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Stock Component of Age-1.3 Sockeye Salmon Returning to Upper Cook Inlet, 1987-1989

by

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and

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State of Alaska Walter J. Hickel, Governor

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ABSTRACT

Scale characteristics were used to estimate the contribution of Kenai River sockeye salmon *Oncorhynchus nerka* to the commercial harvest in upper Cook Inlet, Alaska, between 1987 and 1989. Several multivariate linear discriminant models were developed to classify age-1.3 sockeye salmon. A Monte Carlo simulation was used and provided confidence bounds for the estimates. Kenai River age-1.3 sockeye salmon were the predominant component, ranging from 69% to 80% of the drift gill net and Salamatof Beach set gill net harvests. Meristic traits failed to provide adequate discriminators to segregate sockeye salmon populations.

KEY WORDS: upper Cook Inlet, Alaska, sockeye salmon, *Oncorhynchus nerka*, stock composition, scale pattern analysis, discriminant function, meristic traits, analysis, age

INTRODUCTION

In 1976 the Alaska Department of Fish and Game (ADF&G) initiated research into sockeye salmon *Oncorhynchus nerka* stock identification techniques. Linear discriminant models to separate individual stocks were initially developed by Krasnowski and Bethe (1978) for upper Cook Inlet, Alaska (Figure 1). For purposes of this report, the definition of an individual fish stock is a group of fish originating from the same river system as described by Larkin (1972). Since then, data from this program have been an integral part of the upper Cook Inlet salmon management and research data base (Bethe and Krasnowski 1979; Bethe et al. 1980; Cross et al. 1981, 1982, 1983, 1985, 1986, 1987, 1988; Waltemyer and Tarbox 1988). However, examination of model classification accuracies, model performance for minor stocks (i.e., stocks composing less than 20% of total return), and even model assumptions for the years prior to 1987 indicated these models did not classify stocks with great accuracy. In addition, preliminary results indicated changes, in some cases, in individual scale variables over time within a year (B. Bue, ADF&G, Anchorage, personal communication). Because of these considerations, a review of the stock identification techniques was warranted.

Review of this data took 3 years, during which time no stock identification report was prepared. Instead, an effort was made to resolve the direction of the upper Cook Inlet stock identification program and examine additional stock separation techniques. This report presents the 1987-89 contribution estimates for age-1.3 sockeye salmon for the Kenai River system; this age group comprised 65% to 74% of the total upper Cook Inlet sockeye salmon return. A feasibility study using meristic counts as an alternative approach to stock identification is also reported. We decided that contributions from minor stocks should not be represented in future reports, and that only the Kenai River stock component would be reported "in season" (C. Meacham, ADF&G, Anchorage, personal communication).

METHODS

From 1987 to 1989 scale samples were collected from sockeye salmon migrating up the Kasilof, Kenai, Crescent, and Susitna Rivers. Several locations within the Susitna River drainage were sampled, including the Yentna River (1987-89), the mainstem at river mile 80 (1989), and Larson Creek (1987-88). Samples were taken from fish wheels at all locations except Larson Creek, where they were taken from beach seine gear, and Crescent river, where they were taken from gill nets. Scale samples were also collected from sockeye salmon harvested in the commercial fisheries of upper Cook Inlet (Figure 2). These fisheries consisted of set gill net fisheries in the Eastern, General, Upper (Cohoe/Ninilchik Beach, Kalifonsky Beach, and Salamatof Beach), Western and Kalgin Island Subdistricts and the Central District drift gill net fishery.

A sample goal of 403 fish per stratum was used to ensure an estimate of the true percentage for each age class within 5%, 90% of the time (Thompson 1987). Preferred scales were collected according to the procedures of Koo (1955) and Clutter and Whitesel (1956). Impressions were made in cellulose acetate as

described by Clutter and Whitesel (1956). Age was determined using the criteria of Mosher (1969) and recorded in European notation (Koo 1962).

Linear measurements for discriminant analysis (Moris 1975) were taken along the anterior-posterior axis of each scale as defined in Clutter and Whitesel (1956). Scale impressions were magnified 100X using equipment similar to that described by Ryan and Christie (1976). Scale images were measured on a Talos digitizing tablet and processed by a microcomputer. Seventy-five scale variables were obtained from five incremental distance zones and four circuli count zones (Table 1; Figure 3). Measurements and resultant models were limited to scales from age-1.3 sockeye salmon. We digitized all readable age-1.3 escapement scale samples to build the discriminant models and, in addition, one hundred age-1.3 scales from each commercial fishery sample.

A two-way linear discriminant model was constructed for age 1.3 fish, as outlined by Conrad (1985) using samples from (1) the Kenai River; (2) the Susitna River system that included scales from Yentna River, Susitna River mainstem at river mile 80, and Larson Creek; and (3) the Kasilof River. A weighted sample of Susitna and Kasilof Rivers was combined and termed *Other* in this report. This approach provided specific results for the Kenai River component. We selected scale characteristics for each model by a forward stepwise procedure using partial F statistics ($F = 4.0$; Enslein et al. 1977). Classification accuracy for each model was determined by the leaving-one-out procedure (Lachenbruch 1967).

Following the initial selection of model variables a Monte Carlo simulation (Sokal and Rohlf 1969) was used to classify unknown samples. This procedure consisted of constructing a two-way classification model (Kenai, *Other*) by randomly selecting scales with replacement from the set of scales of known origin, classifying the unknown sample, and repeating the process 100 times. The medians and approximate 90% confidence bounds, here defined as the 6th and 95th ordered estimates, for the Kenai River and *Other* River components were estimated. A resampling strategy of 100 times was based on the work by Efron and Tibshirani (1985).

Stock composition estimates were adjusted for misclassification errors using the procedure of Cook and Lord (1978). Results where the adjusted proportions were less than zero or greater than one were noted as zero or one.

To identify additional stock separation techniques, the numbers of fin rays in the dorsal, anal, and pectoral fins of sockeye salmon escapements from the Kenai, Kasilof, Yentna, and Susitna (mainstem river mile 80) Rivers were examined in 1989. Fin rays were counted using the methods of Hubbs and Lagler (1958) and Trautman (1973).

RESULTS

During the study commercial harvest and escapements were the highest on record. In 1987 a record 9.5 million sockeye salmon were commercially harvested in upper Cook Inlet (Table 2). Harvest numbers decreased in 1988 to 6.8 million fish and

in 1989 to 5.0 million fish (Table 2). Escapement estimates for monitored systems ranged from approximately 1.4 to 2.2 million fish during this time. The estimated Kenai River sockeye salmon escapements of 1.6 million fish in 1987 and 1989 were the highest since escapement enumeration began in 1968.

The percentage of age-1.3 sockeye salmon escapements was substantially different between river systems. Sockeye salmon migrating into the Kenai River were predominately age 1.3, the contribution ranging from 74% to 78% (Tables 3-5). In contrast, age-1.3 sockeye salmon in the Kasilof River were more variable, ranging from 27% to 46% (Tables 3-5). The proportion of age-1.3 sockeye salmon in the Yentna River ranged from 42% to 64% (Tables 3-5).

Age composition of the commercial sockeye salmon harvest was as varied as the escapements. Both the Central District drift gill net and Salamatof Beach set gill net harvests of sockeye salmon had age compositions similar to the Kenai River system (69% to 80% age-1.3, Tables 3-5).

The number of sockeye salmon scale samples collected from selected commercial fisheries ranged from 12,841 in 1989 to 18,069 in 1987 (Table 2). In some cases, notably the drift gill net fishery, samples were severely reduced or not taken due to fishery closures related to the *M/V Exxon Valdez* oil spill in 1989.

A total of 1,361 age-1.3 escapement scales were digitized in 1987, 1,569 in 1988, and 2,648 in 1989 (Table 2). Over half of the scale variables that represent the major growth zones in number of circuli and incremental distance (variables 1, 2, 61, 62, 65, 66, 67, 70, 71, and 109) showed interannual deviations greater than 10% within each river (Figures 4, 5). The mean values and standard errors for all variables by year are presented in Tables 6-8. The number of variables used in developing the discriminate models ranged from four in 1989 to eight in 1988. Model mean classification accuracy ranged from 81% in 1989 to 94% in 1988 (Table 9). Variables 67 and 109 were common to all three yearly models.

The proportion of age-1.3 Kenai River sockeye salmon in the Central District drift gill net fishery increased from late June through the end of July in both 1987 and 1988 (Figure 6). In 1987 the Kenai River component was 5% on 24 June and steadily increased to 97% on 31 July (Table 10). The greatest change in the Kenai proportion--a 33.5% increase--occurred between 29 June and 3 July 1987. During 1988 the Kenai River component of the harvest was 29% on 27 June and increased to 100% on 25 July (Figure 6; Table 11). Noticeable fishery management effects in the Kenai River stock proportion were also observed. On 13 and 17 July 1988, when the Central District drift gill net fleet was restricted to within 3 miles of the Kenai Peninsula shoreline in the Upper Subdistrict, the stock percentage was estimated at 94% and 95%. In contrast, during the proceeding district-wide fishing period, the Kenai River proportions were estimated at 71% (27 June) and 83% (25 July).

In the Upper Subdistrict set gill net harvest from Cohoe/Ninilchik Beach we noted increasing proportions of age-1.3 Kenai River sockeye salmon from early July through the end of July in 1987-1989 (Tables 10-12). In 1987 the Kenai River component increased from 0% on 3 July to 93% on 31 July (Table 10). In 1988 a peak of 89% was noted on 18 July, whereas 0% was measured on 4 July and 79% on 25 July (Table 11). A mid-July increase in the Kenai River component was also

noted in 1989 when the Kenai River stock increased from 35% on 10 July to 92% on 17 July (Table 12).

Results from Kalifonsky Beach set gill net fishery also had a pattern of increasing Kenai River stock contributions through July. In 1987 the Kenai River sockeye salmon age-1.3 component increased from 26% to 46% between 6 and 13 July (Table 10). In 1988 the Kenai component ranged from 51% to 76% for the same period (Table 11). A more dramatic increase from 8% to 43% was noted in 1989 (Table 12).

Consistent with the age composition data, age-1.3 sockeye salmon caught on Salamatof Beach were predominately Kenai River stock. Results indicated proportions typically ranging from 78% to 100% (Tables 10-12). However, in 1989 an estimated Kenai River proportion of 58% was noted on 10 July (Table 12).

Fin ray counts of sockeye salmon revealed no discernible differences among stocks (X^2= 0.35, $p > 0.01$; Table 13, Figures 7-11). The mode of dorsal fin ray counts ranged from 10 to 12; Kenai and Kasilof stocks were equal at 11. Anal fin ray counts indicated the same mode for Kenai and Yentna River stocks at 15. Pectoral fin ray counts were typically 11 or 12 regardless of system.

DISCUSSION

In previous years, detailed sockeye salmon age composition and harvest data have been included with stock identification results in a single document. Because of uncertainty in the stock identification results, this information for the years 1987 to 1989 has been independently summarized and reported by Waltemyer (1989, 1990).

Typically, stock identification results are also used to separate all age classes of sockeye salmon harvested in the upper Cook Inlet commercial fishery by river of origin. As previously noted, a decision was made not to examine minor-stock run components and other age classes. However, the authors realized that the public, other investigators, and the commercial fishing industry have a use for Kenai River stock component results. Precision and accuracy requirements of these users vary. Therefore, this report has been prepared with the goal of presenting the best available data on the Kenai River sockeye salmon stocks at this time. Examination of these data suggested good mean classification accuracy between Kenai River stocks and a composite *Other* stocks. The dominance (65%-74%) of age-1.3 sockeye salmon in the total return and large escapements to the Kenai River system further indicates that this approach is reasonable.

The increasing proportion of Kenai River age-1.3 sockeye salmon in the Central District drift and Upper Subdistrict set net fisheries as the 1987-89 seasons progressed is a typical pattern observed in previous years (Cross et al. 1981, 1982, 1983,1985, 1986). Some factors contributing to this include: (1) the Kasilof River has a distinct entry pattern of age-1.3 sockeye in early July decreasing until the end of July; (2) Susitna River sockeye salmon are leaving the Central District in mid- to late July; and (3) Kenai River stocks have

dominated sockeye salmon returns to upper Cook Inlet. Therefore, the majority of age-1.3 sockeye salmon in late July are Kenai River stocks.

The history of the upper Cook Inlet stock identification program is one of poor model performance. We need to evaluate other discriminators in order to improve program results. The use of meristic counts to identify stocks was unsuccessful. Additional biological discriminators must be explored if a reliable, long-term stock identification program is to be successful.

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Table 1. Scale variables screened for linear discriminant function analysis of age-1.3 sockeye salmon, upper Cook Inlet, Alaska, 1987-89.

Variable Number	Variable Name	Scale Zone
		First Freshwater Annulus
1	NC1FW	Number of circuli first freshwater
2	S1FW	Size (width) of first freshwater
3 (16)	C0-C2	Distance, scale focus (C0) to circulus 2 (C2)
4 (17)	C0-C4	Distance, scale focus to circulus 4
5 (18)	C0-C6	Distance, scale focus to circulus 6
6 (19)	C0-C8	Distance, scale focus to circulus 8
7 (20)	C2-C4	Distance, circulus 2 to circulus 4
8 (21)	C2-C6	Distance, circulus 2 to circulus 6
9 (22)	C2-C8	Distance, circulus 2 to circulus 8
10 (23)	C4-C6	Distance, circulus 4 to circulus 6
11 (24)	C4-C8	Distance, circulus 4 to circulus 8
12	C(NC-4)-E1FW	Distance, circulus (number circuli first freshwater minus 4) to end first freshwater
13	C(NC-2)-E1FW	Distance, circulus (number circuli first freshwater minus 2) to end first freshwater
14	C2-E1FW	Distance, circulus 2 to end first freshwater
15	C4-E1FW	Distance, circulus 4 to end first freshwater
16 thru 24	C0-C2/S1FW ...	Relative widths, (variables 3-11)/S1FW
25	C(NC-4)-E1FW/S1FW	
26	C(NC-2)-E1FW/S1FW	
27	S1FW/NC1FW	Average interval between circuli in first freshwater
28	NC 1ST 3/4	Number of circuli in first 3/4 of first freshwater
29	MAX DIST	Maximum distance between 2 consecutive circuli in first freshwater
30	MAX DIST/S1FW	Relative width, (variable 29)/S1FW

-Continued-

Table 1. (p. 2 of 3)

Variable Number	Variable Name	Scale Zone
		Plus Growth
61	NCPG	Number of circuli in plus growth
62	SPGZ	Size (width) plus growth zone
		Freshwater and Plus Growth
65	NC1FW + NCPG	Total number of circuli first freshwater and plus growth
66	S1FW + SPGZ	Total size (width) first freshwater and plus growth
67	S1FW/(S1FW + SPGZ)	Relative width, (variable 2)/S1FW + SPGZ
		First Marine Annulus
70	NC1OZ	Number of circuli in first ocean zone
71	S1OZ	Size (width) first ocean zone
72 (90)	EFW-C3	Distance, end of freshwater growth to circulus 3
73 (91)	EFW-C6	Distance, end of freshwater growth to circulus 6
74 (92)	EFW-C9	Distance, end of freshwater growth to circulus 9
75 (93)	EFW-C12	Distance, end of freshwater growth to circulus 12
76 (94)	EFW-C15	Distance, end of freshwater growth to circulus 15

-Continued-

Table 1. (p. 3 of 3)

Variable Number	Variable Name	Scale Zone
		First Marine Annulus (continued)
77 (95)	C3-C6	Distance, circulus 3 to circulus 6
78 (96)	C3-C9	Distance, circulus 3 to circulus 9
79 (97)	C3-C12	Distance, circulus 3 to circulus 12
80 (98)	C3-C15	Distance, circulus 3 to circulus 15
81 (99)	C6-C9	Distance, circulus 6 to circulus 9
82 (100)	C6-C12	Distance, circulus 6 to circulus 12
83 (101)	C6-C15	Distance, circulus 6 to circulus 15
84 (102)	C9-C15	Distance, circulus 9 to circulus 15
85	C(NC-6)-E1OZ	Distance, circulus (number circuli first ocean minus 6) to end first ocean
86	C(NC-3)-E13OZ	Distance, circulus (number circuli first ocean minus 3) to end first ocean
87	C3-E1OZ	Distance, circulus 3 to end of first ocean
88	C9-E1OZ	Distance, circulus 9 to end of first ocean
89	C15-E1OZ	Distance, circulus 15 to end of first ocean
90 thru 102	EFW-C3/S1OZ ...	Relative widths, (variables 72-84)/S1OZ
103	C(NC-6)-E13OZ/S1OZ	
104	C(NC-3)-E13OZ/S1OZ	
105	S1OZ/NC1OZ	Average interval between circuli in first ocean
106	NC 1ST 1/2	Number of circuli in first 1/2 of first ocean
107	MAX DIST	Maximum distance between 2 consecutive circuli in first ocean
108	MAX DIST/S1OZ	Relative width, (variable 107)/S1OZ
		Second Marine Annulus
109	S2OZ	Size (width) of second ocean zone

Table 2. Numbers of sockeye salmon, total scale samples, and age-1.3 scales digitized from commercial catches and escapements in upper Cook Inlet, Alaska, 1987-89.

Location	1987 Number of Fish	1987 Total Scale Sample	1987 Total Digitize Sample	1988 Number of Fish	1988 Total Scale Sample	1988 Total Digitize Sample	1989 Number of Fish	1989 Total Scale Sample	1989 Total Digitize Sample
Commercial Catch									
Central District:									
Drift fishery[a]	5,631,691	8,513	1,500	4,103,472	7,800	1,200	[b]		
Upper Subdistrict	3,495,802			2,426,416			4,543,066		
Cohoe/Ninilchik Beach	1,248,383	3,509	600	632,597	2,600	400	938,550	2,979	500
Kalifonsky Beach	1,326,159	2,400	400	910,628	3,000	500	1,796,976	3,000	500
Salamatof Beach	921,260	1,200	200	883,191	1,200	200	1,807,540	2,320	400
Western Subdistrict	103,693	1,177	200	102,057	969	300	55,856	782	200
Kustatan Subdistrict	14,273	NS[c]		6,999	NS		40,256	NS	
Kalgin Island Subdistrict	87,036	NS		33,747	NS		87,650	541	
Chinitna Bay Subdistrict[d]	3,089	NS		2,537	NS		3,069	NS	
Northern District:									
Eastern Subdistrict	67,513	975	200	31,424	600	100	79,533	1,438	300
General Subdistrict	97,089	295	100	98,289	600	100	201,268	1,781	300
Commercial Harvest Total	9,500,186	18,069	3,200	6,804,941	16,769	2,800	5,010,698	12,841	2,200

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Table 2. (p. 2 of 2)

Location	1987 Number of Fish	1987 Total Scale Sample	1987 Total Digitize Sample	1988 Number of Fish	1988 Total Scale Sample	1988 Total Digitize Sample	1989 Number of Fish	1989 Total Scale Sample	1989 Total Digitize Sample
Escapement									
Kenai River	1,596,870	867	442	1,021,469	1,799	765	1,598,042	2,721	1,107
Kasilof River	249,246	1,334	319	204,000	2,642	340	157,739	1,592	414
Crescent River	120,218	194	0	57,716	867	0	70,532	881	0
Packers Creek	35,401	1,357	0	15,481	1,459	0	22,304	887	0
Susitna River Mainstem[e] Larson Creek	16,753	1,133	200	NM[f]	505[g]	20	NM	1,419	516
Yentna River	66,053	972	400	52,330	1,847	444	96,212	1,988	611
Fish Creek	91,215	547	0	71,603	584	0	67,224	572	0
Escapement Total	2,175,756	6,404	1,361	1,422,599	9,703	1,569	2,012,053	10,060	2,648
Upper Cook Inlet Total	11,675,942	24,473	4,561	8,227,540	26,472	4,369	7,022,751	22,901	4,848

[a] Harvest does not include Chinitna Bay Subdistrict.
[b] Drift fishery was closed due to oil deposits found in rip currents of the Central District.
[c] NS - not sampled due to budget constraints and relative contribution to total harvest.
[d] All gear types combined.
[e] River mile 80.
[f] NM - not monitored.
[g] Special sample taken only one time during year.

Table 3. Estimated age composition of sockeye salmon in the major commercial fisheries and escapements of upper Cook Inlet, Alaska, in 1987.

Location	Sample Size		Age Group 0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	Total
Commercial Harvest																	
Central District:																	
Drift[a]	7,675	#	596		32,170	459,681			4,548,110	195,724		4,171	391,240				5,631,691
		%	.01		.57	9.29			77.33	3.66		.12	9.02				100.00
Salamatof Beach	1,089	#	1,676		7,348	41,698			759,338	29,846			81,355				921,260
		%	.18		.91	5.74			80.33	3.55			9.29				100.00
Kalifonsky Beach	2,214	#			2,207	212,824			871,581	138,767			100,779				1,326,159
		%			.09	24.62			52.53	14.95			7.81				100.00
Cohoe/Ninilchik Beach	3,198	#	866		3,069	153,772	304		863,675	110,581		1,735	114,382				1,248,383
		%	.06		.22	14.38	.03		63.26	9.32		.19	12.54				100.00
Western Subdistrict	1,036	#			425	6,938	142		56,474	8,516		425	30,699	38	38		103,693
		%			.29	7.14	.10		51.06	7.72		.29	33.20	.10	.10		100.00
Northern District:																	
Eastern Subdistrict	849	#	143	143	963	27,713	184		23,363	8,731			6,230	41			67,513
		%	.24	.24	1.53	38.63	.35		36.04	13.43			9.42	.12			100.00
General Subdistrict	256	#		379	2,276	19,721	379		39,063	13,274			21,997				97,089
		%		.39	2.34	20.31	.39		40.23	13.67			22.66				100.00
Commercial Harvest Total[b]		#	3,281	522	48,458	922,347	1,009		7,161,604	505,439		6,331	746,682	79	38		9,395,788[c]
		%	.03	.00	.52	9.81	.01		76.23	5.38		.07	7.95	.00	.00		100.00
Escapement																	
Kenai River	745	#			2,143	203,628		2,143	1,251,775	51,443		2,143	83,595				1,596,870
		%			.13	12.75		.13	78.39	3.22		.13	5.23				100.00
Kasilof River	1,248	#		605		108,058	200		68,395	55,796			15,993	200			249,246
		%		.24		43.35	.08		27.44	22.39			6.42	.08			100.00
Crescent River	191	#				3,151			57,275	5,040			54,125		627		120,218
		%				2.62			47.65	4.19			45.03		.52		100.00
Packers Creek	1,330	#				612	4,578		1,224	21,427	80		6,894	399	133	53	35,401
		%				1.73	12.93		3.46	60.53	.23		19.47	1.13	.38	.15	100.00
Susitna River Mainstem																	
Larson Creek	638	#				1,733			14,101	53		53	814				16,753
		%				10.34			84.17	.31		.31	4.86				100.00
Ventna River	1,089	#	869	596	1,607	15,405			33,445	5,699		689	7,744				66,053
		%	1.32	.90	2.43	23.31			50.64	8.63		1.04	11.73				100.00
Fish Creek	772	#		6,026		78,336			2,481	4,372							91,215
		%		6.61		85.88			2.72	4.79							100.00
Escapement Total		#	869	7,227	3,750	410,923	4,778	2,143	1,428,696	143,830	80	2,885	169,165	599	760	53	2,175,756[c]
		%	.04	.33	.17	18.89	.22	.10	65.66	6.61	.00	.13	7.77	.03	.03	.00	100.00
Upper Cook Inlet Total		#	4,150	7,749	52,208	1,333,270	5,787	2,143	8,590,300	649,269	80	9,216	915,847	678	798	53	11,571,544[c]
		%	.04	.07	.45	11.52	.05	.02	74.24	5.61	.00	.08	7.91	.00	.01	.00	100.00

[a] Harvest does not include Chinitna Bay Subdistrict.
[b] Kustatan, Kalgin Island and Chinitna Bay Subdistricts were not sampled. These fisheries represented 1.1% of the total harvest.
[c] Sum of age group totals may differ slightly from the actual total due to rounding error.

Table 4. Estimated age composition of sockeye salmon in the major commercial fisheries and escapements of upper Cook Inlet, Alaska, in 1988.

Location	Sample Size		Age Group 0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	Total
Commercial Harvest																
Central District:																
Drift[a]	6,883	#	4,550	1,073	18,284	407,302	1,975	2,816,529	281,853		9,137	560,385	843	1,541		4,103,472
		%	.07	.03	.36	10.37	.09	68.78	6.60		.20	13.44	.01	.04		100.00
Salamatof Beach	1,022	#				75,581		629,821	57,671		6,078	114,040				883,191
		%				8.71		71.14	6.56		.68	12.92				100.00
Kalifonsky Beach	2,629	#				123,736		568,908	88,540		6,739	120,781		1,923		910,628
		%				13.88		62.42	9.43		.46	13.66		.15		100.00
Cohoe/Ninilchik Beach	2,314	#				119,994	755	336,769	89,996		4,041	80,526		516		632,597
		%				21.35	.09	49.35	14.78		.48	13.87		.09		100.00
Western Subdistrict	823	#			130	12,676	65	47,903	19,055			22,228				102,057
		%			.24	15.31	.12	53.71	13.49			17.13				100.00
Northern District:																
Eastern Subdistrict	520	#		60	121	15,531	242	7,070	6,527			1,873				31,424
		%		.19	.38	49.42	.77	22.50	20.77			5.96				100.00
General Subdistrict	473	#			1,039	29,092		45,092	6,650		623	15,793				98,289
		%			1.06	29.60		45.88	6.77		.63	16.07				100.00
Commercial Harvest Total[b]		#	4,550	1,133	19,574	783,912	3,037	4,452,092	550,292		26,618	915,626	843	3,980		6,761,658[c]
		%	.07	.02	.29	11.59	.04	65.84	8.14		.39	13.54	.01	.06		100.00
Escapement																
Kenai River	1,420	#		2,981	720	120,547	2,236	756,507	31,734		3,505	103,238				1,021,469
		%		.28	.07	11.62	.21	74.15	3.10		.35	10.21				100.00
Kasilof River	2,282	#		131		68,734	223	74,307	35,715		325	24,457		110		204,000[d]
		%		.06		33.69	.11	36.43	17.51		.16	11.99		.05		100.00
Crescent River	741	#				5,461	51	28,498	9,290		318	14,047	51			57,716
		%				10.39	.13	44.94	17.81		.54	26.05	.13			100.00
Packers Creek	902	#		146		264	992	1,172	12,169	162	18	3,502	159		24	18,607
		%		.78		1.55	5.10	6.87	63.64	.78	.10	20.18	.89		.11	100.00
Susitna River Mainstem																
Larson Creek[e]	413	#														
		%		.24		82.81		7.75	8.23		.24	.73				100.00
Yentna River	1,727	#	1,303	222	1,226	14,935	614	25,014	3,056		116	5,817		26		52,330
		%	2.72	.41	2.43	33.53	1.74	41.92	6.54		.23	10.42		.06		100.00
Fish Creek	584	#		9,686		59,465	368	981	1,103							71,603
		%		13.53		83.05	.51	1.37	1.54							100.00
Escapement Total		#	1,303	13,166	1,946	269,406	4,484	886,479	93,067	162	4,282	151,061	210	136	24	1,425,725[c]
		%	.09	.92	.14	18.90	.31	62.18	6.53	.01	.30	10.60	.01	.01	.00	100.00
Upper Cook Inlet Total		#	5,853	14,299	21,520	1,053,318	7,521	5,338,571	643,359	162	30,900	1,066,687	1,053	4,116	24	8,187,383[c]
		%	.07	.17	.26	12.87	.09	65.21	7.86	.00	.38	13.03	.01	.05	.00	100.00

[a] Harvest does not include Chinitna Bay Subdistrict.
[b] Kustatan, Kalgin Island and Chinitna Bay Subdistricts were not sampled. These fisheries represented 0.6% of the total harvest.
[c] Sum of age group totals may differ slightly from the actual total due to rounding error.
[d] Total escapement of 204,000 fish represents the expanded count to account for the difference between the sonar estimate and spawning ground survey estimate.
[e] Larson Creek was not monitored to enumerate escapement, only to collect a sample for age composition.

Table 5. Estimated age composition of sockeye salmon in the major commercial fisheries and escapements of upper Cook Inlet, Alaska, in 1989.

Location	Sample Size		Age Group 0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	Total
Commercial Harvest																	
Central District:																	
Drift[a]																	
Salamatof Beach	2,039	#				180,077	1,587		1,299,516	76,350		5,536	244,474				1,807,540
		%				10.99	.10		71.31	4.17		.39	13.05				100.00
Kalifonsky Beach	2,686	#	1,069			423,403	1,069		1,189,339	56,283		7,739	118,074				1,796,976
		%	.04			21.37	.04		68.43	3.54		.34	6.25				100.00
Cohoe/Ninilchik Beach	2,577	#	561	1,406	1,406	123,398	3,557	845	648,170	58,459		5,073	95,675				938,550
		%	.04	.08	.08	14.20	.19	.04	69.50	5.82		.43	9.62				100.00
Western Subdistrict		#		85		4,264			45,026	597		256	5,628				55,856
	655	%		.15		7.63			80.61	1.07		.46	10.08				100.00
Kalgin Island Subdistrict	454		196	1,543	196	19,695	1,157		31,274	17,179		196	14,865	1,349			87,650
		%	.22	1.76	.22	22.47	1.32		35.68	19.60		.22	16.96	1.54			100.00
Northern District:																	
Eastern Subdistrict		#	258	4,559	371	29,604	326		32,074	7,142		258	4,941				79,533
	1,159	%	.26	4.23	.35	39.17	.43		41.67	8.02		.26	5.61				100.00
General Subdistrict		#	104	385	405	30,852	963		146,402	6,770		245	15,141				201,268
	1,389	%	.14	.14	.14	16.05	.36		66.88	5.54		.14	10.58				100.00
Commercial Harvest Total[b]		#	2,188	7,978	2,378	811,293	8,659	845	3,391,801	222,780		19,303	498,798	1,349			4,967,373[c]
		%	.04	.16	.05	16.33	.17	.02	68.28	4.49		.39	10.04	.03			100.00
Escapement																	
Kenai River	2,275	#	655	1,966	2,055	145,962	8,364		1,199,495	68,215		16,078	154,596		655		1,598,042
		%	.04	.13	.13	9.05	.48		75.30	4.13		1.01	9.67		.04		100.00
Kasilof River	1,216	#		234		70,482			71,574	8,563		200	6,667				157,739
		%		.16		44.00			46.30	5.18		.16	4.19				100.00
Crescent River	728	#				1,841			57,259	388		388	10,560		97		70,532
		%				2.61			81.18	.55		.55	14.97		.14		100.00
Packers Creek	733	#		3,094		8,498	2,092		971	4,667	30		2,258	634	30	31	22,304
		%		13.92		38.06	9.41		4.37	20.87	.14		10.10	2.86	.14	.14	100.00
Susitna River Mainstem[e]	1,169	#															
		%		.43	.17	28.66			65.95	3.25			1.54				100.00
Yentna River	1,362	#	154	1,128	210	25,831	176		61,669	2,750		439	3,855				96,212
		%	.15	1.32	.22	27.17	.22		63.51	3.01		.37	4.04				100.00
Fish Creek	493	#	136	4,500		41,862	1,909		13,636	3,409			1,773				67,224
		%	.20	6.69		62.27	2.84		20.28	5.07			2.64				100.00
Escapement Total		#	945	10,922	2,265	294,476	12,541		1,404,604	87,992	30	17,125	179,709	634	782	31	2,012,053[c]
		%	.05	.54	.11	14.64	.62		69.81	4.37	.00	.85	8.93	.04	.04	.00	100.00
Upper Cook Inlet Total		#	3,133	18,900	4,643	1,105,769	21,200	845	4,796,405	310,772	30	36,428	678,507	1,983	782	31	6,979,426[c]
		%	.05	.27	.07	15.84	.30	.02	68.72	4.45	.00	.52	9.72	.03	.01	.00	100.00

[a] No harvest occurred due to oil deposits found in the rip currents of the Central District.
[b] Kustatan and Chinitna Bay Subdistricts were not sampled. These fisheries represented 0.9% of the total harvest.
[c] Sum of age group totals may differ slightly from the actual total due to rounding error.

Table 6. Mean and standard error of scale variables screened for linear discriminant analysis of age-1.3 sockeye salmon sampled in the Kenai and *Other* river systems, upper Cook Inlet, Alaska, in 1987.

		Kenai[a]		*Other*[b]	
Number	Variable	Mean	S.E.	Mean	S.E.
	First Freshwater Annulus				
1	NC1FW	8.172	0.071	10.122	0.108
2	S1FW	98.348	0.782	124.270	1.208
3	C0-C2	42.939	0.239	45.237	0.260
4	C0-C4	64.532	0.317	69.925	0.376
5	C0-C6	82.262	0.382	91.036	0.440
6	C0-C8	99.100	0.516	109.684	0.529
7	C2-C4	21.593	0.178	24.688	0.208
8	C2-C6	39.325	0.266	45.616	0.318
9	C2-C8	56.093	0.402	64.064	0.435
10	C4-C6	17.643	0.151	20.802	0.183
11	C4-C8	33.904	0.288	39.021	0.321
12	C(NC-4)-E1FW	32.292	0.245	32.481	0.238
13	C(NC-2)-E1FW	14.464	0.140	14.432	0.154
14	C2-E1FW	55.410	0.725	79.033	1.135
15	C4-E1FW	33.893	0.643	54.730	1.038
16	C0-C2/S1FW	0.445	0.003	0.377	0.004
17	C0-C4/S1FW	0.668	0.004	0.580	0.005
18	C0-C6/S1FW	0.841	0.004	0.744	0.005
19	C0-C8/S1FW	0.945	0.003	0.859	0.005
20	C2-C4/S1FW	0.222	0.002	0.204	0.002
21	C2-C6/S1FW	0.400	0.002	0.371	0.003
22	C2-C8/S1FW	0.534	0.003	0.500	0.003
23	C4-C6/S1FW	0.179	0.001	0.169	0.001
24	C4-C8/S1FW	0.322	0.002	0.304	0.002
25	VAR 12/S1FW	0.338	0.004	0.276	0.005
26	VAR 13/S1FW	0.151	0.002	0.122	0.002
27	S1FW/NC1FW	12.129	0.057	12.390	0.063
28	NC 1ST 3/4	4.466	0.050	5.709	0.075
29	MAX DIST	13.817	0.104	15.070	0.118
30	VAR 29/S1FW	0.143	0.001	0.125	0.001
	Plus Growth				
61	NCPG	6.880	0.103	4.183	0.098
62	SPGZ	76.900	1.229	41.859	1.093
	Freshwater and Plus Growth				
65	NC1+NC2+NCPG	15.052	0.096	14.305	0.111
66	S1F+S2F+SPGZ	175.249	1.129	166.129	1.227
67	S1FW/VAR 66	0.570	0.005	0.752	0.006

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Table 6. (p. 2 of 2)

Number	Variable	Kenai[a] Mean	Kenai[a] S.E.	*Other*[b] Mean	*Other*[b] S.E.
	First Marine Annulus				
70	NC10Z	24.864	0.154	25.035	0.150
71	S10Z	397.373	2.345	398.399	2.252
72	EFW-C3	48.036	0.453	47.366	0.513
73	EFW-C6	99.387	0.742	98.279	0.797
74	EFW-C9	153.600	0.913	151.359	1.007
75	EFW-C12	207.717	1.036	204.423	1.102
76	EFW-C15	259.095	1.074	254.873	1.197
77	C3-C6	51.351	0.447	50.913	0.467
78	C3-C9	105.563	0.658	103.993	0.721
79	C3-C12	159.681	0.823	157.056	0.852
80	C3-C15	211.154	0.912	207.507	0.983
81	C6-C9	54.213	0.376	53.080	0.445
82	C6-C12	108.330	0.579	106.143	0.621
83	C6-C15	159.866	0.721	156.594	0.782
84	C9-C15	105.687	0.540	103.514	0.564
85	C(NC-6)-E10Z	77.898	0.507	80.885	0.553
86	C(NC-3)-E10Z	36.507	0.292	38.263	0.320
87	C3-E10Z	349.337	2.445	351.033	2.310
88	C9-E10Z	243.774	2.533	247.040	2.380
89	C15-E10Z	138.456	2.405	143.526	2.288
90	EFW-C3/S10Z	0.123	0.001	0.121	0.002
91	EFW-C6/S10Z	0.255	0.003	0.250	0.002
92	EFW-C9/S10Z	0.393	0.003	0.385	0.003
93	EFW-C12/S10Z	0.530	0.004	0.519	0.004
94	EFW-C15/S10Z	0.661	0.004	0.647	0.004
95	C3-C6/S10Z	0.131	0.058	0.129	0.001
96	C3-C9/S10Z	0.269	0.002	0.264	0.002
97	C3-C12/S10Z	0.407	0.003	0.399	0.003
98	C3-C15/S10Z	0.538	0.003	0.526	0.003
99	C6-C9/S10Z	0.138	0.001	0.135	0.001
100	C6-C12/S10Z	0.276	0.002	0.269	0.002
101	C6-C15/S10Z	0.407	0.002	0.397	0.002
102	C9-C15/S10Z	0.269	0.002	0.262	0.002
103	VAR 85/S10Z	0.198	0.002	0.205	0.002
104	VAR 86/S10Z	0.093	0.001	0.097	0.001
105	S10Z/NC10Z	16.045	0.061	15.982	0.065
106	NC 1ST 1/2	11.041	0.085	11.232	0.085
107	MAX DIST	25.231	0.218	25.268	0.249
108	VAR 107/S10Z	0.064	0.001	0.064	0.001
	Second Marine Annulus				
109	S20Z	345.672	2.303	311.155	2.102

[a] Kenai River scale sample was 442.
[b] *Other* River scale sample of 426 was weighted proportionately to escapement and represented Yentna River with 85, Larson Creek with 22, and Kasilof River with 319 scales.

Table 7. Mean and standard error of scale variables screened for linear discriminant analysis of age-1.3 sockeye salmon sampled in the Kenai and *Other* river systems, upper Cook Inlet, Alaska, in 1988.

		Kenai[a]		*Other*[b]	
Number	Variable	Mean	S.E.	Mean	S.E.
	First Freshwater Annulus				
1	NC1FW	7.021	0.061	10.658	0.094
2	S1FW	90.399	0.622	137.656	1.004
3	C0-C2	44.420	0.213	46.456	0.250
4	C0-C4	64.661	0.263	71.184	0.348
5	C0-C6	81.791	0.354	93.839	0.425
6	C0-C8	97.691	0.640	114.335	0.485
7	C2-C4	20.272	0.139	24.728	0.215
8	C2-C6	37.703	0.241	47.442	0.316
9	C2-C8	54.719	0.474	67.900	0.386
10	C4-C6	17.260	0.147	22.638	0.162
11	C4-C8	33.770	0.348	43.049	0.257
12	C(NC-4)-E1FW	36.357	0.294	37.591	0.315
13	C(NC-2)-E1FW	16.927	0.132	17.398	0.184
14	C2-E1FW	45.979	0.608	91.200	0.976
15	C4-E1FW	26.505	0.553	66.939	0.907
16	C0-C2/S1FW	0.504	0.003	0.345	0.003
17	C0-C4/S1FW	0.730	0.004	0.528	0.004
18	C0-C6/S1FW	0.887	0.004	0.686	0.004
19	C0-C8/S1FW	0.946	0.005	0.826	0.004
20	C2-C4/S1FW	0.227	0.001	0.183	0.002
21	C2-C6/S1FW	0.407	0.002	0.347	0.003
22	C2-C8/S1FW	0.529	0.004	0.490	0.003
23	C4-C6/S1FW	0.186	0.001	0.165	0.001
24	C4-C8/S1FW	0.326	0.003	0.311	0.002
25	VAR 12/S1FW	0.416	0.005	0.281	0.004
26	VAR 13/S1FW	0.192	0.002	0.129	0.002
27	S1FW/NC1FW	13.133	0.068	13.061	0.066
28	NC 1ST 3/4	3.831	0.047	6.435	0.069
29	MAX DIST	12.954	0.083	15.042	0.105
30	VAR 29/S1FW	0.146	0.001	0.111	0.001
	Plus Growth				
61	NCPG	3.712	0.059	1.363	0.049
62	SPGZ	35.230	0.642	5.850	0.638
	Freshwater and Plus Growth				
65	NC1+NC2+NCPG	10.733	0.071	12.021	0.091
66	S1F+S2F+SPGZ	125.629	0.767	143.521	0.958
67	S1FW/VAR 66	0.727	0.004	0.961	0.004

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Table 7. (p. 2 of 2)

Number	Variable	Kenai[a] Mean	Kenai[a] S.E.	*Other*[b] Mean	*Other*[b] S.E.
	First Marine Annulus				
70	NC10Z	25.207	0.102	24.288	0.123
71	S10Z	383.786	1.552	384.860	2.010
72	EFW-C3	36.047	0.235	37.402	0.358
73	EFW-C6	79.720	0.422	85.447	0.634
74	EFW-C9	129.595	0.621	139.479	0.902
75	EFW-C12	183.499	0.738	196.195	1.066
76	EFW-C15	236.483	0.822	250.337	1.217
77	C3-C6	43.673	0.272	48.044	0.414
78	C3-C9	93.548	0.478	102.077	0.708
79	C3-C12	147.452	0.607	158.793	0.893
80	C3-C15	200.446	0.704	212.935	1.058
81	C6-C9	49.875	0.290	54.033	0.419
82	C6-C12	103.779	0.436	110.749	0.641
83	C6-C15	156.788	0.553	164.891	0.824
84	C9-C15	106.927	0.385	110.858	0.596
85	C(NC-6)-E10Z	78.600	0.384	79.807	0.580
86	C(NC-3)-E10Z	36.920	0.224	37.014	0.309
87	C3-E10Z	347.739	1.575	347.458	2.037
88	C9-E10Z	254.191	1.642	245.381	1.999
89	C15-E10Z	147.491	1.561	134.523	1.858
90	EFW-C3/S10Z	0.095	0.001	0.098	0.001
91	EFW-C6/S10Z	0.210	0.001	0.224	0.002
92	EFW-C9/S10Z	0.342	0.002	0.366	0.003
93	EFW-C12/S10Z	0.483	0.003	0.514	0.003
94	EFW-C15/S10Z	0.622	0.003	0.655	0.004
95	C3-C6/S10Z	0.115	0.001	0.126	0.001
96	C3-C9/S10Z	0.247	0.002	0.267	0.002
97	C3-C12/S10Z	0.388	0.002	0.415	0.003
98	C3-C15/S10Z	0.527	0.002	0.557	0.003
99	C6-C9/S10Z	0.131	0.001	0.141	0.001
100	C6-C12/S10Z	0.273	0.001	0.290	0.002
101	C6-C15/S10Z	0.412	0.002	0.431	0.002
102	C9-C15/S10Z	0.281	0.001	0.290	0.002
103	VAR 85/S10Z	0.207	0.001	0.210	0.002
104	VAR 86/S10Z	0.097	0.001	0.097	0.001
105	S10Z/NC10Z	15.274	0.043	15.900	0.066
106	NC 1ST 1/2	11.993	0.057	11.353	0.066
107	MAX DIST	23.569	0.104	24.756	0.153
108	VAR 107/S10Z	0.062	0.000	0.065	0.000
	Second Marine Annulus				
109	S20Z	368.495	1.785	339.053	2.233

[a] Kenai River scale sample was 765.
[b] *Other* River scale sample of 430 was weighted proportionately to escapement and represented Yentna River with 90 and Kasilof River with 340 scales.

Table 8. Mean and standard error of scale variables screened for linear discriminant analysis of age-1.3 sockeye salmon sampled in the Kenai and *Other* river systems, upper Cook Inlet, Alaska, in 1989.

		Kenai[a]		*Other*[b]	
Number	Variable	Mean	S.E.	Mean	S.E.
	First Freshwater Annulus				
1	NC1FW	7.831	0.076	9.832	0.087
2	S1FW	93.807	0.822	126.570	1.009
3	C0-C2	41.565	0.717	46.543	0.226
4	C0-C4	60.841	0.266	70.875	0.312
5	C0-C6	79.278	0.369	91.804	0.392
6	C0-C8	99.438	0.534	111.341	0.455
7	C2-C4	19.274	0.136	24.332	0.161
8	C2-C6	37.352	0.237	45.246	0.255
9	C2-C8	57.173	0.368	64.651	0.327
10	C4-C6	17.503	0.126	20.816	0.152
11	C4-C8	36.285	0.241	39.946	0.238
12	C(NC-4)-E1FW	34.939	0.220	36.702	0.236
13	C(NC-2)-E1FW	16.054	0.099	17.392	0.149
14	C2-E1FW	52.241	0.770	80.027	0.956
15	C4-E1FW	34.557	0.710	55.975	0.893
16	C0-C2/S1FW	0.472	0.004	0.380	0.003
17	C0-C4/S1FW	0.685	0.005	0.577	0.004
18	C0-C6/S1FW	0.818	0.005	0.735	0.004
19	C0-C8/S1FW	0.868	0.005	0.859	0.004
20	C2-C4/S1FW	0.214	0.002	0.197	0.002
21	C2-C6/S1FW	0.382	0.002	0.361	0.002
22	C2-C8/S1FW	0.498	0.003	0.498	0.003
23	C4-C6/S1FW	0.179	0.001	0.165	0.001
24	C4-C8/S1FW	0.316	0.002	0.307	0.002
25	VAR 12/S1FW	0.406	0.005	0.302	0.004
26	VAR 13/S1FW	0.184	0.002	0.142	0.002
27	S1FW/NC1FW	12.201	0.049	13.004	0.055
28	NC 1ST 3/4	4.471	0.057	5.810	0.065
29	MAX DIST	12.565	0.074	15.013	0.096
30	VAR 29/S1FW	0.141	0.001	0.122	0.001
	Plus Growth				
61	NCPG	5.033	0.080	2.658	0.100
62	SPGZ	48.477	0.811	27.637	1.072
	Freshwater and Plus Growth				
65	NC1+NC2+NCPG	12.864	0.070	12.490	0.093
66	S1F+S2F+SPGZ	142.284	0.849	154.207	0.976
67	S1FW/VAR 66	0.664	0.005	0.830	0.006

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Table 8. (p. 2 of 2)

Number	Variable	Kenai[a] Mean	Kenai[a] S.E.	*Other*[b] Mean	*Other*[b] S.E.
	First Marine Annulus				
70	NC10Z	25.251	0.086	25.480	0.110
71	S10Z	426.812	1.355	412.842	1.715
72	EFW-C3	38.788	0.216	38.917	0.299
73	EFW-C6	85.427	0.396	87.880	0.519
74	EFW-C9	136.512	0.569	141.733	0.735
75	EFW-C12	194.416	0.665	199.488	0.860
76	EFW-C15	252.300	0.711	255.808	0.952
77	C3-C6	46.640	0.255	48.963	0.329
78	C3-C9	97.724	0.435	102.817	0.560
79	C3-C12	155.629	0.541	160.572	0.714
80	C3-C15	213.512	0.604	216.892	0.823
81	C6-C9	51.085	0.263	53.853	0.341
82	C6-C12	108.989	0.387	111.608	0.519
83	C6-C15	166.873	0.478	167.928	0.654
84	C9-C15	115.788	0.370	114.075	0.478
85	C(NC-6)-E10Z	81.811	0.304	80.458	0.431
86	C(NC-3)-E10Z	37.964	0.167	37.310	0.231
87	C3-E10Z	388.024	1.408	373.925	1.769
88	C9-E10Z	290.300	1.554	271.108	1.864
89	C15-E10Z	174.512	1.466	157.033	1.770
90	EFW-C3/S10Z	0.092	0.001	0.095	0.001
91	EFW-C6/S10Z	0.203	0.001	0.215	0.002
92	EFW-C9/S10Z	0.325	0.002	0.347	0.002
93	EFW-C12/S10Z	0.461	0.002	0.488	0.003
94	EFW-C15/S10Z	0.598	0.003	0.625	0.003
95	C3-C6/S10Z	0.111	0.001	0.120	0.001
96	C3-C9/S10Z	0.232	0.001	0.252	0.002
97	C3-C12/S10Z	0.369	0.002	0.392	0.002
98	C3-C15/S10Z	0.505	0.002	0.530	0.003
99	C6-C9/S10Z	0.121	0.001	0.132	0.001
100	C6-C12/S10Z	0.258	0.001	0.273	0.002
101	C6-C15/S10Z	0.394	0.001	0.410	0.002
102	C9-C15/S10Z	0.273	0.001	0.278	0.001
103	VAR 85/S10Z	0.194	0.001	0.197	0.001
104	VAR 86/S10Z	0.090	0.000	0.091	0.001
105	S10Z/NC10Z	16.314	0.037	16.260	0.052
106	NC 1ST 1/2	12.472	0.052	11.905	0.062
107	MAX DIST	25.511	0.095	25.238	0.120
108	VAR 107/S10Z	0.060	0.000	0.062	0.000
	Second Marine Annulus				
109	S20Z	329.917	1.229	301.170	1.647

[a] Kenai River scale sample was 1,107.
[b] *Other* River scale sample of 600 was weighted proportionately to escapement and represented Yentna River with 113, Susitna River mainstem (river mile 80) with 114, and Kasilof River with 373 scales.

Table 9. Initial classification matrices derived from discriminant analyses of selected scale variables of age-1.3 sockeye salmon scale samples from the Kenai and *Other* Rivers that maximized classification of the Kenai River component, upper Cook Inlet, Alaska, 1987-89.

Year	Actual Group of Origin	Sample Size	Classification Matrix	
			Kenai	*Other*
1987[a]	Kenai	442	0.853	0.147
	Other[b]	426	0.162	0.838
		mean classification accuracy		0.846
			Kenai	*Other*
1988[c]	Kenai	765	0.954	0.046
	Other[d]	430	0.070	0.930
		mean classification accuracy		0.942
			Kenai	*Other*
1989[e]	Kenai	1,107	0.787	0.213
	Other[f]	600	0.170	0.830
		mean classification accuracy		0.809

[a] 1987 two way model included variables 67, 109, 70, 5, 76, 62, and 93.
[b] *Other* included Yentna River with 85, Larson Creek with 22 and Kasilof River with 319 scales.
[c] 1988 two way model included variables 67, 109, 70, 26, 14, 16, 1, and 4.
[d] *Other* included Yentna River with 90 and Kasilof River with 340 scales.
[e] 1989 two way model included variables 2, 1, 109 and 67.
[f] *Other* included Yentna River with 113, Susitna River mainstem (river mile 80) with 114 and Kasilof River with 373 scales.

Table 10. Estimates of stock composition and statistical precision (90% interval) of 100 resamples of commercial catches using Monte Carlo technique in conjunction with linear discriminant analysis of age-1.3 sockeye salmon, upper Cook Inlet, Alaska, in 1987.

			Kenai			Other[a]		
				90% Interval[b]			90% Interval	
Fishery	Date[c]	MCA[d]	Median[ef]	Lower	Upper	Median	Lower	Upper
Central District: Drift	6/24	0.844	0.049	0.005	0.082	0.951	0.918	0.995
	6/26	0.844	0.000	0.000	0.000	1.000	0.000	0.000
	6/29	0.844	0.000	0.000	0.001	1.000	0.999	1.000
	7/03	0.844	0.335	0.294	0.385	0.665	0.615	0.706
	7/06	0.844	0.551	0.487	0.607	0.447	0.393	0.513
	7/10[g]	0.844	0.481	0.435	0.540	0.517	0.460	0.565
	7/13[h]	0.844	0.546	0.498	0.610	0.451	0.390	0.502
	7/17	0.844	0.595	0.538	0.649	0.404	0.351	0.462
	7/19[i]	0.844	0.760	0.711	0.798	0.239	0.202	0.289
	7/20	0.844	0.828	0.789	0.872	0.171	0.128	0.211
	7/22[j]	0.844	0.798	0.727	0.862	0.201	0.138	0.273
	7/24	0.844	0.846	0.771	0.914	0.154	0.086	0.229
	7/25[j]	0.844	0.801	0.754	0.853	0.198	0.147	0.246
	7/27[j]	0.844	0.967	0.899	1.000	0.032	0.000	0.101
	7/31	0.844	0.971	0.916	1.000	0.028	0.000	0.084
Cohoe/Ninilchik Set	6/26	0.844	0.000	0.000	0.000	1.000	1.000	1.000
	7/03	0.844	0.000	0.000	0.000	1.000	1.000	1.000
	7/10	0.844	0.071	0.031	0.103	0.929	0.897	0.969
	7/16[k]	0.844	0.661	0.616	0.714	0.338	0.286	0.384
	7/21[l]	0.844	0.749	0.696	0.797	0.251	0.203	0.304
	7/31[m]	0.844	0.931	0.869	0.989	0.067	0.011	0.131
Kalifonsky Beach Set	7/06	0.844	0.261	0.209	0.308	0.739	0.692	0.791
	7/13[n]	0.844	0.464	0.399	0.512	0.536	0.488	0.601
	7/17[o]	0.844	0.409	0.357	0.452	0.591	0.548	0.643
	7/24[k]	0.844	1.000	0.985	1.000	0.000	0.000	0.015

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Table 10. (p. 2 of 2)

			Kenai			Other[a]		
				90% Interval[b]			90% Interval	
Fishery	Date[c]	MCA[d]	Median[ef]	Lower	Upper	Median	Lower	Upper
Central District:								
Salamatof Beach Set	7/20	0.844	0.890	0.832	0.940	0.110	0.060	0.168
	7/27	0.844	1.000	0.954	1.000	0.000	0.000	0.046
Western Subdistrict Set	7/06	0.844	0.596	0.529	0.668	0.403	0.332	0.471
	7/31[k]	0.844	0.193	0.119	0.349	0.805	0.651	0.881
Northern District:								
Eastern Subdistrict Set	7/20	0.844	0.148	0.099	0.201	0.851	0.799	0.901
	7/27	0.844	0.607	0.540	0.666	0.393	0.334	0.460
General Subdistrict Set	7/27	0.844	0.295	0.249	0.339	0.704	0.661	0.751

[a] Other represents Yentna River, Larson Creek and Kasilof River samples combined.
[b] 90% interval - represents the lower and upper interval estimates of the mid 90% of 100 ordered model results.
[c] Standard 12 h fishing period if not otherwise noted.
[d] MCA - Mean classification accuracy of the 50th model of 100 ordered model results.
[e] Median - result of the 50th model. Represents an adjusted estimate derived from the Cook and Lord (1978) procedure.
[f] Estimate is less than zero or greater than one as a result of the Cook and Lord (1978) procedure and noted as 0 or 1, respectively.
[g] Restricted to the area south of the latitude of Redoubt Point.
[h] Restricted to the area south of the southern tip of Kalgin Island.
[i] Restricted to the area south of mid Kalifonsky Beach and within three miles.
[j] Restricted to the area east of a line from the East Foreland light to Cape Ninilchik.
[k] 24 hr fishing period.
[l] Restricted to 1/2 mi from shore for 19 h and opened Upper Subdistrict for 5 h.
[m] Restricted to Upper Subdistrict north of Clam Gulch access road for 12 h and opened Upper Subdistrict for 12 h.
[n] Restricted to area south of Blanchard Line for 24 h.
[o] Restricted to area south of Blanchard Line for 7 h and opened Upper Subdistrict for 12 h.

Table 11. Estimates of stock composition and statistical precision (90% interval) of 100 resamples of commercial catches using Monte Carlo technique in conjunction with linear discriminant analysis of age-1.3 sockeye salmon, uper Cook Inlet, Alaska,in 1988.

			Kenai			Other[a]		
				90% Interval[b]			90% Interval	
Fishery	Date[c]	MCA[d]	Median[eh]	Lower	Upper	Median	Lower	Upper
Central District: Drift	6/27	0.937	0.285	0.246	0.323	0.715	0.677	0.754
	7/01	0.937	0.456	0.436	0.473	0.544	0.527	0.564
	7/04	0.937	0.524	0.508	0.548	0.476	0.452	0.492
	7/08	0.937	0.709	0.676	0.749	0.291	0.251	0.324
	7/11	0.937	0.713	0.677	0.757	0.287	0.243	0.323
	7/13[f]	0.937	0.937	0.917	0.963	0.063	0.037	0.083
	7/15	0.937	0.830	0.805	0.849	0.170	0.151	0.195
	7/17[f]	0.937	0.948	0.919	0.975	0.050	0.025	0.081
	7/18	0.937	0.895	0.873	0.911	0.105	0.089	0.127
	7/19[g]	0.937	0.851	0.830	0.867	0.149	0.133	0.170
	7/22[f]	0.937	1.000	0.984	1.000	0.000	0.000	0.016
	7/25[f]	0.937	1.000	0.997	1.000	0.000	0.000	0.003
Cohoe/Ninilchik Set	7/04	0.937	0.000	0.000	0.000	1.000	1.000	1.000
	7/08	0.937	0.240	0.205	0.262	0.760	0.738	0.795
	7/18[i]	0.937	0.891	0.873	0.913	0.107	0.087	0.127
	7/25[j]	0.937	0.792	0.759	0.810	0.208	0.190	0.241
Kalifonsky Beach Set	7/08	0.937	0.708	0.686	0.735	0.291	0.265	0.314
	7/11	0.937	0.512	0.493	0.529	0.488	0.471	0.507
	7/15[j]	0.937	0.763	0.731	0.785	0.236	0.215	0.269
	7/22[j]	0.937	0.980	0.962	1.000	0.020	0.000	0.038
	7/29[k]	0.937	1.000	0.986	1.000	0.000	0.000	0.014
Salamatof Beach Set	7/18[j]	0.937	1.000	0.984	1.000	0.000	0.000	0.016
	7/25[j]	0.937	1.000	0.985	1.000	0.000	0.000	0.015

-Continued-

Table 11. (p. 2 of 2)

			Kenai			Other[a]		
				90% Interval[b]			90% Interval	
Fishery	Date[c]	MCA[d]	Median[eh]	Lower	Upper	Median	Lower	Upper
Central District:								
Western Subdistrict Set	7/08[l]	0.937	0.700	0.674	0.737	0.298	0.263	0.326
	7/14[j]	0.937	0.721	0.699	0.760	0.279	0.240	0.301
	7/29	0.937	1.000	0.972	1.000	0.000	0.000	0.028
Northern District:								
Eastern Subdistrict Set	7/22	0.937	0.367	0.337	0.394	0.633	0.606	0.663
General Subdistrict Set	7/22	0.937	0.323	0.300	0.352	0.676	0.648	0.700

[a] Other represents Yentna River and Kasilof River samples combined.
[b] 90% interval - represents the lower and upper interval estimates of the mid 90% of 100 ordered model results.
[c] Standard 12 h fishing period unless otherwise noted.
[d] MCA - Mean classification accuracy of the 50th model of 100 ordered model results.
[e] Median - result of the 50th model. Represents an adjusted estimate derived from the Cook and Lord (1978) procedure.
[f] Restricted to the area Nikiski to Ninilchik within three miles for a minimum of 12 h.
[g] Restricted to the area Nikiski to mid Kalifonsky Beach within three miles for a minimum of 12 h.
[h] Estimate is less than zero or greater than one as a result of the Cook and Lord (1978) procedure and noted as 0 or 1, respectively.
[i] Upper Subdistrict - 19 h.
[j] 24 hr fishing period.
[k] Upper Subdistrict north of mid Kalifonsky Beach - 12 h; Upper Subdistrict - 12 h.
[l] 17 hr fishing period.

Table 12. Estimates of stock composition and statistical precision (90% interval) of 100 resamples of commercial catches using Monte Carlo technique in conjunction with linear discriminant analysis of age-1.3 sockeye salmon, upper Cook Inlet, Alaska, in 1989.

			Kenai			Other[a]		
				90% Interval[b]			90% Interval	
Fishery	Date[c]	MCA[d]	Median[ef]	Lower	Upper	Median	Lower	Upper
Central District:								
Cohoe/Ninilchik Set	7/03	0.797	0.000	0.000	0.034	1.000	0.966	1.000
	7/10	0.797	0.347	0.297	0.445	0.648	0.555	0.703
	7/17	0.797	0.919	0.855	0.984	0.080	0.016	0.145
	7/24[g]	0.797	0.862	0.797	0.928	0.138	0.072	0.203
	7/31[g]	0.797	0.923	0.868	0.994	0.077	0.006	0.132
Kalifonsky Beach Set	7/03	0.797	0.126	0.060	0.190	0.873	0.810	0.940
	7/07	0.797	0.076	0.014	0.204	0.923	0.796	0.986
	7/14[h]	0.797	0.434	0.387	0.522	0.566	0.478	0.613
	7/20[i]	0.797	0.825	0.755	0.891	0.174	0.109	0.245
	7/28	0.797	0.804	0.720	0.887	0.194	0.113	0.280
Salamatof Beach Set	7/10	0.797	0.578	0.537	0.647	0.422	0.353	0.463
	7/17[g]	0.797	0.917	0.854	0.987	0.083	0.013	0.146
	7/24[g]	0.797	0.781	0.727	0.838	0.217	0.162	0.273
	7/31[g]	0.797	0.782	0.744	0.840	0.217	0.160	0.256
Western Subdistrict Set	7/07	0.797	0.477	0.427	0.542	0.523	0.458	0.573
	7/14	0.797	0.438	0.398	0.504	0.561	0.496	0.602
Northern District:								
Eastern Subdistrict Set	7/17	0.797	0.110	0.068	0.155	0.887	0.845	0.932
	7/21	0.797	0.064	0.021	0.106	0.936	0.894	0.979
	7/24	0.797	0.000	0.000	0.000	1.000	1.000	1.000
General Subdistrict Set	7/17	0.797	0.566	0.533	0.602	0.434	0.398	0.467
	7/24	0.797	0.141	0.101	0.201	0.858	0.799	0.899
	7/31	0.797	0.272	0.206	0.341	0.727	0.659	0.794

-Continued-

Table 12. (p. 2 of 2)

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[a] Other represents Yentna River, Susitna River mainstem and Kasilof River samples combined.
[b] 90% interval - represents the lower and upper interval estimates of the mid 90% of 100 ordered model results.
[c] Standard 12 h fishing period if not otherwise noted.
[d] MCA - Mean classification accuracy of the 50th model of 100 ordered model results.
[e] Median - result of the 50th model. Represents an adjusted estimate derived from the Cook and Lord (1978) procedure.
[f] Estimate is less than zero or greater than one as a result of the Cook and Lord (1978) procedure and noted as 0 or 1, respectively.
[g] 24 h fishing period.
[h] Upper Subdistrict - 19 h; Upper Subdistrict north of mid Kalifonsky Beach - 5 h.
[i] Upper Subdistrict north of mid Kalifonsky Beach - 11 h; Upper Subdistirct - 13 h.

Table 13. Meristic counts of adult sockeye salmon from the Yentna, Susitna, Kenai, and Kasilof Rivers, upper Cook Inlet, Alaska, in 1989.

			Fin Ray Count				
Location	Sample Size	Statistic	Dorsal	Anal[a]	Left Pectoral[a]	Right Pectoral[a]	Character Index[b]
Yentna	159	Mode	12	15	11	11	48
		Range	9-12	12-16	9-13	9-13	43-53
Susitna[c]	158	Mode	10	13	11	12	47
		Range	8-12	10-15	10-13	9-15	38-50
Kenai	412	Mode	11	15	12	12	50
		Range	9-15	8-16	9-15	9-16	36-57
Kasilof	617	Mode	11	14	11	11	46
		Range	9-13	10-16	9-13	8-13	39-52

[a] Fin rays were not counted if less than half the length of the longest rays.
[b] Character Index is the sum of dorsal, anal, and both pectoral fin ray counts.
[c] Susitna River sampled at river mile 80, the location referred to as Sunshine Station.

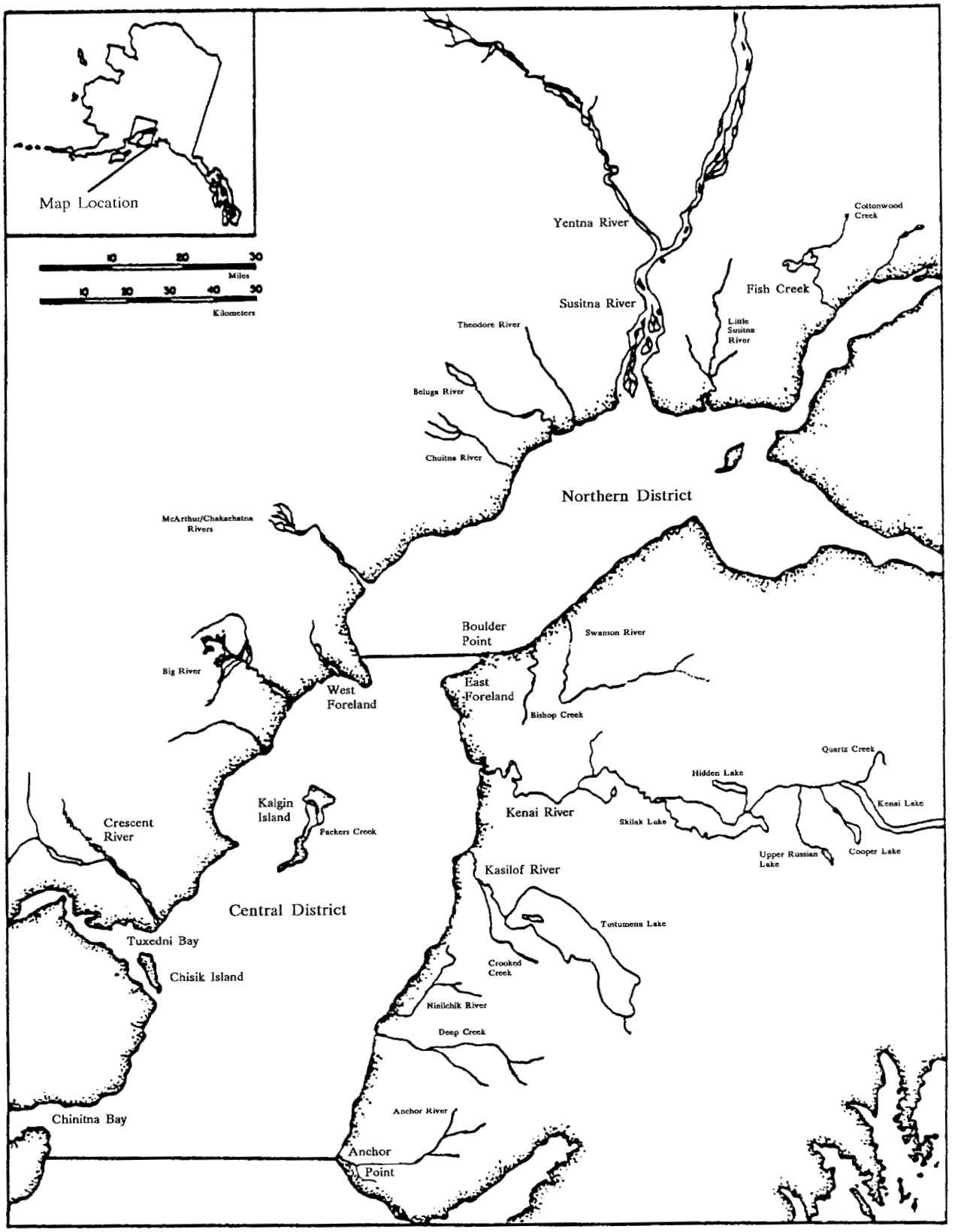

Figure 1. Map of upper Cook Inlet area showing locations of the Northern and Central Districts and the primary salmon spawning drainages.

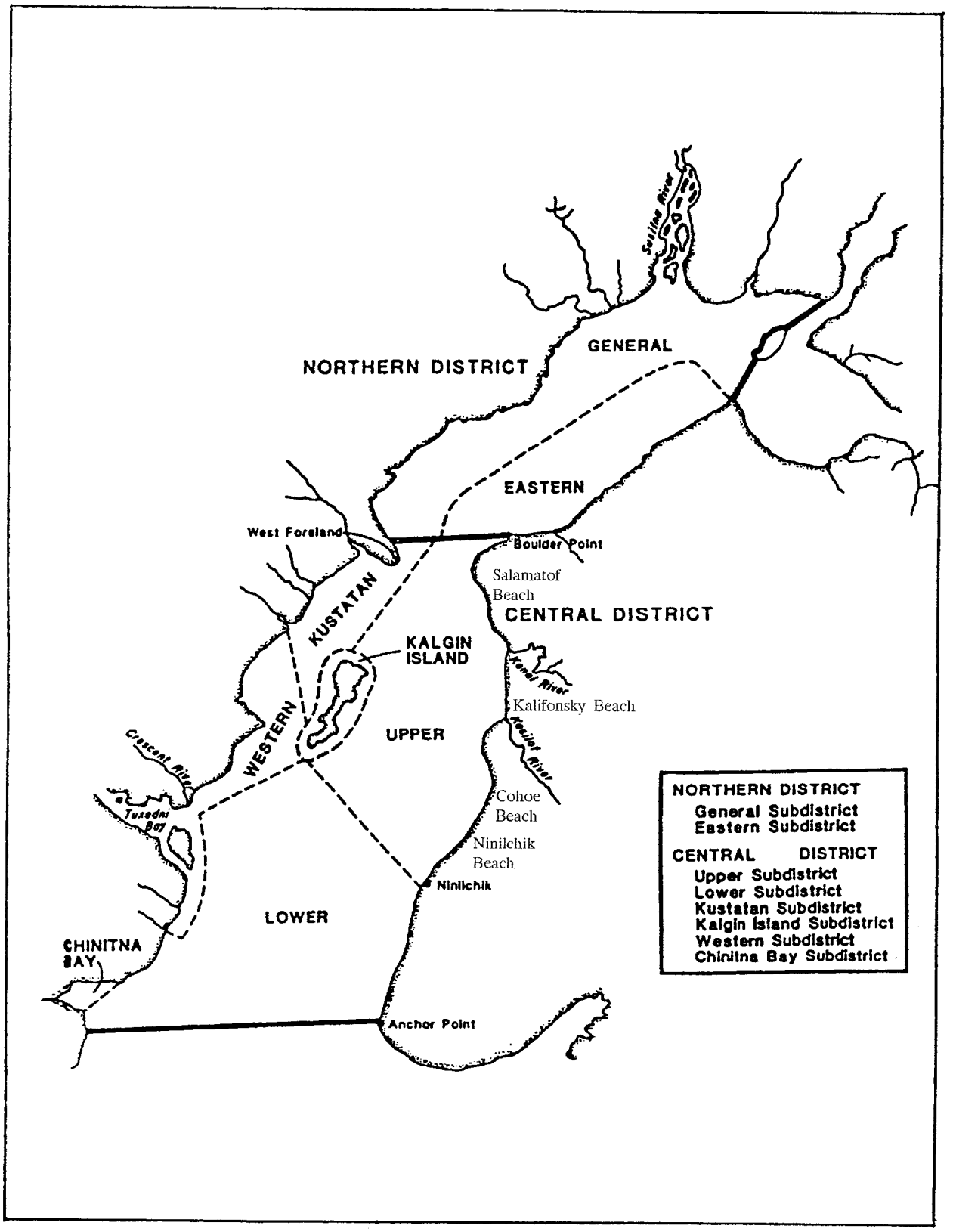

Figure 2. Map of upper Cook Inlet area showing commercial fishing districts and subdistricts.

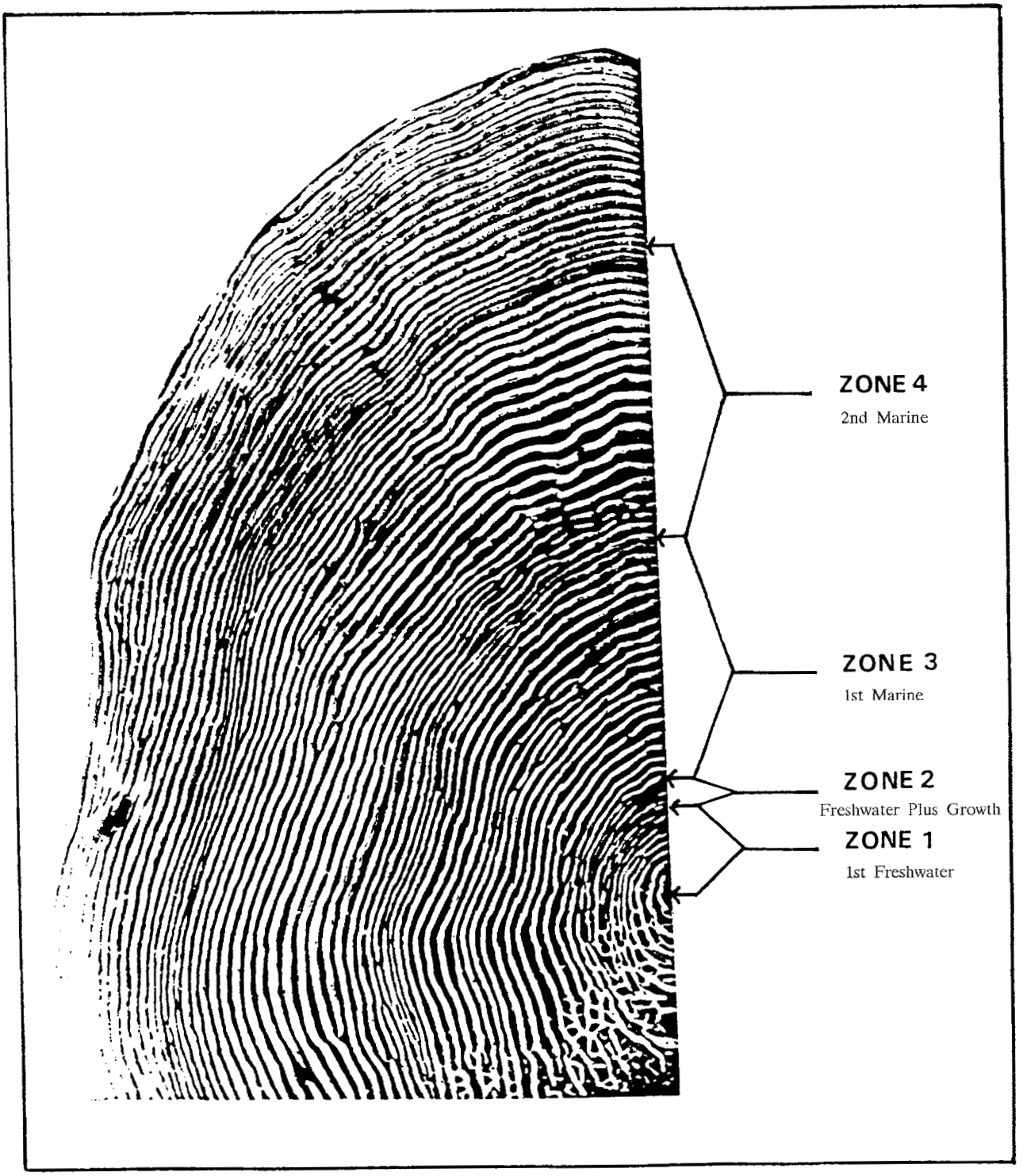

Figure 3. Age-1.3 sockeye salmon scale showing the freshwater and marine growth zones that are measured to generate variables used to build linear discriminant functions.

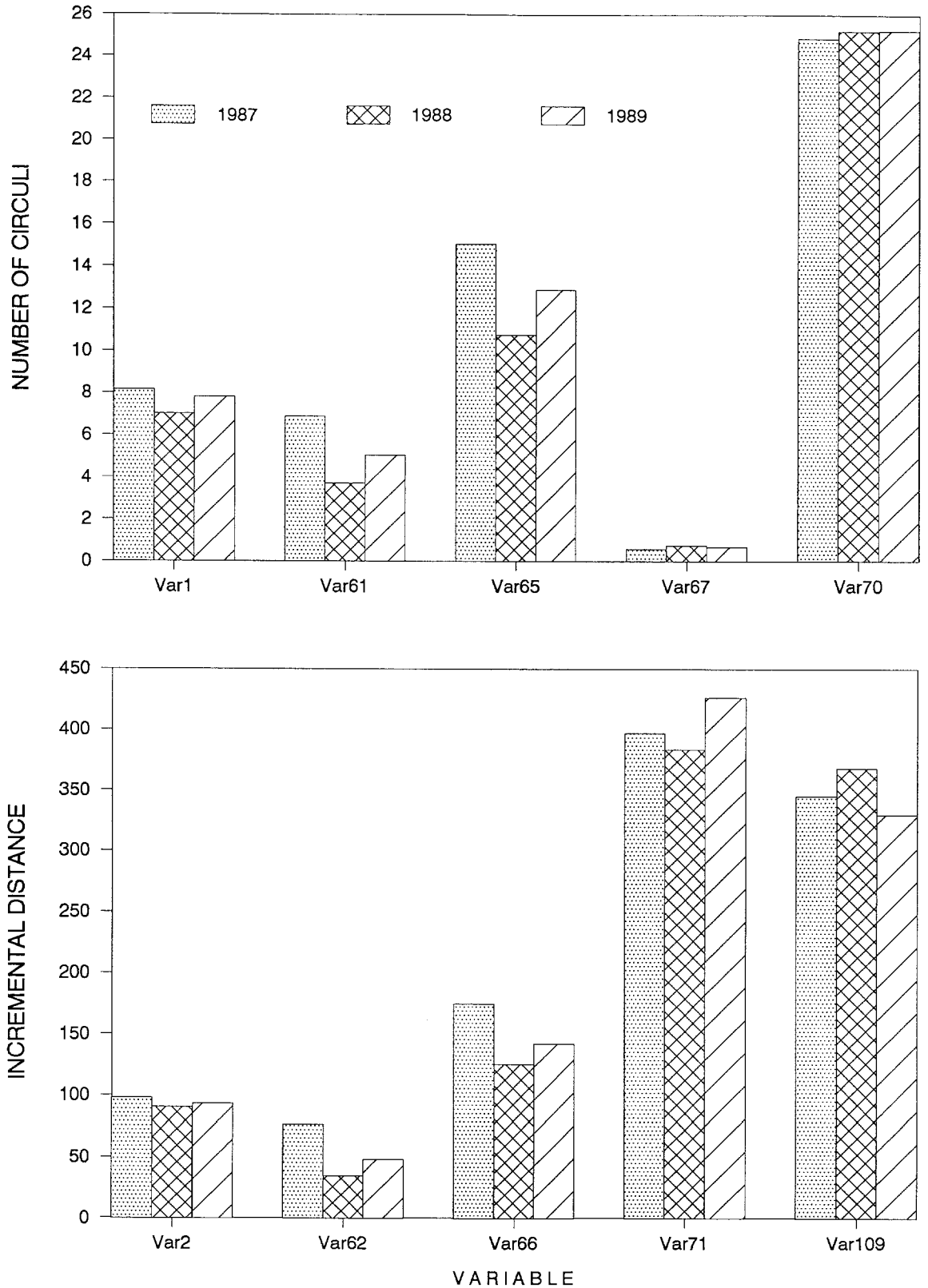

Figure 4. Number of circuli (upper) and incremental distance (lower) of the major growth zones of age-1.3 sockeye salmon scales from the Kenai River, 1987-89.

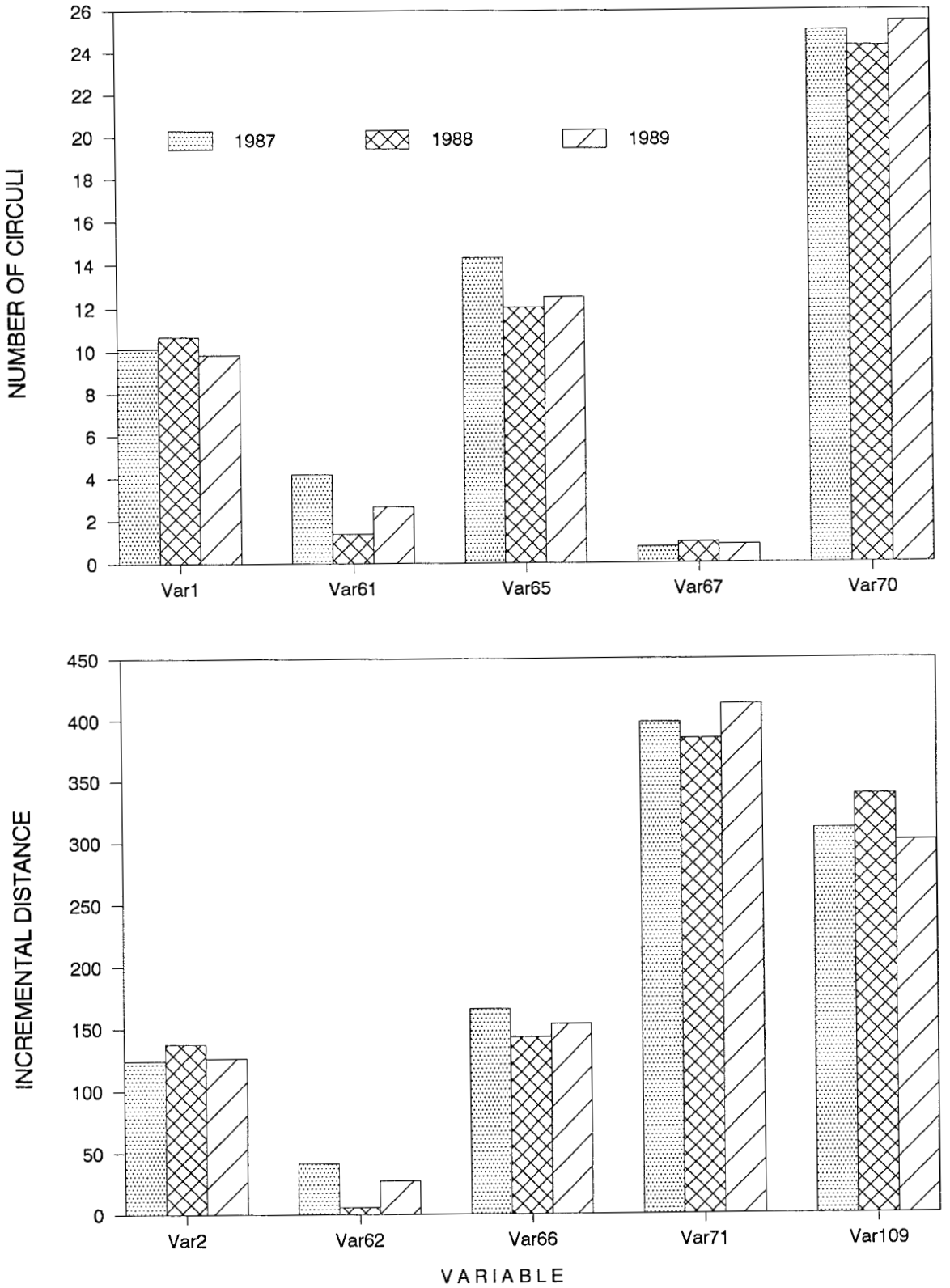

Figure 5. Number of circuli (upper) and incremental distance (lower) of the major growth zones of age-1.3 sockeye salmon scales from the *Other* River, 1987-89.

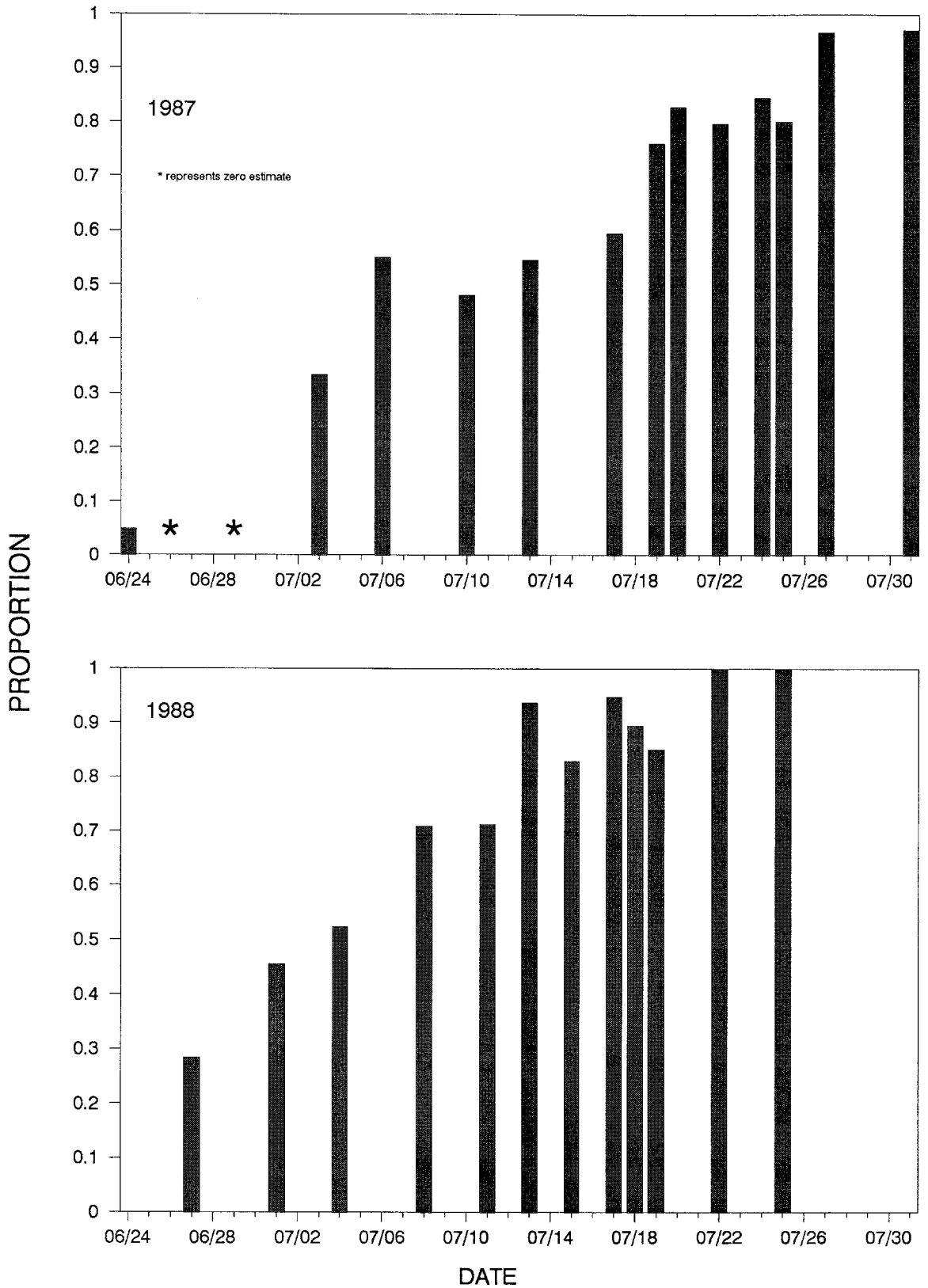

Figure 6. Kenai River stock composition of age-1.3 sockeye salmon in the Central District drift gill net fishery during 1987 (upper) and 1988 (lower).

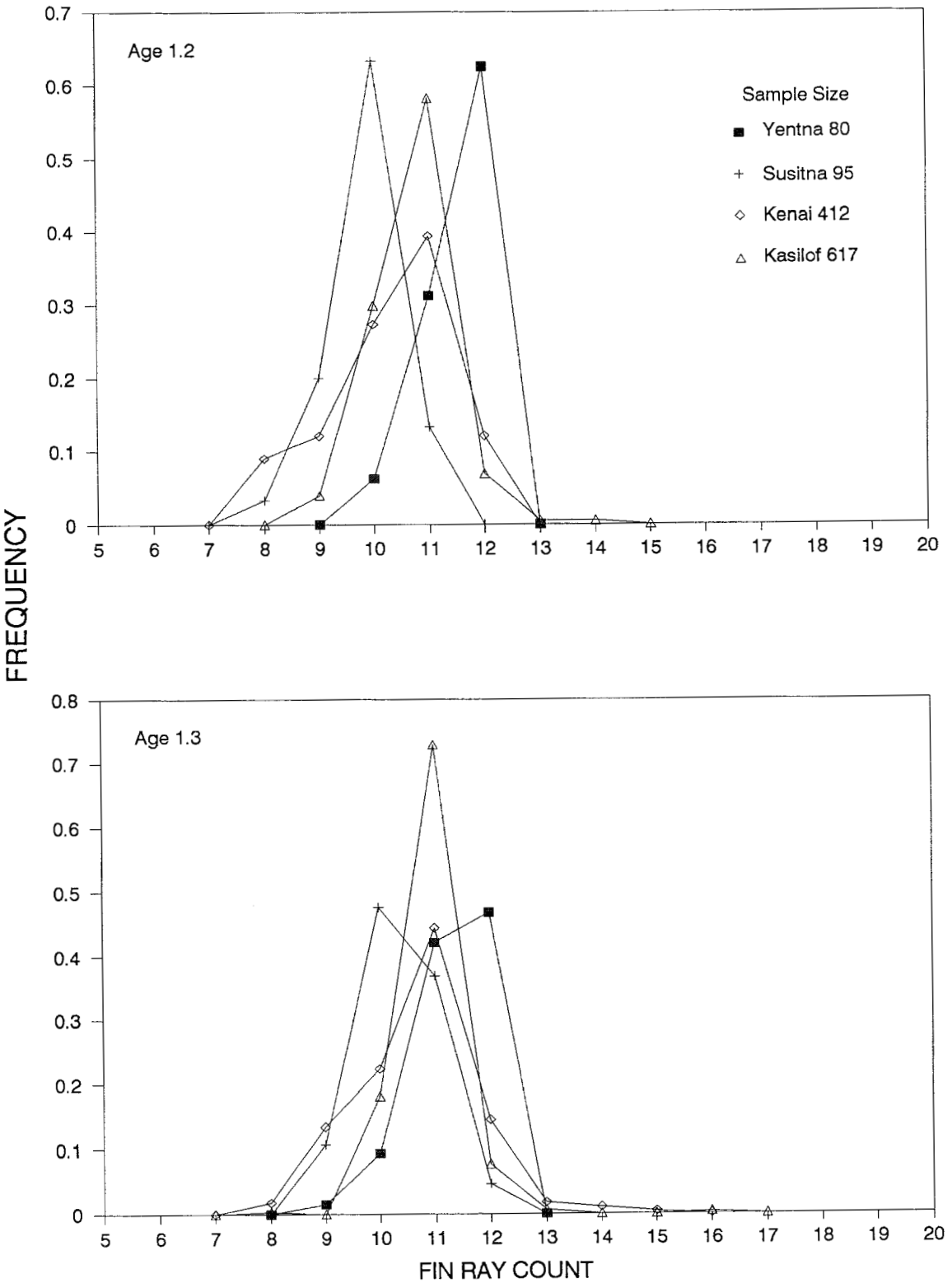

Figure 7. Dorsal fin ray frequency distributions of age-1.2 (upper) and age-1.3 (lower) sockeye salmon for the Yentna, Susitna, Kenai, and Kasilof Rivers, upper Cook Inlet, 1989.

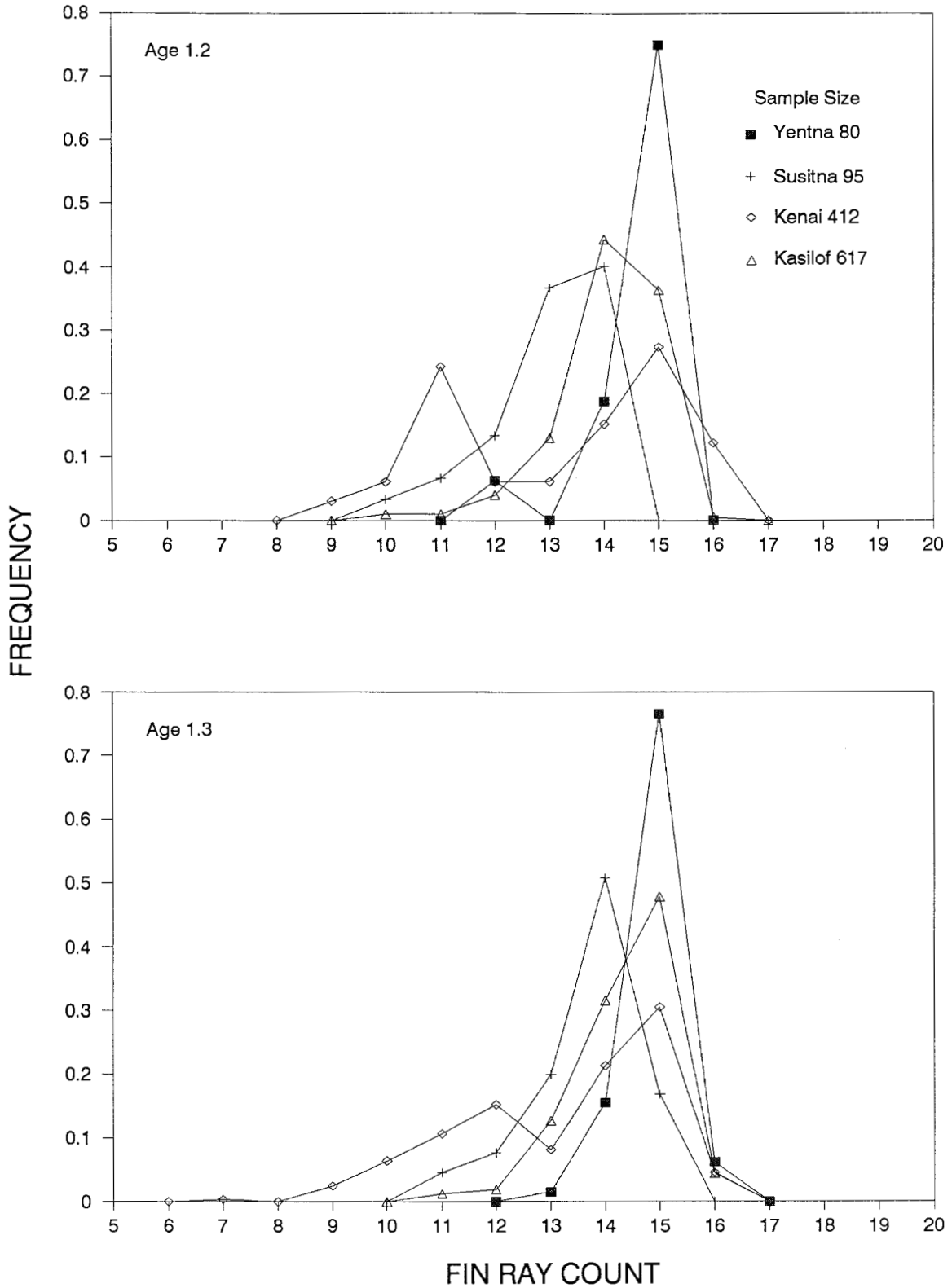

Figure 8. Anal fin ray frequency distributions of age-1.2 (upper) and age-1.3 (lower) sockeye salmon for the Yentna, Susitna, Kenai, and Kasilof Rivers, upper Cook Inlet, 1989.

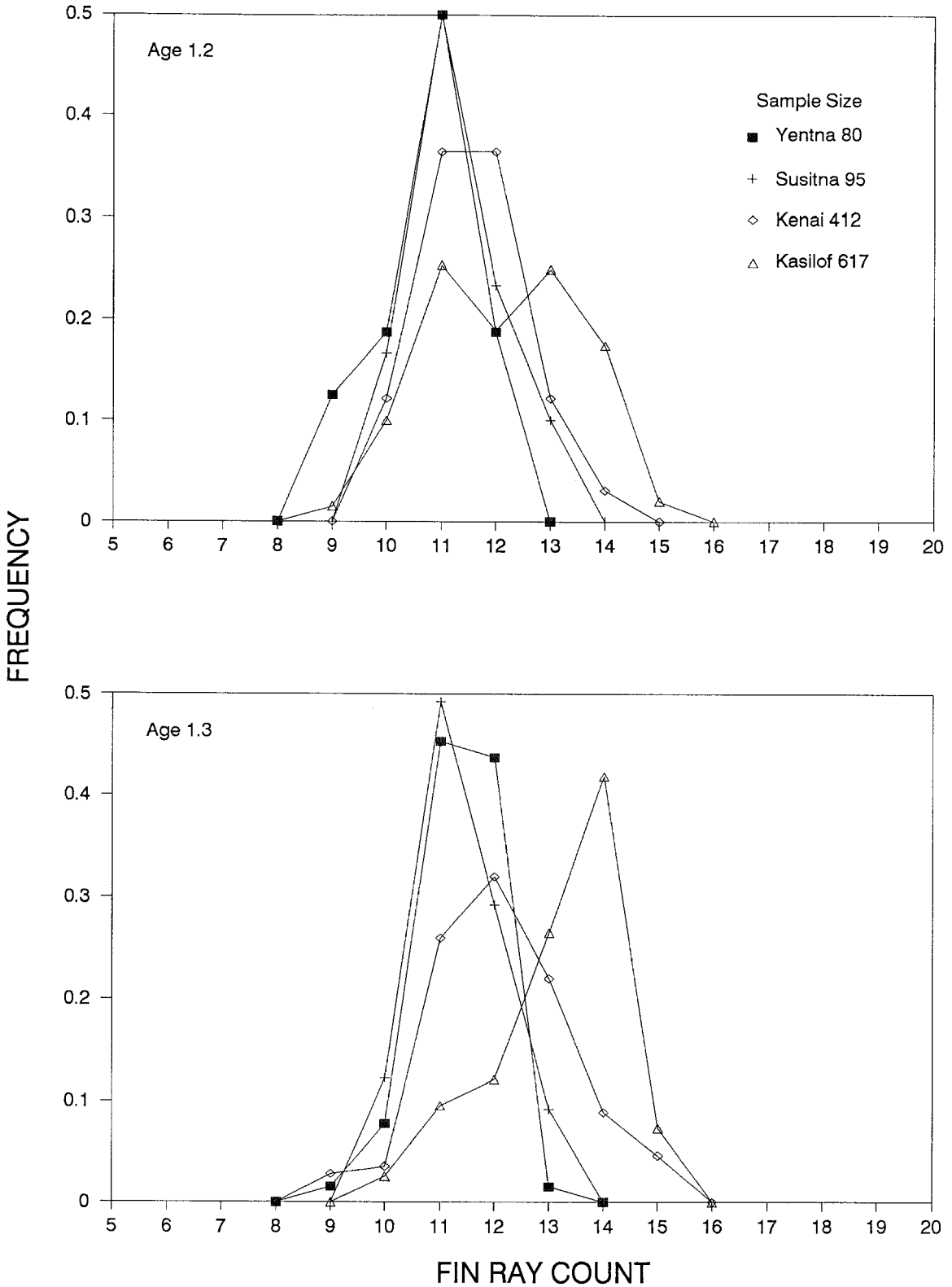

Figure 9. Left pectoral fin ray frequency distributions of age-1.2 (upper) and age-1.3 (lower) sockeye salmon for the Yentna, Susitna, Kenai, and Kasilof Rivers, upper Cool Inlet, 1989.

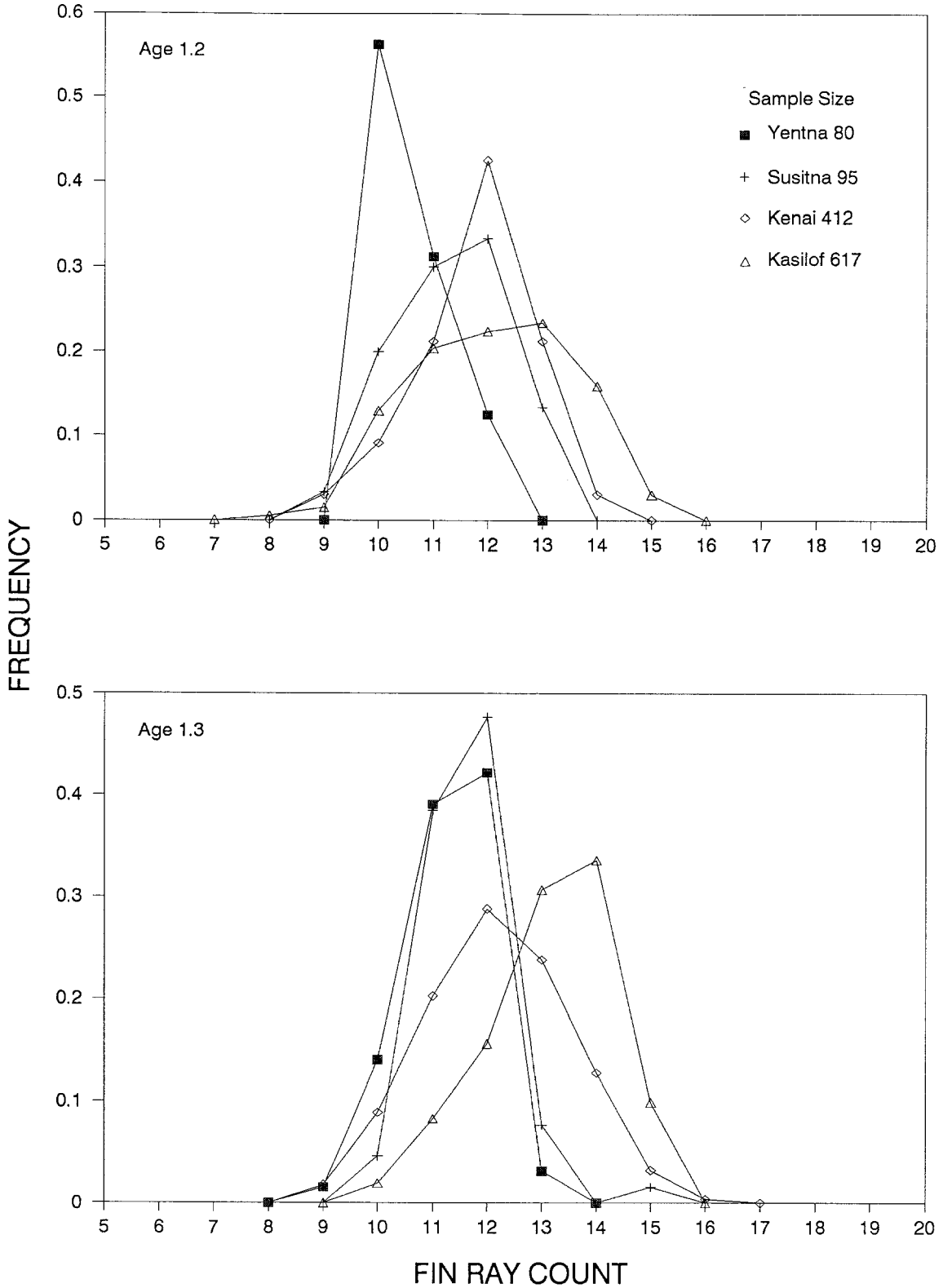

Figure 10. Right pectoral fin ray frequency distributions of age-1.2 (upper) and age-1.3 (lower) sockeye salmon for the Yentna, Susitna, Kenai, and Kasilof Rivers, upper Cook Inlet, 1989.

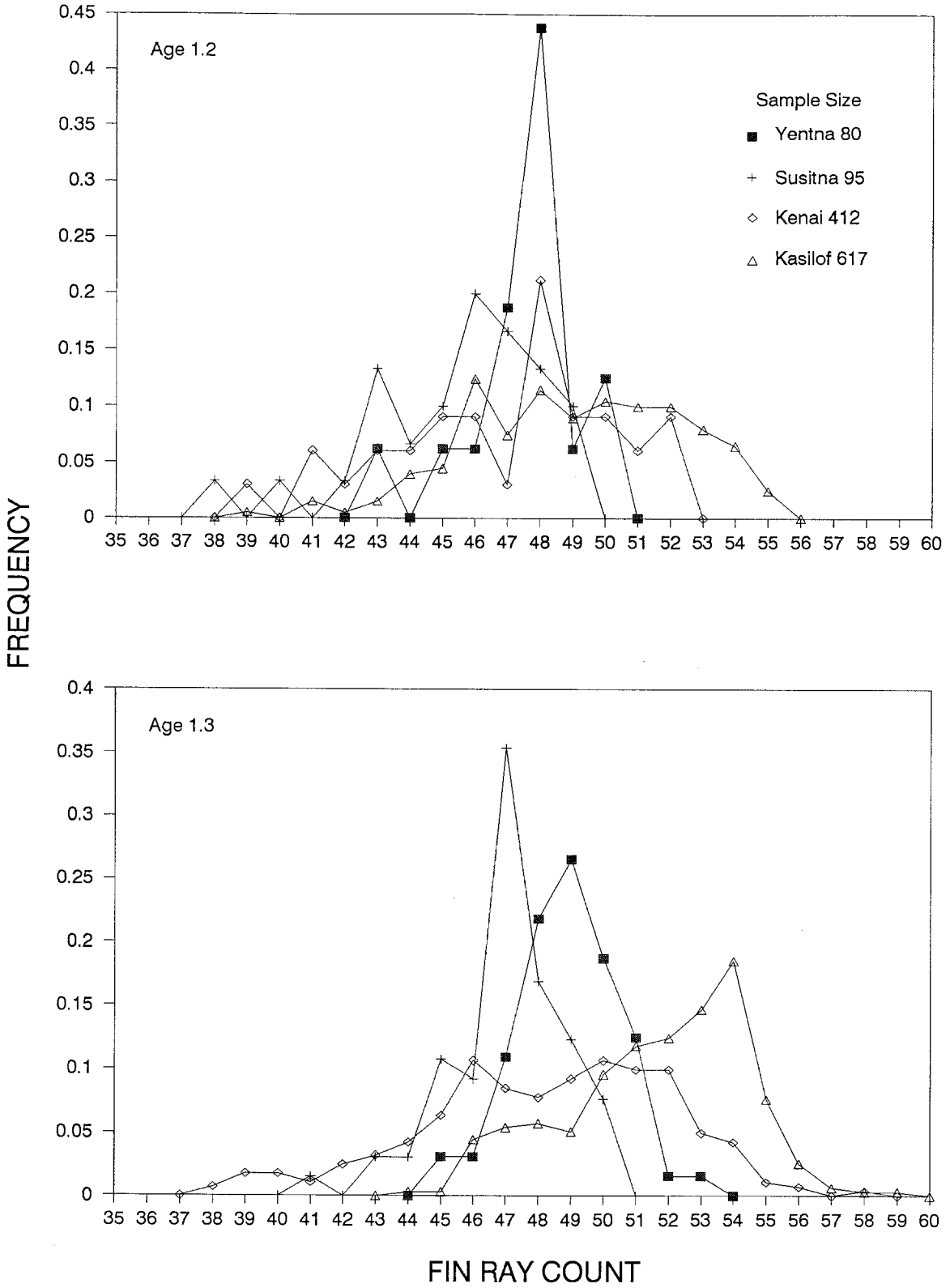

Figure 11. Character index frequency distributions of age 1.2 (upper) and age-1.3 (lower) sockeye salmon for the Yentna, Susitna, Kenai, and Kasilof Rivers, upper Cook Inlet, 1989.

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