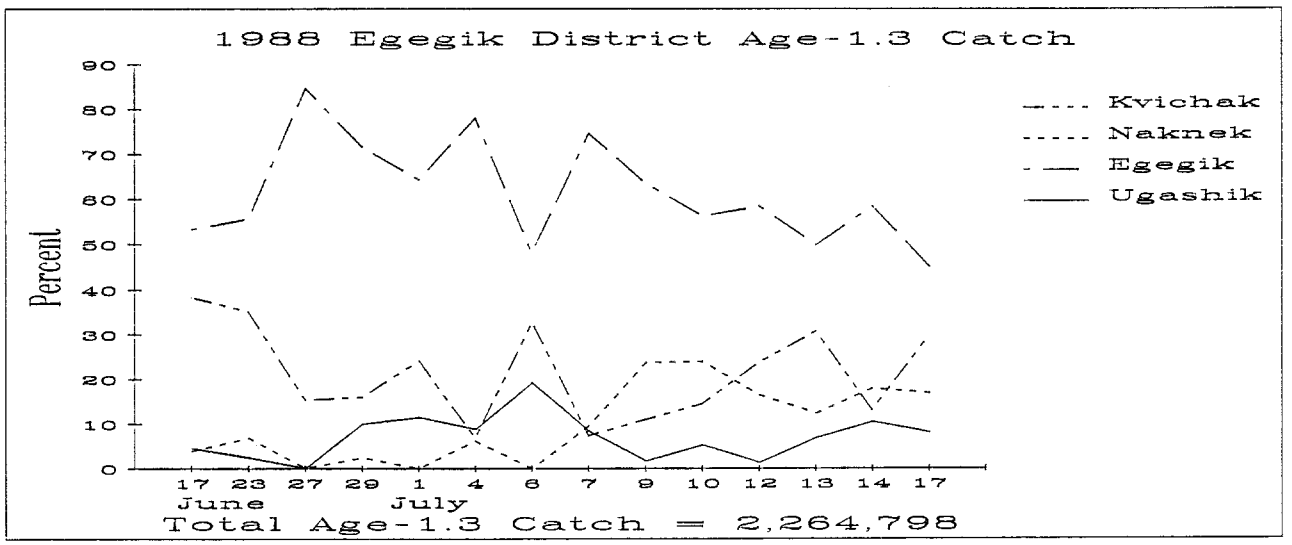
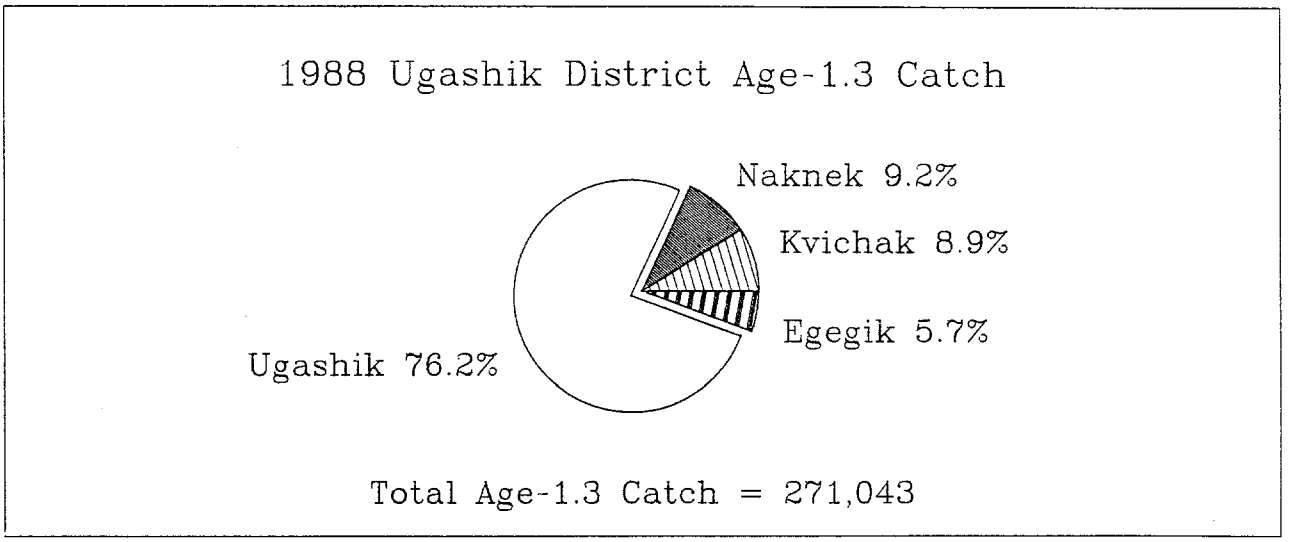
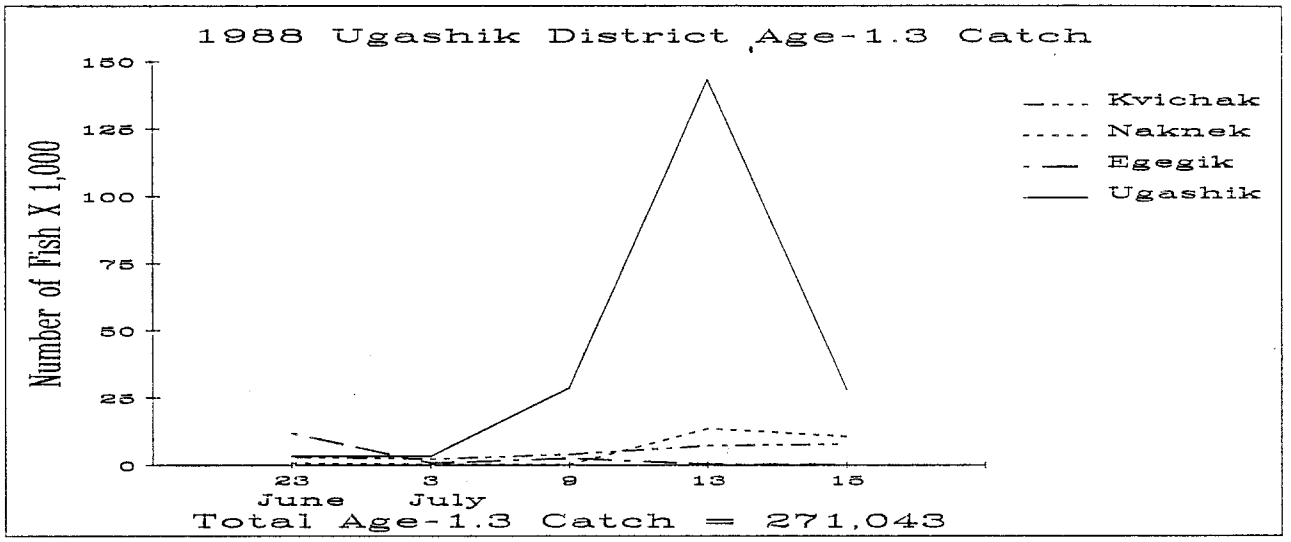


Figure 6. Estimates of stock composition for the 1988 catch of age-1.3 sockeye salmon in the Egegik District in percent and numbers of fish through time.





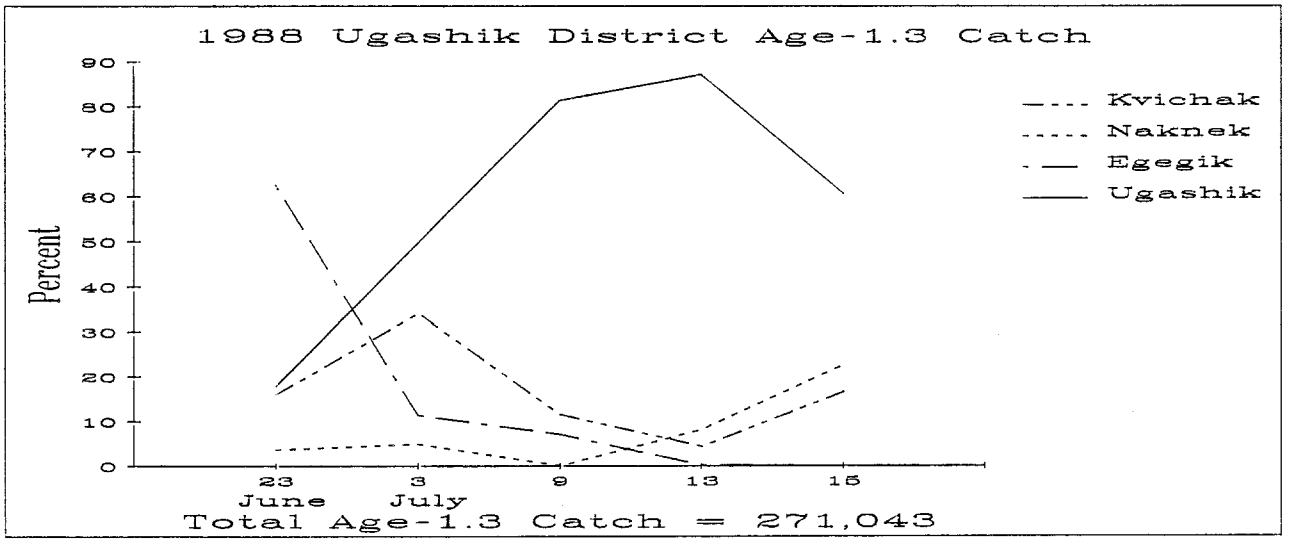
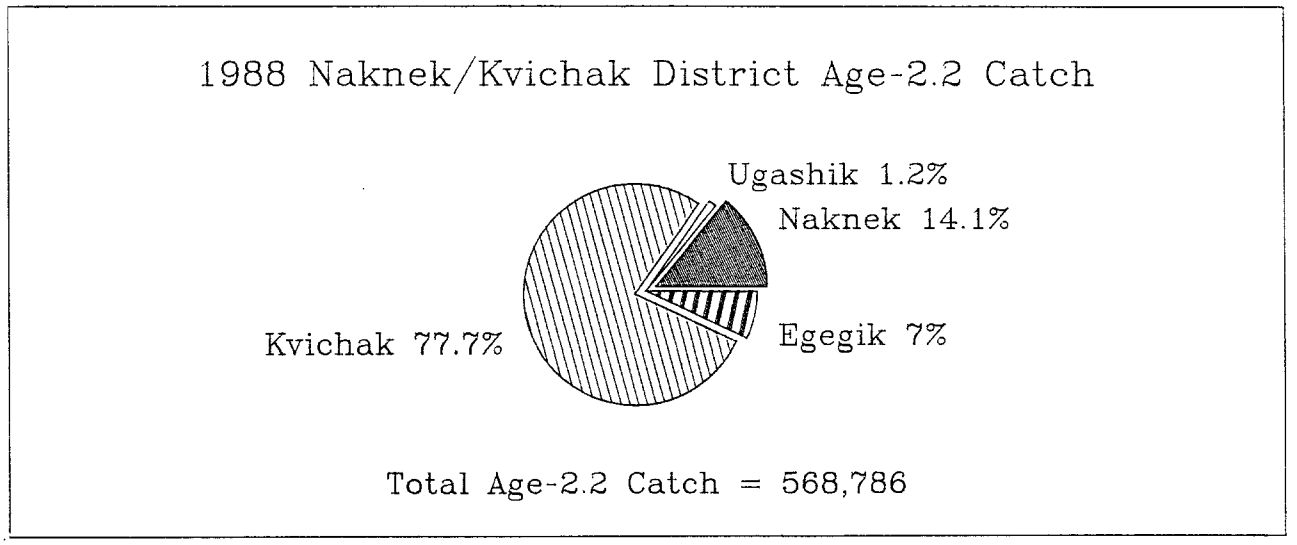
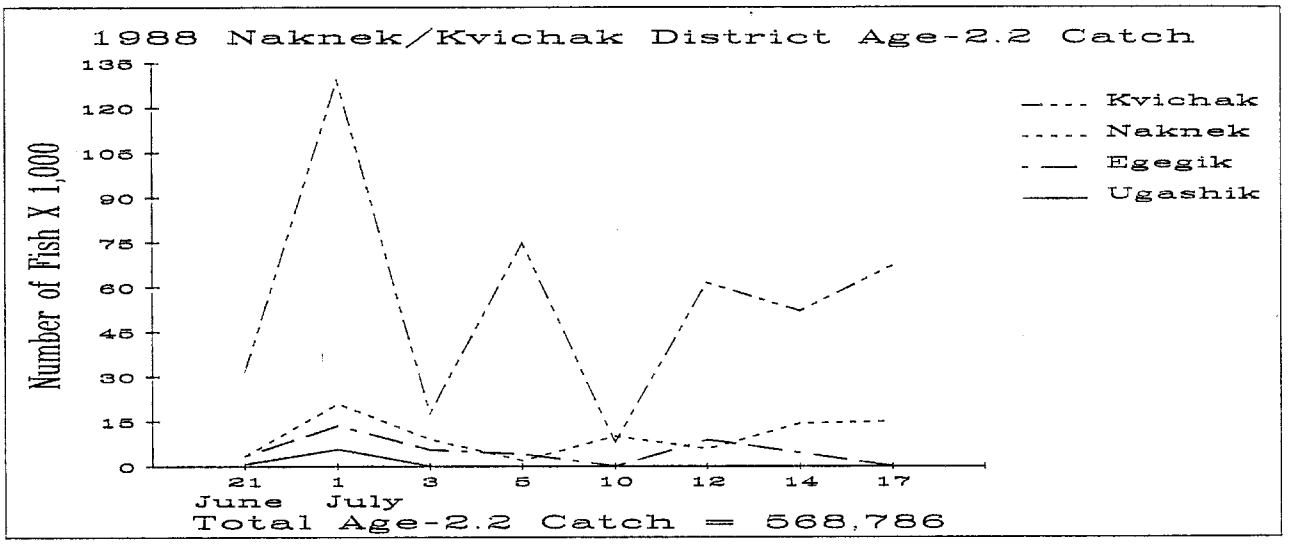


Figure 7. Estimates of stock composition for the 1988 catch of age-1.3 sockeye salmon in the Ugashik District in percent and numbers of fish through time.





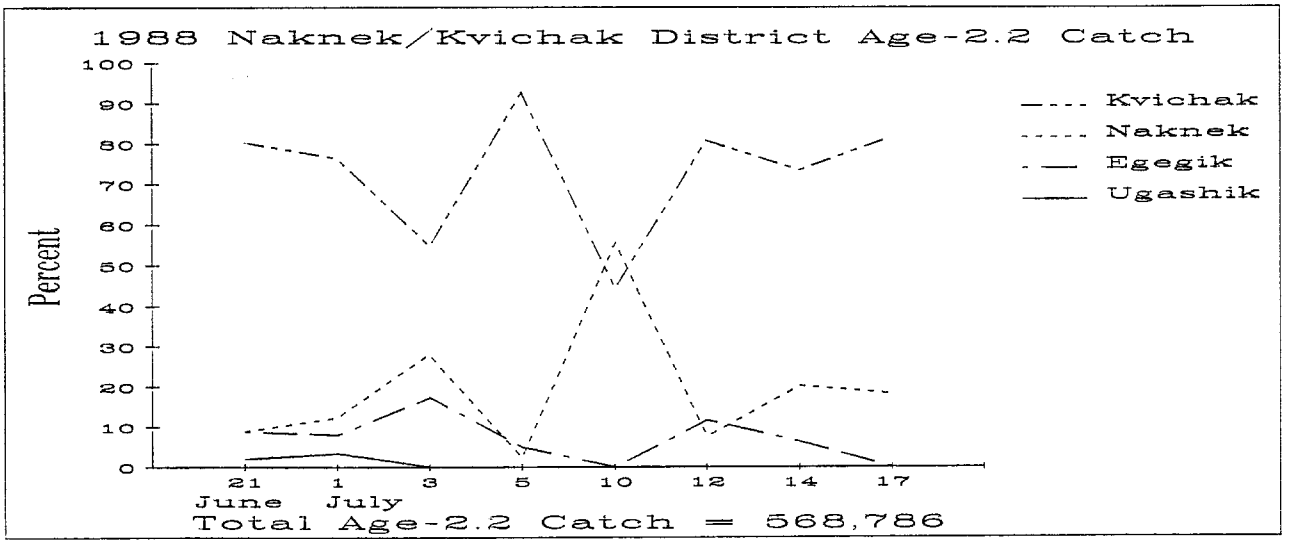
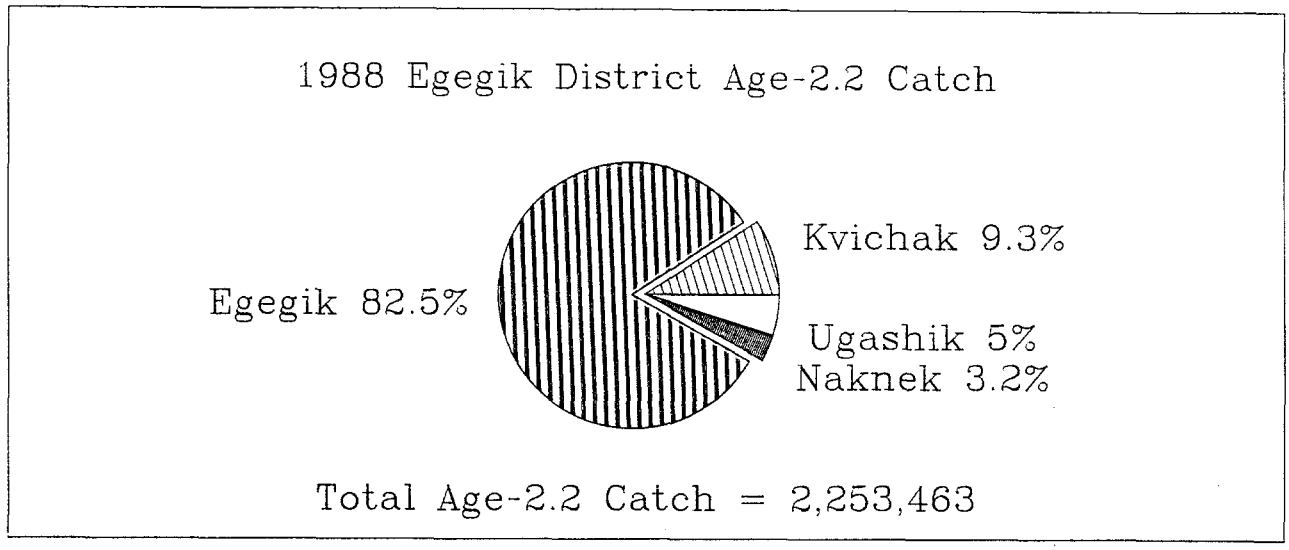
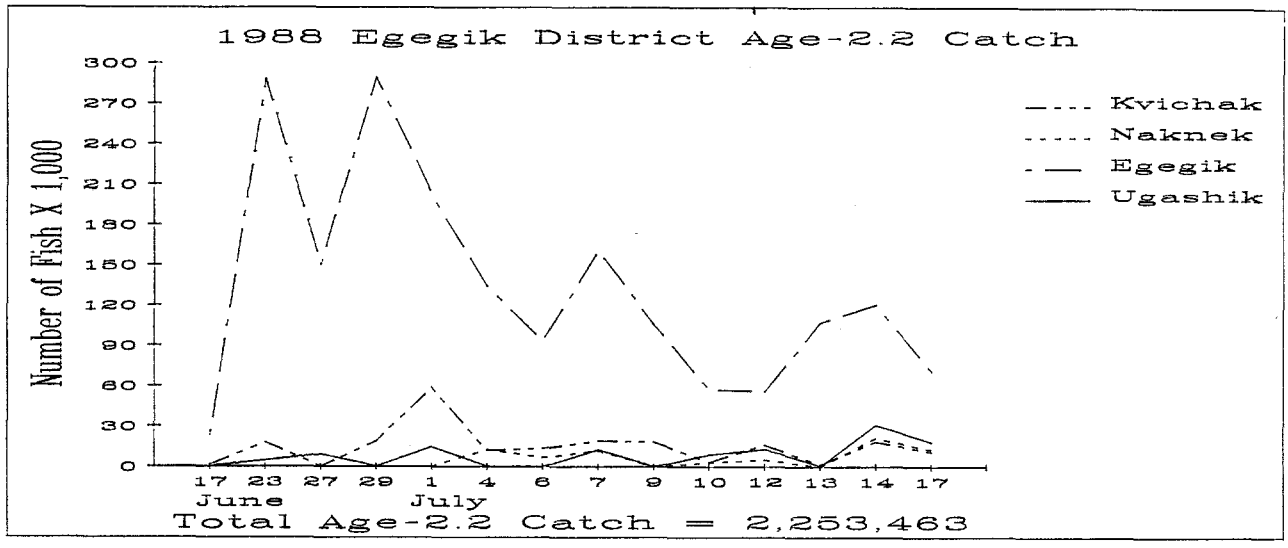


Figure 8. Estimates of stock composition for the 1988 catch of age-2.2 sockeye salmon in the Naknek-Kvichak District in percent and numbers of fish through time.





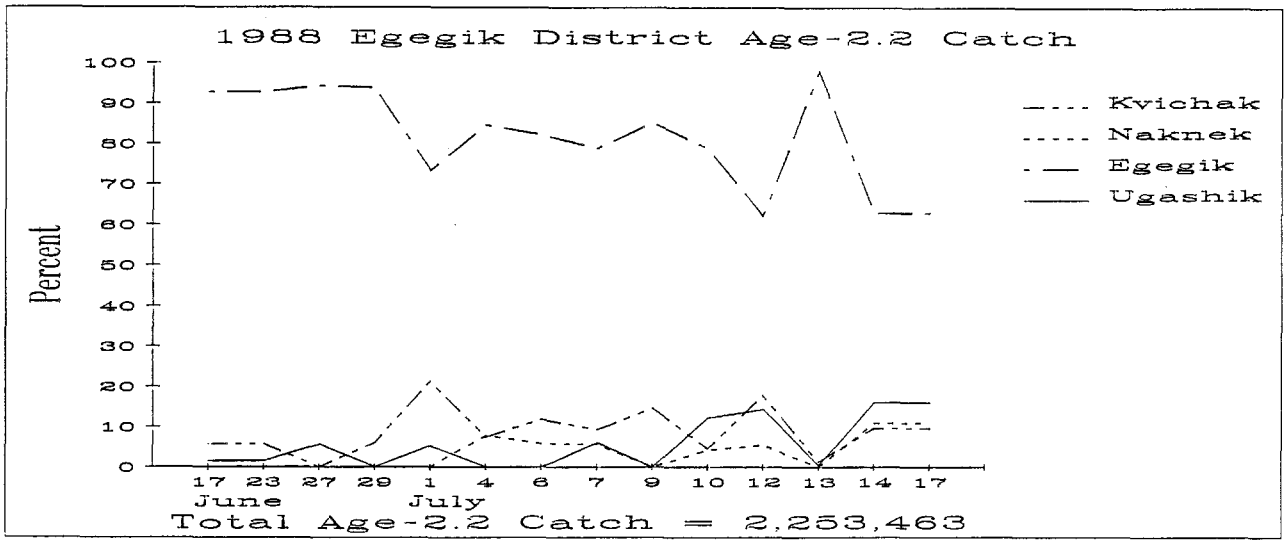
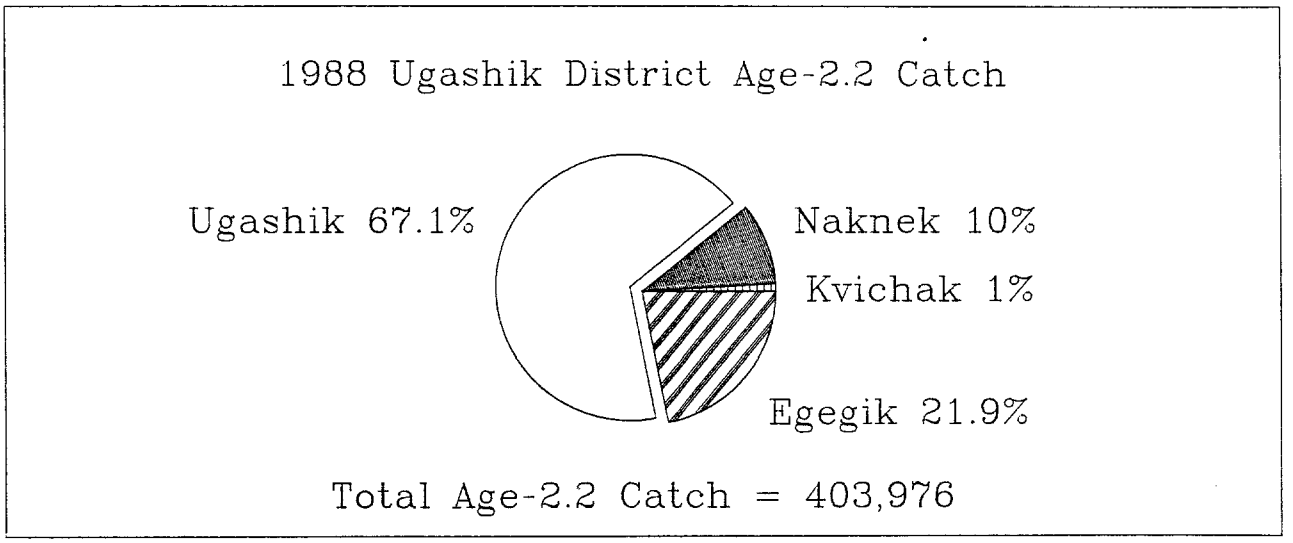
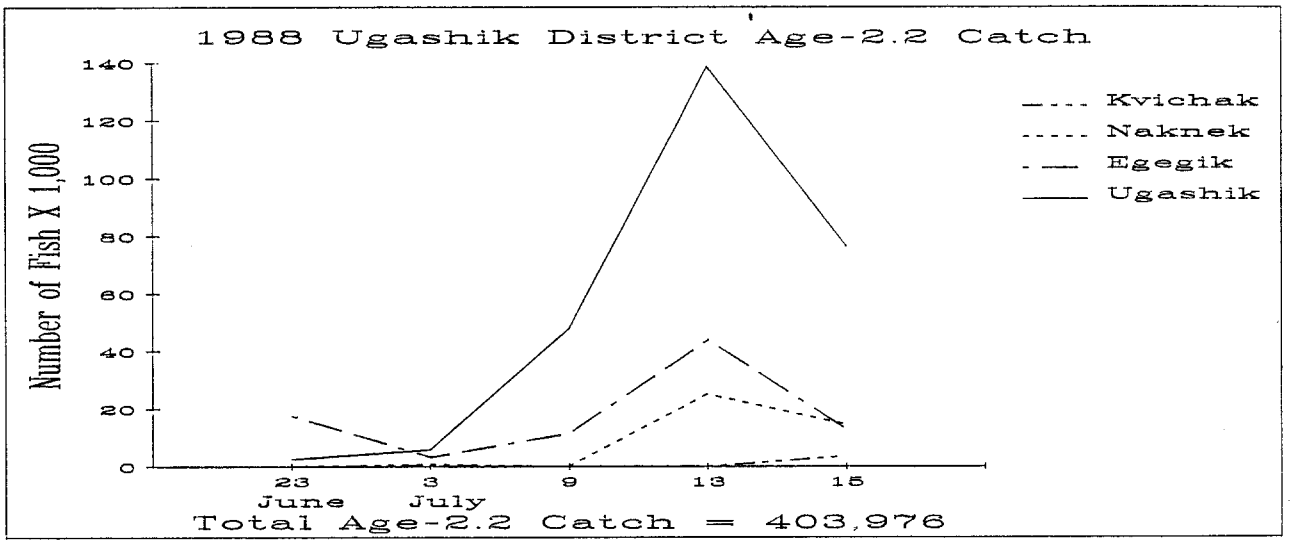


Figure 9. Estimates of stock composition for the 1988 catch of age-2.2 sockeye salmon in the Egegik District in percent and numbers of fish through time.





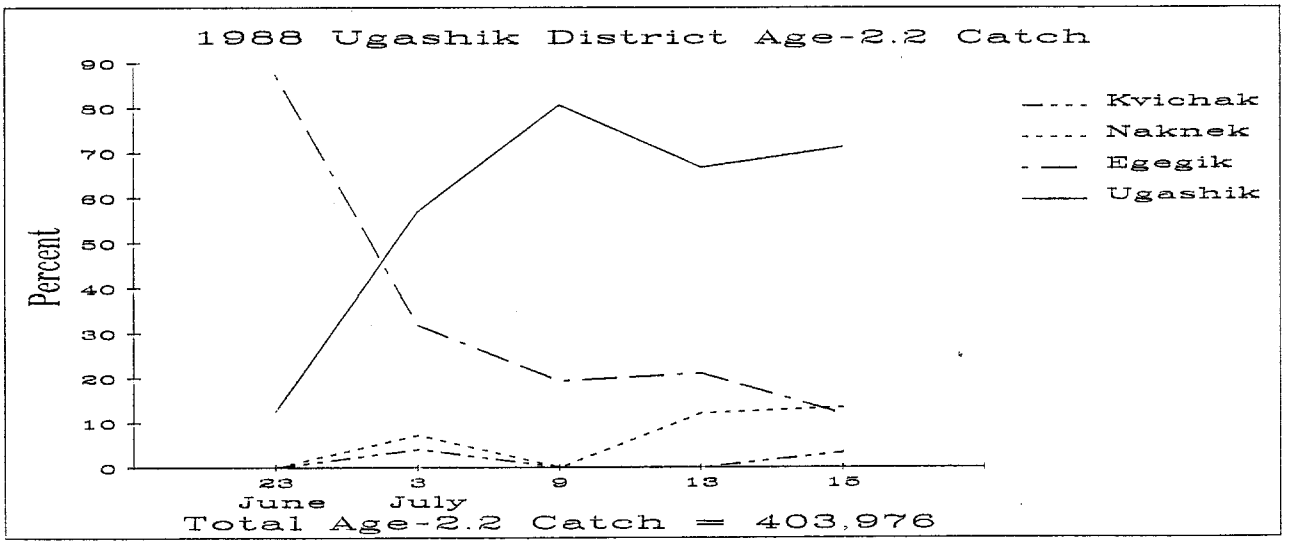
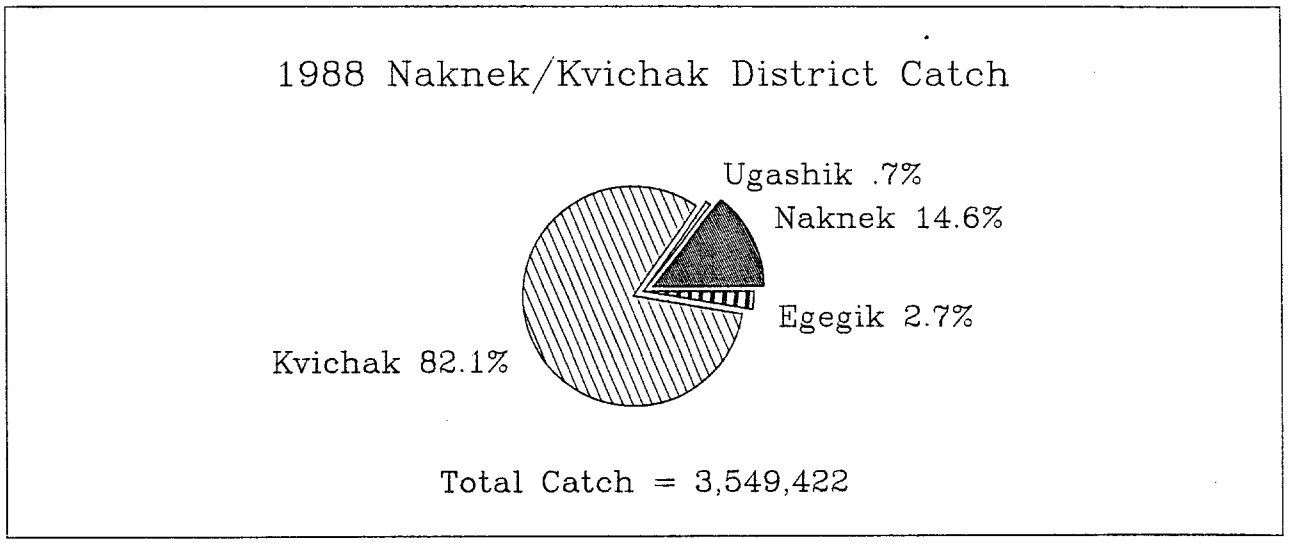
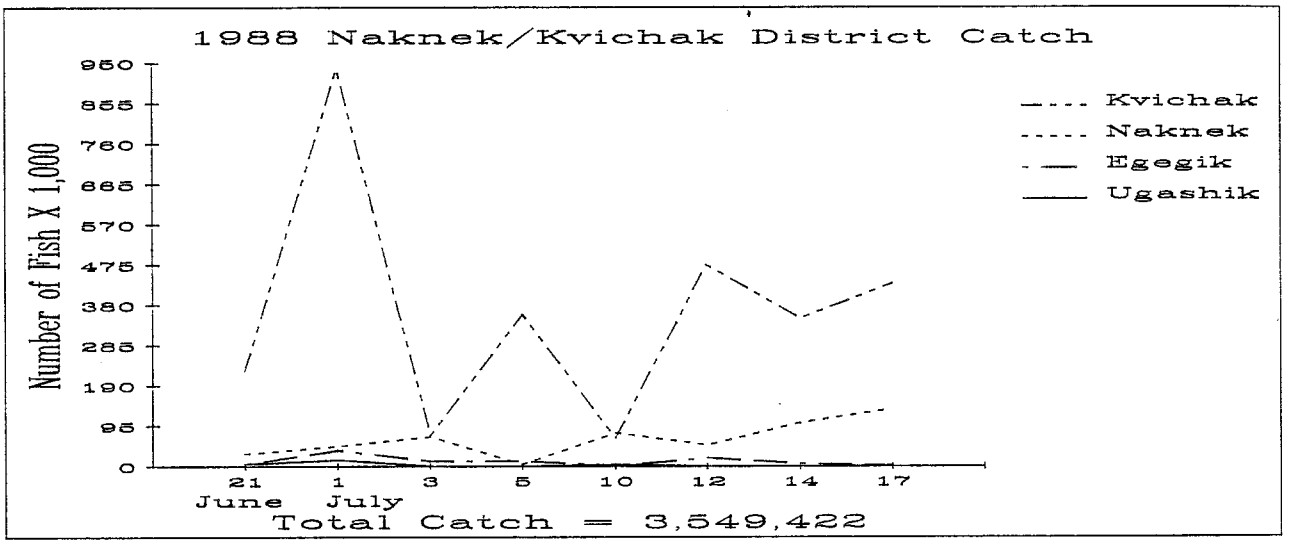


Figure 10. Estimates of stock composition for the 1988 catch of age-2.2 sockeye salmon in the Ugashik District in percent and numbers of fish through time.





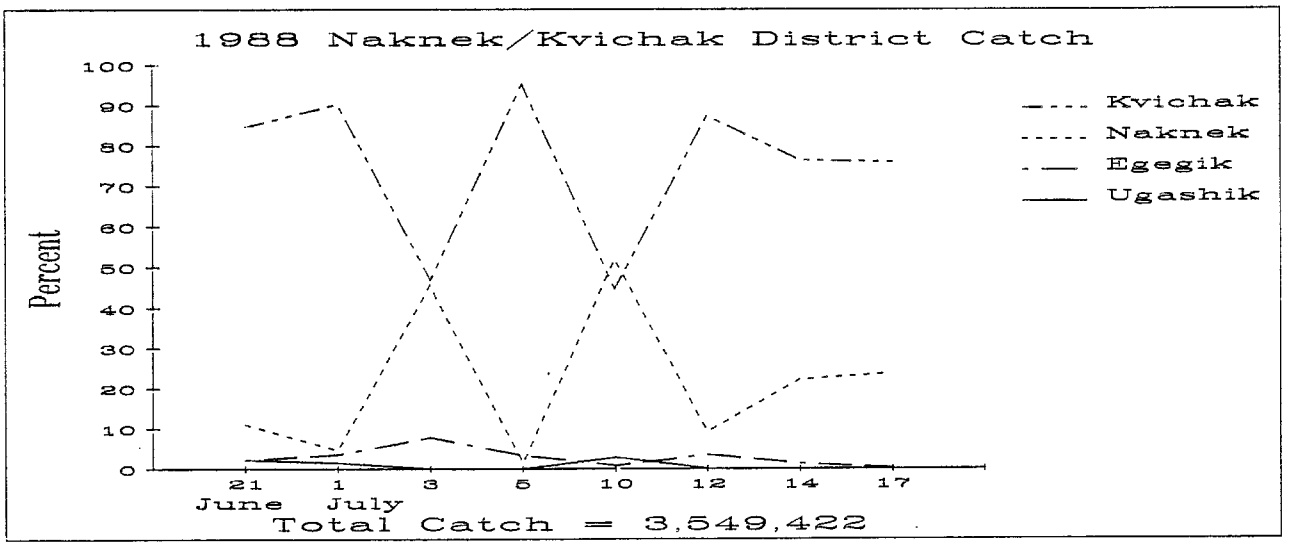
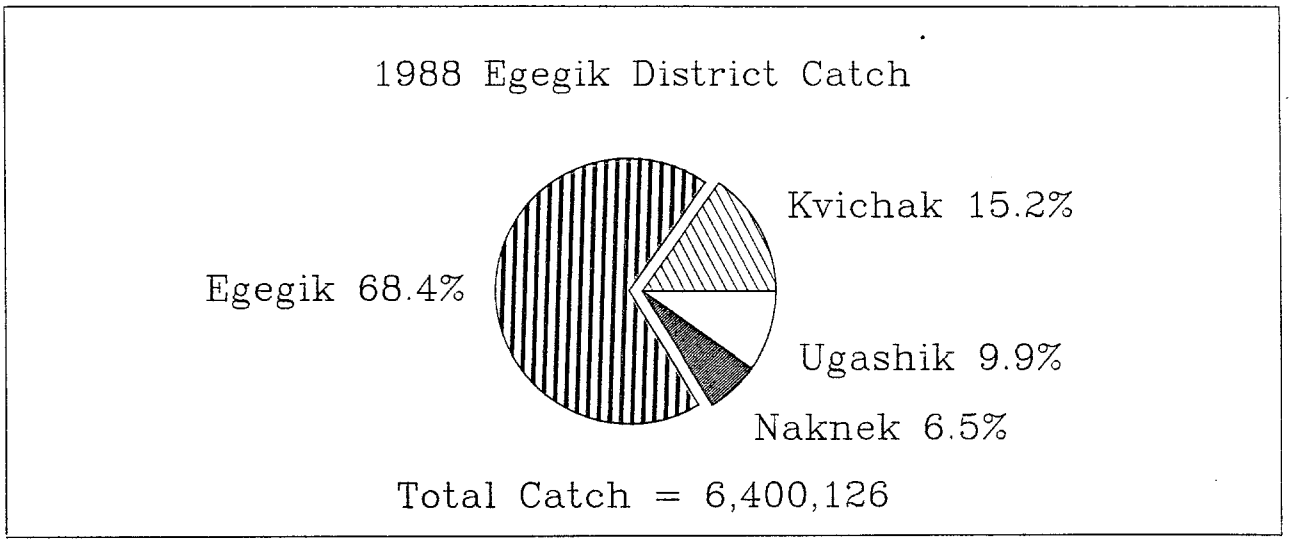
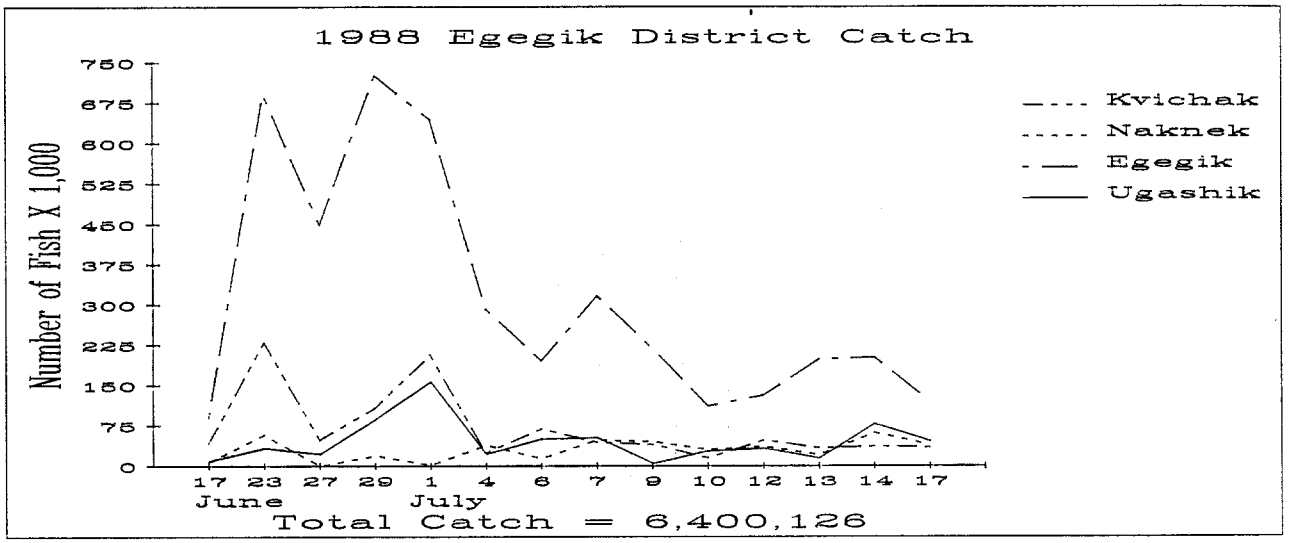


Figure 11. Estimates of stock composition for the 1988 total catch of sockeye salmon in the Naknek-Kvichak District in percent and numbers of fish through time.





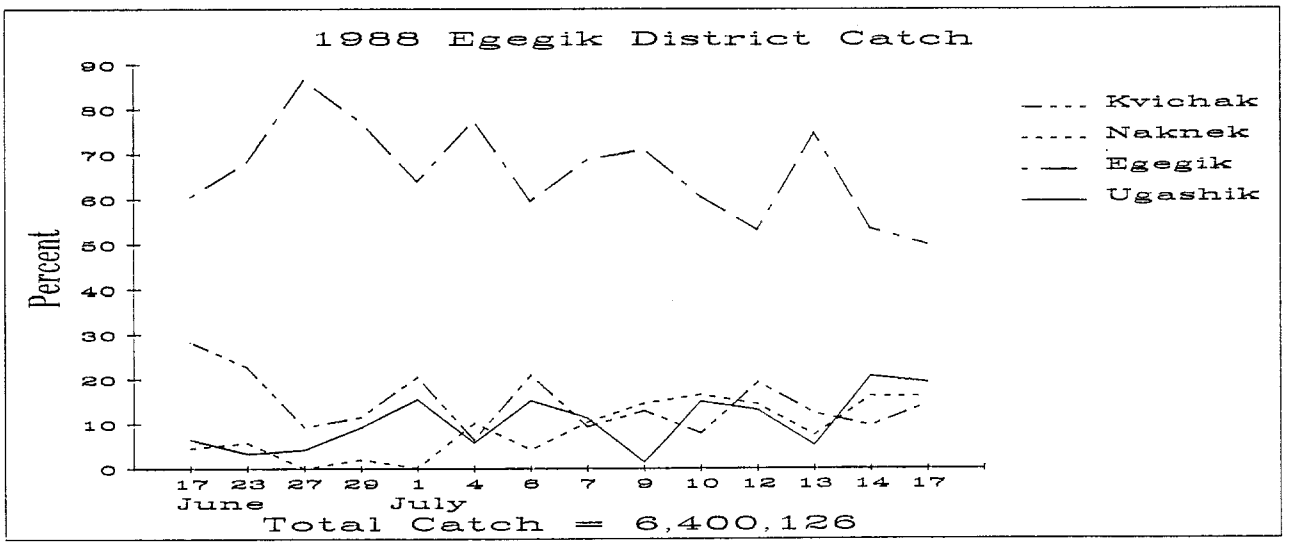
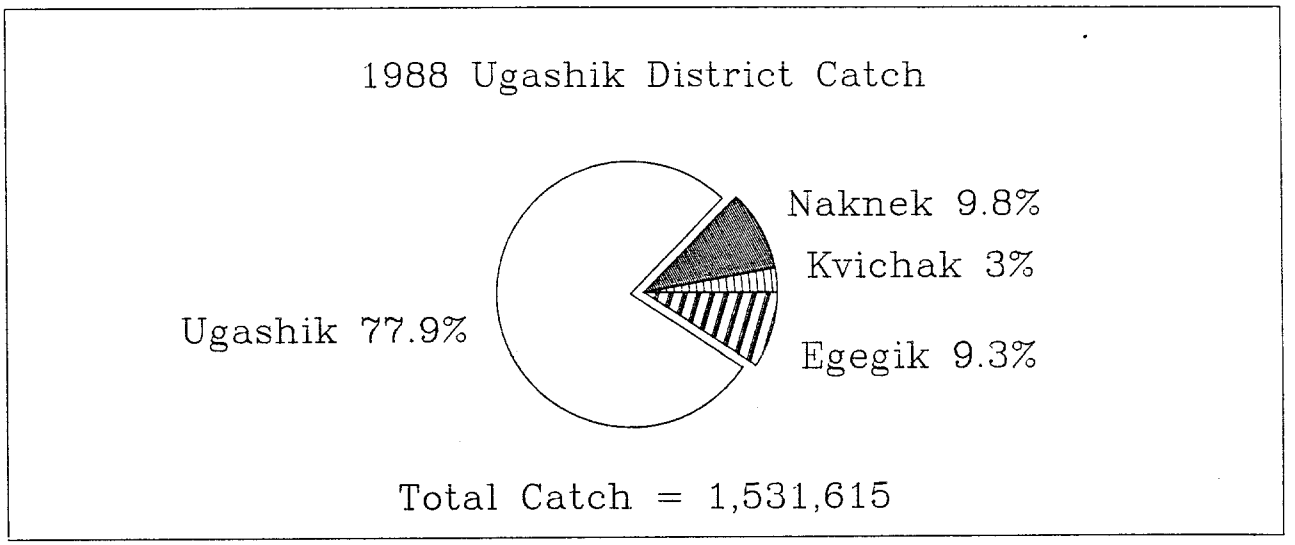
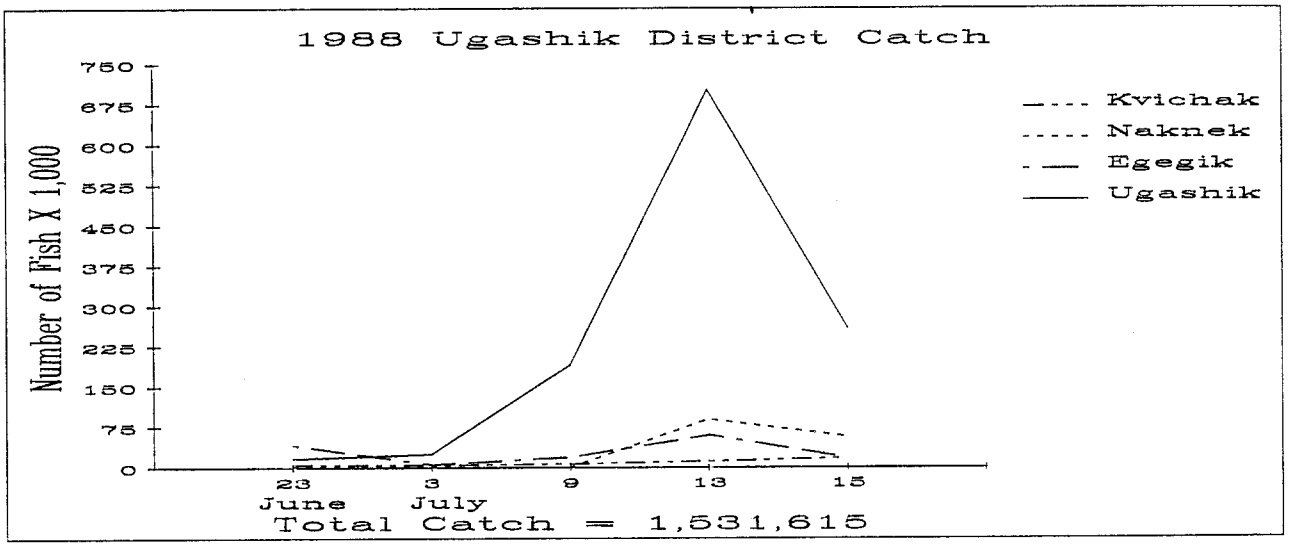


Figure 12. Estimates of stock composition for the 1988 total catch of sockeye salmon in the Egegik District in percent and numbers of fish through time.





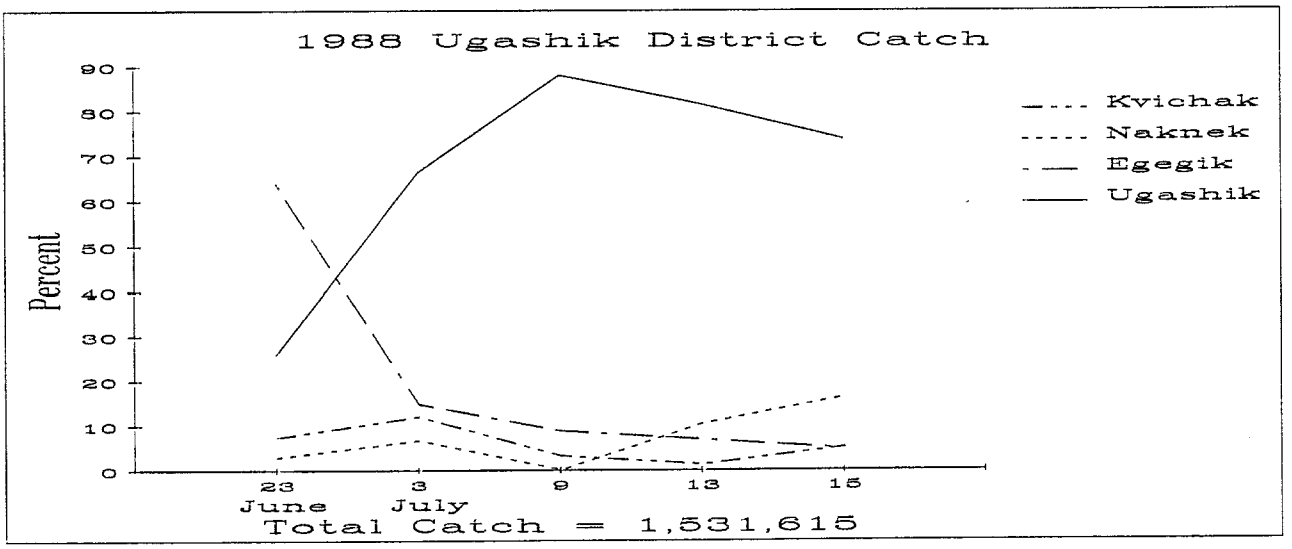
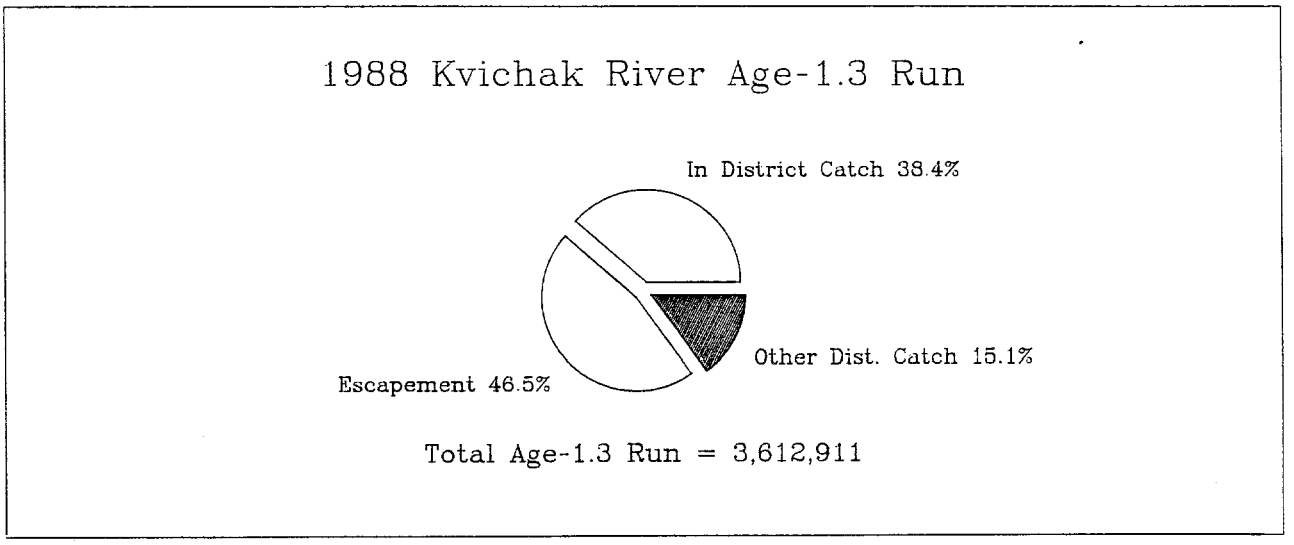
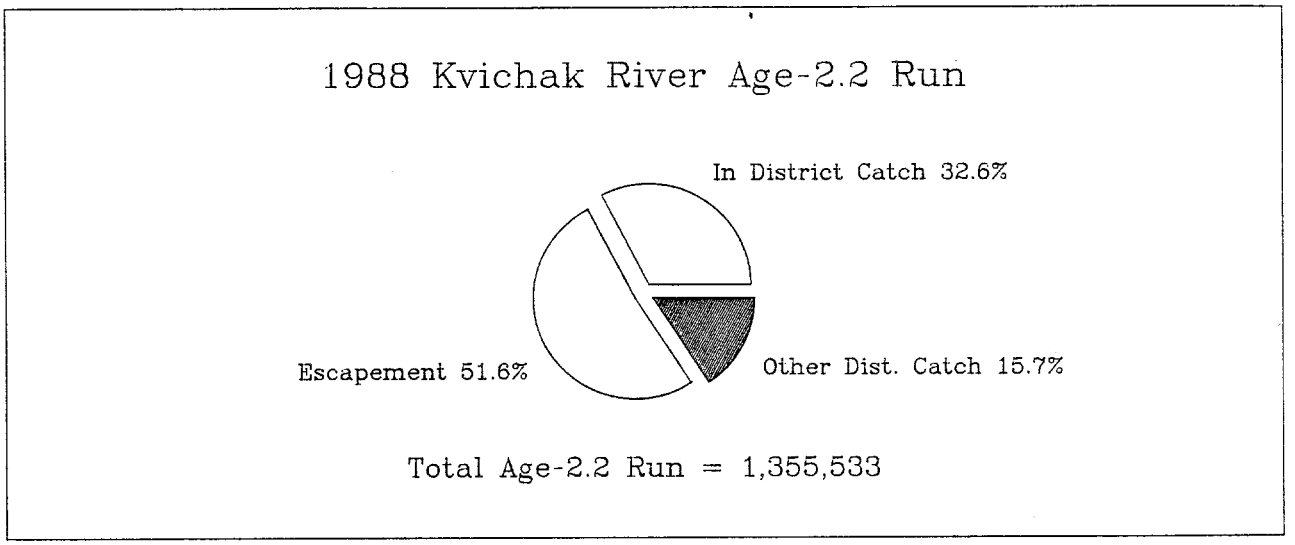


Figure 13. Estimates of stock composition for the 1988 total catch of sockeye salmon in the Ugashik District in percent and numbers of fish through time.





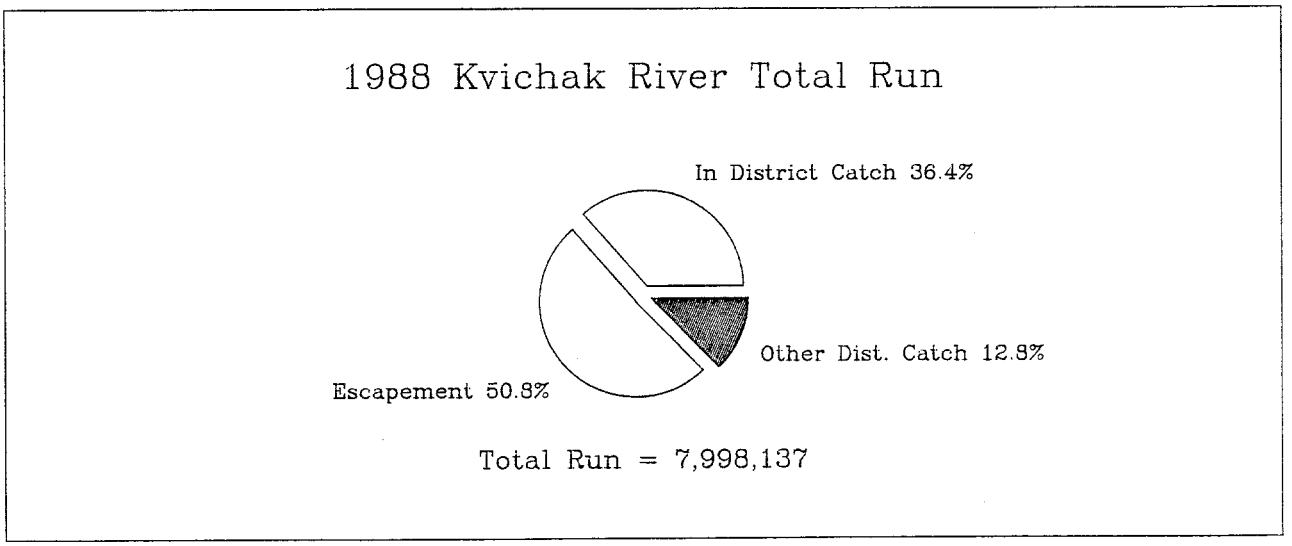
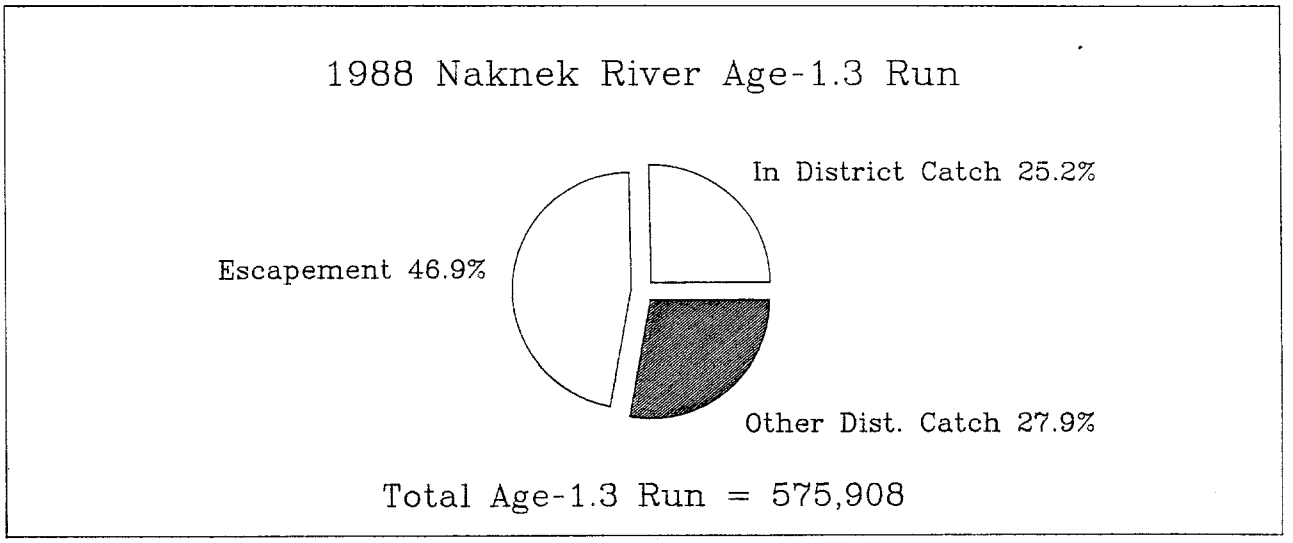
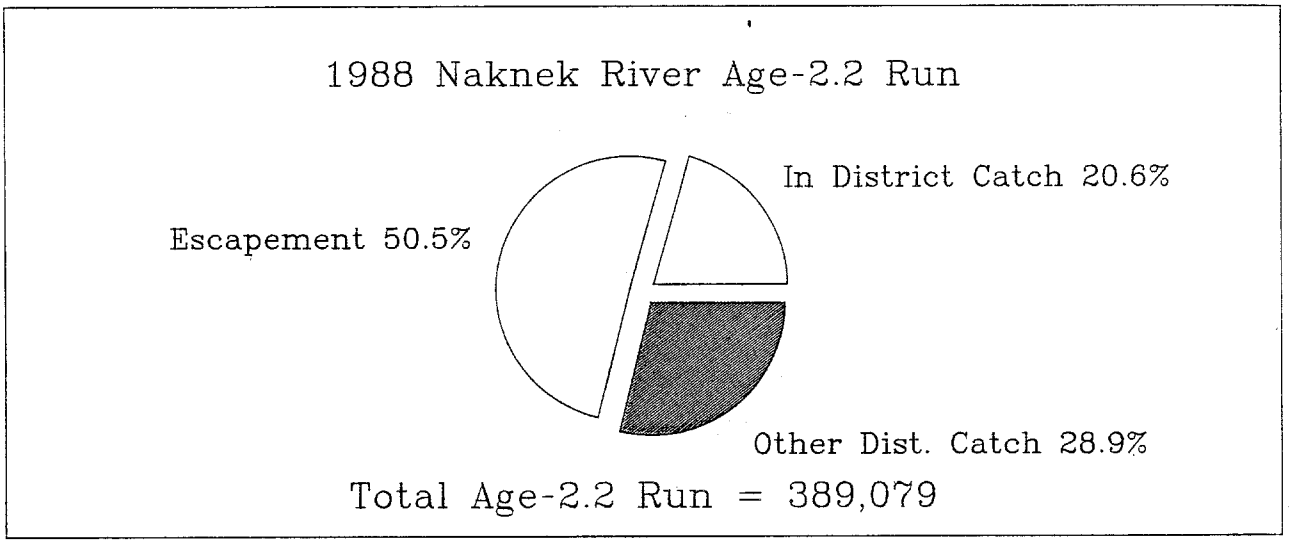


Figure 14. Estimated run of fish (by age and total) to the Kvichak River in 1988 and the breakdown of run to escapement , in district catch, and other district catch.





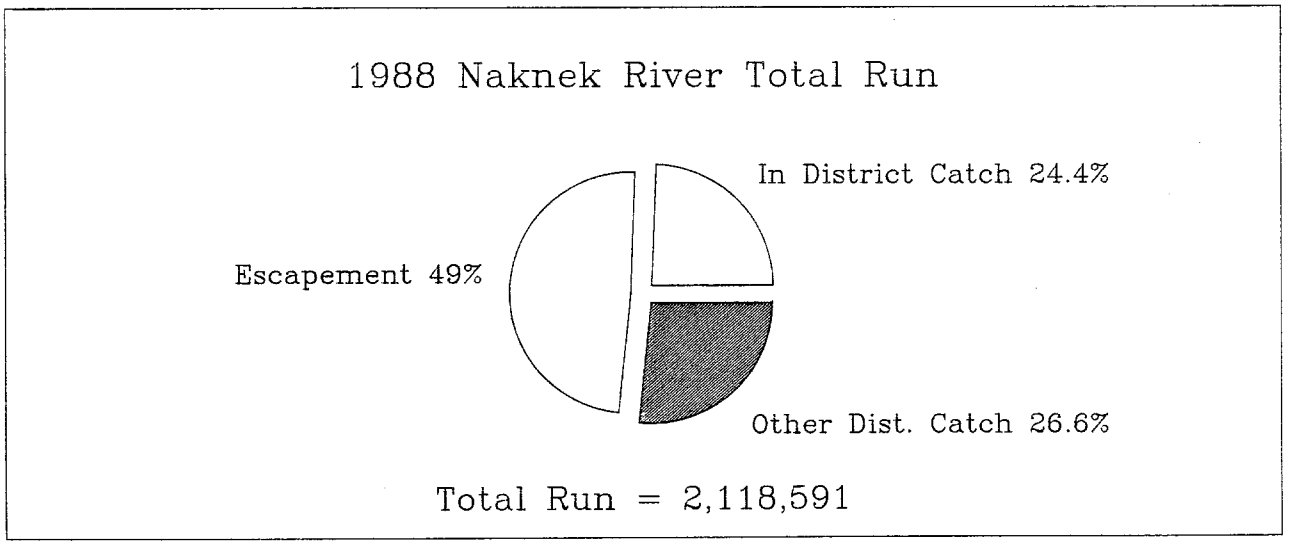
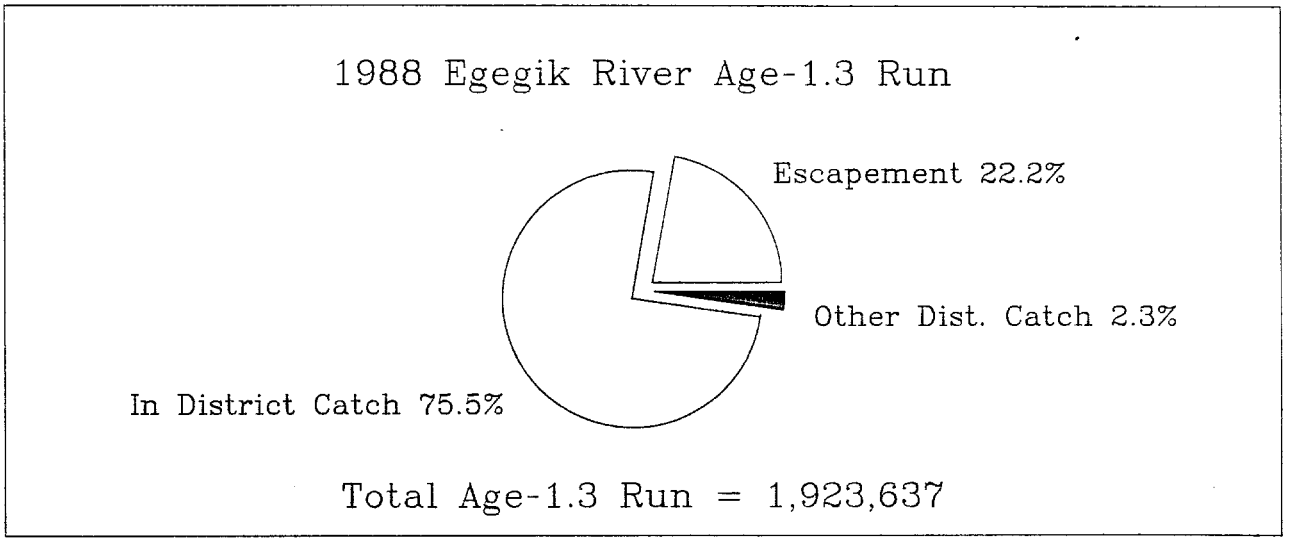
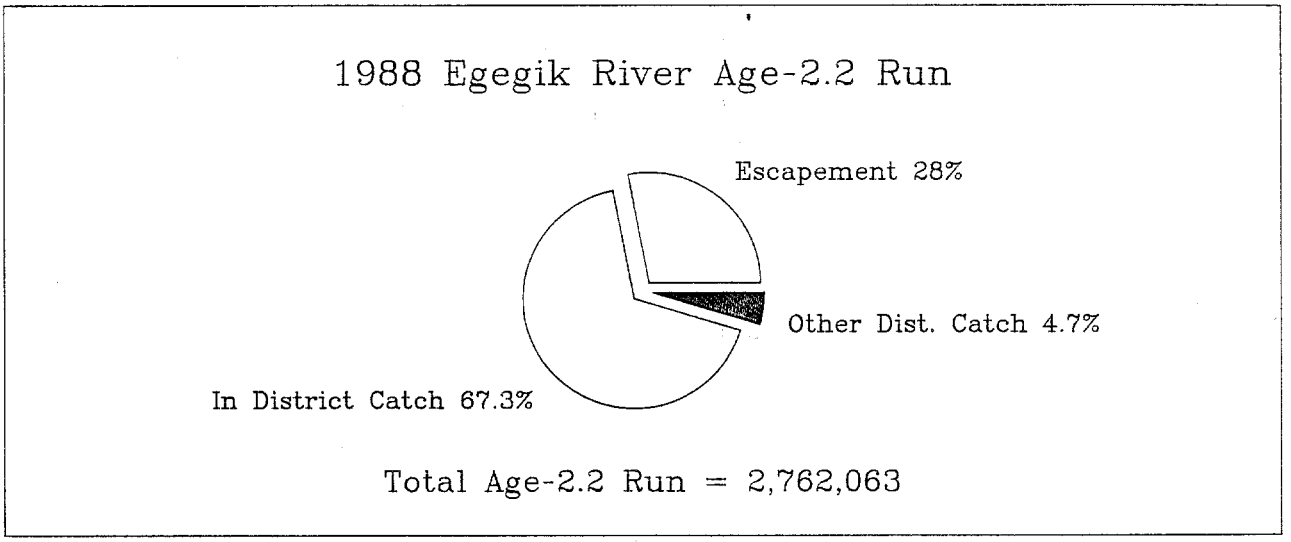


Figure 15. Estimated run of fish (by age and total) to the Naknek River in 1988 and the breakdown of run to escapement , in district catch, and other district catch.





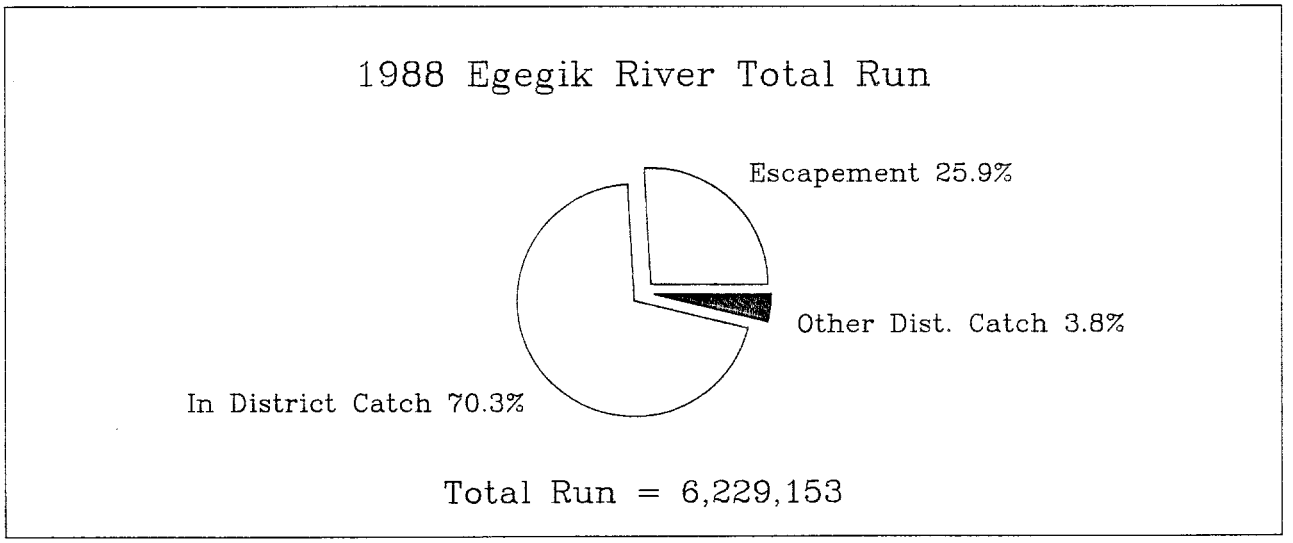
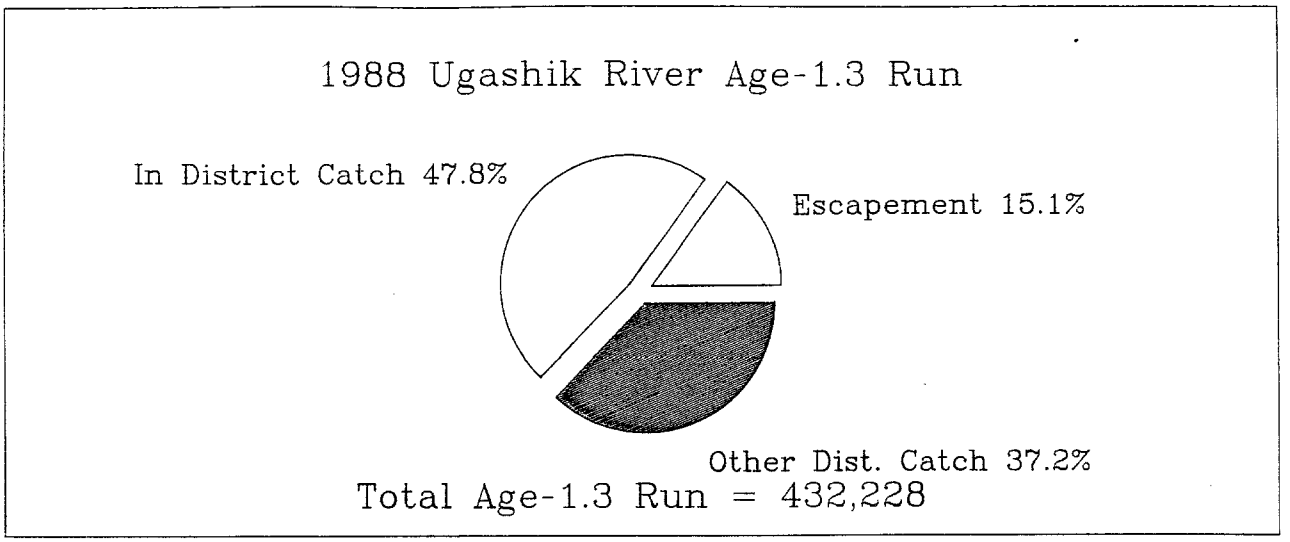
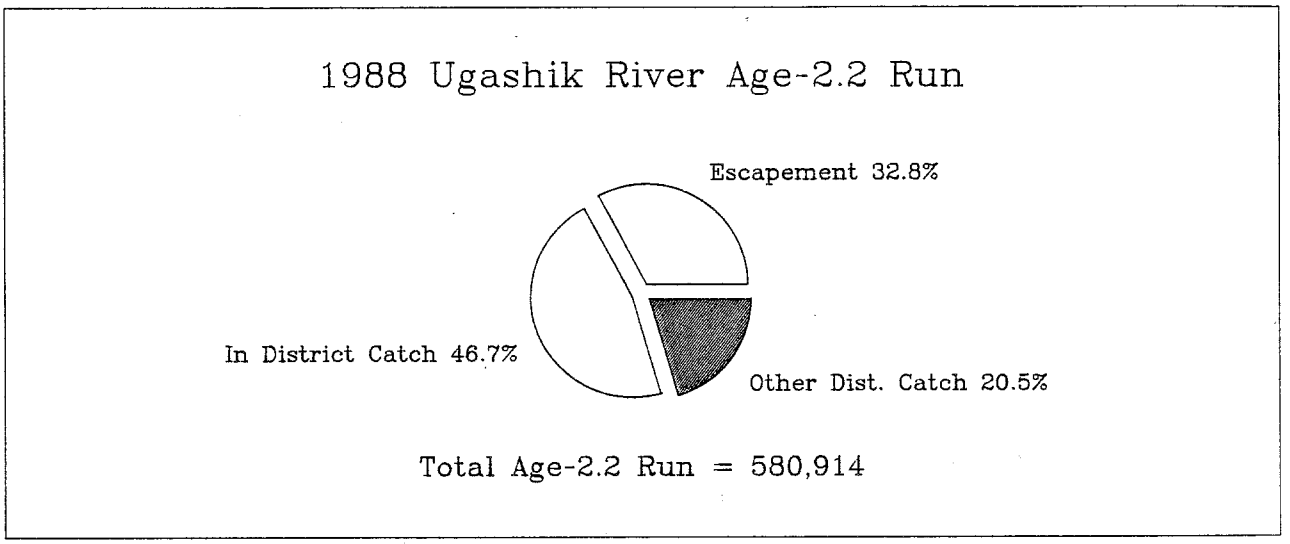


Figure 16. Estimated run of fish (by age and total) to the Egegik River in 1988 and the breakdown of run to escapement , in district catch, and other district catch.





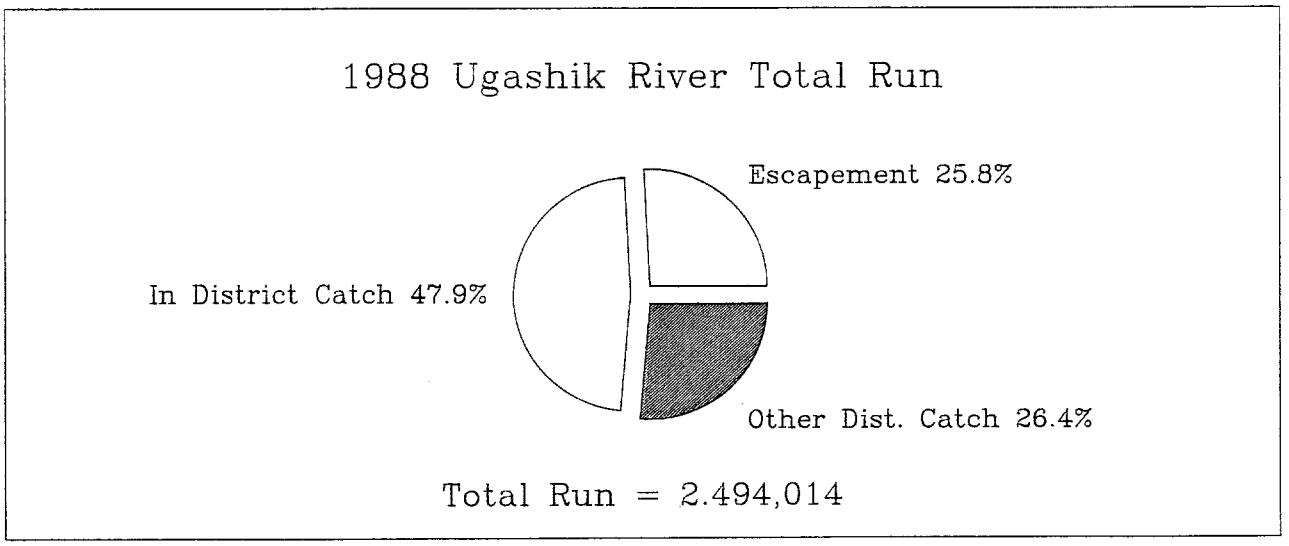


Figure 17. Estimated run of fish (by age and total) to the UgashikRiver in 1988 and the breakdown of run to escapement , in district catch, and other district catch.

Appendix A.1. Classification matrix from discriminant analysis of age-1.3 sockeye salmon sampled from the West Side (Nushagak, Wood, Igushik, Togiak), Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1988.

Actual Group Of Origin	Sample Size	Classified Group of Origin				
		West Side	Kvichak	Naknek	Egegik	Ugashik
West Side	200	0.608	0.141	0.176	0.000	0.075
Kvichak	200	0.070	0.720	0.130	0.000	0.080
Naknek	200	0.192	0.182	0.480	0.015	0.131
Egegik	200	0.020	0.000	0.015	0.865	0.100
Ugashik	200	0.120	0.075	0.110	0.045	0.650

Mean proportion correctly classified = 0.665
Variables used: 2,22,9,95,105,61,18,27,25
Box's Test of Variance-Covariance Equality[a]
F-statistic = 7.89
D.F. = 480, 1715877

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

Appendix A.2. Classification matrix from discriminant analysis of age-1.2 sockeye salmon sampled from the Kvichak, Naknek, Egegik, and Ugashik Rivers of Bristol Bay, 1988.

Actual Group Of Origin	Sample Size	Classified Group of Origin			
		Kvichak	Naknek	Egegik	Ugashik
Kvichak	100	0.788	0.101	0.020	0.091
Naknek	100	0.250	0.230	0.360	0.160
Egegik	100	0.020	0.180	0.690	0.110
Ugashik	100	0.120	0.070	0.100	0.710

Mean proportion correctly classified = 0.604
Variables used: 19,14,78,24,13,1,18,106
Box's Test of Variance-Covariance Equality[a]
F-statistic = 2.79
D.F. = 108, 346550.1

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

Appendix A.3. Classification of age-1.3 samples from Nushagak, Wood, Igushik, and Togiak Rivers with a four-way discriminant model (representing Kvichak, Naknek, Egegik, and Ugashik), 1988.

Actual Group Of Origin	Sample Size	Classified Group of Origin			
		Kvichak	Naknek	Egegik	Ugashik
Nushagak	50	0.435	0.565	0.000	0.000
Wood	50	0.482	0.414	0.000	0.104
Igushik	50	0.000	1.000	0.000	0.000
Togiak	50	0.000	1.000	0.000	0.000