ORIGINS OF CHUM SALMON IN THE UNIMAK ISLAND AND SHUMAGIN ISLANDS FISHERIES DURING JUNE, 1983 DETERMINED BY SCALE PATTERNS ANALYSIS

by

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ORIGINS OF CHUM SALMON IN THE UNIMAK ISLAND AND SHUMAGIN ISLANDS FISHERIES DURING JUNE, 1983 DETERMINED BY SCALE PATTERNS ANALYSIS

INTRODUCTION

The commercial harvests of chum salmon (Oncorhynchus keta) by the purse seine and gillnet fisheries in the Unimak Island and Shumagin Islands areas of the Alaska Peninsula (Fig. 1) have increased dramatically in recent years (Table 1). There is concern that this may be severely reducing the number of fish available for harvest in other Western Alaska chum salmon fisheries. Previous tagging studies by the International North Pacific Fisheries Commission (INPFC) determined that many chum salmon stocks of non-local origin were present in the Unimak-Shumagin Islands area (Aro et al. 1971; Aro 1972; 1974; 1977; 1980; Meyer 1983). Chum salmon tagged in the area of the fisheries were recovered in Western Alaska, Japan, and the Kamchatka Peninsula. In five of the seven years when more than 250 tags were released in the area, the majority of the recoveries in the year of release were from Asia (Japan and the Kamchatka Peninsula). The remaining recoveries in these years were predominately from the Yukon River, Kuskokwim Bay, and Bristol Bay areas (Brannian 1984).

Although the tagging studies revealed which stocks were present in the area, they could not be used to determine the relative abundance of each of the major stocks by area and time strata because of violations of many of the necessary assumptions for such estimates (Brannian 1984). All the tagging experiments in the Unimak-Shumagin Islands areas were conducted prior to 1967, and most of the chum salmon releases were made during the period 1956-1961. Since that time two important factors affecting North Pacific chum salmon stocks have changed: (1) there has been a large increase in the number and extent of commercial chum salmon fisheries in Western Alaska, especially in the Arctic-Yukon-Kuskokwim region, and (2) the production of chum salmon by Japanese hatcheries has increased nearly 400% (Ishida et al. 1983). Because of the increased harvests of chum salmon by the Unimak-Shumagin Islands fisheries and the lack of recent information on which stocks are the major contributors to the

fisheries, a study was initiated to determine the origins of chum salmon in the 1983 commercial catch by analysis of scale patterns. Scale patterns analysis had been used previously by Tanaka et al. (1969) and Ishida et al. (1983) to determine the origins of chum salmon caught in the North Pacific Ocean. This report was written as a contribution to the special panel topic of the Sub-committee on Salmon and summarizes the portion of the study which examined the contribution of chum salmon stocks from Japan and the Kamchatka Peninsula to the fishery area.

METHODS

Scales were collected from maturing chum salmon in the Unimak-Shumagin Islands fisheries and the major Western Alaska chum salmon systems during the summer of 1983 by the Alaska Department of Fish and Game. The scale samples representing each of the major stocks were collected from inshore fisheries near the entrance to the river systems. Twenty individual stocks from seven regional areas were represented in the Western Alaska scale samples (Appendix Table 1). Scale samples representing five Japanese chum salmon hatcheries were provided through the INPFC by the Fisheries Agency of Japan (Appendix Table 2). In addition, a small collection of chum salmon scales from the Kamchatka River was obtained (Appendix Table 2). Separate analyses were conducted for the 0.3 and 0.4 age classes. Combined, these two age classes accounted for more than 95% of the scales collected from the Unimak-Shumagin Islands fisheries (Table 2).

Scale samples (standards) representing the pooled Western Alaska stocks and Japanese hatchery stocks were established for the 0.3 and 0.4 age classes. For the Kamchatka River sample, only the 0.4 age class had sufficient numbers of scales to establish a standard. The number of scales from a particular region in the pooled Western Alaska standards was determined by the catch in the region relative to its contribution to the total Western Alaska chum salmon commercial catch in 1983. The Japanese hatchery standards consisted of scales randomly selected from the five hatchery samples. All age 0.4 scales from the Kamchatka River sample were used in the analysis.

Scales from Western Alaska and Japan were collected from the preferred area of each fish sampled (Clutter and Whitesel 1956). It is not known if the scales from the Kamchatka River were removed from the preferred area. It was assumed that differences in scale patterns between the stocks due to genetic and environmental influences would be much larger than the differences due to the scales being collected from different body areas. Also, only scales from the Kamchatka River were available for the standard. Other important systems producing chum salmon on the Kamchatka Peninsula (the Bol'shaya, Amur, Tym', and Kalininka) were not represented in the discriminant models, therefore, it is necessary to assume that the Kamchatka River scale patterns were representative of all Kamchatka Peninsula stocks.

Images of the scales were projected at 100X magnification and the incremental distance between each circulus in the first and second marine zones, and the total width of the third marine zone, measured along the scale axis defined by Tanaka et al. (1969). All circuli counts and scale measurements were made and recorded using a micro-computer controlled digitizing system. From the initial set of scale measurements, 96 scale characters quantifying the growth patterns on each scale were generated. These characters were screened to find a set which would best separate the groups in an analysis by examining group F-statistics and correlation coefficients between all pairs of characters. The scale characters selected for possible inclusion in the models had either a large F-statistic or were negatively correlated with characters having a large F-statistic. Variables selected using these criteria will provide a good subset for constructing a linear discriminant model (Cochran 1964).

Linear discriminant function (LDF) analysis (Fisher 1936) was used to establish the rules to classify the scales of unknown origin. For an LDF analysis, it is assumed that all groups present in the samples being classified are represented in the models, that the scale characters in the analysis have a multivariate normal distribution, and that the groups in the analysis have a common variance-covariance matrix. Scale variables were entered into the LDF models sequentially by a stepwise procedure using the F-statistic (Enslein et al. 1977). A nearly unbiased estimate of the classification accuracy of each linear discrimi-

nant model was estimated by a leaving-one-out procedure (Lachenbruch 1967).

Scale samples of unknown stock composition from the fisheries were then classified with the appropriate models. For the three-group age 0.4 model, if the proportional estimate for a stock was negative, the stock was omitted from the analysis and a two-group model used to classify the sample. The proportional estimates of stock composition were adjusted for misclassification errors (Cook and Lord 1978) and 90.0% confidence intervals for the adjusted estimates were calculated (Pella and Robertson 1979).

RESULTS

The means and standard errors of the scale variables which provided the best discrimination between the standards in the different analyses are summarized in Table 3. In previous analyses of chum salmon scale patterns, the characters in the first marine zone provided the best discrimination between groups (Tanaka et al. 1969; McGregor and Marshall 1982; Nikolayeva and Semenets 1984). This was found in this study also, as four of the characters which provided the best discrimination between groups were in the first marine zone.

The classification matrices for the LDF models required in the analysis of each age class are presented in Table 4. The mean classification accuracy of the age 0.3 LDF model was 93.3%. Mean accuracies of the classification models for the 0.4 age class were 83.7% for the three-group model, 86.8% for the Western Alaska-Japan model, and 93.5% for the Western Alaska-Kamchatka model.

The results of classifying the scales of unknown origin from the Unimak-Shumagin Islands fishery areas for the 0.3 age class are shown in Fig. 2. In all strata, the majority of the samples were assigned to the Western Alaska group. The contributions of Japanese hatchery chum salmon to the fishery were generally minor throughout all area and time strata, never exceeding 20% in any strata. There were no discernible trends in the contributions by group for the different area and time strata.

The results of the analysis of the 0.4 age class support those of the age 0.3 analyses. Estimated contributions of the Japanese hatchery and Kamchatka River groups to the fishery were small, ranging from 0% to 22.5% (Fig. 3). The majority of the fish in each strata were assigned to the Western Alaska group, its estimated contribution ranging from 69% to 100%. The South Unimak samples suggest an increase in the contribution of the Japanese hatchery group by time concurrent with a decrease in the contribution of the Western Alaska group. The South Unimak sample on 19-21 June had the highest contribution of the Japanese hatchery group (22.5%) and the Sand Point sample on 13-14 June the highest contribution of the Kamchatka group (10.3%).

DISCUSSION

The scale patterns analysis of the chum salmon samples from the Unimak-Shumagin Islands fisheries indicated that the majority of the fish were of Western Alaska origin in 1983. The classification accuracies for the linear discriminant models were high, which in part resulted in stock composition estimates with mean 90% confidence intervals of ± 8% for the 0.3 age class and ± 11% for the 0.4 age class. The classification accuracies of Ishida et al. (1983), which ranged from 85.5%-93.9%, are comparable to those attained in this study.

For both age classes, chum salmon from Western Alaska were estimated to be the predominant stock in all area and time strata. The indicated predominance of Western Alaska fish cannot be definitely concluded because of a violation of a major assumption of linear discriminant analysis, viz., it is assumed that all groups present in the samples being classified are represented in the LDF model. Previous tagging studies determined that chum salmon stocks from the Kamchatka Peninsula were present in the Unimak-Shumagin Islands areas. Unfortunately, there were not enough age 0.3 scales in the Kamchatka River sample for a standard. Therefore, in the age 0.3 analysis fish from the Kamchatka Peninsula present in the fishery samples would be classified as either the Western Alaska or Japanese hatchery group.

The analysis of the 0.4 age class indicated that the Kamchatka River stock was a minor contributor to the Unimak-Shumagin Islands fisheries (less than 11% in all area and time strata). However, other major chum salmon systems on the Kamchatka Peninsula were not represented in the age 0.4 standard. If the scale patterns of the omitted stocks more closely resembled those of either the Western Alaska or Japanese hatchery groups than the Kamchatka River samples, and these stocks were present in the fisheries areas in significant numbers, then the estimates of the contribution of the Kamchatka stock to the fisheries would not be valid. Future scale patterns analyses in the Unimak-Shumagin Islands area will require samples from other Kamchatka Peninsula systems in order to establish standards which are more representative of that area.

LITERATURE CITED

Aro, K. V. 1972. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1970 and 1971, and additional recoveries from earlier taggings by Canada, Japan, and the United States. Fish. Res. Board Can. MS Rept. 1186: 31 pp.

Aro, K. V. 1974. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1972 and 1973, and additional recoveries from earlier taggings by Canada, Japan, and the United States. Fish. Res. Board Can. MS Rept. 1328: 20 pp.

Aro, K. V. 1977. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1974, 1975, and 1976, and additional recoveries from earlier taggings by Canada, Japan, and the United States. Fish. Mar. Serv. Data Rept. 25: 21 pp.

Aro, K. V. 1980. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1977, 1978, and 1979, and additional recoveries from earlier taggings by Canada, Japan, and the United States. Can. Data Rep. Fish. Aquat. Sci. 223: 19 pp.

Aro, K. V., J. A. Thomson, and D. P. Giovando. 1971. Recoveries of salmon tagged offshore in the North Pacific Ocean by Canada, Japan, and the United States, 1956 to 1969. Fish. Res. Board Can. MS Rept. 1147: 493 pp.

Brannian, L. K. 1984. Recovery distribution of chum salmon (Oncorhynchus keta) tagged in the North Pacific offshore of the Alaska Peninsula and Eastern Aleutian Island chain. Alaska Dept. Fish and Game, Inform. Leafl. 237. 30 pp.

Clutter, R. I., and L. E. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Int. Pac. Salmon Fish. Comm., Bull. 9. 159 pp.

Cochran, W. G. 1964. On the performance of the linear discriminant function. Technometrics 6(2):179-190.

Cook, R. C., and G. E. Lord. 1978. Identification of stocks of Bristol Bay sockeye salmon, (Oncorhynchus nerka), by evaluating scale patterns with a polynomial discriminant method. U. S. Fish and Wildlife Service, Fish. Bull. 76(2):415-423.

Enslein, K., A. Ralston, and H. S. Wilf. 1977. Statistical methods for digital computers. John Wiley and Sons, Inc., New York. 454 pp.

Fisher, R. A. 1936. The use of multiple measurements in taxonomic problems. Ann. Eugenics 7:179-188.

Ishida, Y., S. Ito, and K. Takagi. 1983. An analysis of scale patterns of Japanese hatchery reared chum salmon in the North Pacific. (Document submitted to the International North Pacific Fisheries Commission.) Fisheries Agency of Japan, Tokyo. 8 pp.

Lachenbruch, P. A. 1967. An almost unbiased method of obtaining confidence intervals for the probability of misclassification in discriminant analysis. Biometrics 23(4):639-645.

McGregor, A. J., and S. L. Marshall. 1982. Origins of chum salmon (Oncorhynchus keta) in the Excursion Inlet purse seine fishery of 1981 based on scale pattern analysis Alaska Dept. Fish and Game, Inform. Leafl. 201. 34 pp.

Meyer, W. G. 1983. Recoveries of salmonids tagged offshore in the North Pacific Ocean by Japan and the United States in 1980, 1981, and 1982, and additional recoveries from earlier taggings by Canada, Japan, and the United States. FRI Circ. No. 83-1, Fisheries Research Inst., Univ. of Washington, Seattle. 28 pp.

Nikolayeva, Y. T., and N. I. Semenets. 1984. A contribution to stock differentiation of chum salmon, Oncorchynchus keta (Salmonidae), by scale structure in the first year of growth. J. Ichthyol. 23(5):18-28.

Pella, J. J., and T. L. Robertson. 1979. Assessment of composition of stock mixtures. U. S. Fish and Wildlife Service, Fish. Bull. 77(2):387-398.

Tanaka, S., M. P. Shepard, and H. T. Bilton. 1969. Origin of chum salmon (Oncorhynchus keta) in offshore waters of the North Pacific in 1956-1958 as determined from scale studies. Int. N. Pac. Fish. Comm., Bull. 26:57-155.

FIGURES AND TABLES

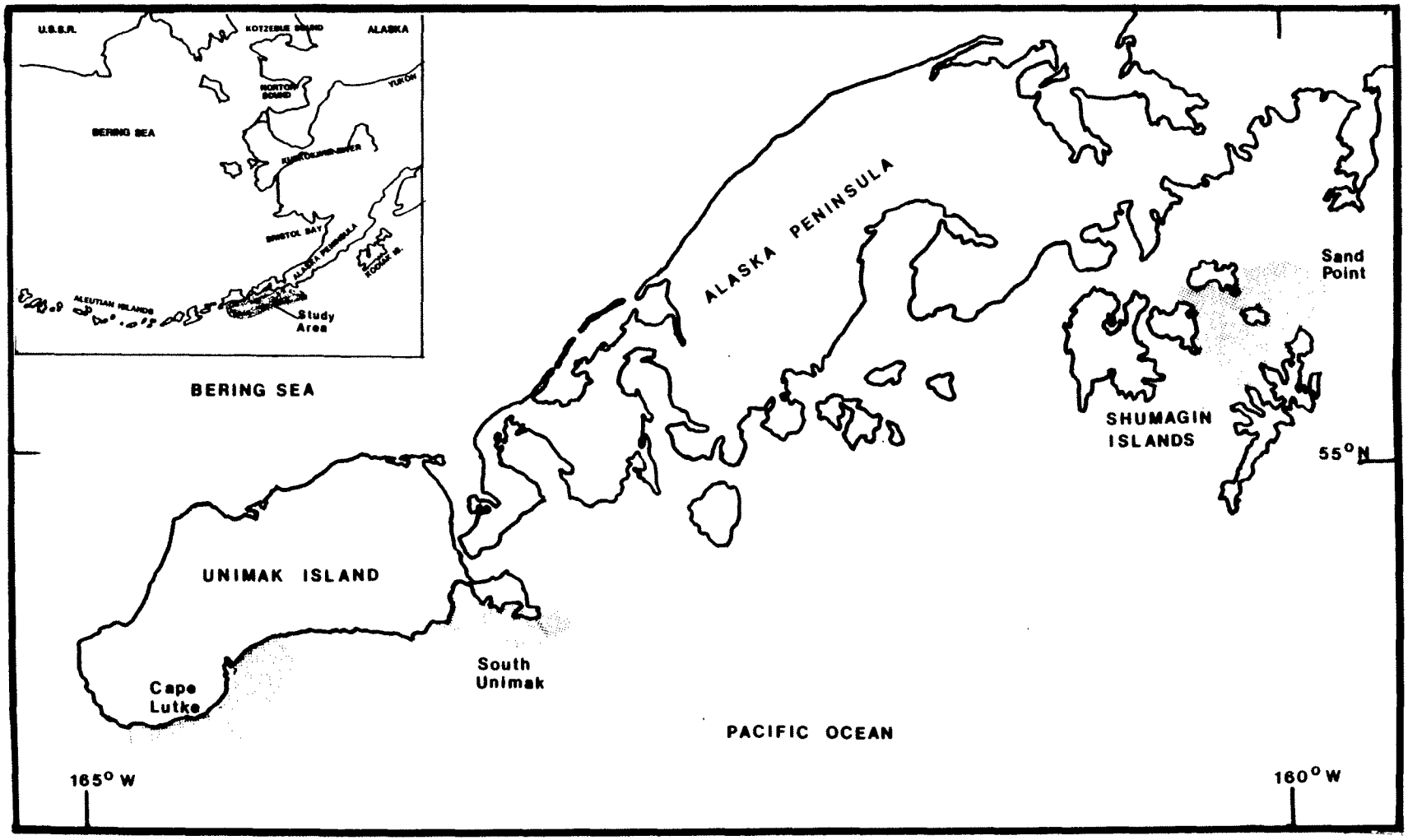

Figure 1. Location of the Unimak Island and Shumagin Islands fisheries with an inset of Western Alaska.

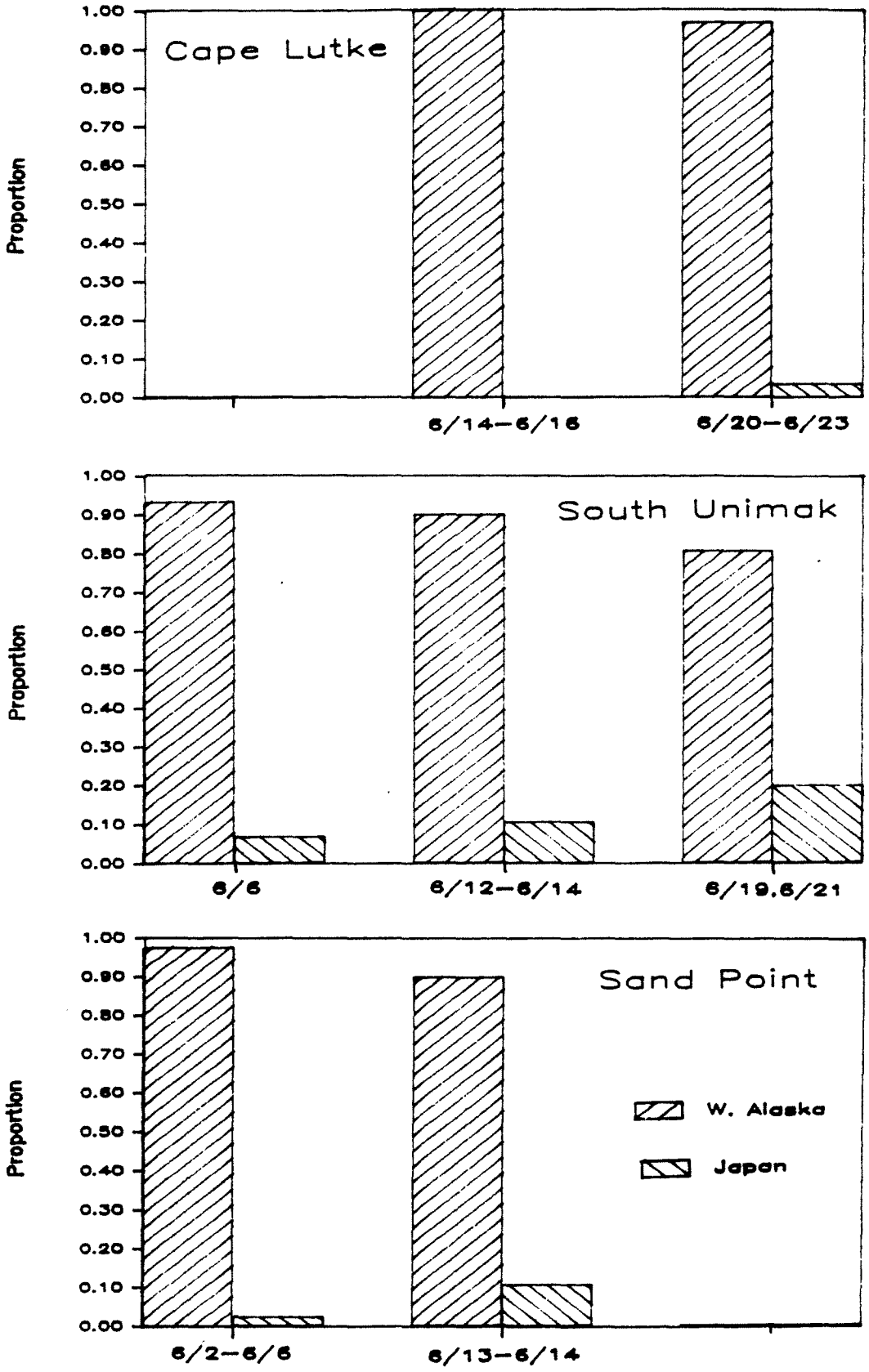

Figure 2. Proportional stock composition estimates by fishery area for age 0.3 chum salmon, 1983.

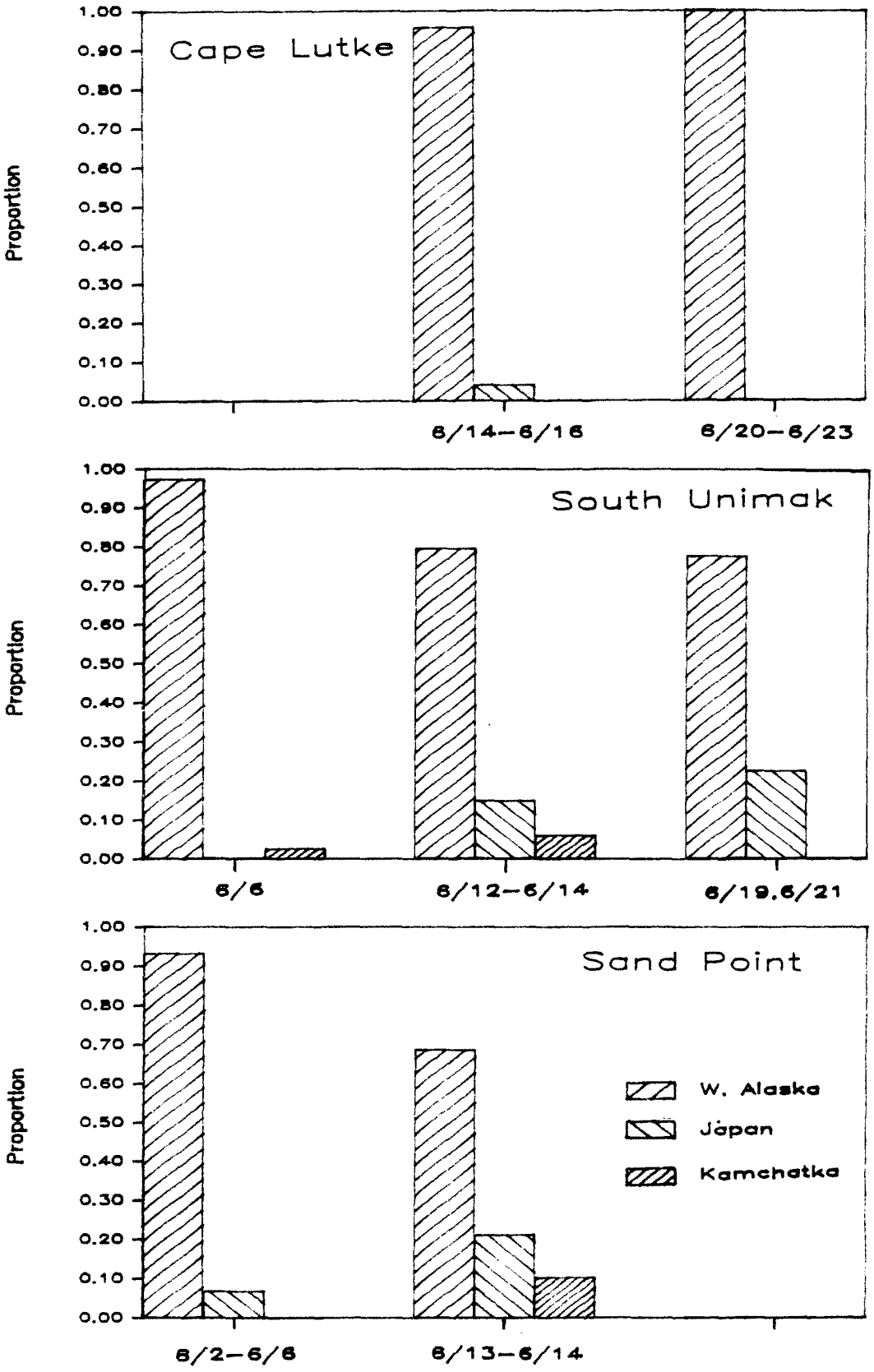

Figure 3. Proportional stock composition estimates by fishery area for age 0.4 chum salmon, 1983.

Table 1. Commercial catch of chum salmon by area for Western Alaska, 1962-1983 (thousands of fish).

Year	Kotzebue	Norton Sound	Yukon River[1]	Kuskokwim Bay[2]	Bristol Bay	June Fisheries	
						Shumagin	Unimak
1962	130	183	53	46	668	61	209
1963	54	155	0	0	370	36	81
1964	76	149	8	1	803	67	161
1965	40	37	23	4	361	45	121
1966	31	80	71	3	343	17	215
1967	29	42	49	8	476	51	73
1968	30	45	67	20	364	51	115
1969	59	83	192	50	333	13	254
1970	160	107	347	61	718	49	403
1971	155	131	290	99	677	115	554
1972	170	101	288	97	657	108	468
1973	375	119	518	184	684	23	189
1974	628	162	879	196	286	0	15
1975	563	212	985	224	325	36	65
1976	160	96	762	232	1,329	74	327
1977	196	200	798	299	1,598	22	93
1978	112	189	1,289	282	1,158	18	105
1979	142	141	1,166	297	907	41	64
1980	367	181	1,356	561	1,405	71	457
1981	677	170	1,678	486	1,475	54	521
1982	418	183	839	325	941	140	875
1983	176	319	1,203	307	1,467	169	615
Average (62-79)	173	124	433	117	670	46	195
Average (80-83)	410	213	1,269	420	1,322	109	617

[1] Does not include Canadian catches.

[2] Includes catches from the Kuskokwim River, Kuskokwim Bay, Quinhagak Bay, and Goodnews Bay.

Table 2. Age composition of chum salmon samples collected during June in the Unimak Island and Shumagin Islands fisheries, 1983.

Location/ Sample Dates	Sample Size	Percent Composition by Age Class				
		0.2	0.3	0.4	0.5	0.6
Cape Lutke						
6/14 - 6/16	583	2.1	42.2	53.3	2.4	0.0
6/20 - 6/23	355	2.3	56.3	40.0	1.4	0.0
South Unimak						
6/ 6	116	0.0	46.5	52.6	0.9	0.0
6/12 - 6/14	420	1.4	54.5	43.1	1.0	0.0
6/19, 6/21	229	2.2	53.7	42.8	1.3	0.0
Sand Point						
6/ 2 - 6/ 6	393	0.5	47.8	50.9	0.8	0.0
6/13 - 6/14	234	2.1	50.9	45.7	1.3	0.0

Table 3. Mean ($\bar{x}$) and standard error (se) of the scale characters which provided the best discriminantion for the groups in the linear discriminant models. All linear distances are in 0.01's of inches measured at 100X magnification.

Group	Sample Size	Scale Character[1] 1		2		3		4		5	
		$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se
Age 0.3											
W. Alaska	200	528.3	3.12	71.9	0.75	0.54	0.01	19.2	0.12	293.1	2.89
Japan	200	479.2	3.80	55.7	0.67	0.50	0.01	16.2	0.11	211.6	2.41
Age 0.4											
W. Alaska	200	508.6	3.49	67.2	0.60	0.50	0.01	17.3	0.10	266.6	2.65
Japan	200	474.9	3.59	61.6	0.66	0.53	0.01	16.6	0.11	211.9	2.63
Kamchatka	100	385.3	5.56	57.0	0.94	0.62	0.01	15.1	0.17	233.0	3.23

[1]Scale character definitions:
1. width of the first marine annular zone
2. distance from the scale focus to circulus 3 (C3) in the first marine annular zone
3. (distance from the scale focus to C15 in the first marine zone)/width of the first marine zone
4. average interval between circuli in the first marine annular zone
5. width of the second marine annular zone

Table 4. Classification matrices for the linear discriminant models used to classify ages 0.3 and 0.4 chum salmon.

Actual Group of Origin	Sample Size	Classified Group of Origin	
0.3 Age Class		W. Alaska	Japan
W. Alaska	200	0.920	0.080
Japan	200	0.055	0.945

mean proportion correctly classified = 0.933

Actual Group of Origin	Sample Size	Classified Group of Origin		
0.4 Age Class		W. Alaska	Japan	Kamchatka
W. Alaska	200	0.845	0.125	0.030
Japan	200	0.130	0.815	0.055
Kamchatka	100	0.030	0.120	0.850

mean proportion correctly classified = 0.837

Actual Group of Origin	Sample Size	Classified Group of Origin	
0.4 Age Class		W. Alaska	Japan
W. Alaska	200	0.880	0.120
Japan	200	0.145	0.855

mean proportion correctly classified = 0.868

Actual Group of Origin	Sample Size	Classified Group of Origin	
0.4 Age Class		W. Alaska	Kamchatka
W. Alaska	200	0.960	0.040
Kamchatka	100	0.090	0.910

mean proportion correctly classified = 0.935

APPENDIX TABLES

Appendix Table 1. Age composition of 1983 chum salmon stocks included in the Western Alaska standards.

Location	Sample Size	Percent Composition by Age Class 0.2	0.3	0.4	0.5	0.6
South Peninsula						
Stepovak Bay	467	2.1	26.4 (8)[1]	68.1 (8)	3.4	0.0
Volcano Bay	213	3.8	78.4 (4)	16.9 (4)	0.9	0.0
Canoe Bay	260	4.2	15.8 (19)	70.8 (19)	9.2	0.0
North Peninsula						
Nelson Lagoon	223	40.3	37.7 (1)	20.2 (1)	1.8	0.0
Herendeen Bay	261	6.9	32.6 (2)	55.9 (2)	4.6	0.0
Frank's Lagoon	58	24.1	36.2 (1)	39.7 (1)	0.0	0.0
Bear River	132	14.4	28.0 (3)	56.1 (3)	1.5	0.0
Sandy River	100	17.0	36.0 (2)	45.0 (2)	2.0	0.0
Three Hills	112	14.3	25.0 (1)	58.0 (1)	2.7	0.0
Ilnik	40	5.0	40.0 (1)	55.0 (1)	0.0	0.0
Bristol Bay						
Nushagak	843	2.5	38.2 (35)	57.3 (19)	2.0	0.0
Togiak	1103	2.3	64.5 (19)	32.4 (35)	0.8	0.0
Kuskokwim						
Kuskokwim	1713	1.0	44.8 (17)	53.0 (17)	1.2	0.0
Quinhagak	484	0.6	59.7 (1)	38.7 (1)	1.0	0.0
Goodnews	217	3.7	41.9 (1)	53.9 (1)	0.5	0.0
Yukon (Emmonak)						
Prior 7/15	1963	0.4	53.5 (43)	45.0 (43)	1.0	0.1
After 7/15	566	0.2	88.0 (13)	11.8 (13)	0.0	0.0
Norton Sound						
Unakleet	330	0.9	56.4 (13)	42.1 (13)	0.6	0.0
Moses Point	450	0.4	62.0 (4)	36.5 (4)	1.1	0.0
Kotzebue	1339	3.4	59.0 (10)	34.7 (10)	2.8	0.1

[1] Numbers in parentheses are the number of scales from each stock in the standard for that age class.

Appendix Table 2. Age compositions of 1983 chum salmon hatchery stocks included in the Japanese standards and for the Kamchatka River sample.

Location	Sample Size	Percent Composition by Age Class 0.2	0.3	0.4	0.5	0.6
Japanese Hatchery						
Chitose	242	83.9	14.9 (36)[1]	1.2 (3)	0.0	0.0
Nishibetsu	505	13.4	72.5 (44)	14.1 (62)	0.0	0.0
Tokachi	240	7.9	50.4 (40)	41.7 (62)	0.0	0.0
Yubetsu	243	16.5	79.4 (40)	4.1 (10)	0.0	0.0
Urappu	393	6.4	54.2 (40)	39.4 (63)	0.0	0.0
Kamchatka River	182	0.5	26.9	72.0 (100)	0.5	0.0

[1]Numbers in parentheses are the number of scales from each stock in the standard for that age class.

Appendix Table 3. Estimated proportions and 90.0% confidence intervals of chum salmon from Western Alaska and Japan for the 0.3 age class in the Unimak-Shumagin Islands fisheries, 1983.

Location/ Sample Dates	Group	Sample Size	Estimated Proportion	90.0% C. I.
Cape Lutke				
6/14 - 6/16	W. Alaska	100	1.000	0.979, 1.091
	Japan		0.000	-0.091, 0.021
Cape Lutke				
6/20 - 6/23	W. Alaska	100	0.965	0.896, 1.034
	Japan		0.035	-0.034, 0.104
South Unimak				
6/ 6	W. Alaska	58	0.933	0.840, 1.026
	Japan		0.067	-0.026, 0.160
South Unimak				
6/12 - 6/14	W. Alaska	100	0.896	0.817, 0.975
	Japan		0.104	0.025, 0.183
South Unimak				
6/19, 6/21	W. Alaska	100	0.803	0.716, 0.891
	Japan		0.197	0.109 0.284
Sand Point				
6/ 2 - 6/ 6	W. Alaska	100	0.977	0.910, 1.044
	Japan		0.023	-0.044, 0.090
Sand Point				
6/13 - 6/14	W. Alaska	100	0.896	0.817, 0.975
	Japan		0.104	0.025, 0.183

Appendix Table 4. Estimated proportions and 90.0% confidence intervals of chum salmon from Western Alaska, Japan, and Kamchatka for the 0.4 age class in the Unimak-Shumagin Islands fisheries, 1983.

Location/ Sample Dates	Group	Sample Size	Estimated Proportion	90.0% C. I.
Cape Lutke				
6/14 - 6/16	W. Alaska	100	0.959	0.865, 1.053
	Japan		0.041	-0.053, 0.135
	Kamchatka		*[1]	
Cape Lutke				
6/20 - 6/23	W. Alaska	100	1.000	0.942, 1.113
	Japan		*	
	Kamchatka		*	
South Unimak				
6/ 6	W. Alaska	65	0.975	0.913, 1.037
	Japan		*	
	Kamchatka		0.025	-0.037, 0.087
South Unimak				
6/12 - 6/14	W. Alaska	110	0.793	0.650, 0.935
	Japan		0.149	0.011, 0.286
	Kamchatka		0.059	-0.015, 0.133
South Unimak				
6/19, 6/21	W. Alaska	91	0.775	0.661, 0.888
	Japan		0.225	0.112, 0.339
	Kamchatka		*	
Sand Point				
6/ 2 - 6/ 6	W. Alaska	100	0.932	0.835, 1.029
	Japan		0.068	-0.029, 0.165
	Kamchatka		*	
Sand Point				
6/13 - 6/14	W. Alaska	100	0.686	0.534, 0.838
	Japan		0.211	0.063, 0.359
	Kamchatka		0.103	0.014, 0.193

[1] * indicates that the estimated proportion for that group was less than zero.