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ORIGINS OF CHINOOK SALMON

IN THE YUKON RIVER FISHERIES, 1996

By

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ABSTRACT

Analysis of scale patterns and age composition ratio analysis of chinook salmon *Oncorhynchus tshawytscha* (Walbaum) from Yukon River escapements in Alaska and salmon tagging-study catches in Canada were used to construct classification models for assigning Yukon River District 1 and 2 commercial and subsistence harvests to run of origin. Linear discriminant models were used to estimate stock composition for age-1.3 and -1.4 fish in District 1 and 2 harvests. Observed age composition differences among escapements were used to estimate runs of origin for other age classes. District 3 and 4 commercial and subsistence harvests were assigned to run of origin using the estimated proportions obtained in the analysis of District 2 harvests combined with assignment of Koyukuk River subsistence harvests to the Middle Yukon Run based on geographic occurrence. Runs of origin for all other drainage harvests were estimated based on geographic occurrence. The total estimated Yukon River harvest in 1996 was 158,234 chinook salmon, of which about 61% was estimated to be the Upper Yukon Run, 8% the Middle Yukon Run, and 30% the Lower Yukon Run.

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 subsistence fisheries in Alaska, Aboriginal and domestic fisheries in Canada, and commercial and sport fisheries in Alaska and Canada (Figures 1 and 2). Commercial harvests consist of fish sold in the round, numbers of fish contributing to commercial roe production, and fish sold in the round by the Alaska Department of Fish and Game (ADF&G) from test fisheries in Districts 1 and 2. Sport fisheries occur primarily in the Tanana River drainage and in Canada. However, small unreported sport fishing harvests are known to occur elsewhere in the Alaska portion of the Yukon River drainage.

In the 20 years after statehood (1960-1979), the total chinook salmon harvest in the Yukon River in both Alaska and Canada ranged from an estimated 77,000 to 170,000 and averaged 123,000 fish annually (JTC 1994). Beginning in 1980, annual harvests increased substantially. During the most recent 5-year period (1991-1995) total annual catches averaged about 187,000 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 1991-95 average commercial harvest in Districts 1 and 2 was about 55% of total drainage harvest, and subsistence harvests in the two districts accounted for another 8%. However, most of the subsistence harvest is taken with fish wheels and gillnets in Districts 4, 5, and 6. In 1996, commercial, subsistence, Aboriginal, domestic, and sport fishermen in Alaska and Canada harvested an estimated 158,234 Yukon River chinook salmon, of which 86,851 fish (54.9%) were taken by District 1 and 2 commercial fishermen (Bergstrom *et al.* 1997).

Chinook salmon harvested in the Yukon River fisheries consist of a mixture of stocks bound for spawning areas throughout the Yukon River drainage. Although more than 100 spawning streams have been documented, 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.

Evaluating stock productivities, spawning escapement goals, 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 fisheries has been studied by the Alaska Department of Fish and Game to provide 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 (Schneiderhan 1997a). Since then, harvest proportions by geographic region of origin have been estimated annually for the entire drainage (Schneiderhan 1997a).

The objective of this study was to estimate the run of origin of all Yukon River chinook salmon harvests for the 1996 season.

METHODS

Schneiderhan (1997a) provides a historical perspective including evolved methodology of SPA from 1981 to 1997 as it has been applied to Yukon River chinook salmon. Current methodology described by Schneiderhan (1997a) was employed for the analysis presented here.

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. Scale impressions were then projected on a digitizing table at 100X magnification, and scale variables were measured (Figure 3). Measurements were automatically recorded in computer files for later statistical analysis. Ages were reported in European notation.

Catch Sampling

Scales were collected from commercial catches in all fishing districts except District 3. There were no chinook salmon commercial harvests in District 3 in 1996. Subsistence catches in Districts 4 and 6 were also sampled. For purposes of this report, I assumed that subsistence fishing in Districts 1 and 2 occurred prior to or near the beginning of commercial fishing and could therefore be described using the Period 1 commercial sample data for each district. In addition, samples were collected from salmon harvested by the District 1 ADF&G gillnet test fishing project and from fish captured in fish wheels by the Canada Department of Fisheries and Oceans (DFO) in Yukon, Canada.

Escapement Sampling

Spawning escapements for the three Yukon River chinook salmon runs were characterized by age composition. Scale samples for age information were collected during the period of peak spawner mortality from the Anvik, Chena, and Salcha Rivers in Alaska. Carcasses were the primary source of samples; however, some samples were obtained from live fish captured with spears or other methods. Live salmon from the Andreafsky River were sampled at a weir project operated by U. S. Fish and Wildlife Service (FWS). Limited sampling of chinook salmon in Canadian tributaries was performed in 1996; however, samples taken by DFO at the Canadian border passage fish wheel sites were used for this analysis in the same manner as recent years.

Since comparable escapement estimates for the Lower Yukon Run tributaries, i.e., Andreafsky and Anvik Rivers, were not available as weighting factors, the age composition of the Lower Yukon Run was estimated using the pooled Andreafsky and Anvik River samples. The Chena and Salcha River escapements, which are used to characterize the Middle Yukon Run, had abundance estimates of comparable quality that were used as weighting factors in conjunction with sample age compositions to obtain an estimate of age composition for the run. The age composition obtained from samples collected at the two DFO salmon tagging sites was used to characterize the spawning escapement for the Upper Yukon Run.

Estimation of Catch Composition

Linear discriminant analysis (LDA, Seber 1984) of scale pattern data, observed differences in age composition between escapements, and geographic occurrence of catches were used to estimate runs of origin for 1996 Yukon River chinook salmon catches.

RESULTS

Escapement Age Composition

Estimated spawning escapement age compositions of Yukon River chinook salmon in 1996 exhibited some differences (non-statistical comparison) between lower and middle Yukon River escapements (Table 1). The samples listed in Table 1 for the White Rock and Sheep Rock sites are not representative of the spawning escapement, because Canadian fisheries upstream resulted in removal from the sampled population after it passed the sampling sites, and fishwheels are thought to capture chinook salmon selectively. However, only limited spawning escapement sampling was conducted for upper Yukon River stocks in 1996. Fish wheels operated at the White Rock and Sheep Rock sites provided samples that were imperfectly comparable to the spawning ground samples obtained prior to 1991.

All escapement sample size objectives were achieved. Age-1.3 fish were more abundant than age-

1.4 fish in lower, middle and upper Yukon River escapements. This has been noted in other years. The large proportions of age 1.5 from the 1989 brood year that were present in 1996 middle Yukon River escapements were unusual, but were preceded by large proportions of age 1.3 in 1994 escapements (Schneiderhan 1996) and age 1.4 in 1995 escapements (Schneiderhan 1997b).

Catch Composition

Scale Pattern Analysis

The scale measurement characters (Appendix A) that were most useful in distinguishing between the three runs of origin for age 1.3 were (1) variable 65, the total number of freshwater circuli, (2) variable 62, width of the freshwater plus growth zone, and (3) variable 1, the number of circuli in the first freshwater annular zone. Variables 111, 100, and 103 were also selected.

The primary distinguishing characters for age 1.4 in order of selection were (1) variable 65, described above, (2) variable 82, the distance from circulus 6 to circulus 12 in the first marine annular zone, and (3) variable 61, the number of circuli in the freshwater plus growth zone. Variables 111, 17, and 67 were also selected. Variables involving freshwater and freshwater plus growth typically accounted for most of the discriminatory power in both models. Variables selected for the classification model are presented in Appendix B with mean and standard error for each run of origin. 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.

Classification Accuracies of Run of Origin Models

A 3-way (Lower, Middle, Upper) classification model was developed using linear discriminant functions (Seber 1984). Classification accuracies were investigated by comparing the true run of origin with that predicted by the model for each scale used in development of the model. The mean classification accuracy of the 3-way, run of origin model for age 1.3 was 67.2%, and for age 1.4 it was 58.0% (Table 2). This is toward the low end of the range of accuracies normally achieved with 3-way models used in other years. Unlike past years, the middle river standard showed the greatest classification accuracy for age 1.4 (63.6%), while, the upper river standard for age 1.3 as in most past years showed the highest classification accuracy (77.2%) of the three runs. Upper river standards most often misclassified to the Middle Yukon Run (12.4% for age 1.3 and 28.6% for age 1.4), and middle river standards most often misclassified to the Lower Yukon Run for age 1.3 (25.6%) and to the Upper Yukon Run for age 1.4 (23.2%). Historically, the Middle Yukon Run has typically misclassified for both age classes to the Upper Yukon Run more strongly than to the Lower Yukon Run.

Proportion of Catch

The commercial chinook salmon catch in Districts 1 and 2 was fairly evenly distributed among the six open periods in each district. Upper Yukon Run fish comprised the largest proportion of the District 1 commercial harvest of age-1.3 chinook salmon in periods 1 - 5. Upper run fish comprised the largest proportion of District 1 harvests of age 1.4 in periods 1, 3 and 5 (Table 3). Similarly, in District 2 Upper Yukon Run fish were the largest proportion of the catch of age 1.3 in periods 1 - 5, while age 1.4 Upper Yukon Run fish dominated the catch only in Period 2 (Table 4).

Usually, Upper Yukon Run fish tend to dominate the harvest during the early commercial fishing periods in District 1 and gradually decrease during the later periods. In 1996 no clear trend was apparent for either age (Figure 4). In terms of numbers of fish caught in District 1 commercial periods (Figure 5, Table 5), generally, more Upper Yukon fish were caught in earlier periods for age 1.3; however, there was less of a pattern for age 1.4.

In District 2, proportions of Upper Yukon Run fish remained uniformly high throughout the season for age 1.3; however, Upper Run fish appeared in substantial proportions only in periods 2, 3 and 6 for age 1.4 (Figure 6). Similarly, Upper Yukon Run fish dominated catches in numbers of fish for each period for age 1.3, while age 1.4 Upper Run fish appeared weak (Figure 7).

The estimated District 1 commercial catch of age-1.3 and -1.4 fish combined was 14,720 (35.0%) Lower, 4,247 (10.1%) Middle, and 23,054 (54.9%) Upper Yukon Run (Table 5). In District 2 the estimated age-1.3 and -1.4 combined catch was 7,790 (31.5%) Lower, 1,683 (6.8%) Middle, and 15,262 (61.7%) Upper Yukon Run (Table 6).

Classification by SPA Analysis

A total of 66,756 age-1.3 and -1.4 fish (42.2% 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. Additionally, 22,406 (14.2% of the total drainage harvest) age-1.3 and -1.4 fish caught in Districts 1 and 2 subsistence fisheries and Districts 3 and 4 commercial and subsistence fisheries were indirectly classified based on the scale pattern analysis.

Classification by Differential Age Composition Analysis

The remaining age classes (0.2, 1.1, 0.3, 1.2, 0.4, 2.2, 2.3, 1.5, 2.4, and 2.5) from Districts 1, 2, 3, and 4 commercial and subsistence catches contributed 25,926 fish (16.4%) to the total drainage harvest (Table 7). With the exception of 205 fish taken in the Koyukuk River subsistence fishery and 164 fish taken in Chandalar River and Black River subsistence fisheries, they were classified to run of origin by applying differences in escapement age composition in each run to classifications derived from the analogous major age class, i.e., age 1.3 or 1.4, through SPA (Schneiderhan 1997a).

Classification by Geographical Analysis

The Koyukuk River subsistence catch of 205 fish in District 4 is represented in the numbers of fish reported in the above sections on SPA and age composition analysis; however, the Koyukuk fish were classified to the Middle River Run based on geographical segregation as explained above. Additionally, a total of 43,146 fish (27.3% of total drainage harvest) in Districts 5, 6, and Yukon Territory was classified to run of origin based on geographical segregation. With the exception of

Chandalar River and Black River subsistence catches, District 5 and Yukon Territory harvests were assumed to be Upper Yukon fish. The Chandalar River and Black River subsistence catch in District 5 was classified to the Middle River Run based on geographical segregation from stocks of the Upper River Run, i.e., Canadian origin. Harvests in District 6 (Table 7) were classified entirely to the Middle Yukon Run based on geographic location of the fisheries.

Total Harvest

All identifiable components of the Yukon River drainage harvest of chinook salmon consisting of 158,234 fish were classified to run of origin (Table 7) based on: (1) findings of the scale pattern analyses of age-1.3 and -1.4 fish in District 1 and 2 commercial catches, (2) age composition analyses of the remaining age classes, (3) assumptions concerning unsampled fisheries, and (4) stock origins based on geographical segregation. Allowing for slight rounding error (<1 fish), the Upper Yukon Run was the largest estimated run component and contributed 96,940 fish or 61.3% of the total drainage harvest. The Lower Yukon Run was next in abundance at 48,076 fish (30.4%), followed by the Middle Yukon Run at 13,218 fish (8.4%).

DISCUSSION

Attainment of sample size objectives presented in the annual sampling plan has been considered to be a fair measure of operational success. For all escapements which contributed to the standard three-way LDF classification model, sample sizes were fair to excellent. Poor sample quality continues to be of concern, especially for middle and upper Yukon escapements. Acceptable sample quality depends on environmental, biological, and methodological factors. When the expected rejection rate is exceeded, the quantity of acceptable specimens may become problematic. The rejection rate attributed to sampling technique is a key factor in determining sample sizes. In order to optimize sampling effort, sampling technique must also be optimized; therefore, the production of good quality samples continues to be very important.

Proportion of total drainage harvest that was attributed to the Lower Yukon Run in 1996 matched that of 1985 as the highest on record, while the proportion attributed to the Middle Yukon Run was the second lowest on record. Table 8 presents a summary of the annual estimates of catch composition as presented in each of the annual reports for this project. Estimates of the Upper Yukon Run component have ranged from 35.4% in 1984 to 74.8% in 1995, with an unweighted average of 58.4% since 1982.

LITERATURE CITED

Bergstrom, D.J. and seven coauthors. 1997. Annual management report, Yukon Area, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A97-41, Anchorage.

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

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

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

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

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

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

Schneiderhan, D.J. 1996. Origins of chinook salmon in the Yukon River Fisheries, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A96-10, Anchorage.

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

LITERATURE CITED (continued)

Schneiderhan, D.J. 1997b. Origins of chinook salmon in the Yukon River Fisheries, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A97-45, Anchorage.

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

TABLES

Table 1. Age proportions of Yukon River chinook salmon escapement samples, 1996.

		Brood Year and Age Group												
		1993		1992		1991			1990		1989		1988	
Location	Sample Size a	0.2	1.1	0.3	1.2	0.4	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5
Lower Yukon														
Andreafsky River b	340	0.0000	0.0150	0.0000	0.0710	0.0000	0.7380	0.0000	0.1350	0.0000	0.0380	0.0030	0.0000	0.0000
Anvik River b	262	0.0000	0.0000	0.0000	0.0990	0.0000	0.5500	0.0040	0.2400	0.0040	0.0990	0.0000	0.0000	0.0040
Average Proportion		0.0000	0.0075	0.0000	0.0850	0.0000	0.6440	0.0020	0.1875	0.0020	0.0685	0.0015	0.0000	0.0020
Middle Yukon														
Chena River b	515	0.0000	0.0210	0.0000	0.0620	0.0000	0.4430	0.0000	0.2350	0.0000	0.2390	0.0000	0.0000	0.0000
Salcha River b	412	0.0000	0.0270	0.0000	0.0610	0.0000	0.3830	0.0000	0.2840	0.0000	0.2450	0.0000	0.0000	0.0000
Average Proportion		0.0000	0.0240	0.0000	0.0615	0.0000	0.4130	0.0000	0.2595	0.0000	0.2420	0.0000	0.0000	0.0000
Upper Yukon (Canada)														
White Rock & Sheep Rock b	794	0.0000	0.0013	0.0000	0.0756	0.0000	0.5882	0.0088	0.1839	0.0957	0.0340	0.0126	0.0000	0.0000

a Samples from the Anvik, Chena, and Salcha Rivers were collected from carcasses and live spawnouts captured with fish spears. Andreafsky River samples were from live fish captured in a weir trap, and White Rock and Sheep Rock samples were obtained from fish captured in fish wheels.

b Escapement index abundance estimates are from mark and recapture studies at the Chena, Salcha, and Canadian sites. Andreafsky and Anvik River age compositions were not weighted due to the non-comparability of escapement estimation results and the close similarity of age compositions between the two rivers.

Table 2. Classification accuracies of linear discriminant run-of-origin models for age-1.3 and -1.4 Yukon River chinook salmon, 1996.

		Classified Run of Origin		
Region of Origin	Sample Size	Lower	Middle	Upper
Age 1.3				
Lower	262	0.660	0.244	0.095
Middle	180	0.256	0.583	0.161
Upper	202	0.104	0.124	0.772
	Mean Classification Accuracy:		**0.672**	
	Variables in Analysis:		65, 62, 1, 111, 100, 103	
Age 1.4				
Lower	85	0.588	0.165	0.247
Middle	151	0.132	0.636	0.232
Upper	91	0.198	0.286	0.516
	Mean Classification Accuracy:		**0.580**	
	Variables in Analysis:		65, 82, 61, 111, 17, 67	

Table 3. Maximum likelihood run composition estimates for age-1.3 and -1.4 chinook salmon commercial catches in Yukon River District 1, 1996.

			Age 1.3				Age 1.4			
Commercial Fishing Period	Dates	Run-of-Origin	N	P	S.E.	Simultaneous 90% CI[a]	N	P	S.E.	Simultaneous 90% CI[a]
1	6/10-11	Lower	19	0.017	0.074	0.000 < P < 0.174	27	0.484	0.147	0.171 < P < 0.797
		Middle	31	0.279	0.098	0.071 < P < 0.487	4	0.000	0.000	0.000 < P < 0.000
		Upper	72	0.704	0.072	0.551 < P < 0.856	36	0.516	0.147	0.203 < P < 0.829
2	6/13-14	Lower	16	0.107	0.081	0.000 < P < 0.280	31	0.508	0.140	0.211 < P < 0.805
		Middle	14	0.020	0.090	0.000 < P < 0.211	4	0.000	0.000	0.000 < P < 0.000
		Upper	66	0.873	0.074	0.715 < P < 1.000	40	0.492	0.140	0.195 < P < 0.789
3	6/17-18	Lower	23	0.113	0.092	0.000 < P < 0.309	32	0.376	0.125	0.110 < P < 0.641
		Middle	31	0.343	0.113	0.103 < P < 0.584	5	0.000	0.000	0.000 < P < 0.000
		Upper	51	0.543	0.078	0.377 < P < 0.709	52	0.624	0.125	0.359 < P < 0.890
4	6/20-21	Lower	9	0.164	0.135	0.000 < P < 0.450	29	0.791	0.165	0.440 < P < 1.000
		Middle	8	0.093	0.150	0.000 < P < 0.412	3	0.000	0.000	0.000 < P < 0.000
		Upper	26	0.743	0.117	0.495 < P < 0.992	23	0.209	0.165	0.000 < P < 0.560
5	6/24-25	Lower	32	0.277	0.104	0.056 < P < 0.498	35	0.438	0.125	0.171 < P < 0.704
		Middle	32	0.328	0.118	0.076 < P < 0.579	5	0.000	0.000	0.000 < P < 0.000
		Upper	40	0.396	0.076	0.235 < P < 0.556	51	0.563	0.125	0.296 < P < 0.829
6	6/27-28	Lower	0	1.000	0.000	0.000 < P < 0.000	0	1.000	0.000	0.000 < P < 0.000
		Middle	31	0.373	0.102	0.156 < P < 0.589	51	0.795	0.124	0.531 < P < 1.000
		Upper	18	0.033	0.102	0.000 < P < 0.249	0	0.000	0.000	0.000 < P < 0.000

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

Table 4. Maximum likelihood run composition estimates for age-1.3 and -1.4 chinook salmon commercial catches in Yukon River District 2, 1996.

			Age 1.3				Age 1.4			
Commercial Fishing Period	Dates	Run-of-Origin	N	P	S.E.	Simultaneous 90% CI[a]	N	P	S.E.	Simultaneous 90% CI[a]
1	6/9	Lower	12	0.000	0.000	0.000 < P < 0.000	43	0.982	0.141	0.682 < P < 1.000
		Middle	22	0.123	0.067	0.000 < P < 0.265	0	0.000	0.000	0.000 < P < 0.000
		Upper	81	0.877	0.067	0.735 < P < 1.000	27	0.018	0.141	0.000 < P < 0.318
2	6/12-13	Lower	13	0.000	0.000	0.000 < P < 0.000	28	0.449	0.141	0.150 < P < 0.748
		Middle	20	0.101	0.066	0.000 < P < 0.242	0	0.000	0.000	0.000 < P < 0.000
		Upper	82	0.899	0.066	0.758 < P < 1.000	43	0.551	0.141	0.252 < P < 0.850
3	6/17	Lower	21	0.130	0.075	0.000 < P < 0.290	39	0.734	0.139	0.437 < P < 1.000
		Middle	17	0.010	0.081	0.000 < P < 0.183	3	0.000	0.000	0.000 < P < 0.000
		Upper	80	0.860	0.067	0.717 < P < 1.000	35	0.266	0.139	0.000 < P < 0.563
4	6/19-20	Lower	10	0.000	0.000	0.000 < P < 0.000	58	1.000	0.000	1.000 < P < 1.000
		Middle	22	0.178	0.747	0.000 < P < 1.000	3	0.000	0.000	0.000 < P < 0.000
		Upper	66	0.822	0.747	0.000 < P < 1.000	32	0.000	0.000	0.000 < P < 0.000
5	6/23-24	Lower	18	0.104	0.096	0.000 < P < 0.308	60	0.962	0.119	0.709 < P < 1.000
		Middle	23	0.266	0.117	0.017 < P < 0.515	0	0.000	0.000	0.000 < P < 0.000
		Upper	48	0.630	0.084	0.451 < P < 0.809	39	0.038	0.119	0.000 < P < 0.291
6	7/1	Lower	0	1.000	0.000	0.000 < P < 0.000	0	0.000	0.000	0.000 < P < 0.000
		Middle	22	0.250	0.101	0.035 < P < 0.464	40	0.608	0.130	0.332 < P < 0.883
		Upper	16	0.065	0.106	0.000 < P < 0.292	0	0.000	0.000	0.000 < P < 0.000

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

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, 1996.

Commercial Fishing Period	Dates and Mesh Size	Region of Origin	Age Group 1.3	Age Group 1.4	Total
1	6/12-13	Lower	99	2,126	2,225
		Middle [a]	1,624	0	1,624
	Unrestricted	Alaska	1,723	2,126	3,850
		Upper	4,096	2,266	6,362
		Total	5,819	4,393	10,212
2	6/15-16	Lower	265	1,152	1,417
		Middle [a]	49	0	49
	Unrestricted	Alaska	314	1,152	1,466
		Upper	2,152	1,115	3,267
		Total	2,465	2,268	4,733
3	6/19	Lower	282	975	1,257
		Middle [a]	854	0	854
	Unrestricted	Alaska	1,135	975	2,110
		Upper	1,351	1,619	2,969
		Total	2,486	2,594	5,080
4	6/22-23	Lower	516	4,211	4,727
		Middle [a]	291	0	291
	Unrestricted	Alaska	807	4,211	5,018
		Upper	2,337	1,111	3,448
		Total	3,143	5,322	8,466
5	6/26-27	Lower	1,137	1,797	2,935
		Middle [a]	1,346	0	1,346
	Unrestricted	Alaska	2,483	1,797	4,280
		Upper	1,625	2,311	3,935
		Total	4,108	4,108	8,215
6	6/27	Lower	958	1,202	2,160
		Middle [a]	84	0	84
	Restricted	Alaska	1,041	1,202	2,243
		Upper	1,527	1,545	3,073
		Total	2,568	2,748	5,316
District 1 Season Total		Lower	3,256	11,464	14,720
		Middle [a]	4,247	0	4,247
		Alaska	7,503	11,464	18,967
		Upper	13,087	9,967	23,054
		Total	20,590	21,431	42,022

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, 1996.

Commercial Fishing Period	Dates and Mesh Size	Region of Origin	Age Group 1.3	1.4	Total
1	6/11-12	Lower	0	2,144	2,144
		Middle [a]	463	0	463
	Unrestricted	Alaska	463	2,144	2,607
		Upper	3,315	39	3,353
		Total	3,778	2,183	5,961
2	6/14	Lower	0	1,177	1,177
		Middle [a]	500	0	500
	Unrestricted	Alaska	500	1,177	1,677
		Upper	4,451	1,444	5,894
		Total	4,951	2,621	7,572
3	6/18	Lower	314	1,104	1,418
		Middle [a]	24	0	24
	Unrestricted	Alaska	339	1,104	1,442
		Upper	2,075	400	2,475
		Total	2,414	1,504	3,917
4	6/19	Lower	0	1,121	1,121
		Middle [a]	239	0	239
	Restricted	Alaska	239	1,121	1,360
		Upper	1,106	0	1,106
		Total	1,345	1,121	2,465
5	6/21-22	Lower	144	1,392	1,536
		Middle [a]	366	0	366
	Unrestricted	Alaska	510	1,392	1,902
		Upper	868	55	923
		Total	1,378	1,447	2,825
6	7/1	Lower	115	279	394
		Middle [a]	90	0	90
	Unrestricted	Alaska	434	879	1,314
		Upper	943	568	1,511
		Total	1,378	1,447	2,825
District 2 Season Total		Lower	573	7,217	7,790
		Middle	1,683	0	1,683
		Alaska	2,255	7,217	9,473
		Upper	12,757	2,505	15,262
		Total	15,013	9,722	24,735

Table 7. Total commercial and subsistence catch of chinook salmon by age class and run in Yukon River Districts 1-6 and Canada, 1996.

			Brood Year and Age Group													
			1992		1991		1990			1989		1988		1987		
District	Fishery	Run of Origin	0.2	1.1	0.3	1.2	0.4	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
1	Commercial Gillnet	Lower	0	0	0	99	0	3,256	0	11,464	101	9,577	9	0	0	24,506
		Middle	0	0	0	145	0	4,247	0	0	0	0	0	0	0	4,393
		Alaska	0	0	0	244	0	7,503	0	11,464	101	9,577	9	0	0	28,898
		Upper	0	0	0	387	0	13,087	0	9,967	88	4,215	0	0	0	27,744
		Total	0	0	0	631	0	20,590	0	21,431	188	13,792	9	0	0	56,642
	Subsistence Gillnet [b]	Lower	0	0	0	4	0	352	0	898	9	954	3	0	0	2,219
		Middle	0	0	0	6	0	459	0	0	0	0	0	0	0	465
		Alaska	0	0	0	10	0	810	0	898	9	954	3	0	0	2,684
		Upper	0	0	0	16	0	1,413	0	780	7	420	24	0	0	2,661
		Total [a]	0	0	0	27	0	2,223	0	1,678	16	1,373	27	0	0	5,344
2	Commercial Gillnet	Lower	0	1	0	6	0	573	0	7,217	114	4,299	21	0	0	12,231
		Middle	0	2	0	21	0	1,683	0	0	0	0	0	0	0	1,706
		Alaska	0	2	0	28	0	2,255	0	7,217	114	4,299	21	0	0	13,936
		Upper	0	13	0	140	0	12,757	0	2,505	40	755	62	0	0	16,272
		Total	0	16	0	168	0	15,013	0	9,722	154	5,054	83	0	0	30,209
	Subsistence Gillnet [c]	Lower	0	0	0	2	0	151	0	1,692	17	1,247	6	0	0	3,115
		Middle	0	0	0	5	0	442	0	0	0	0	0	0	0	447
		Alaska	0	0	0	7	0	593	0	1,692	17	1,247	6	0	0	3,562
		Upper	0	0	0	34	0	3,352	0	587	6	220	18	0	0	4,217
		Total	0	0	0	41	0	3,944	0	2,280	23	1,467	25	0	0	7,780
3	Commercial Gillnet [c]	Lower	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Middle	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Alaska	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Upper	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Subsistence Gillnet [c]	Lower	0	0	0	1	0	131	0	1475	15	1087	5	0	0	2,716
		Middle	0	0	0	5	0	385	0	0	0	0	0	0	0	390
		Alaska	0	0	0	6	0	517	0	1475	15	1087	5	0	0	3,106
		Upper	0	0	0	30	0	2922	0	512	5	191	16	0	0	3,677
		Total	0	0	0	36	0	3439	0	1987	20	1279	21	0	0	6,783
4	Commercial & Subsistence GN & FW [d]	Lower	0	0	0	2	0	154	0	1941	31	1156	6	0	0	3,290
		Middle	0	0	0	8	0	655	0	0	0	0	0	0	0	664
		Alaska	0	1	0	10	0	809	0	1941	31	1156	6	0	0	3,953
		Upper	0	4	0	38	0	3431	0	674	11	203	17	0	0	4,377
		Total	0	4	0	48	0	4240	0	2615	41	1359	22	0	0	8,330

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Table 7. (Page 2 of 2)

			Brood Year and Age Group													
			1992		1991		1990			1989		1988		1987		
District	Fishery	Run of Origin	0.2	1.1	0.3	1.2	0.4	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
5	Commercial & Subsistence GN & FW[e]	Middle	0	1	0	17	0	91	0	49	0	7	0	0	0	164
		Alaska	0	1	0	17	0	91	0	49	0	7	0	0	0	164
		Upper	0	64	0	1,851	0	10,149	0	5,426	0	830	0	0	0	18,320
		Total	0	64	0	1,868	0	10,240	0	5,474	0	837	0	0	0	18,484
6	Commercial & Subsistence GN & FW[f]	Middle	0	277	0	721	0	2,135	0	1,747	0	111	0	0	0	4,990
Canada[g]	Commercial GN & FW	Upper	0	305	11	1,111	22	5,796	11	2,516	33	294	54	0	11	10,164
	Non-Commercial	Upper	0	285	10	1,039	20	5,421	10	2,354	31	275	51	0	10	9,508
TOTAL HARVEST		Lower	0	1	0	114	0	4,616	0	24,688	287	18,320	50	0	0	**48,076**
		Middle	0	280	0	928	0	10,096	0	1,795	0	118	0	0	0	**13,218**
		Alaska	0	281	0	1,042	0	14,713	0	26,483	287	18,438	50	0	0	**61,294**
		Upper	0	671	21	4,647	42	58,329	21	25,322	220	7,403	242	0	21	**96,940**
		Total	0	952	21	5,689	42	73,042	21	51,805	507	25,841	292	0	21	**158,234**

[a] Run composition is based on District 1, period 1 commercial catch samples.

[b] Includes 1,698 fish from ADF&G test fisheries.

[c] Run composition based on District 2, period 1 commercial catch samples.

[d] Gillnet and fish wheel catches combined. Commercial catch = 45 fish, commercial related catch = 92, and subsistence catch = 7,988. The Koyukuk River subsistence catch (205) was assigned to the Middle River Run (see METHODS).

[e] Gillnet and fish wheel catches combined. Commercial catch = 2,757 and subsistence catch = 15,563 plus 164 from the Chandalar and Black Rivers.

[f] Gillnet and fish wheel catches combined. Preliminary data includes 278 commercial, 169 commercial related, 1,392 subsistence, 362 personal use, and 1,100 sport harvest.

[g] Run and age composition are based on Canada DFO tagging study fish wheel samples. Harvest components include commercial (10,164), Canadian Aboriginal fishery (9,240), domestic (141), and sport (850) harvests.

Table 8. Harvest percentages by run of the total Yukon River harvest of chinook salmon, 1982-96.

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
1993	22.3	13.2	64.6
1994	16.1	24.4	59.6
1995	12.0	13.1	74.8
1996	30.4	8.4	61.3
1982-96 Avg	21.7	19.6	58.4
1992-96 Avg	19.7	16.5	63.9

FIGURES

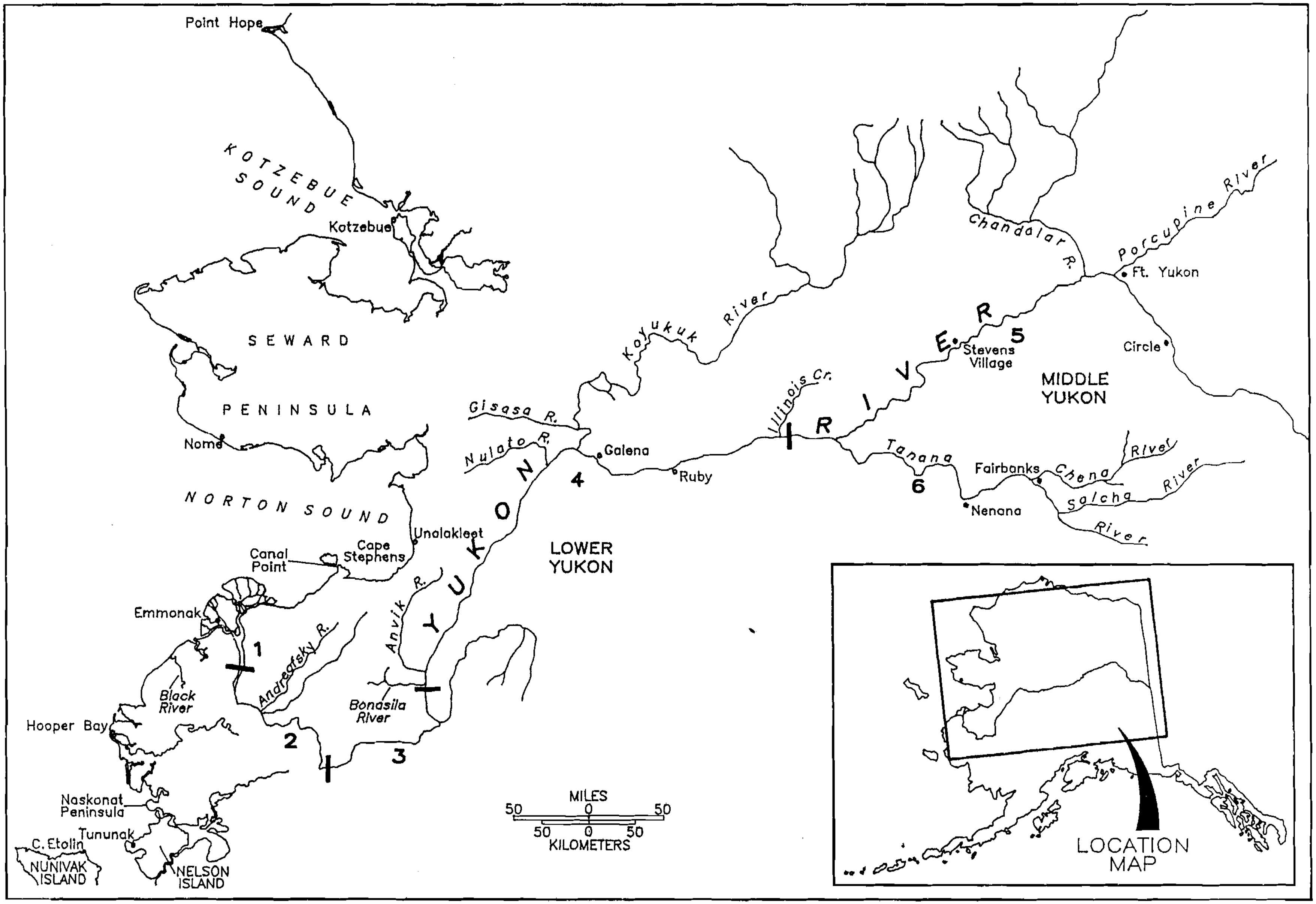

Figure 1. Alaskan portion of the Yukon River with fishing district boundaries.

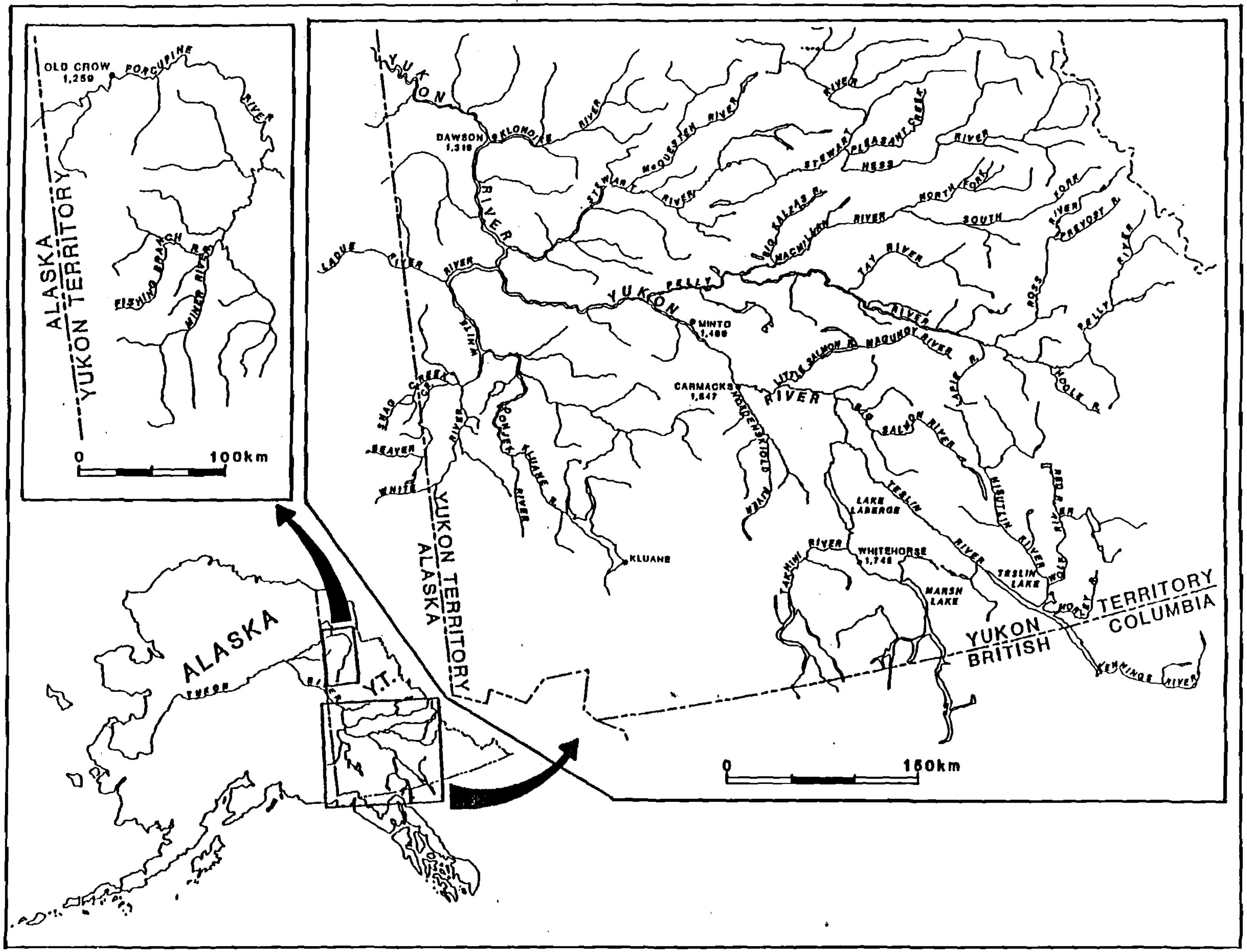

Figure 2. Canadian portion of the Yukon River drainage.

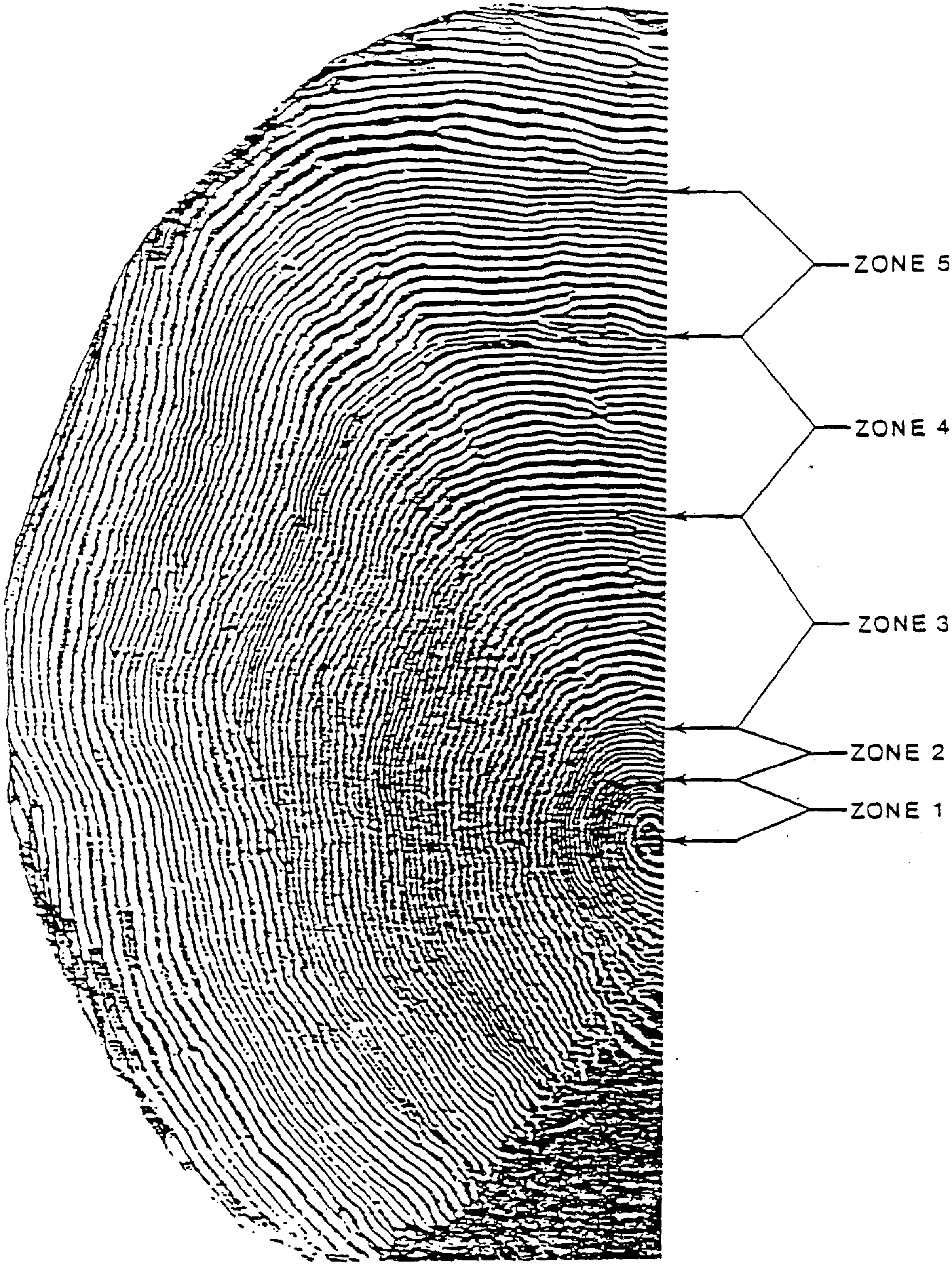

Figure 3. Age-1.4 chinook salmon scale showing zones measured for linear discriminant analysis.

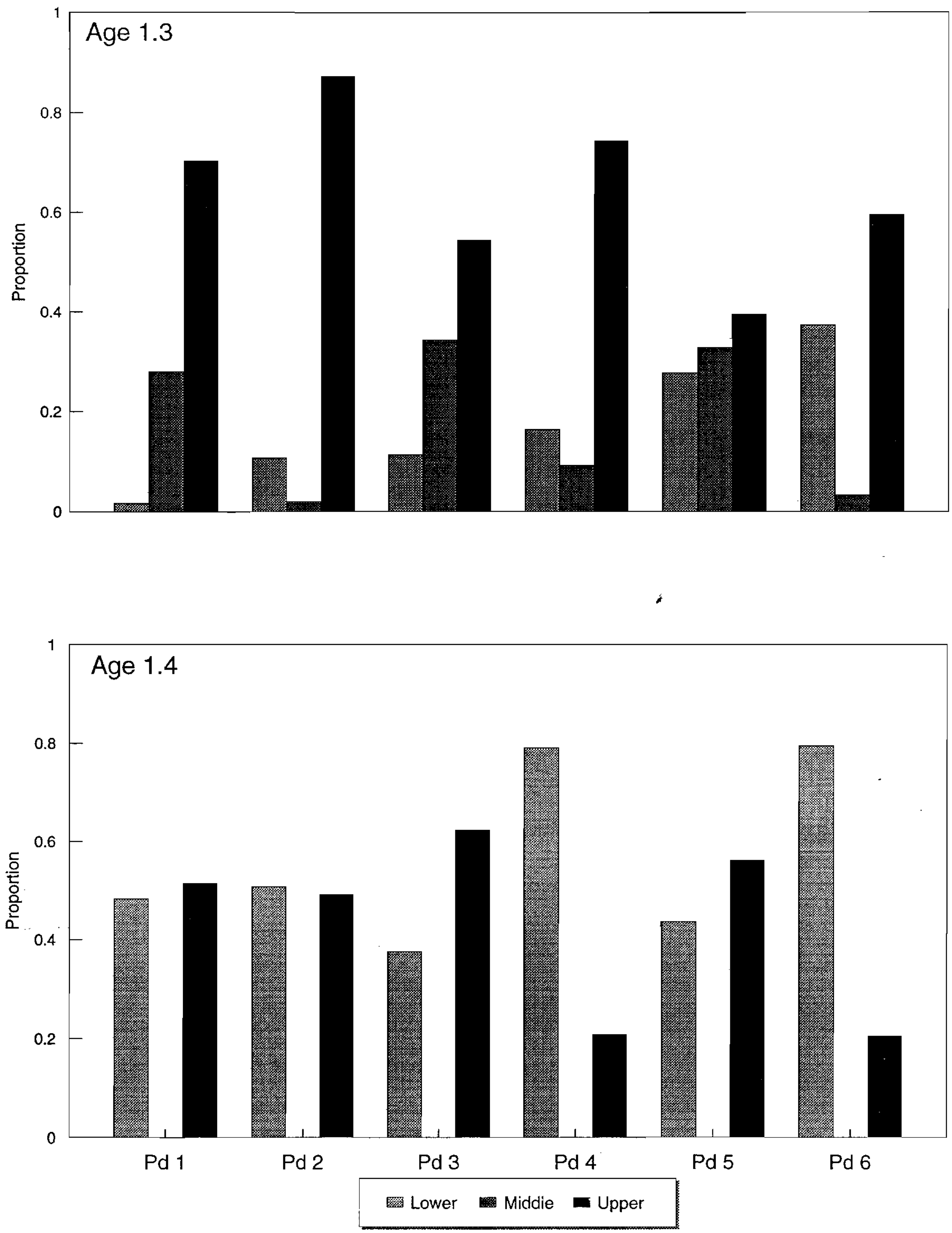

Figure 4. Estimated proportion of catch by period (all periods unrestricted mesh size) and run from scale pattern analysis of age-1.3 and -1.4 chinook salmon, Yukon River District 1, 1996.

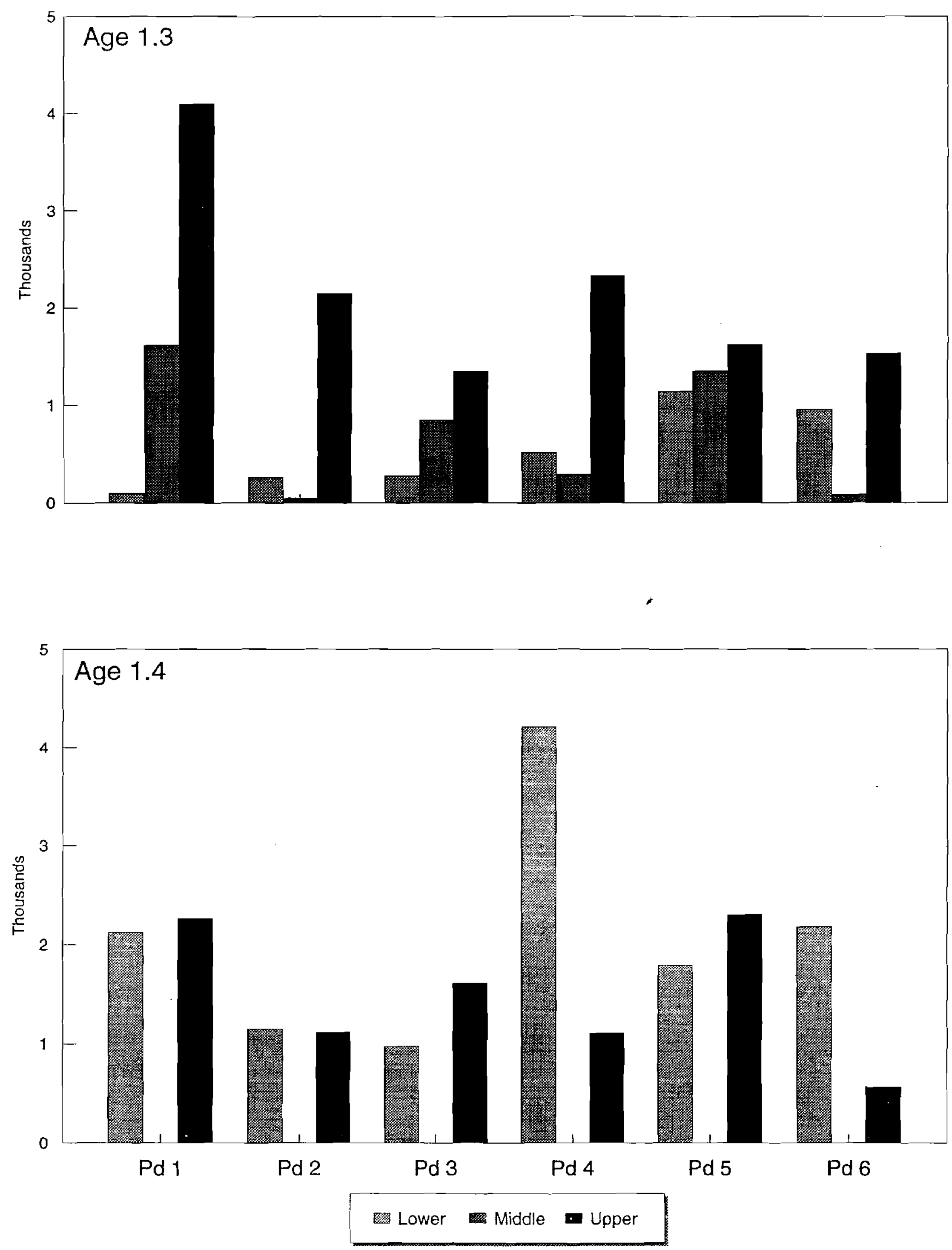

Figure 5. Estimated catch by period (all periods unrestricted mesh size) and run in numbers of fish from scale pattern analysis of age-1.3 and -1.4 chinook salmon, Yukon River District 1, 1996.

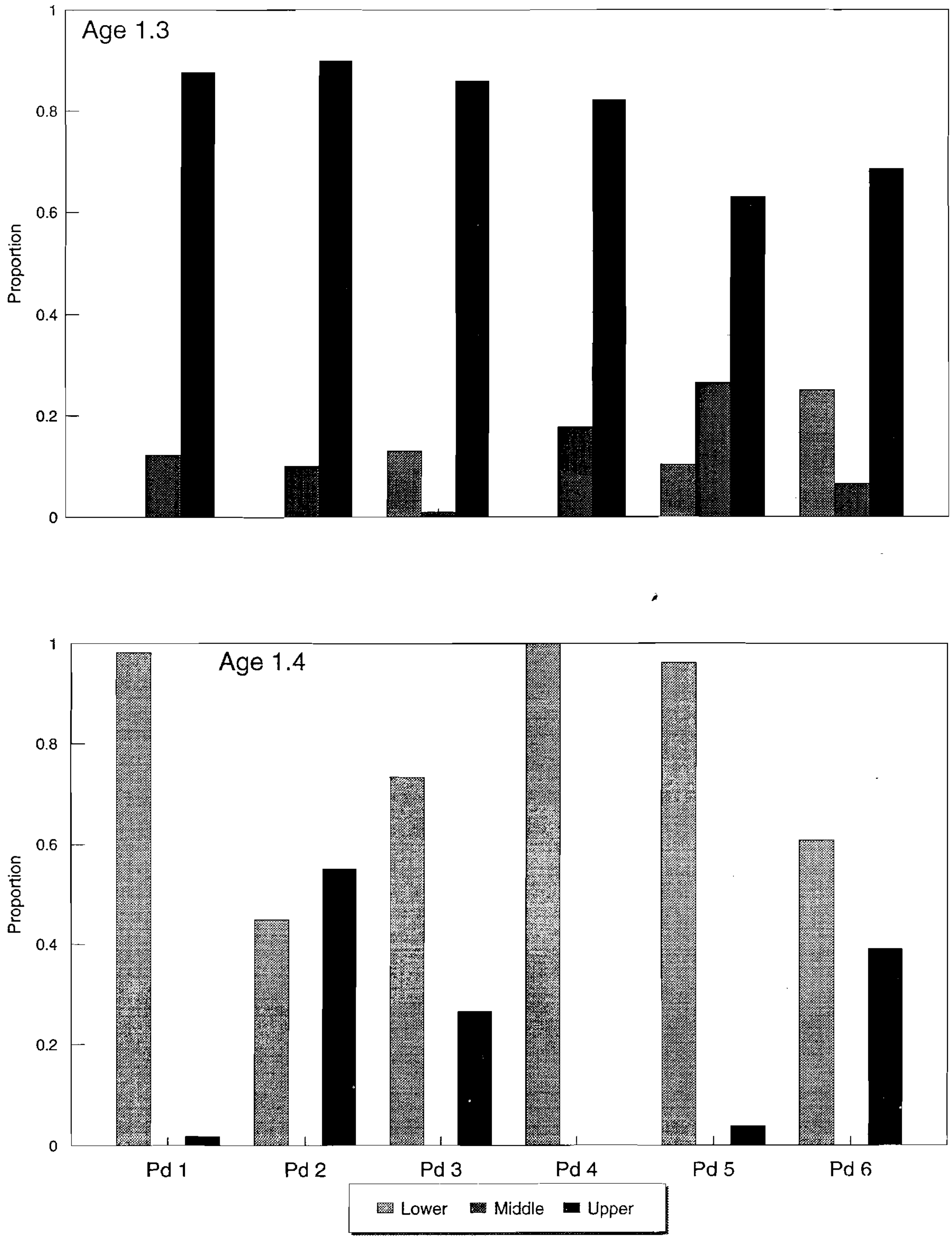

Figure 6. Estimated proportion of catch by period (all periods unrestricted mesh size) and run from scale pattern analysis of age-1.3 and -1.4 chinook salmon, Yukon River District 2, 1996.

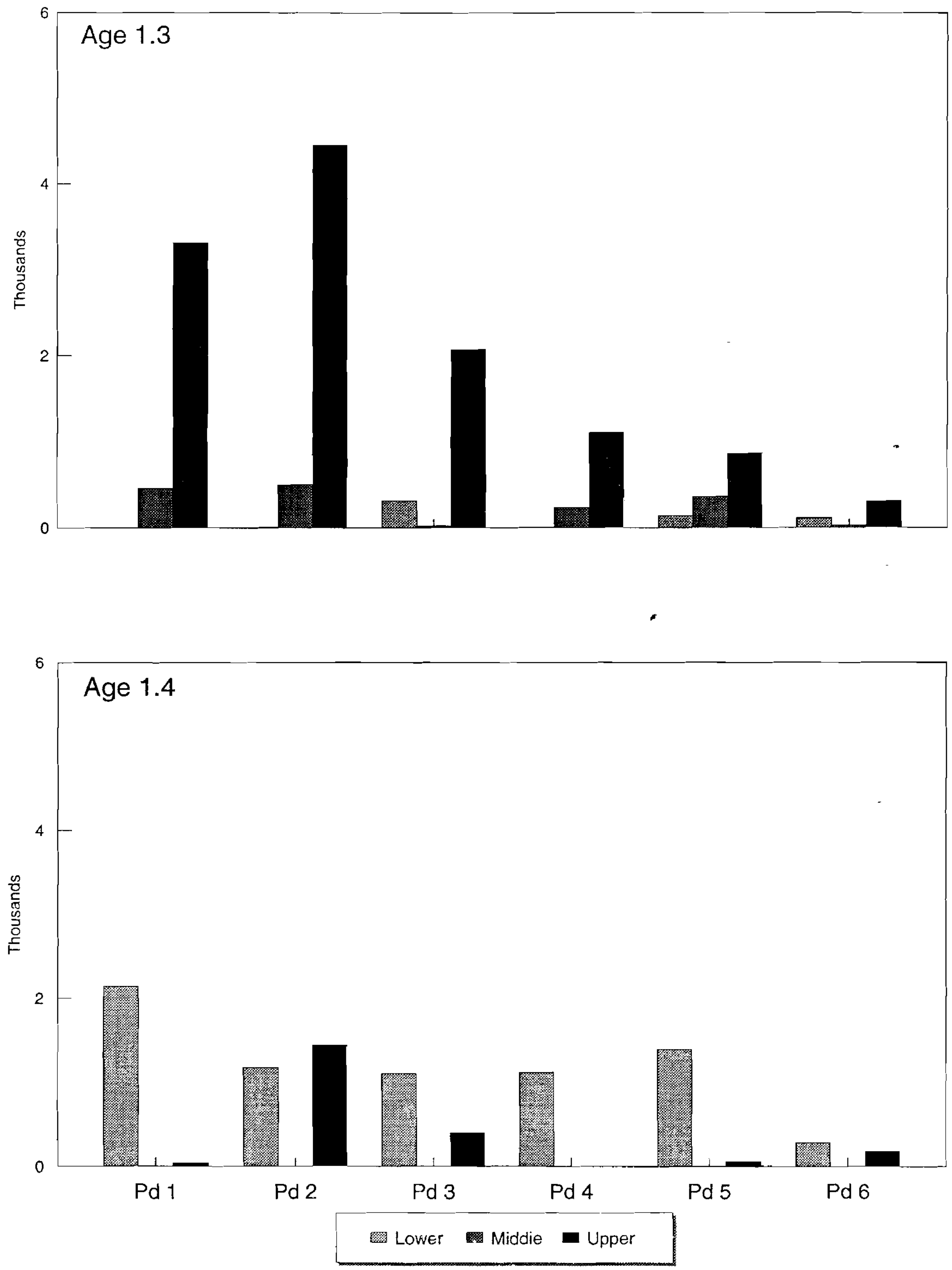

Figure 7. Estimated catch by period (all periods unrestricted mesh size) and run in numbers of fish from scale pattern analysis of age-1.3 and -1.4 chinook salmon, Yukon River District 2, 1996.

APPENDIX

Appendix A. Scale variables screened for linear discriminant function analysis of age-1.3 and -1.4 Yukon River chinook salmon, 1996.

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)

-Continued-

[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, 1996.

		Lower		Middle		Upper	
Growth Zone	Variable	Mean	SE	Mean	SE	Mean	SE
Age-1.3							
1st FW Annular	1	7.557	0.074	8.011	0.093	9.292	0.088
Freshwater Plus	62	40.573	0.469	45.128	0.673	55.538	0.714
All Freshwater	65	11.786	0.094	12.050	0.103	14.228	0.108
First Marine Annular	100	0.227	0.002	0.240	0.003	0.259	0.003
	103	0.261	0.003	0.249	0.003	0.265	0.003
All Marine	111	897.859	5.709	924.039	7.709	882.861	5.952
Age-1.4							
1st FW Annular	17	0.707	0.010	0.791	0.007	0.726	0.009
Freshwater Plus	61	5.230	0.128	4.166	0.051	4.231	0.098
All Freshwater	65	12.460	0.197	10.338	0.103	11.319	0.165
	67	0.671	0.007	0.702	0.003	0.700	0.006
1st Marine Annular	82	112.353	1.919	105.199	1.255	110.110	1.634
All Marine	111	1145.069	18.771	1237.887	9.827	1201.407	13.186

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, 1996.

Growth Zone	Variable	Description	Lower Mean	Lower SE	Middle Mean	Middle SE	Upper Mean	Upper SE	F-Value
Age-1.3									
1st FW Annular	1	No. Circ.	7.557	0.074	8.011	0.093	9.292	0.088	117.269
	2	Distance	104.588	0.885	109.428	1.094	118.099	1.144	46.238
Total FW Growth	61	No. Circ.	4.229	0.048	4.039	0.051	4.936	0.058	74.519
	62	Distance	40.573	.0469	45.128	0.673	55.238	0.714	159.008
1st Ocean Ann.	70	No. Circ.	25.744	0.180	25.450	0.235	24.089	0.215	18.352
	71	Distance	475.439	3.473	480.806	4.362	453.520	3.730	13.382
2nd Ocean Ann.	109	Distance	422.420	3.935	445.710	5.129	429.342	4.201	7.172
Age-1.4									
1st FW Annular	1	No. Circ.	7.230	0.133	6.172	0.080	7.088	0.122	32.984
	2	Distance	102.460	1.521	92.709	1.141	102.385	1.487	19.367
Total FW Growth	61	No. Circ.	5.230	0.128	4.166	0.051	4.231	0.098	43.458
	62	Distance	51.287	1.756	39.152	0.551	44.516	1.323	30.118
1st Ocean Ann.	70	No. Circ.	20.655	0.440	23.702	0.280	22.813	0.335	20.290
	71	Distance	379.080	8.325	423.914	4.918	417.341	6.244	13.796
2nd Ocean Ann.	109	Distance	381.862	10.196	400.629	7.166	382.725	7.631	1.852
3rd Ocean Ann.	110	Distance	384.126	9.914	413.344	5.006	401.341	7.209	4.454