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THE EFFECT OF ALTERING PROPORTIONS OF ASIAN CHINOOK STOCKS ON REGIONAL SCALE PATTERN ANALYSIS

by

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INTRODUCTION

Due primarily to the limited availability of scale samples from U.S.S.R. chinook salmon stocks, U.S. and Japanese researchers have utilized a variety of sources of scale samples to construct Asian standard samples for regional stock identification studies based on scale pattern analysis. Major et al. (1975, 1977a, 1977b) used an Asian standard constructed from scale samples of maturing individuals taken by the 1968 Japanese mothership salmon fishery in the North Pacific between 160°E and 170°E (46°N-54°N). Asian standards utilized by Knudsen et al. (1983) and Myers et al. (1984) were composed of U.S.S.R. scale samples from two major Kamchatka Peninsula stocks: Kamchatka River (East Kamchatka Peninsula) and Bolshaya River (West Kamchatka Peninsula). The Asian standard used by Ito et al. (1985) included scale samples from maturing chinook salmon caught by Japanese salmon research vessels in the area between 150°E and 165°E (42°N-56°N) in addition to U.S.S.R. samples from the Kamchatka and Bolshaya rivers.

Related to these differences in sources of scales as well as to differences in methodology, relative proportions of the component stocks within the Asian standards used by different researchers have varied considerably. The stock composition of Major's et al. (1975, 1977a, 1977b) Asian standard is not known, but their methodology was based on the assumption that their Asian standard was self-weighted, i.e. contained fish from all of the major Asian streams in proportion to their relative abundances. Knudsen et al. (1983) attempted to weight the proportions of Kamchatka River and Bolshaya River chinook in their Asian standards on the basis of the relative abundance of the inshore runs, but when the number of scales from a particular stock was insufficient to provide the desired sample size, all available scales from the stock were used. As a result, the proportions of Kamchatka River scales in Knudsen's et al. two Asian standards for different brood-years were 94% and 31% of the total sample. Myers et al. (1984) used a method similar to that of Knudsen et al. (1983), except that when sample sizes were insufficient, proportions simulating the relative abundance (based on coastal commercial catches) of the two Asian stocks were maintained by reducing the total sample size of the Asian standard. In Myers' et al. (1984) 14 Asian standards for different brood-years and age classes, the percentage of Kamchatka River scales ranged from 75% to 95% of the total sample, reflecting the larger commercial chinook salmon catch in East Kamchatka than in West Kamchatka. Ito et al. (1985) did not weight the proportions of the various stocks included in their Asian standard. In Ito's et al. (1985) Asian standard the proportion of Kamchatka River scales was 26% of the total and the proportion of Bolshaya River scales was 32% of the total. The stock composition of the remaining 42% of their Asian standard is not known, but the largest component (51%) was from samples collected in the Okhotsk Sea off the West Kamchatka coast,

35% were samples from the North Pacific (primarily off the mid-Kuril Islands), and 14% were from INPFC statistical areas bisected by the southern tip of the Kamchatka Peninsula and the Kuril Islands.

The effect of these differences in the relative proportions of component stocks within the Asian standard on the results of regional scale pattern analyses is not known. However, Myers (1985) found that the scale patterns of Kamchatka River and Bolshaya River chinook are sometimes significantly different. In the Asian standards used by Myers et al. (1984), classification errors for Bolshaya were often high, Bolshaya tended to misclassify to central Alaska and Kamchatka tended to misclassify to western Alaska, and Kamchatka and Bolshaya group centroids were often widely separated in multivariate space (Myers 1985). In light of these differences, the relative proportions of the component stocks within the Asian standard may have a significant effect on the results of regional scale pattern analysis.

The purpose of this report is to examine the effect of altering the relative proportions of the component stocks within the Asian standard on the classification accuracies and classification results of regional stock identification studies based on scale pattern analysis.

METHODS

Chinook salmon scale data collected for earlier scale pattern studies at Fisheries Research Institute (FRI) were used in this analysis. Methods of scale ageing, measurement, and construction of brood-year standards at FRI are described in Myers et al. (1984). FRI chinook scale data were available for only two Asian stocks: Kamchatka River and Bolshaya River. Three brood-years (1973, 1974, and 1976) with sample sizes of at least 100 fish (ages 1.3, 1.4, and 1.5) per Asian stock were selected for analysis. Three Asian standards with the following stock proportions were constructed for each brood-year: 1) 50% Kamchatka R. and 50% Bolshaya R. (50-50), 2) 100% Kamchatka R. (100K), and 3) 100% Bolshaya R. (100B). Within each brood-year analysis, the total sample size of all three Asian standards was the same, and was determined by the stock with the smallest number of scales available. When the number of scales available was greater than the desired sample size, scales were randomly selected for inclusion in the standards. The western Alaskan (WEST), central Alaskan (CENT), and southeast Alaskan/British Columbian (SEBC) standards were the same as those used by Myers et al. (1984), and proportions of the component stocks within these standards were not varied during the analysis. The high seas unknowns were also the same as those used by Myers et al. (1984), and were composed of immature age 1.2 chinook salmon sampled during research vessel and mothership operations in the area 40°N-62°N, 160°E-175°W (Fig. 1) in June and July of 1977 (brood-year 1973), 1978 (brood-year 1974), and 1980 (brood-year 1976).

Linear discriminant function (LDF) analysis, as applied by commercial software (program BMDP7M, Dixon et al. 1983) was used to classify

high seas unknowns to month/sub-area and regional fishery area strata (Fig. 1). The proportion of the two Asian stocks was the only factor varying between analyses, as pre-selected character sets were forced into the LDF analyses. To ensure that interpretation of the results would not be specific to a particular character set, all LDF analyses were performed on two character sets. The first character set (Char. Set No. 1, Table 1) was used for all nine brood-year/Asian stock proportion combinations, and was the same character set used by Ito et al. (1985). The method that Ito et al. used to select this character set is not known. The second character set (Char. Set No. 2, Table 1) differed for each brood-year, and was the same brood-year specific character set selected by the BMDP7M algorithm (Dixon et al. 1983) and used by Myers et al. (1984) in their four-region LDF analyses. The statistical differences between scale character means of the regional standards were examined by the Tukey test (Tukey 1953; Zar 1984).

The reader should note that the term 'classification result' in this report refers to the observed (uncorrected) percentages of the stocks in the high seas samples. To enable direct examination of the effect of changes in Asian stock proportions on the classification results, the point and variance estimation procedures used by Myers et al. (1984) were not applied.

RESULTS

The results of Tukey tests on the scale character means of the six regional standards for brood-years 1973, 1974, and 1976 are presented in Tables 2-4. For most of the scale characters there were statistically significant differences among the 50-50, 100K, and 100B Asian standards. The means of only four characters in the brood-year 1973 analysis (Char. Nos. 1, 21, 35, and 39, Table 2), two characters in the brood-year 1974 analysis (Char. Nos. 12 and 39, Table 3), and five characters in the brood-year 1976 analysis (Char. Nos. 1, 12, 27, 32, and 39, Table 4) were not significantly different among the three Asian standards.

The 100B standards consistently had the smallest mean zone sizes (Char. Nos. 1, 5, and 6) and circulus counts (Char. Nos. 12, 16, and 7) and were often significantly different than any of the other regional standards for these characters (Tables 2-4). The mean zone sizes and circulus counts of the 100K standards were often considerably larger than the 100B standards and, for brood-years 1973 and 1974, were sometimes more similar to the CENT standards.

The 100K standards consistently had the smallest mean values of triplets and nonuplets in the early portion of the second year of growth (Char. Nos. 49, 50, 51, and 34) and, for brood-years 1974 and 1976, were often statistically similar to the CENT standards (Tables 2-4). In contrast, the 100B standards occasionally had the largest values for these characters and were often statistically similar to the SEBC standards.

For triplets and nonuplets in the middle or outer portion of the second year of growth (Char. Nos. 54, 58, 35, and 36), the 100B standards typically had the smallest mean values and, again, were often statistically similar to the SEBC standards (Tables 2-4). The 100K standards were often more similar to the CENT or WEST standards for these characters.

Although the mean values of the freshwater triplet (Char. No. 39) were not statistically different for the three Asian standards, the value of the 100B standard varied dramatically between brood-years (Tables 2-4). The brood-year 1973 100B standard had the largest mean freshwater triplet and was most similar the the WEST standard, but the mean values of the brood-year 1974 and 1976 100B standards were among the smallest and were most similar in value to the other Asian standards.

Mean values of circulus spacing (Char. Nos. 9 and 21) were smaller for the 100B standards than the 100K standards (Tables 2-4). For brood-years 1974 and 1976, the 100B standards were statistically similar to SEBC standards and the 100K standards were statistically similar to CENT standards.

The scale character means of the 50-50 standards were sometimes statistically different than either one or both of the other Asian standards, and were often statistically similar to one or more of the North American standards (Tables 2-4).

The results of classifying the standards are presented in Tables 5–7. Overall classification accuracies averaged 72.0% in the 50-50 analyses, 72.6% in the 100K analyses, and 76.8% in the 100B analyses. For analyses with the same brood-year and character set, changing the stock proportions of the Asian standard resulted in classification accuracies that differed by as much as 20.7% for the Asian standards, 9.1% for the WEST standards, 11.1% for the CENT standards, and 3.1% for the SEBC standards.

Classification accuracies of the Asian standards averaged 73.6% in the 50-50 analyses, 75.3% in the 100K analyses, and 88.9% in the 100B analyses (Tables 5-7). With little exception, the 50-50 and 100K standards misclassified mostly to WEST and the 100B standards misclassified mostly to CENT.

Classification accuracies of the WEST standards averaged 80.1% in the 50-50 analyses, 77.8% in the 100K analyses, and 83.2% in the 100B analyses (Tables 5-7). WEST usually misclassified most frequently (average 12.3%) to CENT. Misclassifications of WEST to Asia were highest (average 8.4%) in the 100K analyses and lowest (average 2.6%) in the 100B analyses.

Classification accuracies of the CENT standards averaged 56.4% in the 50-50 analyses, 58.8% in the 100K analyses, and 57.1% in the 100B analyses (Tables 5-7). CENT misclassified most frequently (average

20.6%) to Asia in the brood-year 1973 analyses, and the percentage of CENT scales that misclassified to Asia were highest (average 24.6%) in the 50-50 analyses and lowest (average 17.2%) in the 100K analyses. In the brood-year 1974 and 1976 analyses, CENT misclassified most frequently (average 17.9%) to WEST, and the percentage of CENT scales that misclassified to WEST tended to be highest (average 20.0%) in the 100B analyses. In the brood-year 1974 and 1976 analyses, misclassifications of CENT to Asia were lowest (average 7.2%) in the 100B analyses and were usually highest (average 13.0%) in the 100K analyses.

Classification accuracies of the SEBC standards averaged 78.1% in the 50-50 analyses, 78.6% in the 100K analyses, and 78.2% in the 100B analyses. SEBC scales misclassified most frequently (average 15.4%) to CENT, and the percentage of SEBC scales that misclassified to CENT was highest (average 16.2%) in the 100K analyses. The percentage of SEBC scales that misclassified to Asia was uniformly low (average 3.7%), but was often highest in the 100B analyses (average 4.3%).

Overall classification accuracies were usually somewhat higher in the Char. Set No. 2 analyses than in the Char. Set No. 1 analyses, but the differences are probably not statistically significant (Tables 5-7). However, classification accuracies of the Asian standards were often considerably higher in the Char. Set No. 1 analyses than in the Char. Set No. 2 analyses, and classification accuracies of the WEST and CENT standards were often considerably higher in the Char. Set No. 2 analyses than in the Char. Set No. 1 analyses.

The results of classifying chinook salmon caught as immature age 1.2's in 1977, 1978, and 1980 are presented by month/sub-area strata in Appendix Tables 1-3 and are summarized by regional fishery area in Figs. 2-10. For analyses with the same brood-year, character set, and regional strata, changing the stock proportions of the Asian standard produced classification results that differed by a maximum of 17.2% (average 10.1%) for Asia, 14.5% (average 5.8%) for WEST, 13.0% (average 7.0%) for CENT, and 6.7% (average 1.9%) for SEBC.

Changes in stock proportions of the Asian standard often had the greatest effect on mothership fishery-Bering Sea (MS-BS) area classification results (Figs. 2-4). Results for Asia and WEST varied the most, and the highest results for Asia and the lowest results for WEST in the MS-BS were obtained when the 100K standard was used. Conversely, when the 100B standard was used, the lowest results for ASIA and the highest results for WEST in the MS-BS were obtained. The highest results for CENT in the MS-BS were also obtained with the 100B standard. Classification results for SEBC in the MS-BS varied by less than 1.0% with changes in Asian stock proportions.

In the mothership fishery-North Pacific (MS-PAC) area, changing the proportions of the Asian standard had the greatest effect on the classification results for Asia and CENT (Figs.5-7). In most analyses, the lowest results for Asia and the highest results for CENT were obtained when the 100K standard was used. However, in the brood-year 1976 (Char.

Set No. 2) analysis, the highest results for Asia and the lowest results for CENT were obtained with the 100K standard. For brood-years 1973 and 1976, the lowest results for WEST in the MS-PAC were obtained when the 100K standard was used. But for brood-year 1974, the highest result for WEST in the MS-PAC was obtained when the 100K standard was used. The highest results for SEBC in the MS-PAC were always obtained when the 100K standard was used.

Sample sizes for the landbased driftnet fishery (LBDN) area were smaller than those of the other areas and results were more variable (Figs. 8-10). In the brood-year 1973 analyses, the 100K standard produced the smallest results for Asia and the largest results for CENT in the LBDN. Results for the LBDN in the brood-year 1974 analyses did not vary enough to discern any trends. For brood-year 1976, the highest results for Asia in the LBDN were obtained with the 100K standard.

Classification results for CENT and WEST in the MS-PAC and LBDN often varied dramatically depending on the character set and Asian standard that was used. For example, the result for CENT (26.4%) when Character Set No. 1 and the 50-50 standard was used was less than half the result for CENT (60.4%) when Char. Set No. 2 and the 100B standard was used (Fig. 8). In general, Char. Set No. 1 produced higher results for WEST and lower results for CENT in the MS-PAC and LBDN areas, and Char. Set No. 2 produced higher results for CENT and lower results for WEST in the MS-PAC and LBDN areas. These trends were sometimes opposite in the MS-BS classification results.

DISCUSSION

The results of this study show that altering the relative proportions of the component stocks within the Asian standard changes classification accuracies (Tables 5-7) and classification results (Figs. 2–10). The differences due to changes in Asian stock proportions were usually greatest in the classification accuracies and stock composition results for Asia, but results for all of the regions were affected to some extent. In general, classification results for Asia in the Bering Sea were highest and results for Asia in the North Pacific were lowest when Kamchatka River was the only stock included in the Asian standard. Classification results for western Alaska were usually lowest when Kamchatka was the only stock in the Asian standard, regardless of fishery area. Classification results for central Alaska in the Bering Sea were highest and results for central Alaska in the North Pacific were often lowest when Bolshaya River was the only stock included in the Asian standard. Classification results for central Alaska and southeast Alaska/British Columbia in the North Pacific were often highest when Kamchatka River was the only stock included in the Asian standard.

The results of the present study also show that classification accuracies and stock composition results can vary considerably when different scale character sets are used (Tables 5-7, Figs. 2-10). The use of Ito's et al. (1985) character set (selected by an unknown method)

resulted in high classification accuracies for the Asian standard, but classification accuracies for the western and central Alaska standards were considerably lower than those obtained with Myers' et al. (1984) character sets (selected for highest overall accuracies in separating the four regional stocks). Classification results, particularly for western Alaska and central Alaska, sometimes varied dramatically depending upon which character set was used (Figs. 2-10). These results demonstrate the important influence of the character set on the results of scale pattern analysis. However, U.S. and Japanese researchers have not yet determined or agreed upon the best criterion for scale character selection.

Ito et al. (1985) compared their classification results (uncorrected) to Myers' et al. (1984) estimates (classification results corrected by Cook and Lord's [1978] method). A major difference was that Ito's et al. results showed Asia to be the predominant stock in the MS-PAC and LBDN and Myers' et al. estimates showed central Alaska to be the predominant stock in these areas. Because Ito et al. classified 1974 high seas samples and Myers et al. classified 1975-81 high seas samples, differences in results for the North Pacific may reflect actual changes in stock composition between sample years. However, considering the results of the present study, it is likely that differences in Ito's et al. and Myers' et al. results are attributable, at least in part, to differences in methodology. The methods used in these two studies differed in many respects including, for example, weighting of the Asian standard samples, scale character selection, the LDF classification rule, the use of error correction procedures, and the minimum standard and unknown sample sizes.

In the present study, the trends in classification results when the 100B standard was used were often the opposite of trends when the 100K standard was used (Figs. 2-10). This effect is, no doubt, due to statistically significant differences between the two Asian stocks for many of the scale characters used in the analyses (Tables 2-4). This may explain some of the differences in the results obtained by Myers et al. (1984) and Ito et al. (1985), as Myers' et al. Asian standard was heavily weighted (based on best estimates of relative stock abundance) toward Kamchatka River (East Kamchatka Peninsula) scales and Ito's et al. unweighted Asian standard included a large proportion of Bolshaya River (West Kamchatka Peninsula) scales. Because of statistically significant differences in the scale patterns of East and West Kamchatka Peninsula stocks, unweighted Asian standards should not be used in regional stock identification analyses.

In conclusion, I think that the results of this study emphasize the need for U.S. and Japanese researchers to work together on improving and standardizing scale pattern analysis techniques. Because information from other sources (e.g., tagging and genetic studies) is so limited (Myers et al. 1984), scale pattern analysis is the best tool presently available for determining the relative proportions of Asian and North American chinook stocks in high seas catches. Cooperative efforts to improve scale pattern analysis techniques will ultimately lead to a

better understanding of stock origins and distributions of chinook salmon on the high seas.

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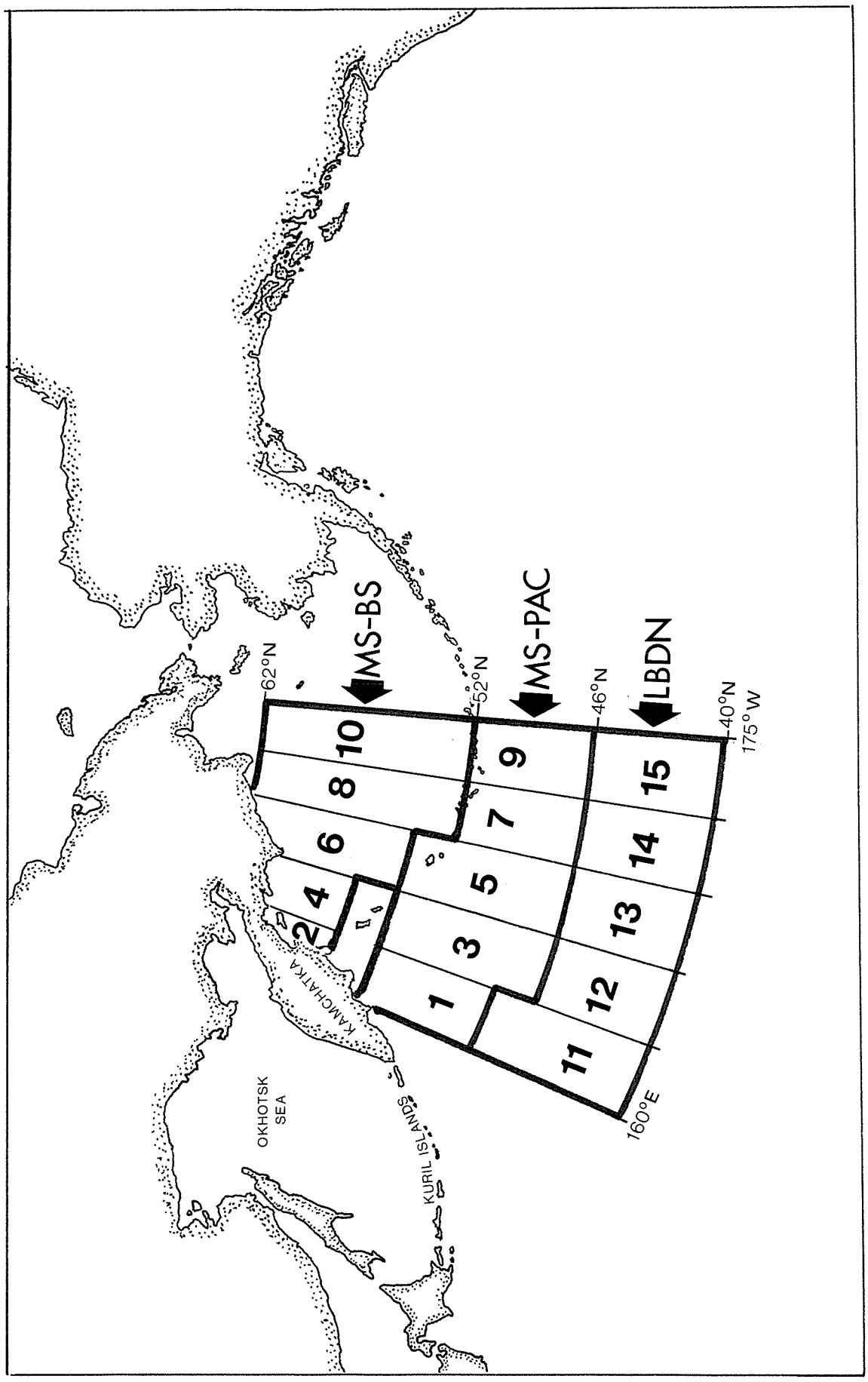

Fig. 1. Bold lines mark the study area for chinook scale analysis, stratified into three regions (MS-BS = mothership fishery in Bering Sea; MS-PAC = mothership fishery in North Pacific; LBDN = landbased driftnet fishery) and 15 5°-longitude sub-areas.

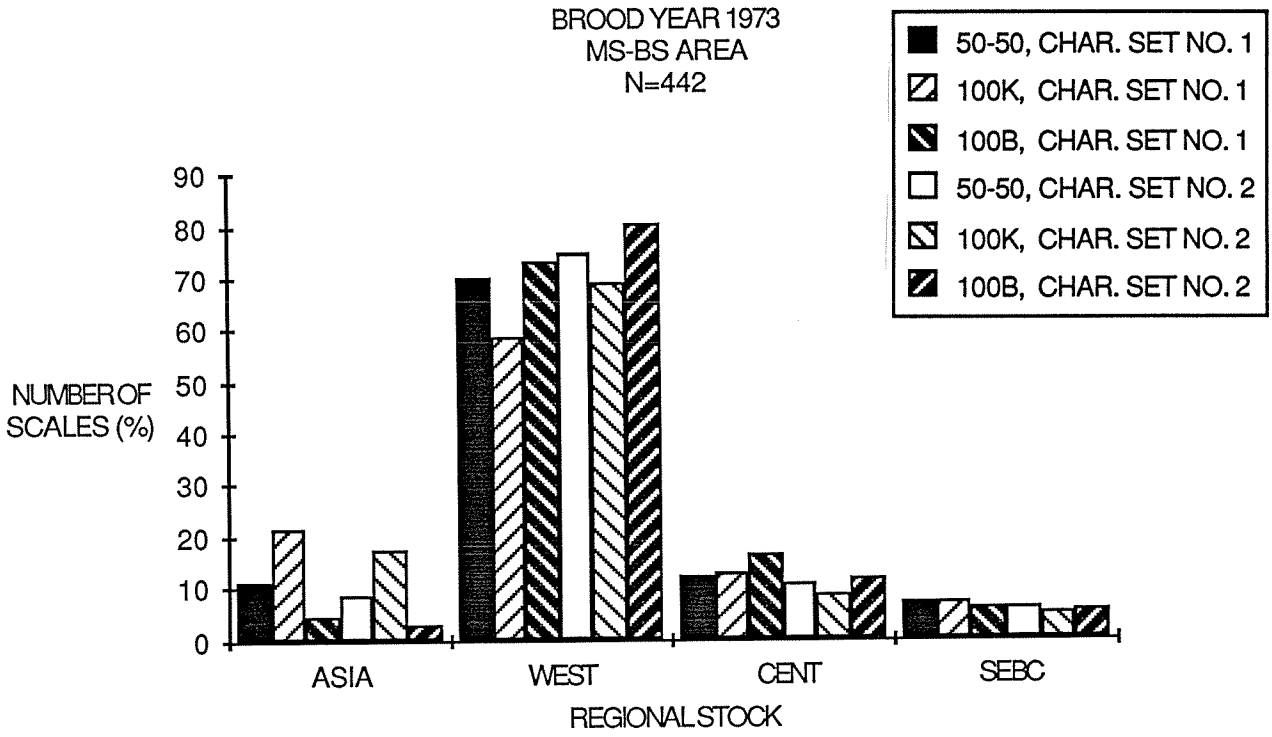

Fig. 2. Results of classifying chinook salmon caught as immature age 1.2's in 1977 in the mothership fishery-Bering Sea (MS-BS) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

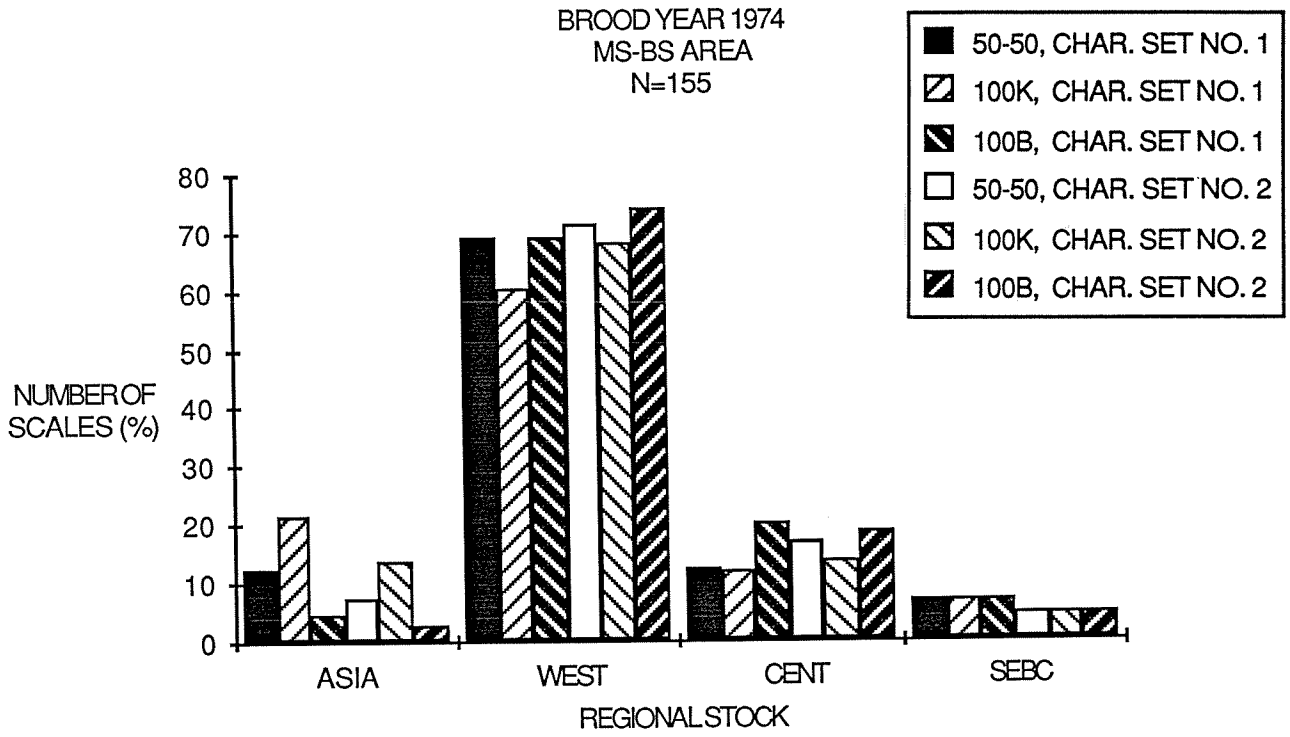

Fig. 3. Results of classifying chinook salmon caught as immature age 1.2's in 1978 in the mothership fishery-Bering Sea (MS-BS) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

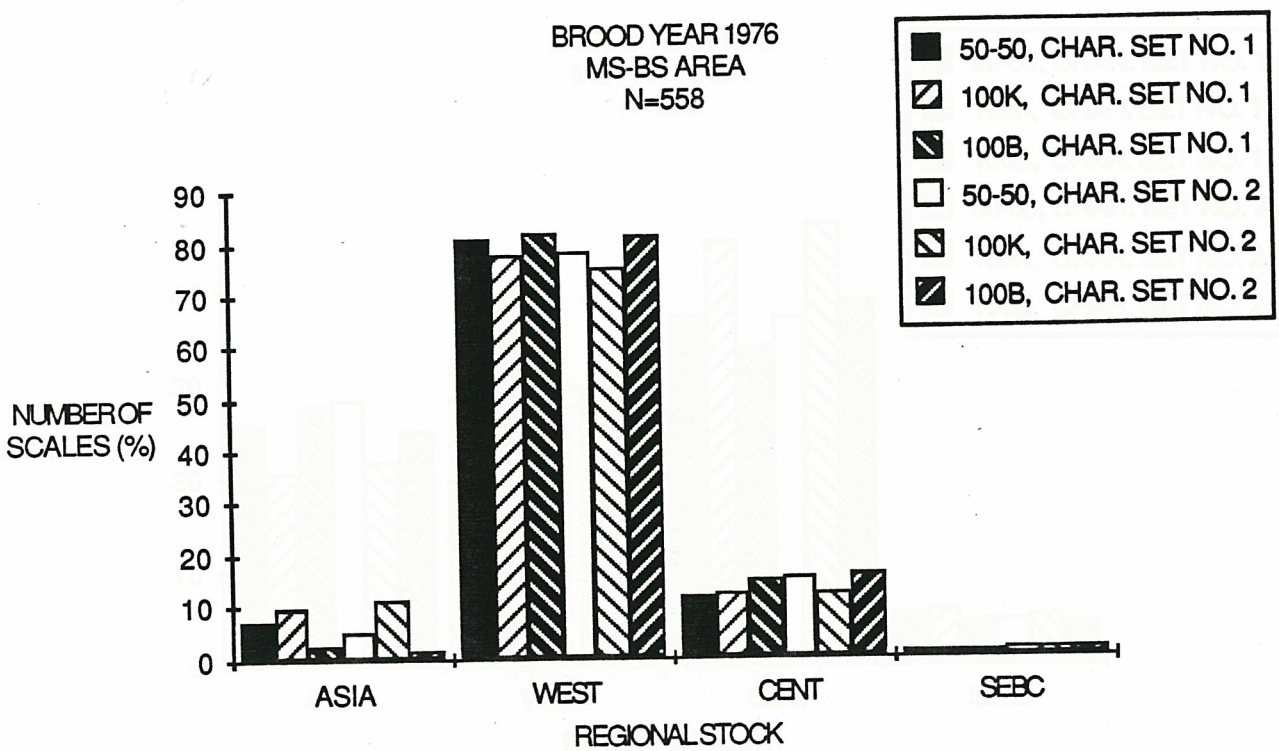

Fig. 4. Results of classifying chinook salmon caught as immature age 1.2's in 1980 in the mothership fishery-Bering Sea (MS-BS) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

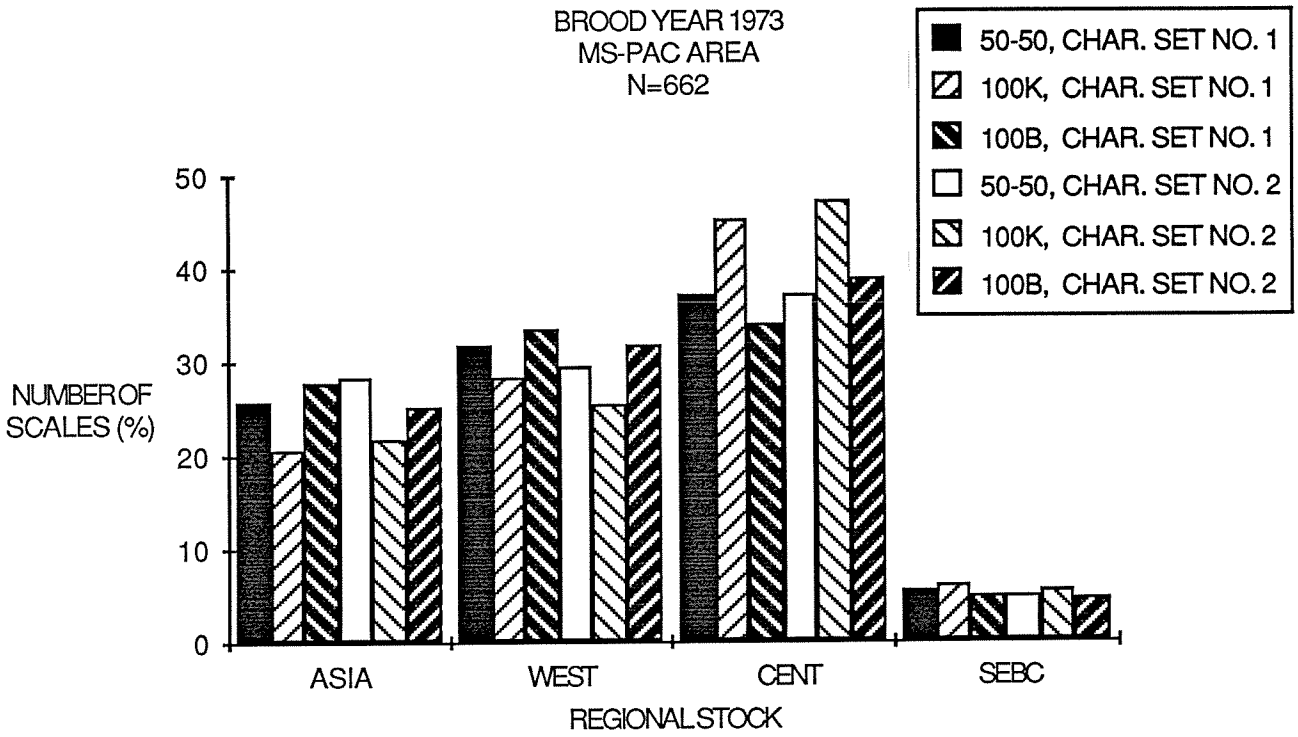

Fig. 5. Results of classifying chinook salmon caught as immature age 1.2's in 1977 in the mothership fishery-North Pacific (MS-NP) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

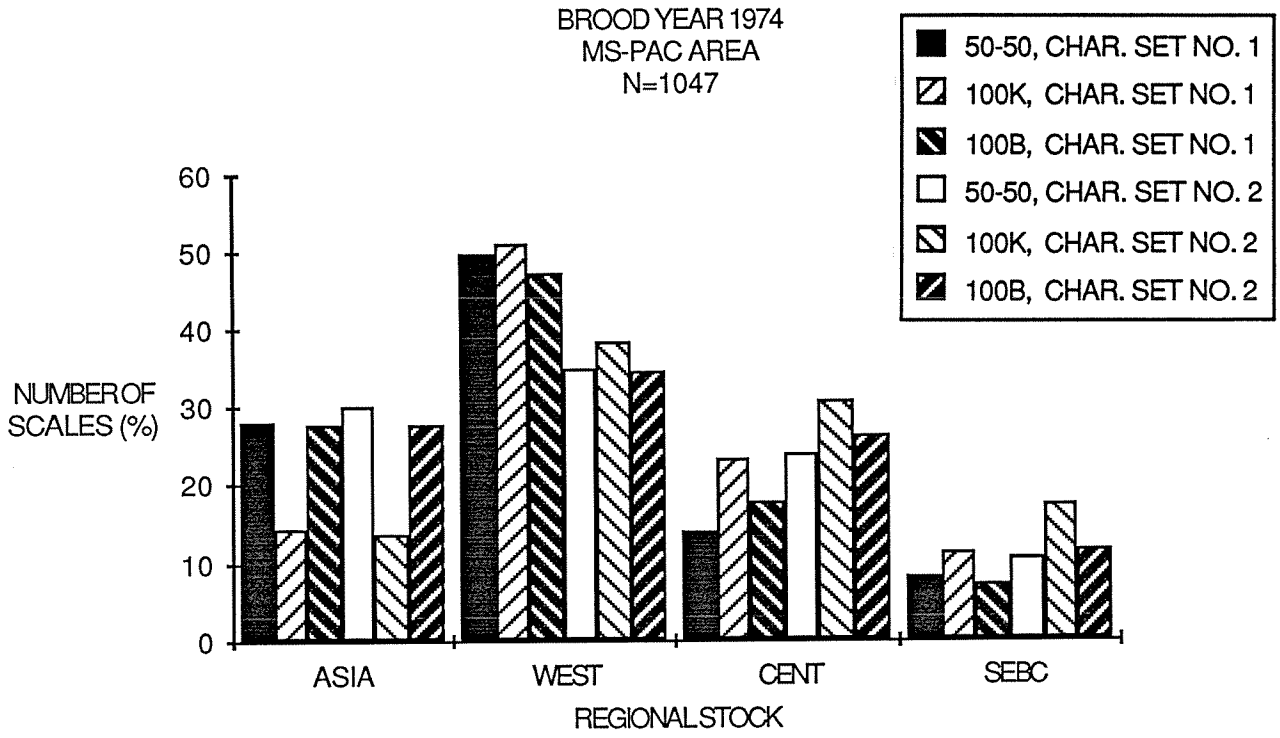

Fig. 6. Results of classifying chinook salmon caught as immature age 1.2's in 1978 in the mothership fishery-North Pacific (MS-NP) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

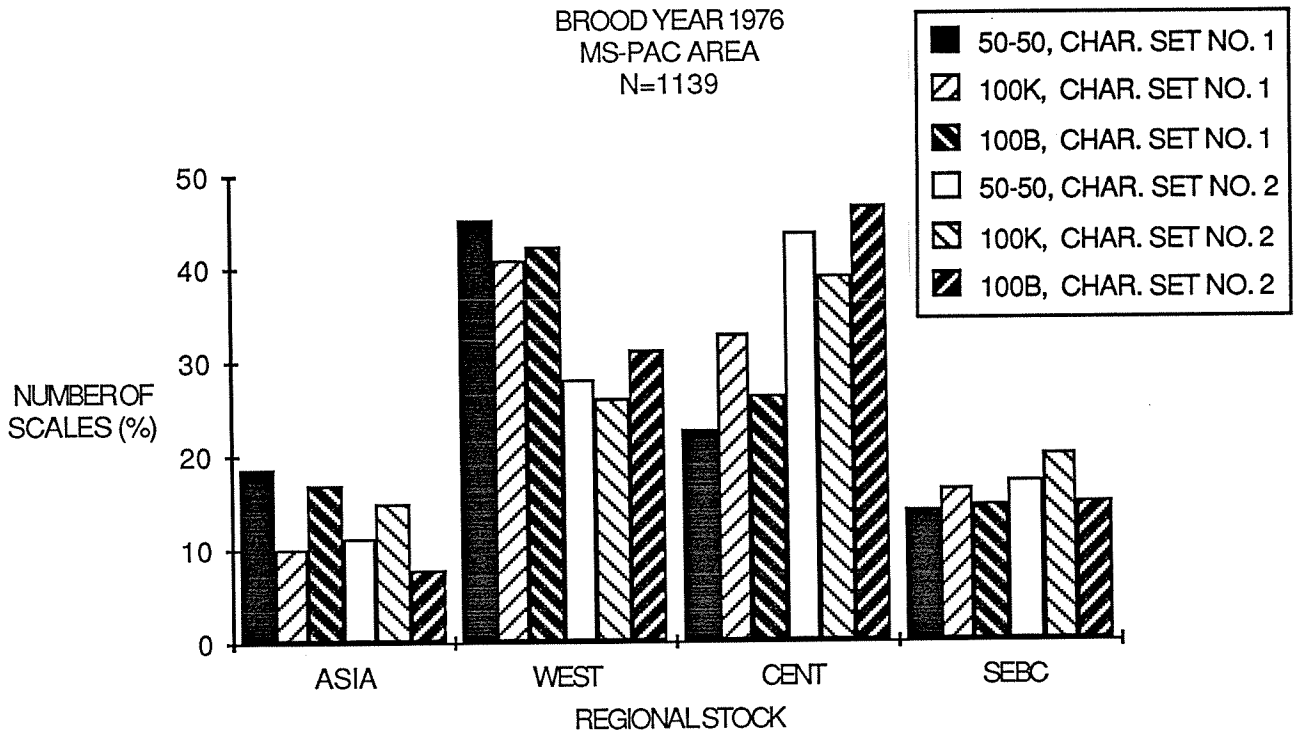

Fig. 7. Results of classifying chinook salmon caught as immature age 1.2's in 1980 in the mothership fishery-North Pacific (MS-NP) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

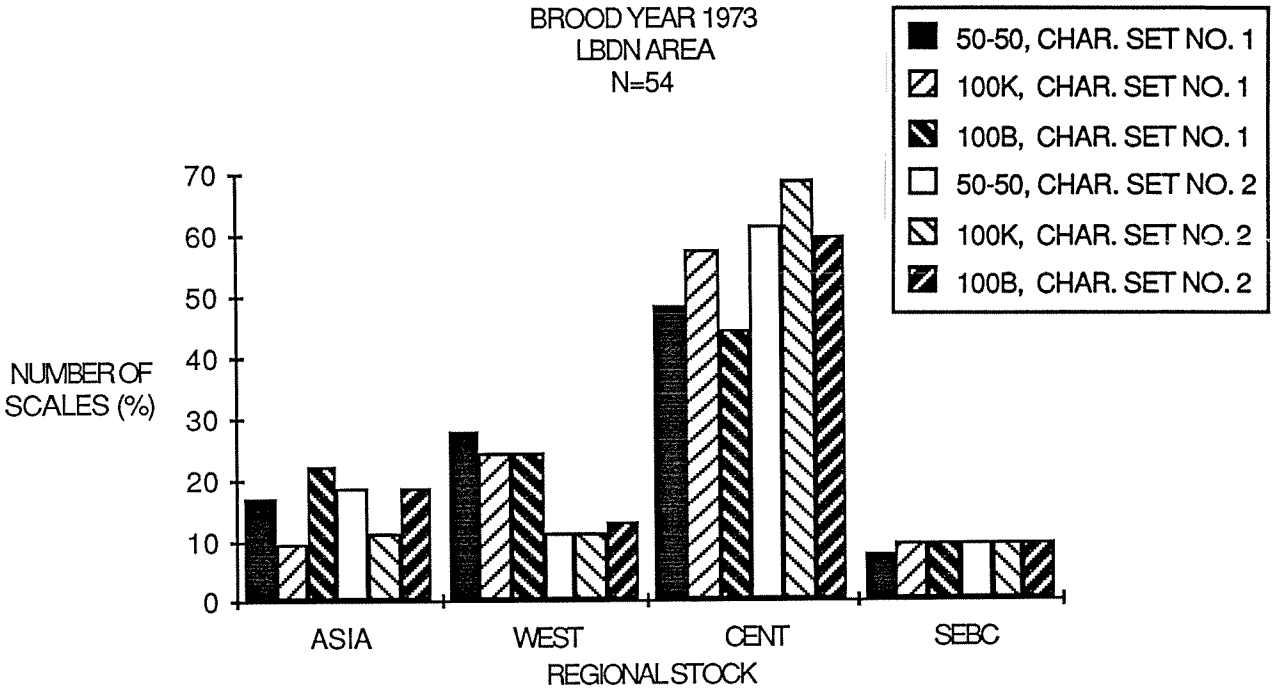

Fig. 8. Results of classifying chinook salmon caught as immature age 1.2's in 1977 in the landbased driftnet fishery (LBDN) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

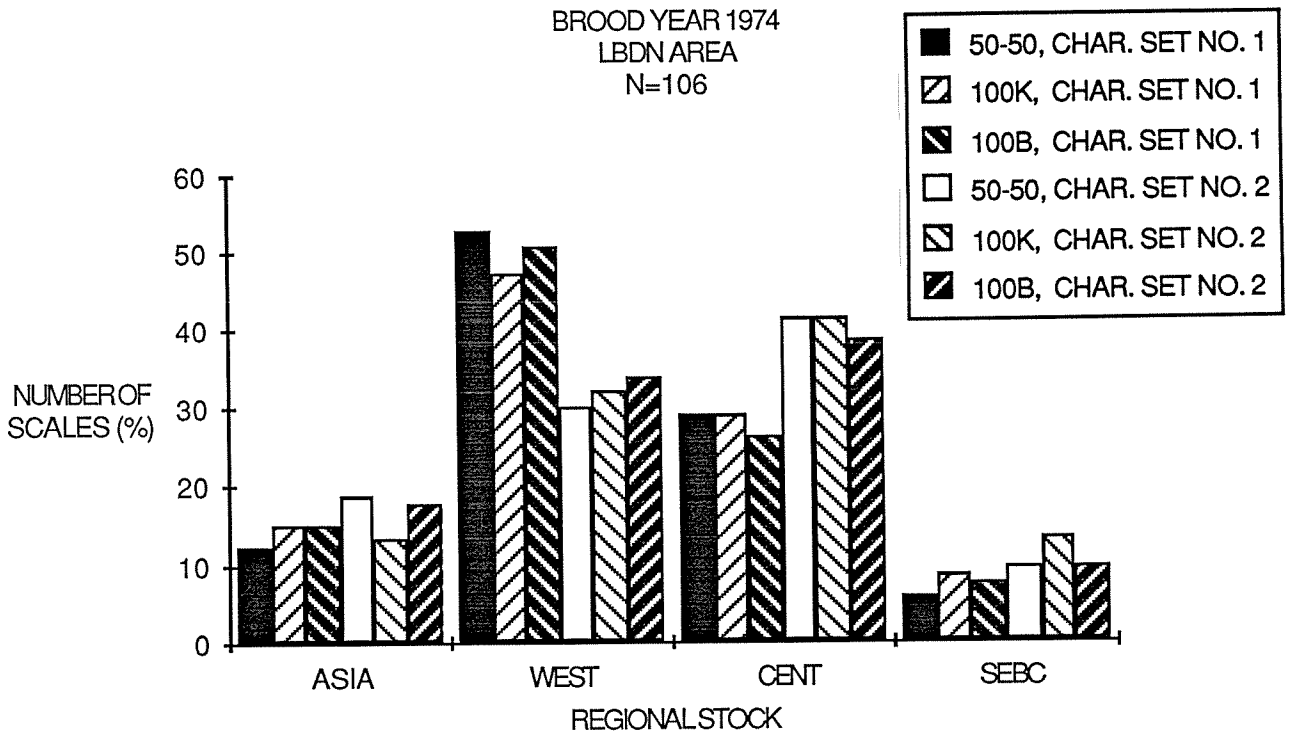

Fig. 9. Results of classifying chinook salmon caught as immature age 1.2's in 1978 in the landbased driftnet fishery (LBDN) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

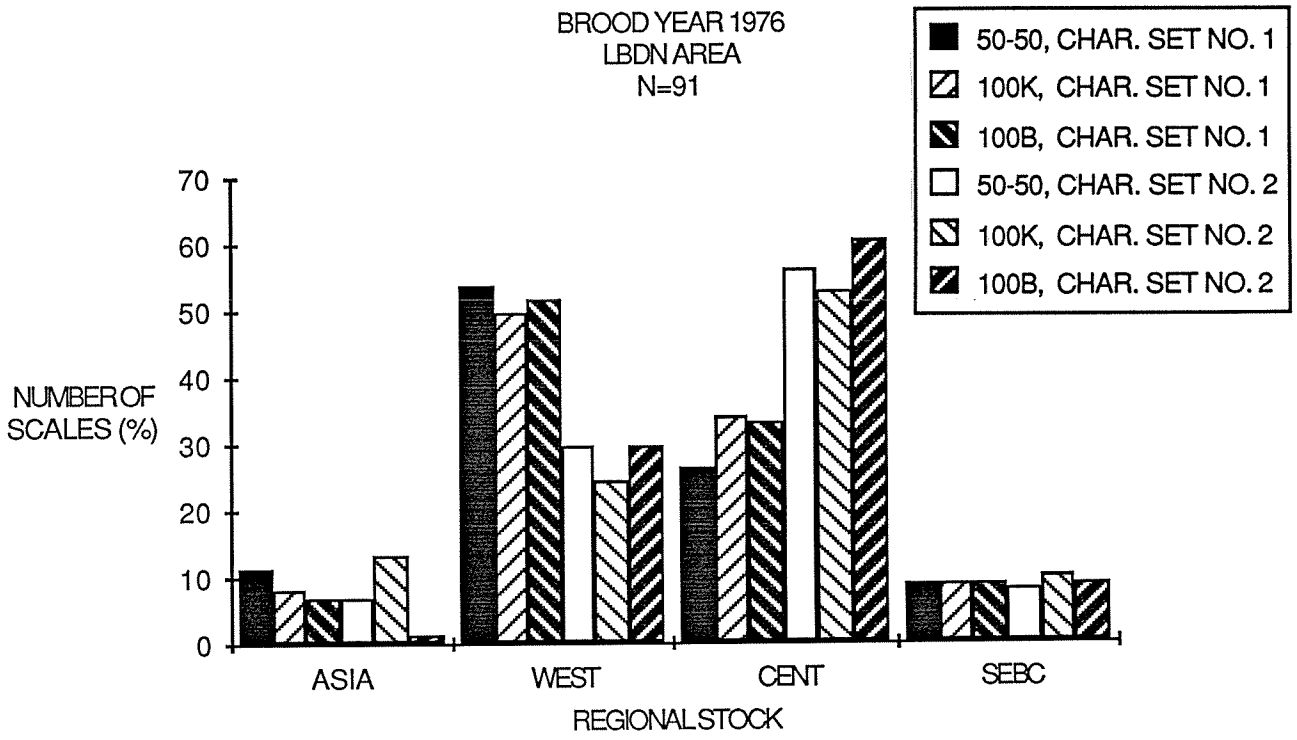

Fig. 10. Results of classifying chinook salmon caught as immature age 1.2's in 1980 in the landbased driftnet fishery (LBDN) area for three Asian stock proportions and two scale character sets. 50-50 = Asian standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian standard composed of 100% Kamchatka R. scales, 100B = Asian standard composed of 100% Bolshaya R. scales, N = sample size. Scale character sets are described in Table 1. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia.

Table 1. Scale character sets used in the analyses.

1) Character set No. 1 (Ito et al. 1985)

Character No.[1]	Description[2]
1 (FCL)	Size zone 1
5 (ŌCL)	Size zones 2+3
12 (FCN)	No. circuli zone 1
16 (ŌCN)	No. circuli zones 2+3
39 (F04)	Distance C2-C4 zone 1
49 (Ō03)	Distance C1-C3 zones 2+3
50 (Ō06)	Distance C4-C6 zones 2+3
51 (Ō09)	Distance C7-C9 zones 2+3

2) Character set No. 2: Brood-year 1973 (Myers et al. 1984)

Character No.[1]	Description[2]
5 (ŌCL)	Size zones 2+3
7	No. circuli zones 1+2+3
11	(Size zones 2+3)/(Size zones 1+2+3)
21	(Size zones 2+3)/(No. circuli zones 2+3)
23	(Distance C4-C6 zones 2+3)/(Size zones 1+2+3)
34	Distance C1-C9 zones 2+3
35	Distance C10-C18 zones 2+3
36	Distance C19-C27 zones 2+3
44	(Distance C2-C4 zone 1)/(Size zones 1+2+3)
52	(Distance C10-C12 zones 2+3)
58	(Distance C28-C30 zones 2+3)

3) Character set No. 2: Brood-year 1974 (Myers et al. 1984)

Character No.[1]	Description[2]
6	Size zones 1+2+3
7	No. circuli zones 1+2+3
11	(Size zones 2+3)/(Size zones 1+2+3)
21	(Size zones 2+3)/(No. circuli zones 2+3)
28	(Distance C19-C21 zones 2+3)/(Size zones 1+2+3)
34	Distance C1-C9 zones 2+3
35	Distance C10-C18 zones 2+3
36	Distance C19-C27 zones 2+3
55	Distance C19-C21 zones 2+3

Table 1. Scale character sets used in the analyses - cont'd..

4) Character set No. 2: Brood-year 1976 (Myers et al. 1984)

Character No.[1]	Description[2]
5 ($\bar{O}$CL)	Size zones 2+3
7	No. circuli zones 1+2+3
9	(Size zones 1+2+3)/(No. circuli zones 1+2+3)
16 ($\bar{O}$CN)	No. circuli zones 2+3
27	(Distance C16-C18 zones 2+3)/(Size zones 1+2+3)
31	(Distance C28-C30 zones 2+3)/(Size zones 1+2+3)
32	(Distance C31-C33 zones 2+3)/(Size zones 1+2+3)
34	Distance C1-C9 zones 2+3
35	Distance C10-C18 zones 2+3
54	Distance C16-C18 zones 2+3
58	Distance C28-C30 zones 2+3

[1]Character nos. are the same as those used by Knudsen et al. (1983) and Myers et al. (1984). Abbreviations in parentheses are those used by Ito et al. (1985).

[2]Zone 1: The radius of the scale from the center of the focus to the outer edge of the last circulus in the freshwater annulus.

Zone 2: The radius of the scale from the outer edge of the last circulus in the freshwater annulus to the outer edge of the last freshwater circulus.

Zone 3: The radius of the scale from the outer edge of the last freshwater circulus to the outer edge of the last circulus in the first ocean annulus.

Cn: The nth circulus from the beginning of the indicated zone.

Table 2. Results of multiple comparison tests (Tukey 1953) on the means of scale characters for brood-year 1973 standards. Sample means are arranged in order of increasing magnitude and homogeneous subsets [subsets of standards whose highest and lowest means do not differ by more than the shortest significant (α = .05) range for a subset of that size] are underlined. Measurements are mm at 100X. 50-50 = Asian regional standard composed of 50% Bolshaya R. scales and 50% Kamchatka R. scales (n = 106), 100K = Asian regional standard composed of 100% Kamchatka R. scales (n = 106), 100B = Asian regional standard composed of 100% Bolshaya R. scales (n = 106); WEST = Western Alaska regional standard (n = 198), CENT = Central Alaska regional standard (n = 134), SEBC = Southeast Alaska/British Columbia regional standard (n = 194). Scale characters are described in Table 1.

Character no.	Subset no.	Regional standard and sample mean					
a) Circulus counts							
12		100B	50-50	100K	CENT	WEST	SEBC
	1	7.86	8.26	8.75	9.19	10.14	12.10
	2						
	3						
	4						
	5						
16		100B	50-50	100K	CENT	WEST	SEBC
	1	24.44	26.37	27.94	29.13	29.82	32.24
	2						
	3						
	4						
	5						
7		100B	50-50	100K	CENT	WEST	SEBC
	1	32.30	34.63	36.69	38.32	39.96	44.35
	2						
	3						
	4						
	5						
	6						
b) Zone sizes							
1		100B	50-50	100K	CENT	WEST	SEBC
	1	24.30	24.60	25.21	28.06	30.39	31.12
	2						
	3						

Table 2 - cont'd.

Character no.	Subset no.	Regional standard and sample mean					
5		100B	50-50	100K	CENT	WEST	SEBC
	1	96.46	104.54	110.76	114.67	119.87	130.46
	2						
	3						
	4						
	5						
c) Triplets							
39		SEBC	CENT	100K	50-50	WEST	100B
	1	8.86	8.99	9.00	9.21	9.49	9.51
	2						
49		100K	50-50	WEST	100B	CENT	SEBC
	1	7.38	8.12	8.29	8.78	9.04	9.42
	2						
	3						
	4						
50		100K	50-50	CENT	100B	WEST	SEBC
	1	8.02	8.97	9.70	10.03	10.15	10.87
	2						
	3						
	4						
51		100K	50-50	CENT	SEBC	WEST	100B
	1	10.02	10.88	11.19	11.33	11.52	11.98
	2						
	3						
52		SEBC	100K	WEST	50-50	CENT	100B
	1	11.89	12.16	12.34	12.65	12.89	13.20
	2						
	3						
58		100B	50-50	100K	CENT	WEST	SEBC
	1	0.00	2.48	4.43	5.28	7.55	8.00
	2						
	3						
	4						

Table 2 - cont'd.

Character no.	Subset no.	Regional standard and sample mean					
d) Nonuplets							
34		100K	50-50	CENT	WEST	100B	SEBC
	1	25.41	27.97	29.93	29.97	30.79	31.62
	2						
	3						
	4						
35		SEBC	CENT	100K	100B	50-50	WEST
	1	36.24	39.90	40.21	40.40	40.52	41.92
	2						
	3						
36		100B	50-50	CENT	SEBC	100K	WEST
	1	21.60	29.60	31.44	32.04	35.39	44.42
	2						
	3						
	4						
e) Zone size ratios							
11		SEBS	100B	CENT	50-50	WEST	100K
	1	.7930	.7984	.8014	.8083	.8108	.8137
	2						
	3						
f) Triplet ratios							
23		100K	WEST	CENT	50-50	SEBC	100B
	1	.0601	.0635	.0694	.0708	.0730	.0837
	2						
	3						
44		WEST	SEBC	CENT	100K	50-50	100B
	1	.0592	.0593	.0638	.0668	.0722	.0790
	2						
	3						
	4						
g) Circulus spacing							
21		SEBC	CENT	100B	50-50	100K	WEST
	1	3.73	3.93	3.95	3.96	3.96	4.39
	2						
	3						

Table 3. Results of multiple comparison tests (Tukey 1953) on the means of scale characters for brood-year 1974 standards. Sample means are arranged in order of increasing magnitude and homogeneous subsets [subsets of standards whose highest and lowest means do not differ by more than the shortest significant (α = .05) range for a subset of that size] are underlined. Measurements are mm at 100X. 50-50 = Asian regional standard composed of 50% Bolshaya R. scales and 50% Kamchatka R. scales (n = 110), 100K = Asian regional standard composed of 100% Kamchatka R. scales (n = 110), 100B = Asian regional standard composed of 100% Bolshaya R. scales (n = 110); WEST = Western Alaska regional standard (n = 200), CENT = Central Alaska regional standard (n = 65), SEBC = Southeast Alaska/British Columbia regional standard (n = 200). Scale characters are described in Table 1.

Character no.	Subset no.	Regional standard and sample mean					
a) Circulus counts							
12		100B	50-50	CENT	100K	WEST	SEBC
	1	8.15	8.50	8.77	8.83	9.94	12.72
	2						
	3						
16		100B	50-50	100K	WEST	CENT	SEBC
	1	23.81	25.59	26.96	30.72	32.92	34.82
	2						
	3						
	4						
	5						
	6						
7		100B	50-50	100K	WEST	CENT	SEBC
	1	31.95	34.09	35.79	40.66	41.69	47.54
	2						
	3						
	4						
	5						
b) Zone sizes							
1		100B	50-50	100K	CENT	WEST	SEBC
	1	23.15	24.38	25.37	26.98	30.14	30.96
	2						
	3						
	4						

Table 3 - cont'd.

Character no.	Subset no.	Regional standard and sample mean					
5		100B	50-50	100K	CENT	SEBC	WEST
	1	89.39	98.63	107.74	127.00	128.52	135.19
	2						
	3						
	4						
	5						
6		100B	50-50	100K	CENT	SEBC	WEST
	1	112.54	123.01	133.11	153.98	159.47	165.32
	2						
	3						
	4						
	5						
c) Triplets							
39		100B	50-50	100K	SEBC	CENT	WEST
	1	8.41	8.75	8.91	9.07	9.49	9.80
	2						
	3						
	4						
49		100K	CENT	50-50	WEST	100B	SEBC
	1	7.57	8.03	8.07	8.37	8.48	8.56
	2						
50		100K	CENT	50-50	WEST	100B	SEBC
	1	8.54	8.98	9.11	9.60	9.79	10.42
	2						
	3						
51		100K	CENT	50-50	WEST	SEBC	100B
	1	9.49	10.45	10.79	11.67	11.77	12.20
	2						
	3						
55		100B	SEBC	50-50	CENT	100K	WEST
	1	9.66	11.57	12.43	13.15	14.77	15.98
	2						
	3						
	4						
	5						

Table 3 - cont'd.

Character no.	Subset no.	Regional standard and sample mean					
d) Nonuplets							
34		100K	CENT	50-50	WEST	100B	SEBC
	1	25.60	27.45	27.97	29.64	30.47	30.76
	2						
	3						
35		SEBC	100B	CENT	50-50	100K	WEST
	1	36.76	37.98	38.94	39.63	41.83	42.85
	2						
	3						
36		100B	50-50	SEBC	100K	CENT	WEST
	1	17.00	26.31	32.80	33.69	36.81	45.10
	2						
	3						
	4						
	5						
e) Zone size ratios							
11		100B	50-50	SEBC	100K	WEST	CENT
	1	.7936	.8009	.8046	.8088	.8174	.8247
	2						
	3						
	4						
f) Triplet ratios							
28		SEBC	100B	CENT	WEST	50-50	100K
	1	.0731	.0848	.0868	.0971	.1005	.1115
	2						
	3						
	4						
g) Circulus spacing							
21		SEBC	100B	50-50	CENT	100K	WEST
	1	3.70	3.76	3.85	3.86	4.00	4.41
	2						
	3						
	4						

Table 4. Results of multiple comparison tests (Tukey 1953) on the means of scale characters for brood-year 1976 standards. Sample means are arranged in order of increasing magnitude and homogeneous subsets [subsets of standards whose highest and lowest means do not differ by more than the shortest significant (α = .05) range for a subset of that size] are underlined. Measurements are mm at 100X. 50-50 = Asian regional standard composed of 50% Bolshaya R. scales and 50% Kamchatka R. scales (n = 118), 100K = Asian regional standard composed of 100% Kamchatka R. scales (n = 118), 100B = Asian regional standard composed of 100% Bolshaya R. scales (n = 118); WEST = Western Alaska regional standard (n = 199), CENT = Central Alaska regional standard (n = 200), SEBC = Southeast Alaska/British Columbia regional standard (n = 200). Scale characters are described in Table 1.

Character no.	Subset no.	Regional standard and sample mean					
a) Circulus counts							
12		100B	50-50	100K	CENT	WEST	SEBC
	1	8.46	8.89	9.02	9.94	10.54	12.73
	2						
	3						
	4						
16		100B	50-50	100K	CENT	WEST	SEBC
	1	25.40	26.57	27.43	33.32	33.63	34.05
	2						
	3						
7		100B	50-50	100K	CENT	WEST	SEBC
	1	33.06	35.46	36.45	43.57	43.86	46.78
	2						
	3						
	4						
b) Zone sizes							
1		100B	50-50	100K	CENT	WEST	SEBC
	1	23.01	23.88	24.46	28.03	30.44	34.40
	2						
	3						
	4						
5		100B	50-50	100K	CENT	WEST	SEBC
	1	94.35	102.90	109.41	129.32	130.72	144.21
	2						
	3						
	4						
	5						

Table 4 - cont'd.

Character no.	Subset no.	Regional standard and sample mean					
c) Triplets							
39		50-50	100B	100K	CENT	SEBC	WEST
	1	8.83	8.86	9.09	9.48	9.70	9.82
	2						
	3						
49		100K	50-50	WEST	100B	CENT	SEBC
	1	7.56	7.95	8.37	8.41	8.41	8.98
	2						
	3						
50		100K	WEST	50-50	CENT	100B	SEBC
	1	7.93	9.04	9.06	9.16	10.01	10.14
	2						
	3						
51		100K	CENT	WEST	50-50	100B	SEBC
	1	10.27	10.60	10.91	10.92	11.49	11.77
	2						
	3						
54		SEBC	100B	CENT	50-50	100K	WEST
	1	12.43	12.57	13.72	13.97	14.94	15.20
	2						
	3						
58		100B	50-50	100K	SEBC	CENT	WEST
	1	0.75	2.46	2.84	9.78	10.08	12.90
	2						
	3						
	4						
d) Nonuplets							
34		100K	50-50	CENT	WEST	100B	SEBC
	1	25.76	27.93	28.17	28.33	29.91	30.89
	2						
	3						
35		SEBC	100B	CENT	50-50	WEST	100K
	1	36.88	37.10	38.36	40.03	40.35	42.34
	2						
	3						
	4						
	5						

Table 4 - cont'd.

Character no.	Subset no.	Regional standard and sample mean					
e) Triplet ratios							
27		SEBC	CENT	WEST	100B	50-50	100K
	1	.0766	.0871	.0875	.1075	.1109	.1125
	2						
	3						
31		100B	50-50	100K	SEBC	CENT	WEST
	1	.0056	.0164	.0186	.0589	.0624	.0734
	2						
	3						
	4						
32		100B	50-50	100K	SEBC	WEST	CENT
	1	.0005	.0018	.0018	.0439	.0442	.0468
	2						
f) Circulus spacing							
9		100B	SEBC	50-50	CENT	100K	WEST
	1	3.46	3.51	3.57	3.64	3.67	3.99
	2						
	3						

Table 5. Decision arrays for brood-year 1973 analyses. Scale characters are described in Table 1. Overall accuracies were calculated as the unweighted mean of the accuracies on the diagonal of the decision array. 50-50 = Asian regional standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian regional standard composed of 100% Kamchatka R. scales, 100B = Asian regional standard composed of 100% Bolshaya R. scales, WEST = Western Alaska regional standard, CENT = Central Alaska regional standard, SEBC = Southeast Alaska/British Columbia regional standard.

A) Brood-year 1973: Asian standard = 50-50, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 69.5 percent

Calculated decision	Correct decision (percent) 50-50	WEST	CENT	SEBC
50-50	72 (67.9)	15 (7.6)	35 (26.1)	9 (4.6)
WEST	20 (18.9)	154 (77.8)	16 (11.9)	7 (3.6)
CENT	13 (12.3)	27 (13.6)	68 (50.7)	20 (10.3)
SEBC	1 (.9)	2 (1.0)	15 (11.2)	158 (81.4)
TOTAL	106	198	134	194

B) Brood-year 1973: Asian standard = 100K, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 70.4 percent

Calculated decision	Correct decision (percent) 100K	WEST	CENT	SEBC
100K	73 (68.9)	23 (11.6)	26 (19.4)	7 (3.6)
WEST	20 (18.9)	141 (71.2)	14 (10.4)	7 (3.6)
CENT	12 (11.3)	31 (15.7)	81 (60.4)	23 (11.9)
SEBC	1 (.9)	3 (1.5)	13 (9.7)	157 (80.9)
TOTAL	106	198	134	194

C) Brood-year 1973: Asian standard = 100B, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 74.1 percent

Calculated decision	Correct decision (percent) 100B	WEST	CENT	SEBC
100B	93 (87.7)	7 (3.5)	28 (20.9)	9 (4.6)
WEST	4 (3.8)	155 (78.3)	25 (18.7)	8 (4.1)
CENT	8 (7.5)	33 (16.7)	66 (49.3)	20 (10.3)
SEBC	1 (.9)	3 (1.5)	15 (11.2)	157 (80.9)
TOTAL	106	198	134	194

Table 5 - cont'd.

D) Brood-year 1973: Asian standard = 50-50, Char. set no. 2
Scale characters used: 5, 7, 11, 21, 23, 34, 35, 36, 44, 52, 58
Overall accuracy: 70.5 percent

Calculated decision	Correct decision (percent)			
	50-50	WEST	CENT	SEBC
50-50	64 (60.4)	20 (10.1)	31 (23.1)	7 (3.6)
WEST	23 (21.7)	165 (83.3)	14 (10.4)	2 (1.0)
CENT	17 (16.0)	10 (5.1)	76 (56.7)	27 (13.9)
SEBC	2 (1.9)	3 (1.5)	13 (9.7)	158 (81.4)
TOTAL	106	198	134	194

E) Brood-year 1973: Asian standard = 100K, Char. set no. 2
Scale characters used: 5, 7, 11, 21, 23, 34, 35, 36, 44, 52, 58
Overall accuracy: 72.1 percent

Calculated decision	Correct decision (percent)			
	100K	WEST	CENT	SEBC
100K	64 (60.4)	22 (11.1)	20 (14.9)	7 (3.6)
WEST	26 (24.5)	160 (80.8)	11 (8.2)	2 (1.0)
CENT	15 (14.2)	13 (6.6)	89 (66.4)	28 (14.4)
SEBC	1 (.9)	3 (1.5)	14 (10.4)	157 (80.9)
TOTAL	106	198	134	194

F) Brood-year 1973: Asian standard = 100B, Char. set no. 2
Scale characters used: 5, 7, 11, 21, 23, 34, 35, 36, 44, 52, 58
Overall accuracy: 78.2 percent

Calculated decision	Correct decision (percent)			
	100B	WEST	CENT	SEBC
100B	86 (81.1)	6 (3.0)	26 (19.4)	8 (4.1)
WEST	3 (2.8)	178 (89.9)	13 (9.7)	3 (1.5)
CENT	16 (15.1)	13 (6.6)	79 (59.0)	22 (11.3)
SEBC	1 (.9)	1 (.5)	16 (11.9)	161 (83.0)
TOTAL	106	198	134	194

Table 6. Decision arrays for brood-year 1974 analyses. Scale characters are described in Table 1. Overall accuracies were calculated as the unweighted mean of the accuracies on the diagonal of the decision array. 50-50 = Asian regional standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian regional standard composed of 100% Kamchatka R. scales, 100B = Asian regional standard composed of 100% Bolshaya R. scales, WEST = Western Alaska regional standard, CENT = Central Alaska regional standard, SEBC = Southeast Alaska/British Columbia regional standard.

A) Brood-year 1974: Asian standard = 50-50, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 75.5 percent

Calculated decision	Correct decision (percent)			
	50-50	WEST	CENT	SEBC
50-50	88 (80.0)	13 (6.5)	10 (15.4)	9 (4.5)
WEST	17 (15.5)	158 (79.0)	11 (16.9)	4 (2.0)
CENT	5 (4.5)	27 (13.5)	39 (60.0)	21 (10.5)
SEBC	0 (.0)	2 (1.0)	5 (7.7)	166 (83.0)
TOTAL	110	200	65	200

B) Brood-year 1974: Asian standard = 100K, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 74.8 percent

Calculated decision	Correct decision (percent)			
	100K	WEST	CENT	SEBC
100K	90 (81.8)	24 (12.0)	12 (18.5)	4 (2.0)
WEST	14 (12.7)	151 (75.5)	8 (12.3)	5 (2.5)
CENT	6 (5.5)	23 (11.5)	38 (58.5)	24 (12.0)
SEBC	0 (.0)	2 (1.0)	7 (10.8)	167 (83.5)
TOTAL	110	200	65	200

C) Brood-year 1974: Asian standard = 100B, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 79.7 percent

Calculated decision	Correct decision (percent)			
	100B	WEST	CENT	SEBC
100B	105 (95.5)	6 (3.0)	6 (9.2)	10 (5.0)
WEST	2 (1.8)	163 (81.5)	14 (21.5)	5 (2.5)
CENT	3 (2.7)	28 (14.0)	39 (60.0)	21 (10.5)
SEBC	0 (.0)	3 (1.5)	6 (9.2)	164 (82.0)
TOTAL	110	200	65	200

Table 6 - cont'd.

D) Brood-year 1974: Asian standard = 50-50, Char. set no. 2
Scale characters used: 6, 7, 11, 21, 28, 34, 35, 36, 55
Overall accuracy: 75.9 percent

Calculated decision	Correct decision (percent)			
	50-50	WEST	CENT	SEBC
50-50	82 (74.5)	11 (5.5)	6 (9.2)	6 (3.0)
WEST	14 (12.7)	165 (82.5)	11 (16.9)	3 (1.5)
CENT	14 (12.7)	23 (11.5)	43 (66.2)	30 (15.0)
SEBC	0 (.0)	1 (.5)	5 (7.7)	161 (80.5)
TOTAL	110	200	65	200

E) Brood-year 1974: Asian standard = 100K, Char. set no. 2
Scale characters used: 6, 7, 11, 21, 28, 34, 35, 36, 55
Overall accuracy: 75.5 percent

Calculated decision	Correct decision (percent)			
	100K	WEST	CENT	SEBC
100K	83 (75.5)	15 (7.5)	9 (13.8)	2 (1.0)
WEST	19 (17.3)	161 (80.5)	9 (13.8)	3 (1.5)
CENT	8 (7.3)	23 (11.5)	42 (64.6)	32 (16.0)
SEBC	0 (.0)	1 (.5)	5 (7.7)	163 (81.5)
TOTAL	110	200	65	200

F) Brood-year 1974: Asian standard = 100B, Char. set no. 2
Scale characters used: 6, 7, 11, 21, 28, 34, 35, 36, 55
Overall accuracy: 78.4 percent

Calculated decision	Correct decision (percent)			
	100B	WEST	CENT	SEBC
100B	93 (84.5)	7 (3.5)	5 (7.7)	5 (2.5)
WEST	3 (2.7)	169 (84.5)	13 (20.0)	2 (1.0)
CENT	14 (12.7)	23 (11.5)	41 (63.1)	30 (15.0)
SEBC	0 (.0)	1 (.5)	6 (9.2)	163 (81.5)
TOTAL	110	200	65	200

Table 7. Decision arrays for brood-year 1976 analyses. Scale characters are described in Table 1. Overall accuracies were calculated as the unweighted mean of the accuracies on the diagonal of the decision array. 50-50 = Asian regional standard composed of 50% Kamchatka R. scales and 50% Bolshaya R. scales, 100K = Asian regional standard composed of 100% Kamchatka R. scales, 100B = Asian regional standard composed of 100% Bolshaya R. scales, WEST = Western Alaska regional standard, CENT = Central Alaska regional standard, SEBC = Southeast Alaska/British Columbia regional standard.

A) Brood-year 1976: Asian standard = 50-50, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 69.4 percent

Calculated decision	Correct decision (percent)			
	50-50	WEST	CENT	SEBC
50-50	97 (82.2)	8 (4.0)	23 (11.5)	13 (6.5)
WEST	11 (9.3)	154 (77.4)	42 (21.0)	7 (3.5)
CENT	8 (6.8)	29 (14.6)	94 (47.0)	38 (19.0)
SEBC	2 (1.7)	8 (4.0)	41 (20.5)	142 (71.0)
TOTAL	118	199	200	200

B) Brood-year 1976: Asian standard = 100K, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 71.1 percent

Calculated decision	Correct decision (percent)			
	100K	WEST	CENT	SEBC
100K	101 (85.6)	9 (4.5)	20 (10.0)	9 (4.5)
WEST	9 (7.6)	155 (77.9)	40 (20.0)	7 (3.5)
CENT	8 (6.8)	27 (13.6)	96 (48.0)	38 (19.0)
SEBC	0 (.0)	8 (4.0)	44 (22.0)	146 (73.0)
TOTAL	118	199	200	200

C) Brood-year 1976: Asian standard = 100B, Char. set no. 1
Scale characters used: 1, 5, 12, 16, 39, 49, 50, 51
Overall accuracy: 74.9 percent

Calculated decision	Correct decision (percent)			
	100B	WEST	CENT	SEBC
100B	113 (95.8)	3 (1.5)	15 (7.5)	11 (5.5)
WEST	1 (.8)	161 (80.9)	42 (21.0)	8 (4.0)
CENT	4 (3.4)	27 (13.6)	103 (51.5)	38 (19.0)
SEBC	0 (.0)	8 (4.0)	40 (20.0)	143 (71.5)
TOTAL	118	199	200	200

Table 7 - cont'd.

D) Brood-year 1976: Asian standard = 50-50, Char. set no. 2
Scale characters used: 5, 7, 9, 16, 27, 31, 32, 34, 35, 54, 58
Overall accuracy: 71.4 percent

Calculated decision	Correct decision (percent)			
	50-50	WEST	CENT	SEBC
50-50	90 (76.3)	3 (1.5)	16 (8.0)	5 (2.5)
WEST	10 (8.5)	160 (80.4)	33 (16.5)	6 (3.0)
CENT	16 (13.6)	31 (15.6)	116 (58.0)	47 (23.5)
SEBC	2 (1.7)	5 (2.5)	35 (17.5)	142 (71.0)
TOTAL	118	199	200	200

E) Brood-year 1976: Asian standard = 100K, Char. set no. 2
Scale characters used: 5, 7, 9, 16, 27, 31, 32, 34, 35, 54, 58
Overall accuracy: 71.8 percent

Calculated decision	Correct decision (percent)			
	100K	WEST	CENT	SEBC
100K	94 (79.7)	7 (3.5)	19 (9.5)	3 (1.5)
WEST	9 (7.6)	161 (80.9)	35 (17.5)	6 (3.0)
CENT	15 (12.7)	26 (13.1)	110 (55.0)	48 (24.0)
SEBC	0 (.0)	5 (2.5)	36 (18.0)	143 (71.5)
TOTAL	118	199	200	200

F) Brood-year 1976: Asian standard = 100B, Char. set no. 2
Scale characters used: 5, 7, 9, 16, 27, 31, 32, 34, 35, 54, 58
Overall accuracy: 75.7 percent

Calculated decision	Correct decision (percent)			
	100B	WEST	CENT	SEBC
100B	105 (89.0)	2 (1.0)	9 (4.5)	8 (4.0)
WEST	0 (.0)	167 (83.9)	35 (17.5)	6 (3.0)
CENT	11 (9.3)	25 (12.6)	119 (59.5)	45 (22.5)
SEBC	2 (1.7)	5 (2.5)	37 (18.5)	141 (70.5)
TOTAL	118	199	200	200

APPENDIX

Appendix Table 1. Classification results for brood-year 1973 chinook salmon caught as immature age 1.2's in 1977. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia, N = sample size.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	June	5	26	7 (26.9)	7 (26.9)	8 (30.8)	4 (15.4)
	100K				7 (26.9)	5 (19.2)	10 (38.5)	4 (15.4)
	100B				5 (19.2)	7 (26.9)	11 (42.3)	3 (11.5)
2	50-50				6 (23.1)	9 (34.6)	10 (38.5)	1 (3.8)
	100K				5 (19.2)	7 (26.9)	12 (46.2)	2 (7.7)
	100B				5 (19.2)	9 (34.6)	10 (38.5)	2 (7.7)
1	50-50	June	7	114	13 (11.4)	47 (41.2)	48 (42.1)	6 (5.3)
	100K				12 (10.5)	42 (36.8)	55 (48.2)	5 (4.4)
	100B				21 (18.4)	47 (41.2)	41 (36.0)	5 (4.4)
2	50-50				16 (14.0)	37 (32.5)	52 (45.6)	9 (7.9)
	100K				12 (10.5)	36 (31.6)	58 (50.9)	8 (7.0)
	100B				15 (13.2)	38 (33.3)	54 (47.4)	7 (6.1)
1	50-50	June	8	41	4 (9.8)	34 (82.9)	1 (2.4)	2 (4.9)
	100K				8 (19.5)	29 (70.7)	2 (4.9)	2 (4.9)
	100B				3 (7.3)	34 (82.9)	2 (4.9)	2 (4.9)
2	50-50				6 (14.6)	32 (78.0)	1 (2.4)	2 (4.9)
	100K				6 (14.6)	30 (73.2)	3 (7.3)	2 (4.9)
	100B				3 (7.3)	32 (78.0)	4 (9.8)	2 (4.9)
1	50-50	June	9	50	15 (30.0)	14 (28.0)	19 (38.0)	2 (4.0)
	100K				10 (20.0)	13 (26.0)	25 (50.0)	2 (4.0)
	100B				14 (28.0)	16 (32.0)	18 (36.0)	2 (4.0)
2	50-50				17 (34.0)	12 (24.0)	19 (38.0)	2 (4.0)
	100K				11 (22.0)	11 (22.0)	26 (52.0)	2 (4.0)
	100B				12 (24.0)	15 (30.0)	21 (42.0)	2 (4.0)

Appendix Table 1 - cont'd.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	June	10	99	5 (5.1)	78 (78.8)	7 (7.1)	9 (9.1)
	100K				19 (19.2)	67 (67.7)	6 (6.1)	7 (7.1)
	100B				0 (0.0)	82 (82.8)	11 (11.1)	6 (6.1)
2	50-50				2 (2.0)	84 (84.8)	10 (10.1)	3 (3.0)
	100K				13 (13.1)	77 (77.8)	7 (7.1)	2 (2.0)
	100B				0 (0.0)	90 (90.9)	7 (7.1)	2 (2.0)
1	50-50	July	3	36	10 (27.8)	10 (27.8)	15 (41.7)	1 (2.8)
	100K				8 (22.2)	9 (25.0)	17 (47.2)	2 (5.6)
	100B				9 (25.0)	11 (30.6)	15 (41.7)	1 (2.8)
2	50-50				11 (30.6)	8 (22.2)	16 (44.4)	1 (2.8)
	100K				9 (25.0)	7 (19.4)	19 (52.8)	1 (2.8)
	100B				8 (22.2)	7 (19.4)	20 (55.6)	1 (2.8)
1	50-50	July	5	227	58 (25.6)	72 (31.7)	82 (36.1)	15 (6.6)
	100K				40 (17.6)	68 (30.0)	100 (44.1)	19 (8.4)
	100B				66 (29.1)	72 (31.7)	76 (33.5)	13 (5.7)
2	50-50				63 (27.8)	73 (32.2)	80 (35.2)	11 (4.8)
	100K				46 (20.3)	59 (26.0)	107 (47.1)	15 (6.6)
	100B				60 (26.4)	73 (32.2)	84 (37.0)	10 (4.4)
1	50-50	July	7	136	42 (30.9)	43 (31.6)	46 (33.8)	5 (3.7)
	100K				42 (30.9)	36 (26.5)	52 (38.2)	6 (4.4)
	100B				32 (23.5)	52 (38.2)	47 (34.6)	5 (3.7)
2	50-50				43 (31.6)	43 (31.6)	44 (32.4)	6 (4.4)
	100K				43 (31.6)	37 (27.2)	50 (36.8)	6 (4.4)
	100B				30 (22.1)	52 (38.2)	49 (36.0)	5 (3.7)
1	50-50	July	8	40	11 (27.5)	21 (52.5)	8 (20.0)	0 (0.0)
	100K				14 (35.0)	16 (40.0)	10 (25.0)	0 (0.0)
	100B				4 (10.0)	23 (57.5)	13 (32.5)	0 (0.0)
2	50-50				9 (22.5)	20 (50.0)	8 (20.0)	3 (7.5)
	100K				14 (35.0)	18 (45.0)	5 (12.5)	3 (7.5)
	100B				1 (2.5)	24 (60.0)	12 (30.0)	3 (7.5)

Appendix Table 1 - cont'd.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	July	9	66	23 (34.8)	13 (19.7)	29 (43.9)	1 (1.5)
	100K				14 (21.2)	12 (18.2)	39 (59.1)	1 (1.5)
	100B				36 (54.5)	11 (16.7)	18 (27.3)	1 (1.5)
2	50-50				30 (45.5)	10 (15.2)	25 (37.9)	1 (1.5)
	100K				16 (24.2)	10 (15.2)	39 (59.1)	1 (1.5)
	100B				35 (53.0)	12 (18.2)	18 (27.3)	1 (1.5)
1	50-50	July	10	254	29 (11.4)	171 (67.3)	35 (13.8)	19 (7.5)
	100K				52 (20.5)	144 (56.7)	37 (14.6)	21 (8.3)
	100B				13 (5.1)	179 (70.5)	44 (17.3)	18 (7.1)
2	50-50				21 (8.3)	190 (74.8)	25 (9.8)	18 (7.1)
	100K				42 (16.5)	176 (69.3)	21 (8.3)	15 (5.9)
	100B				9 (3.5)	203 (79.9)	26 (10.2)	16 (6.3)
1	50-50	July	11	30	5 (16.7)	7 (23.3)	17 (56.7)	1 (3.3)
	100K				2 (6.7)	6 (20.0)	20 (66.7)	2 (6.7)
	100B				7 (23.3)	6 (20.0)	15 (50.0)	2 (6.7)
2	50-50				3 (10.0)	3 (10.0)	22 (73.3)	2 (6.7)
	100K				2 (6.7)	2 (6.7)	24 (80.0)	2 (6.7)
	100B				6 (20.0)	2 (6.7)	20 (66.7)	2 (6.7)

[1]Character sets are described in Table 1.
[2]50-50: The Asian standard was composed of 50% Kamchatka R. and 50% Bolshaya R. scales.
100K: The Asian standard was composed of 100% Kamchatka R. scales.
100B: The Asian standard was composed of 100% Bolshaya R. scales.
[3]Sub-areas are shown in Fig. 1.

Appendix Table 2. Classification results for brood-year 1974 chinook salmon caught as immature age 1.2's in 1978. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia, N = sample size.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	June	5	261	73 (28.0)	129 (49.4)	36 (13.8)	23 (8.8)
	100K				40 (15.3)	131 (50.2)	57 (21.8)	33 (12.6)
	100B				62 (23.8)	127 (48.7)	50 (19.2)	22 (8.4)
2	50-50				70 (26.8)	103 (39.5)	54 (20.7)	34 (13.0)
	100K				33 (12.6)	109 (41.8)	69 (26.4)	50 (19.2)
	100B				60 (23.0)	100 (38.3)	62 (23.8)	39 (14.9)
1	50-50	July	3	50	15 (30.0)	26 (52.0)	6 (12.0)	3 (6.0)
	100K				7 (14.0)	26 (52.0)	11 (22.0)	6 (12.0)
	100B				16 (32.0)	25 (50.0)	6 (12.0)	3 (6.0)
2	50-50				14 (28.0)	21 (42.0)	12 (24.0)	3 (6.0)
	100K				6 (12.0)	20 (40.0)	19 (38.0)	5 (10.0)
	100B				14 (28.0)	21 (42.0)	12 (24.0)	3 (6.0)
1	50-50	July	5	593	178 (30.0)	275 (46.4)	83 (14.0)	57 (9.6)
	100K				83 (14.0)	290 (48.9)	148 (25.0)	72 (12.1)
	100B				191 (32.2)	256 (43.2)	99 (16.7)	47 (7.9)
2	50-50				189 (31.9)	190 (32.0)	148 (25.0)	66 (11.1)
	100K				78 (13.2)	205 (34.6)	200 (33.7)	110 (18.5)
	100B				178 (30.0)	184 (31.0)	158 (26.6)	73 (12.3)
1	50-50	July	7	71	18 (25.4)	42 (59.2)	9 (12.7)	2 (2.8)
	100K				11 (15.5)	43 (60.6)	12 (16.9)	5 (7.0)
	100B				14 (19.7)	40 (56.3)	14 (19.7)	3 (4.2)
2	50-50				24 (33.8)	26 (36.6)	16 (22.5)	5 (7.0)
	100K				13 (18.3)	36 (50.7)	12 (16.9)	10 (14.1)
	100B				24 (33.8)	26 (36.6)	17 (23.9)	4 (5.6)

Appendix Table 2 - cont'd.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	July	9	68	10 (14.7)	49 (72.1)	9 (13.2)	0 (0.0)
	100K				8 (11.8)	46 (67.6)	13 (19.1)	1 (1.5)
	100B				7 (10.3)	48 (70.6)	13 (19.1)	0 (0.0)
2	50-50				17 (25.0)	28 (41.2)	20 (29.4)	3 (4.4)
	100K				11 (16.2)	32 (47.1)	20 (29.4)	5 (7.4)
	100B				12 (17.6)	29 (42.6)	24 (35.3)	3 (4.4)
1	50-50	July	10	103	11 (10.7)	70 (68.0)	14 (13.6)	8 (7.8)
	100K				22 (21.4)	61 (59.2)	12 (11.7)	8 (7.8)
	100B				4 (3.9)	68(66.0)	23 (22.3)	8 (7.8)
2	50-50				8 (7.8)	73 (70.9)	16 (15.5)	6 (5.8)
	100K				12 (11.7)	72 (69.9)	14 (13.6)	5 (4.9)
	100B				3 (2.9)	77 (74.8)	18 (17.5)	5 (4.9)

[1]Character sets are described in Table 1.
[2]50-50: The Asian standard was composed of 50% Kamchatka R. and 50% Bolshaya R. scales.
100K: The Asian standard was composed of 100% Kamchatka R. scales.
100B: The Asian standard was composed of 100% Bolshaya R. scales.
[3]Sub-areas are shown in Fig. 1.

Appendix Table 3. Classification results for brood-year 1976 chinook salmon caught as immature age 1.2's in 1977. WEST = Western Alaska, CENT = Central Alaska, SEBC = Southeast Alaska/British Columbia, N = sample size.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	June	5	214	43 (20.1)	104 (48.6)	35 (16.4)	32 (15.0)
	100K				20 (9.3)	100 (46.7)	57 (26.6)	37 (17.3)
	100B				39 (18.2)	104 (48.6)	40 (18.7)	31 (14.5)
2	50-50				24 (11.2)	73 (34.1)	77 (36.0)	40 (18.7)
	100K				29 (13.6)	69 (32.2)	69 (32.2)	47 (22.0)
	100B				16 (7.5)	80 (37.4)	83 (38.8)	35 (16.4)
1	50-50	July	3	46	6 (13.0)	24 (52.2)	12 (26.1)	4 (8.7)
	100K				2 (4.3)	21 (45.7)	19 (41.3)	4 (8.7)
	100B				7 (15.2)	21 (45.7)	12 (26.1)	6 (13.0)
2	50-50				3 (6.5)	16 (34.8)	22 (47.8)	5 (10.9)
	100K				5 (10.9)	14 (30.4)	22 (47.8)	5 (10.9)
	100B				2 (4.3)	17 (37.0)	23 (50.0)	4 (8.7)
1	50-50	July	5	760	151 (19.9)	324 (42.6)	174 (22.9)	111 (14.6)
	100K				83 (10.9)	288 (37.9)	256 (33.7)	133 (17.5)
	100B				136 (17.9)	299 (39.3)	208 (27.4)	117 (15.4)
2	50-50				90 (11.8)	189 (24.9)	343 (45.1)	138 (18.2)
	100K				118 (15.5)	174 (22.9)	308 (40.5)	160 (21.1)
	100B				61 (8.0)	210 (27.6)	370 (48.7)	119 (15.7)
1	50-50	July	6	93	8 (8.6)	70 (75.3)	12 (12.9)	3 (3.2)
	100K				10 (10.8)	65 (69.9)	15 (16.1)	3 (3.2)
	100B				4 (4.3)	69 (74.2)	17 (18.3)	3 (3.2)
2	50-50				7 (7.5)	68 (73.1)	15 (16.1)	3 (3.2)
	100K				14 (15.1)	63 (67.7)	13 (14.0)	3 (3.2)
	100B				2 (2.2)	72 (77.4)	18 (19.4)	1 (1.1)

Appendix Table 3 - cont'd.

Character set no.[1]	Asian stock proportions[2]	Month	Sub-area[3]	N	Number of scales (%) ASIA	WEST	CENT	SEBC
1	50-50	July	8	266	19 (7.1)	219 (82.3)	27 (10.2)	1 (0.4)
	100K				26 (9.8)	213 (80.1)	25 (9.4)	2 (0.8)
	100B				8 (3.0)	223 (83.8)	34 (12.8)	1 (0.4)
2	50-50				12 (4.5)	205 (77.1)	47 (17.7)	2 (0.8)
	100K				35 (13.2)	196 (73.7)	33 (12.4)	2 (0.8)
	100B				5 (1.9)	215 (80.8)	43 (16.2)	3 (1.1)
1	50-50	July	9	56	7 (12.5)	32 (57.1)	15 (26.8)	2 (3.6)
	100K				6 (10.7)	28 (50.0)	19 (33.9)	3 (5.4)
	100B				4 (7.1)	30 (53.6)	19 (33.9)	3 (5.4)
2	50-50				6 (10.7)	22 (39.3)	24 (42.9)	4 (7.1)
	100K				11 (19.6)	18 (32.1)	20 (35.7)	7 (12.5)
	100B				3 (5.4)	25 (44.6)	24 (42.9)	4 (7.1)
1	50-50	July	10	185	10 (5.4)	149 (80.5)	26 (14.1)	0 (0.0)
	100K				14 (7.6)	144 (77.8)	27 (14.6)	0 (0.0)
	100B				2 (1.1)	151 (81.6)	32 (17.3)	0 (0.0)
2	50-50				7 (3.8)	155 (83.8)	21 (11.4)	2 (1.1)
	100K				12 (6.5)	151 (81.6)	19 (10.3)	3 (1.6)
	100B				1 (0.1)	157 (84.9)	25 (13.5)	2 (1.1)

[1]Character sets are described in Table 1.
[2]50-50: The Asian standard was composed of 50% Kamchatka R. and 50% Bolshaya R. scales.
100K: The Asian standard was composed of 100% Kamchatka R. scales.
100B: The Asian standard was composed of 100% Bolshaya R. scales.
[3]Sub-areas are shown in Fig. 1.