ORIGINS OF CHINOOK SALMON

IN THE YUKON RIVER FISHERIES, 1997

By

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ABSTRACT

The stock composition of all harvests of chinook salmon *Oncorhynchus tshawytscha* (Walbaum) within the Yukon River drainage in 1997 are estimated, and revised estimates for 1996 are presented. Stock composition proportions were estimated for three geographically based stock groups, termed Lower, Middle and Upper. Maximum likelihood models were used to estimate stock composition for the most abundant age classes, age-1.3 and -1.4 fish in District 1 and 2 harvests. Observed age composition ratios among escapements, in combination with maximum likelihood estimates, were used to estimate the stock composition of the less abundant age classes. District 1 test fishing catches and subsistence harvest were apportioned to run of origin using estimated proportions of the first commercial period in District 1. District 2 subsistence harvest was apportioned to run of origin using estimated proportions of the first commercial period in District 2. District 3 subsistence harvest was apportioned to run of origin using the estimated proportions obtained from District 2. District 4 commercial and subsistence harvests were apportioned to run of origin using the estimated proportions obtained in the analysis of District 2 and age data collected District 4. Run of origin for Districts 5 and 6, and Canadian harvests, were assigned based on the geographic location of the harvests. The total estimated Yukon River harvest in 1997 was 191,153 chinook salmon, of which 56.9% were estimated to be Upper, 16.7% Middle and 26.4% Lower Yukon River run of origin. Revised estimates for the 1996 Yukon River harvest of 158,234 chinook salmon were 68.6% were Upper, 10.4% Middle and 21.0% Lower Yukon River run of origin.

INTRODUCTION

Yukon River chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), have been historically harvested in a wide range of fisheries in both marine and fresh waters. Within the Yukon River, returning adults are harvested in subsistence and personal use fisheries in Alaska, Aboriginal and domestic fisheries in Canada, and commercial and sport fisheries in Alaska and Canada (Figures 1 and 2). The large size, high oil content and rich flavor of Yukon River chinook salmon make it one of the most commercially valuable salmon in the state. Chinook salmon are an important component of the diet of subsistence fishers within the Yukon River drainage. Commercial harvests consist of fish sold in the round, numbers of fish contributing to commercial roe production, and fish harvested by the Alaska Department of Fish and Game (ADF&G) in test fisheries in Districts 1 and 2. Sport fisheries occur primarily in tributaries of the Tanana River and in Canada. Smaller sport fishing harvests are known to occur elsewhere in the Alaska portion of the Yukon River drainage.

In the first 20 years after statehood (1960-1979), the total chinook salmon harvest in the Yukon River in both Alaska and Canada ranged from an estimated 77,000 to 170,000 and averaged 123,000 fish annually (JTC 1994). Beginning in 1980, annual total harvests increased substantially. During the most recent 5-year period (1992-1996), the total annual harvest averaged about 183,000 fish. While chinook salmon are harvested throughout the length of the Yukon River, the majority of the catch is taken in commercial gillnet fisheries in Districts 1 and 2. In 1997, commercial, subsistence, personal use, Aboriginal, domestic, and sport fishermen in Alaska and Canada harvested an estimated 191,153 chinook salmon, of which 105,747 fish (55.3%) were taken by District 1 and 2 commercial fishermen (Bergstrom et al. 1998). The 1992-96 average commercial harvest in Districts 1 and 2 was about 85% of the total drainage commercial harvest. Conversely, most of the subsistence harvest in Alaska is taken with fish wheels and gillnets in Districts 4, 5, and 6.

Chinook salmon harvested in the Yukon River fisheries consist of a mixture of stocks bound for spawning areas throughout the Yukon River drainage. The Yukon River drains roughly 330,000 square miles, originating 30 miles from the Gulf of Alaska in northern British Columbia, and flowing 2,300 miles to the Bering Sea (Bergstrom et al. 1998). Returning chinook salmon spawn in tributaries near the mouth, such as the Andreafsky River, and as far upriver as the Swift River in British Columbia near the Yukon Territory border. Although more than 100 spawning streams have been documented, aerial surveys of chinook salmon escapements indicate that the largest concentrations of spawning salmon occur in three distinct geographic regions: (1) tributary streams in Alaska that drain the Andreafsky Hills and Kaltag Mountains between river miles 100 and 500, (2) Upper Koyukuk River and Tanana River tributaries in Alaska between river miles 800 and 1,100, and (3) tributary streams in Canada that drain the Pelly and Big Salmon Mountains between river miles 1,300 and 1,800. Chinook salmon stocks within these geographic regions were collectively termed runs (McBride and Marshall 1983) and are now referred to as the Lower, Middle and Upper Yukon River runs.

Evaluating stock production, spawning escapement goals and management strategies requires information on the stock composition of the various harvests. In addition, the U.S. and Canada have been engaged in treaty negotiations concerning management and conservation of stocks spawned in Canada. Biological information on these stocks provides the technical basis for the negotiations.

Harvest estimates of western Alaskan and Canadian Yukon River chinook salmon in the Japanese high seas gillnet fisheries have been made using scale pattern analysis (SPA; Rogers et al. 1984; Meyers et al. 1984; Meyers and Rogers 1985). Stock composition of Yukon River fishery harvests has been studied by the Alaska Department of Fish and Game. Feasibility studies using scale growth measurements to differentiate chinook salmon run of origin for District 1 commercial fishery samples were first conducted in 1980 and 1981 (McBride and Marshall, 1983). Since then, harvests within the drainage have been apportioned to geographic run of origin annually. These post season assessments provide valuable information for management and conservation of the various runs of chinook salmon. The objective of this study was to estimate the run of origin of all Yukon River chinook salmon harvested in the drainage during the 1997 season and re-analyze 1996 data. Information previously reported concerning 1996 is considered invalid due to a flawed model construction.

METHODS

Overview

The various runs of origin are sampled in portions of the drainage where they can be assumed to be separated. Scales are taken from each fish sampled. The scale data are used to estimate the age composition at each sampling location. The scales of the more abundant age classes, termed major age classes, are digitized, and a number of growth measurements are made on each scale. These data are assumed to characterize all salmon from each of the runs of origin, and are the central component of the stock identification project. Similar data are collected from samples of the commercial harvests, nearly always in Districts 1 and 2, and sometimes in other districts, and the stock composition of the harvests are estimated using the data collected when the runs were separated.

Scale Processing

Scales were collected from the left side of the fish approximately two rows above the lateral line in an area transected by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Clutter and Whitesel 1956). Scales were mounted on gummed cards and impressions made in cellulose acetate. Three scales were collected from each chinook salmon to better ensure a scale of adequate quality. Scale impressions were then aged using a microfiche with a 40x lens and reported in European notation. The European method is a two number system. The first number refers to the number of years spent in fresh water after hatching. The second number, separated by the first with a period, represents the number of years spent in the ocean. The total age of the salmon is calculated by summing the first and second number, then adding 1.

After being aged, each scale impression is enlarged by a factor of 100x and projected onto a digitizing table. Scale growth zones (first freshwater annulus, freshwater plus growth zone, and first, second and third ocean zones) are identified (Figure 3), and distances between circuli are measured in millimeters. Measurements within each zone are identified by a specific cursor key code. The focus, where digitizing begins, represents "0", the origin or zero distance. Therefore, the first incremental distance measured is from the focus, or "0", to the first circuli. In a one freshwater annulus fish, typically cursor key 1 identifies the first freshwater annulus, key 2 the freshwater plus growth zone, key 3 the first ocean zone, key 4 the second ocean zone, and key 5 the third ocean zone. The distances between consecutive circuli are measured in the freshwater zones and the first ocean zone. With other ocean zones, only the entire width is measured. Ocean measurements for age-1.3 chinook salmon end with the second ocean zone. The last measurement for a salmon with an age of 1.4 would be the third ocean zone. Measurements were then automatically recorded in computer files for later statistical analysis. For some scales with different origins, differences can often be seen without visual aids (Figure 4).

Age-1.3 and -1.4 chinook salmon are the major age classes and account for the bulk of the total run. These two age classes are the age classes normally digitized. Occasionally, a sufficient number of samples from another age class is obtained to include a third major age in the analysis.

Analytical Methods

Prior to the analysis of data collected in 1997, linear discriminant functions (LDF) based on scale circuli measurement data were used to classify the major age classes, usually ages 1.3 and 1.4, of harvest samples to run of origin. The stock composition of the remaining minor age classes were estimated using the major age class results in conjunction with ratios of relative age class abundance in the escapement samples. Schneiderhan (1997) provides a summary of the analysis methods used historically in the stock identification program. The methods were implemented in several computer programs written for DOS, and data from individual programs had to be manually deciphered by the project biologist. The project biologist was also required to manually interpret the results and prepare one program's output as input to a subsequent program. This procedure was inefficient, and offered unnecessary opportunity for errors to be made. Since 1988, these programs had not been procedurally or statistically examined. In the spring of 1998, a dedicated effort was made to develop a program that would assimilate scale pattern and age data more efficiently and accurately.

A program (SPAYK.EXE) was written to combine multiple steps previously required into a single program, taking advantage of new software and the increased capacity and speed of modern desktop computers. Manually completed tasks are automated and improved analytical methods were implemented wherever possible. For example, an automated stepwise variable selection algorithm was implemented, and the stock composition of all age classes in all harvests are estimated in a single execution of the program. Analytical improvements in the new program primarily occurred in two areas. The first improvement involves the method of estimating the stock composition of major age classes. The linear discriminant model used previously is now replaced with a maximum likelihood mixture model (Bromaghin and Bruden, 1998). The second improvement involves adoption of robust estimators of sample means and variance-covariance matrices, which reduces the influence of extreme observations on estimates (Campbell, 1980). These changes substantially decreased the time required to complete an analysis and impute data into spreadsheets, as well as increasing the statistical quality of stock composition estimates. Bromaghin and Bruden (1999) details the methods implemented in the program.

Scale measurement data from the escapement samples of each stock group were assumed to represent the escapement of the entire stock group. For each major age class and stock group, the data were assumed to have a multivariate normal probability distribution (Johnson and Kotz, 1972), although robust estimators of the mean vector and the covariance matrix (Campbell, 1980) were used to minimize the influence of outliers. For each major age, a stepwise variable selection algorithm based on Wilks' ratio (Seber, 1984) was used to select variables for inclusion in the model. The harvest samples were modeled as a weighted mixture of the estimated probability distributions of each of the stock groups, with the weights being the stock composition proportions (Bromaghin and Bruden, 1999). The stock composition proportions for each major age class were estimated using maximum likelihood techniques.

A simulation study was conducted to investigate the estimation accuracy of the maximum likelihood estimator for fish of each major age class and each run. For each run within each major age class, artificial mixture samples consisting of fish from that run were constructed by selecting fish at random and with replacement from the observed data. This process is termed bootstrap sampling (Efron, 1982). Artificial mixture samples were treated as harvest samples, and the stock composition of the mixture was estimated and compared with the correct answer, which was 100% in each case. Sample sizes for the bootstrap samples were equal to the observed sample size. A total of 500 artificial mixture samples were drawn from each major age class and run, and the average estimate was computed. This simulation study was conducted using robust estimators of the mean vector and variance-covariance matrix.

Harvest of minor age classes with associated digitized data were apportioned to run of origin based on escapement age composition ratios (Schneiderhan 1997). Age composition data used in the analysis for Lower Run stocks was collected from the Andreafsky, Anvik and Gisasa Rivers. Middle run stock age data came from the Chena, Salcha, Chatanika and South Fork Koyukuk Rivers. Upper run stock age data, obtained from fishwheels located up river of the U.S./Canada border, were provided by DFO staff. Age composition estimates from multiple projects within each run were weighted by abundance information, when available (Appendix Table 2). Fishwheel age composition data from Canada were temporally stratified but had no corresponding abundance information, and were therefore pooled into a single sample. The estimated age composition of the Upper run stocks as observed in the fishwheels was not used directly. Fishwheels, as a gear type, preferentially harvest younger fish, and fishwheel age composition estimates therefore do not represent the true age of the population. In 1996, a comparative analysis of historical age information from fishwheels, commercial gillnet catches and spawning ground escapements in Canada was conducted. Selectivity coefficients from this analysis were used to estimate the age composition of the chinook salmon border passage from the observed fishwheel age composition to obtain a more accurate estimate of the border passage age composition.

A harvest with no digitized information was apportioned using one or more harvests with digitized information whose stock composition was assumed to be similar. An example would be subsistence harvest. Since subsistence harvests are not sampled, they are typically apportioned to run of origin using data from the nearest commercial harvest within the district or the nearest adjacent district. Harvests occurring in a known stock of origin drainage were apportioned to that run. An example would be harvests in the Tanana River, which would be apportioned entirely to the Middle run.

Catch Sampling

Scale samples were collected from harvests in most commercial periods in the Lower Yukon River. These scale samples were digitized, and also used for age composition analysis. One restricted mesh size (6 inch or less) commercial opening in Districts 1 and 2 was not sampled in 1997. These two openings were apportioned using two other restricted mesh size openings in District 1 that occurred later in the season. No commercial fishing occurred in District 3 in 1997. Commercial catch samples collected in Districts 4, 5 and 6 were solely used for age composition analysis (Appendix Table 1). Where possible, for these upper river districts, age composition was broken out by gear type and statistical area. For purposes of this report, it was assumed that subsistence fishing in Districts 1 and 2 occurred prior to or near the beginning of the commercial fishing season, and could therefore be described using Period 1 commercial sample data for each district. District 3 subsistence harvest was apportioned using a combination of District 1 and 2 first period commercial harvest stock composition information. The subsistence and commercial harvest for District 4 was apportioned using commercial harvest stock composition data from District 2. Harvests in District 5 were apportioned to the Upper run and District 6 harvests were apportioned to the Middle run. Sport fish harvests in Alaska were apportioned to the Middle run, as that area supports the majority of that harvest. Canadian harvests were apportioned to the Upper run. However, because the majority of the commercial harvest is by gillnet, those fish were apportioned to age class using District 5 commercial catch age composition data, not the fishwheel age composition data collected in the Canadian portion of the drainage.

Escapement Sampling

Scale samples were collected during the period of peak spawning mortality from the Anvik, Chena, and Salcha Rivers in Alaska. Carcasses were the primary source of samples; however, some samples were obtained from live fish captured with beach seines or other methods. Live salmon were sampled at weir projects operated by the U. S. Fish and Wildlife Service (USFWS) on the East Fork Andreafsky, South Fork Koyukuk and Gisasa Rivers. Samples were also collected from fish captured in fish wheels by the Canada Department of Fisheries and Oceans (DFO) in the Yukon Territory, Canada. These data were used to estimate the age composition of the escapements, and scales from major age classes were digitized for subsequent analysis.

RESULTS

Escapement Age Composition

All escapement sample size objectives were achieved. However, due to the strong return of age-1.4 salmon, there were fewer age-1.3 fish for analysis than desired. In general though, younger fish (age 1.2 and 1.3) were more abundant in the Lower Yukon River escapements than age-1.4 fish, and older fish were more abundant in the Middle and Upper Yukon River escapements (Appendix Table 2). The Middle river escapements seemed to be more evenly distributed among age classes then either of the other regions. Upper river stocks were older and were characterized by a higher proportion of fish with 2 freshwater annuli. This occurrence is fairly typical. The strong return of 6-year-old salmon in 1997 is not surprising as harvests and escapements from 1996 were comprised of a strong 5-year-old age class (Richard Price, ADF&G, personal communication).

Catch Composition

Scale Pattern Analysis

The scale measurement characters (Appendix Table 3) that were most useful in distinguishing between the three runs of origin for age 1.3 were: (1) variable 67, the distance of the 1st freshwater divided by the total freshwater distance; (2) variable 96, distance between the 3rd and 9th circuli in the 1st ocean zone, divided by the width of the 1st ocean zone; and (3) variable 1, the number of circuli in the 1st freshwater annular zone. The primary distinguishing characters for age 1.4 in order of selection were: (1) variable 65 number of circuli in the 1st freshwater and the plus growth zone; (2) variable 72, distance from the end of the freshwater zone to the 3rd circuli in the 1st ocean zone; (3) variable 8, distance between the 2nd and 4th circuli; and (4) variable 68, freshwater plus growth zone divided by the total distance of the freshwater area. Variables 5, 10, 85, 82, 26, 18, 103, 100, 90 and 107 were also selected. The number of variables selected for age-1.4 chinook salmon reflects the difficulty in distinguishing between the stocks for that age group, even though this age class had a large sample size. Variables involving freshwater and freshwater plus growth typically account for most of the discriminatory power in the models. This was the case for 1997 data as two of the three variables in the age 1.3 group, and two of the top four variables in the age 1.4 group were related to freshwater growth. The minimum, maximum, mean and standard deviation for each variable used for both age groups were calculated (Appendix Table 4). The variables are listed in the order that they were placed into the model. In other words, the variable that separates the stocks the best is the first variable listed.

Estimation Accuracy Simulations

The estimation accuracy simulation results are presented in Table 1. Estimation accuracies for age-1.3 salmon were 0.940 for Lower, 0.823 for Middle and 0.980 for the Upper river standard. Estimation accuracies for the age 1.4 group were 0.855 for Lower, 0.870 for Middle and 0.832 for the Upper river standard (Table 1). The mean estimation accuracies were 0.914 for age 1.3 and

0.852 for age 1.4. This high level of accuracy, which has not been observed in previous years, is believed to be due to the adoption of a maximum likelihood estimator. The greatest estimation bias (0.122) occurred between the age-1.3 Middle and Upper runs. Although analytical methods in the past were different, estimation bias between these two stocks has been common in prior years. Another possible contributing factor is that this age group had a lower than desired sample size. The age-1.4 model is well balanced across the model with little estimation bias. The Upper river standard showed the greatest estimation accuracy for age 1.3 (0.980), while the Middle river standard was the highest for age 1.4 (0.870). To have the highest accuracy for an age in Middle river standards is atypical.

Canonical variable plots provide a partial visual summary of the separation between the runs of origin, given the variables selected for each major age class. Canonical variables are uncorrelated linear combinations of the variables which maximize the value of the F-statistic in an analysis of variance hypothesis test of equal means (Johnson, 1998). A scatter plot of the first two canonical variables provides a 2 dimensional summary of the separation between the runs.

The first two canonical scores were plotted for each fish of each stock group used in the analysis (Figure 9). The mean of each stock was also calculated and plotted for each age group. Age-1.3 chinook salmon exhibit better separation between the stocks than do the age-1.4 chinook salmon. This analysis lends weight to the classification accuracies in Table 1, where accuracy was higher for age 1.3 (.914) than for age 1.4 (.852).

Maximum Likelihood Estimates For Major Age Classes

In 1997, there were eight commercial fishing periods in District 1, with five periods of unrestricted gillnet mesh size and three or restricted mesh size. Maximum likelihood stock composition estimates for District 1 harvests are presented in Table 2. Upper run stocks comprised the largest proportion of the District 1 commercial harvest of age-1.3 for the first three openings, while Lower run stocks dominated the last five openings. Upper run proportions, however, were similar to or greater than Lower run proportions in all of the District 1 commercial openings for age-1.4. Typically, the Upper run tends to dominate the harvest during early commercial fishing periods in District 1 and gradually decreases thereafter. This transition from Upper to Lower run of origin salmon through the 1997 commercial fishery is evident in the District 1 commercial harvest of age-1.3 salmon, but it is not evident in the harvest of age-1.4 salmon (Figures 5 and 6). Proportions of age-1.3 salmon clearly show a decrease for the Upper run and an increase for Lower run through time. However, proportions of stocks in the age 1.4 group change very little through time.

Of the five District 2 commercial periods, four were with unrestricted mesh size and one was with restricted mesh size. Trends in stock composition estimates through time were similar to those in District 1 (Table 3). Age-1.3 chinook salmon show a decrease for the Upper run and an increase for the Lower run through time (Figures 7 and 8). As in District 1, age 1.4 stock groups are fairly consistent through time in the commercial catch, with no directional trend by a single stock. The aspect which is most outstanding is the apparent lack of Middle run stocks in all but one of the District 2 commercial period catches for age-1.3 salmon. Again, it is thought that sample size is a contributing factor to the results.

Of the 66,384 chinook salmon caught in the District 1 commercial fishery, 61,612 (92.7%) were age-1.3 and -1.4 fish. Of these, an estimated 20,955 (0.340) were Lower run, 12,349 (0.200) Middle run, and 28,308 (0.459) Upper run (Table 5). In District 2, a total of 39,363 chinook were caught in the commercial fishery. An estimated 37,305 (94.8%) were age-1.3 and -1.4 fish. Lower run contributed 12,599 (.338), Middle run 5,289 (.0142), and Upper run 19,417 (0.521) (Table 7).

An estimated total of 98,917 age-1.3 and -1.4 chinook, 51.7% of the total drainage chinook salmon harvest, from District 1 and 2 commercial catches was directly classified to run of origin based on results of scale pattern analysis. Additionally, 19.0% of the total drainage harvest, or 36,568, age-1.3 and -1.4 fish caught in Districts 1 and 2 subsistence and test fisheries, and Districts 3 and 4 commercial and subsistence fisheries, were indirectly classified based on scale pattern analysis (Tables 8 and 9).

Differential Age Composition Analysis

The minor age classes (1.1, 1.2, 2.2, 2.3, 1.5 and 2.4) from the Districts 1-4 commercial, test fishing and subsistence catches contributed 9,156 fish (4.8%) to the total drainage harvest. These were classified to run of origin by applying escapement age composition ratios in each run to maximum likelihood abundance estimates from the analogous major age class, i.e., age 1.3 or 1.4 (Schneiderhan 1997).

Assignment by Geographical Analysis

An Upper Koyukuk River subsistence harvest of 591 chinook salmon was assigned to the Middle run. Prior genetic stock identification information indicate these fish are more similar to Middle run stocks than Lower or Upper run stocks (Wilmot et al. 1992). The Chandalar and Black River subsistence harvest of 314 chinook salmon, although occurring in District 5, was assigned to the Middle run based on geographic location of the harvest. Although this harvest occurs in District 5, the origin of the salmon are not of the Upper run, i.e., Canadian origin. A commercial harvest of 3,678 chinook and subsistence harvest of 17,735 chinook in District 5 (Table 10) were assigned to the Upper run. This component comprised 11.2% of the total harvest. Harvests in District 6 were assigned entirely to the Middle Yukon Run based on the geographic location of the fisheries (Table 11). The sport harvest estimate of 1,913 chinook is from Tanana River tributaries and other areas of the Alaska portion of the Yukon River drainage. These estimates are preliminary and subject to change. The Chena, Salcha and Chatanika Rivers support the largest sport fish harvest in the Alaska portion of the Yukon River drainage. All other sport harvests occurring in the Alaska portion of the Yukon River drainage are considered minor (Matt Evensen, ADF&G, personal communication). Total Canadian fishery harvests were 16,528 chinook or 8.7% of the drainage wide total. Of these, 5,311 were harvested in the commercial fishery and 11,217 were harvested in other fisheries (Table 12). The entire Canadian harvest was assigned to the Upper run. The non-commercial harvest includes 9,699 Aboriginal, 288 domestic and 1,230 sport fish caught chinook salmon.

Total Harvest

The run of origin of all the 1997 Yukon River drainage harvest of chinook salmon, consisting of 191,153 fish. The Upper run was the largest estimated run component, contributing an estimated 108,690 fish, or 56.9% of the total drainage harvest. The Lower run was next in abundance with 50,420 fish (26.4%), and the Middle run contributed an estimated 32,043 fish, or 16.8% (Tables 13-16).

For 1996, an estimated total of 158,234 chinook salmon were harvested. Of these, 108,570 fish (68.6%) were estimated to be Upper, 16,386 fish (10.4%) Middle and 33,278 fish (21.0%) Lower Yukon River run of origin (Tables 15 and 16). Tabular information from 1996 data, similar to that presented for 1997 data, has been constructed. Those tables are available upon request from the primary author of this report.

DISCUSSION

Because of the different methodology used in 1997, this year's results may not be directly comparable to previous years, though simulation results show no systematic difference between the methods (Bromaghin and Bruden, 1998). In general, however, proportional results of the total drainage harvest that were attributed to the Lower, Middle and Upper river run in 1997 are similar to and within the range of results.

It is intended that historical data will be reanalyzed in reverse chronological order as time allows using the new program to standardize the historical database to the extent feasible. Future data collection and analysis will be reported in the same format as this report. Annual summaries of these anlyses will be presented in the historical summary tables of future annual reports. Once all of the historical data have been re-processed using the new methodology, detailed tabular information for the entire database will be presented in a Regional Information Report. That report would then become the new reference for the historical database concerning stock identification using analysis of scale patterns. Because of the number of years yet to be re-analyzed (1982-1995), that report may take several years to complete.

The new program, SPAYK, used to generate the data presented in this report not only statistically improves output but also self-documents all of the age and harvest data used in this report. It also writes data files of the variables used and their values. The ability to change input data such as harvest information, age composition and methodology, then re-run the highly automated analysis provides flexibility previously not available. Although the process is substantially less tedious, files of harvest and age data listed in the program control file must be carefully edited.

Attainment of sample size objectives presented in the annual sampling plan has been considered to be a reasonable measure of operational success. In 1997, sample sizes were judged adequate for age-1.4 chinook salmon, but less than desired for age-1.3 fish. This is due to the substantially higher proportion of age-1.4 fish in the 1997 run. Poor sample quality continues to be of concern, especially for escapement samples which are obtained from carcasses, or from live salmon with longer migrations. Acceptable sample quality depends on environmental, biological, and methodological factors. When the expected rejection rate of ageable scales is exceeded, the quantity of remaining useable samples become problematic. The rejection rate attributed to sampling technique is a key factor in determining sample sizes. In order to prevent unacceptably small sample sizes, sampling techniques must be optimized so that the sample size used in the analysis remains acceptable. The collection of good quality samples continues to be the foundation upon which this stock identification program rests.

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Table 1. Average accuracy of maximum likelihood estimates of Yukon River chinook salmon stock composition observed over 500 simulations for each age and stock group, 1997. For each age and stock group, simulation samples were constructed by bootstrap re-sampling data from only that age and stock group.

Age Group	Stock Group	Sample Size	Stock Composition Lower	Middle	Upper	Total
Age 1.3	Lower	78	0.940	0.000	0.060	1.000
	Middle	55	0.055	0.823	0.122	1.000
	Upper	150	0.004	0.016	0.980	1.000
			Average Percent Accuracy			0.914
			Lower	Middle	Upper	Total
Age 1.4	Lower	179	0.855	0.084	0.061	1.000
	Middle	180	0.063	0.870	0.067	1.000
	Upper	308	0.094	0.075	0.832	1.000
			Average Percent Accuracy			0.852

Table 2. Yukon River District 1 chinook salmon commercial catch estimated stock composition by period for ages-1.3 and -1.4 fish, 1997.

	Estimated stock composition for age-1.3				Estimated stock composition for age-1.4			
	Sample Size	Stock Group	Estimate	Standard Error	Sample Size	Stock Group	Estimate	Standard Error
District 1 Period 1 12-Jun Unrestricted Mesh Size	26	Lower	0.212	0.170	167	Lower	0.351	0.060
		Middle	0.004	0.222		Middle	0.184	0.047
		Upper	0.784	0.224		Upper	0.465	0.066
District 1 Period 2 17-Jun Unrestricted Mesh Size	22	Lower	0.208	0.161	190	Lower	0.314	0.054
		Middle	0.196	0.260		Middle	0.255	0.050
		Upper	0.596	0.230		Upper	0.430	0.060
District 1 Period 3 20-Jun Unrestricted Mesh Size	17	Lower	0.238	0.489	190	Lower	0.382	0.057
		Middle	0.076	0.206		Middle	0.235	0.048
		Upper	0.686	0.274		Upper	0.383	0.056
District 1 Period 4 22-Jun Restricted Mesh Size	No commercial catch data was collected. Therefore, there are no stock composition proportions. Data from District 1, period 6 and 7 were used to allocate this commercial harvest.							
District 1 Period 5 24-Jun Unrestricted Mesh Size	13	Lower	0.616	0.363	180	Lower	0.346	0.057
		Middle	0.000	0.760		Middle	0.172	0.044
		Upper	0.384	0.207		Upper	0.482	0.063
District 1 Period 6 27-Jun Unrestricted Mesh Size	15	Lower	0.613	0.361	181	Lower	0.258	0.051
		Middle	0.144	0.305		Middle	0.225	0.048
		Upper	0.243	0.259		Upper	0.517	0.062
District 1 Period 7 28-Jun Restricted Mesh Size	11	Lower	0.875	0.424	20	Lower	0.454	0.192
		Middle	0.000	0.551		Middle	0.058	0.128
		Upper	0.125	0.127		Upper	0.488	0.186
District 1 Period 8 30-Jun Restricted Mesh Size	Insufficient sample size to support maximum likelihood estimation.				21	Lower	0.226	0.195
						Middle	0.181	2.483
						Upper	0.593	0.193

Table 3. Yukon River District 2 chinook salmon commercial catch estimated stock composition by period for ages-1.3 and -1.4 fish, 1997.

	Estimated stock composition for age-1.3				Estimated stock composition for age-1.4			
	Sample Size	Stock Group	Estimate	Standard Error	Sample Size	Stock Group	Estimate	Standard Error
District 2	14	Lower	0.000	0.878	142	Lower	0.292	0.600
Period 1		Middle	0.000	0.604		Middle	0.120	0.048
16-Jun		Upper	1.000	0.408		Upper	0.588	0.079
Unrestricted								
Mesh Size								
District 2	28	Lower	0.128	0.126	132	Lower	0.267	0.059
Period 2		Middle	0.000	0.225		Middle	0.151	0.045
17-Jun		Upper	0.872	0.227		Upper	0.582	0.076
Unrestricted								
Mesh Size								
District 2	17	Lower	0.510	0.392	140	Lower	0.433	0.069
Period 3		Middle	0.000	0.632		Middle	0.176	0.053
20-Jun		Upper	0.490	0.216		Upper	0.392	0.065
Unrestricted								
Mesh Size								
District 2	No commercial catch data was collected. Therefore, there are no stock composition proportions.							
Period 4	Data from District 1, period 6 and 7 were used to allocate this commercial harvest.							
25-Jun								
Restricted								
Mesh Size								
District 2	19	Lower	0.333	0.176	153	Lower	0.318	0.060
Period 5		Middle	0.000	0.252		Middle	0.187	0.072
1-Jul		Upper	0.668	0.230		Upper	0.495	0.068
Unrestricted								
Mesh Size								

Table 4. Yukon River District 1 commercial chinook salmon catch by age, run of origin and period, 1997.

		Age Group							
Strata	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Period 1	Lower	0	265	315	3,268	0	15	0	3,863
12-Jun	Middle	0	6	6	1,714	0	37	0	1,763
Unrestricted Mesh Size	**Alaska**	**0**	**271**	**321**	**4,982**	**0**	**52**	**0**	**5,626**
	Upper	0	59	1,168	4,330	0	152	34	5,743
	Total	**0**	**330**	**1,489**	**9,312**	**0**	**204**	**34**	**11,369**
Period 2	Lower	0	157	234	2,984	0	12	0	3,387
17-Jun	Middle	0	172	221	2,423	0	45	0	2,861
Unrestricted Mesh Size	**Alaska**	**0**	**329**	**455**	**5,407**	**0**	**57**	**0**	**6,248**
	Upper	0	27	672	4,085	0	122	0	4,906
	Total	**0**	**356**	**1,127**	**9,492**	**0**	**179**	**0**	**11,154**
Period 3	Lower	0	274	545	6,489	0	39	0	7,347
20-Jun	Middle	0	102	174	3,993	0	112	0	4,381
Unrestricted Mesh Size	**Alaska**	**0**	**376**	**719**	**10,482**	**0**	**151**	**0**	**11,728**
	Upper	0	48	1,572	6,499	0	292	0	8,411
	Total	**0**	**424**	**2,291**	**16,981**	**0**	**443**	**0**	**20,139**
Period 4	Lower	0	606	300	351	0	3	0	1,260
22-Jun	Middle	0	62	20	106	0	2	0	190
Restricted Mesh Size	**Alaska**	**0**	**668**	**320**	**457**	**0**	**5**	**0**	**1,450**
	Upper	0	10	70	517	0	28	0	625
	Total	**0**	**678**	**390**	**974**	**0**	**33**	**0**	**2,075**
Period 5	Lower	0	485	501	2,071	0	7	0	3,064
24-Jun	Middle	0	0	0	1,029	0	16	0	1,045
Unrestricted Mesh Size	**Alaska**	**0**	**485**	**501**	**3,100**	**0**	**23**	**0**	**4,109**
	Upper	0	18	313	2,881	0	73	0	3,285
	Total	**0**	**503**	**814**	**5,981**	**0**	**96**	**0**	**7,394**
Period 6	Lower	0	712	726	2,780	0	7	0	4,225
27-Jun	Middle	0	194	170	2,417	0	29	0	2,810
Unrestricted Mesh Size	**Alaska**	**0**	**906**	**896**	**5,197**	**0**	**36**	**0**	**7,035**
	Upper	0	17	288	5,560	0	106	0	5,971
	Total	**0**	**923**	**1,184**	**10,757**	**0**	**142**	**0**	**13,006**
Period 7	Lower	0	248	137	156	0	2	0	543
28-Jun	Middle	0	0	0	20	0	1	0	21
Restricted Mesh Size	**Alaska**	**0**	**248**	**137**	**176**	**0**	**3**	**0**	**564**
	Upper	0	2	19	168	0	17	0	206
	Total	**0**	**250**	**156**	**344**	**0**	**20**	**0**	**770**
Period 8	Lower	0	116	43	55	0	0	0	214
30-Jun	Middle	0	37	12	44	0	0	0	93
Restricted Mesh Size	**Alaska**	**0**	**153**	**55**	**99**	**0**	**0**	**0**	**307**
	Upper	0	4	23	143	0	0	0	170
	Total	**0**	**157**	**78**	**242**	**0**	**0**	**0**	**477**

Table 5. Yukon River District 1 commercial, subsistence and test fish chinook salmon catch by age, run of origin and fishery, 1997.

		Age Group							
Strata	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Unrestricted Mesh Size Season Total	Lower	0	1,893	2,321	17,592	0	80	0	21,886
	Middle	0	474	571	11,576	0	239	0	12,860
	Alaska	**0**	**2,367**	**2,892**	**29,168**	**0**	**319**	**0**	**34,746**
	Upper	0	169	4,013	23,355	0	745	34	28,316
	Total	**0**	**2,536**	**6,905**	**52,523**	**0**	**1,064**	**34**	**63,062**
Restricted Mesh Size Season Total	Lower	0	970	480	562	0	5	0	2,017
	Middle	0	99	32	170	0	3	0	304
	Alaska	**0**	**1,069**	**512**	**732**	**0**	**8**	**0**	**2,321**
	Upper	0	16	112	828	0	45	0	1,001
	Total	**0**	**1,085**	**624**	**1,560**	**0**	**53**	**0**	**3,322**
Commercial Season Total	Lower	0	2,863	2,801	18,154	0	85	0	23,903
	Middle	0	573	603	11,746	0	242	0	13,164
	Alaska	**0**	**3,436**	**3,404**	**29,900**	**0**	**327**	**0**	**37,067**
	Upper	0	185	4,125	24,183	0	790	34	29,317
	Total	**0**	**3,621**	**7,529**	**54,083**	**0**	**1,117**	**34**	**66,384**
District 1 Test Fish Catch	Lower	0	65	78	808	0	4	0	955
	Middle	0	1	1	424	0	9	0	435
	Alaska	**0**	**66**	**79**	**1,232**	**0**	**13**	**0**	**1,390**
	Upper	0	15	289	1,071	0	38	8	1,421
	Total	**0**	**81**	**368**	**2,303**	**0**	**51**	**8**	**2,811**
District 1 Subsistence	Lower	0	176	209	2,170	0	10	0	2,565
	Middle	0	4	4	1,138	0	25	0	1,171
	Alaska	**0**	**180**	**213**	**3,308**	**0**	**35**	**0**	**3,736**
	Upper	0	39	776	2,875	0	101	23	3,814
	Total	**0**	**219**	**989**	**6,183**	**0**	**136**	**23**	**7,550**
District 1 Season Total	Lower	0	3,104	3,088	21,132	0	99	0	27,423
	Middle	0	578	608	13,308	0	276	0	14,770
	Alaska	**0**	**3,682**	**3,696**	**34,440**	**0**	**375**	**0**	**42,193**
	Upper	0	239	5,190	28,129	0	929	65	34,552
	Total	**0**	**3,921**	**8,886**	**62,569**	**0**	**1,304**	**65**	**76,745**

Table 6. Yukon River District 2 commercial chinook salmon catch by age, run of origin and period, 1997.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Period 1	Lower	0	0	0	1,847	0	3	0	1,850
16-Jun	Middle	0	0	0	757	0	5	0	762
Unrestricted Mesh Size	**Alaska**	**0**	**0**	**0**	**2,604**	**0**	**8**	**0**	**2,612**
	Upper	0	146	756	3,711	0	41	0	4,654
	Total	**0**	**146**	**756**	**6,315**	**0**	**49**	**0**	**7,266**
Period 2	Lower	0	301	201	2,000	0	3	0	2,505
19-Jun	Middle	0	0	0	1,133	0	9	0	1,142
Unrestricted Mesh Size	**Alaska**	**0**	**301**	**201**	**3,133**	**0**	**12**	0	**3,647**
	Upper	0	123	1,364	4,364	0	53	32	5,936
	Total	**0**	**424**	**1,565**	**7,497**	**0**	**65**	**32**	**9,583**
Period 3	Lower	0	530	728	5,670	0	16	0	6,944
23-Jun	Middle	0	0	0	2,306	0	30	0	2,336
Unrestricted Mesh Size	**Alaska**	**0**	**530**	**728**	**7,976**	**0**	**46**	**0**	**9,280**
	Upper	0	31	700	5,130	0	107	0	5,968
	Total	**0**	**561**	**1,428**	**13,106**	**0**	**153**	**0**	**15,248**
Period 4	Lower	0	91	45	53	0	1	0	190
25-Jun	Middle	0	9	3	16	0	0	0	28
Restricted Mesh Size	**Alaska**	**0**	**100**	**48**	**69**	**0**	**1**	**0**	**218**
	Upper	0	1	10	78	0	4	0	93
	Total	**0**	**101**	**58**	**147**	**0**	**5**	**0**	**311**
Period 5	Lower	0	349	229	1,826	0	9	0	2,413
1-Jul	Middle	0	0	0	1,074	0	23	0	1,097
Unrestricted Mesh Size	**Alaska**	**0**	**349**	**229**	**2,900**	**0**	**32**	**0**	**3,510**
	Upper	0	42	461	2,843	0	99	0	3,445
	Total	**0**	**391**	**690**	**5,743**	**0**	**131**	**0**	**6,955**

Table 7. Yukon River District 2 commercial and subsistence chinook salmon catch by age, run of origin and fishery, 1997.

		Age Group							
Strata	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Unrestricted Mesh Size Season Total	Lower	0	1,180	1,158	11,343	0	31	0	13,712
	Middle	0	0	0	5,270	0	67	0	5,337
	Alaska	**0**	**1,180**	**1,158**	**16,613**	**0**	**98**	**0**	**19,049**
	Upper	0	342	3,281	16,048	0	300	32	20,003
	Total	**0**	**1,522**	**4,439**	**32,661**	**0**	**398**	**32**	**39,052**
Restricted Mesh Size Season Total	Lower	0	91	45	53	0	1	0	190
	Middle	0	9	3	16	0	0	0	28
	Alaska	**0**	**100**	**48**	**69**	**0**	**1**	**0**	**218**
	Upper	0	1	10	78	0	4	0	93
	Total	**0**	**101**	**58**	**147**	**0**	**5**	**0**	**311**
Commercial Season Total	Lower	0	1,271	1,203	11,396	0	32	0	13,902
	Middle	0	9	3	5,286	0	67	0	5,365
	Alaska	**0**	**1,280**	**1,206**	**16,682**	**0**	**99**	**0**	**19,267**
	Upper	0	343	3,291	16,126	0	304	32	20,096
	Total	**0**	**1,623**	**4,497**	**32,808**	**0**	**403**	**32**	**39,363**
Subsistence Catch	Lower	0	0	0	2,377	0	4	0	2,381
	Middle	0	0	0	974	0	6	0	980
	Alaska	**0**	**0**	**0**	**3,351**	**0**	**10**	**0**	**3,361**
	Upper	0	188	973	4,775	0	53	0	5,989
	Total	**0**	**188**	**973**	**8,126**	**0**	**63**	**0**	**9,350**
Season Total	Lower	0	1,271	1,203	13,773	0	36	0	16,283
	Middle	0	9	3	6,260	0	73	0	6,345
	Alaska	**0**	**1,280**	**1,206**	**20,033**	**0**	**109**	**0**	**22,628**
	Upper	0	531	4,264	20,901	0	357	32	26,085
	Total	**0**	**1,811**	**5,470**	**40,934**	**0**	**466**	**32**	**48,713**

Table 8. Yukon River District 3 subsistence chinook salmon catch by age and run of origin, 1997. [a, b]

		Age Group							
Strata	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Subsistence Season Total	Lower	0	90	107	1,732	0	6	0	1,935
	Middle	0	2	2	837	0	14	0	855
	Alaska	**0**	**92**	**109**	**2,569**	**0**	**20**	**0**	**2,790**
	Upper	0	69	652	2,723	0	65	12	3,521
	Total	**0**	**161**	**761**	**5,292**	**0**	**85**	**12**	**6,311**

[a] No commercial salmon fishing occurred in 1997.

[b] Run of origin and age composition estimate is based on data from the first commercial period in District 1 and 2.

Table 9. Yukon River District 4 commercial and subsistence chinook salmon catch by age, run of origin and fishery, 1997. [a]

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
District 4B Commercial Gillnet Season Total	Lower	0	1	2	15	0	0	0	18
	Middle	0	0	0	7	0	0	0	7
	Alaska	**0**	**1**	**2**	**22**	**0**	**0**	**0**	**25**
	Upper	0	0	4	21	0	0	0	25
	Total	**0**	**1**	**6**	**43**	**0**	**0**	**0**	**50**
District 4C Commercial Gillnet Season Total	Lower	0	0	11	156	0	1	0	168
	Middle	0	0	0	72	0	1	0	73
	Alaska	**0**	**0**	**11**	**228**	**0**	**2**	**0**	**241**
	Upper	0	0	29	221	0	4	0	254
	Total	**0**	**0**	**40**	**449**	**0**	**6**	**0**	**495**
District 4 Commercial Fishwheel Season Total	Lower	0	105	61	189	0	0	0	355
	Middle	0	1	0	88	0	1	0	90
	Alaska	**0**	**106**	**61**	**277**	**0**	**1**	**0**	**445**
	Upper	0	28	167	267	0	5	0	467
	Total	**0**	**134**	**228**	**544**	**0**	**6**	**0**	**912**
District 4 Commercial Season Total	Lower	0	106	74	360	0	1	0	541
	Middle	0	1	0	167	0	2	0	170
	Alaska	**0**	**107**	**74**	**527**	**0**	**3**	**0**	**711**
	Upper	0	28	200	509	0	9	0	746
	Total	**0**	**135**	**274**	**1,036**	**0**	**12**	**0**	**1,457**
District 4 Subsistence Season Total	Lower	0	830	580	2,820	0	8	0	4,238
	Middle	0	8	0	1,308	0	16	0	1,332
	Alaska	**0**	**838**	**580**	**4,128**	**0**	**24**	**0**	**5,570**
	Upper	0	219	1,567	3,988	0	71	0	5,845
	Total	**0**	**1,057**	**2,147**	**8,116**	**0**	**95**	**0**	**11,415**
District 4 Commercial and Subsistence Season Total	Lower	0	936	654	3,180	0	9	0	4,779
	Middle	0	9	0	1,475	0	18	0	1,502
	Alaska	**0**	**945**	**654**	**4,655**	**0**	**27**	**0**	**6,281**
	Upper	0	247	1,767	4,497	0	80	0	6,591
	Total	**0**	**1,192**	**2,421**	**9,152**	**0**	**107**	**0**	**12,872**

[a] Age composition is based on samples from District 4. Run of origin apportion estimate is based on data from a combination of all commercial periods in District 2.

Table 10. Yukon River District 5 commercial and subsistence chinook salmon catch by age and fishery, 1997, with run of origin presumed to be Upper Run based on geographic location.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Commercial Gillnet	Upper	0	34	251	1,276	11	34	46	1,652
Commercial Fishwheel	Upper	0	338	399	1,177	10	51	51	2,026
Commercial Season Total	Upper	0	372	650	2,453	21	85	97	3,678
Subsistence	Upper	0	1,794	3,134	11,828	101	410	468	17,735
Commercial and Subsistence Season Total	Upper	0	2,166	3,784	14,281	122	495	565	21,413

Table 12. Yukon River Canadian chinook salmon catch by age and fishery, 1997, with run of origin presumed to be Upper Run based on geographic location.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
Commercial	Upper	0	537	939	3,542	30	123	140	5,311
Non-Commercial [a]	Upper	0	1,135	1,982	7,481	64	259	296	11,217
Commercial and Subsistence Season Total	Upper	0	1,672	2,921	11,023	94	382	436	16,528

[a] Non-commercial harvets includes Aboriginal, domestic and sport fish catches.

Table 13. Yukon River chinook salmon catch by age, run of origin and fishery, 1997.

			Age Group							
District	Fishery	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
1	Commercial [a]	Lower	0	2,928	2,879	18,962	0	89	0	24,858
		Middle	0	574	604	12,170	0	251	0	13,599
		Alaska	**0**	**3,502**	**3,483**	**31,132**	**0**	**340**	**0**	**38,457**
		Upper	0	200	4,414	25,254	0	828	42	30,738
		Total	**0**	**3,702**	**7,897**	**56,386**	**0**	**1,168**	**42**	**69,195**
	Subsistence	Lower	0	176	209	2,170	0	10	0	2,565
		Middle	0	4	4	1,138	0	25	0	1,171
		Alaska	**0**	**180**	**213**	**3,308**	**0**	**35**	**0**	**3,736**
		Upper	0	39	776	2,875	0	101	23	3,814
		Total	**0**	**219**	**989**	**6,183**	**0**	**136**	**23**	**7,550**
2	Commercial	Lower	0	1,271	1,203	11,396	0	32	0	13,902
		Middle	0	9	3	5,286	0	67	0	5,365
		Alaska	**0**	**1,280**	**1,206**	**16,682**	**0**	**99**	**0**	**19,267**
		Upper	0	343	3,291	16,126	0	304	32	20,096
		Total	**0**	**1,623**	**4,497**	**32,808**	**0**	**403**	**32**	**39,363**
	Subsistence	Lower	0	0	0	2,377	0	4	0	2,381
		Middle	0	0	0	974	0	6	0	980
		Alaska	**0**	**0**	**0**	**3,351**	**0**	**10**	**0**	**3,361**
		Upper	0	188	973	4,775	0	53	0	5,989
		Total	**0**	**188**	**973**	**8,126**	**0**	**63**	**0**	**9,350**
3	Subsistence	Lower	0	90	107	1,732	0	6	0	1,935
		Middle	0	2	2	837	0	14	0	855
		Alaska	**0**	**92**	**109**	**2,569**	**0**	**20**	**0**	**2,790**
		Upper	0	69	652	2,723	0	65	12	3,521
		Total	**0**	**161**	**761**	**5,292**	**0**	**85**	**12**	**6,311**
4	Commercial	Lower	0	106	74	360	0	1	0	541
		Middle	0	1	0	167	0	2	0	170
		Alaska	**0**	**107**	**74**	**527**	**0**	**3**	**0**	**711**
		Upper	0	28	200	509	0	9	0	746
		Total	**0**	**135**	**274**	**1,036**	**0**	**12**	**0**	**1,457**
	Subsistence	Lower	0	830	580	2,820	0	8	0	4,238
		Middle	0	8	0	1,308	0	16	0	1,332
		Alaska	**0**	**838**	**580**	**4,128**	**0**	**24**	**0**	**5,570**
		Upper	0	219	1,567	3,988	0	71	0	5,845
		Total	**0**	**1,057**	**2,147**	**8,116**	**0**	**95**	**0**	**11,415**
5	Commercial	Upper	0	372	650	2,453	21	85	97	3,678
	Subsistence	Upper	0	1,794	3,134	11,828	101	410	468	17,735
6	Commercial	Middle	0	1,545	510	673	0	0	0	2,728
	Sport Fish	Middle	2	451	267	1,165	0	27	1	1,913
	Subsistence	Middle	0	2,226	735	969	0	0	0	3,930
Canada	Commercial	Upper	0	537	939	3,542	30	123	140	5,311
	Subsistence	Upper	0	1,135	1,982	7,481	64	259	296	11,217
		Total	**0**	**1,672**	**2,921**	**11,023**	**94**	**382**	**436**	**16,528**
Total Harvest		Lower	0	5,401	5,052	39,817	0	150	0	50,420
		Middle	2	4,820	2,125	24,687	0	408	1	32,043
		Alaska	**2**	**10,221**	**7,177**	**64,504**	**0**	**558**	**1**	**82,463**
		Upper	0	4,924	18,578	81,554	216	2,308	1,110	108,690
		Total	**2**	**15,145**	**25,755**	**146,058**	**216**	**2,866**	**1,111**	**191,153**

[a] District 1 includes 2,811 chinook salmon caught by test fishing projects.

Table 14. Yukon River chinook salmon catch proportions by age, run of origin and fishery, 1997.

District	Fishery	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	Total
1	Commercial	Lower	0.000	0.042	0.042	0.274	0.000	0.001	0.000	0.359
		Middle	0.000	0.008	0.009	0.176	0.000	0.004	0.000	0.197
		Alaska	**0.000**	**0.051**	**0.050**	**0.450**	**0.000**	**0.005**	**0.000**	**0.556**
		Upper	0.000	0.003	0.064	0.365	0.000	0.012	0.001	0.444
		Total	**0.000**	**0.054**	**0.114**	**0.815**	**0.000**	**0.017**	**0.001**	**1.000**
	Subsistence	Lower	0.000	0.023	0.028	0.287	0.000	0.001	0.000	0.340
		Middle	0.000	0.001	0.001	0.151	0.000	0.003	0.000	0.155
		Alaska	**0.000**	**0.024**	**0.028**	**0.438**	**0.000**	**0.005**	**0.000**	**0.495**
		Upper	0.000	0.005	0.103	0.381	0.000	0.013	0.003	0.505
		Total	**0.000**	**0.029**	**0.131**	**0.819**	**0.000**	**0.018**	**0.003**	**1.000**
2	Commercial	Lower	0.000	0.032	0.031	0.290	0.000	0.001	0.000	0.353
		Middle	0.000	0.000	0.000	0.134	0.000	0.002	0.000	0.136
		Alaska	**0.000**	**0.033**	**0.031**	**0.424**	**0.000**	**0.003**	**0.000**	**0.489**
		Upper	0.000	0.009	0.084	0.410	0.000	0.008	0.001	0.511
		Total	**0.000**	**0.041**	**0.114**	**0.833**	**0.000**	**0.010**	**0.001**	**1.000**
	Subsistence	Lower	0.000	0.000	0.000	0.254	0.000	0.000	0.000	0.255
		Middle	0.000	0.000	0.000	0.104	0.000	0.001	0.000	0.105
		Alaska	**0.000**	**0.000**	**0.000**	**0.358**	**0.000**	**0.001**	**0.000**	**0.359**
		Upper	0.000	0.020	0.104	0.511	0.000	0.006	0.000	0.641
		Total	**0.000**	**0.020**	**0.104**	**0.869**	**0.000**	**0.007**	**0.000**	**1.000**
3	Subsistence	Lower	0.000	0.014	0.017	0.274	0.000	0.001	0.000	0.307
		Middle	0.000	0.000	0.000	0.133	0.000	0.002	0.000	0.135
		Alaska	**0.000**	**0.015**	**0.017**	**0.407**	**0.000**	**0.003**	**0.000**	**0.442**
		Upper	0.000	0.011	0.103	0.431	0.000	0.010	0.002	0.558
		Total	**0.000**	**0.026**	**0.121**	**0.839**	**0.000**	**0.013**	**0.002**	**1.000**
4	Commercial	Lower	0.000	0.073	0.051	0.247	0.000	0.001	0.000	0.371
		Middle	0.000	0.001	0.000	0.115	0.000	0.001	0.000	0.117
		Alaska	**0.000**	**0.073**	**0.051**	**0.362**	**0.000**	**0.002**	**0.000**	**0.488**
		Upper	0.000	0.019	0.137	0.349	0.000	0.006	0.000	0.512
		Total	**0.000**	**0.093**	**0.188**	**0.711**	**0.000**	**0.008**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.073	0.051	0.247	0.000	0.001	0.000	0.371
		Middle	0.000	0.001	0.000	0.115	0.000	0.001	0.000	0.117
		Alaska	**0.000**	**0.073**	**0.051**	**0.362**	**0.000**	**0.002**	**0.000**	**0.488**
		Upper	0.000	0.019	0.137	0.349	0.000	0.006	0.000	0.512
		Total	**0.000**	**0.093**	**0.188**	**0.711**	**0.000**	**0.008**	**0.000**	**1.000**
5	Commercial	Upper	0.000	0.101	0.177	0.667	0.006	0.023	0.026	1.000
	Subsistence	Upper	0.000	0.101	0.177	0.667	0.006	0.023	0.026	1.000
6	Commercial	Middle	0.000	0.566	0.187	0.247	0.000	0.000	0.000	1.000
	Sport Fish	Middle	0.001	0.236	0.140	0.609	0.000	0.014	0.001	1.000
	Subsistence	Middle	0.000	0.566	0.187	0.247	0.000	0.000	0.000	1.000
Canada	Commercial	Upper	0.000	0.101	0.177	0.667	0.006	0.023	0.026	1.000
	Subsistence	Upper	0.000	0.101	0.177	0.667	0.006	0.023	0.026	1.000
Total Harvest		Lower	0.000	0.028	0.026	0.208	0.000	0.001	0.000	0.264
		Middle	0.000	0.025	0.011	0.129	0.000	0.002	0.000	0.168
		Alaska	**0.000**	**0.053**	**0.038**	**0.337**	**0.000**	**0.003**	**0.000**	**0.431**
		Upper	0.000	0.026	0.097	0.427	0.001	0.012	0.006	0.569
		Total	**0.000**	**0.079**	**0.135**	**0.764**	**0.001**	**0.015**	**0.006**	**1.000**

Table 15. Yukon River chinook salmon historical harvest by run of origin for the United States and Canada, 1996-1997.

			Upper			
Year	Lower	Middle	U.S.	Canada	Total	Total
1996	33,278	16,386	88,958	19,612	108,570	158,234
1997	50,420	32,043	92,162	16,528	108,690	191,153

Table 16. Yukon River chinook salmon historical harvest proportions by run of origin for the United States and Canada, 1996-1997.

			Upper			
Year	Lower	Middle	U.S.	Canada	Total	Total
1996	0.210	0.104	0.562	0.124	0.686	1.000
1997	0.264	0.168	0.482	0.086	0.569	1.000

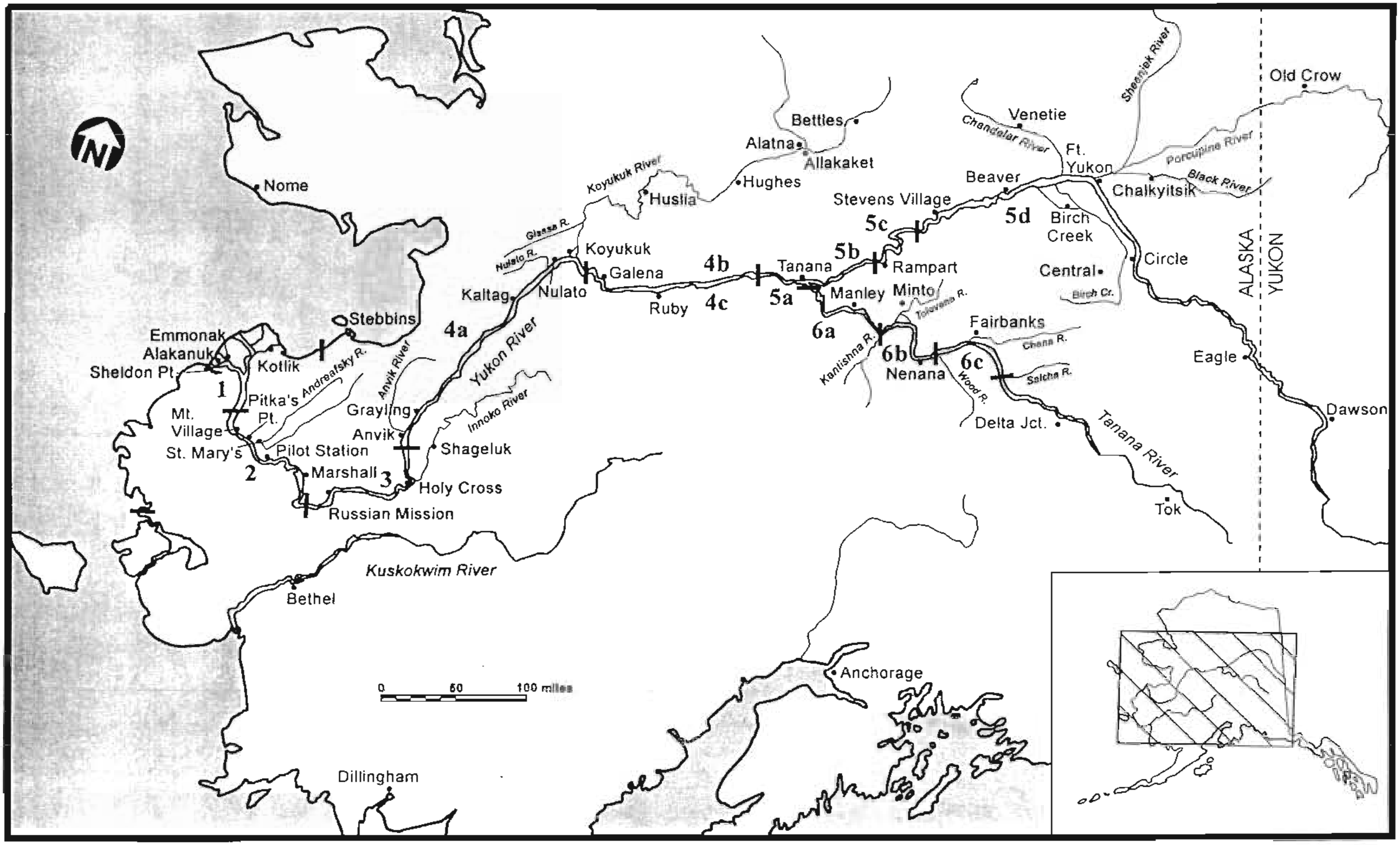


Figure 1. Alaska portion of the Yukon River drainage with district and subdistrict boundaries, and major spawning tributaries.

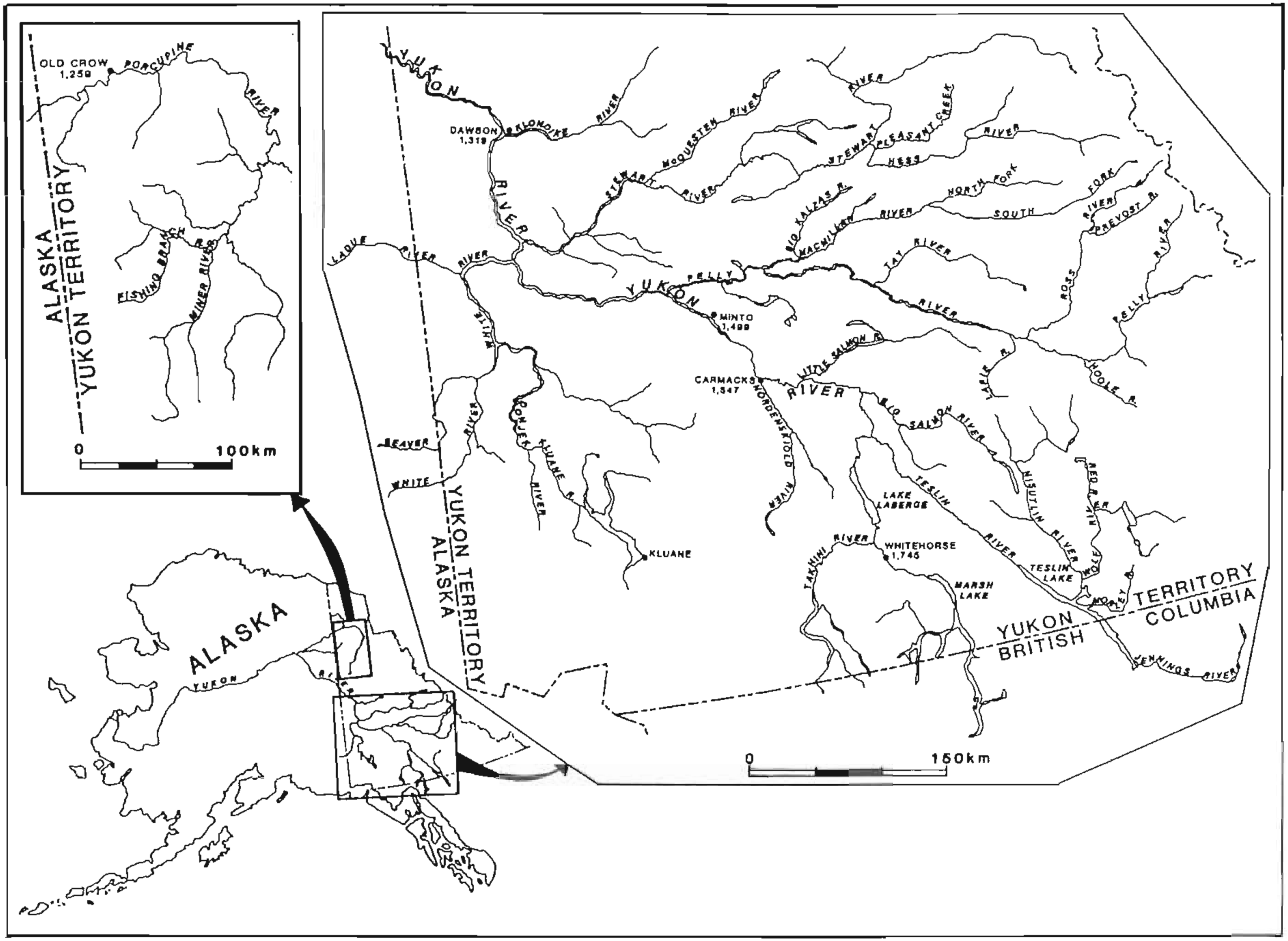


Figure 2. Canada portion of the Yukon River drainage and major spawning tributaries.

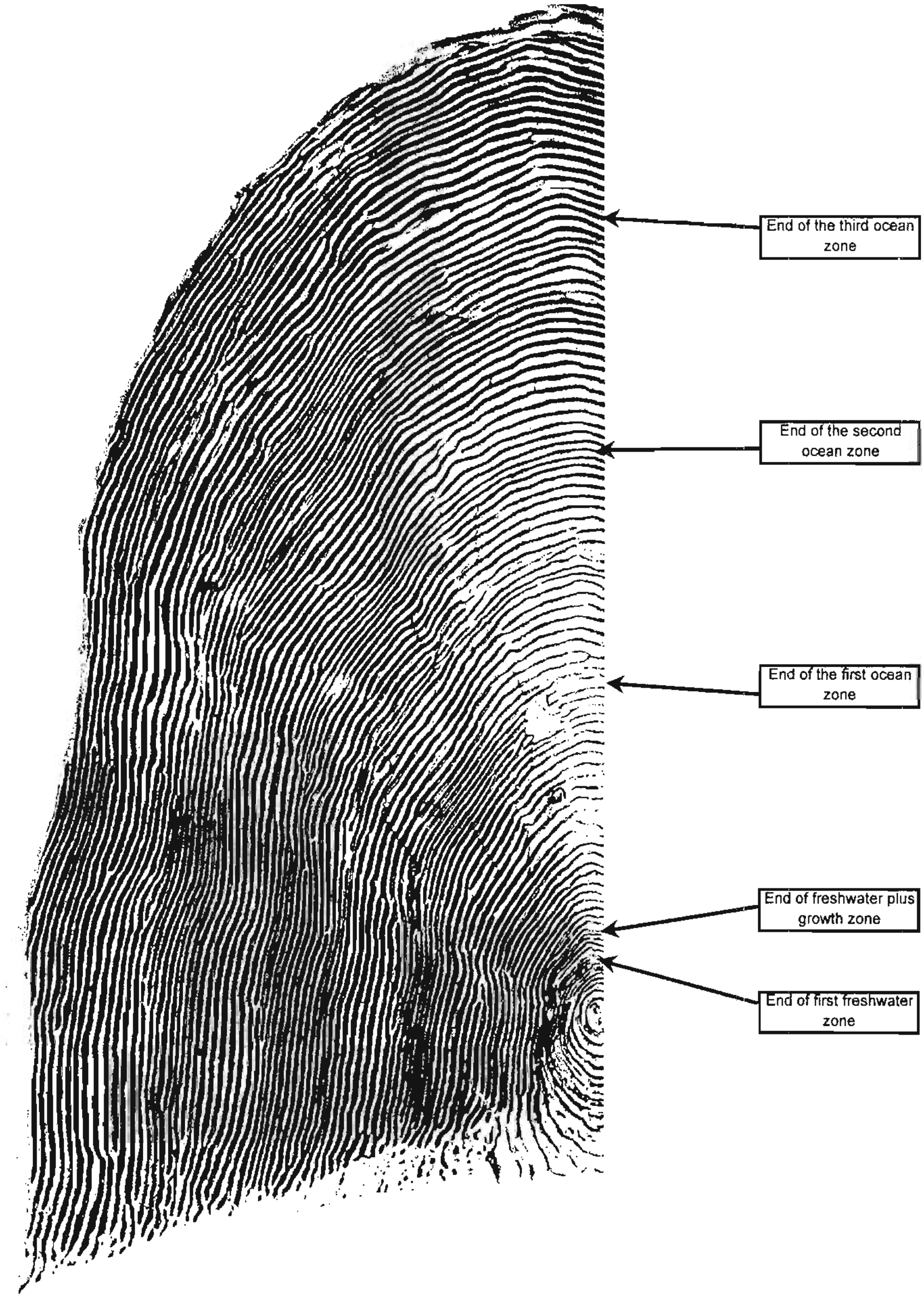
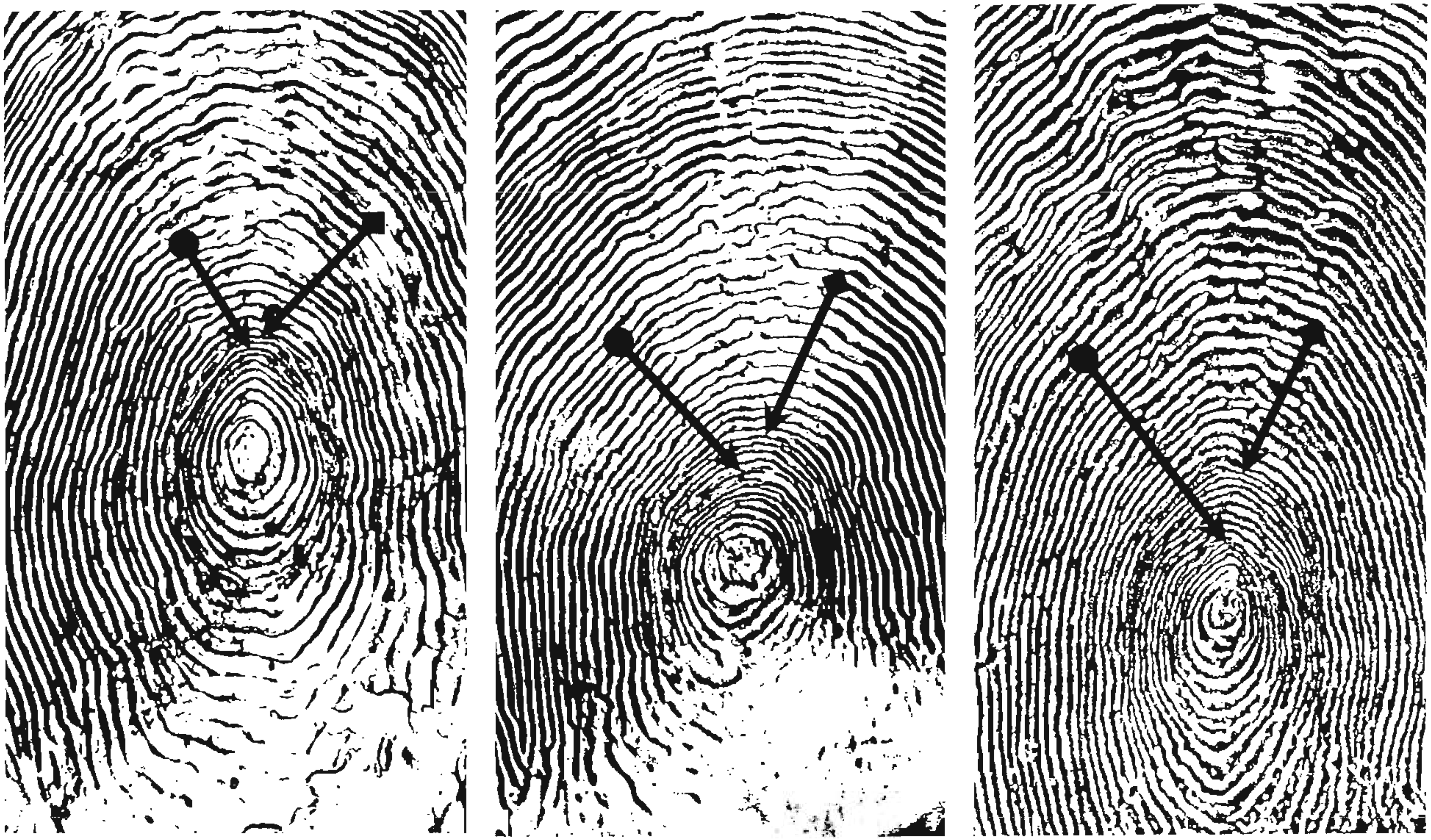
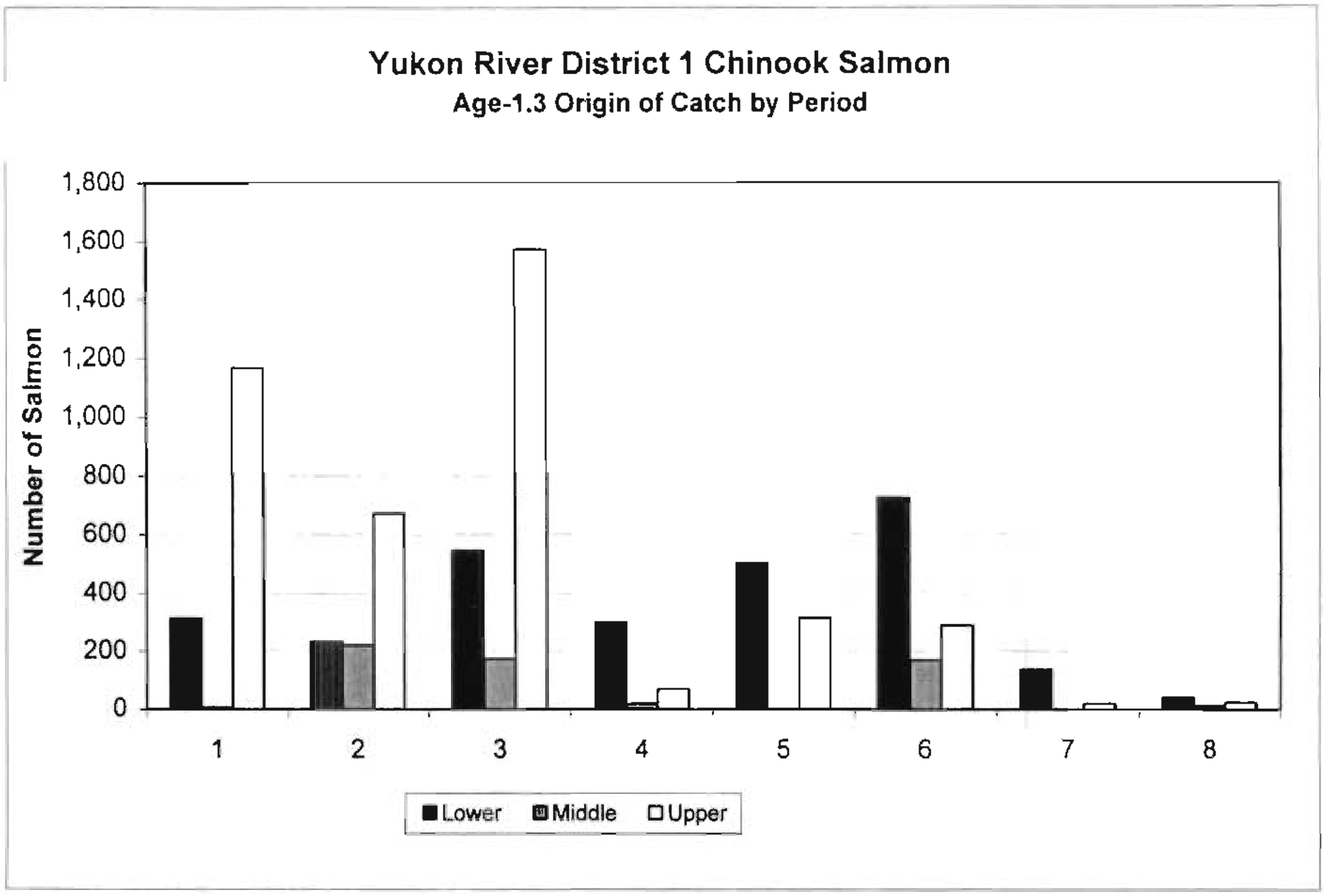


Figure 3. Scale of a chinook salmon showing the different zones that are measured for scale pattern analysis.



Andreafsky River Escapement | **Salcha River Escapement** | **Dawson Commercial Catch**

Figure 4. Yukon River chinook salmon fresh water scale areas, comparing scales from the Andreafsky River escapement (Lower Run), the Salcha River escapement (Middle Run) and the Canadian commercial catch (Upper Run). (Arrows with "dots" indicate the first freshwater annulus, arrows with "diamonds" indicate the end of the freshwater plus growth zone.)



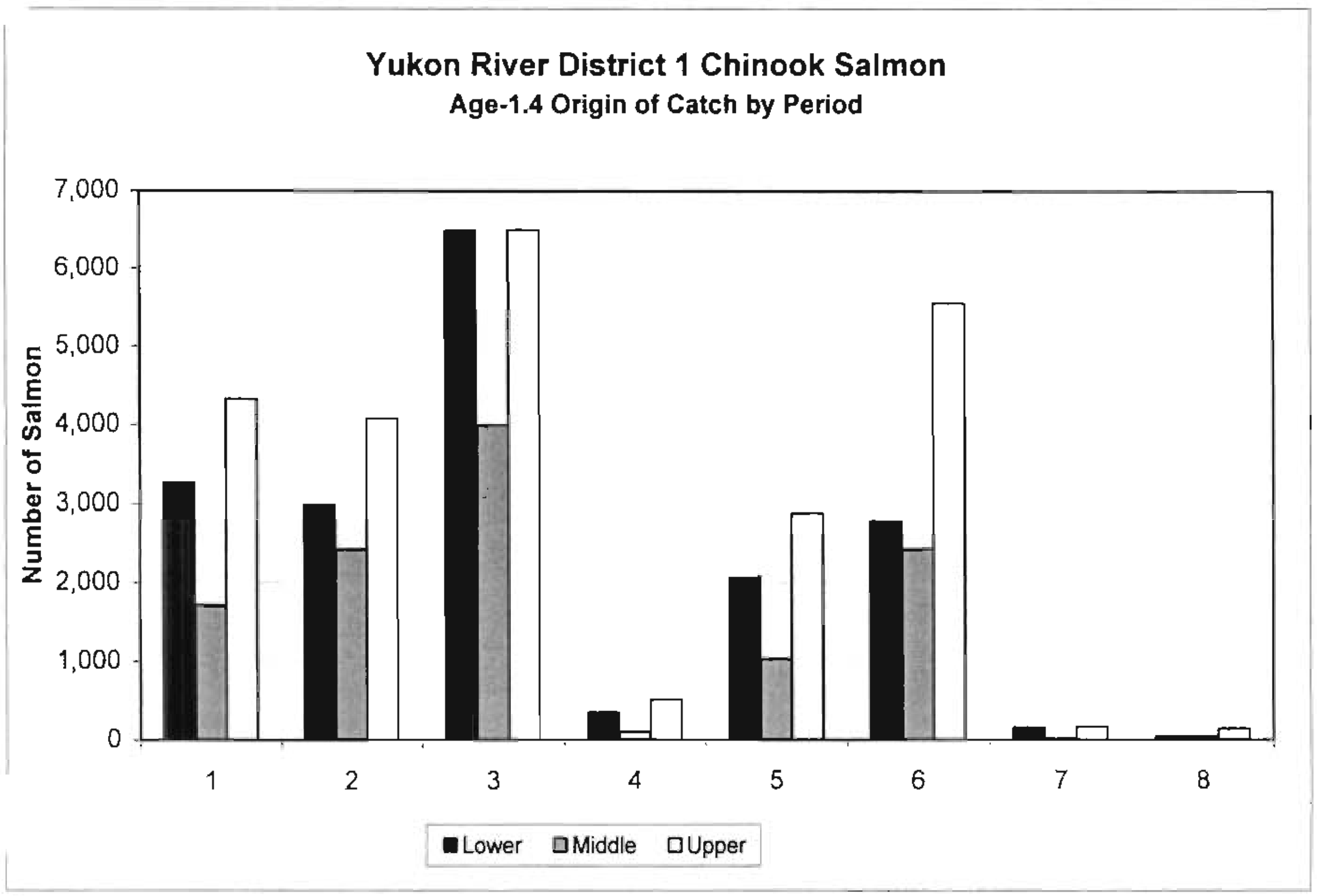
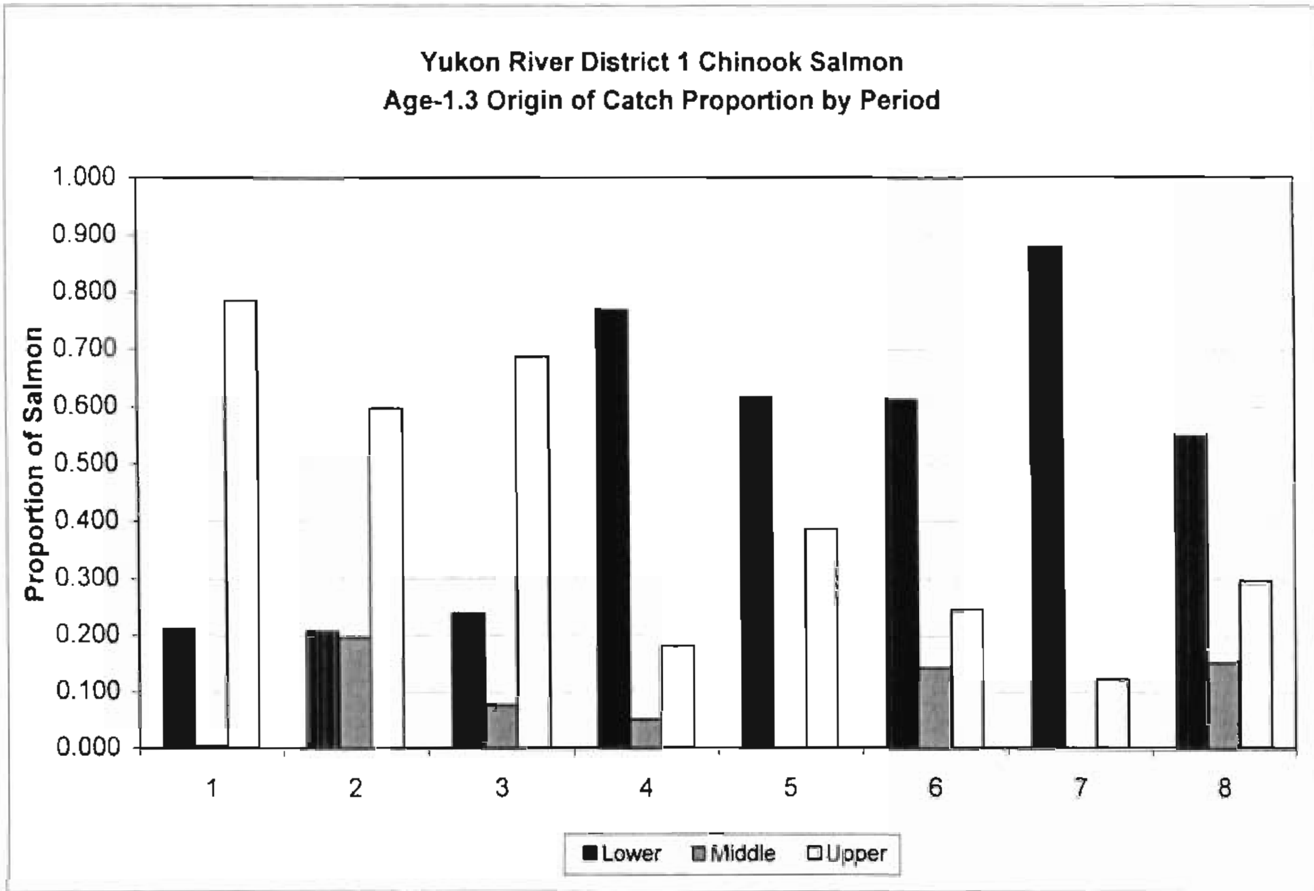


Figure 5. Estimated number of age-1.3 and -1.4 chinook salmon harvested by period and run of origin, Yukon River District 1, 1997.



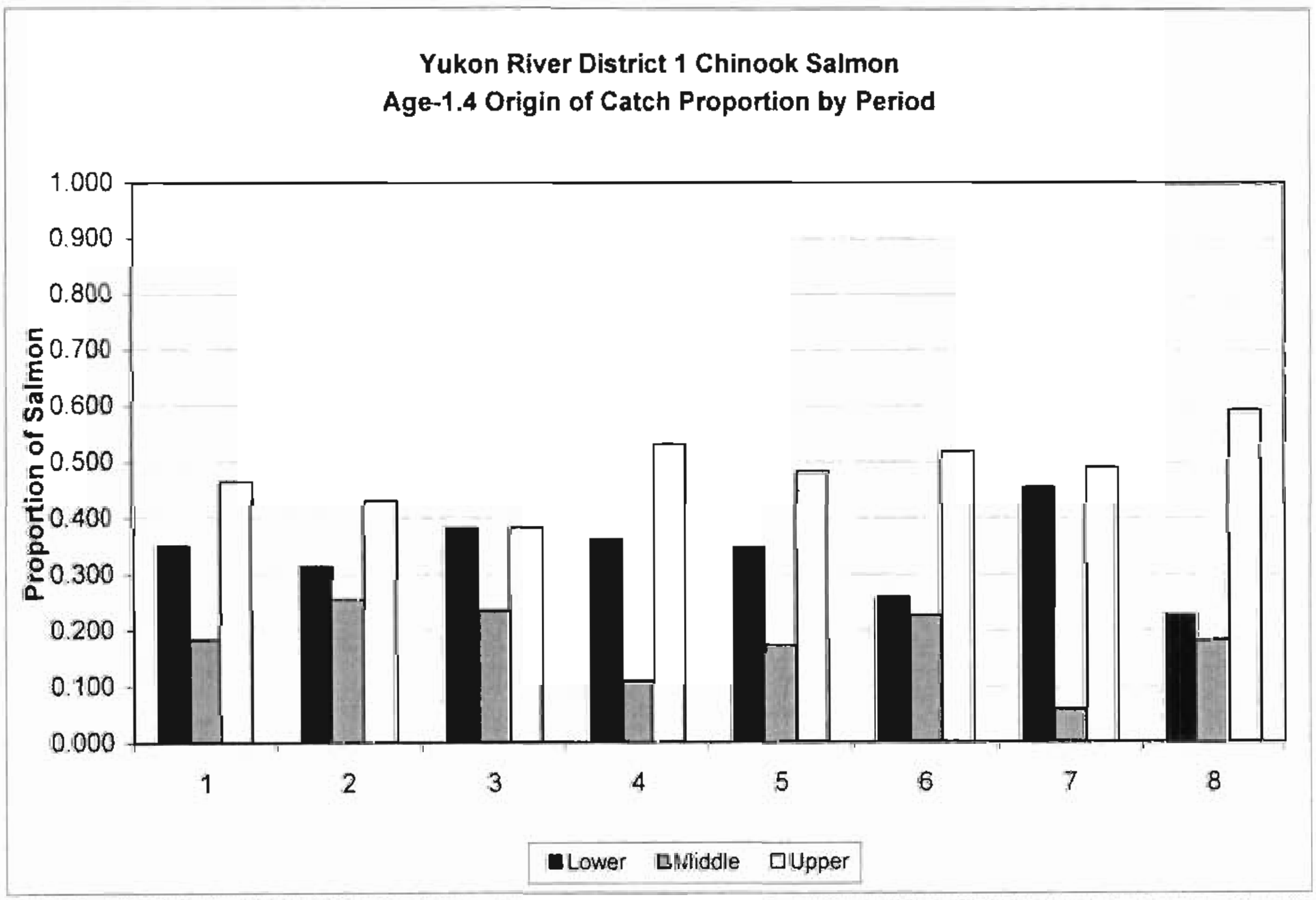
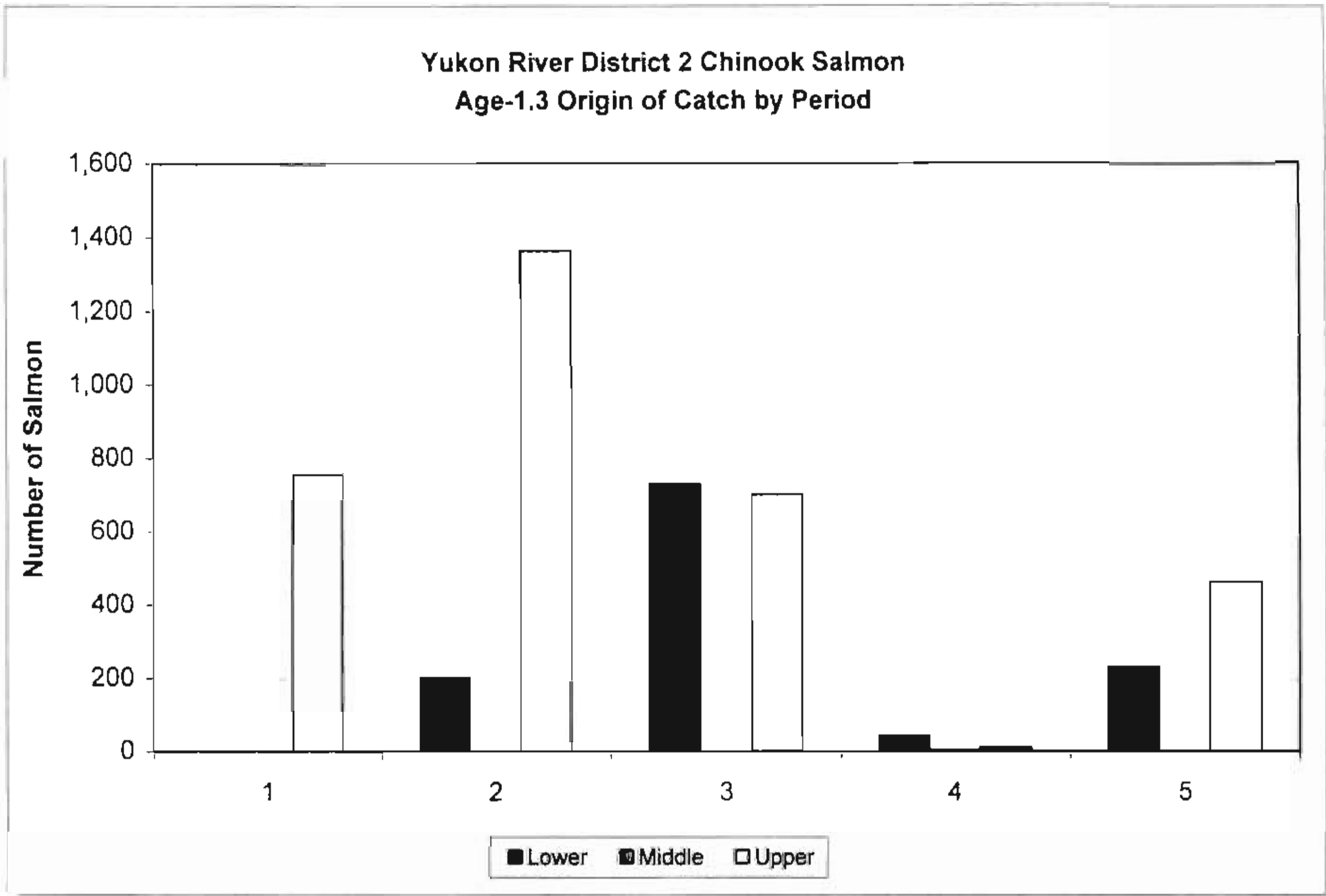


Figure 6. Estimated proportion of age-1.3 and -1.4 chinook salmon harvested by period and run of origin, Yukon River District 1, 1997.



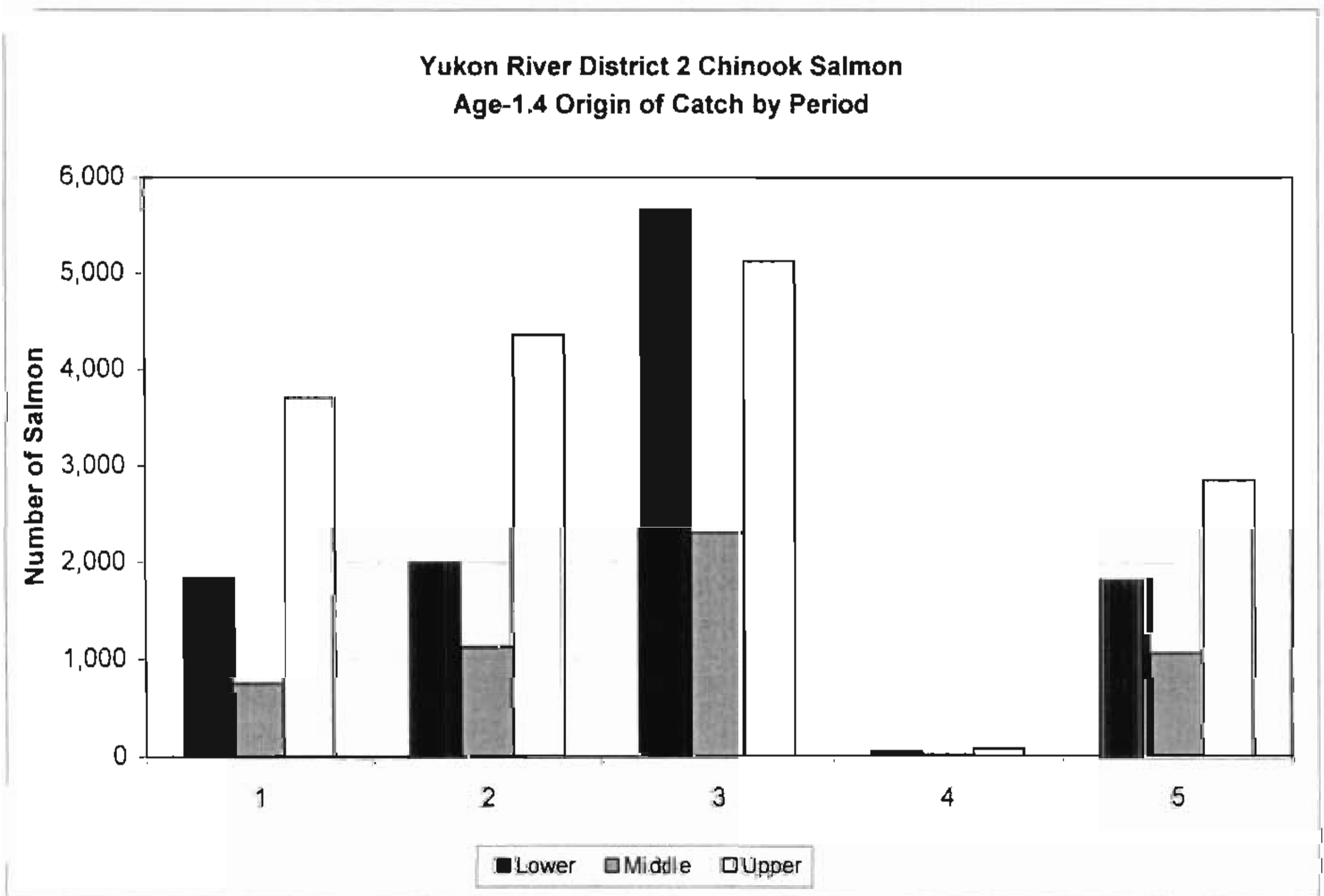
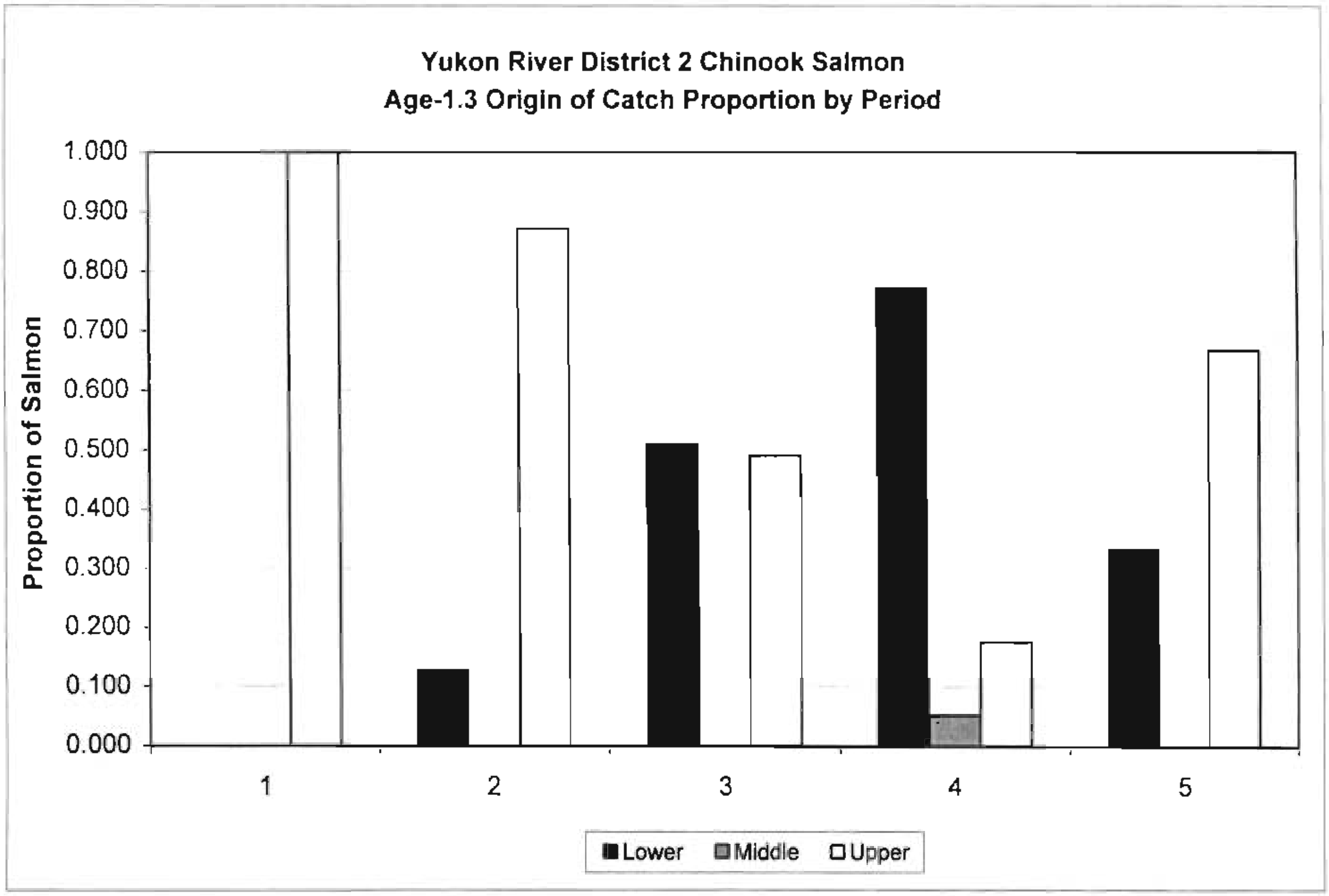


Figure 7. Estimated number of age-1.3 and -1.4 chinook salmon harvested by period and run of origin, Yukon River District 2, 1997.



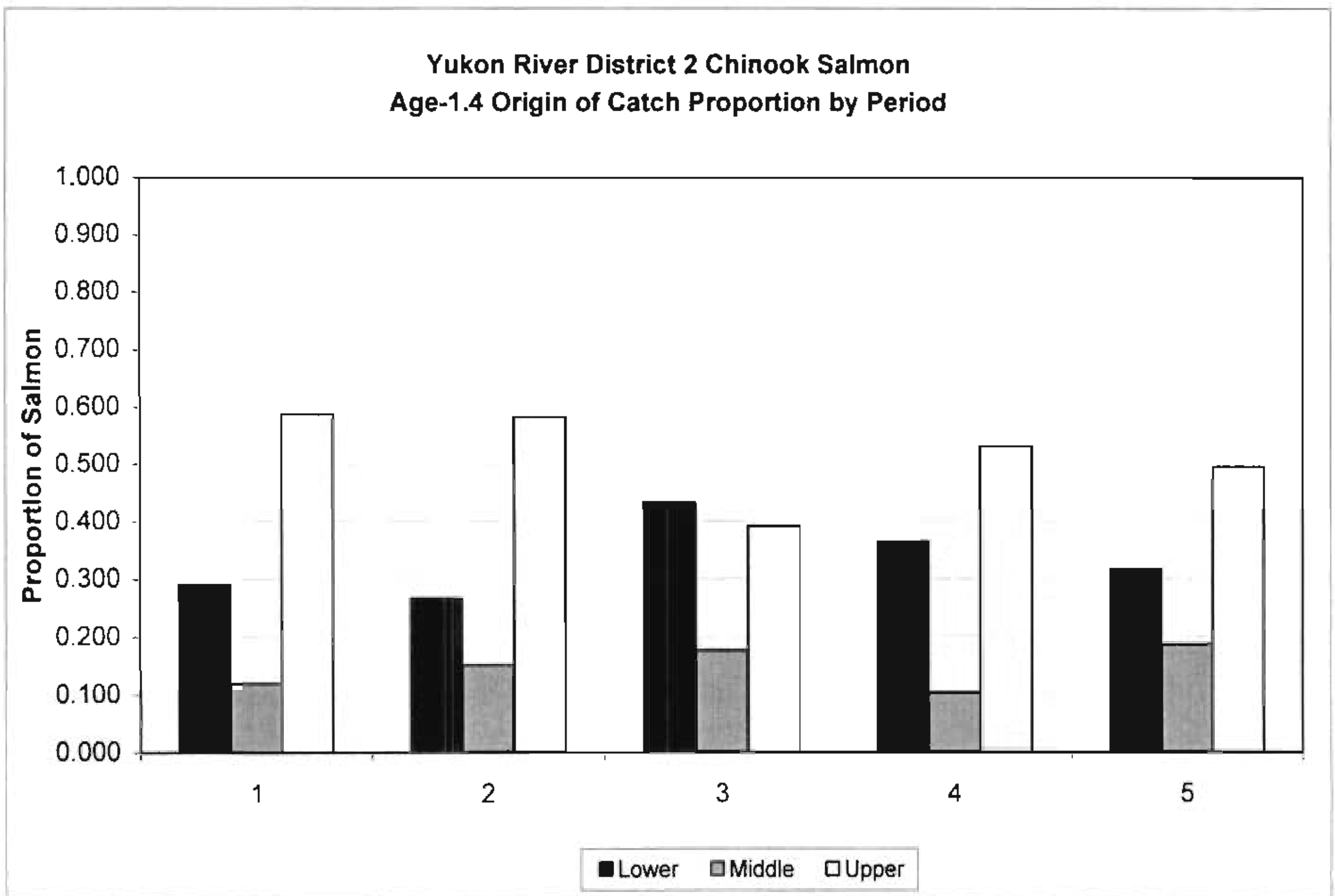
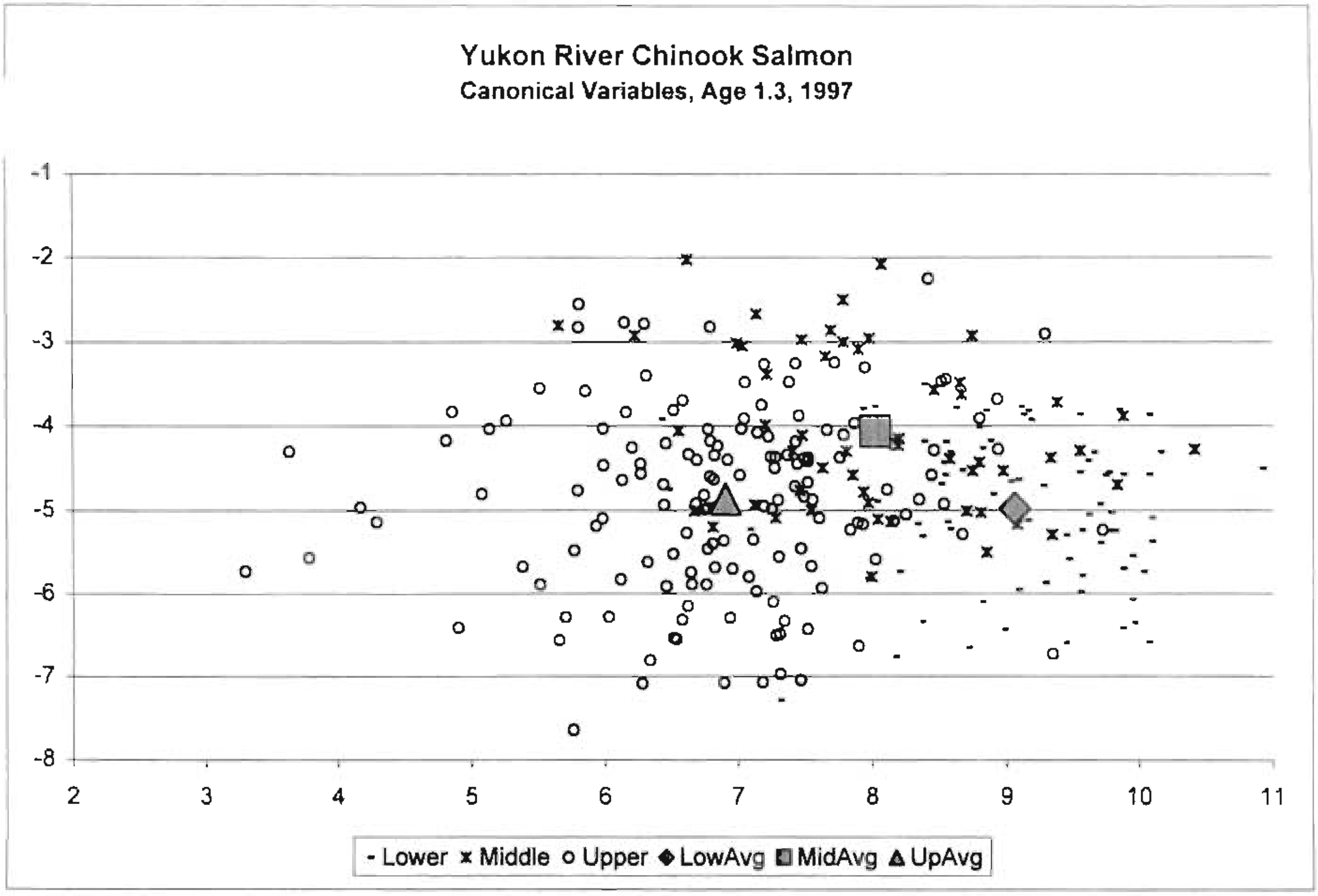


Figure 8. Estimated proportion of age-1.3 and -1.4 chinook salmon harvested by period and run of origin, Yukon River District 2, 1997.



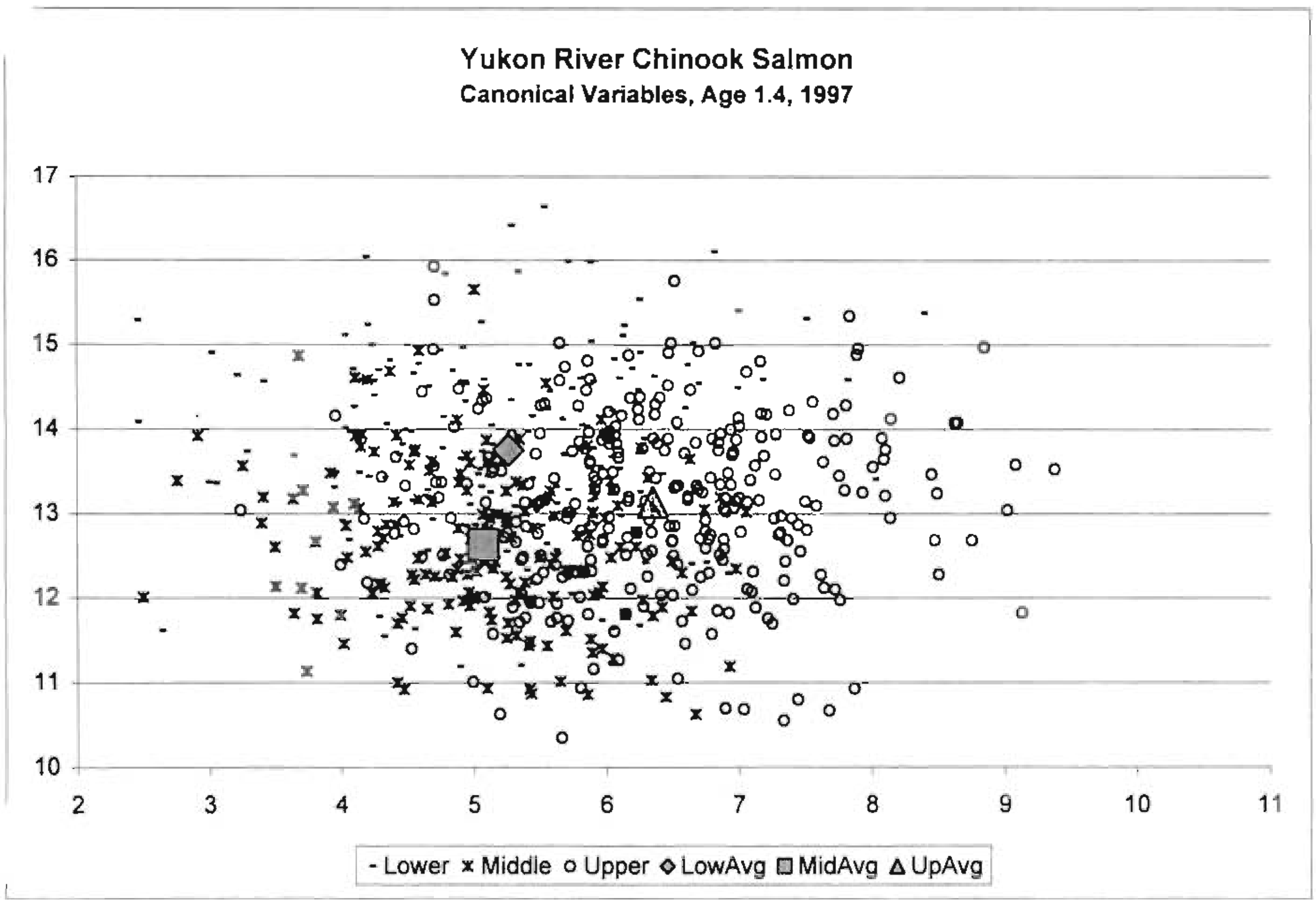


Figure 9. Canonical variable plots for Yukon River age-1.3 and -1.4 chinook salmon, 1997.

Appendix Table 1. Yukon River chinook salmon commercial catch age composition by district, gear type and stratum, 1997.

			Age Group						
District	Gear	Date	1.1	1.2	1.3	1.4	2.3	1.5	2.4
District 1	Unrestricted	6/12/97	0.000	0.029	0.131	0.819	0.000	0.018	0.003
	Unrestricted	6/17/97	0.000	0.032	0.101	0.851	0.000	0.016	0.000
	Unrestricted	6/20/97	0.000	0.021	0.114	0.843	0.000	0.022	0.000
	Unrestricted	6/24/97	0.000	0.068	0.110	0.809	0.000	0.013	0.000
	Unrestricted	6/27/97	0.000	0.071	0.091	0.827	0.000	0.011	0.000
	Restricted	6/28/97	0.000	0.324	0.203	0.446	0.000	0.027	0.000
	Restricted	6/30/97	0.000	0.329	0.164	0.507	0.000	0.000	0.000
District 2	Unrestricted	6/16/97	0.000	0.020	0.104	0.869	0.000	0.007	0.000
	Unrestricted	6/19/97	0.000	0.044	0.163	0.782	0.000	0.007	0.003
	Unrestricted	6/23/97	0.000	0.037	0.094	0.860	0.000	0.010	0.000
	Restricted	6/25/97	0.000	0.327	0.184	0.476	0.000	0.014	0.000
	Unrestricted	6/26/97	0.000	0.056	0.099	0.826	0.000	0.019	0.000
District 3	There was no commercial fishing in 1997								
District 4	Y4B Set Gillnet	7/03-7/18	0.000	0.031	0.125	0.844	0.000	0.000	0.000
	Y4C Set Gillnet	7/07-7/15	0.000	0.000	0.080	0.908	0.000	0.011	0.000
	Y4C Fish Wheel	6/30-7/25	0.000	0.147	0.250	0.597	0.000	0.007	0.000
District 5	Y5C Fish Wheel	7/09	0.000	0.167	0.197	0.581	0.005	0.025	0.025
	Y5C Set Gillnet	7/05	0.000	0.021	0.152	0.772	0.007	0.021	0.028
District 6	Y6B Fish Wheel	7/12-8/10	0.000	0.566	0.187	0.247	0.000	0.000	0.000

Appendix Table 2. Yukon River chinook salmon escapement age composition by tributary with the weighted age composition for each geographic area, 1997.

			Age Group								
Region	Tributary	Strata	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	Total
Lower	Andreafsky R.	6/23-9/08	0.000	0.508	0.160	0.000	0.332	0.000	0.000	0.000	1.000
	Anvik R.	7/06-8/13	0.000	0.250	0.306	0.000	0.441	0.000	0.003	0.000	1.000
	Gisasa R.	6/29-7/27	0.005	0.367	0.271	0.002	0.353	0.001	0.002	0.000	1.000
	Lower River Weighted		**0.002**	**0.365**	**0.251**	**0.001**	**0.379**	**0.000**	**0.002**	**0.000**	**1.000**
Middle	Salcha R.	8/12-8/14	0.000	0.144	0.144	0.000	0.694	0.000	0.017	0.000	1.000
	Chena R.	7/31-8/07	0.003	0.372	0.134	0.000	0.480	0.000	0.010	0.001	1.000
	Chatanika R.	7/08-8/08	0.000	0.573	0.153	0.000	0.266	0.000	0.007	0.000	1.000
	Koyukuk R.	7/19-8/12	0.000	0.097	0.130	0.000	0.763	0.000	0.010	0.000	1.000
	Middle River Weighted		**0.001**	**0.236**	**0.140**	**0.000**	**0.609**	**0.000**	**0.014**	**0.001**	**1.000**
Upper	Sheep Rock	7/03-9/01	0.000	0.188	0.222	0.003	0.540	0.006	0.014	0.026	1.000
	White Rock	6/26-9/10	0.000	0.310	0.172	0.010	0.406	0.021	0.007	0.074	1.000
	Upper River Weighted [a]		**0.000**	**0.009**	**0.100**	**0.003**	**0.731**	**0.019**	**0.026**	**0.112**	**1.000**

[a] Border passage age composition after gear-selectivity coefficients were applied to the fishwheel age composition to obtain a more accurate estimate of the border passage age composition.

Appendix Table 3. Final set of scale variables and their descriptions selected for Yukon River chinook salmon stock separation studies, 1997.

Age Group	Scale Variable	Description of the Scale Characteristic
Age 1.3	67	Distance of the 1st freshwater divided by the total freshwater distance.
	96	Distance between the 3rd and 9th circuli in the 1st ocean zone, divided by the width of the 1st ocean zone.
	1	Number of circuli in the first fresh water zone.
Age 1.4	65	Number of circuli in the 1st freshwater AND plus growth zone.
	72	Distance from the end of the freshwater zone to the 3rd circuli in the 1st ocean zone.
	8	Distance between the 2nd and 4th circuli.
	68	Freshwater plus growth zone divided by the total distance of the freshwater zone.
	5	Distance between the origin an the 6th circuli.
	10	Distance between the 4th and 6th circuli, 1st freshwater annulus.
	85	Distance from the 6th to the last circuli in the first ocean zone to the end of the 1st ocean zone.
	82	Distance between the 6th and 12th circuli, 1st marine.
	26	Distance between the 2nd to the last circuli in the 1st freshwater zone to the end of the 1st freshwater zone, divided by the total distance of the 1st freshwater zone.
	18	Distance between the origin and the 6th circuli in the 1st freshwater zone, divided by the total distance of the 1st freshwater zone.
	103	Distance between the 3rd circuli in the 1st ocean zone and the end of the 1st ocean zone, divided by the width of the 1st ocean zone.
	100	Distance between the 6th and 12th circuli in the 1st ocean zone, divided by the width of the 1st ocean zone.
	90	Distance between the end of the freshwater growth and 3rd circuli in the 1st ocean zone, divided by the width of the 1st ocean zone.
	107	Maximum distance between 2 consecutive circuli in 1st ocean zone.

Appendix Table 4. Final set of scale variables and their corresponding values for Lower, Middle and Upper river stocks selected for Yukon River chinook salmon stock separation studies, 1997.

Age Group	Variable	Minimum			Maximum			Average			Standard Deviation		
		Lwr	Mid	Upr	Lwr	Mid	Upr	Lwr	Mid	Upr	Lwr	Mid	Upr
Age 1.3	67	0.534	0.497	0.443	0.824	0.806	0.794	0.730	0.661	0.617	0.053	0.059	0.061
	96	0.163	0.164	0.132	0.477	0.584	0.716	0.230	0.264	0.287	0.055	0.070	0.077
	1	7	5	5	13	10	13	8.8	7.7	9.0	1.3	1.3	1.6
Age 1.4	65	10	10	10	20	16	20	13.8	12.4	14.3	1.8	1.4	1.9
	72	26	24	25	69	70	70	44.7	41.9	39.9	7.4	7.3	6.9
	8	31	26	23	64	67	65	44.9	42.9	42.6	6.3	6.7	6.8
	68	0.219	0.169	0.202	0.470	0.477	0.545	0.325	0.332	0.362	0.053	0.053	0.060
	5	66	66	59	117	126	115	89.5	88.9	86.6	8.9	9.9	9.6
	10	12	10	9	34	30	29	20.1	19.4	18.6	3.8	3.9	3.8
	85	80	76	75	175	151	166	120.2	112.7	113.9	16.1	14.1	14.3
	82	83	81	82	158	153	163	110.2	110.0	114.2	12.3	13.0	13.3
	26	0.059	0.091	0.060	0.313	0.296	0.255	0.155	0.173	0.149	0.039	0.040	0.033
	18	0.540	0.653	0.594	1.000	1.000	1.000	0.817	0.864	0.818	0.099	0.083	0.087
	103	0.160	0.149	0.154	0.463	0.395	0.419	0.271	0.251	0.263	0.050	0.043	0.047
	100	0.177	0.169	0.177	0.488	0.411	0.444	0.249	0.245	0.264	0.048	0.040	0.048
	90	0.056	0.059	0.051	0.219	0.208	0.209	0.101	0.094	0.092	0.025	0.021	0.022
	107	21	20	20	52	44	44	28.9	28.4	28.1	4.4	3.8	4.2