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Alaska Department of Fish and Game
Commercial Fisheries Management
and Development Division
P.O. Box 25526
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Origins of Chinook Salmon in the Yukon River Fisheries, 1992

by

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State of Alaska Walter J. Hickel, Governor

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ABSTRACT

Analysis of scale patterns and age composition of chinook salmon *Oncorhynchus tshawytscha* (Walbaum) from Yukon River escapements in Alaska and salmon tagging- study catches in Canada were used to construct run-of-origin classification models for directly allocating Yukon River District 1 and 2 commercial and subsistence harvests. District 3 and 4 commercial and subsistence harvests were allocated using the estimated proportions obtained in the analysis of District 1 and 2 harvests. Linear discriminant models were used to estimate stock composition for age-1.3 and -1.4 fish. Observed age composition differences among escapements were used to estimate runs of origin for other age groups. Runs of origin for all other drainage harvests were estimated from geographic occurrence. The total Yukon River harvest was 187,161 chinook salmon, of which 59% was estimated to be the Upper Yukon Run, 23% the Middle Yukon Run, and 18% the Lower Yukon Run. The fraction of the District 1 and 2 commercial catch composed of the Lower Yukon Run generally increased through time, while the fraction composed of the Upper Yukon Run generally declined. The middle run component displayed no consistent trends.

KEY WORDS: Chinook salmon, *Oncorhynchus tshawytscha*, stock separation, catch and run composition, linear discriminant function analysis, Yukon River

INTRODUCTION

Yukon River chinook salmon *Oncorhynchus tshawytscha* (Walbaum) have historically been harvested in a wide range of fisheries in both marine and fresh waters. Within the Yukon River returning adults are harvested in commercial and subsistence fisheries in both Alaska and Canada (Figures 1, 2). Sport fisheries produce small harvests in the Tanana River drainage and in Canada.

In the 20 years after statehood (1960-1979), the total commercial and subsistence harvest of Yukon River chinook salmon from both Alaska and Canada ranged from 77,250 to 169,053 and averaged 122,971 fish annually (JTC 1992). Beginning in 1980, annual harvests increased substantially. During the most recent 5-year period (1987 through 1991), annual commercial and subsistence catches together averaged 177,543 fish. While chinook salmon are harvested virtually throughout the length of the Yukon River, the majority of the catch has been taken in commercial gillnet fisheries in Districts 1 and 2. The 1987-91 average was 54% of total drainage harvest, and subsistence harvests accounted for another 33%. Most of the subsistence harvest is taken with fish wheels and gillnets in Districts 4, 5, and 6. In 1992, commercial, subsistence, and sport fishermen in Alaska and Canada harvested a total of 187,161 chinook salmon, of which 113,281 fish (61%) were taken by District 1 and 2 commercial fishermen.

Chinook salmon harvested in the Yukon River fisheries consist of a mixture of stocks destined for spawning areas throughout the Yukon River drainage. Although more than 100 spawning streams have been documented (Barton 1984), aerial surveys of chinook salmon escapements indicate that the largest concentrations of spawners occur in three distinct geographic regions: (1) tributary streams in Alaska that drain the Andreafsky Hills and Kaltag Mountains between river miles 100 and 500, (2) Upper Koyukuk River and Tanana River tributaries in Alaska between river miles 800 and 1,100, and (3) tributary streams in Canada that drain the Pelly and Big Salmon Mountains between river miles 1,300 and 1,800. Chinook salmon stocks within these geographic regions were collectively termed runs by McBride and Marshall (1983) and are now referred to as the Lower, Middle, and Upper Yukon Runs, respectively.

Evaluating stock productivities, spawning escapement objectives, and management strategies requires information on the stock composition of the harvest. In addition, the U.S. and Canada are engaged in treaty negotiations concerning management and conservation of stocks spawned in Canada. Biological information on these stocks provides the technical basis for the negotiations.

Harvest estimates of western Alaskan and Canadian Yukon River chinook salmon in the Japanese high seas gillnet fisheries were made using scale pattern analysis (SPA; Rogers et al. 1984; Meyers et al. 1984; Meyers and Rogers 1985). Stock composition of Yukon River freshwater fisheries has been studied by the Alaska Department of Fish and Game to provide useful postseason information for management and conservation of the various runs of chinook salmon. For Yukon River chinook salmon, stock composition estimates derived from scale pattern analysis of the catch through time were first available for 1980 and 1981 District 1 harvests (McBride and Marshall 1983). Since then, harvest proportions by geographic region of origin have been estimated annually for the entire drainage (Wilcock and McBride 1983; Wilcock 1984, 1985, 1986, 1990; Merritt et al. 1988; Merritt 1988; Schneiderhan and Wilcock 1992; Schneiderhan 1993).

The objective of this study was to classify all chinook salmon harvests to run of origin.

METHODS

Age Determination

Scale samples provided age information for fish in the catch and escapement. Scales were collected from the left side of the fish approximately two rows above the lateral line in an area transected by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Clutter and Whitesel 1956). Scales were mounted on gummed cards and impressions made in cellulose acetate. Ages were reported in European notation.

Catch Sampling

Scales were collected from commercial catches in all fishing districts except District 3. Subsistence catches in Districts 4, 5, and 6 were also sampled. District 3 was not targeted for sampling because relatively few fish were harvested in that portion of the Yukon River and access was difficult. Salmon harvested in District 3 and delivered to buyers in St. Mary's could at times have comprised a small fraction of the District 2 catch sample. For purposes of this report, I assumed that subsistence fishing in Districts 1 and 2 occurred largely in conjunction with commercial fishing and followed a similar temporal distribution of effort and harvest. Samples were collected from salmon harvested by the District 1 ADF&G gillnet test fishing crew and from fish captured in fish wheels by personnel from the Department of Fisheries and Oceans (DFO) in Yukon, Canada. Some preliminary analyses included the District 1 test fishing samples, but that data was not needed in the final analysis. Escapement samples were collected in Alaska from the Andreafsky, Anvik, Chena, Salcha, and Goodpaster Rivers and from Barton Creek.

Escapement Sampling

Scale samples were collected during the period of peak spawner mortality from the Andreafsky, Anvik, Chena, Salcha, and Goodpaster Rivers and Barton Creek in Alaska. Samples were primarily collected from carcasses; however, some samples were obtained from live fish captured with spears or other methods. Canadian tributaries were not sampled in 1992.

The age composition of Lower, Middle, and Upper Yukon Runs was estimated by weighting the age composition calculated for the individual spawning tributaries in each area by the escapement to each tributary as indexed by aerial surveys or mark/recapture spawning population estimates. Those tributaries which were sampled but for which no abundance estimate was available were not used in the estimation process.

Estimation of Catch Composition

Linear discriminant function analysis (Fisher 1936) of scale patterns data, observed differences in age composition between escapements, and geographic occurrence of catches were used to estimate runs of origin for 1992 Yukon River chinook salmon catches.

Scale Pattern Analysis

Escapement samples from Alaska and salmon tagging study samples from Canada provided scales of known origin that were used to build linear discriminant functions (LDF). Scales representing the Lower Yukon Run were selected from samples collected on the Andreafsky and Anvik Rivers. The Middle Yukon Run was represented by scales from the Chena, Salcha, and Goodpaster Rivers and from Barton Creek. The Upper Yukon Run was represented by samples collected from test fish wheels which were operated in conjunction with the DFO tagging study at White Rock and Sheep Rock sites located in Canada between 6 and 12 mi (10-20 km) upstream from the U.S.-Canada border.

Scales from the lower river commercial gillnet fishery catch samples were classified to run of origin using the discriminant functions. Only scales with one freshwater annulus (age 1.) were considered for digitizing and subsequent analysis. Run proportions of fish aged 1.3 and 1.4 were estimated for District 1 and 2 catches for all fishing periods. The sampling plan was designed to provide sample sizes of 50 or more for each major age class and harvest strata; however, in order to present allocation results by period, smaller samples were sometimes used. Allocation estimates for District 1 periods 2, 5, and 6 were used in place of missing data for District 2 periods 3, 5, and 6. This strategy loosely provided for a 2- to 3-d migratory lag time between the two districts.

Measurements of scale features were made as described by McBride and Marshall (1983). Scale images were projected at 100X magnification using equipment similar to that described by Ryan and Christie (1976). Measurements taken along an axis located at the approximate apex of circuli formations in the freshwater growth zone were recorded by a microcomputer-controlled digitizing system.

The apex of circuli formations tends to differ between growth zones and consistency of axis placement was deemed most likely to occur if the apex of circuli in the freshwater zone served as the axis indicator. The distance between each circulus in each of three scale growth zones (Figure 3) was recorded. The three zones were (1) scale focus to the outside edge of the freshwater annulus (first freshwater annulus zone), (2) outside edge of the freshwater annulus to the last circulus of freshwater growth (freshwater plus growth zone), and (3) the last circulus of the freshwater plus growth zone to the outer edge of the first ocean annulus (first marine annular zone). In addition, the total width of successive scale pattern zones was also measured for (1) the last circulus of the first ocean annulus to the last circulus of the second ocean annulus and (2) the last circulus of the second ocean annulus to the last circulus of the third ocean annulus. Seventy-eight scale characters (variables, Appendix A) were calculated from the basic incremental distances and circuli counts. Run-of-origin standards (pooled rivers) were weighted by aerial abundance estimates for the Lower Yukon Run and by spawning population estimates from mark/recapture studies on the Chena and Salcha Rivers for the Middle Yukon Run. Run-of-origin models were constructed for age-1.3 and -1.4 fish.

Selection of scale characters for linear discriminant functions was by a forward stepping procedure using partial F-statistics as the criteria for entry and deletion of variables (Enslein et al. 1977). A nearly unbiased estimate of classification accuracy for each LDF was determined using a leaving-one-out procedure (Lachenbruch 1967).

Contribution rates for age-1.3 and -1.4 fish in the District 1 and 2 catches were estimated for each fishing period using the procedures described above. The resultant estimates were adjusted for misclassification errors using a constrained maximum likelihood procedure similar to that described by Hoenig and Heisey (1987). Variances were approximated using an infinitesimal jackknife procedure described by Millar (1987).

Results of the age-specific scale patterns analysis by fishing period were summed to estimate total contribution by run of origin for age-1.3 and -1.4 chinook salmon to the District 1 and 2 commercial catches.

Age Composition Ratio Analysis

Age classes in the District 1 and 2 commercial catches which were not classified by SPA were apportioned to run of origin based on escapement age composition ratios. An assumption implicit in this calculation is that fisheries did not differentially harvest stocks or age groups. This assumption may have been violated, but any bias introduced was believed to be minor. Escapement age composition data, weighted by aerial survey estimates, were used to compute ratios of proportional abundance (R_{cia}) for each run:

$$\hat{R}_{cia} = \frac{\hat{E}_{ci}}{\hat{E}_{ca}}, \qquad (1)$$

where:

c = run of origin, e.g. Lower, Middle, or Upper Yukon Run;

a = age class in the escapement which was classified to run of origin by SPA, e.g., age 1.3 or 1.4;

i = unclassified (unknown proportion by run) escapement age class which was determined to be an analog of age class a;

$\hat{E}_{ca}$ = estimated proportion of fish of age class a in run c escapement samples;

$\hat{E}_{ci}$ = estimated proportion of fish of age class i in run c escapement samples.

In previous years the proportion of age-1.2 and -2.2 fish in escapement samples have tended to decrease as the distance upriver increased; therefore, proportions for the age class were divided by the proportion of age-1.3 fish, which analogously have displayed a similar tendency and were from the same brood year. Proportions of age-2.3, -1.5, -2.4, -1.6, and -2.5 fish were similarly treated as analogs of age-1.4 fish because these ages have historically increased with distance upriver. Further, age-2.3 fish were treated as analogs of age-1.4 fish because both were from the same brood year.

The catch of each age class for each run was approximated by multiplying the run- and age-specific rate of proportional abundance for each unclassified age class by the estimated catch, by run, of the analogous age class (e.g., age 1.3 or 1.4).

Run- and age-specific contribution rates were then estimated by dividing the approximated catch-by-run of an unclassified age class by the total approximated catch of the same age class. Multiplying the run- and age-specific contribution rates by the catch of the age class (from sample age compositions and reported commercial harvests) yielded age-specific run contribution estimates, or

$$\hat{F}_{ci} = \frac{\hat{R}_{cia} N_{ca}}{\sum_{c=1}^{n} \hat{R}_{cia} N_{ca}}, \qquad (2)$$

where:

$\hat{F}_{ci}$ = estimated proportion of fish of run c in the total catch of age class i, (e.g., N_i),

N_{ca} = catch of age group a (where a was either age 1.3 or 1.4 in run c) and

n = number of runs or 3.

The total harvest of run c for age group i was then

$$\hat{N}_{ci} = \hat{F}_{ci} N_i, \qquad (3)$$

where:

$\hat{N}_{ci}$ = catch of age class i in run c, and

N_i = total catch of age class i.

Estimation of Catch Composition by Fishery

Estimates of run composition from SPA and differential age composition analysis were used to classify District 1 and 2 commercial catches by period. Classifications of Districts 1 and 2 subsistence catches were based on estimates of run composition from SPA and differential age composition analysis of commercial harvests in each district. The proportions by age class and run obtained through analysis of total District 2 commercial and subsistence catches were then used to classify commercial and subsistence catches in Districts 3 and 4.

Catch Composition Based on Geographical Segregation

Commercial and subsistence harvests in District 5, District 6, and Yukon Territory were classified to run of origin based on geographical segregation. The entire District 5 harvest was assumed to be from the Upper Yukon Run. This assumption was made because (1) most of the District 5 catch occurred above the confluence of the Tanana River, and (2) aerial survey counts of chinook salmon spawning in the Porcupine and Chandalar River drainages, totaling less than 100 fish for each year since 1980, are the only documented chinook salmon spawning concentrations between the Tanana River confluence and the Yukon Territory fishery centered in Dawson. This assumption was known to be violated because a small but unknown proportion of the District 5 subsistence harvest were taken on the south bank below the Tanana River confluence. Those fish were believed to be mostly of Tanana River (District 6) origin. Violation of the assumption affected the results of this study by providing a positive bias to the Upper Yukon Run and a corresponding negative bias to the Middle Yukon Run.

The entire District 6 harvest was considered to be from the Middle Yukon Run because neither Lower nor Upper Yukon Runs were present in the Tanana River. The Yukon Territory harvest was assigned to the upper run because neither lower nor middle runs were present in Yukon Territory.

RESULTS

Escapement Age Composition

Yukon River chinook salmon escapement age compositions in 1992 exhibited a variety of trends and contrasts (Table 1). Due to extremely abundant pink salmon in the Andreafsky River, a very small sample of chinook salmon was obtained and large sex and size biases were likely. Except in the Andreafsky River, age-1.3 fish were typically less abundant than age 1.4 fish in Lower and Middle Yukon River escapements. The large proportion of age 1.3 relative to age 1.4 in the Upper Yukon Run is reverse of the expected age class ratio. Unusually large proportions of age 1.2 were present in Middle and Upper Yukon River escapements. Generally, the expected trend for the proportion of older fish to increase progressively upriver was reversed; this compares to 1991 when the expected trend was noted, though less pronounced than usual. More specifically, proportions of ages 1.4 and 1.5 were larger in the Anvik River than in tributaries farther upriver. The proportion of age-1.4 fish in the middle river tributaries was somewhat lower than usual. Samples of Upper Yukon Run fish from the White Rock and Sheep Rock sites exhibited an unusually small proportion of age-1.4 fish. As in most other years, the largest proportion of age-2. fish was attributed to the Upper Yukon Run, whereas relatively few age-2. fish were attributed to Lower or Middle Yukon Runs.

Classification Accuracies of Run of Origin Models

Typical of past years, mean classification accuracy of the 3-way, run-of-origin model for age 1.3 was 74.7% and for age 1.4 was 75.4% (Table 2). Also similar to past years, the lower river standard showed the greatest classification accuracy for age 1.3 (89.6%); however, for the first time, the upper river standard showed the greatest classification accuracy for age 1.4 (80.5%). The accuracy of classification of the middle run standards was similar to or slightly less than usual: 69.2% for age 1.3 and 66.7% for age 1.4. As usual, upper river standards most often misclassified to the Middle Yukon Run (about 25% for age 1.3 and about 18% for age 1.4), and middle river standards most often misclassified to the Upper Yukon Run (about 26% for age 1.3 and about 19% for age 1.4).

Catch Composition

Scale Pattern Analysis

The scale measurement characters (Appendix A) that were most powerful in distinguishing between the three runs of origin for age 1.3 were (1) variable 67, the freshwater annular zone divided by the total width of freshwater growth zones, (2) variable 14, the distance from circuli 2 to the end of the first freshwater annular zone, and (3) variable 79, the distance from circuli 3 to circuli 12 in the first marine annular zone (Appendix B). Variables 61, 8, and 98 provided somewhat less discrimination to the model. The primary distinguishing characters for age 1.4 in order of selection were (1) variable 62, the width of the freshwater plus growth zone, and (2) variable 67, the freshwater annular zone divided by the total width of the freshwater growth zone. Variables 89 and 27 were also selected. Measurements of freshwater growth typically accounted for most of the discriminatory power in both models. Group means and standard errors for the number of circuli and width of the first freshwater annular, plus growth, and marine annular zones are listed in Appendix C.

Proportion of Catch

The majority of the commercial chinook salmon catch in Districts 1 and 2 was taken in the first five fishing periods. Upper Yukon Run fish comprised the largest proportion of the District 1 commercial harvest of age-1.3 chinook salmon in periods 1, 2, and 6, and Upper Yukon Run fish comprised the largest proportion of District 1 harvests of age 1.4 in the first five periods and in period 7 (Table 3). Similarly, in District 2 Upper Yukon Run fish comprised the largest proportion for age 1.3 in the first four periods, while Upper Yukon Run fish predominated for age 1.4 in the first five periods in District 2 (Table 4). The high proportions of Upper Yukon Run fish in Districts 1 and 2 did not significantly decrease until after July 1, with the exception that the proportion of Upper Yukon Run age-1.3 fish in District 1 declined considerably between periods 2 and 6 (Table 3). Run contribution estimates through time in Districts 1 and 2 (Figures 4, 5, 6) generally demonstrated increasing proportions of Lower Yukon fish and decreasing proportions of Upper Yukon fish. However, the large proportion of Lower Yukon Run age-1.3 fish and the lack of Middle Yukon Run age- 1.3 fish, in District 2 period 2 was a notable exception. District 1 and 2 proportions and harvests of Middle Yukon fish demonstrated no clear overall trend in relative abundance; however, Middle Run fish appeared to be most consistently abundant in periods 4, 5, and 6 in both districts (Figures 4-6).

The estimated District 1 commercial catch of age-1.3 and -1.4 fish combined was 14,401 (20.1%) Lower, 16,565 (23.9%) Middle, and 38,339 (55.3%) Upper Yukon Run (Table 5). In District 2 the estimated age-1.3 and -1.4 combined catch was 7,620 (21.5%) Lower, 11,153 (31.5%) Middle, and 16,630 (47.0%) Upper Yukon Run (Table 6).

Classification by SPA Analysis

A total of 104,707 age-1.3 and -1.4 fish (55.9% of the total drainage harvest) from District 1 and 2 commercial catches were directly classified to run of origin based on results of scale pattern analysis. There were 28,886 (15.4% of the total drainage harvest) age-1.3 and -1.4 fish in Districts 1 and 2 subsistence harvests and Districts 3 and 4 commercial and subsistence harvests.

Classification by Differential Age Composition Analysis

The remaining age classes (1.1, 1.2, 2.3, 1.5, 2.4, 1.6, and 2.5) from Districts 1, 2, 3, and 4 commercial and subsistence catches contributed 10,849 fish (5.8%) to the total drainage harvest (Table 7). They were classified to run of origin using differences in escapement age composition in each run.

Classification by Geographical Analysis

A total of 42,721 fish (22.8% of total drainage harvest) in Districts 5, 6, and Yukon Territory was classified to run of origin based on geographical segregation. District 5 and Yukon Territory commercial, subsistence, and sport catches were assumed to be Upper Yukon fish. Commercial, subsistence, and sport catches in District 6 (Table 7) were classified entirely to the Middle Yukon Run.

Total Harvest

The commercial and subsistence harvest of chinook salmon from the entire Yukon River drainage was classified to run of origin (Table 7) based on (1) findings of the scale patterns analysis of age-1.3 and -1.4 fish in District 1 and 2 commercial catches, (2) age composition analysis of the remaining age classes, (3) assumptions concerning unsampled fisheries, and (4) stock origins based on geographical segregation. The Upper Yukon Run composed the largest run component and contributed 111,037 fish or 59.3% of the total drainage harvest. The Middle Yukon Run was next in abundance at 43,332 fish (23.2%), followed by the Lower Yukon Run at 32,792 fish (17.5%).

DISCUSSION

Proportions of total drainage harvest that were allocated to each run were typical of most other years (Table 8). Estimates of the Upper Yukon Run component have ranged from 35.4% in 1984 to 67.9% in 1986, with an unweighted average of 55.6% since 1982. Age 1.4 in the total harvest is usually composed of relatively more Upper Yukon Run fish than the other major age classes. Exceptions to this seem to occur in years when the relative harvest of Upper-Yukon-Run fish is smaller than usual, i.e. 1991. Therefore, it seems possible that the large catches of age 1.4 in Districts 1 and 2 accounted for much of the increased proportion of Upper Yukon Run fish in the total drainage harvest.

Except for the Andreafsky River, overall sample sizes were fair to excellent for all escapements which contribute to the standard three-way LDF classification model. Andreafsky River samples were few due to the very large numbers of pink salmon carcasses which too often hid chinook salmon carcasses. Also, relatively small proportions of age-1.3 fish in escapements plus the small Andreafsky sample provided smaller than desired samples for the lower and middle components of the model. Catch sample sizes in District 1 were excellent overall, though weak in later periods when small catches prevented sampling objectives from being obtained. District 2 catches were not sampled during restricted mesh-size openings, and District 1 data was used to allocate those catches. The schedule of District 2 mesh-size restrictions is often quite different from that of District 1. This is an important factor which precludes logical application of District 1 age-class allocation results to District 2 harvests. Because the combined District 1 and 2 harvest is the largest single proportion of the total drainage harvest, it is important to continue to acquire adequate samples in both districts. Future sampling plans should include sampling at least 200 chinook salmon from District 2 harvests taken with restricted mesh-size gear.

A continuing problem concerns sampling upper Yukon tributaries. The Upper Yukon Run is sampled in Canada near the U.S.-Canada border at the DFO tagging project sites. Total abundance estimates for the Upper Yukon Run have been obtained from that study, and scales taken from chinook salmon have provided the Upper Yukon Run scale pattern standard when commercial harvest samples were inadequate or unavailable, as in 1992. For allocation of harvests to run of origin, the approach of using samples from the DFO mainstem Yukon River test fish wheels to build run-of-origin models assumes that those samples are representative of the run of Canadian-spawned chinook salmon. Test fish wheels may not catch all sizes of chinook salmon and all component stocks in proportion to their abundance. Therefore, appropriately weighted escapement samples, such as those used for the Lower and Middle Yukon Runs, could improve the construction of the Upper Yukon Run stock composition model. Unfortunately, escapement sampling effort has failed to provide data that can be confidently used for the Upper Yukon Run stock standard. At this time the scales collected from tagging fish wheel catches are accepted as the best compromise available. The dominant age classes which are modeled for the SPA analysis are adequately represented in catches from the tagging study fish wheels and the sample is assumed to represent age and stock compositions in Canadian harvests, as well as total Upper Yukon Run escapements.

Failure to obtain appropriate sample sizes from DFO to adequately represent the Upper Yukon Run would seriously weaken or invalidate the SPA analysis. Curtailment of harvest and escapement sampling effort in Canada by DFO and ADF&G highlights the importance of the DFO test fish wheel scale samples as the only remaining source for the Upper Yukon Run chinook SPA stock standard and for sex and age composition of salmon in Canada. Prior to 1991, ADF&G mounted an extensive effort in cooperation with the U.S. Fish and Wildlife Service and DFO to sample Yukon River tributaries in Canada. Aimed at documenting the age and sex composition of chinook salmon in the Upper River escapement, those sampling efforts have since been eliminated by tightening budgets. Additionally, DFO stopped sampling the commercial salmon catch in Canada for age and sex information. Lack of catch and escapement sampling in the Canadian portion of the drainage results in a lack of basic biological information on the age and sex composition of the run and makes the scale pattern analyses characterizing the stock standard dependent on DFO tagging study fish wheel samples.

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Table 1. Age proportions of Yukon River chinook salmon escapement samples, 1992.

			Brood Year and Age Group									
			1989	1988	1987		1986		1985		1984	
Location	Escapement Index Abundance Estimate	Sample Size[a]	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5
Lower Yukon												
Andreafsky River[b]	3,032	52	0.0000	0.2308	0.4808	0.0000	0.2500	0.0000	0.0385	0.0000	0.0000	0.0000
Anvik River	1,536	315	0.0000	0.0952	0.3778	0.0032	0.5079	0.0000	0.0159	0.0000	0.0000	0.0000
Average Proportion			0.0000	0.1852	0.4461	0.0011	0.3367	0.0000	0.0309	0.0000	0.0000	0.0000
Middle Yukon												
Chena River[c]	5,230	464	0.0194	0.4095	0.1616	0.0000	0.4030	0.0022	0.0022	0.0022	0.0000	0.0000
Salcha River[c]	8,410	646	0.0124	0.3080	0.2848	0.0015	0.3793	0.0031	0.0093	0.0015	0.0000	0.0000
Average Proportion			0.0151	0.3469	0.2376	0.0010	0.3884	0.0027	0.0066	0.0018	0.0000	0.0000
Upper Yukon (Canada)												
White Rock & Sheep Rock[c]	24,359	1,234	0.0065	0.2318	0.3971	0.0000	0.3460	0.0041	0.0081	0.0057	0.0000	0.0008

[a] All samples were collected from carcasses and live spawnouts captured with fish spears, unless otherwise noted. Escapement index abundance estimates are peak aerial survey counts except as noted.

[b] Includes respective East and West Fork aerial survey counts of 1,030 and 2,002.

[c] Mark and recapture population estimate.

Table 2. Classification accuracies of linear discriminant run–of–origin models for age–1.3 and –1.4 Yukon River chinook salmon, 1992.

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Age 1.3				
Lower	48	0.896	0.063	0.042
Middle	65	0.046	0.692	0.262
Upper	127	0.094	0.252	0.654
	Mean Classification Accuracy:	**0.747**		
	Variables in Analysis:	67, 14, 79, 61, 8, 98		
Age 1.4				
Lower	108	0.790	0.177	0.032
Middle	148	0.146	0.667	0.188
Upper	271	0.017	0.178	0.805
	Mean Classification Accuracy:	**0.754**		
	Variables in Analysis:	62, 67, 89, 27		

Table 3. Run composition estimates for age-1.3 and -1.4 chinook salmon commercial catches in Yukon River District 1, 1992.

Commercial Fishing Period	Dates	Run-of-Origin	Age 1.3 N	Age 1.3 P	Age 1.3 S.E.	Age 1.3 Simultaneous 90% CI[a]	Age 1.4 N	Age 1.4 P	Age 1.4 S.E.	Age 1.4 Simultaneous 90% CI[a]
1	6/20	Lower	14	0.331	0.055	0.214 < P < 0.448	108	0.190	0.052	0.079 < P < 0.302
		Middle		0.057	0.237	0.000 < P < 0.562		0.091	0.082	0.000 < P < 0.265
		Upper		0.612	0.281	0.014 < P < 1.000		0.719	0.073	0.564 < P < 0.874
2	6/22-23	Lower	17	0.262	0.136	0.000 < P < 0.551	134	0.108	0.044	0.015 < P < 0.201
		Middle		0.208	0.239	0.000 < P < 0.716		0.262	0.081	0.089 < P < 0.435
		Upper		0.530	0.264	0.000 < P < 1.000		0.630	0.069	0.484 < P < 0.776
3	6/25-26	Lower	16	0.368	0.147	0.055 < P < 0.681	75	0.134	0.057	0.013 < P < 0.254
		Middle		0.296	0.242	0.000 < P < 0.811		0.100	0.099	0.000 < P < 0.310
		Upper		0.336	0.255	0.000 < P < 0.878		0.766	0.087	0.581 < P < 0.952
4	6/27	Lower	13	0.306	0.150	0.000 < P < 0.626	22	0.138	0.105	0.000 < P < 0.362
		Middle		0.694	0.150	0.375 < P < 1.000		0.101	0.183	0.000 < P < 0.490
		Upper		0.000	0.000			0.761	0.161	0.419 < P < 1.000
5	7/29-30	Lower	10	0.412	0.185	0.019 < P < 0.805	47	0.253	0.095	0.051 < P < 0.454
		Middle		0.514	0.311	0.000 < P < 1.000		0.333	0.141	0.032 < P < 0.634
		Upper		0.074	0.287	0.000 < P < 0.685		0.415	0.112	0.177 < P < 0.652
6	7/02-03	Lower	19	0.233	0.123	0.000 < P < 0.494	94	0.318	0.071	0.166 < P < 0.470
		Middle		0.365	0.238	0.000 < P < 0.871		0.355	0.101	0.140 < P < 0.569
		Upper		0.403	0.251	0.000 < P < 0.937		0.328	0.076	0.166 < P < 0.489
7	7/06	Lower	11	0.905	0.141	0.605 < P < 1.000	24	0.385	0.139	0.088 < P < 0.681
		Middle		0.023	0.166	0.000 < P < 0.377		0.148	0.181	0.000 < P < 0.533
		Upper		0.072	0.173	0.000 < P < 0.441		0.468	0.151	0.146 < P < 0.790
8	7/09	Lower	19	0.547	0.140	0.249 < P < 0.845	23	0.456	0.149	0.139 < P < 0.773
		Middle		0.141	0.191	0.000 < P < 0.548		0.170	0.187	0.000 < P < 0.569
		Upper		0.311	0.211	0.000 < P < 0.761		0.374	0.149	0.058 < P < 0.691

[a] Confidence intervals are calculated as $p \pm ((z_{(alpha/2k)})(\text{S.E. of } p))$, where $k=3$ and $z_{(alpha/2k)}=2.128$.

Table 4. Run composition estimates for age–1.3 and –1.4 chinook salmon commercial catches in Yukon River District 2, 1992.

Commercial Fishing Period	Dates	Run–of–Origin	Age 1.3 N	Age 1.3 P	Age 1.3 S.E.	Age 1.3 Simultaneous 90% CI[a]	Age 1.4 N	Age 1.4 P	Age 1.4 S.E.	Age 1.4 Simultaneous 90% CI[a]
1	6/22	Lower	8	0.199	0.190	0.000 < P < 0.603	48	0.065	0.073	0.000 < P < 0.220
		Middle		0.081	0.338	0.000 < P < 0.801		0.446	0.144	0.139 < P < 0.753
		Upper		0.720	0.389	0.000 < P < 1.000		0.489	0.117	0.239 < P < 0.738
2	6/24–25	Lower	17	0.535	0.148	0.220 < P < 0.851	94	0.240	0.064	0.104 < P < 0.376
		Middle		0.000	0.000	0.000 < P < 0.000		0.246	0.097	0.040 < P < 0.451
		Upper		0.465	0.148	0.149 < P < 0.780		0.515	0.080	0.345 < P < 0.685
3[b]	6/26	Lower	17	0.262	0.136	0.000 < P < 0.551	134	0.108	0.044	0.015 < P < 0.201
		Middle		0.208	0.239	0.000 < P < 0.716		0.262	0.081	0.089 < P < 0.435
		Upper		0.530	0.264	0.000 < P < 1.000		0.630	0.069	0.484 < P < 0.776
4	6/28	Lower	11	0.231	0.166	0.000 < P < 0.584	74	0.132	0.067	0.000 < P < 0.274
		Middle		0.147	0.294	0.000 < P < 0.771		0.438	0.116	0.191 < P < 0.685
		Upper		0.622	0.331	0.000 < P < 1.000		0.430	0.092	0.233 < P < 0.626
5[b]	7/01–02	Lower	10	0.412	0.185	0.019 < P < 0.805	47	0.253	0.095	0.051 < P < 0.454
		Middle		0.514	0.311	0.000 < P < 1.000		0.333	0.141	0.032 < P < 0.634
		Upper		0.074	0.287	0.000 < P < 0.685		0.415	0.112	0.177 < P < 0.652
6[b]	7/06	Lower	19	0.233	0.123	0.000 < P < 0.494	94	0.318	0.071	0.166 < P < 0.470
		Middle		0.365	0.238	0.000 < P < 0.871		0.355	0.101	0.140 < P < 0.569
		Upper		0.403	0.251	0.000 < P < 0.937		0.328	0.076	0.166 < P < 0.489
7	7/08	Lower	12	0.626	0.171	0.263 < P < 0.989	73	0.351	0.084	0.171 < P < 0.530
		Middle		0.265	0.245	0.000 < P < 0.785		0.421	0.116	0.173 < P < 0.669
		Upper		0.109	0.231	0.000 < P < 0.601		0.228	0.082	0.055 < P < 0.402

[a] Confidence intervals are calculated as $p \pm ((z_{(alpha/2k)})(\text{S.E. of } p))$, where k=3 and $z_{(alpha/2k)}=2.128$.

[b] Samples not available. Data from District 1 periods 2, 5, and 6 were substituted for District 2 periods 3, 5, and 6, respectively.

Table 5. Classification of age−1.3 and −1.4 chinook salmon catches by run and fishing period for the commercial fishery in Yukon River District 1, 1992.

Commercial Fishing Period	Dates and Mesh Size	Region of Origin	Age Group 1.3	Age Group 1.4	Total
1	6/20	Lower	473	2,047	2,521
		Middle	81	976	1,058
	Unrestricted	Alaska	555	3,024	3,578
		Upper	875	7,729	8,604
		Total	1,429	10,753	12,182
2	6/22−23	Lower	731	1,969	2,701
		Middle	582	4,773	5,355
	Unrestricted	Alaska	1,313	6,742	8,055
		Upper	1,481	11,473	12,954
		Total	2,794	18,216	21,010
3	6/25−26	Lower	431	1,127	1,558
		Middle	347	840	1,186
	Unrestricted	Alaska	778	1,966	2,744
		Upper	394	6,447	6,841
		Total	1,172	8,413	9,585
4	6/27	Lower	761	590	1,351
		Middle	1,724	433	2,157
	Restricted	Alaska	2,486	1,022	3,508
		Upper	0	3,263	3,263
		Total	2,486	4,285	6,771
5	6/29−30	Lower	747	1,647	2,395
		Middle	931	2,168	3,099
	Restricted	Alaska	1,678	3,815	5,494
		Upper	135	2,701	2,836
		Total	1,813	6,517	8,329
6	7/02−03	Lower	314	2,717	3,030
		Middle	492	3,030	3,522
	Unrestricted	Alaska	806	5,747	6,553
		Upper	544	2,799	3,343
		Total	1,350	8,546	9,895
7	7/06	Lower	329	212	541
		Middle	9	82	90
	Restricted	Alaska	337	294	632
		Upper	26	258	285
		Total	364	553	916
8	7/09	Lower	141	164	305
		Middle	36	61	98
	Restricted	Alaska	177	225	402
		Upper	80	135	215
		Total	257	360	617
District 1 Season Total		Lower	3,928	10,473	14,401
		Middle	4,202	12,363	16,565
		Alaska	8,130	22,836	30,966
		Upper	3,534	34,805	38,339
		Total	11,664	57,641	69,305

Table 6. Classification of age-1.3 and -1.4 chinook salmon catches by run and fishing period for the commercial fishery in Yukon River District 2, 1992.

Commercial Fishing Period	Dates and Mesh Size	Region of Origin	Age Group 1.3	Age Group 1.4	Total
1	6/22	Lower	115	314	428
		Middle	47	2,138	2,184
	Unrestricted	Alaska	161	2,451	2,613
		Upper	415	2,343	2,758
		Total	576	4,794	5,370
2	6/24-25	Lower	987	2,468	3,455
		Middle	0	2,528	2,528
	Unrestricted	Alaska	987	4,996	5,983
		Upper	857	5,297	6,153
		Total	1,843	10,293	12,136
3[a]	6/26	Lower	104	281	386
		Middle	83	682	765
	Restricted	Alaska	188	963	1,151
		Upper	212	1,639	1,850
		Total	399	2,602	3,001
4	6/28	Lower	205	812	1,017
		Middle	130	2,687	2,817
	Unrestricted	Alaska	335	3,498	3,833
		Upper	551	2,637	3,188
		Total	886	6,136	7,022
5[a]	7/01-02	Lower	305	673	978
		Middle	380	886	1,266
	Restricted	Alaska	686	1,559	2,244
		Upper	55	1,104	1,158
		Total	741	2,662	3,403
6[a]	7/06	Lower	61	526	587
		Middle	95	587	683
	Restricted	Alaska	156	1,114	1,270
		Upper	105	542	648
		Total	262	1,656	1,918
7	7/08	Lower	116	652	769
		Middle	183	727	910
	Unrestricted	Alaska	299	1,379	1,678
		Upper	202	672	874
		Total	501	2,051	2,552
District 2 Season Total		Lower	1,893	5,726	7,620
		Middle	918	10,234	11,153
		Alaska	2,812	15,961	18,772
		Upper	2,397	14,233	16,630
		Total	5,208	30,194	35,402

[a] Samples not available. Respective classifications for periods 3, 5, and 6 were calculated using data from District 1 periods 2, 5, and 6.

Table 7. Total commercial and subsistence catch of chinook salmon by age class and run in Yukon River Districts 1–6 and Canada, 1992.

			Brood Year and Age Group										
			1989	1988	1987		1986		1985		1984		
District	Fishery	Run of Origin	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
1	Commercial Gillnet	Lower	0	634	3,928	0	10,473	0	1,962	0	0	0	16,996
		Middle	0	1,391	4,202	0	12,363	29	215	42	0	0	18,243
		Alaska	0	2,025	8,130	0	22,836	29	2,177	42	0	0	35,239
		Upper	0	903	3,534	0	34,805	65	395	199	0	0	39,901
		Total [a]	0	2,928	11,664	0	57,641	94	2,571	242	0	0	75,142
	Subsistence Gillnet [b]	Lower	0	56	345	0	919	0	172	0	0	0	1,491
		Middle	0	122	369	0	1,085	3	19	4	0	0	1,600
		Alaska	0	178	713	0	2,003	3	191	4	0	0	3,091
		Upper	0	79	310	0	3,053	6	35	17	0	0	3,500
		Total	0	257	1,023	0	5,057	8	226	21	0	0	6,592
2	Commercial Gillnet	Lower	0	168	1,893	2	5,726	0	944	0	0	0	8,735
		Middle	0	867	918	6	10,234	24	173	63	0	0	12,284
		Alaska	0	1,035	2,812	8	15,961	24	1,117	63	0	0	21,019
		Upper	0	74	2,397	0	14,233	30	185	172	0	29	17,120
		Total [c]	0	1,109	5,208	8	30,194	54	1,302	235	0	29	38,139
	Subsistence Gillnet [d]	Lower	0	10	351	0	1,062	0	163	0	0	0	1,586
		Middle	0	190	170	1	1,898	2	21	5	0	0	2,290
		Alaska	0	200	521	2	2,960	2	184	5	0	0	3,876
		Upper	0	6	445	0	2,640	8	57	38	0	5	3,198
		Total	0	206	966	2	5,600	10	242	44	0	5	7,074
3	Commercial Gillnet [d]	Lower	0	8	90	0	273	0	45	0	0	0	417
		Middle	0	41	44	0	488	1	8	3	0	0	586
		Alaska	0	49	134	0	761	1	53	3	0	0	1,002
		Upper	0	4	114	0	679	1	9	8	0	1	817
		Total	0	53	248	0	1,440	3	62	11	0	1	1,819
	Subsistence Gillnet [d]	Lower	0	7	237	0	717	0	110	0	0	0	1,070
		Middle	0	128	115	1	1,281	2	14	4	0	0	1,545
		Alaska	0	135	352	1	1,997	2	124	4	0	0	2,615
		Upper	0	4	300	0	1,781	5	39	26	0	4	2,158
		Total	0	139	652	1	3,779	7	163	29	0	4	4,773
4	Commercial & Subsistence GN & FW [e]	Lower	0	48	541	1	1,637	0	270	0	0	0	2,497
		Middle	0	248	262	2	2,926	7	49	18	0	0	3,512
		Alaska	0	296	804	2	4,563	7	319	18	0	0	6,009
		Upper	0	21	685	0	4,069	9	53	49	0	8	4,894
		Total	0	317	1,489	2	8,632	15	372	67	0	8	10,903

-Continued-

Table 7. (Page 2 of 2)

			Brood Year and Age Group										
			1989	1988	1987		1986		1985		1984		
District	Fishery	Run of Origin	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
5	Commercial & Subsistence GN & FW[f]	Upper	140	4,994	8,556	0	7,456	87	175	122	0	17	21,546
6	Commercial & Subsistence GN & FW[g]	Middle	49	1,135	777	3	1,271	9	21	6	0	0	3,272
Canada	Commercial GN & FW[h]	Upper	71	2,521	4,319	0	3,764	44	88	62	0	9	10,877
	Non–Commercial[i]	Upper	46	1,628	2,790	0	2,431	28	57	40	0	6	7,026
TOTAL HARVEST		Lower	0	930	7,385	3	20,807	0	3,666	0	0	0	**32,792**
		Middle	49	4,123	6,858	13	31,546	76	522	145	0	0	**43,332**
		Alaska	49	5,053	14,243	17	52,353	76	4,188	145	0	0	**76,124**
		Upper	256	10,233	23,449	0	74,911	283	1,091	735	0	79	**111,037**
		Total	305	15,286	37,692	17	127,264	359	5,279	879	0	79	**187,161**

[a] Includes 930 fish from ADF&G test fisheries and 1,218 fish from illegal sales discovered during investigations by the Alaska Division of Fish and Wildlife Protection (FWP).

[b] Run composition is based on season total District 1 commercial catch samples.

[c] Includes 207 fish from illegal sales investigated by FWP.

[d] Run composition based on season total District 2 commercial catch samples.

[e] Age composition in total row is based on District 4 combined commercial and subsistence fish wheel and gillnet samples. Stock composition of age class is proportioned using District 2 stock composition by age class. Commercial catch = 1,651 fish, commercial related catch = 743, and subsistence catch = 8,509 fish.

[f] Gillnet & fish wheel catches combined. Commercial catch = 3,852, commercial related catch = 3, and subsistence catch = 17,691.

[g] Gillnet and fish wheel catches combined. Preliminary data includes 572 commercial, 180 commercial related, 2,438 subsistence, 32 test fish, and 50 sport caught fish.

[h] Run and age composition based on Canada DFO fish wheel samples from Sheep Rock and White Rock tagging sites near Dawson.

[i] Run and age composition are based on Canada DFO tagging study fish wheel samples. Preliminary harvest components include Yukon River Indian food (6,449), domestic (277), and sport (300) harvests.

Table 8. Harvest percentages by run of the total Yukon River harvest of chinook salmon, 1982–92.

Year	Lower Run	Middle Run	Upper Run
1982	13.5	23.7	62.8
1983	12.4	36.8	50.8
1984	29.0	35.6	35.4
1985	30.9	19.5	49.6
1986	26.5	5.6	67.9
1987	16.5	17.3	66.2
1988	27.2	11.3	61.4
1989	25.7	15.9	58.4
1990	19.3	22.2	58.5
1991	26.1	29.0	44.9
1992	17.5	23.2	59.3
1982–91 Avg	22.7	21.7	55.6
1987–91 Avg	23.0	19.1	57.9

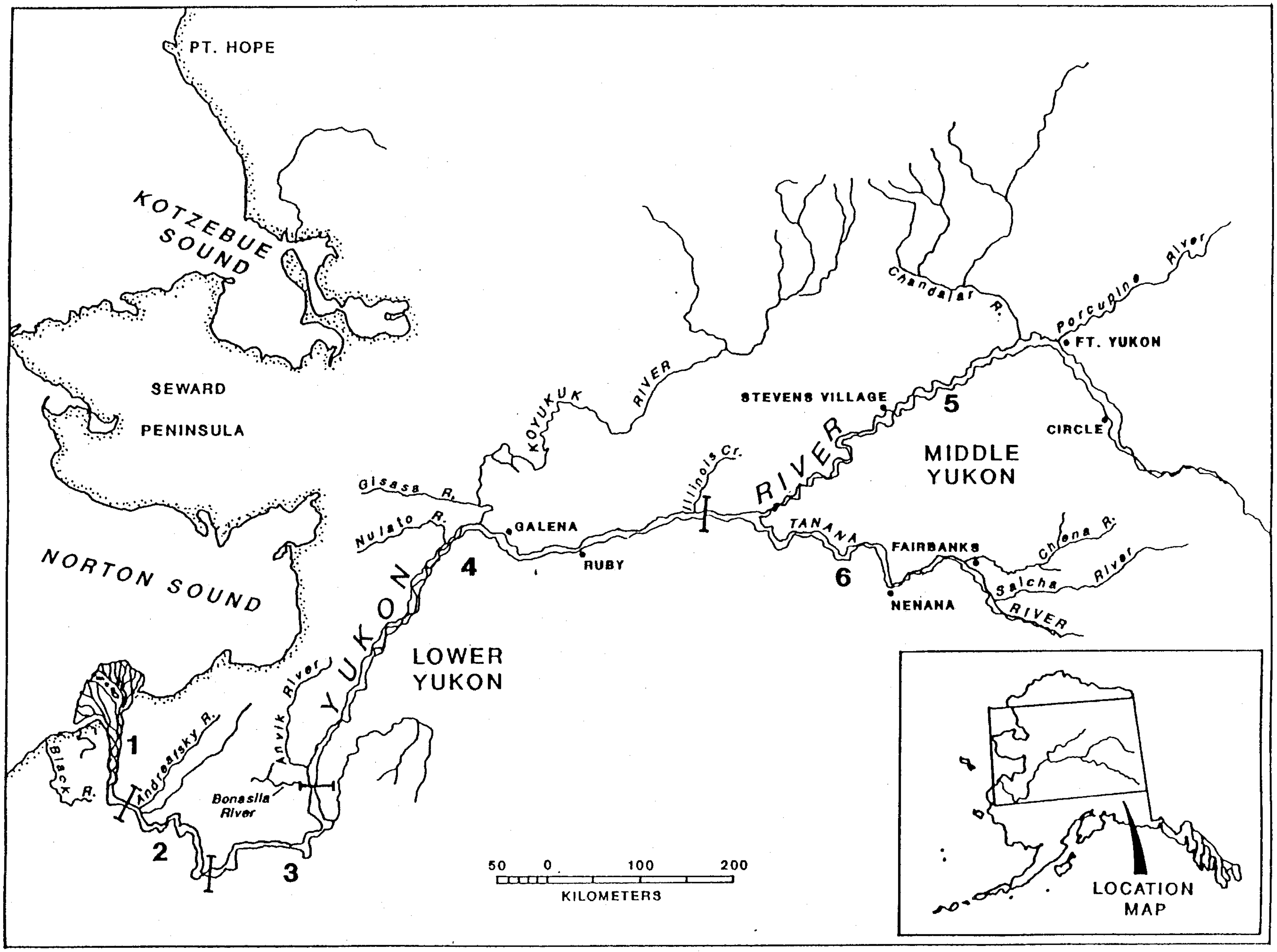

Figure 1. Alaskan portion of the Yukon River showing fishing district boundaries.

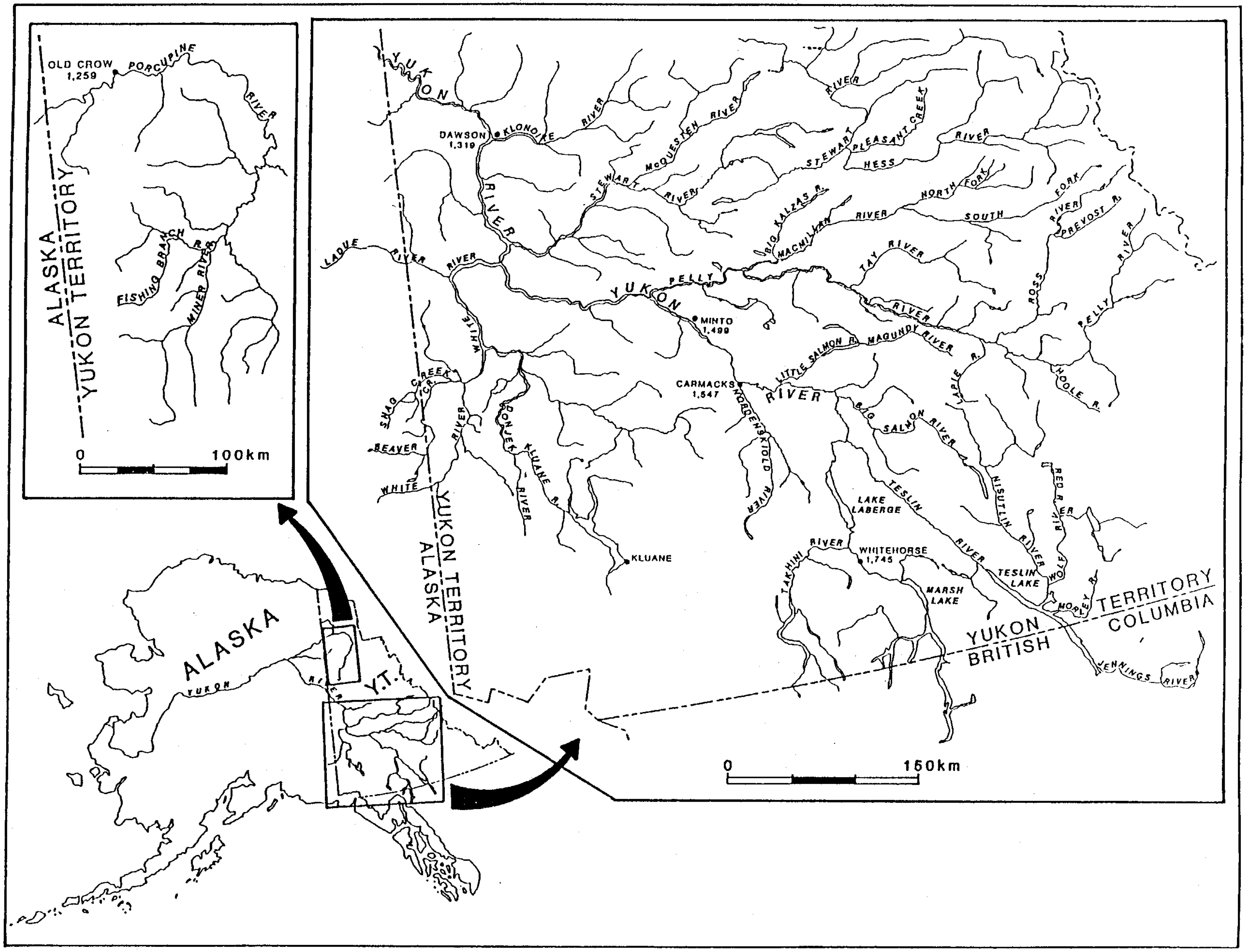

Figure 2. Canadian portion of the Yukon River drainage.

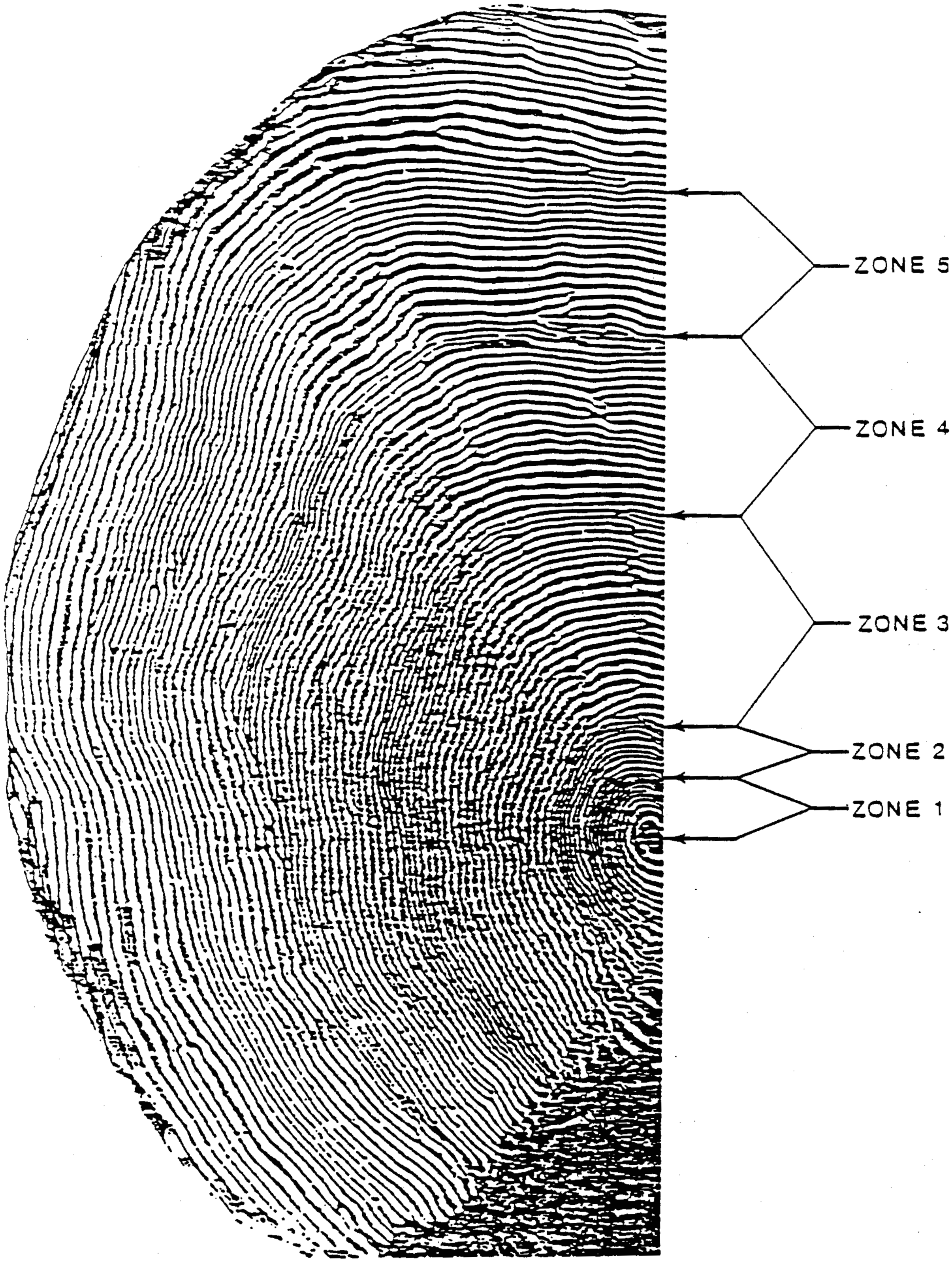

Figure 3. Age-1.4 chinook salmon scale showing zones measured for linear discriminant analysis.

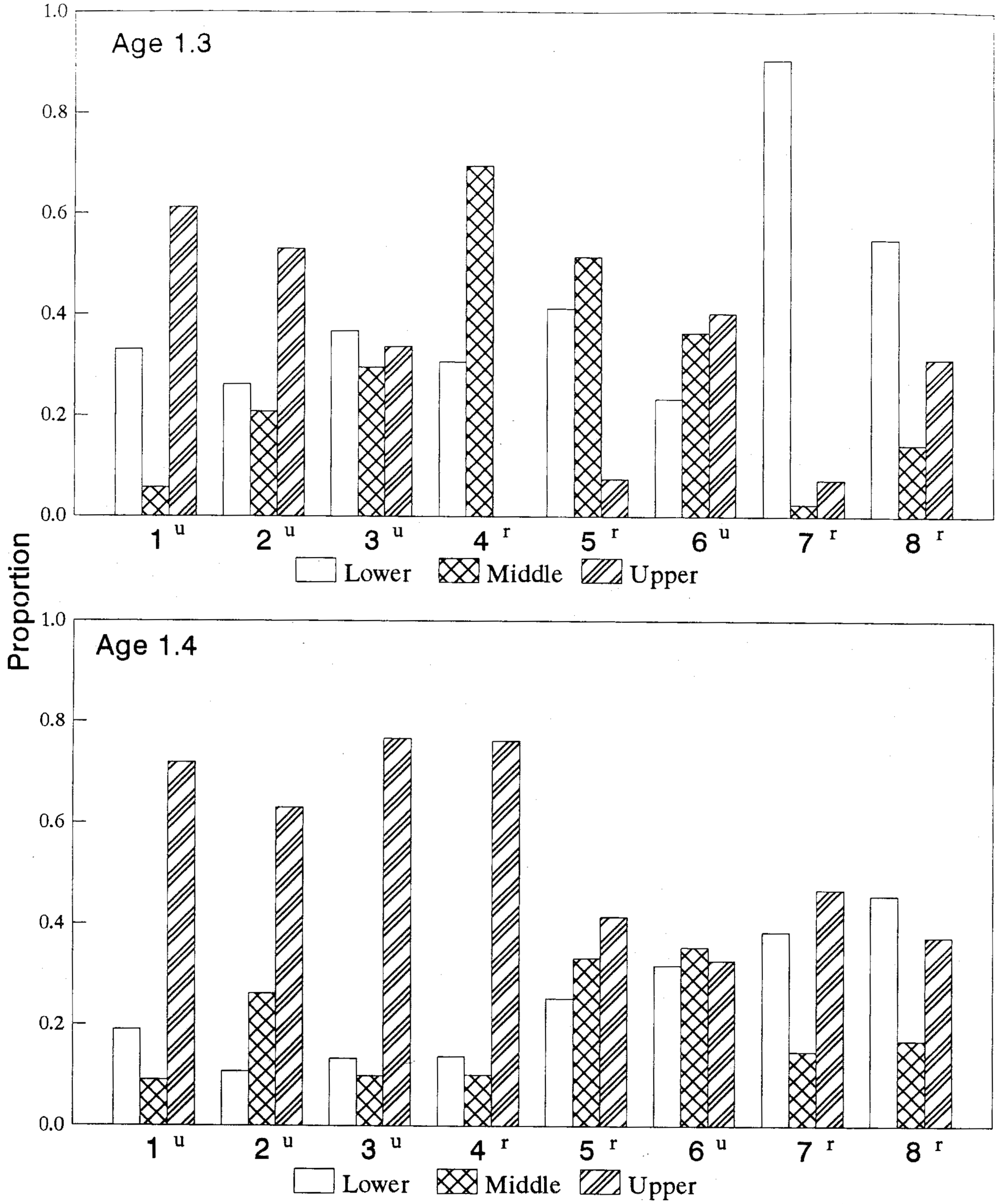

Figure 4. Estimated proportion of catch by period (u = unrestricted, r = restricted mesh size) and run from scale pattern analysis of age−1.3 and −1.4 chinook salmon, Yukon River District 1, 1992.

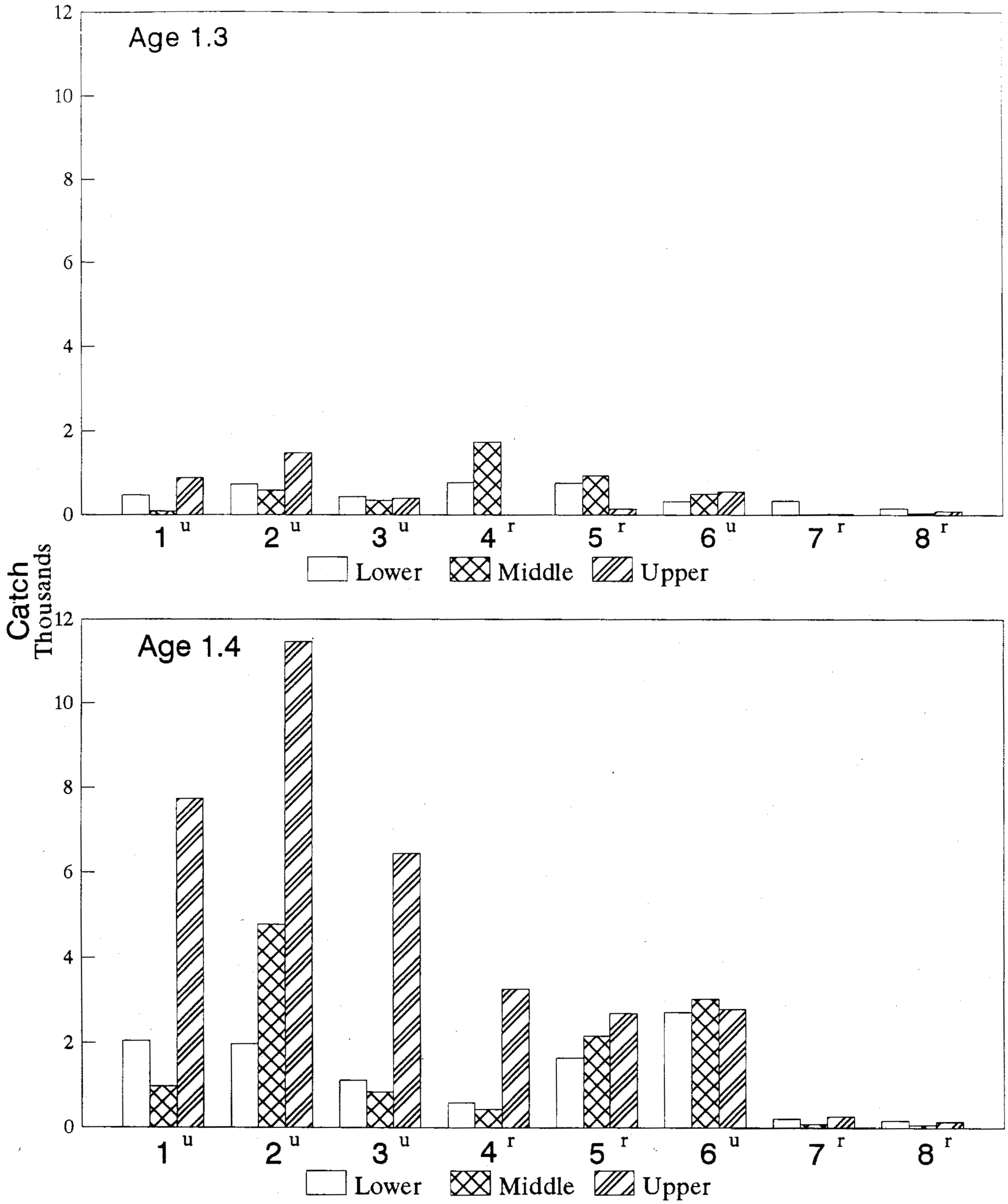

Figure 5. Estimated catch by period (u = unrestricted, r = restricted mesh size) and run in numbers of fish from scale pattern analysis of age−1.3 and −1.4 chinook salmon, Yukon River District 1, 1992.

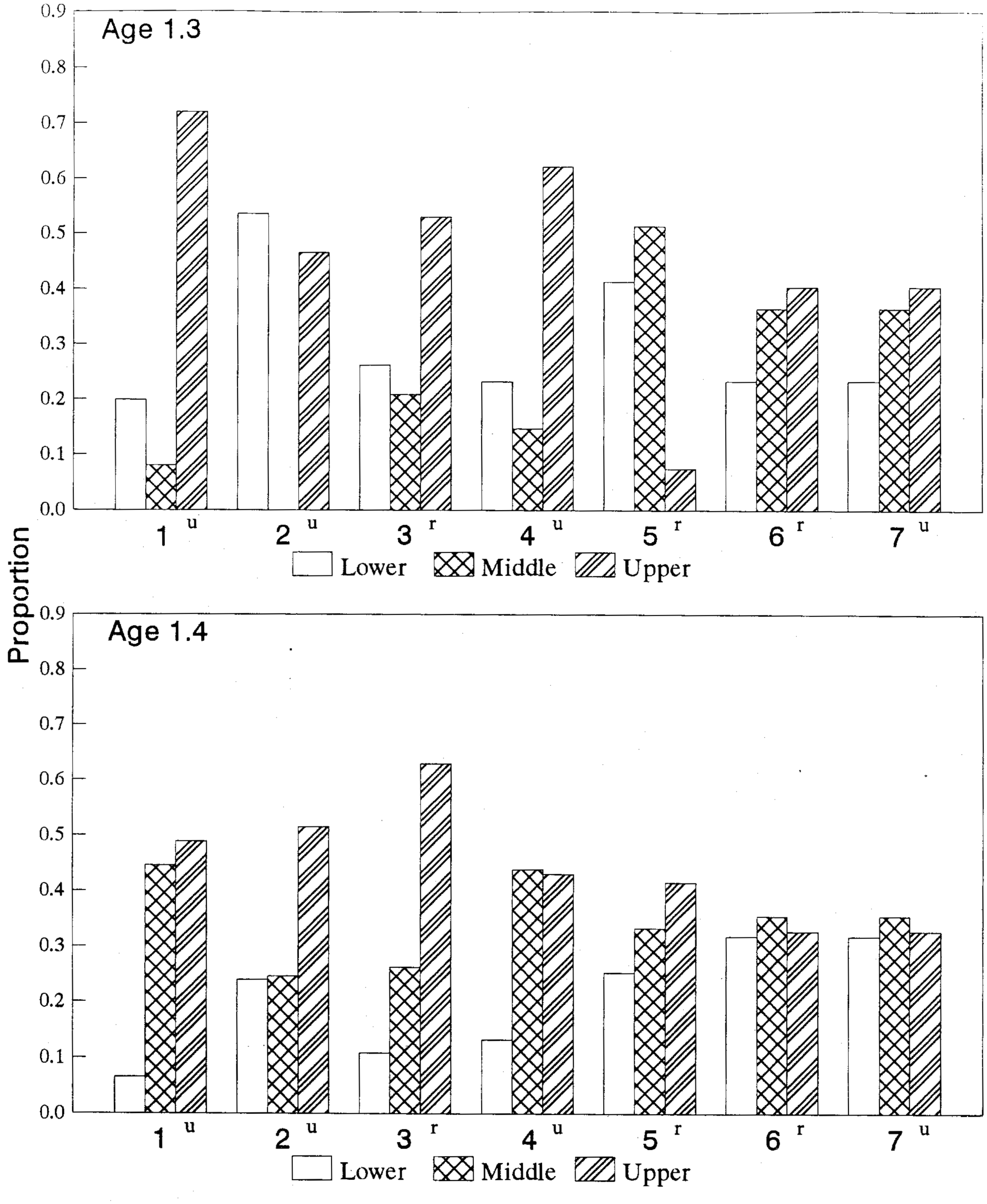

Figure 6. Estimated proportion of catch by period (u = unrestricted, r = restricted mesh size) and run from scale pattern analysis of age−1.3 and −1.4 chinook salmon, Yukon River District 2, 1992.

APPENDIX

Appendix A. Scale variables screened for linear discriminant function analysis of age-1.3 and -1.4 Yukon River chinook salmon, 1992.

Variable		1st Freshwater Annular Zone	
1		Number of Circuli	(NC1FW)[a]
2		Width of Zone	(S1FW)[b]
3	(16)	Distance, scale focus (C0) to circulus 2 (C2)	
4		Distance, C0-C4	
5	(18)	Distance, C0-C6	
6		Distance, C0-C8	
7	(20)	Distance, C2-C4	
8		Distance, C2-C6	
9	(22)	Distance, C2-C8	
10		Distance, C4-C6	
11	(24)	Distance, C4-C8	
12		Distance, C(NC1FW -4) to end of zone	
13	(26)	Distance, C(NC1FW -2) to end of zone	
14		Distance, C2 to end of zone	
15		Distance, C4 to end of zone	
16-26		Relative widths, (variables 3-13)/S1FW	
27		Average interval between circuli, S1FW/NC1FW	
28		Number of circuli in first 3/4 of zone	
29		Maximum distance between 2 consecutive circuli	
30		Relative width, (variable 29)/S1FW	

Variable	Freshwater Plus Growth	
61	Number of Circuli	(NCPG)[c]
62	Width of Zone	(SPGZ)[d]

Variable	All Freshwater Zones	
65	Total number of freshwater circuli	(NC1FW+NCPG)
66	Total width of freshwater zone	(S1FW+SPGZ)
67	Relative width, S1FW/(S1FW+SPGZ)	

Continued

Variable		1st Marine Annular Zone
70		Number of circuli (NC1OZ)[e]
71		Width of zone (S1OZ)[f]
72	(90)	Distance, end of freshwater growth (EFW) to C3
73		Distance, EFW-C6
74	(92)	Distance, EFW-C9
75		Distance, EFW-C12
76	(94)	Distance, EFW-C15
77		Distance, C3-C6
78	(96)	Distance, C3-C9
79		Distance, C3-C12
80	(98)	Distance, C3-C15
81		Distance, C6-C9
82	(100)	Distance, C6-C12
83		Distance, C6-C15
84	(102)	Distance, C(NC1OZ -6) to end of zone
85		Distance, C(NC1OZ -3) to end of zone
86	(104)	Distance, C3 to end of zone
87		Distance, C9 to end of zone
88		Distance, C15 to end of zone
90-104		Relative widths, (variables 73-86)/S1OZ
105		Average interval between circuli, S1OZ/NC1OZ
106		Number of circuli in first 1/2 of zone
107		Maximum distance between 2 consecutive circuli
108		Relative width, (variable 107)/S1OZ

Variable	All Marine Zones	
109	Width of 2nd Marine zone,	(S2OZ)
110	Width of 3rd Marine zone,	(S3OZ)
111	Total width of marine zones	(S1OZ+S2OZ+S3OZ)
112	Relative width,	S1OZ/(S1OZ+S2OZ+S3OZ)
113	Relative width,	S2OZ/(S1OZ+S2OZ+S3OZ)

[a] Number of circuli, 1st freshwater zone.
[b] Size (axial length) 1st freshwater zone.
[c] Number of circuli, plus growth zone.
[d] Size (axial length) plus growth zone.
[e] Number of circuli, 1st ocean zone.
[f] Size (axial length) 1st ocean zone.

Appendix B. Group means, standard errors, and one-way analysis of variance F-statistic for scale variables selected for use in linear discriminant models of age-1.3 and -1.4 Yukon River chinook salmon runs, 1992.

Growth Zone	Variable	Lower		Middle		Upper		F-Value
		Mean	SE	Mean	SE	Mean	SE	
Age-1.3								
1st FW Annular	8	45.25	0.98	35.65	0.59	40.35	0.52	33.79
	14	94.98	3.12	54.72	1.85	69.67	1.53	73.10
FW Plus Growth	61	4.31	0.21	6.18	0.20	7.22	0.13	64.86
Total FW Growth	67	0.75	0.01	0.61	0.01	0.60	<0.01	83.80
1st Marine Ann.	79	168.15	3.47	165.09	2.29	184.35	2.03	20.37
	98	0.50	0.01	0.54	<0.01	0.58	<0.01	26.10
Age-1.4								
1st FW Annular	27	13.87	0.13	13.40	0.15	12.85	0.15	10.68
FW Plus Growth	62	42.32	1.61	57.47	1.41	57.92	1.32	136.95
Total FW Growth	67	0.75	<0.01	0.65	<0.01	0.60	<0.01	112.79
1st Marine Ann.	89	227.90	6.07	199.07	5.27	161.55	4.00	42.86

Appendix C. Group means, standard errors, and one-way analysis of variance F-statistic for the number of circuli and incremental distance of salmon scale growth zone measurements from age-1.3 and -1.4 Yukon River chinook salmon runs, 1992.

			Lower		Middle		Upper		
Growth Zone	Variable	Description	Mean	SE	Mean	SE	Mean	SE	F-Value
<u>Age-1.3</u>									
1st FW Annular	1	No. Circ.	11.94	0.26	8.49	0.20	9.60	0.15	57.30
	2	Distance	146.65	3.39	104.27	2.10	121.35	1.65	67.47
Total FW Growth	61	No. Circ.	4.31	0.21	6.18	0.20	7.22	0.13	64.86
	62	Distance	49.38	2.77	68.96	2.53	82.55	1.55	55.90
1st Ocean Ann.	70	No. Circ.	25.02	0.45	23.36	0.30	22.34	0.22	18.56
	71	Distance	468.85	9.96	416.82	6.12	425.22	4.91	10.23
2nd Ocean Ann.	109	Distance	424.94	8.77	408.03	7.37	424.91	5.68	1.78
<u>Age-1.4</u>									
1st FW Annular	1	No. Circ.	9.24	0.16	7.98	0.15	9.16	0.14	22.43
	2	Distance	127.66	2.09	106.05	1.85	116.40	1.47	31.45
Total FW Growth	61	No. Circ.	3.84	0.14	5.16	0.13	6.59	0.11	111.58
	62	Distance	42.32	1.61	57.47	1.41	76.92	1.32	136.95
1st Ocean Ann.	70	No. Circ.	26.74	0.30	25.88	0.25	24.04	0.20	32.17
	71	Distance	492.34	5.00	465.33	5.79	449.53	4.10	16.11
2nd Ocean Ann.	109	Distance	470.13	6.55	440.25	5.95	433.51	4.70	9.81
3rd Ocean Ann.	110	Distance	423.65	5.96	404.82	5.26	408.84	4.96	2.65