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Division of Commercial Fisheries
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Origins Of Chinook Salmon In The Yukon River Fisheries, 1990

by

Daniel J. Schneiderhan

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 border escapement tagging studies in Canada were used to construct classification models for assigning Yukon River Districts 1, 2, 3, and 4 commercial and subsistence harvests to runs of origin. Linear discriminant models were used to estimate stock composition for age-1.2, -1.3, and -1.4 fish. Observed age composition differences among escapements were used to estimate run of origin for other age groups. Run of origin for all other drainage harvests was estimated from geographic occurrence. Total Yukon River harvest was 168,357 chinook salmon of which 58% was estimated to be the Upper Yukon Run, 23% the Middle Yukon Run, and 19% the Lower Yukon Run. The fraction of the District 1 and 2 commercial catch composed of the Lower Yukon Run generally increased through time, whereas the fraction composed of the Upper Yukon Run generally declined. The middle run component fluctuated slightly through the season.

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

INTRODUCTION

Yukon River chinook salmon *Oncorhynchus tshawytscha* (Walbaum) are harvested in a wide range of fisheries in both marine and fresh waters. During their ocean residence, they are harvested in gillnet fisheries in the North Pacific Ocean and Bering Sea and as an incidental catch in trawl fisheries in the Bering Sea (Meyers and Rogers 1985). 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.

During the 20 years following statehood, 1960–1979, total chinook harvest for the Alaskan and Canadian portions of the Yukon River averaged 122,971 fish annually (JTC 1991). Beginning in 1980, annual harvests increased substantially. During the most recent 5 years, 1986 to 1990, the total harvest averaged 175,829 fish (JTC 1991). Although 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 where the 1986–90 average catch was 55% of the total drainage harvest. Subsistence harvests throughout the drainage, including Canadian catches, accounted for 33% of the total harvest from 1986 to 1990. Most of the subsistence harvest is taken with fish wheels and gillnets in Districts 4, 5, and 6. In the Yukon River drainage the 1990 commercial, subsistence, and sport harvest was 168,357 chinook salmon, of which 84,374 fish, or 50%, were taken by District 1 and 2 commercial fishermen.

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

A controversy currently facing managers of Yukon River chinook salmon regards allocation of the harvest among competing user groups. Two such allocation issues which have received considerable attention are (1) Yukon River-bound chinook interceptions in the gillnet and trawl fisheries in the North Pacific Ocean and Bering Sea; and (2) inriver harvest of Canadian-origin chinook salmon. To ameliorate these problems, Yukon River fishery managers need to identify distinct stocks taken in Yukon River fisheries. Harvest estimates of Yukon chinook salmon from Western Alaska and Canada in the Japanese high seas gillnet fisheries were major elements in the regulation of those ocean fisheries (Rogers et al. 1984; Meyers et al. 1984; Meyers and Rogers 1985). Similarly, stock composition studies of inriver fisheries provided useful information for inriver allocation decisions through a better understanding of spatial and temporal migratory patterns of Yukon stocks. Estimates of how the stock composition of the catch varied over time for Yukon River chinook salmon became available in 1980 and 1981 in an initial investigation of scale pattern analysis in District 1 (McBride and Marshall 1983). Since then, harvest proportions by region of origin have been estimated annually for the entire drainage (Wilcock and McBride 1983; Wilcock 1984, 1985, 1986; Merritt et al. 1988; Merritt 1988; Wilcock 1990; Schneiderhan and Wilcock 1992).

This report presents the 1990 Yukon River chinook salmon commercial and subsistence harvests and estimates of their run-of-origin proportions.

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 Districts 1, 2, 4, 5, 6, and in Yukon Territory, Canada. Subsistence catches in Districts 4, 5, and 6 were also sampled. District 3 was not sampled because few fish were harvested in that portion of the Yukon River and access was difficult. A small fraction of the District 2 catch occasionally included catches from District 3 delivered in District 2. Most subsistence fishing in Districts 1 and 2 occurred concurrently with commercial fishing, and the age composition of the subsistence catch was assumed to be the same as the commercial catch. Samples were also collected from a test gillnet fishery in District 1 and from test fish wheels in Yukon Territory, Canada. Sampling of Alaskan fisheries was conducted by the Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries; Canadian test fish wheel samples were collected by the Canada Department of Fisheries and Oceans (DFO).

Escapement Sampling

Scale samples were collected during peak spawner mortality from Barton Creek and the Andreafsky, Anvik, Chena (Evanson 1991), Salcha (Burkholder 1991), and Goodpaster Rivers in Alaska; in Canada samples were taken from Tatchun Creek and from the McQuesten, Big Salmon, Little Salmon, Nisutlin, Morley, Nordenskjold, and Takhini Rivers. Samples were primarily collected from carcasses; however, some samples were obtained from live fish captured with spears.

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. We did not use those tributaries that were sampled but for which no abundance estimate was available. Age composition estimates and escapement abundance indices were available for all Alaskan tributaries that were targeted by this study. Escapement abundance indices were available for several Canadian tributaries that were most important to the development of this analysis. Age compositions were available for other less important Canadian tributaries that were not used to develop escapement abundance indices and therefore were not usable in this analysis.

Estimation of Catch Composition

Linear discriminant function analysis (Fisher 1936) of scale pattern data, observed differences in age composition between escapements, and geographic distribution of catches were used to estimate runs of origin of 1990 Yukon River chinook salmon catches.

Scale Pattern Analysis

Escapement samples from Alaska and 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 Barton Creek and the Chena, Salcha, and Goodpaster, Rivers. Canadian escapement samples could not be pooled to form a representative standard because of the lack of samples from several substantial spawning populations. Therefore, the Upper Yukon Run was represented by samples collected from test fish wheels operated in conjunction with the DFO tagging study near Dawson, Yukon Territory.

Scales from the lower river commercial gillnet fishery catch samples were classified to run of origin using discriminant functions. Only scales with one freshwater annulus, i.e., from age-1. fish, were used. Run proportions of fish aged 1.2, 1.3, and 1.4 were estimated for District 1 and 2 catches from fishing periods with adequate sample sizes. The preferred sample size was 50 or more for each age class; however, smaller samples were often used to describe a subset of the data, i.e., commercial fishing period, where relatively few fish were landed.

Measurements of scale features were made as described by McBride and Marshall (1983). Scale images were projected at 100X using magnification 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 using a computer digitizer.

The apex of circuli formations tends to differ between growth zones; 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) centrum to the outside edge of the freshwater annulus, or first freshwater annulus zone; (2) outside edge of the freshwater annulus to the last circulus of freshwater growth, or freshwater-plus growth zone; and (3) the last circulus of the freshwater plus growth zone to the outer edge of the first ocean annulus, or 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-nine scale characters or variables (Appendix A) were calculated from the basic incremental distances and circuli counts. Run-of-origin standards, i.e., pooled escapement samples, 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-1.2, -1.3, and -1.4 fish.

We selected scale characters for linear discriminant functions 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-1.2, -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). Variance estimates were obtained using a bootstrap resampling procedure (Efron 1982), and approximate simultaneous confidence intervals were constructed according to Goodman (1965).

Results of the age-specific scale pattern analysis by fishing period were summed to estimate total contribution by run of origin for age-1.2, -1.3, and -1.4 chinook salmon in the District 1 and 2 commercial catches.

Analysis of Age Composition

Age classes in the District 1 and 2 commercial catches that were not classified by scale pattern analysis 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 rates 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 scale pattern analysis, e.g., age 1.2, 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; and

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

Because the proportion of age-2.2 fish in escapement samples from previous years have tended to decrease as the distance upriver increased, proportions for the age class were divided by the proportion of age-1.3 fish, which have displayed a similar tendency and were from the same brood year. Similarly, proportions of age-2.3, -1.5, -2.4, -1.6, and -2.5 fish were treated as analogs of age-1.4 fish because these ages have historically increased in proportion with distance upriver. Furthermore, age-2.3 and -1.4 fish are 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, i.e., 1.2, 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:

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

where

$\hat{P}_{ci}$ = estimated proportion of fish of run c in N_i,

N_{ca} = catch of age group a where a was either age 1.2, 1.3, or 1.4 in run c, and

n = the number of runs, i.e., 3.

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

$$\hat{N}_{ci} = \hat{P}_{ci} N_i, \tag{3}$$

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 scale pattern analysis and differential age composition analysis of District 1 and 2 commercial catches were used to classify the catches of subsistence fisheries in Districts 1 and 2 as well as commercial and subsistence fisheries in District 3.

District 4 catches were divided into two components for estimating catch proportions by stock: (1) commercial and subsistence catches from the mainstem Yukon River, and (2) subsistence catches from the Koyukuk River. Mainstem catches were classified based on estimates of run composition from scale pattern analysis and differential age composition analysis of pooled samples from commercial and subsistence gillnet and fish wheel catches. Subsistence catches from the Koyukuk river were assumed to be similar to middle run stocks (Schneiderhan and Wilcock 1992).

Catch Composition Based on Geographical Segregation

Subsistence harvests in Districts 5 and 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 because most of the District 5 catch occurred above the confluence of the Tanana River. Also aerial survey counts of chinook salmon spawning in the Porcupine and Chandalar River drainages, totaling <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 is known to be violated because a small but unknown proportion of the District 5 subsistence harvest is taken on the south bank below the Tanana confluence, but we did not consider the proportion to be significant.

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

RESULTS

Escapement Age Composition

Escapement age compositions of Yukon River chinook salmon in 1990 exhibited a variety of trends (Table 1). Age-1.2 fish were notably more abundant than usual in middle and upper river escapements. Age-1.3 fish were observed in typical abundance throughout the drainage. The trend for the proportion of older fish to increase with distance upriver was not as pronounced as usual. Age 1.4, generally the predominant age class, was more abundant than usual in the Andreafsky and Anvik Rivers. The high proportion of age-1.4 fish in the middle river tributaries was typical. Two Canadian tributaries, Big Salmon and Nisutlin Rivers, exhibited the usual high proportions of age-1.4 fish, although the Little Salmon River had an atypically low representation of age 1.4. Canadian tributaries exhibited unusually low proportions of age-1.5 fish, and although substantial returns of age 2.4 were noted in the Nisutlin River, combined Canadian returns from the age-7 cohort, 1983 brood year, were in much lower proportions than usual. As in most other years, the greatest proportions of age-2.3, -2.4, and -2.5 fish were found in Upper Yukon Run samples; however, those age classes were proportionally smaller than usual.

Classification Accuracies of Run of Origin Models

Age-1.2 fish were classified for the first time in 1990. A mean classification accuracy for the 3-wayage-1.2 model of 76.8% (Table 2) was notably higher than previous averages for ages 1.3 and 1.4. Mean accuracies of 3-way, run-of-origin models for age-1.3 (80.6%) and -1.4 fish (77.8%) were higher than usual in 1990. As in past years the lower river standard showed the greatest accuracies for age-1.2 (93.7%), -1.3 (91.8%), and -1.4 (91.3%). Upper river standards yielded fairly typical accuracies for age-1.2 (67.4%), -1.3 (75.7%), and -1.4 fish (66.7%) and had the greatest likelihood of misclassifying as Middle Yukon Run. The accuracy of the middle river standards was also fairly typical for age 1.2 (69.3%), 1.3 (74.5%), and 1.4 (75.5%). Relatively high misclassification between middle and upper river standards has been observed every year since initiation of the Yukon River chinook salmon stock identification study in 1980.

Catch Composition

Scale Pattern Analysis

The scale measurement characters (Appendix A) which were most powerful in distinguishing between the three runs of origin for age 1.2 were variable 67, the freshwater annular zone divided by the total width of freshwater growth zones, and variable 102, the width of the last six circuli of the first ocean zone divided by the width of the first ocean zone (Appendix B). Secondary variables were derived primarily from measurements within the total freshwater zone and the first marine annular zone. The primary distinguishing characters for age 1.3 were variable 17, the freshwater annular zone divided by the total width of freshwater growth zones, and variable 67, the width of the first six freshwater circuli divided by the width of the first freshwater annular zone (Appendix B). Secondary variables were derived from measurements within the first freshwater annular zone, the freshwater plus growth zone, and the first marine annular zone. The primary distinguishing characters for age 1.4 were variable 18, the freshwater annular zone divided by the total width of freshwater growth zones, and variable 67, the width of the freshwater plus growth zone. Secondary variables were derived from measurements within the first freshwater annular zone and total marine zones. Atypically, measurements of marine growth provided noticeable discrimination in all models. Group means and their 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 was taken in the first four fishing periods in Districts 1 and 2. Upper Yukon Run fish composed the largest proportion of the District 1 and 2 commercial harvest of age-1.2, -1.3, and -1.4 chinook salmon in periods 1 and 2. This proportion decreased somewhat in periods 3 and 4 (Tables 3, 4). Run contribution estimates through time in Districts 1 and 2 generally demonstrated increasing proportions of Lower Yukon fish and decreasing proportions of Upper Yukon fish (Figures 4–7). District 1 and 2 harvests of Middle Yukon fish demonstrated no clear overall trend in relative abundance. A notable feature of the Middle Yukon Run was the low level of abundance in period 2 in both districts for all ages.

The estimated District 1 commercial catch of age-1.2, -1.3, and -1.4 fish combined was classified as 11,863 (25.3%) Lower, 12,224 (26.1%) Middle, and 22,774 (48.6%) Upper Yukon Run (Table 5); District 2 was 9,515 (30.7%) Lower, 7,479 (24.1%) Middle, and 13,996 (45.2%) Upper Yukon Run (Table 6).

A total of 77,851 age-1.2, -1.3, and -1.4 fish, or 46.2% of total drainage harvest, from District 1 and 2 commercial catches were directly classified to run of origin by scale pattern analysis (SPA). An additional 37,149 fish, or 22.1% of total drainage harvest, from Districts 1, 2, 3, and 4 (except Koyukuk River) subsistence and Districts 3 and 4 commercial harvests were also classified to run of origin by applying season total SPA results to individual district season totals by age class (Table 7).

Differential Age Composition Analysis

The remaining age classes, other than age 1.2, 1.3, or 1.4, from Districts 1 and 2 commercial catches contributed 6,559 fish, or 3.9%, to the total drainage harvest. They were classified to run of origin using differences in escapement age composition in each run (Table 7). Virtually all age-2.0 fish were classified to the Upper Yukon Run.

Geographical Analysis

A total of 46,863 fish, or 27.8% of total drainage harvest, was classified to run of origin based on geographical segregation. District 5 and Yukon Territory commercial, subsistence, and sport catches, 23.2% of total drainage harvest, were assumed to be Upper Yukon fish. Commercial, subsistence, and sport catches in District 6 and subsistence catches from the Koyukuk River in District 4 (Table 7) were classified entirely to the Middle Yukon Run and totaled 7,831 fish, or 4.7% of total drainage harvest.

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) scale pattern analysis of age-1.2, -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, contributing 98,103 fish (58.3%) of the total drainage harvest. This was followed by the Middle Yukon Run at 37,976 fish (22.6%) and the Lower Yukon Run at 32,307 fish (19.2%).

DISCUSSION

Perspective

Proportions of age classes allocated in 1990 to each run of origin were similar to previous years. No significant departures from past observations were noted. Sample sizes were fair to excellent for all escapements which contribute to the standard three-way LDF classification model. Catch sample sizes in Districts 1 and 2 were generally excellent, although logistics or small catches for some periods prevented sufficiently numerous samples from being obtained. An unusually large number of age-1.2 fish in catch and escapement samples allowed it to be included in the SPA analysis for the first time.

Upper Yukon Run Sampling

Chinook salmon from the Upper Yukon Run were sampled in Canada near the U.S.-Canada border at the DFO tagging project site. 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, e.g., 1990. Harvest runs of origin, based on samples from the DFO mainstem Yukon River test fish wheels, required and assumption that those samples be representative of the run of Canadian chinook salmon. It is uncertain whether fish wheels catch all sizes of chinook salmon in proportion to their abundance. Therefore, it is thought that weighted escapement samples, such as those used for the Lower and Middle Yukon Runs, would be a consistent basis for the construction of the Upper Yukon Run model as well. Unfortunately, escapement sampling effort in Canada has failed to provide data which 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 because the dominant age classes used in SPA are adequately represented.

Failure to obtain appropriate sample sizes from DFO to adequately represent the Upper Yukon Run would seriously weaken or invalidate the SPA analysis. The recent reduction in Upper Yukon River harvest and escapement sampling effort by DFO and ADF&G highlights the importance of the DFO test fish wheel as the only remaining source for the Upper Yukon Run chinook SPA stock standard and for sex and age composition data of salmon in Canadian tributaries. Between 1980 and 1990, ADF&G mounted a cooperative sampling effort with FWS and DFO in Canada in order to document the age and sex composition of chinook salmon in the Upper River escapement. Tightening budgets in 1989 required DFO to eliminate participation in this program. ADF&G decided to discontinue the program in 1991. Additionally, in 1989 DFO stopped sampling the commercial salmon catch in Canada for age and sex, and in 1991 ADF&G discontinued aerial escapement counts of salmon in Canadian tributaries. This is seriously weakening ADF&G's ability to qualitatively assess the escapement of Upper River Run chinook salmon.

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Table 1. Age composition of Yukon River chinook salmon escapement samples, 1990.

Location	Escapement Index Abundance Estimate	Sample Size[a]	1987	1986	1985		1984		1983		1982	
			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]	4,048	583	0.4	30.0	27.4	0.0	40.9	0.0	1.3	0.0	0.0	0.0
Anvik River	1,595	407	0.3	26.2	26.0	0.0	43.4	0.3	3.8	0.0	0.0	0.0
Middle Yukon												
Chena River[c]	5,603	522	0.0	23.8	25.3	0.4	46.7	0.0	3.8	0.0	0.0	0.0
Salcha River[c]	10,728	498	0.2	17.6	24.9	0.0	49.0	0.0	8.3	0.0	0.0	0.0
Canada (Upper Yukon)												
Tatchun Creek[d]	655	126	0.0	11.7	62.5	0.0	24.7	0.0	1.1	0.0	0.0	0.0
Little Salmon River	665	110	0.0	33.0	32.1	0.0	29.4	0.0	5.5	0.0	0.0	0.0
Big Salmon River	1,806	136	0.0	10.5	24.8	0.8	51.1	0.8	12.0	0.0	0.0	0.0
Nisutlin River	652	131	0.0	0.8	14.5	0.8	50.3	9.2	3.1	20.5	0.0	0.8

Note: columns 1987–1982 are grouped under "Brood Year and Age Group".

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

[b] Includes respective East and West Fork aerial survey counts of 2,503 and 1,545.

[c] Mark and recapture population estimate (Burkholder 1991, Evanson 1991).

[d] DFO foot survey.

Table 2. Classification accuracies of linear discriminant run-of-origin models for age-1.2, -1.3, and -1.4 Yukon River chinook salmon, 1990.

Age 1.2

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Lower	127	<u>0.937</u>	0.047	0.016
Middle	101	0.050	<u>0.693</u>	0.257
Upper	86	0.047	0.279	<u>0.674</u>

Mean Classification Accuracy: 0.768
Variables in Analysis: 67, 102, 65, 84, 70

Age 1.3

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Lower	120	<u>0.918</u>	0.050	0.033
Middle	94	0.011	<u>0.745</u>	0.245
Upper	115	0.035	0.209	<u>0.757</u>

Mean Classification Accuracy: 0.806
Variables in Analysis:67, 17, 106, 62, 27, 76, 80

Age 1.4

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Lower	160	<u>0.913</u>	0.075	0.013
Middle	155	0.032	<u>0.755</u>	0.213
Upper	114	0.035	0.298	<u>0.667</u>

Mean Classification Accuracy: 0.778
Variables in Analysis: 67, 62, 111, 27, 1, 18

Table 3. Run composition estimates for age−1.2, −1.3, and −1.4 chinook salmon commercial catches in Yukon River District 1, 1990.

Commercial Fishing Period	Dates	Run	Age 1.2 N	Age 1.2 P	Age 1.2 S.E.	Age 1.2 Simultaneous 90% CI	Age 1.3 N	Age 1.3 P	Age 1.3 S.E.	Age 1.3 Simultaneous 90% CI	Age 1.4 N	Age 1.4 P	Age 1.4 S.E.	Age 1.4 Simultaneous 90% CI
Prior to Season[a]		Lower	29	0.2180	0.0909	0.023 < P < 0.413	33	0.1100	0.0646	0.000 < P < 0.248	52	0.0710	0.0479	0.000 < P < 0.174
		Middle		0.1980	0.2065	0.000 < P < 0.641		0.4340	0.1642	0.082 < P < 0.787		0.5190	0.1554	0.185 < P < 0.853
		Upper		0.5850	0.2131	0.127 < P < 1.000		0.4550	0.1684	0.094 < P < 0.816		0.4100	0.1542	0.079 < P < 0.740
1[b]	6/14−15	Lower	17	0.0838	0.0809	0.000 < P < 0.254	46	0.2926	0.0747	0.135 < P < 0.450	139	0.0688	0.0307	0.004 < P < 0.133
		Middle		0.5037	0.2547	0.000 < P < 1.000		0.3058	0.1262	0.040 < P < 0.571		0.3019	0.1153	0.059 < P < 0.544
		Upper		0.4126	0.2567	0.000 < P < 0.952		0.4016	0.1327	0.122 < P < 0.681		0.6293	0.1145	0.388 < P < 0.870
2[c]	6/18−19	Lower	89	0.3281	0.0586	0.205 < P < 0.451	73	0.3079	0.0596	0.183 < P < 0.433	62	0.1002	0.0478	0.000 < P < 0.201
		Middle		0.0595	0.0751	0.000 < P < 0.217		0.0721	0.0752	0.000 < P < 0.230		0.1505	0.1256	0.000 < P < 0.415
		Upper		0.6125	0.0938	0.415 < P < 0.810		0.6200	0.0880	0.435 < P < 0.805		0.7493	0.1281	0.480 < P < 1.000
3	6/21−22	Lower	13	0.2036	0.1289	0.000 < P < 0.475	34	0.2193	0.0778	0.056 < P < 0.383	153	0.3442	0.0461	0.247 < P < 0.441
		Middle		0.3602	0.2630	0.000 < P < 0.913		0.5333	0.1604	0.196 < P < 0.871		0.2262	0.0939	0.029 < P < 0.424
		Upper		0.4363	0.2706	0.000 < P < 1.000		0.2558	0.1555	0.000 < P < 0.583		0.4296	0.0979	0.224 < P < 0.636
4	6/28−29	Lower	16	0.6411	0.1373	0.352 < P < 0.930	33	0.3185	0.0906	0.128 < P < 0.509	142	0.4190	0.0469	0.320 < P < 0.518
		Middle		0.1539	0.1471	0.000 < P < 0.463		0.3253	0.1506	0.009 < P < 0.642		0.3172	0.0887	0.131 < P < 0.504
		Upper		0.2050	0.1574	0.000 < P < 0.536		0.3562	0.1570	0.026 < P < 0.686		0.2638	0.0827	0.090 < P < 0.438
5	7/02−03	Lower	10	0.6103	0.1459	0.304 < P < 0.917	9	0.3470	0.1687	0.000 < P < 0.702	44	0.3248	0.0782	0.160 < P < 0.489
		Middle		0.1753	0.1761	0.000 < P < 0.546		0.1682	0.1848	0.000 < P < 0.557		0.0269	0.0595	0.000 < P < 0.152
		Upper		0.2144	0.1825	0.000 < P < 0.598		0.4848	0.2265	0.008 < P < 0.961		0.6482	0.0954	0.448 < P < 0.849

[a] Samples from District 1 test fishery collected prior to onset of commercial fishing.

[b] Unrestricted mesh size.

[c] Chum salmon season, 6 in (15.2 cm) maximum mesh size.

Table 4. Run composition estimates for age−1.2, −1.3, and −1.4 chinook salmon commercial catches in Yukon River District 2, 1990.

			Age 1.2				Age 1.3				Age 1.4			
Commercial Fishing Period	Dates	Run	N	P	S.E.	Simultaneous 90% CI	N	P	S.E.	Simultaneous 90% CI	N	P	S.E.	Simultaneous 90% CI
1[a]	6/18	Lower	23	0.1432	0.0896	0.000 < P < 0.332	53	0.2102	0.0646	0.074 < P < 0.346	117	0.2408	0.0468	0.142 < P < 0.339
		Middle		0.0575	0.1019	0.000 < P < 0.272		0.3003	0.1341	0.018 < P < 0.582		0.2962	0.1093	0.066 < P < 0.526
		Upper		0.7994	0.1333	0.519 < P < 1.000		0.4895	0.1414	0.192 < P < 0.787		0.4636	0.1098	0.233 < P < 0.694
2	6/20−21	Lower	42	0.2959	0.0805	0.127 < P < 0.465	26	0.3518	0.1041	0.133 < P < 0.571	13	0.1478	0.1052	0.000 < P < 0.369
		Middle		0.1893	0.1499	0.000 < P < 0.505		0.0511	0.0833	0.000 < P < 0.226		0.3975	0.2647	0.000 < P < 0.954
		Upper		0.5149	0.1556	0.188 < P < 0.842		0.5971	0.1275	0.329 < P < 0.865		0.4547	0.2620	0.000 < P < 1.000
3	6/24	Lower	12	0.2326	0.1332	0.000 < P < 0.513	35	0.3574	0.0890	0.170 < P < 0.545	139	0.2986	0.0464	0.201 < P < 0.396
		Middle		0.4386	0.2572	0.000 < P < 0.980		0.2998	0.1351	0.016 < P < 0.584		0.2854	0.0985	0.078 < P < 0.493
		Upper		0.3288	0.2498	0.000 < P < 0.854		0.3428	0.1413	0.046 < P < 0.640		0.4160	0.0978	0.210 < P < 0.622
4	6/29	Lower	27	0.4439	0.1034	0.226 < P < 0.661	16	0.5665	0.1366	0.279 < P < 0.854	32	0.3639	0.0949	0.164 < P < 0.563
		Middle		0.0792	0.1070	0.000 < P < 0.304		0.0000	0.0000	0.000 < P < 0.000		0.2557	0.1645	0.000 < P < 0.602
		Upper		0.4769	0.1411	0.180 < P < 0.774		0.4335	0.1366	0.146 < P < 0.721		0.3804	0.1685	0.026 < P < 0.735
5[a]	7/01−02	Lower	19	0.5240	0.1227	0.266 < P < 0.782	30	0.3453	0.0988	0.138 < P < 0.553	171	0.4655	0.0421	0.377 < P < 0.554
		Middle		0.0263	0.0666	0.000 < P < 0.166		0.2117	0.1355	0.000 < P < 0.497		0.2749	0.0801	0.107 < P < 0.443
		Upper		0.4496	0.1343	0.167 < P < 0.732		0.4430	0.1533	0.121 < P < 0.765		0.2596	0.0745	0.103 < P < 0.416
6[a]	7/04−05	Lower	6	0.1488	0.1494	0.000 < P < 0.463	11	0.3070	0.1644	0.000 < P < 0.653	62	0.3486	0.0694	0.203 < P < 0.495
		Middle		0.0766	0.1557	0.000 < P < 0.404		0.1133	0.1516	0.000 < P < 0.432		0.1744	0.1249	0.000 < P < 0.437
		Upper		0.7746	0.2115	0.330 < P < 1.000		0.5163	0.2080	0.079 < P < 0.954		0.4769	0.1302	0.203 < P < 0.751

[a] Chum salmon season, 6 in (15.2 cm) maximum mesh size.

Table 5. Classification of age−1.2, −1.3, and −1.4 chinook salmon catches by run and fishing period for the commercial fishery in Yukon River District 1, 1990.

Commercial Fishing Period	Dates	Region of Origin	Age Group 1.2	1.3	1.4	Total
1	6/14−15	Lower	122	1,406	737	2,266
		Middle	734	1,470	3,233	5,436
		Alaska	856	2,876	3,970	7,702
		Upper	601	1,930	6,739	9,270
		Total	1,457	4,806	10,709	16,972
2	6/18−19	Lower	1,166	948	193	2,307
		Middle	211	222	291	724
		Alaska	1,377	1,170	484	3,031
		Upper	2,177	1,909	1,446	5,532
		Total	3,554	3,079	1,930	8,563
3	6/21−22	Lower	205	583	3,453	4,241
		Middle	362	1,474	2,270	4,106
		Alaska	567	2,057	5,723	8,347
		Upper	439	707	4,310	5,456
		Total	1,006	2,764	10,033	13,803
4	6/28−29	Lower	249	345	1,857	2,451
		Middle	60	352	1,406	1,818
		Alaska	309	697	3,262	4,269
		Upper	80	386	1,169	1,634
		Total	389	1,083	4,431	5,903
5	7/02−03	Lower	119	82	359	559
		Middle	34	40	30	103
		Alaska	153	121	388	663
		Upper	42	114	716	871
		Total	195	235	1,104	1,534
6−11	7/4−8/31	Lower	8	7	25	39
		Middle	0	0	37	37
		Alaska	8	7	62	76
		Upper	3	6	0	10
		Total	11	13	62	86
District 1 Season Total		Lower	1,869	3,370	6,624	11,863
		Middle	1,402	3,557	7,265	12,224
		Alaska	3,270	6,928	13,889	24,087
		Upper	3,342	5,052	14,380	22,774
		Total	6,612	11,980	28,269	46,861

Table 6. Classification of age-1.2, -1.3, and -1.4 chinook salmon catches by run and fishing period for the commercial fishery in Yukon River District 2, 1990.

Commercial Fishing Period	Dates	Region of Origin	Age Group 1.2	1.3	1.4	Total
1	6/18	Lower	124	657	1,323	2,103
		Middle	50	938	1,632	2,619
		Alaska	173	1,595	2,954	4,722
		Upper	690	1,529	2,554	4,773
		Total	863	3,124	5,508	9,495
2	6/20-21	Lower	1,013	695	153	1,861
		Middle	648	101	412	1,161
		Alaska	1,662	796	565	3,023
		Upper	1,763	1,179	472	3,414
		Total	3,425	1,975	1,037	6,437
3	6/24	Lower	91	596	1,524	2,211
		Middle	172	500	1,456	2,128
		Alaska	263	1,096	2,980	4,339
		Upper	129	572	2,123	2,824
		Total	392	1,668	5,103	7,163
4	6/29	Lower	357	285	407	1,050
		Middle	64	0	286	350
		Alaska	421	286	693	1,399
		Upper	383	218	426	1,028
		Total	804	504	1,119	2,427
5	7/01-02	Lower	161	300	1,362	1,824
		Middle	8	184	804	997
		Alaska	170	485	2,166	2,820
		Upper	138	385	760	1,284
		Total	308	870	2,926	4,104
6	7/04-05	Lower	14	94	342	449
		Middle	7	29	171	207
		Alaska	21	123	513	656
		Upper	71	131	467	670
		Total	92	254	980	1,326
7-12	7/06-8/31	Lower	2	4	11	17
		Middle	0	0	17	17
		Alaska	2	4	28	34
		Upper	1	3	0	4
		Total	3	7	28	38
District 2 Season Total		Lower	1,762	2,631	5,122	9,515
		Middle	949	1,752	4,778	7,479
		Alaska	2,711	4,383	9,900	16,994
		Upper	3,176	4,019	6,801	13,996
		Total	5,887	8,402	16,701	30,990

Table 7. Total catch by age class and run of chinook salmon from Yukon River Districts 1 – 6, and Canada commercial and subsistence catches, 1990.

District	Fishery	Run of Origin	Brood Year and Age Group										Total
			1987	1986	1985		1984		1983		1982		
			1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	
1	Commercial Gill Net	Lower	0	1,869	3,370	0	6,624	4	220	0	0	0	12,087
		Middle	0	1,402	3,557	59	7,265	0	697	0	0	0	12,980
		Alaska	0	3,271	6,927	59	13,889	4	918	0	0	0	25,067
		Upper	0	3,342	5,052	257	14,380	178	1,723	1,105	0	56	26,094
		Total	0	6,613	11,979	315	28,269	181	2,637	1,102	0	56	51,161
	Subsistence Gill Net[a]	Lower	0	261	471	0	926	1	31	0	0	0	1,690
		Middle	0	196	497	8	1,016	0	97	0	0	0	1,815
		Alaska	0	457	968	8	1,942	1	128	0	0	0	3,505
		Upper	0	467	706	36	2,011	25	241	154	0	8	3,648
		Total	0	925	1,675	44	3,952	25	369	154	0	8	7,153
2	Commercial Gill Net	Lower	0	1,762	2,631	0	5,122	5	216	0	0	0	9,736
		Middle	0	949	1,752	5	4,778	0	581	0	0	0	8,065
		Alaska	0	2,711	4,383	5	9,900	5	797	0	0	0	17,801
		Upper	0	3,176	4,019	35	6,801	149	1,002	202	28	0	15,412
		Total	0	5,887	8,402	41	16,701	159	1,831	208	29	0	33,213
	Subsistence Gill Net[b]	Lower	0	506	756	0	1,472	1	62	0	0	0	2,798
		Middle	0	273	504	1	1,373	0	167	0	0	0	2,318
		Alaska	0	779	1,260	1	2,845	1	229	0	0	0	5,117
		Upper	0	913	1,155	10	1,955	43	288	58	8	0	4,430
		Total	0	1,692	2,415	11	4,800	44	517	58	8	0	9,546
3	Commercial Gill Net[b]	Lower	0	124	185	0	361	0	15	0	0	0	686
		Middle	0	67	123	0	337	0	42	0	0	0	569
		Alaska	0	191	309	0	698	0	56	0	0	0	1,255
		Upper	0	224	283	2	479	10	71	14	2	0	1,086
		Total	0	415	592	3	1,177	11	127	14	2	0	2,341
	Subsistence Gill Net[b]	Lower	0	214	319	0	622	1	26	0	0	0	1,182
		Middle	0	115	213	1	580	0	71	0	0	0	979
		Alaska	0	329	532	1	1,202	1	97	0	0	0	2,161
		Upper	0	385	488	4	825	18	122	25	3	0	1,871
		Total	0	714	1,020	5	2,027	19	218	25	3	0	4,031

– Continued –

Table 7. (Page 2 of 2)

			Brood Year and Age Group										
			1987	1986	1985		1984		1983		1982		
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
4	Commercial & Subsistence[c]	Lower	0	747	1,115	0	2,171	2	92	0	0	0	4,127
		Middle	0	478	883	3	2,407	0	293	0	0	0	4,063
		Alaska	0	1,225	1,998	3	4,578	2	385	0	0	0	8,190
		Upper	0	1,346	1,704	15	2,883	63	425	86	12	0	6,533
		Total	0	2,571	3,701	17	7,461	65	809	86	12	0	14,722
5	Commercial & Subsistence GN & FW[d]	Upper	0	4,075	5,157	45	8,727	191	1,286	259	36	0	19,776
6	Commercial & Subsistence GN & FW[e]	Middle	0	846	1,561	5	4,258	0	518	0	0	0	7,187
Canada	Commercial Gill Net	Upper	0	2,334	2,953	26	4,997	109	736	148	21	0	11,324
	Subsistence Gill Net[f]	Upper	0	1,629	2,061	18	3,487	76	514	104	14	0	7,903
TOTAL HARVEST		Lower	0	5,484	8,848	0	17,298	14	663	0	0	0	**32,307**
		Middle	0	4,326	9,090	81	22,013	0	2,466	0	0	0	**37,976**
		Alaska	0	9,809	17,938	81	39,311	14	3,129	0	0	0	**70,283**
		Upper	0	17,891	23,578	448	46,545	864	6,406	2,155	124	64	**98,074**
		Total	0	27,700	41,516	530	85,856	877	9,535	2,155	124	64	**168,357**

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

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

[c] Gill net and fish wheel catches combined. Commercial catch = 3,538 fish. Subsistence catch = 11,184 fish including the Innoko and Koyukuk River catches (644 fish) estimated to be entirely of middle Yukon origin.

[d] Gill net and fish wheel catches combined. Commercial catch = 3,365. Subsistence catch = 16,411.

[e] Gill net and fish wheel catches combined; includes commercial (2,156), subsistence (3,759), sport (439), and ADF&G test fish (833) catches.

[f] Run and age composition based on Canada DFO fish wheel samples from White Rock and Sheep Rock. Harvest components are from domestic (247), Indian food (7,109), sport (300), and Porcupine River Indian food (247) fisheries.

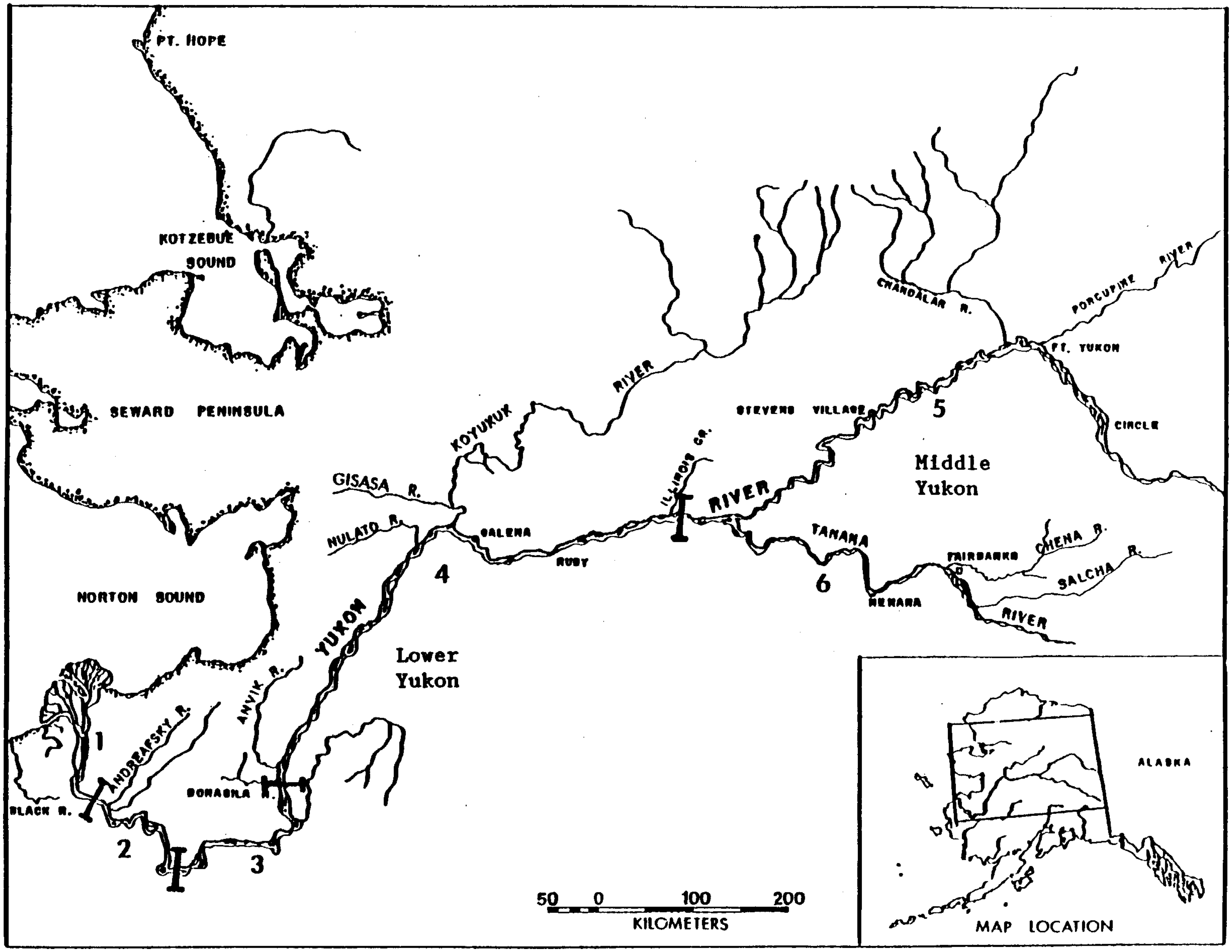

Figure 1. Alaskan portion of the Yukon River drainage showing fishing district boundaries.

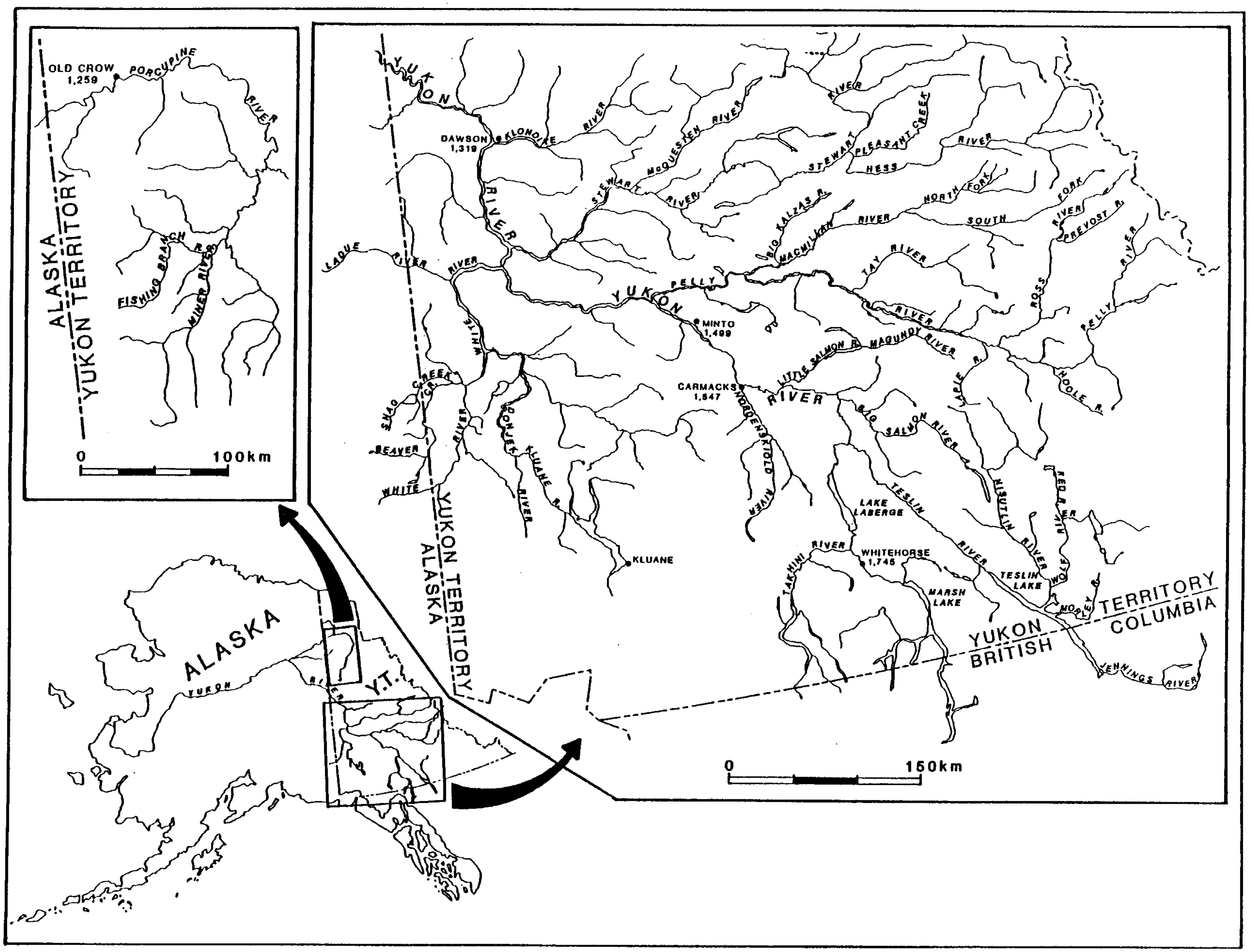

Figure 2. Canadian portion of the Yukon River drainage.

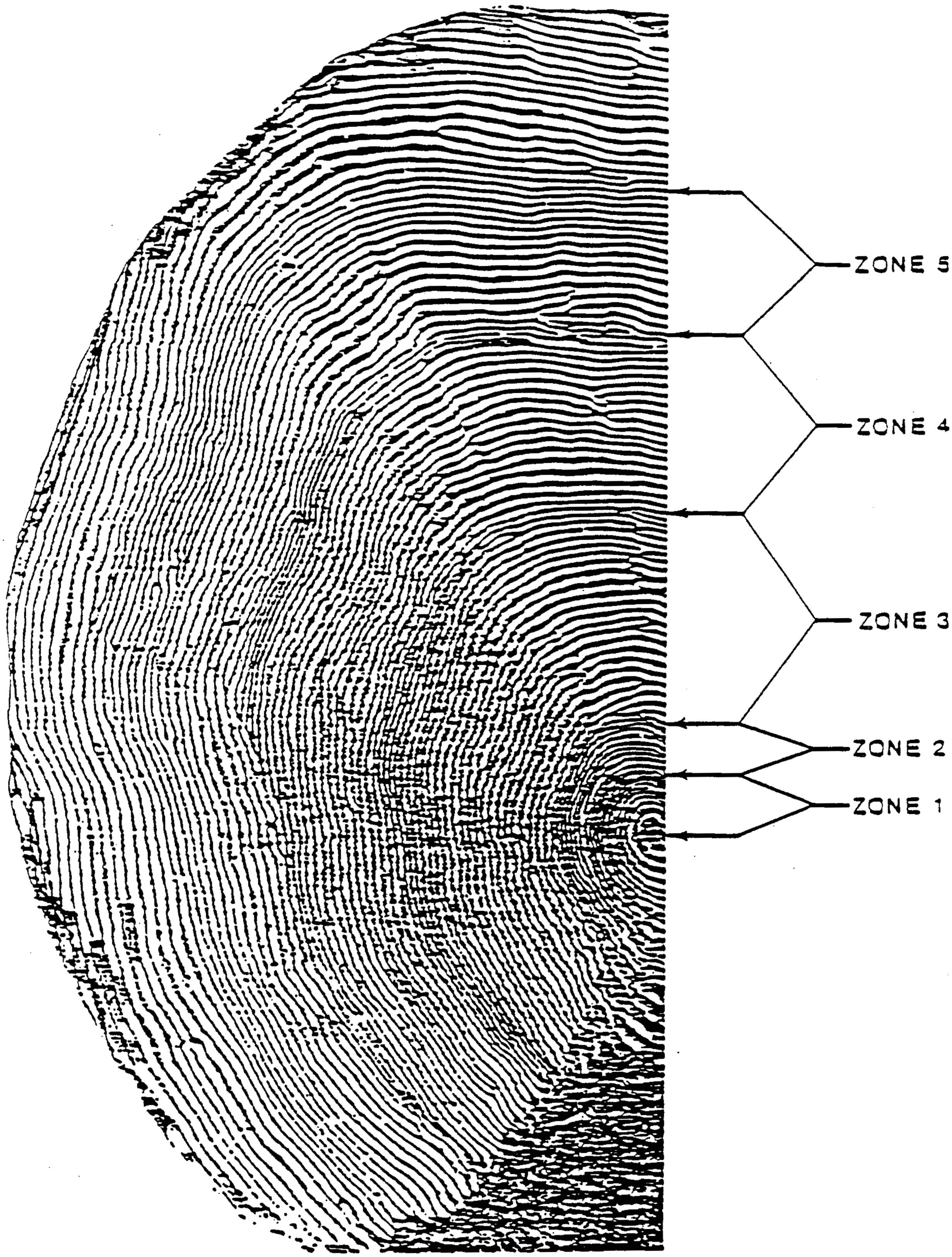

Figure 3. Age-1.4 chinook salmon scale showing zones measured for linear discriminant analysis.

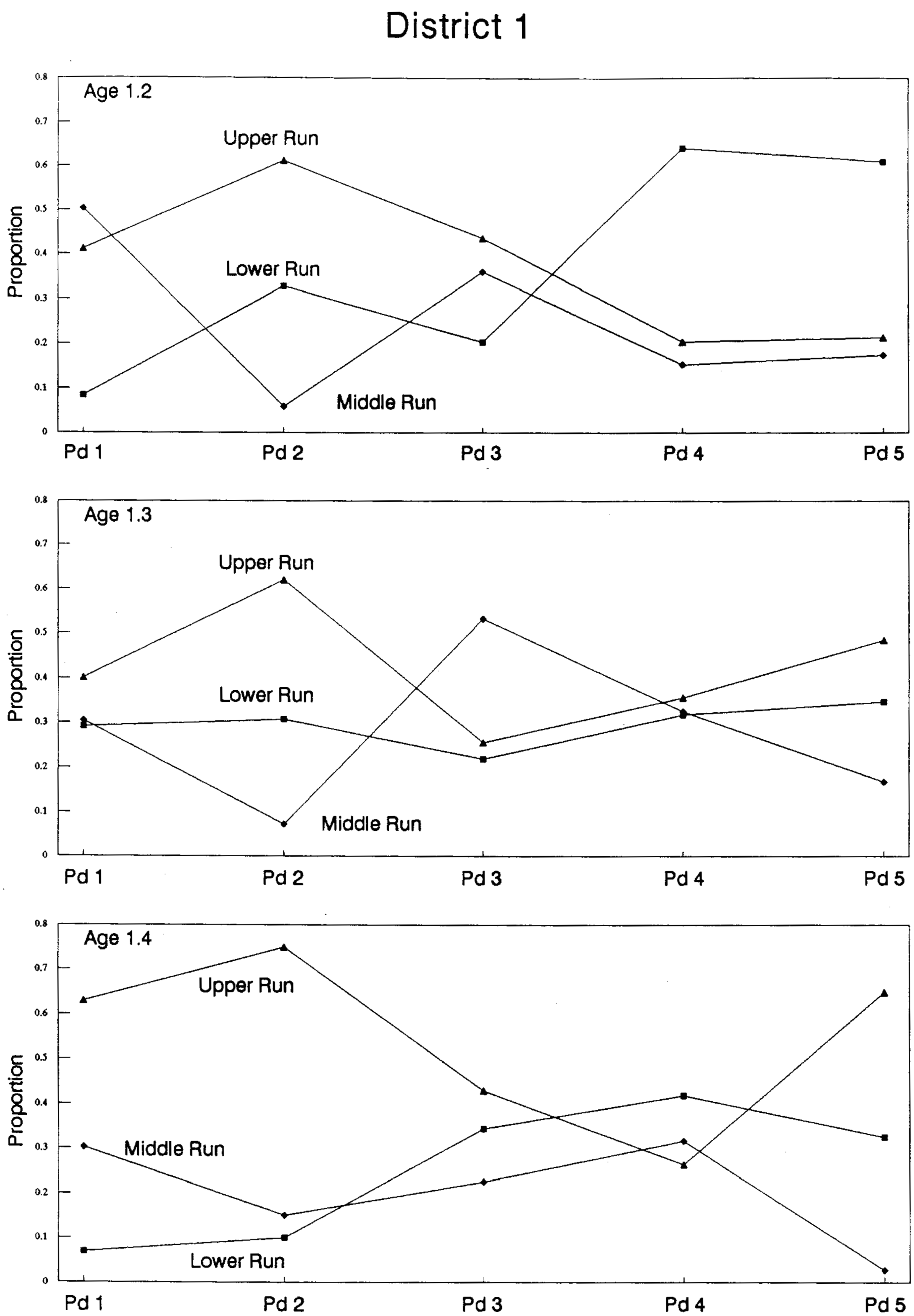

Figure 4. Proportion of catch by run estimated from scale pattern analysis of age−1.2, −1.3, and −1.4 chinook salmon, Yukon River District 1, 1990.

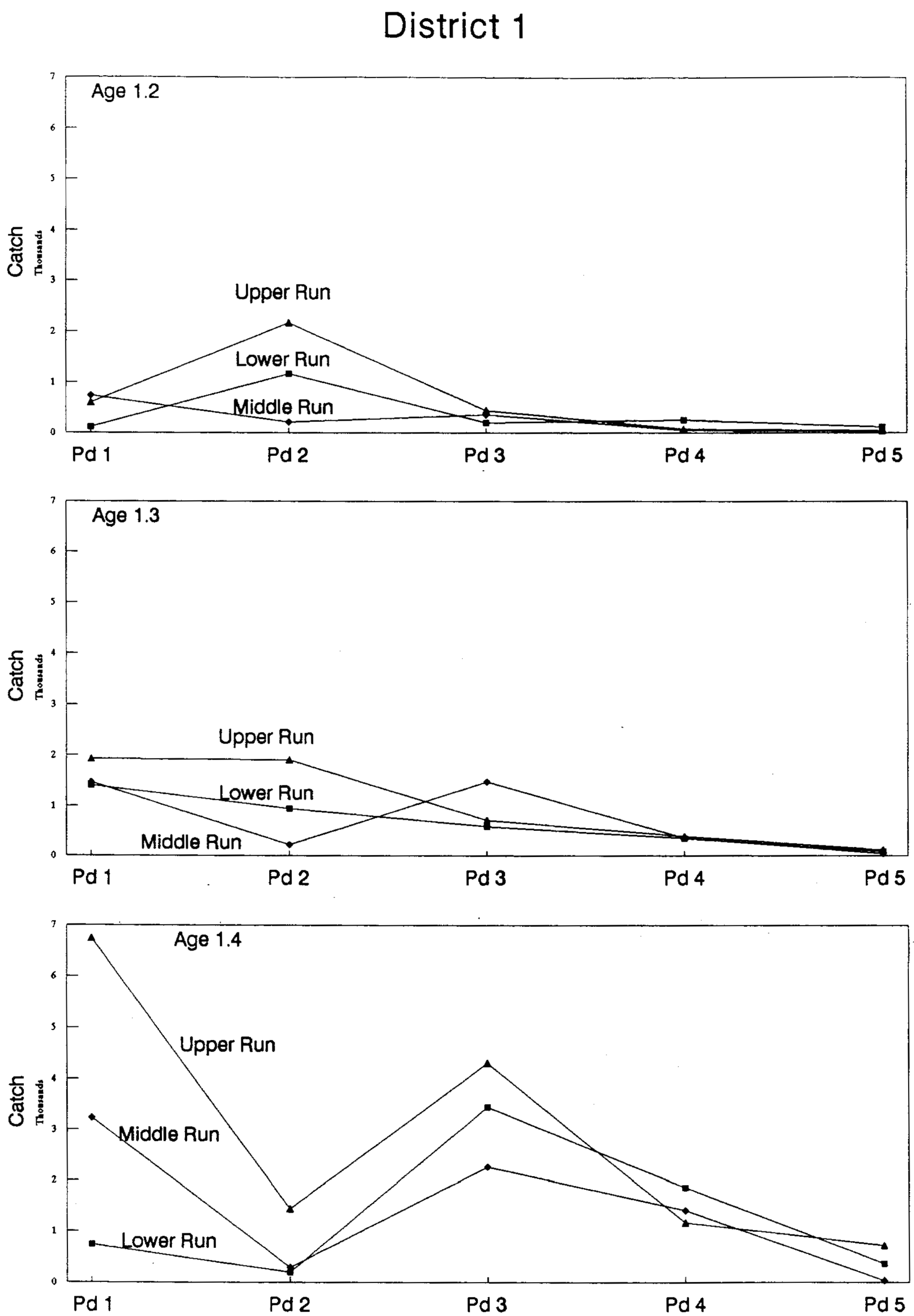

Figure 5. Catch by run in numbers of fish estimated from scale pattern analysis of age–1.2, –1.3, and –1.4 chinook salmon, Yukon River District 1, 1990.

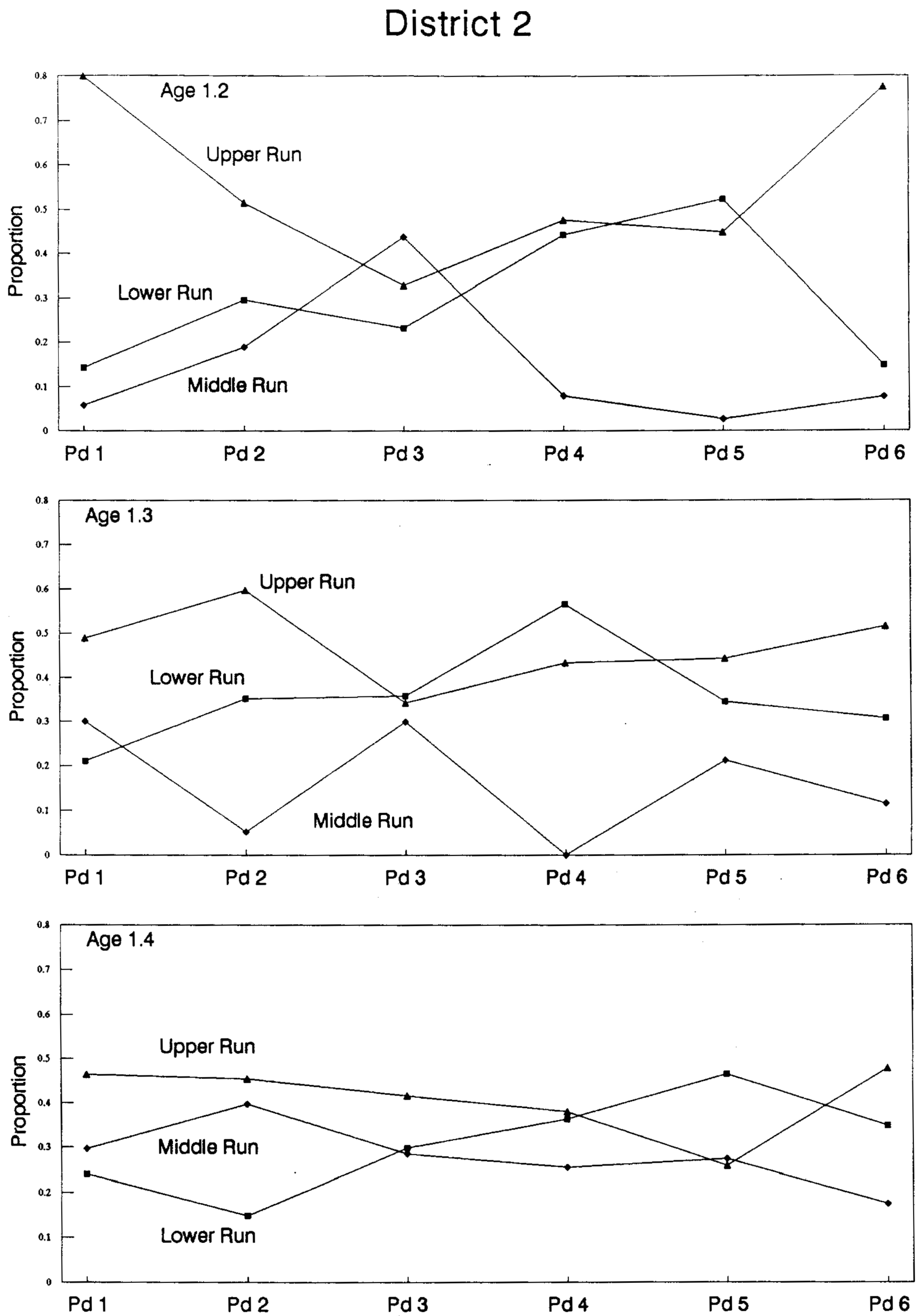

Figure 6. Proportion of catch by run estimated from scale pattern analysis of age−1.2, −1.3, and −1.4 chinook salmon, Yukon River District 2, 1990.

District 2

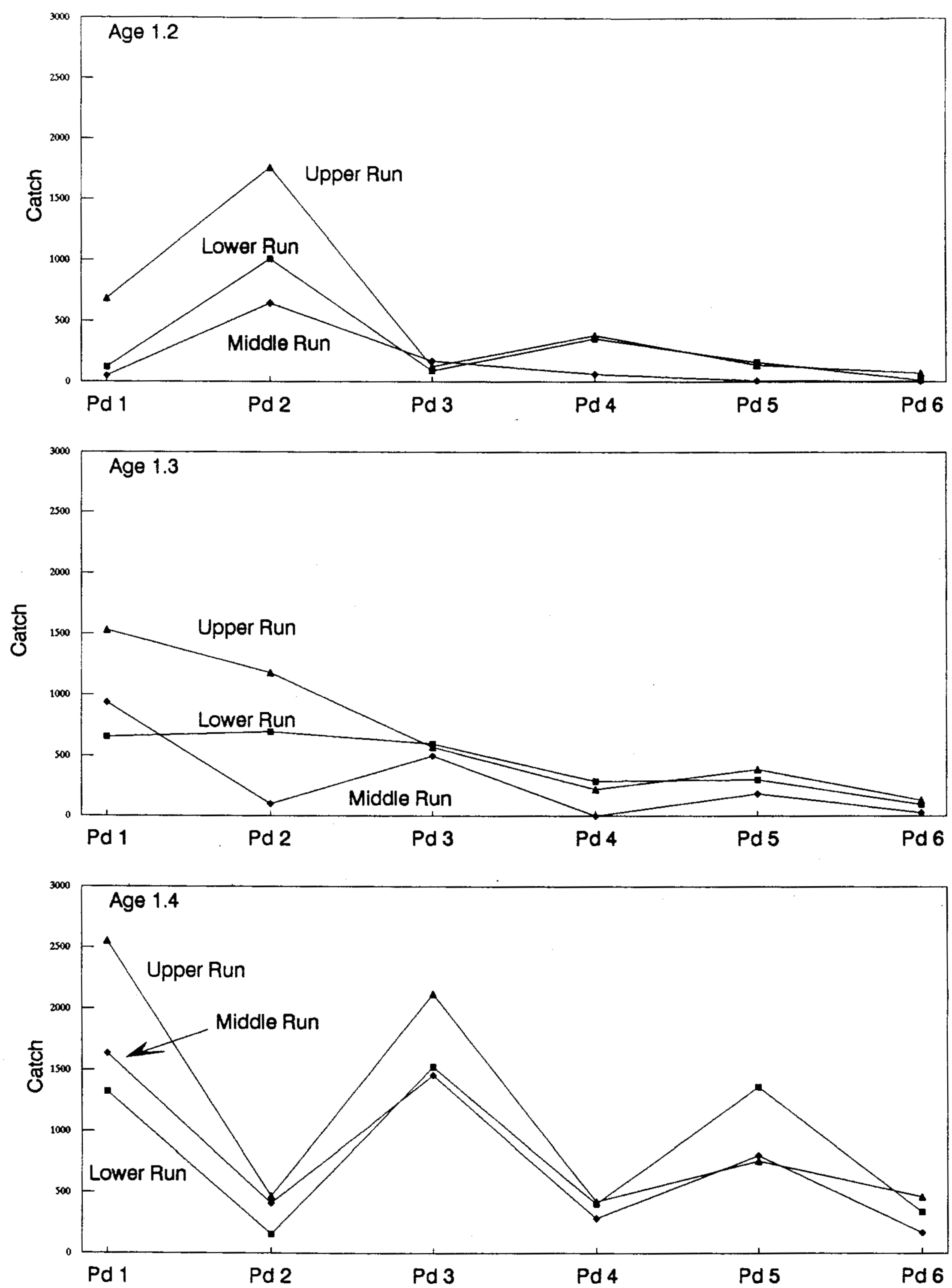

Figure 7. Catch by run in numbers of fish estimated from scale pattern analysis of age−1.2, −1.3, and −1.4 chinook salmon, Yukon river District 2, 1990.

APPENDIX

Appendix A. Scale variables screened for linear discriminant function analysis of age-1.2, -1.3, and -1.4 Yukon River chinook salmon, 1990.

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 interaval 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 interaval 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 freshwaterzone.
[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-1.2, -1.3, and -1.4 Yukon River chinook salmon runs, 1990.

Growth Zone	Variable	Lower		Middle		Upper		F-Value
		Mean	SE	Mean	SE	Mean	SE	
<u>Age-1.2</u>								
Total FW Growth	65	12.40	0.15	13.55	0.17	15.31	0.22	68.05
	67	0.86	<.01	0.66	0.01	0.65	<.01	351.24
1st Marine Ann.	70	28.78	0.23	26.50	0.28	25.45	0.28	43.90
	84	115.38	1.18	129.16	1.58	130.90	1.43	40.38
	102	0.22	<.01	0.26	<.01	0.27	>.01	77.47
<u>Age-1.3</u>								
1st FW Annular	17	0.59	<.01	0.74	<.01	0.65	<.01	104.93
	27	13.04	0.10	13.35	0.17	12.57	0.13	95.10
FW Plus Growth	62	22.06	1.14	60.98	1.55	69.43	1.79	295.73
Total FW Growth	67	0.86	<.01	0.62	<.01	0.62	<.01	411.79
1st Marine Ann.	76	263.45	2.09	275.50	2.41	284.47	2.25	23.83
	80	220.99	1.82	229.86	2.10	237.88	1.96	20.06
	106	14.32	0.13	13.09	0.15	12.04	0.14	69.49
<u>Age-1.4</u>								
1st FW Annular	1	10.15	0.10	8.03	0.10	8.78	0.14	103.55
	18	0.75	<.01	0.87	<.01	0.83	<.01	91.30
	27	12.64	0.08	13.09	0.11	12.69	0.13	6.00
FW Plus Growth	62	24.42	0.80	58.11	1.11	69.40	1.66	411.62
Total FW Growth	67	0.84	<.01	0.64	<.01	0.62	<.01	501.11
Total Marine Growth	111	1321.14	8.40	1280.14	9.98	1232.23	8.49	22.05

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-1.2, -1.3, and -1.4 Yukon River chinook salmon runs, 1990.

			Lower		Middle		Upper		
Growth Zone	Variable	Description	Mean	SE	Mean	SE	Mean	SE	F-Value
Age-1.2									
1st FW Annular	1	No. Circ.	10.01	0.13	8.12	0.12	9.34	0.18	47.94
	2	Distance	128.13	1.47	108.53	1.50	115.08	1.79	44.03
Total FW Growth	61	No. Circ.	2.39	0.10	5.43	0.13	5.98	0.16	260.92
	62	Distance	21.19	0.97	56.55	1.46	63.35	1.77	298.79
1st Ocean Ann.	70	No. Circ.	28.78	0.23	26.50	0.28	25.45	0.28	43.90
	71	Distance	529.32	4.73	495.56	6.21	481.55	5.17	23.86
Age-1.3									
1st FW Annular	1	No. Circ.	10.22	0.12	7.40	0.13	8.97	0.13	113.66
	2	Distance	132.57	1.52	97.98	1.64	111.84	1.48	124.82
Total FW Growth	61	No. Circ.	2.36	0.11	5.81	0.13	6.48	0.16	289.55
	62	Distance	22.06	1.14	60.98	1.55	69.43	1.79	295.73
1st Ocean Ann.	70	No. Circ.	27.81	0.24	26.40	0.29	24.64	0.27	38.08
	71	Distance	513.87	4.53	489.07	6.11	462.25	5.40	25.47
2nd Ocean Ann.	109	Distance	412.12	6.93	408.60	6.95	401.91	5.86	0.66
Age-1.4									
1st FW Annular	1	No. Circ.	10.15	0.10	8.03	0.10	8.78	0.14	103.55
	2	Distance	127.83	1.23	104.54	1.29	110.40	1.50	90.55
Total FW Growth	61	No. Circ.	2.64	0.08	5.53	0.10	6.58	0.15	376.13
	62	Distance	24.42	0.80	58.11	1.11	69.40	1.66	411.62
1st Ocean Ann.	70	No. Circ.	26.88	0.19	25.16	0.23	23.90	0.23	46.52
	71	Distance	500.81	3.30	460.93	4.62	445.83	4.10	48.82
2nd Ocean Ann.	109	Distance	423.56	4.67	415.63	4.98	393.81	5.58	8.37
3rd Ocean Ann.	110	Distance	396.78	4.17	403.58	4.21	392.60	4.72	1.55