ORIGINS OF CHINOOK SALMON

IN THE YUKON RIVER FISHERIES, 1999

By

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and

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OEO/ADA STATEMENT

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ABSTRACT

Stock composition of all harvests of chinook salmon *Oncorhynchus tshawytscha* within the Yukon River drainage were estimated in 1999. 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 Districts 1 through 4 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. Districts 1 and 2 subsistence harvests and District 3 subsistence and commercial harvests were apportioned to stock groups using estimated proportions of lower Yukon River testing fishing and commercial catch samples. The District 4 subsistence harvest was apportioned to stock groups using the estimated proportions and age composition obtained in the analysis of District 4 commercial data. Stock group 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 1999 was 136,770 chinook salmon, of those, 40.3% were estimated to be of Lower, 6.3% Middle and 53.4% Upper Yukon River stock group origin.

INTRODUCTION

The goal of this study is to estimate the proportion of stock groups (i.e., geographic region) for all Yukon River chinook salmon *Oncorhynchus tshawytscha*, harvested in the drainage during the 1999 season utilizing scale pattern data with a maximum likelihood estimator. Results from scale pattern analysis on these stocks provide valuable stock separation information for management and conservation of the various runs of chinook salmon throughout the Yukon River drainage.

Yukon River chinook salmon are harvested annually in a variety of fisheries in both marine and fresh waters. Within the Yukon River, returning adult salmon 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). Commercially sold harvests consist of fish in the round, fish utilized for commercial roe harvests and fish harvested by the Alaska Department of Fish and Game (ADF&G) in test fishing projects. Sport fisheries primarily occur in tributaries of the Tanana River and in Canada; smaller sport fishing harvests occur throughout the Alaska portion of the Yukon River drainage. The total harvest of chinook salmon within the Yukon River drainage based on a 10 year average from 1990-1999 is approximately, 64.9 % commercial harvest, 34.1 % subsistence harvest, 0.5 % personal use, 0.8 % test fish and 1.0 % sport fish harvest (JTC 2001).

The Yukon River drains roughly 531,100 square kilometers and originates in northern British Columbia, and flows 3,700 kilometers to the Bering Sea (Bergstrom et al. 1999). Chinook salmon spawn in major tributaries, such as the Andreafsky River approximately 161 river kilometers from the mouth of the Yukon River, and upriver 3,200 kilometers in the Swift River in British Columbia near the Yukon Territory border. More than 100 spawning streams have been documented in the Yukon River drainage. Aerial surveys of chinook salmon escapements indicate the largest concentrations of spawning salmon occur in tributary groupings in three distinct geographic regions: 1) the Alaskan tributary streams draining the Andreafsky Hills and Kaltag Mountains (river kilometer 161-805); 2) the Alaskan tributary streams in the Upper Koyukuk River and Tanana River (river kilometers 1,290-1,770); and 3) the Canadian tributary streams that drain the Pelly and Big Salmon Mountains (river kilometers 2,090-2,900). Initially, chinook salmon stocks within these geographic regions were collectively termed runs (McBride and Marshall 1983) but are now referred to as the Lower, Middle and Upper Yukon River stock groups (Lingnau and Bromaghin 1999).

Evaluating stock production, spawning escapement goals and management strategies requires information on the stock composition of the various Yukon River mixed stock harvests. Stock composition of Yukon River fishery harvests has been studied by ADF&G using scale growth measurements to differentiate chinook salmon stock groups. Annually, harvests within the drainage are apportioned to their geographic stock group (lower, middle or upper stock group). In addition, the U.S. and Canada have been engaged in the cooperative management and conservation of Canadian stocks spawning in Canada.

In the first 20 years after statehood (1960-1979), the total chinook salmon harvest in the Yukon River in Alaska and Canada combined ranged from an estimated 77,000 to 170,000 and averaged 123,000 fish annually (JTC 1994). Beginning in 1980, total annual harvests increased, and for the

period of 1993-1997 the average total annual harvest was approximately 184,200 fish. In 1999, the chinook salmon total harvest in Alaska and Canada combined was 136,770 chinook salmon, of which 64,294 fish (47%) were harvested by District 1 and 2 commercial fishers (Bergstrom et al. 2000). For Alaska, a substantial portion of the harvests occurring in Districts 1, 2 and 3 are from commercial fisheries conversely, the larger proportion of harvests for Districts 4, 5 and 6 are from subsistence fisheries. In 1999 75.5% of the total harvest in Districts 1, 2 and 3 was caught commercially. In Districts 4, 5 and 6, 82.7% of the harvest was caught in subsistence fisheries.

METHODS

Overview

The three stocks of origin were sampled from spawning grounds in areas of the Yukon River drainage where the stocks are assumed to be separated. Scales were collected from the preferred area on the left side of the fish approximately two rows above the lateral line in an area transected by a diagonal line from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Clutter and Whitesel 1956). Three scales were collected from each chinook salmon to increase the probability of scale readability to provide accurate age determination. All of the scale samples were mounted on gummed cards. The scale data were used to estimate the age composition at each sampling location. The scales of the abundant age classes, termed major age classes, were digitized (several growth measurements were made on each scale). These data are considered to characterize all salmon from each of the distinct stock groups, and are the main component of the stock identification project.

Escapement Sampling

Scale samples were collected by ADF&G personnel during the period of peak spawning mortality from the Anvik, Chena, and Salcha Rivers in Alaska. Carcasses were the primary source of scale samples; however, some samples were obtained from electorshocked fish used for a mark-recapture project on the Chena River. Live salmon were sampled at weir projects operated by the U. S. Fish and Wildlife Service on the East Fork Andreafsky and Gisasa Rivers. Scale samples were also collected from fish captured in fish wheels used for a mark-recapture project at White Rock and Sheep Rock locations by the Canadian Department of Fisheries and Oceans (CDFO) in the Yukon Territory, Canada. These scale samples provided data used to estimate the age composition of the escapement, and major age classes were digitized from the scales for subsequent analysis.

Catch Sampling

Scale samples were collected during each commercial fishing period in Districts 1 and 2. These scales were used for age composition analysis and subsequently digitized. Because of reduced commercial fishing in 1999, subsistence harvests occurred throughout the duration of the run and it was assumed that subsistence fishing in Districts 1 and 2 could therefore be described using lower

Yukon River test fishing and commercial fishing samples. No scale samples were collected during commercial or subsistence fishing periods in Districts 3 in 1999. The District 3 commercial and subsistence harvests were apportioned using District 2 commercial fishing samples.

Scale samples from District 4 were collected during commercial fishing periods from both fish wheels and gillnets. These scales were aged and digitized. In addition, scale samples collected during subsistence fishing periods in District 4 were used solely for age composition analysis. The majority of the District 4 subsistence harvests were thought to have been taken with large mesh gillnets. Therefore, the subsistence harvest in District 4 was apportioned using a combination of age composition data from District 4 gillnet subsistence samples and stock composition estimates from District 4 combined fish wheel and gillnet commercial samples.

Scale samples from Districts 5 and 6 were collected during commercial fishing periods and used solely for age composition analysis. Where possible, the age composition in these upper river districts was reported by gear type and statistical area. Harvests in these districts were apportioned to geographic areas where the chinook salmon were harvested. 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 most of the sport fishing harvest. All harvests occurring in Canada were apportioned to the Upper run. Age composition of Canadian harvests was allocated using gillnet test fishing samples collected in Canada.

Scale Processing

All scales samples were mounted on gummed cards and impressions were made in cellulose acetate. Scale impressions were aged using a microfiche reader with a 40x lens and ages were 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 and the second number, separated by the first with a period, represents the number of years spent in the ocean. The total age is calculated by summing the two numbers and then adding 1 for the time the eggs spend in the gravel while incubating.

The center of scale growth, the area enclosed by the first circulus is identified as the focus. On a salmon scale a year's growth is represented by a zone of widely spaced circuli (the summer growth) followed by a zone of closely spaced circuli (the winter growth) these closely spaced circuli are defined as an annulus. In fresh water, the growth of the fish is slower than in salt water and the circuli on the scale formed in fresh water are spaced closer together than those formed in salt water. This distinction makes it possible to define the periods the fish spend in each environment.

Age-1.3 and -1.4 chinook salmon were the major age classes in 1999 and accounted for the largest segment of samples in 1999 (these two age classes are the age classes normally digitized). After the scales are aged, each scale impression was enlarged by a factor of 100 and projected onto a digitizing tablet. 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 were measured in millimeters. Measurements within each zone were identified by a

specific cursor key code. The focus, where digitizing begins, represents "0", the origin. Therefore, the first incremental distance measured is from "0", to the first circuli. In a one freshwater annulus fish, typically cursor key 1 identifies the first freshwater zone, 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. Distances between consecutive circuli were measured only in the freshwater zones and the first ocean zone. With other ocean zones, only the entire width of the zone was measured, the measurements for age-1.3 chinook salmon ended with the second ocean zone and age-1.4 ended with the third ocean zone. Measurements were automatically recorded in computer files for later statistical analysis. For some scales with different origins, differences could often be seen without visual aids (Figure 4).

Analytical Methods

In 1998, a program (SPAYK.EXE) was written by agency staff to combine the multiple steps required for the analysis into a single comprehensive program, taking advantage of new commercial software and the increased capacity and speed of modern desktop computers. Several processing tasks were automated, and improved analytical methods were implemented. The stock composition of all age classes, in all harvests, was estimated in a single execution of the program. Schneiderhan (1997) provides a summary of the analysis methods used historically in the stock identification program.

Analytical improvements in the new program primarily occurred in two areas, the first improvement involved the method of estimating the stock composition of major age classes. The linear discriminant model used previously was replaced with a maximum likelihood estimation mixture model (Bromaghin and Bruden 1998). The second improvement incorporated robust estimators of sample means and variance-covariance matrices, which reduced the influence of extreme observations on estimates (Campbell 1980). These changes substantially decreased the requisite data processing and increased the statistical quality of stock composition estimates, Bromaghin and Bruden (1999) detail the methods implemented in the new program.

Several assumptions were necessary, for example, scale measurement data from the escapement samples of each stock group were assumed to represent characteristics of the entire stock group. In addition, the data for each major age class and stock group 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 was conducted to investigate the estimation accuracy of the maximum likelihood estimator for fish of each major age class and stock group. For each stock group within each major age class, artificial mixture samples consisting of fish from that stock group were constructed by

selecting fish at random 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 the variance-covariance matrix.

Harvest of minor age classes, with associated digitized data were apportioned to stock group based on escapement age composition ratios (Schneiderhan 1997). Age composition data used in the analysis for Lower Run stocks were collected from the Andreafsky, Anvik and Gisasa Rivers. Middle run stock age data were collected from the Chena, Salcha and Chatanika Rivers. CDFO provided upper run stock age data, obtained from fish wheels located just up river from the U.S./Canada border. Age composition estimates from multiple projects within each run were weighted by abundance information, when available. Raw fish wheel age composition data from Canada was collected, however, there was no corresponding abundance information to pair with it. Therefore, those data were pooled into a single sample. The estimated age composition of the Upper run stocks observed in fish wheel catches was not used directly. Fish wheels preferentially harvest younger fish, so the age composition of fish wheel catches does not represent the true age of the population. In 1996, a comparative analysis of historical age information from fish wheels, commercial gillnets and spawning ground escapements in Canada was conducted (Jeff Bromaghin, ADF&G, Commercial Fisheries Division, Anchorage, personal communication). Selectivity coefficients from this analysis were used to estimate the age composition of the chinook salmon border passage from the observed fish wheel catch age composition to obtain a more accurate estimate of the border passage age composition.

RESULTS

Age Composition

All escapement sample size objectives were achieved in 1999 with the exception of the Chena and Salcha River projects, which fell just short of the 400-sampling goal. The combined adjusted Canada border passage escapement age composition estimate for Sheep and White Rock age-1.4 fish was 83.7% (Table 1), this does not characterize proportions of age-1.3 and -1.4 chinook salmon normally observed. Age-1.4 characteristically ranges between 60% and 65%. The weak return of 6-year-old salmon in the Andreafsky, Anvik and Gisasa in 1999 was not anticipated because escapements in 1993, the parent year for 6-year-old salmon, were judged average to above average in magnitude (Bergstrom et al. 1999). The age composition for the Yukon River chinook salmon commercial fishery is reported in Table 2.

Catch Composition

Scale Pattern Analysis

The scale measurement characters, or variables, that were selected in distinguishing the three stock groups for age-1.3 fish were 67, 14, 85, 93, 81, 10, 2, 62, 23, 107, and 111 (Table 3). Variables selected for age-1.4 fish were 67, 62, 66, 93, 87, 28, 12, 92, and 16 (Table 3). The number of variables selected for age-1.3 and age-1.4 chinook salmon reflects the difficulty in distinguishing between the stocks for those age groups. Variables involving freshwater and freshwater plus growth usually account for the majority of the discriminatory power in the models. For the 1999 data, age-1.3 fish had two of the best five variables related to freshwater growth while age-1.4 fish had three of the best five variables related to freshwater growth. The minimum, maximum, mean, and standard deviation for each variable used for both age groups were calculated (Table 4). The variables listed first, best separates the stocks and were placed into the model accordingly.

Estimation Accuracy Simulations

Estimation accuracies for age-1.3 salmon were 0.948 for Lower, 0.955 for Middle and 0.953 for the Upper river standard. Estimation accuracies for the age-1.4 group were 0.912 for Lower, 0.901 for Middle and 0.912 for the Upper river standard. The mean estimation accuracies were 0.952 for age-1.3 fish and 0.908 for age-1.4 fish. The greatest estimation bias (0.076) occurred between the age-1.4 Middle and Upper runs (Table 5). Although previous methodologies were different, estimation bias between these two stocks has been common in prior years. The estimation accuracy for age-1.3 had a small range of 0.948 to 0.955 between stocks and was greater than age-1.4 group. The Middle and Upper river standard showed the greatest estimation accuracy for age-1.3 (Table 5). Historically, the Lower and Upper river stocks have been the easiest to separate.

Canonical variable plots provide a visual indication of the separation between the stock groups, given the variables selected for each major age class. Canonical variables are uncorrelated linear combinations of the variables that 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 for each age group that was digitized 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 5). The mean of each stock was also calculated and plotted for each age group.

Maximum Likelihood Estimates For Major Age Classes

In 1999, there were five commercial fishing periods with unrestricted gillnet mesh size in District 1. Maximum likelihood stock composition estimates for District 1 harvests are presented in Table 6. Typically, the Upper run dominates harvests during early commercial fishing periods in District 1 and proportionate contribution gradually decreases thereafter. There were not enough samples to allocate age-1.3 chinook salmon caught in Period 4 using maximum likelihood estimates. However, for the other commercial openings in District 1 in 1999, the Lower run stocks comprised the largest portion for age-1.3 fish and Upper run stocks comprised the second largest portion of age-1.3 fish (Table 6). Significantly lacking, and absent in commercial periods 3 and 5, were Middle run stocks in the age-1.3 group (Table 7). The proportionate contribution of the age 1.4 group was similar to

the age-1.3 fish with Lower river stocks making up the largest portions in all the commercial openings. Upper run stocks made up the second largest portion in all the commercial openings with Middle run stocks significantly lacking in the age 1.4 group (Figures 6 and 7). Of the 37,161 chinook salmon caught in the District 1 commercial fishery, a combined 35,734 (96%) were age-1.3 and -1.4 fish. Of these, an estimated 23,296 fish (65%) were Lower run, 1,596 (4%) Middle run and 10,842 (30%) Upper run stocks (Table 8).

All commercial openings in District 2 were conducted with unrestricted gillnet mesh size. The lack of middle river stocks by age group in District 2 was similar to District 1 (Table 9). Besides Period 1, when Upper river stocks made up 60% of the age-1.3 chinook salmon, age-1.3 fish consisted mostly of Lower run stocks. For age-1.4 chinook salmon, Lower and Upper stock proportions were nearly equal for Period 2. Upper run stocks were predominant in Period 1 and Lower river stocks were dominant in Periods 3 and 4 (Table 10, Figures 8 and 9). In District 2, a total of 27,133 chinook were caught in the commercial fishery. A combined 25,883 (95%) were age-1.3 and -1.4 fish. Of these, the Lower run stocks contributed 13,674 fish (53%), Middle run 701 (3%) fish, and Upper run stocks contributed 11,508 fish (44%) (Table 11).

During the three commercial fishing periods in District 3, only 538 chinook salmon were harvested. All the commercial openings were conducted with unrestricted gillnet mesh size. No samples taken from District 3 and the commercial and subsistence harvests were indirectly classified based on scale growth analysis information from Districts 1 and 2. (Table 12 and 13).

The fish wheel and gillnet commercial fisheries in District 4 were sampled and the maximum likelihood stock composition estimates are presented in Table 14. An estimated total of 1,236 age-1.3 and –1.4 chinook salmon were directly classified in District 4. The subsistence harvest in District 4 was indirectly classified using information from the District 4 commercial fishery (Table 15).

Overall, an estimated total of 62,853 (46% of the drainage harvest) age-1.3 and -1.4 chinook salmon from Districts 1, 2 and 4 commercial catches were directly classified to stock group based on results of scale growth analysis. Additionally, 35,290 age-1.3 and -1.4 chinook salmon, or 26% of the total drainage harvest were indirectly classified based on scale growth analysis.

Differential Age Composition Analysis

The minor age classes (age-1.1, -1.2, -2.3, -1.5, -2.4 and -2.5 fish) from Districts 1 through 4 commercial, test fishing and subsistence catches contributed 4,093 fish (3%) to the total drainage harvest. These were classified to stock group 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

A commercial harvest of 2,604 chinook salmon and a subsistence harvest of 14,168 chinook salmon in District 5 were assigned to the Upper run, this component comprised 12% of the total harvest (Table 16).

Prior genetic stock identification information indicated that Upper Koyukuk River fish are more similar to Middle run stocks than to Lower or Upper run stocks (Wilmot et al. 1992). Therefore, the Upper Koyukuk River subsistence harvest of 314 chinook salmon was assigned to the Middle run and the harvest numbers are included with District 6 data in Table 17. The Chandalar and Black River subsistence harvests of 162 chinook salmon were also assigned to the Middle run. Although these harvests occurred in District 5, which are classified as Upper run, they occur in tributaries within Alaska and therefore are not assigned to the Upper run (Canadian origin). Chandalar and Black River harvest data are also included in Table 17. A commercial harvest of 689 fish and a subsistence harvest of 2,431 (including 314 salmon from Upper Koyukuk and 162 salmon from Chandalar and Black River) chinook salmon in District 6 were assigned entirely to the Middle Yukon Run based on the geographic location of the fisheries (Table 17). The Chena, Salcha and Chatanika Rivers support the largest sport fish harvest of chinook salmon in the Alaska portion of the Yukon River drainage. Therefore, all sport caught fish were assigned to Middle Yukon Run. The sport fish harvest of 1,023 chinook salmon is found on Table 17. All other sport harvests occurring in the Alaska portion of the Yukon River drainage are considered minor (Matt Evensen, ADF&G, Sport Fish Division, Fairbanks, personal communication). The total harvest of chinook salmon assigned to the Middle run based on geographical location was 4,143 fish or 3% of the total drainage harvest.

Total harvest from Canadian fisheries was 12,455 chinook salmon, or 9% of the drainage wide total. The entire Canadian harvest was assigned to the Upper run. Of these, 3,160 fish were harvested in the commercial fishery and 9,295 fish were harvested in non-commercial fisheries. The non-commercial harvest includes 8,804 Aboriginal, 213 domestic and 278 sport fishing caught chinook salmon (Table 18).

Total Harvest

The total 1999 Yukon River drainage harvest of chinook salmon, consisted of 136,770 fish. The Upper run was the largest estimated run component, contributing an estimated 73,363 fish, or 54% of the total drainage harvest. This percent is slightly below the 1981 - 1998 average of 56%. The Lower run was next in abundance with an estimated 54,788 fish (40%) and above the 1981 – 1998 average of 21%. The Middle run contributed an estimated 8,619 fish, or 6% of the total, well below the 1998 – 1998 average of 23% (Tables 19, 20, 21 and 22).

DISCUSSION

A complete data series, using maximum likelihood methodology (1982-1999), allows year-to-year comparisons. Simulation results have shown no systematic difference between the methods (Bromaghin and Bruden 1998). In general, proportional results of the total drainage harvest that were attributed to the Lower, Middle and Upper river run in 1999 are within the range of historical results.

Future data collection and analysis will be reported, following the same format of this report. Annual summaries of these analyses will be presented in updated historical summary tables in future annual reports. The historical data has now been reprocessed using the new methodology. Detailed tabular information for the 1981-1998 database can be found in the Regional Information Report, *Origins of Chinook Salmon in the Yukon River Fisheries, 1981-1996* (Lingnau 2000). This report is now the new reference for the historical database concerning stock identification of Yukon River chinook salmon using analysis of scale patterns.

Attainment of sample size objectives presented in the annual sampling plan has been considered a reasonable measure of operational success. In 1999, sample sizes were judged less than desired for age-1.3 chinook salmon, but adequate for age-1.4 fish. This was due to a weak return of age-1.3 fish in the 1999 run. Acceptable sample quality depends on environmental, biological, and sampling methodology factors. The quality of scales collected from escapements is an annual concern because escapement samples are obtained from carcasses or live fish with longer migrations then the mixed stock samples. When the expected rejection rate of ageable scales is exceeded, the reduced quantity of useable samples can become problematic in developing a stock group model. The rejection rate attributed to sampling technique is an essential factor in determining sample sizes. In order for size of the data set used in the analysis to remain acceptable, sampling techniques must be optimized to prevent unacceptably small sample sizes. The collection of good quality samples forms the foundation upon which this stock identification program rests.

LITERATURE CITED

Bergstrom, D.J. and ten co-authors. 1999. Annual management report, Yukon Area, 1998. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A99-26, Anchorage.

Bergstrom, D.J. and ten co-authors. 2000. Annual management report, Yukon Area, 1999. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A99-26, Anchorage.

Bromaghin, J.F. and Bruden, D.A. 1998. A simulation of classification and maximum likelihood estimators of the stock composition of Yukon River chinook salmon harvests. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A98-31, Anchorage.

Bromaghin, J.F. and Bruden, D.A. 1999. The estimation of stock composition in mixed stock fisheries using program SPAYK. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A99-01, Anchorage.

Campbell, N. A. 1980. Robust procedures in multivariate analysis. I. Robust covariance estimation. Applied Statistics 27: 251-258.

Clutter, R.I., and L.E. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission 9, Vancouver, British Columbia.

Efron, B. 1982. The Jackknife, the Bootstrap and Other Resampling Plans. Conference Series in Applied Mathematics, Report 38. Philadelphia: Society for Industrial and Applied Mathematics.

Johnson, D. E. 1998. Applied multivariate methods for data analysis. Brooks/Cole Publishing. Pacific Grove, California.

Johnson, N. L., and S. Kotz. 1972. Distributions in Statistics: Continuous Multivariate Distributions. John Wiley & Sons. New York.

JTC (Joint United States/Canada Yukon River Technical Committee). 1994. Yukon River salmon season review for 1994 and technical committee report (December 1994). Whitehorse, Yukon Territory.

Lingnau, T.L., and J.F. Bromaghin. 1999. Origins of chinook salmon in the Yukon River fisheries, 1997. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A99-09, Anchorage.

LITERATURE CITED (Continued)

Lingnau, T.L. 2000. Origins of chinook salmon in the Yukon River fisheries, 1981-1996. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A00-25, Anchorage.

McBride, D.N., and S.L. Marshall. 1983. Feasibility of scale pattern analysis to identify the origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Lower Yukon River commercial gillnet fishery, 1980-1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 208, Juneau.

Meyers, K.W., and five co-authors. 1984. Origins of chinook salmon in the area of the Japanese mothership and landbased driftnet salmon fisheries in 1975-1981. (Report to annual meeting of the International North Pacific Fisheries Commission, Vancouver, November 1984). University of Washington, Fisheries Research Institute, Seattle.

Meyers, K.W., and D.E. Rogers. 1985. Determination of stock origins of chinook salmon incidentally caught in foreign trawls in the Alaskan FCZ. Draft Report, University of Washington, Fisheries Research Institute, Contract No. 84-3 FRI-UW-8502, Seattle.

Rogers, D. E., and five co-authors. 1984. Origins of chinook salmon in the area of the Japanese mothership salmon fishery. University of Washington, Fisheries Research Institute, Final Report, July 1983-September 1984, Contract 84-0152, Seattle.

Schneiderhan, D.J. 1997. A history of scale pattern analysis as applied to stock identification of chinook and chum salmon in the Yukon River. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 3A97-33, Anchorage.

Seber, G. A. F. 1984. Multivariate Observations. John Wiley & Sons. New York.

Wilmot, Richard L. and 3 co-authors. 1992. Genetic stock identification of Yukon River chum and chinook salmon, 1987 to 1990 progress report. U.S. Fish and Wildlife Service, Alaska Fish and Wildlife Research Center, Anchorage.

Table 1. Yukon River chinook salmon escapement age composition by tributary with the weighted age composition for each geographic area, 1999.

	Age Group								
	1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
East Fork Andreafsky	0.003	0.345	0.322	0.325	0.000	0.006	0.000	0.000	1.00
Anvik	0.000	0.093	0.426	0.481	0.000	0.000	0.000	0.000	1.00
Gisasa	0.004	0.169	0.417	0.405	0.000	0.006	0.000	0.000	1.00
Lower River Weighted	0.002	0.192	0.391	0.412	0.000	0.003	0.000	0.000	1.00
Salcha	0.009	0.079	0.252	0.654	0.000	0.006	0.000	0.000	1.00
Chena	0.000	0.091	0.241	0.664	0.000	0.003	0.000	0.000	1.00
Middle River Weighted	0.004	0.086	0.245	0.660	0.000	0.005	0.000	0.000	1.00
Sheep Rock	0.000	0.036	0.304	0.657	0.000	0.003	0.000	0.000	1.00
White Rock	0.009	0.206	0.303	0.475	0.000	0.006	0.000	0.000	1.00
Upper River Combined (unadjusted)	0.005	0.120	0.304	0.567	0.000	0.005	0.000	0.000	1.00
Upper River Combined (adjusted) [a]	0.001	0.004	0.147	0.837	0.000	0.011	0.000	0.000	1.00

[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 escapement age composition.

Table 3. Final set of scale variables and their descriptions selected for Yukon River chinook salmon stock identification, 1999.

Age Group	Scale Variable	Description of the Scale Characteristics
1.3	67	Distance of the 1st freshwater zone divided by the total freshwater distance.
	14	Total distance of the 1st. freshwater zone minus the distance between the scale focus to the 2nd ciculi in the 1st freshwater zone.
	85	Distance from the 6th to the last circuli in the first ocean zone to the end of the 1st ocean zone.
	93	Distance between the beginning of the 1st ocean zone to the 12th circuli in the 1st ocean zone, divided by the total distance within in the 1st ocean zone.
	81	Distance between the 6th and 9th-circuli in the 1st ocean zone.
	10	Distance between the 4th and 6th ciculi, 1st freshwater annulus.
	2	Total distance of the 1st freshwater annulus.
	62	Total distance of the freshwater plus growth zone.
	23	Distance between the 4th and 6th circuli in the 1st feashwater zone, divided by the total width of the 1st freashwater zone.
	107	Maximum distance between 2 consecutive ciculi in 1st ocean zone.
	111	Total distance of the 1st, 2nd and 3rd ocean zone.
1.4	67	Distance of the 1st freshwater zone divided by the total freshwater distance.
	62	Total distance of the freshwater plus growth zone.
	66	Total distance of the 1st freashwater annulus and the freashwater plus zone.
	93	Distance between the beginning of the 1st ocean zone to the 12th circuli in the 1st ocean zone, divided by the total distance within in the 1st ocean zone.
	87	Total distance within the 1st ocean zone minus the distance from the beginning to the 3rd circuli in the 1st ocean zone.
	28	Number of circuli within the 1st 75% of the 1st freashwater zone.
	12	Distance from the 4th circulus preceding the end of the 1st freshwater zone to the end of the 1st freshwater zone.
	92	Distance between the end of the freshwater growth and the 9th circuli in the 1st ocean zone, divided by the width of the 1st ocean zone.
	16	Distance between the scale focus and the 2nd circuli divided by the total distance of the 1st freshwater zone.

Table 2. Yukon River chinook salmon commercial catch age composition by district, gear type and stratum, 1999.

			Age Group								
District	Date	Gear [a]	1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
1	22-Jun	UGN	0.000	0.008	0.103	0.876	0.003	0.008	0.003	0.000	1.000
	26-Jun	UGN	0.000	0.022	0.129	0.839	0.000	0.011	0.000	0.000	1.000
	30-Jun	UGN	0.000	0.035	0.169	0.771	0.000	0.019	0.005	0.000	1.000
	3-Jul	RGN	0.000	0.030	0.225	0.717	0.000	0.016	0.011	0.000	1.000
	7-Jul	UGN	0.000	0.014	0.172	0.801	0.000	0.014	0.000	0.003	1.000
Big Eddy	Season	8.5" SGN	0.000	0.004	0.098	0.871	0.000	0.027	0.000	0.000	1.000
Middle Mouth	Season	8.5" SGN	0.000	0.012	0.085	0.875	0.000	0.028	0.000	0.000	1.000
2	25-Jun	UGN	0.000	0.019	0.105	0.858	0.000	0.019	0.000	0.000	1.000
	28-Jun	UGN	0.000	0.030	0.139	0.806	0.000	0.025	0.000	0.000	1.000
	2-Jul	UGN	0.000	0.022	0.143	0.805	0.000	0.016	0.013	0.000	1.000
	5-Jul	UGN	0.000	0.022	0.182	0.779	0.006	0.006	0.006	0.000	1.000
3	2-Jul	UGN [b]	0.000	0.022	0.143	0.805	0.000	0.016	0.013	0.000	1.000
	6-Jul	UGN [c]	0.000	0.022	0.182	0.779	0.006	0.006	0.006	0.000	1.000
	9-Jul	UGN [c]	0.000	0.022	0.182	0.779	0.006	0.006	0.006	0.000	1.000
4	Season	SGN	0.000	0.000	0.176	0.811	0.000	0.013	0.000	0.000	1.000
	Season	FW	0.000	0.121	0.348	0.522	0.000	0.009	0.000	0.000	1.000
5	Season	All	0.000	0.086	0.351	0.543	0.000	0.020	0.000	0.000	1.000
6	Season	All	0.000	0.164	0.433	0.403	0.000	0.000	0.000	0.000	1.000
Dawson Test Fish	Season	GN	0.000	0.000	0.195	0.793	0.000	0.006	0.006	0.000	1.000

[a] UGN is untrestricted mesh size gillnet; RGN is restricted mesh size gillnet; SGN is set gillnet; GN is gillnet; FW is fishwheel.

[b] Age compostion based on samples taken during the 2-Jul period in District 2.

[c] Age compostion based on samples taken during the 5-Jul period in District 2.

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 identification, 1999.

Age Group	Variable	Minimum			Maximum			Mean			Standard Deviation		
		Lwr	Mid	Upr	Lwr	Mid	Upr	Lwr	Mid	Upr	Lwr	Mid	Upr
Age 1.3	67	0.64	0.53	0.42	0.88	0.76	0.77	0.75	0.63	0.63	0.44	0.05	0.07
	14	30	21	40	109	92	111	63	45	74.5	15	12	15.8
	85	81	81	77	175	148	156	122.9	108.2	108.8	19.7	15.35	14.8
	93	0.28	0.26	0.30	0.71	0.78	0.94	0.44	0.49	0.56	0.07	0.12	0.12
	81	38	32	39	109	89	86	55.13	50.46	60.4	10.7	9.93	9.59
	10	9	8	8	29	22	34	19.7	15.02	19	3.42	3.25	4.7
	2	75	54	80	149	138	154	109	87.3	119	15.5	14.9	16.9
	62	16	24	32	59	78	123	36	49.6	70.6	7.7	11.7	19.8
	23	0.1	0.1	0.08	0.3	0.3	0.24	0.2	0.2	0.16	0.0	0	0.03
	107	23	21	24	68	43	40	32.1	29	30	5.52	5.3	3.7
	111	685	553	648	1228	1232	1212	929.8	825.3	872.4	102.2	140.5	125.3
Age 1.4	67	0.59	0.45	0.48	0.83	0.75	0.78	0.73	0.61	0.63	0.4	0.58	0.06
	62	18	22	29	82	91	111	42.2	54	69	11.4	13	15
	66	90	89	122	229	222	245	160	141	188	23	25.3	22.6
	93	0.25	0.34	0.35	1	0.89	0.94	0.47	0.5	0.55	0.10	0.10	0.09
	87	189	217	211	735	513	517	416.2	358.6	372	71.7	67.49	59.3
	28	2	2	3	9	8	9	5.13	4.01	5.43	1.16	1.21	1.16
	12	21	21	23	57	52	53	38	32.5	34.4	6.5	6.1	6.17
	92	0.17	0.24	0.24	0.69	0.64	0.71	0.34	0.36	0.40	0.07	0.07	0.07
	16	0.23	0.30	0.20	0.57	0.65	0.53	0.38	0.48	0.38	0.06	0.07	0.05

Table 5. Average accuracy of maximum likelihood estimates of Yukon River chinook salmon stock composition observed over 500 simulations for each age and stock group, 1999.

Age Group	Stock Group	Sample Size	Stock Composition			
			Lower	Middle	Upper	Total
Age 1.3	Lower	158	0.948	0.041	0.012	1.000
	Middle	97	0.026	0.955	0.019	1.000
	Upper	93	0.021	0.026	0.953	1.000
					Average Percent Accuracy	0.952
			Lower	Middle	Upper	Total
Age 1.4	Lower	185	0.912	0.030	0.058	1.000
	Middle	183	0.023	0.901	0.076	1.000
	Upper	203	0.072	0.016	0.912	1.000
					Average Percent Accuracy	0.908

Table 6. Yukon River District 1 chinook salmon commercial catch estimated stock composition by period for ages-1.3 and -1.4 fish, 1999.

	Estimated stock composition for age-1.3				Estimated stock composition for age-1.4			
Strata	Sample Size	Stock Group	Estimate	Standard Error	Sample Size	Stock Group	Estimate	Standard Error
Period 1	24	Lower	0.500	0.145	180	Lower	0.604	0.062
22-Jun		Middle	0.203	0.096		Middle	0.052	0.022
Unrestricted		Upper	0.298	0.124		Upper	0.344	0.050
Mesh Size								
Period 2	26	Lower	0.645	0.173	205	Lower	0.635	0.059
26-Jun		Middle	0.031	0.736		Middle	0.023	0.021
Unrestricted		Upper	0.324	0.235		Upper	0.342	0.047
Mesh Size								
Period 3	38	Lower	0.508	0.121	178	Lower	0.696	0.066
30-Jun		Middle	0.000	0.318		Middle	0.068	0.029
Unrestricted		Upper	0.492	0.267		Upper	0.237	0.042
Mesh Size								
Period 4		Insufficient sample size to			165	Lower	0.710	0.068
3-Jul		support maximum likelihood				Middle	0.044	0.020
Unrestricted						Upper	0.246	0.043
Mesh Size								
Period 5	46	Lower	0.679	0.125	190	Lower	0.688	0.064
7-Jul		Middle	0.000	0.618		Middle	0.001	0.024
Unrestricted		Upper	0.322	29.898		Upper	0.311	0.045
Mesh Size								

Table 7. Yukon River District 1 chinook salmon commercial catch by age, stock group and period, 1999.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Period 1	Lower	0	65	577	5915	10	43	10	0	6,620
22-Jun	Middle	0	19	234	508	10	3	10	0	784
Unrestricted Mesh Size	**Alaska**	**0**	**84**	**811**	**6,423**	**20**	**46**	**20**	**0**	**7,404**
	Upper	0	2	344	3366	10	40	10	0	3,772
	Total	**0**	**86**	**1,155**	**9,789**	**30**	**86**	**30**	**0**	**11,176**
Period 2	Lower	0	198	815	5219	0	55	0	0	6,287
26-Jun	Middle	0	7	39	190	0	2	0	0	238
Unrestricted Mesh Size	**Alaska**	**0**	**205**	**854**	**5,409**	**0**	**57**	**0**	**0**	**6,525**
	Upper	0	6	410	2808	0	48	0	0	3,272
	Total	**0**	**211**	**1,264**	**8,217**	**0**	**105**	**0**	**0**	**9,797**
Period 3	Lower	0	253	648	4049	0	88	14	0	5,052
30-Jun	Middle	0	0	0	395	0	7	14	0	416
Unrestricted Mesh Size	**Alaska**	**0**	**253**	**648**	**4,444**	**0**	**95**	**28**	**0**	**5,468**
	Upper	0	14	627	1377	0	48	14	0	2,080
	Total	**0**	**267**	**1,275**	**5,821**	**0**	**143**	**42**	**0**	**7,548**
Period 4	Lower	0	186	1301	3203	0	64	23	0	4,777
3-Jul	Middle	0	3	31	197	0	3	23	0	257
Unrestricted Mesh Size	**Alaska**	**0**	**189**	**1,332**	**3,400**	**0**	**67**	**46**	**0**	**5,034**
	Upper	0	1	84	1111	0	36	23	0	1,255
	Total	**0**	**190**	**1,416**	**4,511**	**0**	**103**	**69**	**0**	**6,289**
Period 5	Lower	0	31	274	1295	0	19	0	0	1,619
7-Jul	Middle	0	0	0	2	0	0	0	0	2
Unrestricted Mesh Size	**Alaska**	**0**	**31**	**274**	**1,297**	**0**	**19**	**0**	**0**	**1,621**
	Upper	0	1	130	585	0	14	0	0	730
	Total	**0**	**32**	**404**	**1,882**	**0**	**33**	**0**	**0**	**2,351**

Table 8. Yukon River District 1 commercial, subsistence and test fish chinook salmon catch by age, stock group and fishery, 1999.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Unrestricted Mesh Size Season Total	Lower	0	733	3,615	19,681	10	269	47	0	24,355
	Middle	0	29	304	1,292	10	15	47	0	1,697
	Alaska	**0**	**762**	**3,919**	**20,973**	**20**	**284**	**94**	**0**	**26,052**
	Upper	0	24	1,595	9,247	10	186	47	0	11,109
	Total	**0**	**786**	**5,514**	**30,220**	**30**	**470**	**141**	**0**	**37,161**
Commercial Season Total	Lower	0	733	3,615	19,681	10	269	47	0	24,355
	Middle	0	29	304	1,292	10	15	47	0	1,697
	Alaska	**0**	**762**	**3,919**	**20,973**	**20**	**284**	**94**	**0**	**26,052**
	Upper	0	24	1,595	9,247	10	186	47	0	11,109
	Total	**0**	**786**	**5,514**	**30,220**	**30**	**470**	**141**	**0**	**37,161**
Test Fish Catch	Lower	0	6	48	553	0	14	0	0	621
	Middle	0	2	20	48	0	1	0	0	71
	Alaska	**0**	**8**	**68**	**601**	**0**	**15**	**0**	**0**	**692**
	Upper	0	0	29	315	0	13	0	0	357
	Total	**0**	**8**	**97**	**916**	**0**	**28**	**0**	**0**	**1,049**
Subsistence	Lower	0	40	350	3623	6	32	6	0	4,057
	Middle	0	12	142	311	6	2	6	0	479
	Alaska	**0**	**52**	**492**	**3,934**	**12**	**34**	**12**	**0**	**4,536**
	Upper	0	1	209	2062	5	30	5	0	2,312
	Total	**0**	**53**	**701**	**5,996**	**17**	**64**	**17**	**0**	**6,848**
Season Total	Lower	0	779	4,013	23,857	16	315	53	0	29,033
	Middle	0	43	466	1,651	16	18	53	0	2,247
	Alaska	**0**	**822**	**4,479**	**25,508**	**32**	**333**	**106**	**0**	**31,280**
	Upper	0	25	1,833	11,624	15	229	52	0	13,778
	Total	**0**	**847**	**6,312**	**37,132**	**47**	**562**	**158**	**0**	**45,058**

Table 9. Yukon River District 2 chinook salmon commercial catch estimated stock composition by period for ages-1.3 and -1.4 fish, 1999.

	Estimated stock composition for age-1.3				Estimated stock composition for age-1.4			
Strata	Sample Size	Stock Group	Estimate	Standard Error	Sample Size	Stock Group	Estimate	Standard Error
Period 1	25	Lower	0.303	0.116	204	Lower	0.412	0.050
25-Jun		Middle	0.092	0.088		Middle	0.011	0.022
Unrestricted		Upper	0.605	5.035		Upper	0.577	0.058
Mesh Size								
Period 2	33	Lower	0.550	0.132	191	Lower	0.509	0.055
28-Jun		Middle	0.065	0.121		Middle	0.013	0.020
Unrestricted		Upper	0.384	0.143		Upper	0.479	0.055
Mesh Size								
Period 3	34	Lower	0.681	0.148	168	Lower	0.526	0.061
2-Jul		Middle	0.000	10.163		Middle	0.058	0.037
Unrestricted		Upper	0.319	2.172		Upper	0.416	0.059
Mesh Size								
Period 4	36	Lower	0.595	0.132	153	Lower	0.799	0.076
5-Jul		Middle	0.032	0.314		Middle	0.013	0.016
Unrestricted		Upper	0.373	0.131		Upper	0.188	0.041
Mesh Size								

Table 10. Yukon River District 2 chinook salmon commercial catch by age, stock group and period, 1999.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Period 1	Lower	0	113	256	2850	0	46	0	0	3,265
25-Jun	Middle	0	24	78	76	0	1	0	0	179
Unrestricted Mesh Size	**Alaska**	**0**	**137**	**334**	**2,926**	**0**	**47**	**0**	**0**	**3,444**
	Upper	0	13	510	3985	0	104	0	0	4,612
	Total	**0**	**150**	**844**	**6,911**	**0**	**151**	**0**	**0**	**8,056**
Period 2	Lower	0	207	597	3189	0	75	0	0	4,068
28-Jun	Middle	0	18	71	78	0	2	0	0	169
Unrestricted Mesh Size	**Alaska**	**0**	**225**	**668**	**3,267**	**0**	**77**	**0**	**0**	**4,237**
	Upper	0	8	417	3005	0	114	0	0	3,544
	Total	**0**	**233**	**1,085**	**6,272**	**0**	**191**	**0**	**0**	**7,781**
Period 3	Lower	0	148	686	2977	0	48	32	0	3,891
2-Jul	Middle	0	0	0	330	0	5	31	0	366
Unrestricted Mesh Size	**Alaska**	**0**	**148**	**686**	**3,307**	0	**53**	**63**	**0**	**4,257**
	Upper	0	4	321	2353	0	61	31	0	2,770
	Total	**0**	**152**	**1,007**	**5,660**	0	**114**	**94**	**0**	**7,027**
Period 4	Lower	0	88	463	2656	8	17	8	0	3,240
5-Jul	Middle	0	3	25	43	8	0	8	0	87
Unrestricted Mesh Size	**Alaska**	**0**	**91**	**488**	**2,699**	**16**	**17**	**16**	**0**	**3,327**
	Upper	0	3	290	627	8	6	8	0	942
	Total	**0**	**94**	**778**	**3,326**	**24**	**23**	**24**	**0**	**4,269**

Table 11. Yukon River District 2 commercial, subsistence and test fish chinook salmon catch by age, stock group and fishery, 1999.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Unrestricted Mesh Size Season Total	Lower	0	556	2,002	11,672	8	186	40	0	14,464
	Middle	0	45	174	527	8	8	39	0	801
	Alaska	**0**	**601**	**2,176**	**12,199**	**16**	**194**	**79**	**0**	**15,265**
	Upper	0	28	1,538	9,970	8	285	39	0	11,868
	Total	**0**	**629**	**3,714**	**22,169**	**24**	**479**	**118**	**0**	**27,133**
Commercial Season Total	Lower	0	556	2,002	11,672	8	186	40	0	14,464
	Middle	0	45	174	527	8	8	39	0	801
	Alaska	**0**	**601**	**2,176**	**12,199**	**16**	**194**	**79**	**0**	**15,265**
	Upper	0	28	1,538	9,970	8	285	39	0	11,868
	Total	**0**	**629**	**3,714**	**22,169**	**24**	**479**	**118**	**0**	**27,133**
Test Fish Catch	Lower	0	1	7	82	0	2	0	0	92
	Middle	0	0	3	7	0	0	0	0	10
	Alaska	**0**	**1**	**10**	**89**	**0**	**2**	**0**	**0**	**102**
	Upper	0	0	5	47	0	2	0	0	54
	Total	**0**	**1**	**15**	**136**	**0**	**4**	**0**	**0**	**156**
Subsistence	Lower	0	136	349	3902	0	69	0	0	4,456
	Middle	0	30	112	142	0	2	0	0	286
	Alaska	**0**	**166**	**461**	**4,044**	**0**	**71**	**0**	**0**	**4,742**
	Upper	0	15	618	4930	0	134	0	0	5,697
	Total	**0**	**181**	**1,079**	**8,974**	**0**	**205**	**0**	**0**	**10,439**
Season Total	Lower	0	693	2,358	15,656	8	257	40	0	19,012
	Middle	0	75	289	676	8	10	39	0	1,097
	Alaska	**0**	**768**	**2,647**	**16,332**	**16**	**267**	**79**	**0**	**20,109**
	Upper	0	43	2,161	14,947	8	421	39	0	17,619
	Total	**0**	**811**	**4,808**	**31,279**	**24**	**688**	**118**	**0**	**37,728**

Table 12. Yukon River District 3 chinook salmon commercial catch by age, stock group and period, 1999.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Period 1 [a]	Lower	0	5	24	103	0	2	1	0	135
2-Jul	Middle	0	0	0	12	0	0	1	0	13
Unrestricted	**Alaska**	**0**	**5**	**24**	**115**	**0**	**2**	**2**	**0**	**148**
Mesh Size	Upper	0	0	11	81	0	2	1	0	95
	Total	**0**	**5**	**35**	**196**	**0**	**4**	**3**	**0**	**243**
Period 2 [b]	Lower	0	3	16	90	0	1	0	0	110
6-Jul	Middle	0	0	1	2	0	0	0	0	3
Unrestricted	**Alaska**	**0**	**3**	**17**	**92**	**0**	**1**	**0**	**0**	**113**
Mesh Size	Upper	0	0	10	22	0	0	0	0	32
	Total	**0**	**3**	**27**	**114**	**0**	**1**	**0**	**0**	**145**
Period 3 [b]	Lower	0	3	16	94	1	1	0	0	115
9-Jul	Middle	0	0	1	2	0	0	0	0	3
Unrestricted	**Alaska**	**0**	**3**	**17**	**96**	**0**	**1**	**0**	**0**	**118**
Mesh Size	Upper	0	0	10	22	0	0	0	0	32
	Total	**0**	**3**	**27**	**118**	0	**1**	**0**	**0**	**150**

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

Table 13. Yukon River District 3 chinook salmon commercial and subsistence catch by age and stock group, 1999.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Unrestricted Mesh Size Season Total	Lower	0	11	56	287	1	4	1	0	360
	Middle	0	0	2	16	0	0	1	0	19
	Alaska	**0**	**11**	**58**	**303**	**1**	**4**	**2**	**0**	**379**
	Upper	0	0	31	125	0	2	1	0	159
	Total	**0**	**11**	**89**	**428**	**1**	**6**	**3**	**0**	**538**
Commercial Season Total	Lower	0	11	56	287	1	4	1	0	360
	Middle	0	0	2	16	0	0	1	0	19
	Alaska	**0**	**11**	**58**	**303**	**1**	**4**	**2**	**0**	**379**
	Upper	0	0	31	125	0	2	1	0	159
	Total	**0**	**11**	**89**	**428**	**1**	**6**	**3**	**0**	**538**
Subsistence Season Total [a]	Lower	0	101	258	2883	0	51	0	0	3,293
	Middle	0	22	83	105	0	2	0	0	212
	Alaska	**0**	**123**	**341**	**2,988**	**0**	**53**	**0**	**0**	**3,505**
	Upper	0	11	457	3643	0	99	0	0	4,210
	Total	**0**	**134**	**798**	**6,631**	**0**	**152**	**0**	**0**	**7,715**
Season Total	Lower	0	112	314	3,170	1	55	1	0	3,653
	Middle	0	22	85	121	0	2	1	0	231
	Alaska	**0**	**134**	**399**	**3,291**	**1**	**57**	**2**	**0**	**3,884**
	Upper	0	11	488	3,768	0	101	1	0	4,369
	Total	**0**	**145**	**887**	**7,059**	**1**	**158**	**3**	**0**	**8,253**

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

Table 14. Yukon River District 4 chinook salmon commercial catch estimated stock composition for ages -1.3 and -1.4 fish, 1999.

	Estimated stock composition for age-1.3				Estimated stock composition for age-1.4			
Strata	Sample Size	Stock Group	Estimate	Standard Error	Sample Size	Stock Group	Estimate	Standard Error
Commercial Season Total	33	Lower	0.237	0.089	83	Lower	0.243	0.064
		Middle	0.150	0.074		Middle	0.043	0.043
		Upper	0.613	0.141		Upper	0.714	0.100

Table 15. Yukon River District 4 chinook salmon commercial and subsistence catch by age and stock group, 1999.

Strata	Stock Group [a]	Age Group [b] 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Commercial Gillnet Season Total	Lower	0	10	0	46	0	1	0	0	57
	Middle	0	6	0	8	0	0	0	0	14
	Alaska	**0**	**16**	**0**	**54**	**0**	**1**	**0**	**0**	**71**
	Upper	0	25	0	135	0	2	0	0	162
	Total	**0**	**41**	**0**	**189**	**0**	**3**	**0**	**0**	**233**
Commercial Fishwheel Season Total	Lower	0	91	99	152	0	2	0	0	344
	Middle	0	41	63	27	0	0	0	0	131
	Alaska	**0**	**132**	**162**	**179**	**0**	**2**	**0**	**0**	**475**
	Upper	0	14	257	449	0	9	0	0	729
	Total	**0**	**146**	**419**	**628**	**0**	**11**	**0**	**0**	**1,204**
Commercial Season Total	Lower	0	101	99	198	0	3	0	0	401
	Middle	0	47	63	35	0	0	0	0	145
	Alaska	**0**	**148**	**162**	**233**	**0**	**3**	**0**	**0**	**546**
	Upper	0	39	257	584	0	11	0	0	891
	Total	**0**	**187**	**419**	**817**	**0**	**14**	**0**	**0**	**1,437**
Subsistence Season Total	Lower	0	66	565	2,014	0	44	0	0	2,689
	Middle	0	66	339	351	0	0	0	0	756
	Alaska	**0**	**132**	**904**	**2,365**	**0**	**44**	**0**	**0**	**3,445**
	Upper	0	66	1,413	5,912	0	88	0	0	7,479
	Total	**0**	**198**	**2,317**	**8,277**	**0**	**132**	**0**	**0**	**10,924**
Season Total	Lower	0	167	664	2,212	0	47	0	0	3,090
	Middle	0	113	402	386	0	0	0	0	901
	Alaska	**0**	**280**	**1,066**	**2,598**	**0**	**47**	**0**	**0**	**3,991**
	Upper	0	105	1,670	6,496	0	99	0	0	8,370
	Total	**0**	**385**	**2,736**	**9,094**	**0**	**146**	**0**	**0**	**12,361**

[a] Run of origin estimates are based on data from scales sampled from fishwheel catches in District 4.
[b] Age composition estimates are based on data from test fisheries in the Lower Yukon River.

Table 16. Yukon River District 5 commercial and subsistence chinook salmon catch by age and fishery, 1999, with stock group 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	2.5	Total
Commercial Gillnet and Fishwheel Season Total	Upper	0	224	914	1,414	0	52	0	0	2,604
Commercial Season Total	Upper	0	224	914	1,414	0	52	0	0	2,604
Subsistence	Upper	0	1,219	4,973	7,693	0	283	0	0	14,168
Season Total	**Upper**	**0**	**1,443**	**5,887**	**9,107**	**0**	**335**	**0**	**0**	**16,772**

Table 17. Yukon River District 6 commercial, subsistence and sport fish chinook salmon catch by age and fishery, 1999, with stock group presumed to be Middle Run based on geographic location.

Strata	Stock Group	Age Group 1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
Commercial Season Total All Gear	Middle	0	113	298	278	0	0	0	0	689
Subsistence [a]	Middle	100	618	717	956	0	40	0	0	2,431
Sport Fish Catch	Middle	0	74	250	697	0	2	0	0	1,023
Commercial and Subsistence Season Total	Middle	100	731	1,015	1,234	0	40	0	0	3,120
Season Total	**Middle**	**100**	**805**	**1,265**	**1,931**	**0**	**42**	**0**	**0**	**4,143**

[a] Includes Upper Koyukuk River subsistence harvest because these salmon are more closely related to the Middle Run than the Upper or Lower Run. Chandalar and Black River harvests are included because those fish are bound for spawning grounds within the Alaska portion of the Yukon River.

Table 18. Yukon River Canadian chinook salmon catch by age and fishery, 1999, with stock group 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	2.5	Total
Commercial	Upper	0	0	616	2504	0	20	20	0	3,160
Aborginal	Upper	0	0	1716	6976	0	56	56	0	8,804
Test Fish	Upper	0	0	42	169	0	1	1	0	213
Sport Fish	Upper	0	1	41	233	0	3	0	0	278
Non-commercial Total	**Upper**	**0**	**1**	**1799**	**7378**	**0**	**60**	**57**	**0**	**9,295**
Season Total	**Upper**	**0**	**1**	**2,415**	**9,882**	**0**	**80**	**77**	**0**	**12,455**

Table 19. Yukon River chinook salmon catch by age, stock group and fishery, 1999.

			Age Group								
District	Fishery	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
1	Commercial [a]	Lower	0	739	3,663	20,234	10	283	47	0	24,976
		Middle	0	31	324	1,340	10	16	47	0	1,768
		Alaska	**0**	**770**	**3,987**	**21,574**	**20**	**299**	**94**	**0**	**26,744**
		Upper	0	24	1,624	9,562	10	199	47	0	11,466
		Total	**0**	**794**	**5,611**	**31,136**	**30**	**498**	**141**	**0**	**38,210**
	Subsistence	Lower	0	40	350	3,623	6	32	6	0	4,057
		Middle	0	12	142	311	6	2	6	0	479
		Alaska	**0**	**52**	**492**	**3,934**	**12**	**34**	**12**	**0**	**4,536**
		Upper	0	1	209	2,062	5	30	5	0	2,312
		Total	**0**	**53**	**701**	**5,996**	**17**	**64**	**17**	**0**	**6,848**
2	Commercial [b]	Lower	0	557	2,009	11,754	8	188	40	0	14,556
		Middle	0	45	177	534	8	8	39	0	811
		Alaska	**0**	**602**	**2,186**	**12,288**	**16**	**196**	**79**	**0**	**15,367**
		Upper	0	28	1,543	10,017	8	287	39	0	11,922
		Total	**0**	**630**	**3,729**	**22,305**	**24**	**483**	**118**	**0**	**27,289**
	Subsistence	Lower	0	136	349	3,902	0	69	0	0	4,456
		Middle	0	30	112	142	0	2	0	0	286
		Alaska	**0**	**166**	**461**	**4,044**	**0**	**71**	**0**	**0**	**4,742**
		Upper	0	15	618	4,930	0	134	0	0	5,697
		Total	**0**	**181**	**1,079**	**8,974**	**0**	**205**	**0**	**0**	**10,439**
3	Commercial	Lower	0	11	56	287	1	4	1	0	360
		Middle	0	0	2	16	0	0	1	0	19
		Alaska	**0**	**11**	**58**	**303**	**1**	**4**	**2**	**0**	**379**
		Upper	0	0	31	125	0	2	1	0	159
		Total	**0**	**11**	**89**	**428**	**1**	**6**	**3**	**0**	**538**
	Subsistence	Lower	0	101	258	2,883	0	51	0	0	3,293
		Middle	0	22	83	105	0	2	0	0	212
		Alaska	**0**	**123**	**341**	**2,988**	**0**	**53**	**0**	**0**	**3,505**
		Upper	0	11	457	3,643	0	99	0	0	4,210
		Total	**0**	**134**	**798**	**6,631**	**0**	**152**	**0**	**0**	**7,715**
4	Commercial	Lower	0	101	99	198	0	3	0	0	401
		Middle	0	47	63	35	0	0	0	0	145
		Alaska	**0**	**148**	**162**	**233**	**0**	**3**	**0**	**0**	**546**
		Upper	0	39	257	584	0	11	0	0	891
		Total	**0**	**187**	**419**	**817**	**0**	**14**	**0**	**0**	**1,437**
	Subsistence	Lower	0	66	565	2,014	0	44	0	0	2,689
		Middle	0	66	339	351	0	0	0	0	756
		Alaska	**0**	**132**	**904**	**2,365**	**0**	**44**	**0**	**0**	**3,445**
		Upper	0	66	1,413	5,912	0	88	0	0	7,479
		Total	**0**	**198**	**2,317**	**8,277**	**0**	**132**	**0**	**0**	**10,924**
5	Commercial	Upper	0	224	914	1,414	0	52	0	0	2,604
	Subsistence	Upper	0	1,219	4,973	7,693	0	283	0	0	14,168
6	Commercial	Middle	0	113	298	278	0	0	0	0	689
	Sport Fish	Middle	0	74	250	697	0	2	0	0	1,023
	Subsistence	Middle	100	618	717	956	0	40	0	0	2,431
Canada	Commercial	Upper	0	0	616	2,504	0	20	20	0	3,160
	Non commercial	Upper	0	1	1,799	7,378	0	60	57	0	9,295
		Total	**0**	**1**	**2,415**	**9,882**	**0**	**80**	**77**	**0**	**12,455**
Total Harvest		Lower	0	1,751	7,349	44,895	25	674	94	0	54,788
		Middle	100	1,058	2,507	4,765	24	72	93	0	8,619
		Alaska	**100**	**2,809**	**9,856**	**49,660**	**49**	**746**	**187**	**0**	**63,407**
		Upper	0	1,628	14,454	55,824	23	1,265	169	0	73,363
		Total	**100**	**4,437**	**24,310**	**105,484**	**72**	**2,011**	**356**	**0**	**136,770**

[a] District 1 includes 1,049 chinook salmon caught by test fishing projects.

[b] District 2 includes 156 chinook salmon caught by test fishing projects.

Table 20. Yukon River chinook salmon catch proportions by age, stock group and fishery, 1999.

			Age Group								
District	Fishery	Stock Group	1.1	1.2	1.3	1.4	2.3	1.5	2.4	2.5	Total
1	Commercial	Lower	0.000	0.019	0.096	0.530	0.000	0.007	0.001	0.000	0.654
		Middle	0.000	0.001	0.008	0.035	0.000	0.000	0.001	0.000	0.046
		Alaska	**0.000**	**0.020**	**0.104**	**0.565**	**0.001**	**0.008**	**0.002**	**0.000**	**0.700**
		Upper	0.000	0.001	0.043	0.250	0.000	0.005	0.001	0.000	0.300
		Total	**0.000**	**0.021**	**0.147**	**0.815**	**0.001**	**0.013**	**0.004**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.006	0.051	0.529	0.001	0.005	0.001	0.000	0.592
		Middle	0.000	0.002	0.021	0.045	0.001	0.000	0.001	0.000	0.070
		Alaska	**0.000**	**0.008**	**0.072**	**0.574**	**0.002**	**0.005**	**0.002**	**0.000**	**0.662**
		Upper	0.000	0.000	0.031	0.301	0.001	0.004	0.001	0.000	0.338
		Total	**0.000**	**0.008**	**0.102**	**0.876**	**0.002**	**0.009**	**0.002**	**0.000**	**1.000**
2	Commercial	Lower	0.000	0.020	0.074	0.431	0.000	0.007	0.001	0.000	0.533
		Middle	0.000	0.002	0.006	0.020	0.000	0.000	0.001	0.000	0.030
		Alaska	**0.000**	**0.022**	**0.080**	**0.450**	**0.001**	**0.007**	**0.003**	**0.000**	**0.563**
		Upper	0.000	0.001	0.057	0.367	0.000	0.011	0.001	0.000	0.437
		Total	**0.000**	**0.023**	**0.137**	**0.817**	**0.001**	**0.018**	**0.004**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.013	0.033	0.374	0.000	0.007	0.000	0.000	0.427
		Middle	0.000	0.003	0.011	0.014	0.000	0.000	0.000	0.000	0.027
		Alaska	**0.000**	**0.016**	**0.044**	**0.387**	**0.000**	**0.007**	**0.000**	**0.000**	**0.454**
		Upper	0.000	0.001	0.059	0.472	0.000	0.013	0.000	0.000	0.546
		Total	**0.000**	**0.017**	**0.103**	**0.860**	**0.000**	**0.020**	**0.000**	**0.000**	**1.000**
3	Commercial	Lower	0.000	0.020	0.104	0.533	0.002	0.007	0.002	0.000	0.669
		Middle	0.000	0.000	0.004	0.030	0.000	0.000	0.002	0.000	0.035
		Alaska	**0.000**	**0.020**	**0.108**	**0.563**	**0.002**	**0.007**	**0.004**	**0.000**	**0.704**
		Upper	0.000	0.000	0.058	0.232	0.000	0.004	0.002	0.000	0.296
		Total	**0.000**	**0.020**	**0.165**	**0.796**	**0.002**	**0.011**	**0.006**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.013	0.033	0.374	0.000	0.007	0.000	0.000	0.427
		Middle	0.000	0.003	0.011	0.014	0.000	0.000	0.000	0.000	0.027
		Alaska	**0.000**	**0.016**	**0.044**	**0.387**	**0.000**	**0.007**	**0.000**	**0.000**	**0.454**
		Upper	0.000	0.001	0.059	0.472	0.000	0.013	0.000	0.000	0.546
		Total	**0.000**	**0.017**	**0.103**	**0.859**	**0.000**	**0.020**	**0.000**	**0.000**	**1.000**
4	Commercial	Lower	0.000	0.070	0.069	0.138	0.000	0.002	0.000	0.000	0.279
		Middle	0.000	0.033	0.044	0.024	0.000	0.000	0.000	0.000	0.101
		Alaska	**0.000**	**0.103**	**0.113**	**0.162**	**0.000**	**0.002**	**0.000**	**0.000**	**0.380**
		Upper	0.000	0.027	0.179	0.406	0.000	0.008	0.000	0.000	0.620
		Total	**0.000**	**0.130**	**0.292**	**0.569**	**0.000**	**0.010**	**0.000**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.006	0.052	0.184	0.000	0.004	0.000	0.000	0.246
		Middle	0.000	0.006	0.031	0.032	0.000	0.000	0.000	0.000	0.069
		Alaska	**0.000**	**0.012**	**0.083**	**0.216**	**0.000**	**0.004**	**0.000**	**0.000**	**0.315**
		Upper	0.000	0.006	0.129	0.541	0.000	0.008	0.000	0.000	0.685
		Total	**0.000**	**0.018**	**0.212**	**0.758**	**0.000**	**0.012**	**0.000**	**0.000**	**1.000**
5	Commercial	Upper	0.000	0.086	0.351	0.543	0.000	0.020	0.000	0.000	1.000
	Subsistence	Upper	0.000	0.086	0.351	0.543	0.000	0.020	0.000	0.000	1.000
6	Commercial	Middle	0.000	0.164	0.433	0.403	0.000	0.000	0.000	0.000	1.000
	Sport Fish	Middle	0.000	0.072	0.244	0.681	0.000	0.002	0.000	0.000	1.000
	Subsistence	Middle	0.041	0.254	0.295	0.393	0.000	0.016	0.000	0.000	1.000
Canada	Commercial	Upper	0.000	0.000	0.195	0.792	0.000	0.006	0.006	0.000	1.000
	Non commercial	Upper	0.000	0.000	0.194	0.794	0.000	0.006	0.006	0.000	1.000
		Total	**0.000**	**0.000**	**0.194**	**0.793**	**0.000**	**0.006**	**0.006**	**0.000**	**1.000**
Total Harvest		Lower	0.000	0.013	0.054	0.328	0.000	0.005	0.001	0.000	0.401
		Middle	0.001	0.008	0.018	0.035	0.000	0.001	0.001	0.000	0.063
		Alaska	**0.001**	**0.021**	**0.072**	**0.363**	**0.000**	**0.005**	**0.001**	**0.000**	**0.464**
		Upper	0.000	0.012	0.106	0.408	0.000	0.009	0.001	0.000	0.536
		Total	**0.001**	**0.032**	**0.178**	**0.771**	**0.001**	**0.015**	**0.003**	**0.000**	**1.000**

Table 21. Yukon River chinook salmon historical harvest by stock group for the United States and Canada, 1981-1999.

Year	Lower	Middle	Upper			Total
			U.S.	Canada	Total	
1981	11,164	112,669	64,644	18,109	82,753	206,586
1982	23,601	41,967	87,241	17,208	104,449	170,017
1983	28,081	73,361	96,994	18,952	115,946	217,388
1984	45,210	71,656	44,735	16,795	61,530	178,396
1985	57,770	46,753	85,773	19,301	105,074	209,597
1986	32,517	15,894	97,593	20,364	117,957	166,368
1987	32,847	40,281	115,258	17,614	132,872	206,000
1988	36,967	26,805	84,649	21,427	106,076	169,848
1989	42,872	27,936	86,798	17,944	104,742	175,550
1990	34,007	42,430	72,996	19,227	92,223	168,660
1991	49,113	44,328	61,210	20,607	81,817	175,258
1992	30,330	40,600	97,261	17,903	115,164	186,094
1993	38,592	45,671	78,815	16,611	95,426	179,689
1994	35,161	41,488	95,666	21,218	116,884	193,533
1995	35,518	44,404	97,741	20,887	118,628	198,550
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
1998	34,759	18,509	46,947	5,937	52,884	106,152
1999	54,788	8,619	60,908	12,455	73,363	136,770
1981-1998 Average	36,234	43,510	83,080	18,125	101,205	180,949

Table 22. Yukon River chinook salmon historical harvest proportions by stock group for the United States and Canada, 1981-1999.

Year	Lower	Middle	Upper			Total
			U.S.	Canada	Total	
1981	0.054	0.545	0.313	0.088	0.401	1.000
1982	0.139	0.247	0.513	0.101	0.614	1.000
1983	0.129	0.337	0.446	0.087	0.533	1.000
1984	0.253	0.402	0.251	0.094	0.345	1.000
1985	0.276	0.223	0.409	0.092	0.501	1.000
1986	0.195	0.096	0.587	0.122	0.709	1.000
1987	0.159	0.196	0.560	0.086	0.645	1.000
1988	0.218	0.158	0.498	0.126	0.625	1.000
1989	0.244	0.159	0.494	0.102	0.597	1.000
1990	0.202	0.252	0.433	0.114	0.547	1.000
1991	0.280	0.253	0.349	0.118	0.467	1.000
1992	0.163	0.218	0.523	0.096	0.619	1.000
1993	0.215	0.254	0.439	0.092	0.531	1.000
1994	0.182	0.214	0.494	0.110	0.604	1.000
1995	0.179	0.224	0.492	0.105	0.597	1.000
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
1998	0.327	0.174	0.442	0.056	0.498	1.000
1999	0.401	0.063	0.445	0.091	0.536	1.000
1981-1998 Average	0.200	0.240	0.459	0.100	0.559	1.000

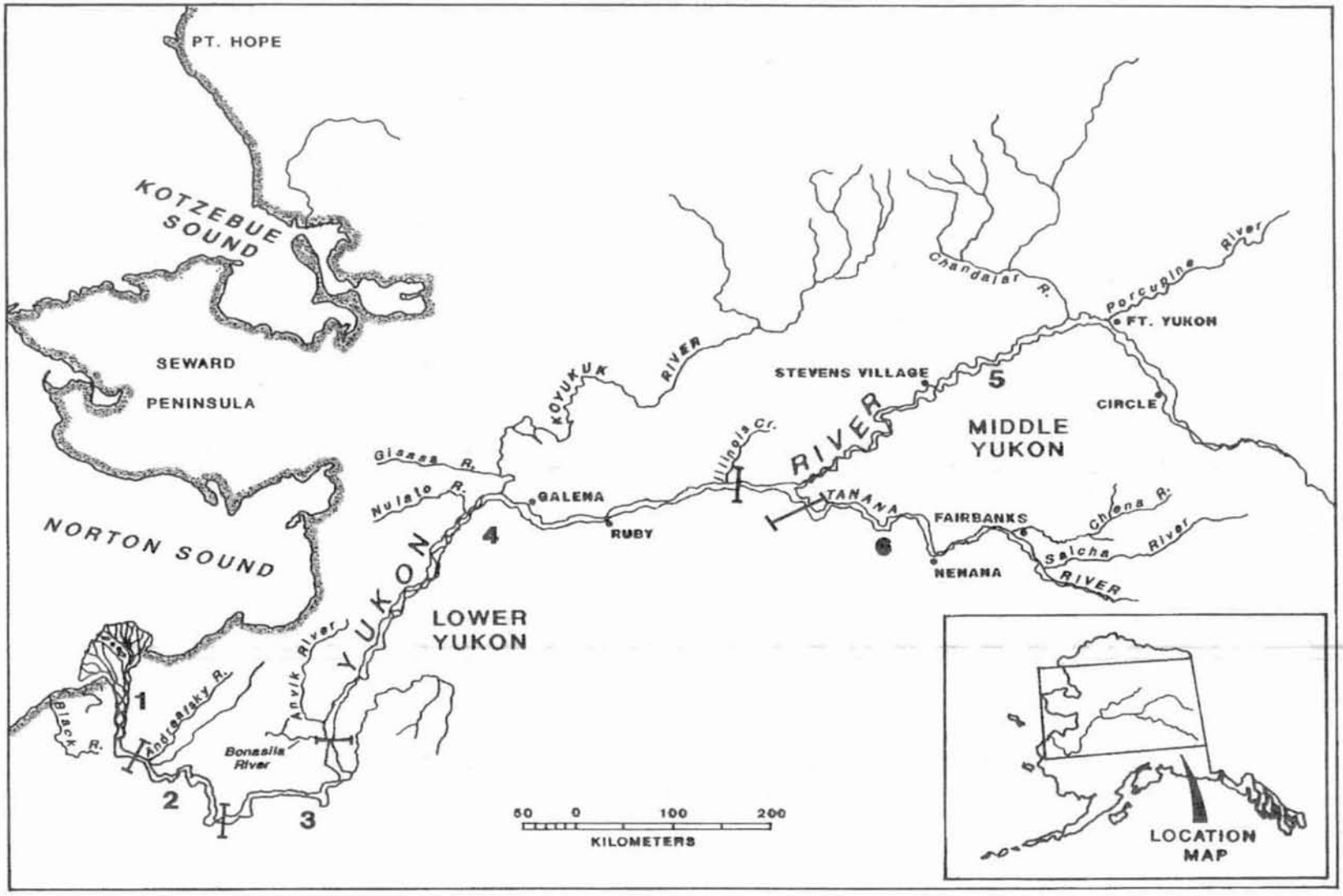


Figure 1. Alaska portion of the Yukon River drainage with district boundaries and major spawning tributaries.

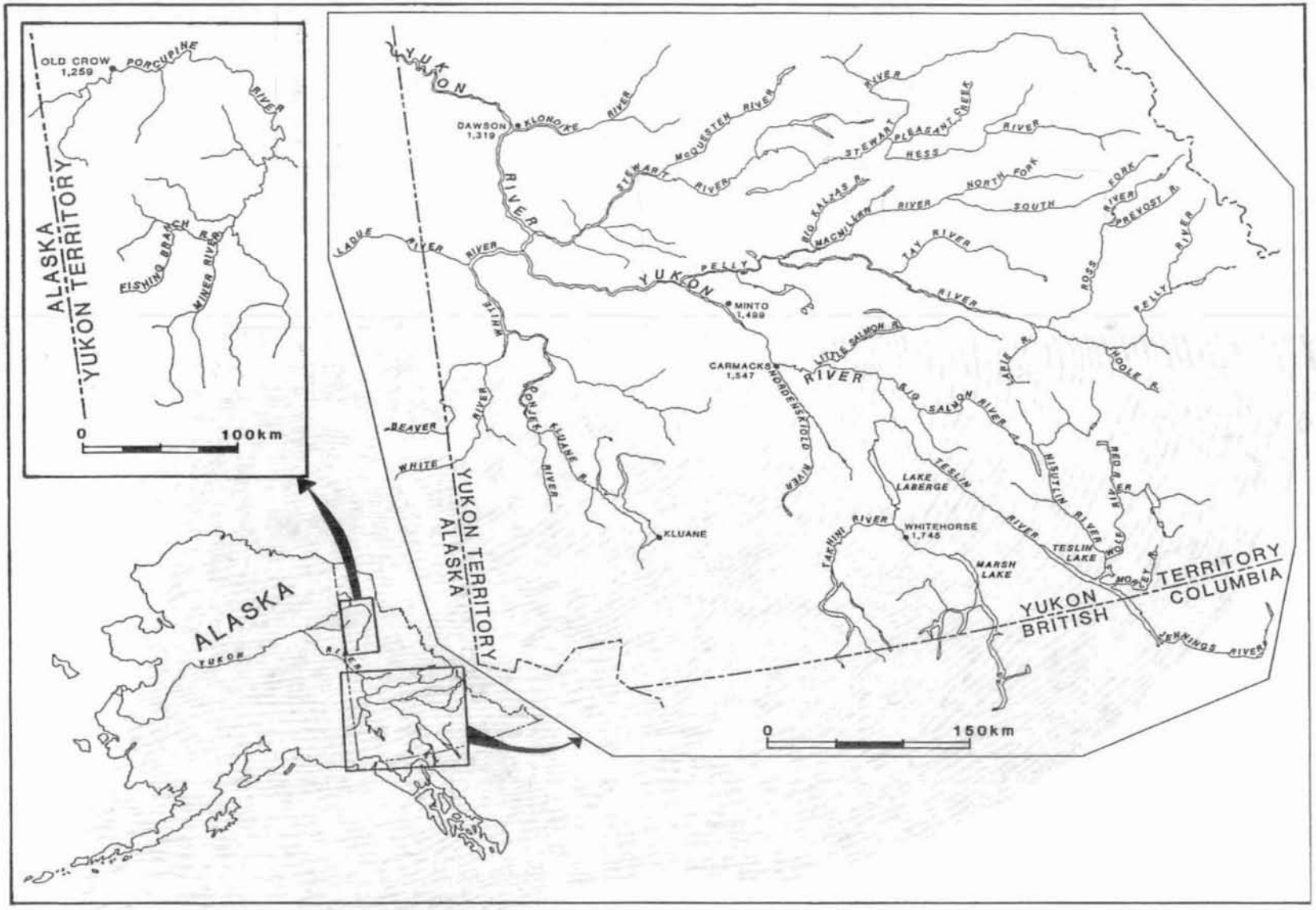


Figure 2. Canada portion of the Yukon River drainage and major spawning tributaries.

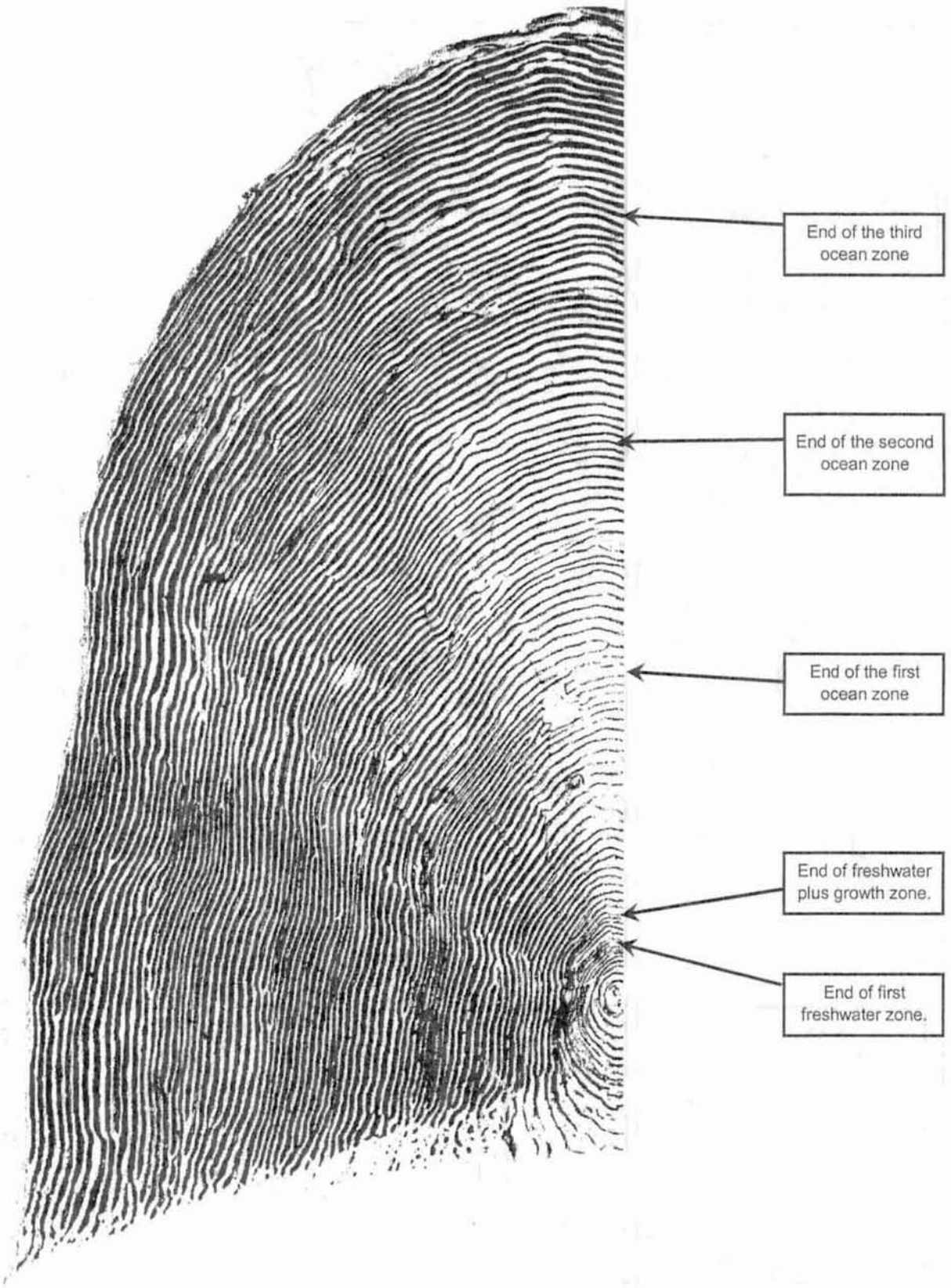
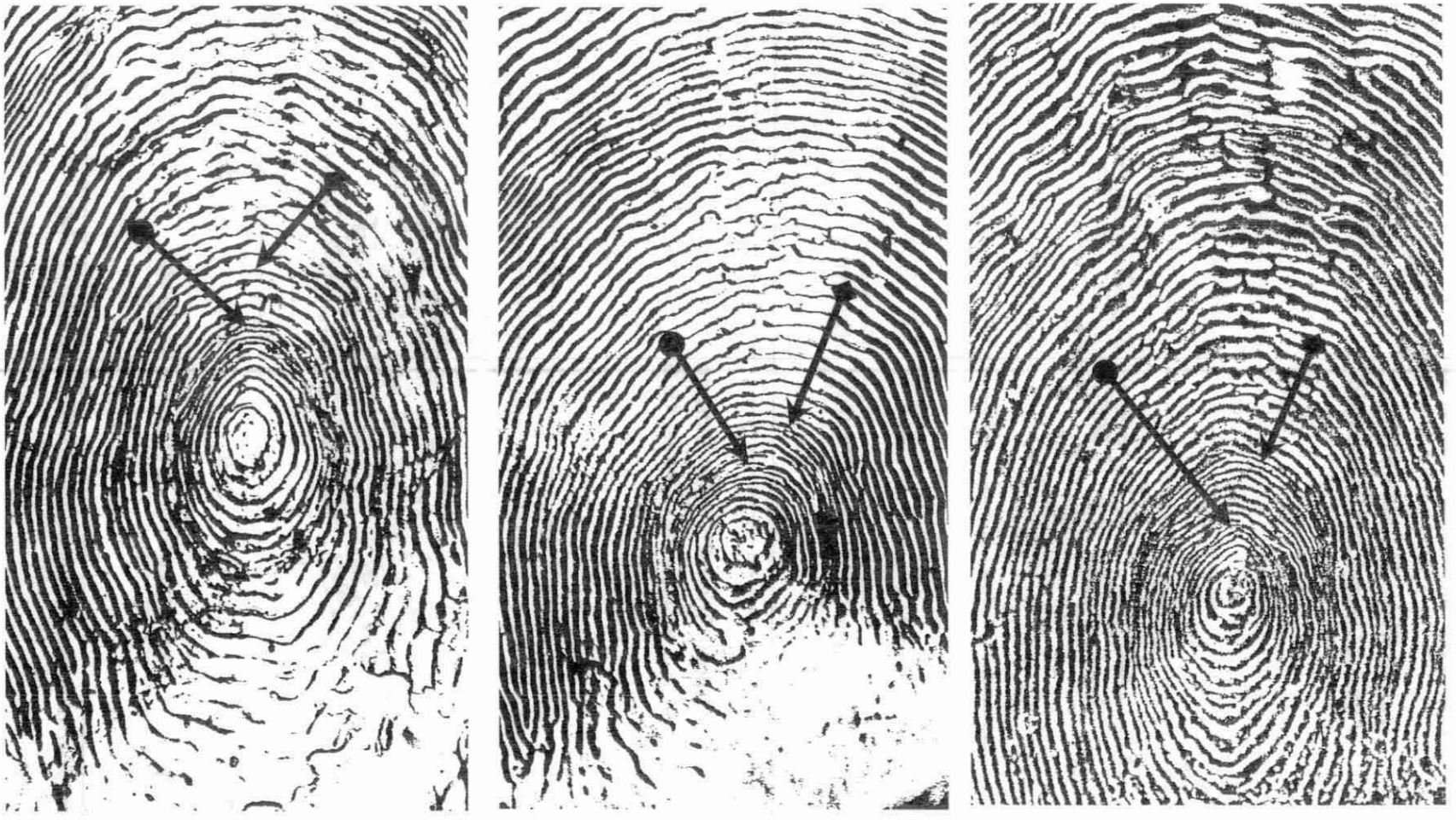
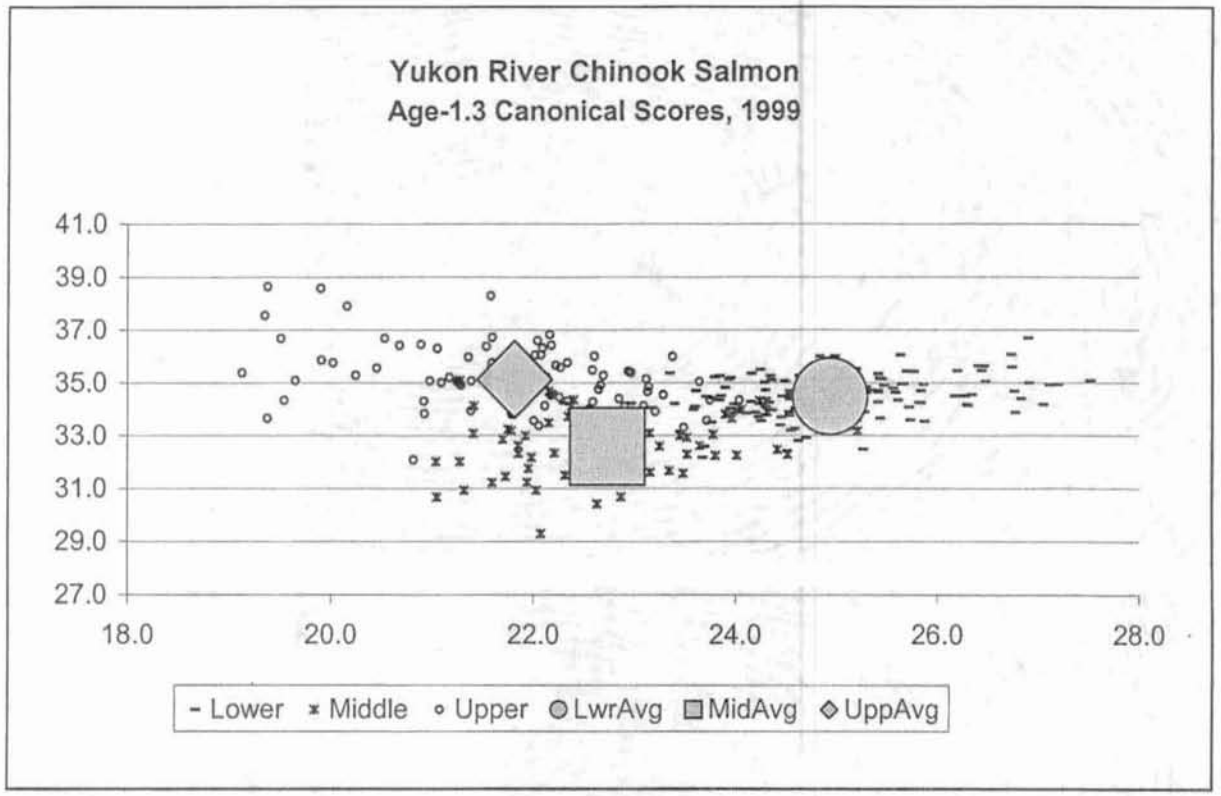


Figure 3. Scale of a chinook salmon illustrating the different zones that are measured for scale growth analysis.



Andreafsky River Escapement | Salcha River Escapement | Canadian Commercial Catch

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



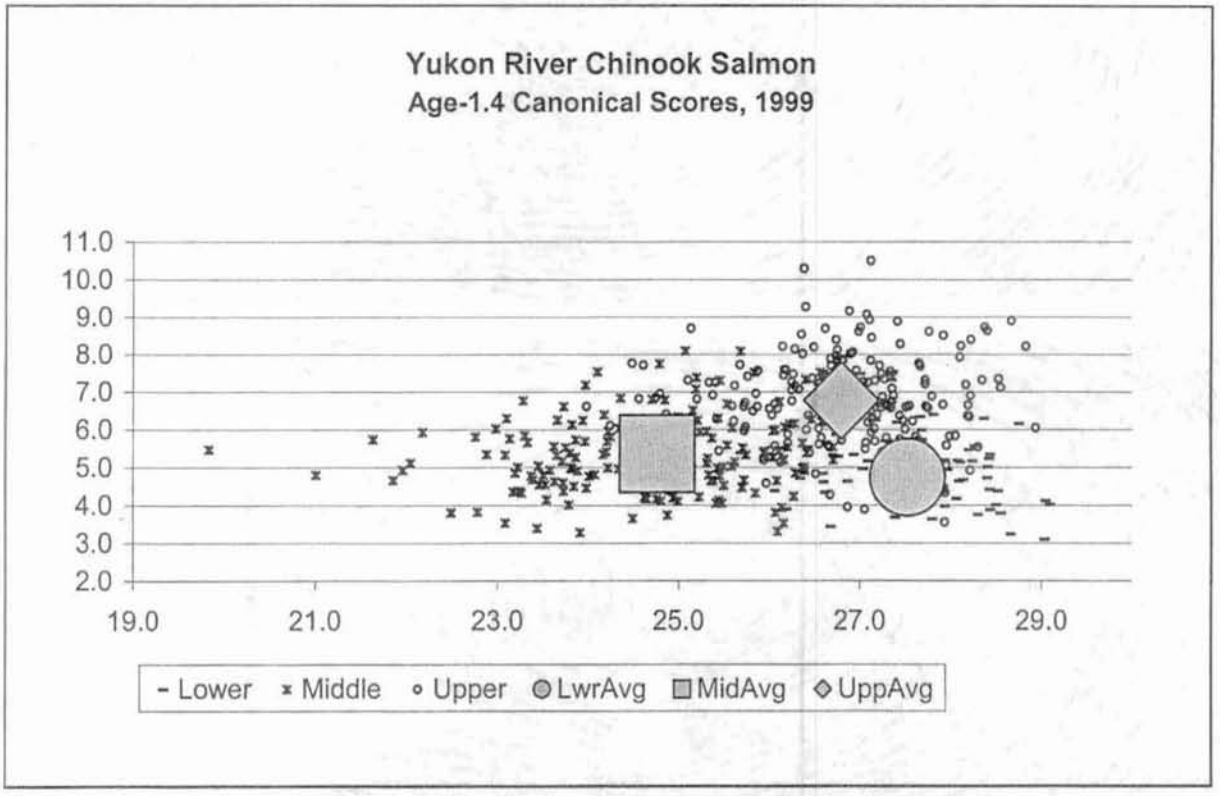
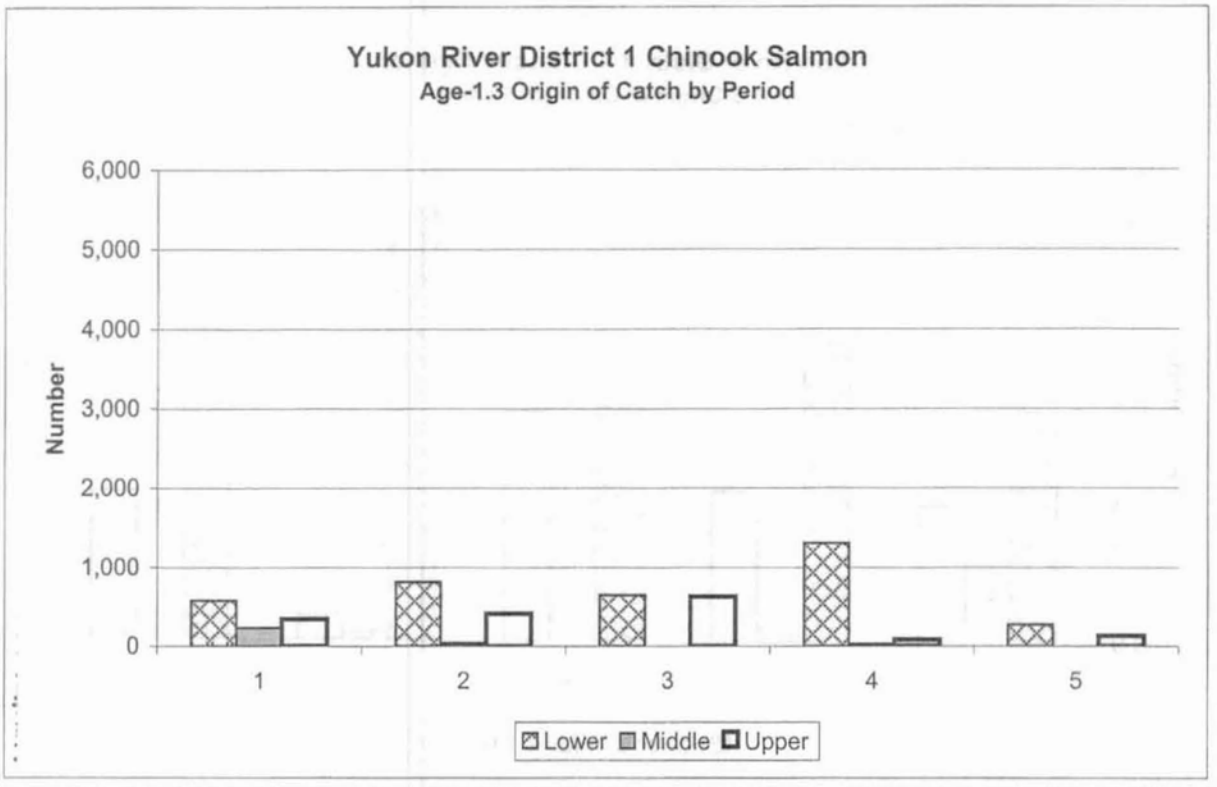


Figure 5. Canonical variable plots for Yukon River age-1.3 and -1.4 chinook salmon, 1999.



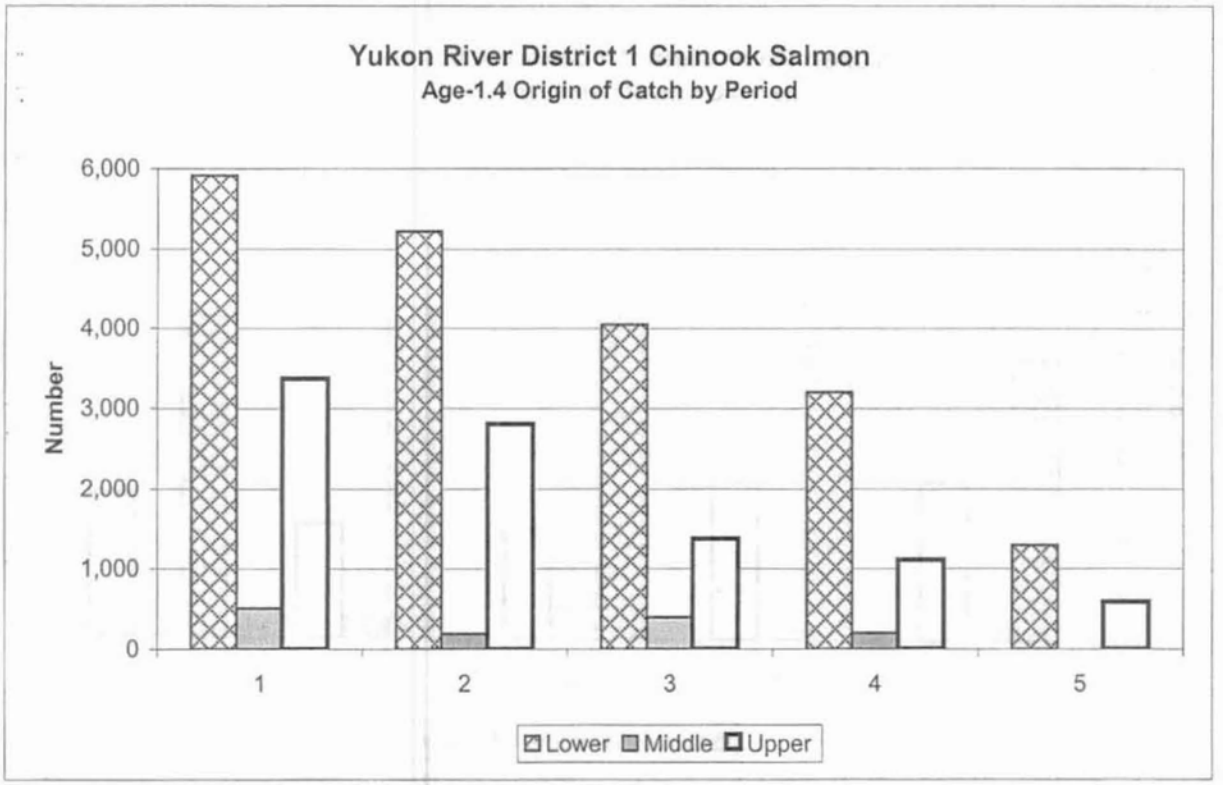
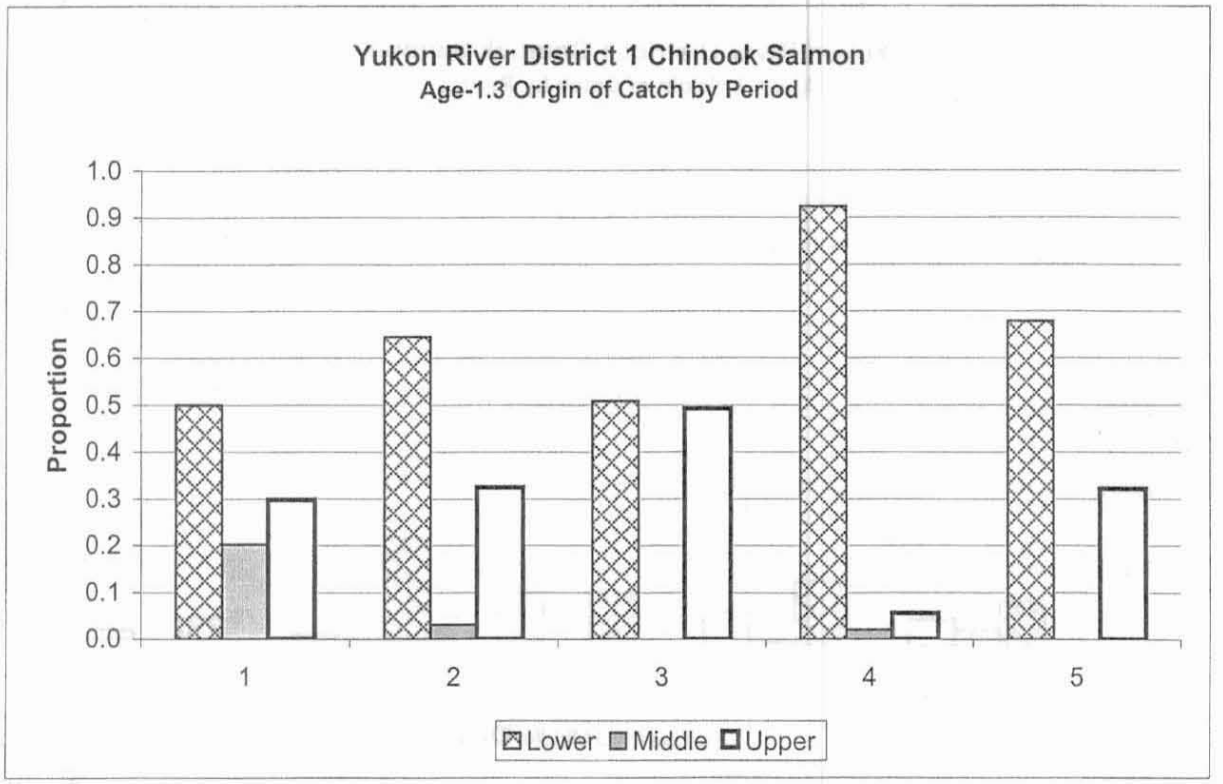


Figure 6. Estimated number of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 1, 1999.



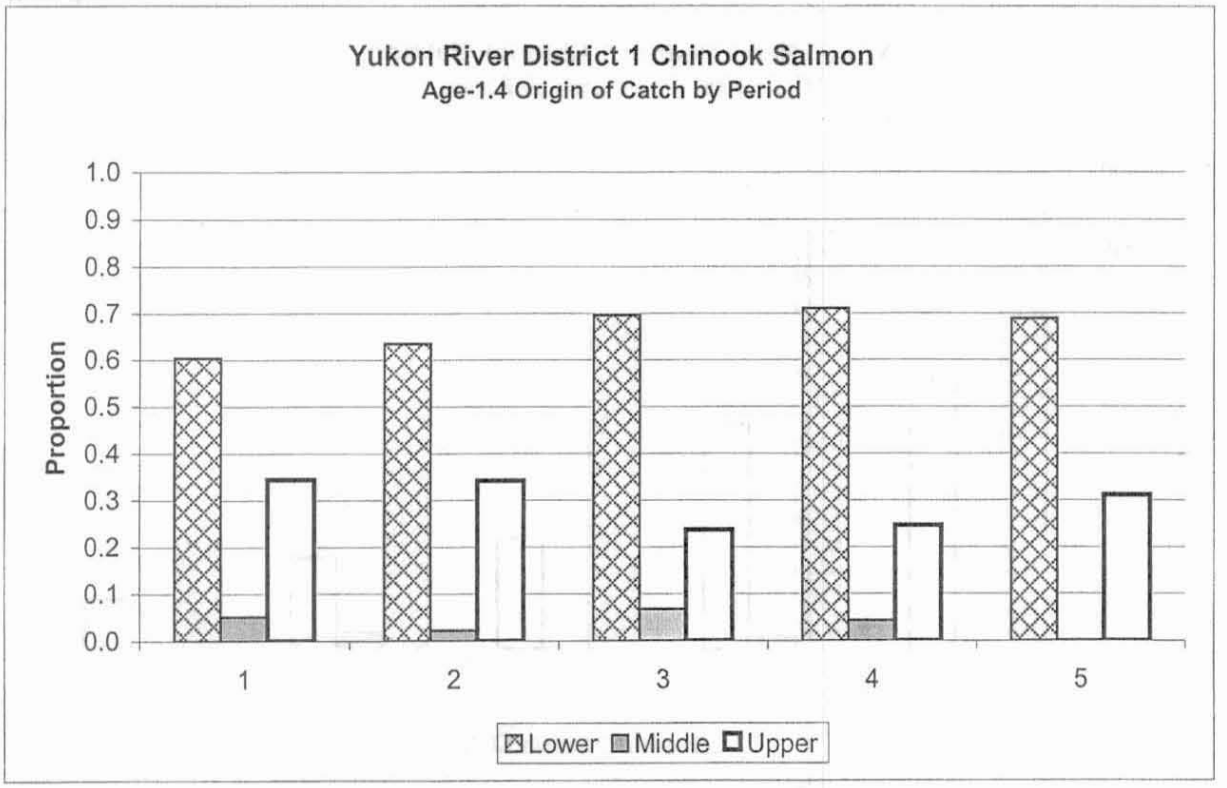


Figure 7. Estimated proportion of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 1, 1999.

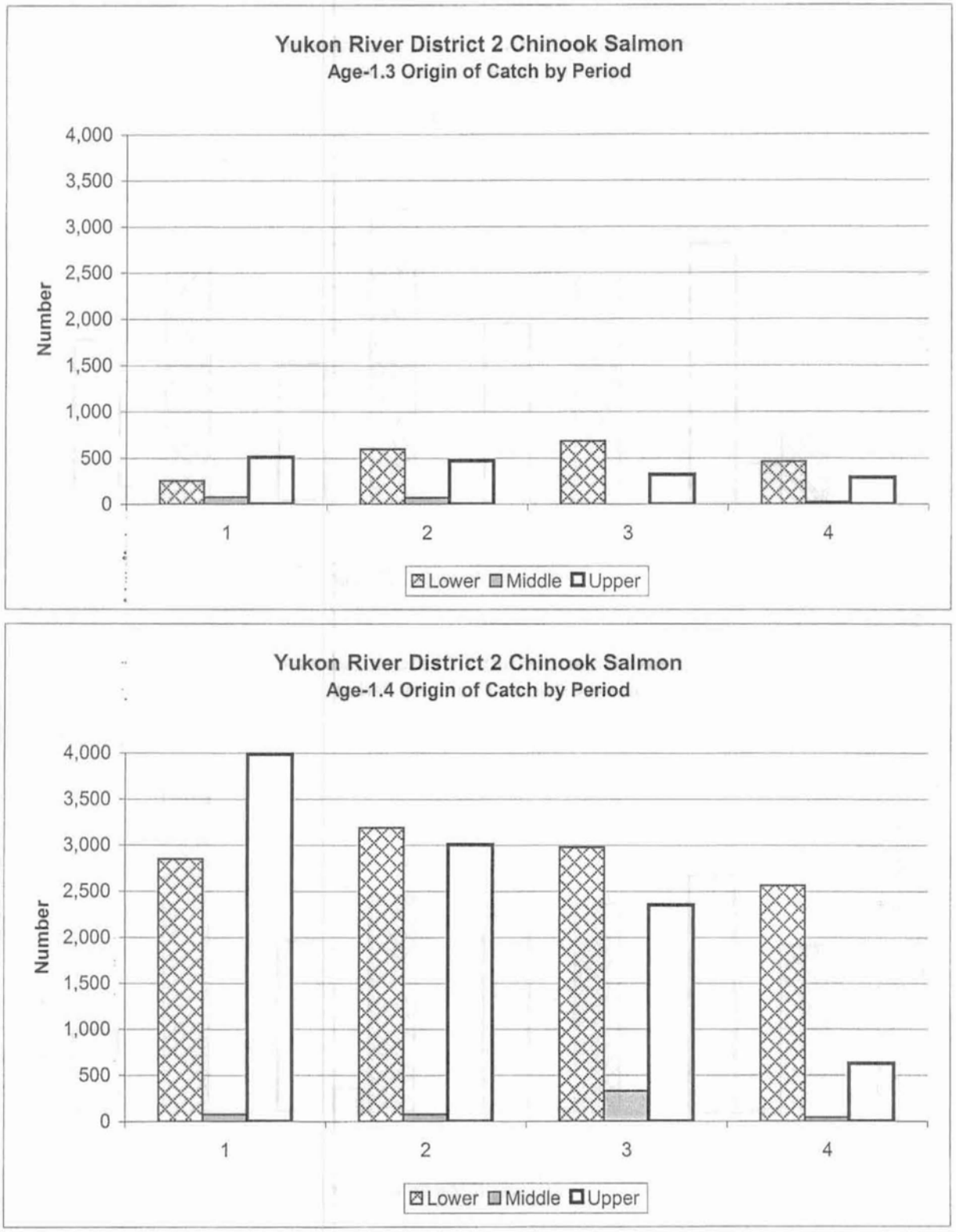
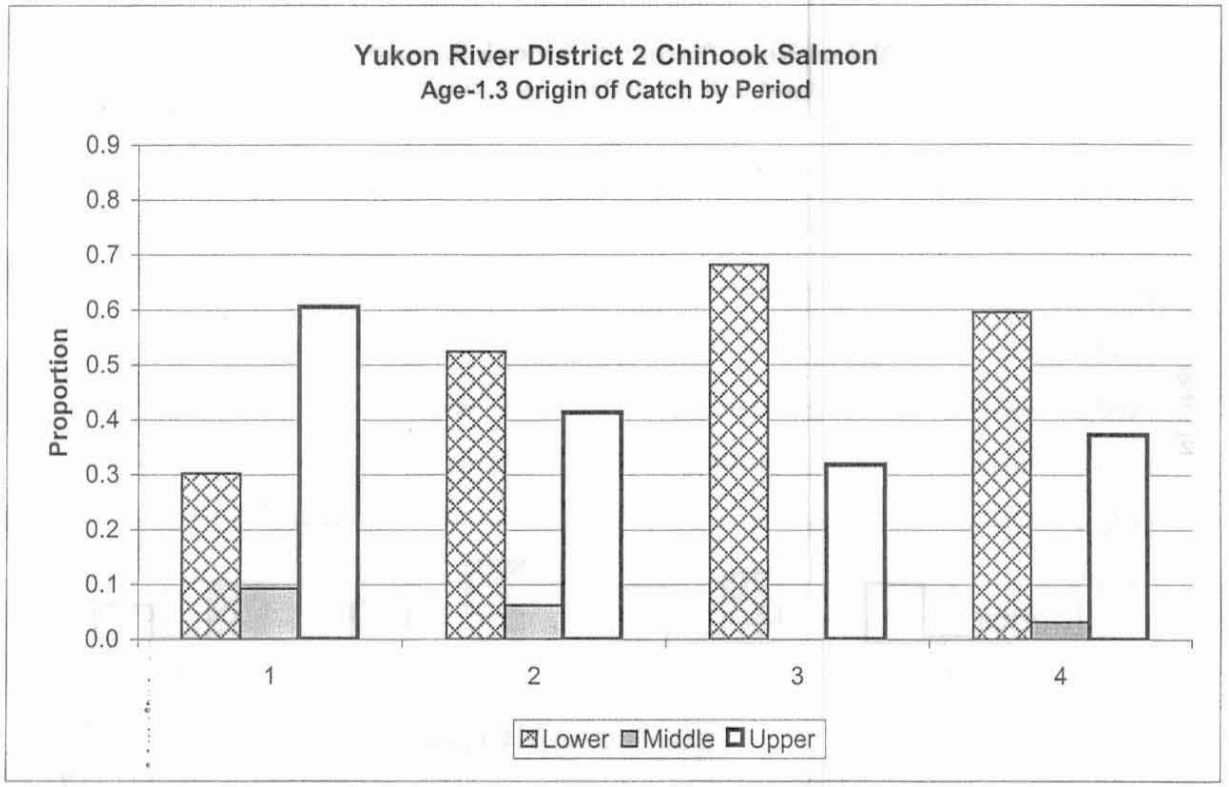


Figure 8. Estimated number of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 2, 1999.



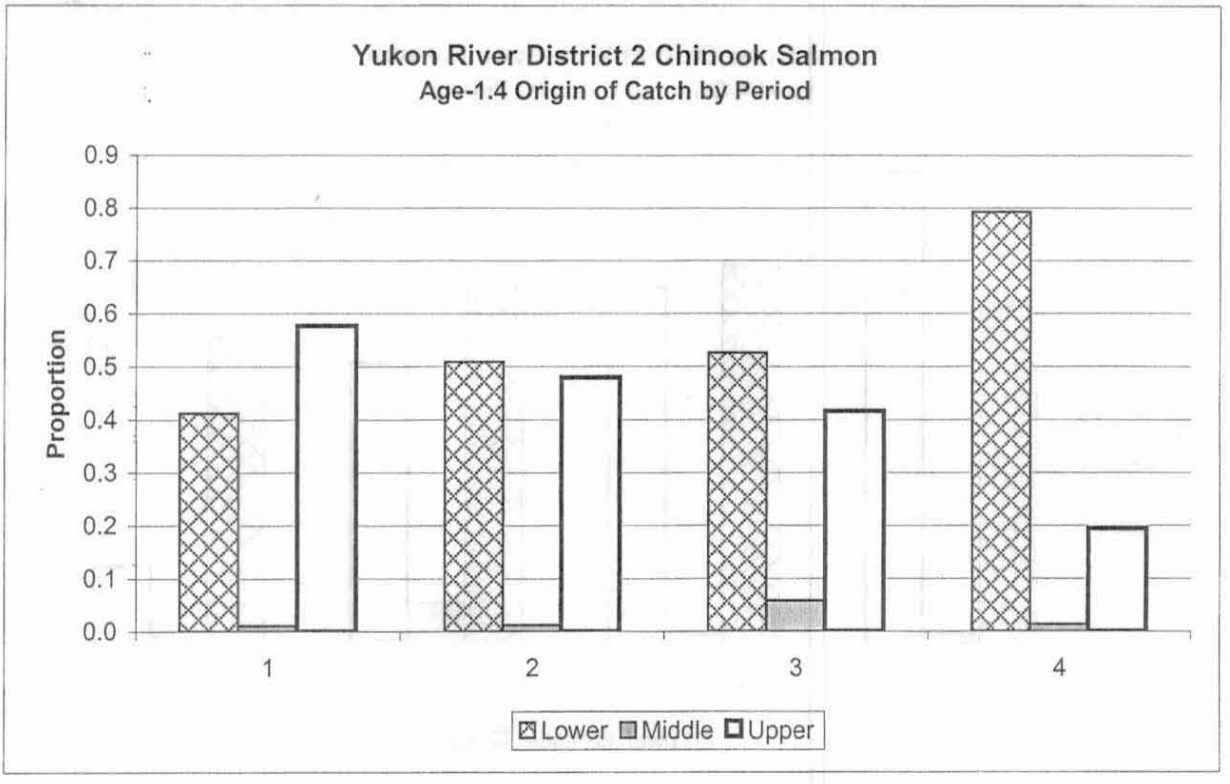


Figure 9. Estimated proportion of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 2, 1999.