ORIGINS OF CHINOOK SALMON

IN THE YUKON RIVER FISHERIES, 2000

By

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and

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ABSTRACT

Stock composition of all harvests of chinook salmon *Oncorhynchus tshawytscha,* within the Yukon River, drainage were estimated in 2000. 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 were apportioned to stock groups using estimated proportions of lower Yukon River commercial catch samples. District 3 subsistence samples were apportioned using a combination of District 1 and 2 maximum likelihood estimates, and age composition from the Russian Mission radio telemetry, tagging project. The District 4 subsistence harvest was apportioned to stock groups using samples collected from that fishery. Districts 5 and 6, and Canadian harvests, were assigned based on the geographic location of the harvests. The total estimated Yukon River harvest in 2000 was 50,187 chinook salmon, of those, 33.9% were estimated to be of Lower, 12.3% Middle and 53.8% Upper Yukon River stock group origin.

KEYWORDS: radio telemetry, chinook salmon, Yukon River, *Oncorhynchus tshawytscha,* stock composition, Russion Mission, tagging, subsistence harvests, Andreafsky Hill, Kaltag Mountains, Koyukuk River and Tanana River, sport fishing, commercial fishing

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 2000 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 1991-2000 is approximately, 60.7% commercial harvest, 37.1% subsistence harvest, 0.1 % personal use, 0.9% test fish and 1.2% sport fish harvest (Vania et al. 2002).

The Yukon River drains roughly 531,100 square kilometers and originates in northern British Columbia, and flows 3,700 kilometers to the Bering Sea (Vania et al. 2002). 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 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 2000, the chinook salmon total harvest in Alaska and Canada combined was 50,187 chinook salmon, of which 9,115 fish (18%) were harvested by District 1 and 2 commercial fishers (Vania et al. 2002). Historically in 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 2000, due to the low abundance of chinook salmon, 32% of the total harvest in Districts 1, 2 and 3 was caught commercially. In Districts 4, 5 and 6, 100% 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

ADF&G personnel collected scale samples during the period of peak spawning mortality from the Anvik, Chena, and Salcha Rivers in Alaska. These scale samples were collected from carcasses. 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 digitized for scale pattern analysis. Because of reduced commercial fishing in 2000, subsistence harvests occurred throughout the duration of the run. Therefore, it was assumed that subsistence fishing in District 1 could be described using lower Yukon River test fishing and commercial fishing samples. District 2 subsistence harvest was

described using age composition data collect at Marshal and stock composition data from Districts 1 and 2 commercial fishing samples.

No scale samples were collected during subsistence fishing periods in Districts 3 in 2000. The District 3 subsistence harvest was apportioned using stock composition data from Districts 1 and 2 commercial fishing samples and age composition data collected from the Russian Mission Tagging project.

Scale samples from District 4 were collected during subsistence fishing periods from gillnets fished in the Kaltag area. These scales were aged and digitized. 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 the age composition data and stock composition estimates from District 4 gillnet subsistence samples.

No scale samples were taken from Districts 5 or 6 during 2000 and Districts 5 and 6 age compositions were estimated using subsistence samples collected in District 4. Harvests in these districts were apportioned to geographic areas where the chinook salmon were harvested. Harvests in District 5 were apportioned to the Upper stock group and District 6 harvests were apportioned to the Middle stock group. Sport fish harvests in Alaska were apportioned to the Middle stock group with the age composition based on escapement samples. Tributaries in the middle river, specifically the Chena and Salcha Rivers, supports most of the sport fishing harvest. All harvests occurring in Canada were apportioned to the Upper stock group. Age composition of Canadian harvests was estimated 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 2000 and accounted for the largest segment of samples in 2000 (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 stock group, 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 the Lower stock group were collected from the Andreafsky, Anvik and Gisasa Rivers. Middle stock age data were collected from the Chena, Salcha and Chatanika Rivers. CDFO provided Upper 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 stock group were weighted by abundance information, when available. Raw fish wheel age composition data from Canada were collected, however, there was no corresponding abundance information to pair with them. Therefore, those data were pooled into a single sample. The estimated age composition of the Upper stock group 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

Only one escapement sample size objective was achieved in the Alaska portion of the drainage in 2000 (Gisasa, 646 samples). The Anvik, E.F. Andreafsky, Chena and Salcha Rivers all fell short of the 400 fish sampling goal. The combined fishwheel sample size from the Canadian tagging project at the border was 967 fish. The combined adjusted Canada border passage escapement age composition estimate for Sheep and White Rock age-1.4 fish was 63.3% (Table 1), within the proportions of age-1.3 and -1.4 chinook salmon normally observed. Weak returns of both the 5 and 6-year-old salmon in 2000 was not anticipated because escapements in 1995 and 1994, the parent years for 5 and 6-year-old salmon, were above average (JTC 2001). The age composition for the Yukon River chinook salmon commercial and test fisheries 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, 89, 65, 107, 103, 109, 18, and 20 (Table 3). Variables selected for age-1.4 fish were 68, 111, 65, 97, 108, 78, 105, 12, and 81 (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 most of the discriminatory power in the models. For the 2000 data, both age-1.3 and age-1.4 fish had two of the best five variables related to freshwater growth. The minimum, maximum, average, 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 0.960 for Lower, 0.911 for Middle and 0.905 for the Upper river standard. Estimation accuracies for the age-1.4 group were 0.959 for Lower, 0.975 for Middle and 0.987 for the Upper river standard. The mean estimation accuracies were 0.925 for age-1.3 fish and 0.973 for age-1.4 fish. The greatest estimation bias (0.069) occurred between the age-1.3 Middle and Upper stock groups (Table 5). Although previous methodologies were different, estimation bias between these two stocks has been common in prior years. The Middle and Upper river standards showed the greatest estimation accuracy for age-1.4 (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 stocks. 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 2000, there were two 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 stock dominates harvests during early commercial fishing periods in District 1 and proportionate contribution gradually decreases thereafter. However, in both District 1 commercial openings, Lower stocks of both age-1.3 and -1.4 fish were predominant in 2000 (Tables 6 and 7, Figures 6 and 7). Upper river stocks were second most dominant in both age groups. Of the 4,735 chinook salmon caught in the District 1 commercial fishery, a combined 4,335 (91.6%) were age-1.3 and -1.4 fish. Of these, an estimated 2,668 fish (61.6%) were Lower stock, 424 (9.8%) Middle stock and 1,243 (28.6%) Upper stock (Table 8).

The commercial opening in District 2 was conducted with unrestricted gillnet mesh size. Similar to District 1, the Lower stock group was predominant for both age-1.3 and -1.4 fish (Table 9 and 10, Figures 8 and 9). In District 2, a total of 3,783 chinook salmon were caught in the commercial fishery. A combined 3,416 (90.3%) were age-1.3 and -1.4 fish. Of these, the Lower stock group contributed 1,818 fish (53.2%), Middle stock, 560 fish (16.4%), and the Upper stock group contributed 1,038 fish (30.4%) (Table 10).

No samples were taken from District 3 and the subsistence harvest was indirectly classified based on scale growth analysis information from Districts 1 and 2. Age composition for District 3 was based on samples collected from the Russian Mission tagging project (Table 11).

Subsistence gillnet caught fish in District 4 were sampled and the maximum likelihood stock composition estimates are presented in Table 12. Of the 5,741 chinook salmon subsistence harvest, an estimated total of 4,920 age-1.3 and -1.4 chinook salmon (85.7%) were directly classified in District 4. Of these, the Lower stock group contributed 1,398 fish (28.4%), Middle stock 174 (3.5%) fish, and Upper stock group contributed 3,384 fish (68.1%) (Tables 12 and 13).

Of the 31,504 age-1.3 and -1.4 chinook salmon harvested in mixed stock fisheries in Districts 1 through 4, 13,205 (42.5%) were directly classified, and 17,894 (57.5%) were indirectly classified to stock group based on results of scale growth analysis. Of the total drainage harvest of 50,187 chinook salmon, 26.3% of these fish, which were harvested in mixed stock fisheries, were directly classified, and 35.6% 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 3,542 fish (7.1%) to the total drainage harvest. These were classified to stock group by applying escapement age composition ratios in each stock group 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 subsistence harvest of 8,751 chinook salmon in District 5 was assigned to the Upper stock group (Table 14), this component comprised 17.4% of the total harvest.

Prior genetic stock identification information indicated that Upper Koyukuk River fish are more similar to Middle stocks than to Lower or Upper stocks (Wilmot et al. 1992). Therefore, the Upper Koyukuk River subsistence harvest of 523 chinook salmon was assigned to the Middle stock group and the harvest numbers are included with District 6 data in Table 15. The Chandalar and Black River subsistence harvests of 103 chinook salmon were also assigned to the Middle stock group. Although these harvests occurred in District 5, which are classified as Upper stock group, they occur in tributaries within Alaska and therefore are not assigned to the Upper stock group (Canadian origin). Chandalar and Black River harvest data are also included in Table 14. A subsistence harvest of 1,684 (including 523 salmon from Upper Koyukuk and 103 salmon from Chandalar and Black River) chinook salmon in District 6 were assigned entirely to the Middle stock group based on the

geographic location of the fisheries (Table 15). 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 the Middle stock group. The sport fish harvest of 277 chinook salmon is recorded in Table 15. 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 stock group based on geographical location was 1,961 fish or 3.9% of the total drainage harvest.

Total harvest from Canadian fisheries was 4,879 chinook salmon, or 9.7% of the drainage wide total. The entire Canadian harvest was assigned to the Upper stock group. Of these, 4,118 fish were harvested in the Aboriginal fisheries and 761 fish were harvest from a test fishery to recover marked tags. (Table 16).

Total Harvest

The total 2000 Yukon River drainage harvest of chinook salmon, consisted of 50,187 fish. The Upper stock group was the largest estimated component, contributing an estimated 27,022 fish, or 53.8% of the total drainage harvest. This percent is slightly below the 1981 - 1999 average of 55.8%. The Lower stock group was next in abundance with an estimated 16,989 fish (33.9%), well above the 1981 – 1999 average of 20.8%. The Middle stock group contributed an estimated 6,176 fish, or 12.3% of the total, well below the 1998 – 1999 average of 23.3% (Tables 17, 18, 19 and 20).

DISCUSSION

A complete data series, using maximum likelihood methodology (1981-2000), 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 stock groups in 2000 are within the range of historical results.

Future data collection and analysis will be reported, following the same format as this report. Annual summaries of these analyses will be presented in updated historical summary tables in future annual reports. The historical data have 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 2000, sample sizes were judged less than desired for both age-1.3 and age-1.4 chinook salmon. This reduction was caused by a weak return of both age classes during the 2000 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 than 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. 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.

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Table 1. Yukon River chinook salmon escapement age composition by tributary with the weighted age composition for each geographic area, 2000.

	Age Group										
	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
East Fork Andreafsky	0.000	0.126	0.491	0.000	0.383	0.000	0.000	0.000	0.000	0.000	1.00
Anvik	0.000	0.049	0.419	0.000	0.527	0.000	0.005	0.000	0.000	0.000	1.00
Gisasa	0.000	0.070	0.514	0.000	0.395	0.000	0.022	0.000	0.000	0.000	1.00
Lower River Weighted	0.000	0.079	0.480	0.000	0.429	0.000	0.011	0.000	0.000	0.000	1.00
Salcha	0.000	0.205	0.384	0.000	0.332	0.000	0.079	0.000	0.000	0.000	1.00
Chena	0.003	0.302	0.390	0.000	0.283	0.000	0.022	0.000	0.000	0.000	1.00
Chatanika	0.000	0.171	0.571	0.000	0.257	0.000	0.000	0.000	0.000	0.000	1.00
Henshaw	0.000	0.189	0.622	0.000	0.189	0.000	0.000	0.000	0.000	0.000	1.00
Middle River Weighted	0.002	0.255	0.406	0.000	0.297	0.000	0.041	0.000	0.000	0.000	1.00
Sheep Rock	0.003	0.091	0.423	0.000	0.453	0.000	0.030	0.000	0.000	0.000	1.00
White Rock	0.004	0.152	0.499	0.000	0.314	0.000	0.030	0.000	0.000	0.000	1.00
Upper River Combined (unadjusted)	0.004	0.133	0.476	0.000	0.357	0.000	0.030	0.000	0.000	0.000	1.00
Upper River Combined (adjusted)[a]	0.001	0.006	0.278	0.000	0.633	0.000	0.084	0.000	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 2. Yukon River chinook salmon commercial catch, test fish and subsistence age composition by district, gear type and stratum, 2000.

			Age Group										
District	Date	Gear [a]	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
District 1 Commercial	24-Jun	UGN	0.000	0.012	0.266	0.000	0.654	0.000	0.062	0.006	0.000	0.000	1.000
	29-Jun	UGN	0.000	0.011	0.294	0.000	0.616	0.000	0.076	0.003	0.000	0.000	1.000
Big Eddy/ Middle Mouth Test Fish	Season	8.5" SGN	0.001	0.006	0.185	0.000	0.717	0.000	0.088	0.004	0.000	0.000	1.000
District 2 Commercial	27-Jun	UGN	0.000	0.005	0.299	0.000	0.604	0.000	0.084	0.008	0.000	0.000	1.000
Russian Mission Tagging Project	Season	8.5" DGN	0.000	0.011	0.332	0.000	0.568	0.000	0.086	0.004	0.000	0.000	1.000
District 4 Subsistence	Season	UGN	0.000	0.024	0.389	0.000	0.468	0.000	0.119	0.000	0.000	0.000	1.000
Dawson Test Fish	Season	GN	0.000	0.005	0.244	0.005	0.620	0.000	0.127	0.000	0.000	0.000	1.000

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

Table 3. Final set of scale variables and their descriptions selected for Yukon River chinook salmon stock identification, 2000.

Age Group	Scale Variable	Description of the Scale Characteristics
1.3	67	Distance of the 1st freshwater zone divided by the total freshwater distance.
	89	Total distance within the 1st ocean zone minus the distance from the beginning of the 1st ocean zone to circulus 15.
	65	Number of circuli in the 1st freshwater and the plus growth zone.
	107	Maximum distance between 2 consecutive ciculi in 1st ocean zone.
	103	The distance from the 6th cirulus preceding the end of the 1st ocean zone to the end of the 1st ocean zone divided by the width of the 1st ocean zone.
	109	Total distance within the 2nd ocean zone.
	18	The distance from the scale focus to the 6th cirulus divided by the width of the 1st freshwater zone.
	20	Distance between the 2nd and 4th circuli divided by the total width of the 1st freshwater zone.
1.4	68	The total distance of the freshwater plus growth zone divided by the total freshwater distance.
	111	Total distance of the 1st, 2nd and 3rd ocean zone.
	65	Number of circuli in the 1st freshwater and the plus growth zone.
	97	The distance from the circulus 3 to 12 of the 1st ocean zone divided by total distance of the 1st ocean zone.
	108	Maximum distance between 2 consecutive circuli in 1st ocean zone divided by the total distance within the 1st ocean zone.
	78	Distance between the 3rd and 9th circuli in the 1st ocean zone.
	105	The total distance of the 1st ocean zone divided by the number of circuli within the 1st ocean zone.
	12	Distance from the 4th circulus preceding the end of the 1st freshwater zone to the end of the 1st freshwater zone.
	81	Distance between the 6th and 9th circuli in the 1st ocean zone.

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, 2000.

Age Group	Variable	Minimum			Maximum			Mean			Standard Deviation		
		Lwr	Mid	Upr	Lwr	Mid	Upr	Lwr	Mid	Upr	Lwr	Mid	Upr
Age 1.3	67	0.52	0.51	0.52	0.86	0.80	0.77	0.74	0.63	0.66	0.06	0.06	0.06
	89	16.00	12.00	0.00	369.00	413.00	264.00	218.31	144.62	133.07	77.73	67.16	64.91
	65	10.00	12.00	10.00	21.00	19.00	19.00	13.08	13.88	14.79	1.81	1.46	1.84
	107	22.00	21.00	23.00	70.00	53.00	55.00	35.37	31.48	30.67	8.18	7.73	5.98
	103	0.15	0.16	0.20	0.45	0.41	0.45	0.27	0.28	0.29	0.06	0.06	0.06
	109	226.00	239.00	231.00	642.00	581.00	523.00	396.54	379.34	381.60	81.14	83.88	63.89
	18	0.58	0.63	0.62	1.00	1.00	0.92	0.78	0.82	0.78	0.08	0.09	0.08
	20	0.11	0.12	0.11	0.28	0.25	0.23	0.17	0.17	0.17	0.03	0.03	0.03
Age 1.4	68	0.14	0.17	0.22	0.46	0.53	0.59	0.27	0.38	0.39	0.06	0.07	0.06
	111	738.00	831.00	907.00	1499.00	1424.00	1398.00	1236.04	1121.71	1160.63	116.00	107.43	114.61
	65	9.00	10.00	10.00	16.00	17.00	22.00	12.26	13.32	15.72	1.58	1.73	2.14
	97	0.24	0.28	0.26	0.68	0.58	0.70	0.39	0.43	0.49	0.07	0.07	0.09
	108	0.05	0.06	0.06	0.12	0.16	0.16	0.07	0.08	0.08	0.01	0.02	0.02
	78	81.00	71.00	76.00	153.00	140.00	194.00	106.69	102.43	117.33	13.68	13.85	16.12
	105	15.80	17.78	15.15	24.50	23.31	24.50	19.59	18.46	19.27	1.66	1.52	1.77
	12	24.00	22.00	20.00	62.00	52.00	52.00	39.21	33.97	32.53	7.30	7.06	6.25
	81	34.00	29.00	43.00	87.00	85.00	93.00	55.78	52.71	61.69	9.59	9.54	10.01

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, 2000.

Age Group	Stock Group	Sample Size	Stock Composition			
			Lower	Middle	Upper	Total
Age 1.3	Lower	118	0.960	0.002	0.038	1.000
	Middle	58	0.032	0.911	0.058	1.000
	Upper	132	0.026	0.069	0.905	1.000
					Average Percent Accuracy	0.925
			Lower	Middle	Upper	Total
Age 1.4	Lower	116	0.959	0.040	0.001	1.000
	Middle	65	0.023	0.975	0.002	1.000
	Upper	112	0.012	0.001	0.987	1.000
					Average Percent Accuracy	0.973

Table 6. Yukon River District 1 chinook salmon commercial catch estimated stock composition by period for ages-1.3 and -1.4 fish, 2000.

	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	58	Lower	0.531	0.109	110	Lower	0.507	0.076
24-Jun		Middle	0.044	0.051		Middle	0.136	0.053
Unrestricted Mesh Size		Upper	0.426	0.103		Upper	0.357	0.068
Period 2	60	Lower	0.831	0.126	111	Lower	0.691	0.084
29-Jun		Middle	0.066	0.043		Middle	0.094	0.043
Unrestricted Mesh Size		Upper	0.103	0.064		Upper	0.215	0.057

Table 7. Yukon River District 1 chinook salmon commercial catch by age, stock group and period, 2000.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Period 1	Lower	0	21	361	0	849	0	26	5	0	0	1,262
24-Jun	Middle	0	7	30	0	227	0	38	5	0	0	307
Unrestricted	**Alaska**	**0**	**28**	**391**	**0**	**1,076**	**0**	**64**	**10**	**0**	**0**	**1,569**
Mesh Size	Upper	0	2	290	0	598	0	95	5	0	0	990
	Total	**0**	**30**	**681**	**0**	**1,674**	**0**	**159**	**15**	**0**	**0**	**2,559**
Period 2	Lower	0	18	531	0	927	0	49	2	0	0	1,527
29-Jun	Middle	0	6	42	0	125	0	36	2	0	0	211
Unrestricted	**Alaska**	**0**	**24**	**573**	**0**	**1,052**	**0**	**85**	**4**	**0**	**0**	**1,738**
Mesh Size	Upper	0	0	66	0	289	0	81	2	0	0	438
	Total	**0**	**24**	**639**	**0**	**1,341**	**0**	**166**	**6**	**0**	**0**	**2,176**

Table 8. Yukon River District 1 commercial, subsistence and test fish chinook salmon catch by age, stock group and fishery, 2000.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Unrestricted Mesh Size Season Total	Lower	0	39	892	0	1,776	0	75	7	0	0	2,789
	Middle	0	13	72	0	352	0	74	7	0	0	518
	Alaska	**0**	**52**	**964**	**0**	**2,128**	**0**	**149**	**14**	**0**	**0**	**3,307**
	Upper	0	2	356	0	887	0	176	7	0	0	1,428
	Total	**0**	**54**	**1,320**	**0**	**3,015**	**0**	**325**	**21**	**0**	**0**	**4,735**
Commercial Season Total	Lower	0	39	892	0	1,776	0	75	7	0	0	2,789
	Middle	0	13	72	0	352	0	74	7	0	0	518
	Alaska	**0**	**52**	**964**	**0**	**2,128**	**0**	**149**	**14**	**0**	**0**	**3,307**
	Upper	0	2	356	0	887	0	176	7	0	0	1,428
	Total	**0**	**54**	**1,320**	**0**	**3,015**	**0**	**325**	**21**	**0**	**0**	**4,735**
Test Fish Catch [a]	Lower	0	1	26	0	101	0	4	0	0	0	132
	Middle	0	1	2	0	27	0	6	0	0	0	36
	Alaska	**0**	**2**	**28**	**0**	**128**	**0**	**10**	**0**	**0**	**0**	**168**
	Upper	0	0	21	0	71	0	15	0	1	0	108
	Total	**0**	**2**	**49**	**0**	**199**	**0**	**25**	**0**	**1**	**0**	**276**
Subsistence [b]	Lower	0	46	804	0	1,975	0	62	10	0	0	2,897
	Middle	0	17	67	0	528	0	91	10	0	0	713
	Alaska	**0**	**63**	**871**	**0**	**2,503**	**0**	**153**	**20**	**0**	**0**	**3,610**
	Upper	0	4	647	0	1,391	0	229	10	0	0	2,281
	Total	**0**	**67**	**1,518**	**0**	**3,894**	**0**	**382**	**30**	**0**	**0**	**5,891**
Season Total	Lower	0	86	1,722	0	3,852	0	141	17	0	0	5,818
	Middle	0	31	141	0	907	0	171	17	0	0	1,267
	Alaska	**0**	**117**	**1,863**	**0**	**4,759**	**0**	**312**	**34**	**0**	**0**	**7,085**
	Upper	0	6	1,024	0	2,349	0	420	17	1	0	3,817
	Total	**0**	**123**	**2,887**	**0**	**7,108**	**0**	**732**	**51**	**1**	**0**	**10,902**

Table 9. Yukon River District 2 chinook salmon commercial catch estimated stock composition by period for ages-1.3 and -1.4 fish, 2000.

	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	77	Lower	0.632	0.099	106	Lower	0.483	0.077
27-Jun		Middle	0.038	0.033		Middle	0.226	0.063
Unrestricted Mesh Size		Upper	0.330	0.078		Upper	0.291	0.069

Table 10. Yukon River District 2 commercial, subsistence and test fish chinook salmon catch by age, stock group and fishery, 2000.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Period 1	Lower	0	15	715	0	1,103	0	47	10	0	0	1,890
27-Jun	Middle	0	3	43	0	517	0	121	10	0	0	694
Unrestricted	**Alaska**	**0**	**18**	**758**	**0**	**1,620**	**0**	**168**	**20**	**0**	**0**	**2,584**
Mesh Size	Upper	0	1	373	0	665	0	150	10	0	0	1,199
	Total	**0**	**19**	**1,131**	**0**	**2,285**	**0**	**318**	**30**	**0**	**0**	**3,783**
Commercial	Lower	0	15	715	0	1,103	0	47	10	0	0	1,890
Season Total	Middle	0	3	43	0	517	0	121	10	0	0	694
	Alaska	**0**	**18**	**758**	**0**	**1,620**	**0**	**168**	**20**	**0**	**0**	**2,584**
	Upper	0	1	373	0	665	0	150	10	0	0	1,199
	Total	**0**	**19**	**1,131**	**0**	**2,285**	**0**	**318**	**30**	**0**	**0**	**3,783**
Test Fish	Lower	0	5	56	0	91	0	4	1	0	0	157
Catch [a]	Middle	0	5	5	0	25	0	6	0	0	0	41
	Alaska	**0**	**10**	**61**	**0**	**116**	**0**	**10**	**1**	**0**	**0**	**198**
	Upper	0	0	45	0	64	0	15	0	0	0	124
	Total	**0**	**10**	**106**	**0**	**180**	**0**	**25**	**1**	**0**	**0**	**322**
Subsistence [b]	Lower	0	89	1,827	0	3,329	7	163	7	0	0	5,422
	Middle	0	26	131	0	1,005	7	260	7	0	0	1,436
	Alaska	**0**	**115**	**1,958**	**0**	**4,334**	**14**	**423**	**14**	**0**	**0**	**6,858**
	Upper	0	5	829	0	1,794	7	435	7	0	0	3,077
	Total	**0**	**120**	**2,787**	**0**	**6,128**	**21**	**858**	**21**	**0**	**0**	**9,935**
Season Total	Lower	0	109	2,598	0	4,523	7	214	18	0	0	7,469
	Middle	0	34	179	0	1,547	7	387	17	0	0	2,171
	Alaska	**0**	**143**	**2,777**	**0**	**6,070**	**14**	**601**	**35**	**0**	**0**	**9,640**
	Upper	0	6	1,247	0	2,523	7	600	17	0	0	4,400
	Total	**0**	**149**	**4,024**	**0**	**8,593**	**21**	**1,201**	**52**	**0**	**0**	**14,040**

[a] Apportions based on Maximum Likelihood Estimates from commercial catch samples, and test fish age composition.

[b] Apportions based on Maximum Likelihood Estimates from commercial catch samples.

Table 11. Yukon River District 3 chinook salmon subsistence catch by age and stock group, 2000.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Subsistence	Lower	0	31	852	0	1,207	0	64	5	0	0	2,159
Season Total [a]	Middle	0	9	61	0	364	0	102	5	0	0	541
	Alaska	**0**	**40**	**913**	**0**	**1,571**	**0**	**166**	**10**	**0**	**0**	**2,700**
	Upper	0	2	387	0	651	0	170	4	0	0	1,214
	Total	**0**	**42**	**1,300**	**0**	**2,222**	**0**	**336**	**14**	**0**	**0**	**3,914**

[a] Stock group estimate is based on data from the first commercial period in District 1 and 2. Age composition is based on Russian Mission Tagging project.

Table 12. Yukon River District 4 chinook salmon subsistence catch estimated stock composition by period for ages-1.3 and -1.4 fish, 2000.

	Estimated stock composition age-1.3				Estimated stock composition age-1.4			
Strata	Sample Size	Stock Group	Estimate	Standard Error	Sample Size	Stock Group	Estimate	Standard Error
Subsistence Harvest Unrestricted Mesh Size	35	Lower	0.303	0.117	35	Lower	0.269	0.109
		Middle	0.007	0.088		Middle	0.059	0.083
		Upper	0.690	0.167		Upper	0.672	0.161

Table 13. Yukon River District 4 chinook salmon subsistence catch by age and stock group, 2000.

Strata	Stock Group [a]	Age Group [b] 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Subsistence Season Total	Lower	0	100	675	0	723	0	45	0	0	0	1,543
	Middle	0	9	16	0	158	0	53	0	0	0	236
	Alaska	**0**	**109**	**691**	**0**	**881**	**0**	**98**	**0**	**0**	**0**	**1,779**
	Upper	0	28	1,541	0	1,807	0	586	0	0	0	3,962
	Total	**0**	**137**	**2,232**	**0**	**2,688**	**0**	**684**	**0**	**0**	**0**	**5,741**

[a] Stock group estimates are based on data from scales sampled from gillnet catches in District 4.

[b] Age composition estimates are based on data from gillnet samples in District 4.

Table 14. Yukon River District 5 subsistence chinook salmon catch by age and fishery, 2000, with stock group presumed to be Upper run based on geographic location.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Subsistence	Upper	0	62	3,404	0	3,991	0	1,294	0	0	0	8,751

Table 15. Yukon River District 6 subsistence and sport fish chinook salmon catch by age and fishery, 2000, with stock group presumed to be Middle run based on geographic location.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Subsistence [a]	Middle	0	64	114	0	1,128	0	378	0	0	0	1,684
Sport Fish Catch	Middle	1	71	112	0	82	0	11	0	0	0	277
Season Total	**Middle**	**1**	**135**	**226**	**0**	**1,210**	**0**	**389**	**0**	**0**	**0**	1,961

[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 16. Yukon River Canadian chinook salmon catch by age and fishery, 2000, with stock group presumed to be Upper run based on geographic location.

Strata	Stock Group	Age Group 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Aborginal[a]	Upper	0	22	1,007	16	2,554	0	519	0	0	0	4,118
Test Fish	Upper	0	4	186	3	472	0	96	0	0	0	761
Season Total	**Upper**	**0**	**26**	**1,193**	**19**	**3,026**	**0**	**615**	**0**	**0**	**0**	**4,879**

[a] Includes 50 chinook salmon from the Porcupine River Aboriginal harvest.

Table 17. Yukon River chinook salmon catch by age, stock group and fishery, 2000.

			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	40	918	1,877	0	79	7	0	2,921
		Middle	0	14	74	379	0	80	7	0	554
		Alaska	**0**	**54**	**992**	**2,256**	**0**	**159**	**14**	**0**	**3,475**
		Upper	0	2	377	958	0	191	7	0	1,535
		Total	**0**	**56**	**1,369**	**3,214**	**0**	**350**	**21**	**0**	**5,010**
	Subsistence	Lower	0	46	804	1,975	0	62	10	0	2,897
		Middle	0	17	67	528	0	91	10	0	713
		Alaska	**0**	**63**	**871**	**2,503**	**0**	**153**	**20**	**0**	**3,610**
		Upper	0	4	647	1,391	0	229	10	0	2,281
		Total	**0**	**67**	**1,518**	**3,894**	**0**	**382**	**30**	**0**	**5,891**
2	Commercial [b]	Lower	0	20	771	1,194	0	51	11	0	2,047
		Middle	0	8	48	542	0	127	10	0	735
		Alaska	**0**	**28**	**819**	**1,736**	**0**	**178**	**21**	**0**	**2,782**
		Upper	0	1	418	729	0	165	10	0	1,323
		Total	**0**	**29**	**1,237**	**2,465**	**0**	**343**	**31**	**0**	**4,105**
	Subsistence	Lower	0	89	1,827	3,329	7	163	7	0	5,422
		Middle	0	26	131	1,005	7	260	7	0	1,436
		Alaska	**0**	**115**	**1,958**	**4,334**	**14**	**423**	**14**	**0**	**6,858**
		Upper	0	5	829	1,794	7	435	7	0	3,077
		Total	**0**	**120**	**2,787**	**6,128**	**21**	**858**	**21**	**0**	**9,935**
3	Subsistence	Lower	0	31	852	1,207	0	64	5	0	2,159
		Middle	0	9	61	364	0	102	5	0	541
		Alaska	**0**	**40**	**913**	**1,571**	**0**	**166**	**10**	**0**	**2,700**
		Upper	0	2	387	651	0	170	4	0	1,214
		Total	**0**	**42**	**1,300**	**2,222**	**0**	**336**	**14**	**0**	**3,914**
4	Subsistence	Lower	0	100	675	723	0	45	0	0	1,543
		Middle	0	9	16	158	0	53	0	0	236
		Alaska	**0**	**109**	**691**	**881**	**0**	**98**	**0**	**0**	**1,779**
		Upper	0	28	1,541	1,807	0	586	0	0	3,962
		Total	**0**	**137**	**2,232**	**2,688**	**0**	**684**	**0**	**0**	**5,741**
5	Subsistence	Upper	0	62	3,404	3,991	0	1,294	0	0	8,751
6	Sport Fish	Middle	1	71	112	82	0	11	0	0	277
	Subsistence	Middle	0	64	114	1,128	0	378	0	0	1,684
Canada	Aboriginal	Upper	0	22	1,007	16	2,554	0	519	0	4,118
	Test Fish	Upper	0	4	186	3	472	0	96	0	761
		Total	**0**	**26**	**1,193**	**19**	**3,026**	**0**	**615**	**0**	**4,879**
Total Harvest		Lower	0	326	5,847	10,305	7	464	40	0	16,989
		Middle	1	218	623	4,186	7	1,102	39	0	6,176
		Alaska	**1**	**544**	**6,470**	**14,491**	**14**	**1,566**	**79**	**0**	**23,165**
		Upper	0	130	8,796	11,340	3,033	3,070	653	0	27,022
		Total	**1**	**674**	**15,266**	**25,831**	**3,047**	**4,636**	**732**	**0**	**50,187**

[a] District 1 includes 275 chinook salmon caught by test fishing projects.

[b] District 2 includes 322 chinook salmon caught by test fishing projects.

Table 18. Yukon River chinook salmon catch proportions by age.stock group and fishery, 2000.

			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	0.008	0.183	0.375	0.000	0.016	0.001	0.000	0.583
		Middle	0.000	0.003	0.015	0.076	0.000	0.016	0.001	0.000	0.111
		Alaska	**0.000**	**0.011**	**0.198**	**0.450**	**0.000**	**0.032**	**0.003**	**0.000**	**0.694**
		Upper	0.000	0.000	0.075	0.191	0.000	0.038	0.001	0.000	0.306
		Total	**0.000**	**0.011**	**0.273**	**0.642**	**0.000**	**0.070**	**0.004**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.008	0.136	0.335	0.000	0.011	0.002	0.000	0.492
		Middle	0.000	0.003	0.011	0.090	0.000	0.015	0.002	0.000	0.121
		Alaska	**0.000**	**0.011**	**0.148**	**0.425**	**0.000**	**0.026**	**0.003**	**0.000**	**0.613**
		Upper	0.000	0.001	0.110	0.236	0.000	0.039	0.002	0.000	0.387
		Total	**0.000**	**0.011**	**0.258**	**0.661**	**0.000**	**0.065**	**0.005**	**0.000**	**1.000**
2	Commercial	Lower	0.000	0.005	0.188	0.291	0.000	0.012	0.003	0.000	0.499
		Middle	0.000	0.002	0.012	0.132	0.000	0.031	0.002	0.000	0.179
		Alaska	**0.000**	**0.007**	**0.200**	**0.423**	**0.000**	**0.043**	**0.005**	**0.000**	**0.678**
		Upper	0.000	0.000	0.102	0.178	0.000	0.040	0.002	0.000	0.322
		Total	**0.000**	**0.007**	**0.301**	**0.600**	**0.000**	**0.084**	**0.008**	**0.000**	**1.000**
	Subsistence	Lower	0.000	0.009	0.184	0.335	0.001	0.016	0.001	0.000	0.546
		Middle	0.000	0.003	0.013	0.101	0.001	0.026	0.001	0.000	0.145
		Alaska	**0.000**	**0.012**	**0.197**	**0.436**	**0.001**	**0.043**	**0.001**	**0.000**	**0.690**
		Upper	0.000	0.001	0.083	0.181	0.001	0.044	0.001	0.000	0.310
		Total	**0.000**	**0.012**	**0.281**	**0.617**	**0.002**	**0.086**	**0.002**	**0.000**	**1.000**
3	Subsistence	Lower	0.000	0.008	0.218	0.308	0.000	0.016	0.001	0.000	0.552
		Middle	0.000	0.002	0.016	0.093	0.000	0.026	0.001	0.000	0.138
		Alaska	**0.000**	**0.010**	**0.233**	**0.401**	**0.000**	**0.042**	**0.003**	**0.000**	**0.690**
		Upper	0.000	0.001	0.099	0.166	0.000	0.043	0.001	0.000	0.310
		Total	**0.000**	**0.011**	**0.332**	**0.568**	**0.000**	**0.086**	**0.004**	**0.000**	**1.000**
4	Subsistence	Lower	0.000	0.017	0.118	0.126	0.000	0.008	0.000	0.000	0.269
		Middle	0.000	0.002	0.003	0.028	0.000	0.009	0.000	0.000	0.041
		Alaska	**0.000**	**0.019**	**0.120**	**0.153**	**0.000**	**0.017**	**0.000**	**0.000**	**0.310**
		Upper	0.000	0.005	0.268	0.315	0.000	0.102	0.000	0.000	0.690
		Total	**0.000**	**0.024**	**0.389**	**0.468**	**0.000**	**0.119**	**0.000**	**0.000**	**1.000**
5	Subsistence	Upper	0.000	0.007	0.389	0.456	0.000	0.148	0.000	0.000	1.000
6	Sport Fish	Middle	0.004	0.256	0.404	0.296	0.000	0.040	0.000	0.000	1.000
	Subsistence	Middle	0.000	0.038	0.068	0.670	0.000	0.224	0.000	0.000	1.000
Canada	Aboriginal	Upper	0.000	0.005	0.206	0.003	0.523	0.000	0.106	0.000	0.844
	Test Fish	Upper	0.000	0.001	0.038	0.001	0.097	0.000	0.020	0.000	0.156
		Total	**0.000**	**0.005**	**0.245**	**0.004**	**0.620**	**0.000**	**0.126**	**0.000**	**1.000**
Total Harvest		Lower	0.000	0.006	0.117	0.205	0.000	0.009	0.001	0.000	0.339
		Middle	0.000	0.004	0.012	0.083	0.000	0.022	0.001	0.000	0.123
		Alaska	**0.000**	**0.011**	**0.129**	**0.289**	**0.000**	**0.031**	**0.002**	**0.000**	**0.462**
		Upper	0.000	0.003	0.175	0.226	0.060	0.061	0.013	0.000	0.538
		Total	**0.000**	**0.013**	**0.304**	**0.515**	**0.061**	**0.092**	**0.015**	**0.000**	**1.000**

Table 19. Yukon River chinook salmon historical harvest by stock group for the United States and Canada, 1981-2000.

			Upper			
Year	Lower	Middle	U.S.	Canada	Total	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	12,569	73,363	136,770
2000	16,989	6,176	22,143	4,879	27,022	50,187
1981-1999 Average	37,210	41,674	81,913	17,832	99,739	178,623

Table 20. Yukon River chinook salmon historical harvest proportions by stock group for the United States and Canada, 1981-2000.

			Upper			
Year	Lower	Middle	U.S.	Canada	Total	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	0.444	0.092	0.536	1.000
2000	0.339	0.123	0.441	0.097	0.538	1.000
1981-1999 Average	0.208	0.233	0.459	0.100	0.558	1.000

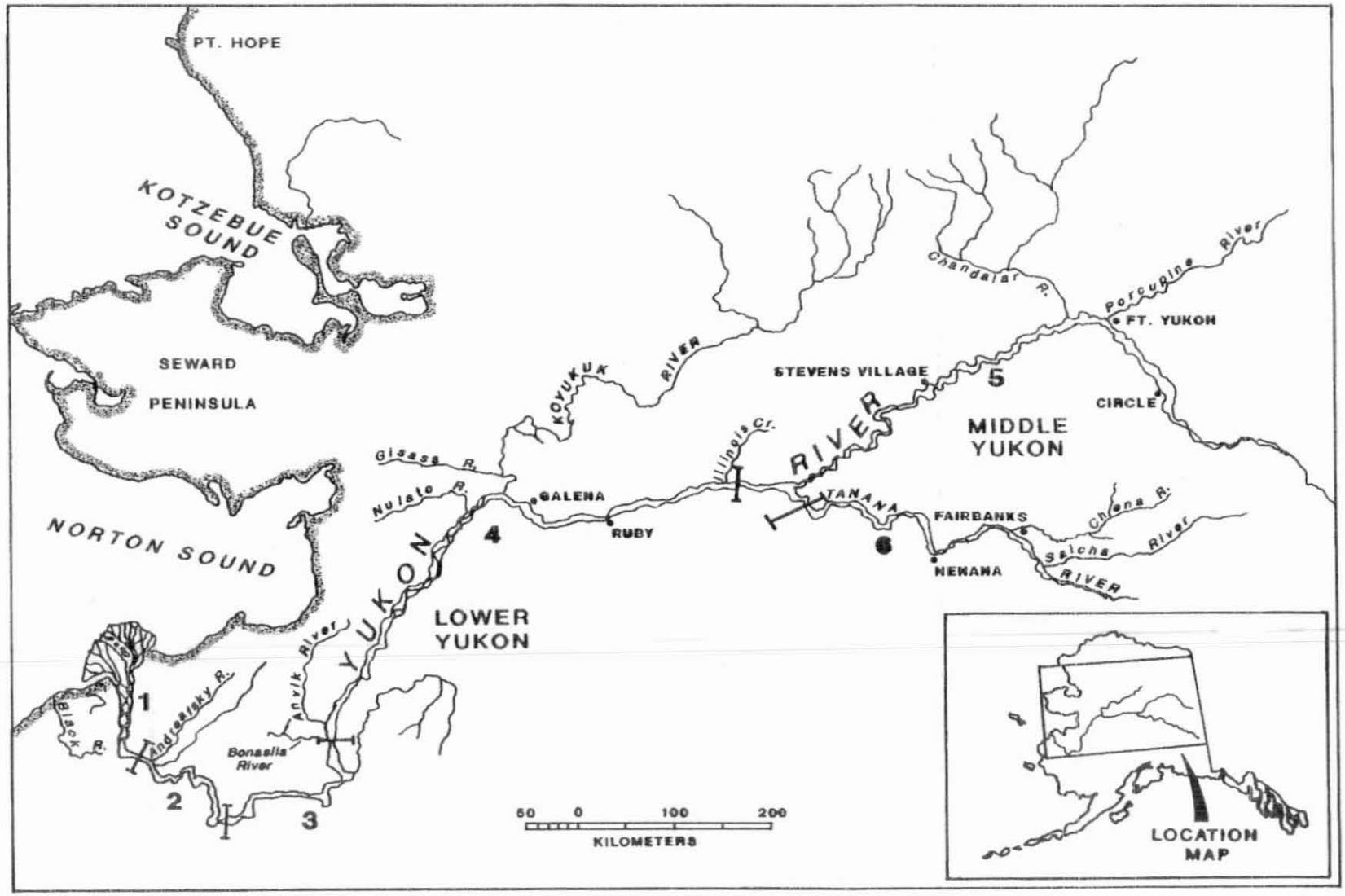


Figure 1. Alaska portion of the Yukon River drainage with district boundaries and major spawning tributaries.

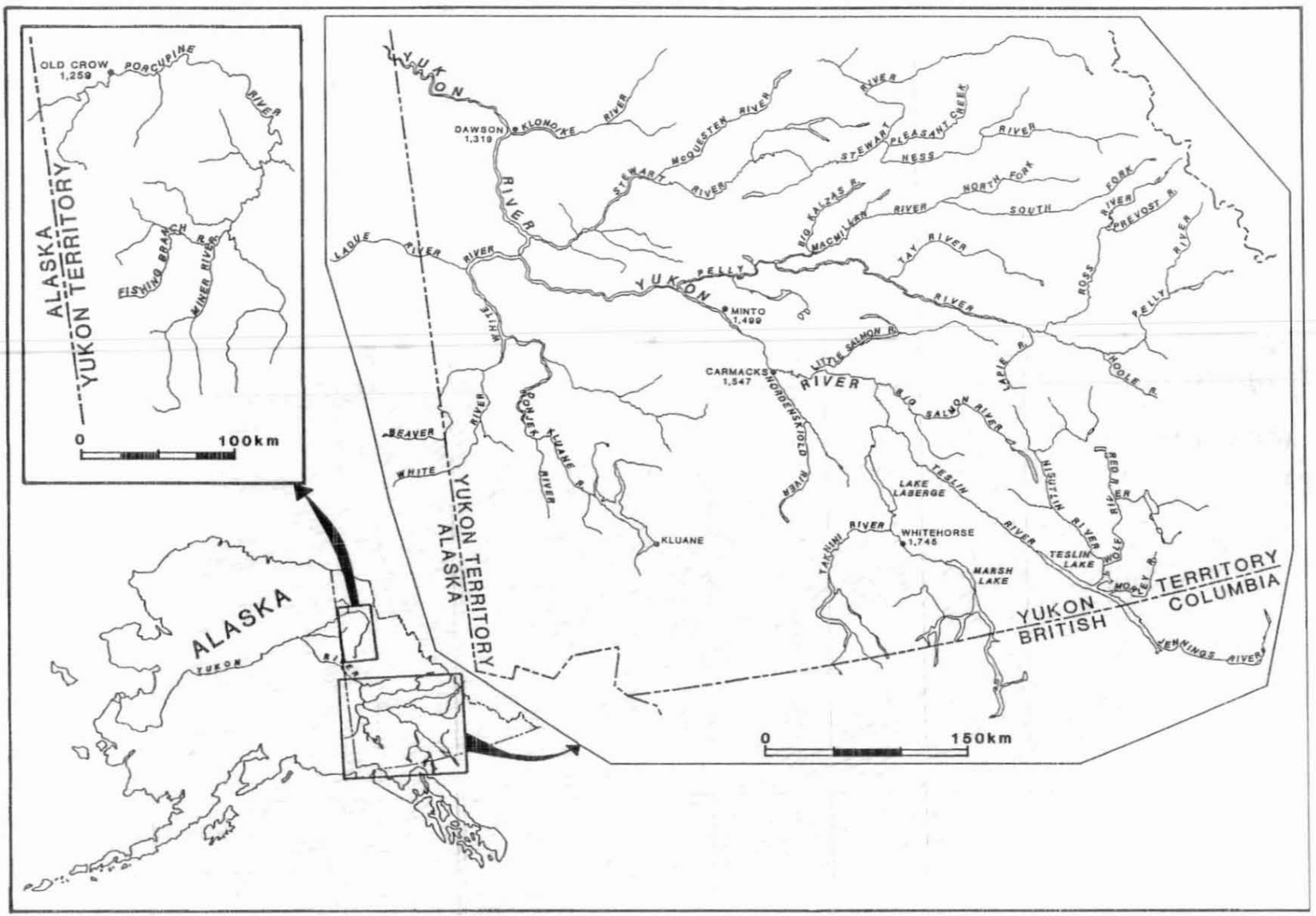


Figure 2. Canada portion of the Yukon River drainage and major spawning tributaries.

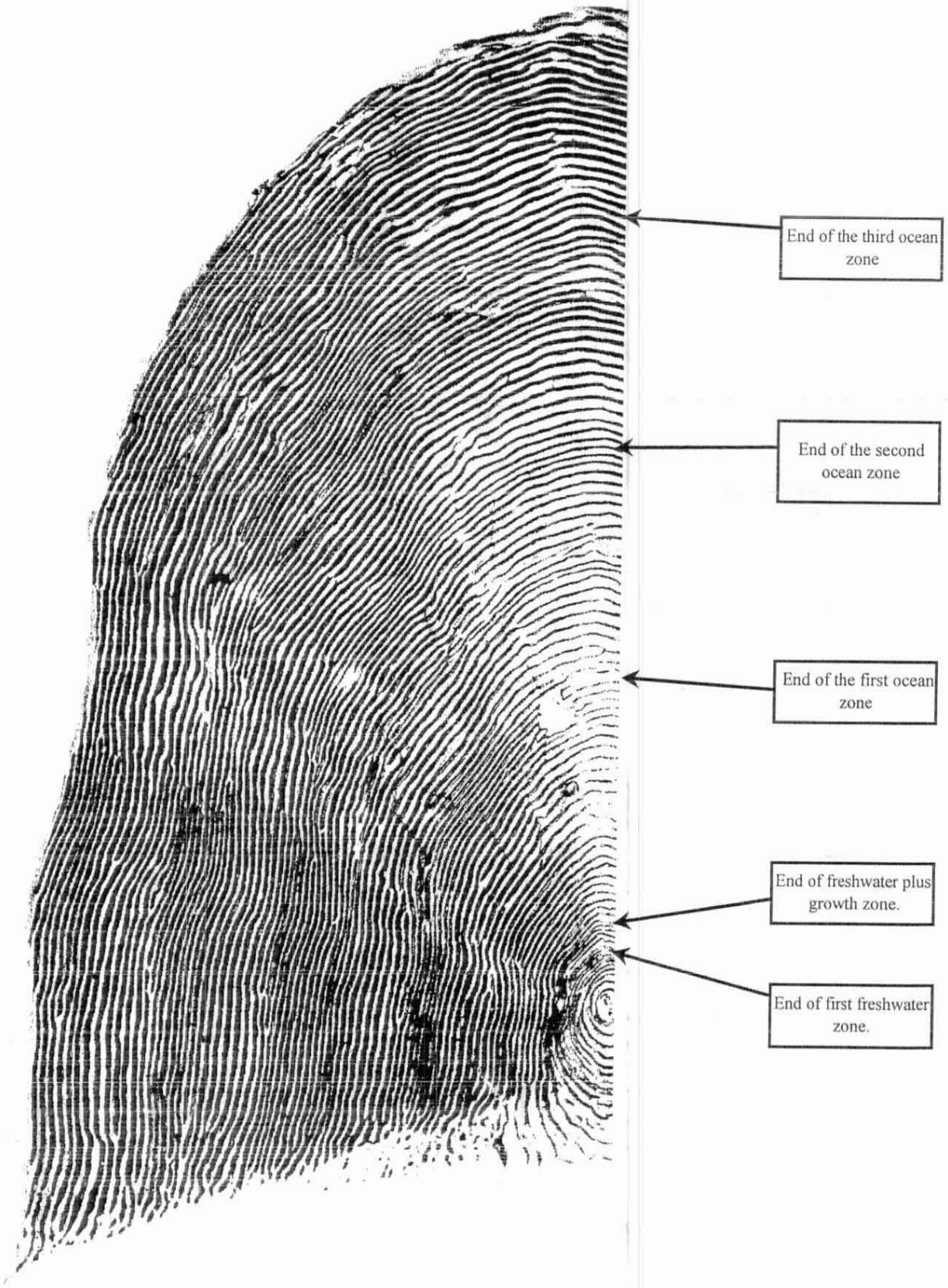
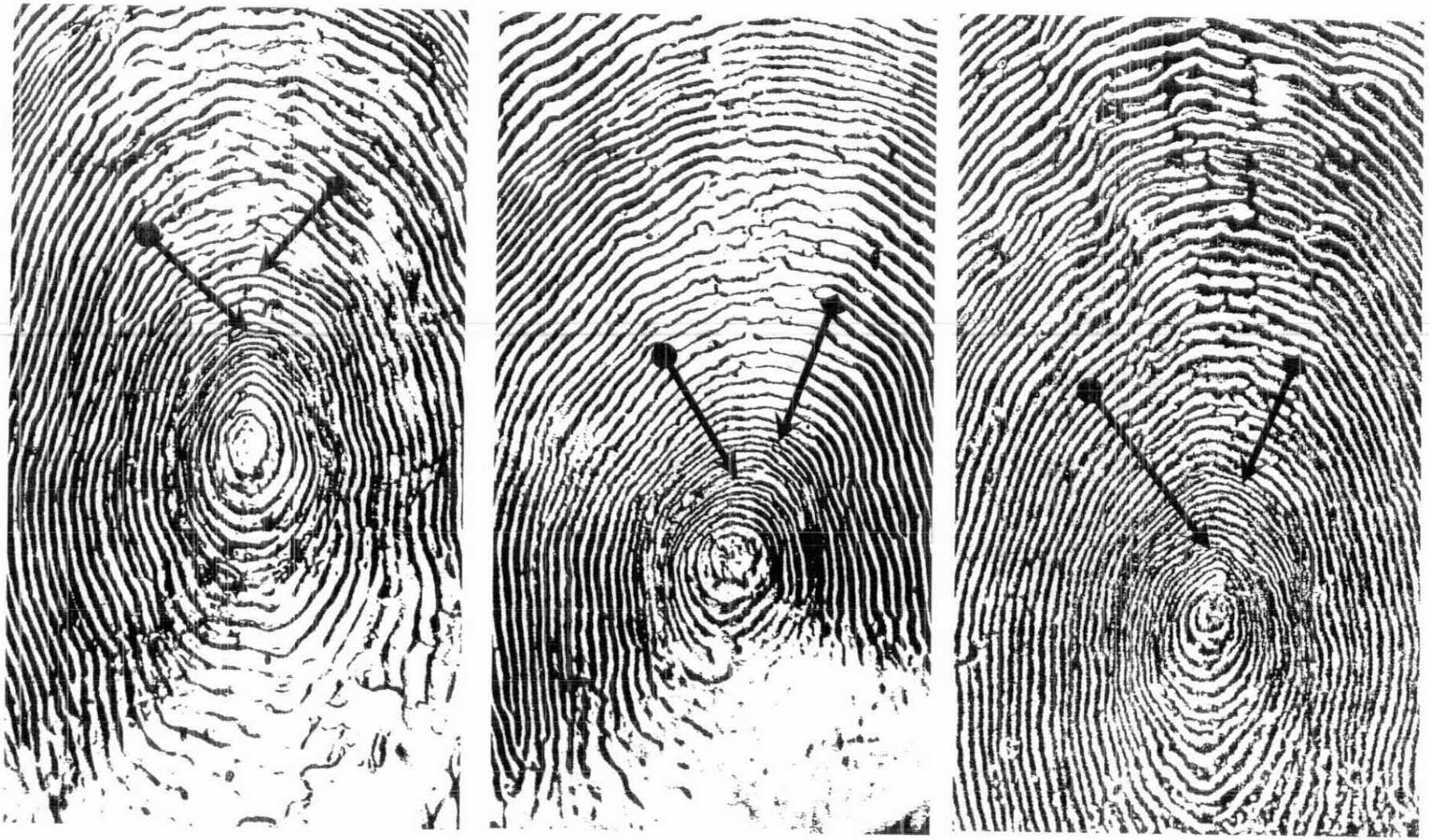


Figure 3. Scale of a chinook salmon illustrating the different zones that are measured for scale growth analysis.

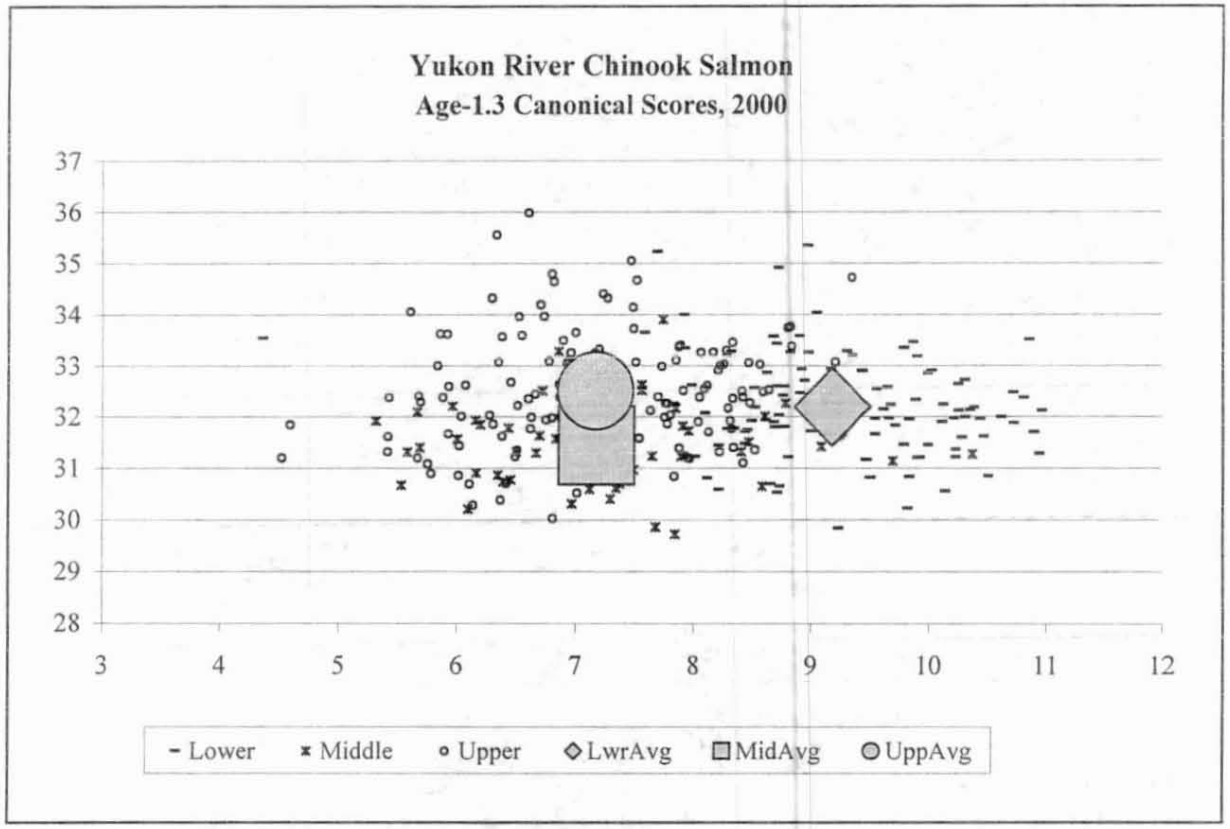


Andreafsky River Escapement

Salcha River Escapement

Canadian Commercial Catch

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



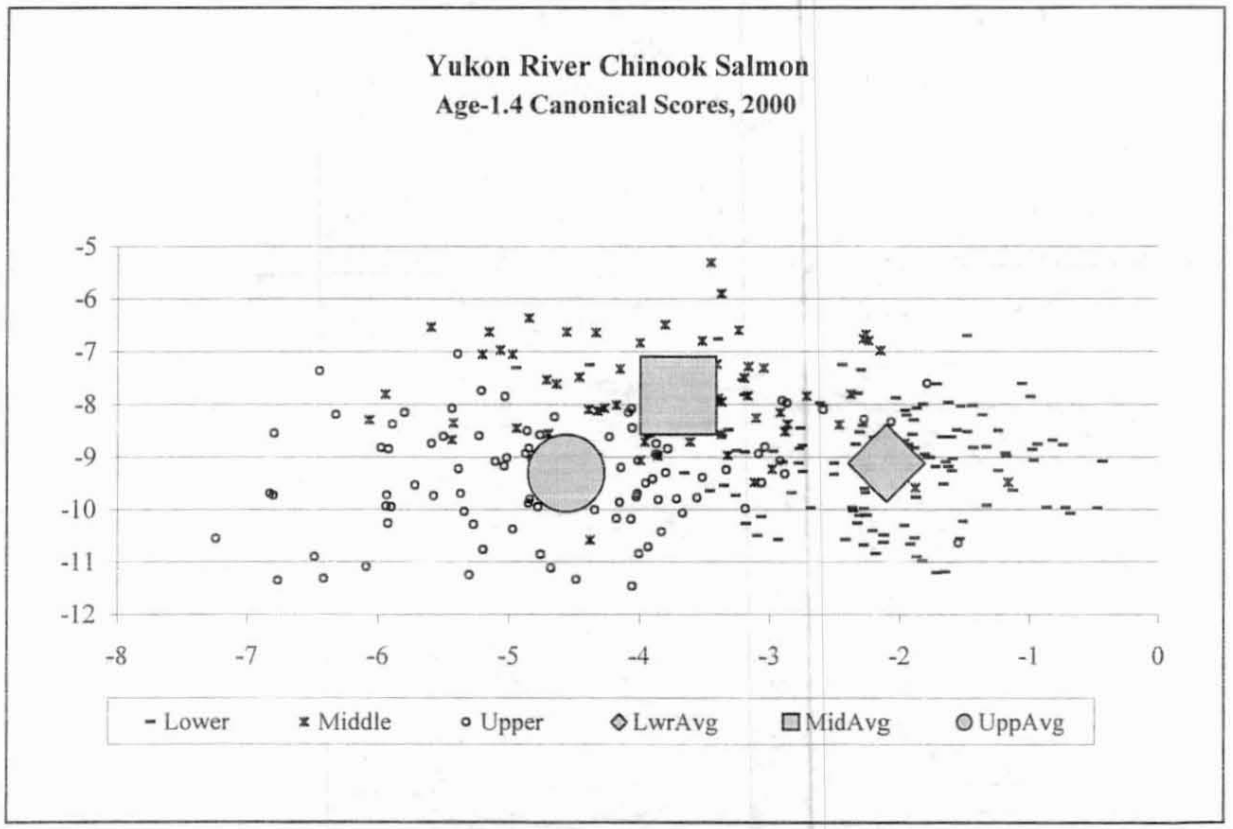
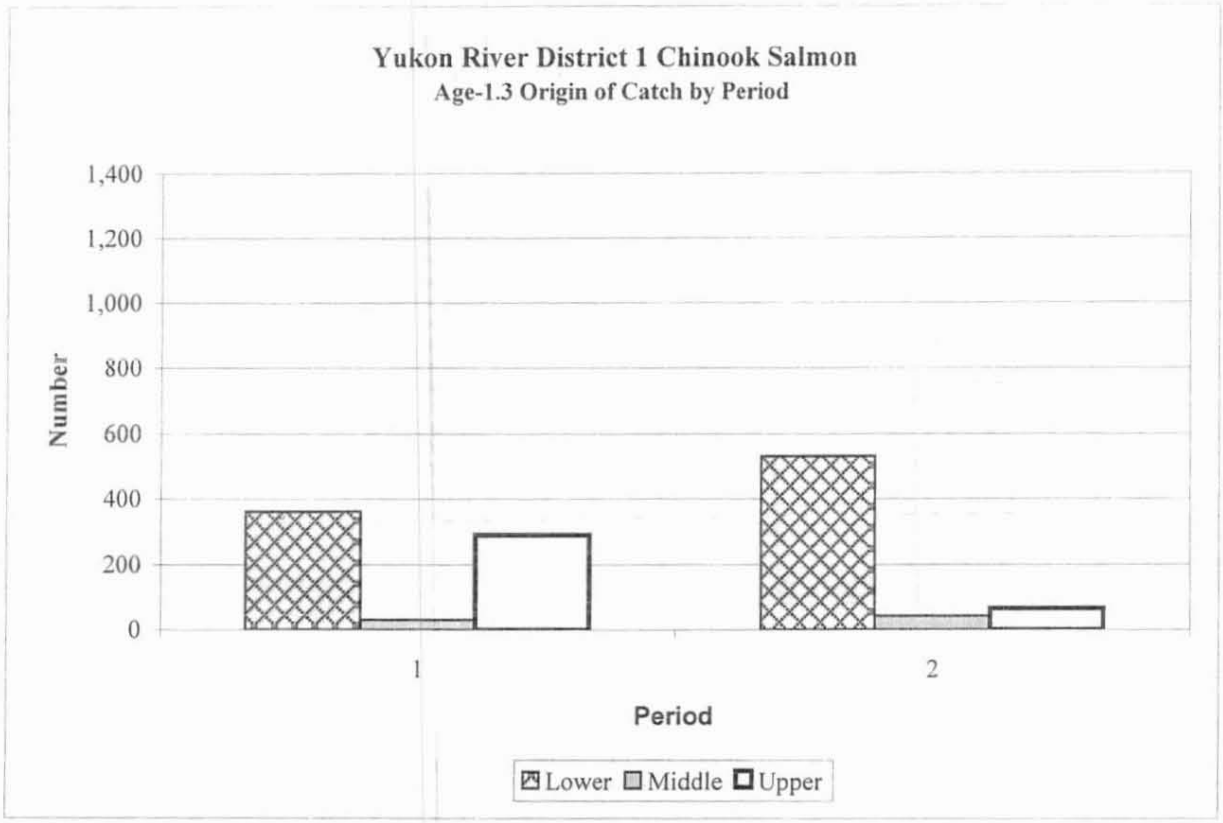


Figure 5. Canonical variable plots for Yukon River age-1.3 and -1.4 chinook salmon, 2000.



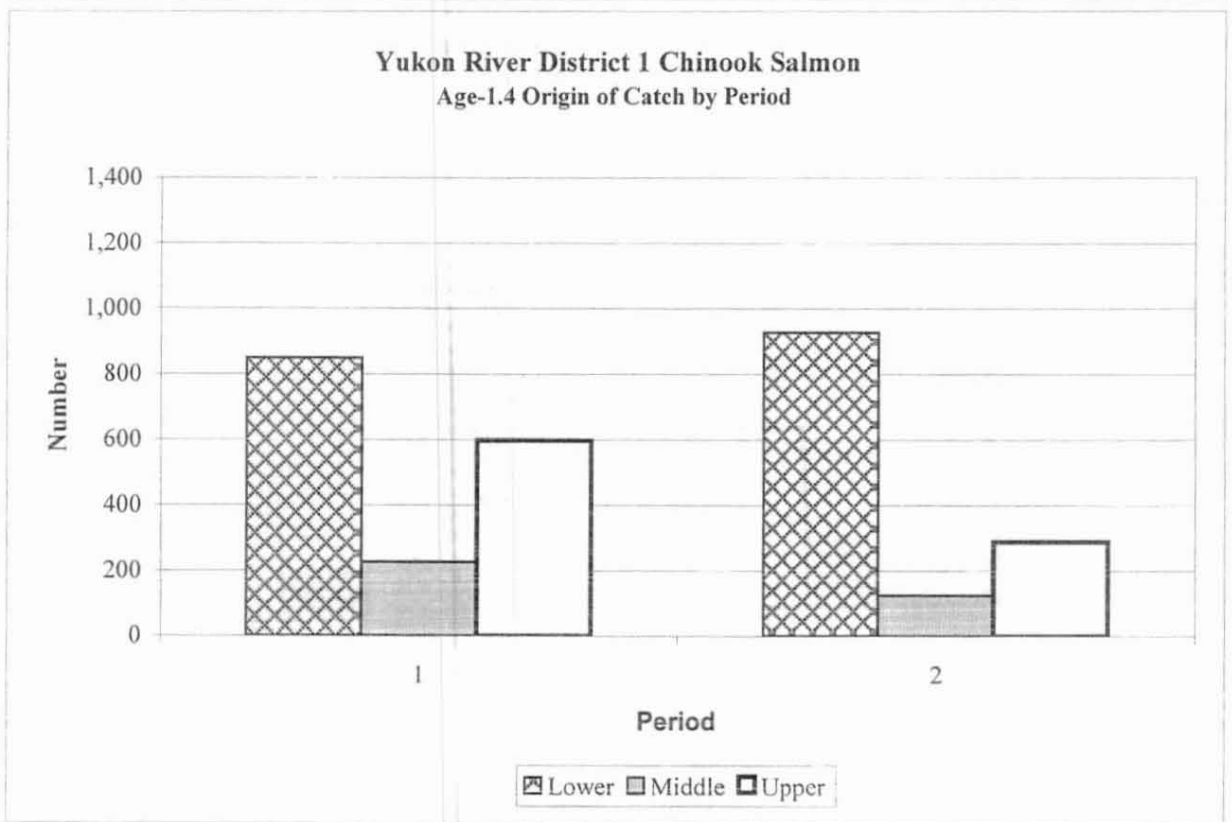
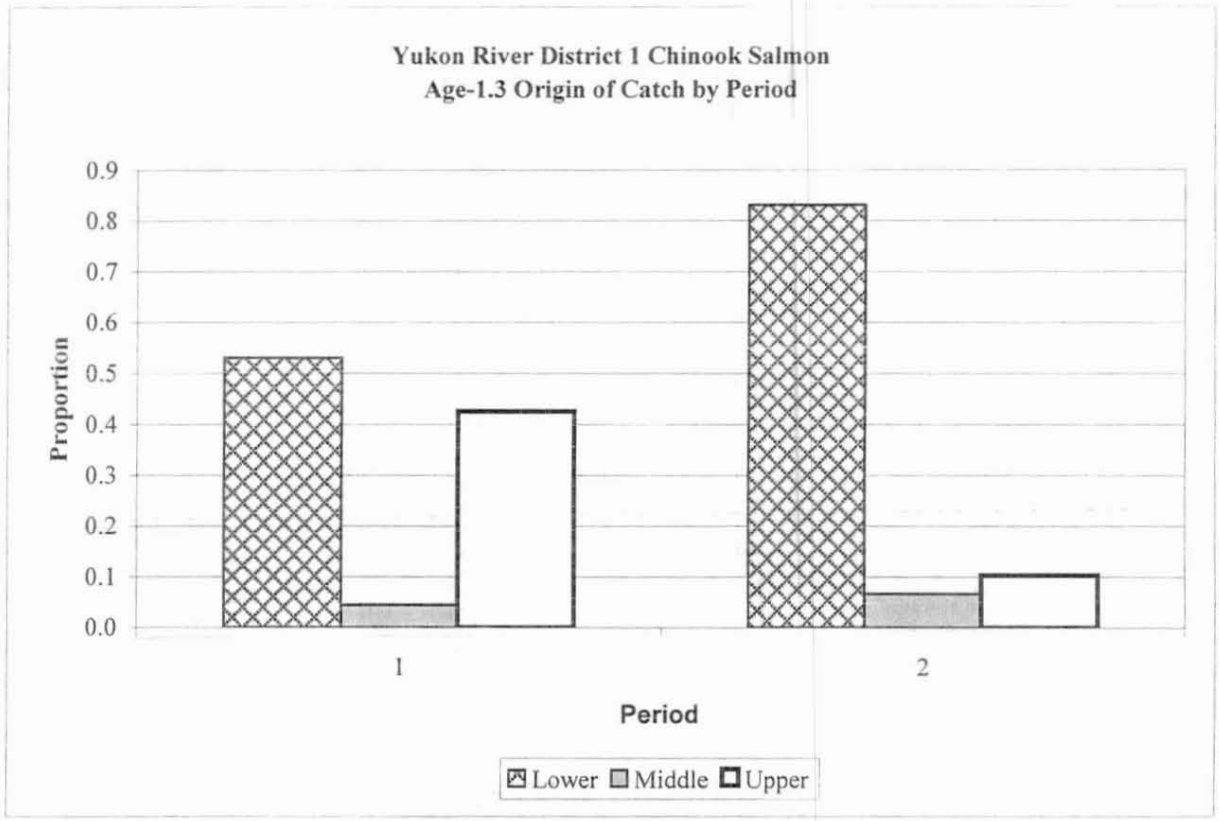


Figure 6. Estimated number of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 1, 2000.



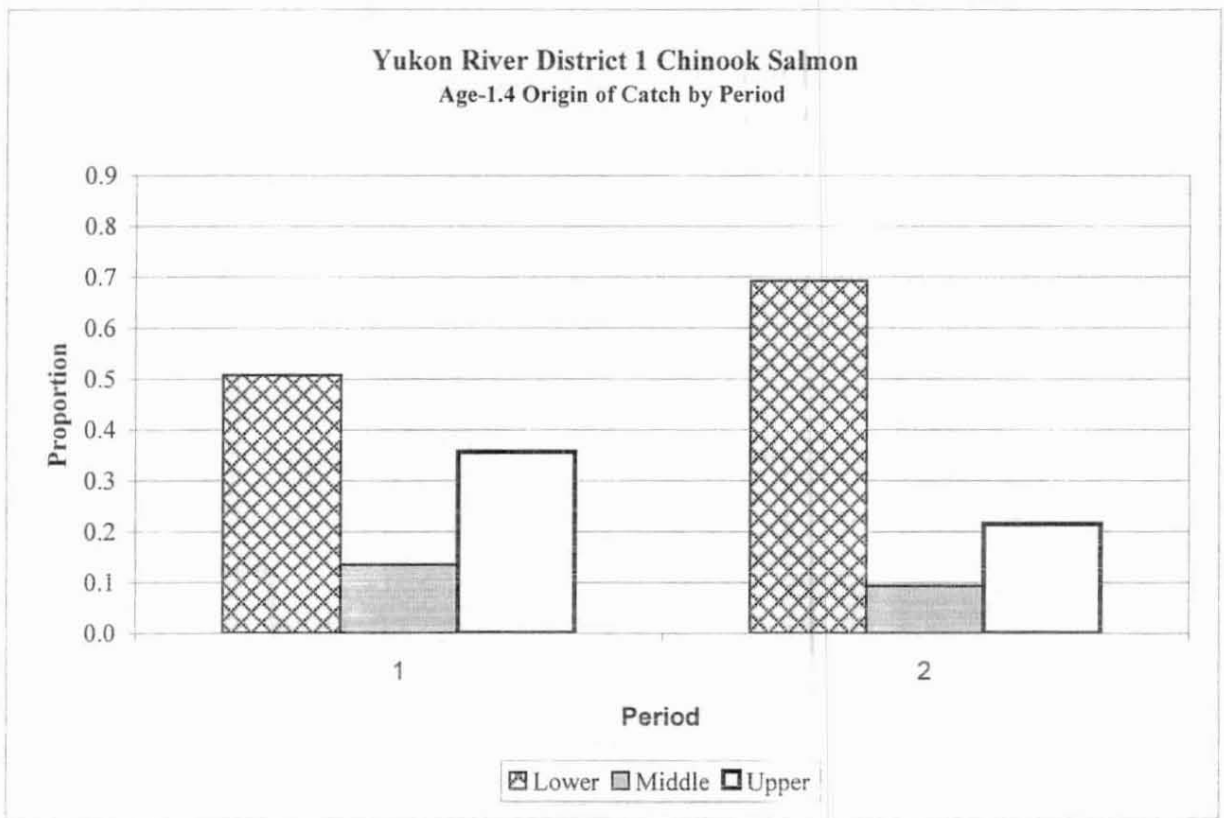
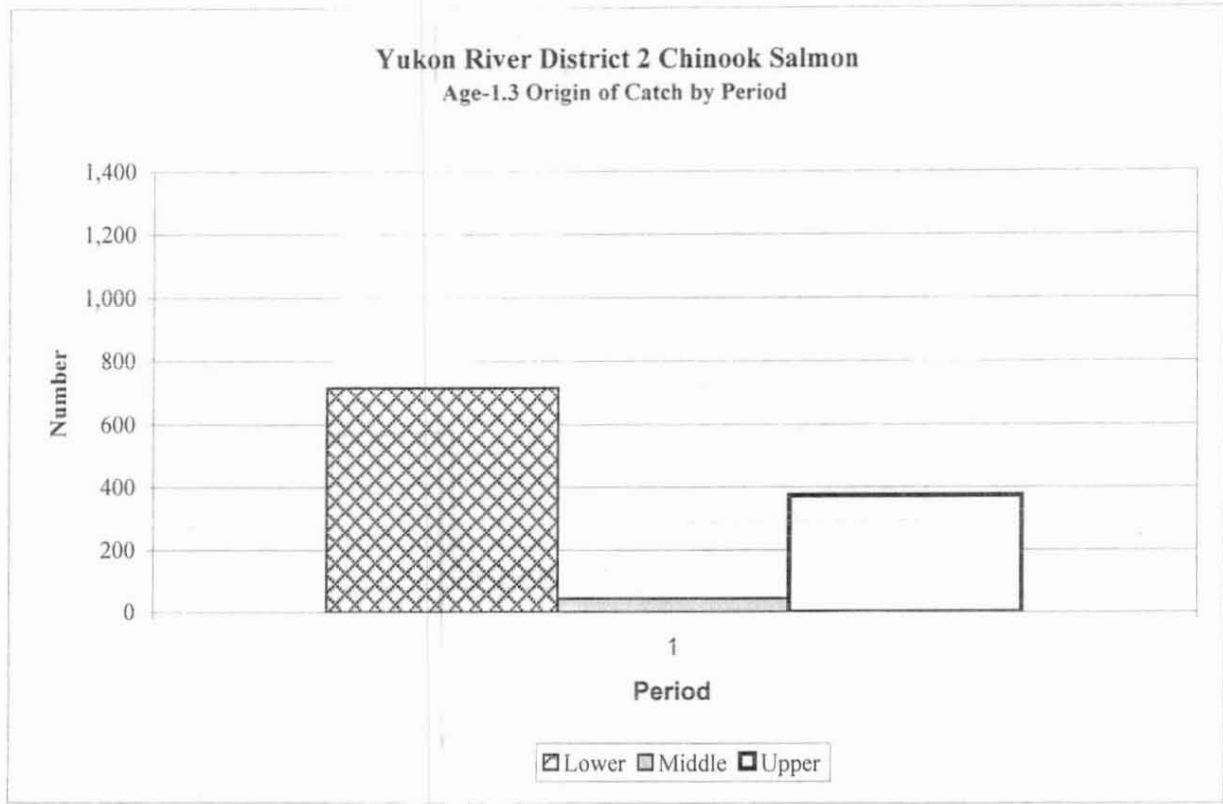


Figure 7. Estimated proportion of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 1, 2000.



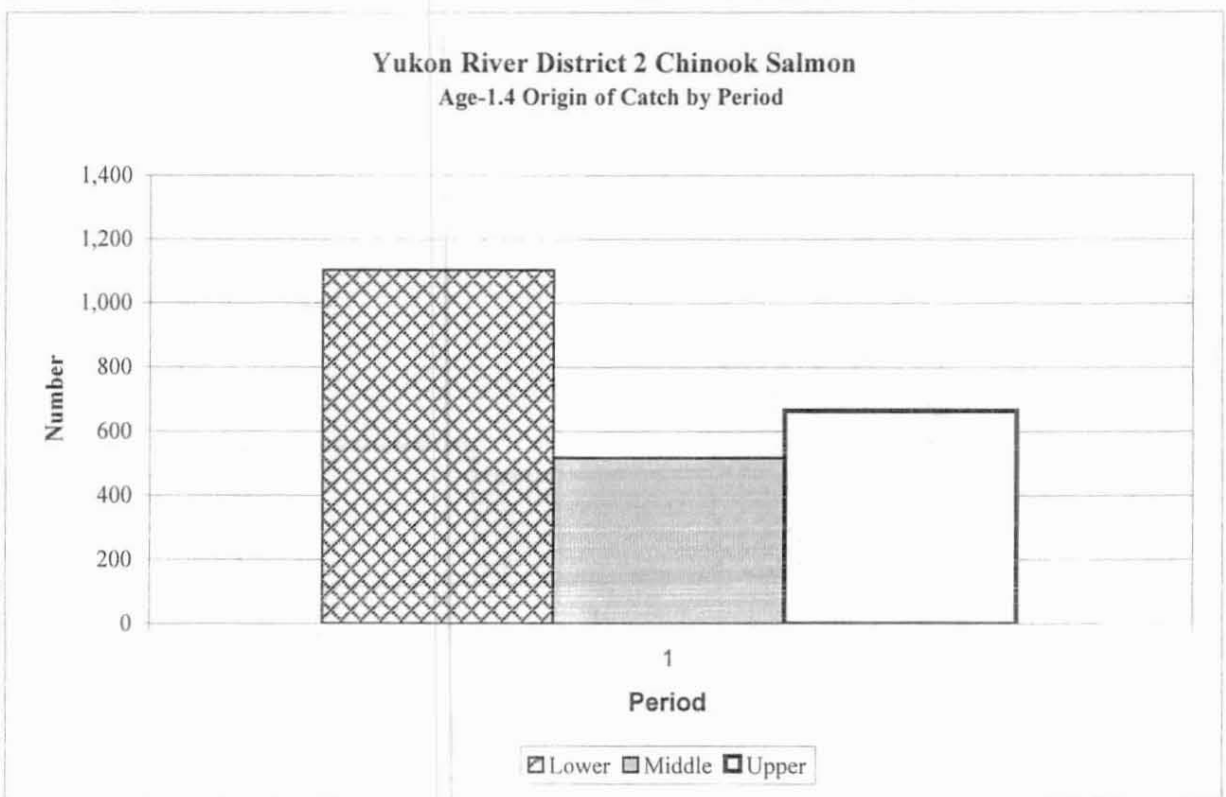
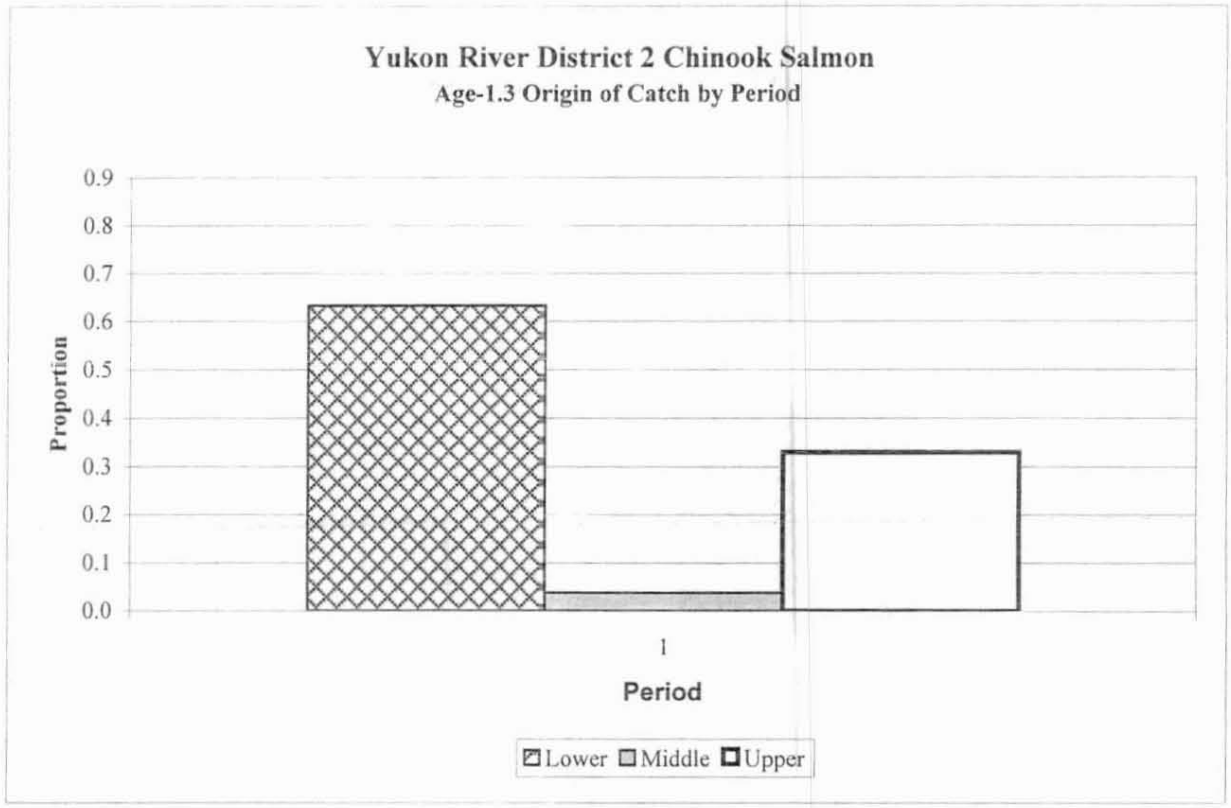


Figure 8. Estimated number of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 2, 2000.



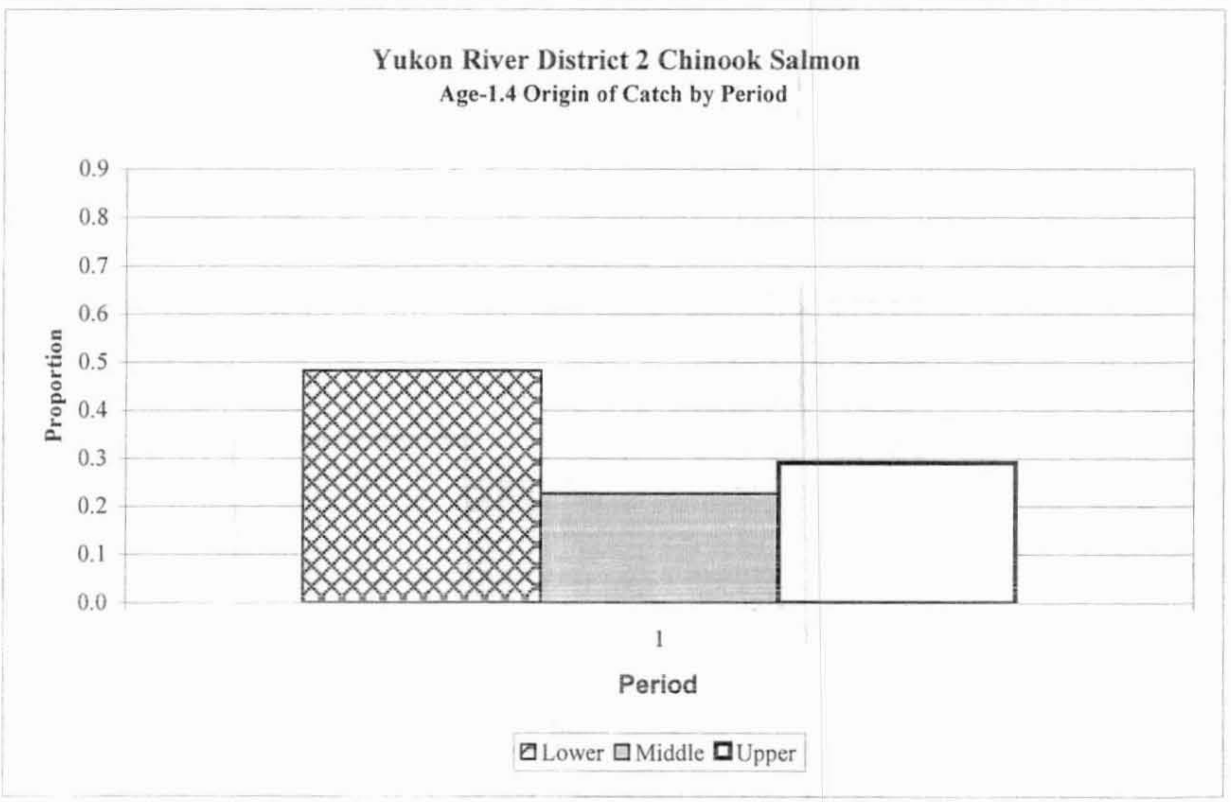


Figure 9. Estimated proportion of age-1.3 and -1.4 chinook salmon harvested by period and stock group, Yukon River District 2, 2000.