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ORIGINS OF CHINOOK SALMON IN THE AREA OF THE JAPANESE MOTHERSHIP AND LANDBASED DRIFTNET SALMON FISHERIES IN 1980

by

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INTRODUCTION

The United States has for many years been concerned about the level of high seas interceptions of U.S.-origin chinook salmon, particularly by the Japanese mothership salmon fishery in the central Bering Sea. This concern was greatly intensified following the record 1980 mothership catch of 703,798 chinook salmon (previous maximum was 553,892 fish in 1969; 1952-1979 mean annual catch is 169,981). Because of the paucity of information on origins of chinook in the Bering Sea and in other areas of the mothership fishing region, the Fisheries Research Institute (FRI) undertook a research project, funded by the Alaska Department of Fish and Game and the U.S. National Marine Fisheries Service, to determine by scale pattern analysis chinook origins in the mothership fishery area in 1975-81. At the last INPFC annual meeting, the United States suggested that the Salmon Sub-committee's Special Panel Topic include discussion on stock composition of chinook in the Bering Sea.

Since 1978 a considerable part of high seas salmonid research has been directed to determination of continental origins of all species of salmonids in the area of the Japanese landbased driftnet (LBDN) fishery (south of 46^{o}N), pursuant to Article III.1.(d) of the revised Protocol amending the International Convention for the High Seas Fisheries of the North Pacific Ocean. Although the LBDN fishery catches of chinook have been small relative to those made by the mothership fishery, we included the LBDN area in the scope of the scale pattern analysis of 1975-81 high seas samples.

This report summarizes progress to date in this chinook scale pattern study. Virtually all of the scale samples and background stock abundance data required for the entire 1975-81 analysis have been acquired, but only the 1980 high seas samples have been analyzed at this time. Results of analysis pertaining to both the mothership and LBDN fisheries are included in this report, since the methodologies for both studies are identical and since very few samples are available from the LBDN area.

REVIEW OF PREVIOUS WORK

There is very little information on origins of chinook salmon in the central and western North Pacific Ocean and Bering Sea, owing largely to the low relative abundance of the species and consequent low catches in research vessel operations. Available information comes largely from tagging studies and one previous scale pattern analysis.

Information From Tagging

Figure 1 shows all 13 coastal or near-coastal recoveries of externally tagged chinook salmon reported to the INPFC to date, for waters west of 155°W. Nine of these resulted from releases in the Bering Sea, largely in the area of the mothership fishery, and four were from releases in the North Pacific Ocean south of the central Aleutian Islands. The recoveries from Bering Sea releases have all been from western Alaska, particularly from Yukon, Kuskokwim, and Nushagak river fisheries. The four recoveries from releases in the North Pacific Ocean suggest a more diverse stock composition in that area. Three of the four recoveries were from the Kamchatka River, the Togiak River of western Alaska, and the upper Columbia River system. Recovery number 11 in Figure 1 was not a coastal recovery, but rather was from the Fairweather grounds troll fishery. The exact origin of the fish cannot be determined, as chinook in the Fairweather area are known to originate from central Alaska to California.

The recent effort by U.S. observers to recover coded-wire tagged salmon from incidental catches of foreign groundfish vessels in the U.S. Fishery Conservation Zone has provided new information on origins of chinook salmon in the eastern Bering Sea. Figure 2, which is based on recoveries made west of 155°W reported by Dahlberg (1982) and Wertheimer and Dahlberg (1983), shows that stocks from a large region from central Alaska to Oregon can occur in the eastern Bering Sea. The great majority of incidental chinook catches by groundfish vessels is made in winter, but recoveries 5 and 7 in Figure 2 were made on 9 May and 27 June, respectively. Recovery 6 was made on 8 November. These coded-wire tag recoveries do not provide direct information on origins of chinook in epipelagic waters of the mothership fishery area in the central Bering Sea, but they do attest a diverse stock composition in at least the eastern Bering Sea in fall, spring and possibly early summer.

Information From Previous Chinook Scale Pattern Analysis

Major et al. (1977) applied linear discriminant analysis to scale pattern data to determine origins of chinook salmon in the Japanese mothership fishery area in 1966-72 (their work is summarized by Major et al., 1978). A linear discriminant function was developed from 1968 samples of known origin to classify high seas samples taken from immature chinook of various age groups. Only two regional categories were considered, Asia and western Alaska. Standard (= known origin) samples representing western Alaska were collected from inshore fisheries, while those representing Asia were taken from maturing chinook caught by the mothership fishery west of 170°E, under the assumption that they would all be Asian fish.

Results of the study indicated that Asian and western Alaskan fish intermingle throughout most of the mothership fishery area. Point estimates of mixing proportion of Asian fish were generally higher for sub-areas in the North Pacific Ocean than for sub-areas in the Bering Sea (sub-areas of the mothership fishery were defined by Fredin and Worlund 1974). Especially in the Bering Sea, point estimates for western Alaska generally decreased westward, although some high estimates (over 50%) for western Alaska occurred as far west as sub-area 4, between 165°-170°E. In the Bering Sea, where most of the mothership chinook catches have traditionally been made, estimates for western Alaska in June and July ranged from 42% to 100% and averaged 67% in sub-area 8 (between 175°E-180°) and ranged from 65% to 100% and averaged 93% in sub-area 10 (between 180°-175°W).

The investigators considered their results provisional pending further research to examine possible sources of bias in the analysis, one being perhaps the occurrence of other stock-complexes (besides Asia and western Alaska) in the high seas study area.

METHODS

Scope of Study

Chinook salmon scale samples collected on board Japanese salmon motherships and on research vessels were requested for the area 48°-60°N, 160°E-175°W during June and July (when the mothership fishery operates), and for 38°-48°N, 160°E-175°W during May through July (when the LBDN fishery operates), 1975-1981. Only analysis of samples collected in 1980 is presented in this document.

When this study was originally designed, only the disc tag recoveries depicted in Figure 1 were reported. Because chinook from Kamchatka and from North American areas as far south as the Columbia River were known to occur in the central Aleutian Island region, we planned to establish standard samples for five major regions: Asia (= Kamchatka), western Alaska, central Alaska, southeast Alaska/British Columbia, and Washington/Oregon/California (Fig. 3). Scale samples and run size information (catch and/or escapement statistics) were requested of numerous agencies involved in management of these stocks. Although age determinations were in many cases already made by these agencies, we decided to re-age all samples so that age determinations would be based on the same criteria.

The high seas (= unknown origin) samples were also re-aged by FRI biologists to maintain consistency with the standard samples. Tables 1 and 2 compare age compositions of the 1980 high seas samples as determined by the Japan Fisheries Agency and by FRI. FRI biologists considered a larger number of scales to be regenerated. The age compositions based on only those scales that were aged completely (i.e., freshwater and ocean age) compared very closely between the two agencies. The great majority of the total high seas sample consisted of immature age 1.2 or 1.3 fish. Therefore, only these two age/maturity groups were considered in this analysis.

Construction of Regional Standard Samples

Within the five regional categories considered in this analysis are 19 major stock groupings. As in our previous scale pattern studies of sockeye and coho origins, we constructed regional standards so as to weight the component stocks or stock-groupings according to best estimates of relative abundance within the region.

Since the age at maturity of the immature chinook salmon sampled on the high seas is not known, we decided to classify "unknown" scale samples with regional standards of the same brood year. An attempt was made to include in the brood year standards all ages at which fish in the high seas samples might have matured. For example, age 1.2 immature chinook in 1980 were classified according to standard samples containing age 1.3 matures returning in 1981 and age 1.4 matures returning in 1982. No samples were available for 1983, and so they could not be included in the brood year standards. Brood year 1975 standards were developed to classify age 1.3 immature chinook and brood year 1976 standards were developed to classify age 1.2 immature chinook.

The Asian brood year standards were composed of scales from chinook returning in 1981 to the Kamchatka and Bolshaya rivers. These are the only stocks and year for which scale samples were available representing the same brood year as the unknowns. Abundance estimates for Asian chinook are limited to unofficial commercial catch statistics for East and West Kamchatka in 1981 (Table 3).

The western Alaska regional standards were composed of six stocks: Yukon, Kuskokwim, Kanektok, Nushagak, and Togiak rivers and Goodnews Bay (Table 3). The total run size estimates for the Yukon, Kuskokwim, Kanektok and Goodnews Bay stocks are based on the harvest, an escapement index, and an assumed exploitation rate between 0.5 and 0.8. Estimates for Nushagak and Togiak river run sizes include commercial and subsistence catch and escapement estimates.

Central Alaska regional standards were made up of scales sampled from Cook Inlet and Copper River chinook. Reliable estimates of escapement are not available for most Central Alaska stocks. Therefore, proportions of Cook Inlet and Copper River chinook were weighted by the catch (commercial, subsistence and sport) statistics in Table 3.

Southeast Alaska/British Columbia regional standards include seven major chinook stocks (Fraser, Skeena, Nass, Bella Coola, Stikine, Taku, and Alsek rivers). The total run size estimates in Table 3 include terminal and in-river commercial, Alaskan and British Columbian native subsistence, and sport catches, and escapement estimates. Techniques of surveying and estimation of the above indices vary among stocks. Although these estimates represent the best available information on abundance, they may not be reliable (personal communication, P. J. Starr, Can. Dept. Fish. Oceans, 1983).

The Washington/Oregon/California regional standards were constructed from six major stock groupings: Washington inland waters, Washington coast, Columbia River spring chinook, Columbia River fall chinook, Oregon coast, and California. Run size estimates for these stocks (Table 3) included terminal or in-river commercial and sport catches, and escapement estimates.

Scale samples were aged by FRI scale specialists, and age composition of each major stock by year was computed (Tables 4 to 8). Regenerated scales were not digitized or included in age composition calculations.

Run size data and estimated age compositions were used to determine a "total return" for each age class in each stock by year. The total return for each age class and stock to be included in a particular brood year standard was then summed to obtain a total "brood year return". Then, the proportion of the total brood year return represented by each age class and stock was computed. This proportion was multiplied by the total desired sample size of each brood year standard (200 scales) to determine the number of scales needed from each age class and stock.

The desired and final sample sizes for brood years 1975 and 1976 are shown by region, stock, return year, and age class in Tables 9 and 10, respectively. Final sample sizes of less than 200 scales occurred for some standards as not enough samples were available to complete the standard. When the number of scales from a particular stock was insufficient to provide desired sample size, all available scales from the stock were used. The Washington/Oregon/California regional standard for brood year 1975 could not be constructed due to the very small number of age 1.4 and 1.5 chinook salmon available from that region (<50 in 1981 and 1982 combined).

Scale Measurement and Characteristics

Chinook salmon scales were digitized with a micro-computer based digitizing system, along a measurement axis perpendicular to the boundary of the sculptured field of the scale and intersecting the center of the focus (Fig. 4). Incremental measurements of the distance to the outer edge of each circulus through three zones were made. Zone one included the area from the focus to the outer edge of the last circulus in the freshwater annulus. Zone two began at the outer edge of the last circulus in zone one and extended to the outer edge of the last freshwater circulus. The third zone began at the outer edge of the last freshwater circulus and extended to the outer edge of the last circulus in the first ocean annulus.

Sixty characters were created from the digitized scale data (Table 11). From these sixty characters subsets of 3 to 6 characters were selected for use in each discriminant analysis.

Classification and Estimation Procedures

The methods of character selection, classification, and point and variance estimation are the same as those used by Cook et al. (1981). Brood year standards for 1975 and 1976 were classified by a direct density, leaving-one-out approach (Cook 1982) to establish the level of accuracy that would be obtained in classifying "unknowns". Overall classification accuracies were calculated as the unweighted mean of the accuracies on the diagonal of the classification arrays.

Temporal stratification in the analysis was by 10-day period and month. Three different geographic schemes were used to stratify the study area. The first employed INPFC $2^{\circ} \times 5^{\circ}$ areas as study area divisions. The second scheme divided the study area into Japanese mothership fishery sub-areas (after Fredin and Worlund 1974), and additional sub-areas south of 46°N, defined in this report (Fig. 5). The third scheme divided the study area into three large high seas regions roughly corresponding to the Japanese landbased driftnet fishery area (south of 46°N), northern North Pacific Ocean (46°N-52°N), and Bering Sea (north of 52°N) (Fig. 6). The spatial and temporal distributions of measured high seas samples are shown in Figures 7 (for age 1.2 fish in June), 8 (1.2 fish in July), 9 (1.3 fish in June), and 10 (1.3 fish in July).

Point estimates of stock composition and 90% confidence intervals were calculated for each time-period/area stratum represented by at least 25 measured scales. There were no strata in May that met this minimum sample size. "Significant" estimates are those with 90% confidence intervals that do not include zero.

RESULTS

Table 12 presents the scale characters used in all five-, four- three-, and two-way analyses. Descriptive statistics and frequency distributions of the scale characters used in the five-way analyses are shown in Appendix Figures 1 - 3 (for brood year 1975) and 4 and 5 (for brood year 1976). The results of classifying standard samples for each five-, four-, three-, and two-way regional combination are given in Tables 13 to 18. Overall classification accuracies for brood year 1976 five-way and four-way regional combinations were 70.0% and 68.4%, respectively. The ranges of overall classification accuracies for three-way and two-way regional combinations were 75.4% to 85.0% and 81.3% to 90.3%, respectively. Overall classification accuracies for the four-way and three-way regional combinations of brood year 1975 standards were 79.3% and 87.5%, respectively.

Immature Age 1.2 Chinook

Mixing proportion estimates for immature age 1.2 chinook are given in Tables 19-22 for the various levels of temporal and spatial stratification. Subsequent discussion will be based mainly on results for the twenty 10-day period/INPFC area strata in Table 19. Only one of these strata (E6542 in late June) pertains to the LBDN fishery area.

Significant estimates for Asia, ranging from 19.8% to 53.9%, were obtained for 12 strata, and in seven of those Asia was the predominant stock. The proportion of Asian fish in the population was apparently higher in the North Pacific Ocean than in the Bering Sea; the mean estimate for the area south of 52°N is 37.2% while the mean for north of 52°N is 9.2%. The same conclusion can be drawn by examining the results by high seas region, in Table 22. All of the seven 10-day period/INPFC area strata in which Asian fish predominated were in the region south of 52^{o}N.

Significant estimates for western Alaska, ranging from 11.2% to 100%, were obtained for 16 strata, and the stock-complex predominated in 10 of these. Estimates were generally higher in the Bering Sea region; Table 22 shows that estimates for western Alaska for the region 46^{o}-52^{o}N were 32.7% and 19.1% in June and July, respectively, while the estimate for north of 52^{o}N in July was 84.2%. One of the significant estimates, indicating predominance of western Alaska fish, was obtained for an area in the LBDN region, E6542 in late June (42.6%).

Central Alaska stocks were generally in much lower relative abundance than were those of Asia and western Alaska. Only two significant estimates for 10-day period/INPFC area were obtained (E7048 in early and late July). Estimates for strata north of 52^{o}N averaged 5.4%, while those for the two regions south of 52^{o}N averaged 11.7%. The analysis stratified by high seas region also showed a low incidence of central Alaska fish in the Bering Sea and a higher (up to 18.7% in July) incidence in the region 46^{o}-52^{o}N (Table 22).

Seven statistically significant estimates, ranging from 22.8% to 57.1%, were obtained for the southeast Alaska/British Columbia complex, and in two of these (E7050 in early July and W8048 in mid-July) the stock-group apparently predominated. One of the significant estimates was obtained for E6542 in late June. Estimates for 10-day period/INPFC area strata north of 52°N averaged 4.0% and none were statistically significant. Estimates for the strata south of 52°N averaged 27.3%.

Only one, very low 10-day period/area estimate was obtained for the Washington/Oregon/California region, indicating that the stock-group is not abundant in the study area. Estimates derived for the other levels of stratification also indicated that the group did not occur in detectable proportions in the study area (Tables 20-22).

The results show no clear temporal trends in relative abundance, except that the western Alaska group appeared to be at its highest relative abundance in sub-area 5 in the first two 10-day periods of June (Table 21).

Immature Age 1.3 Chinook

Table 23 gives the mixing proportion estimates for immature age 1.3 chinook salmon, by 10-day period or month and INPFC area, sub-area, and high seas region. Sample availability was much less for this age group owing to its low relative abundance, and only 14 sets of estimates could be made across all levels of stratification.

Significant estimates for Asian fish were obtained for sub-area 5 in mid-June, sub-area 5 in July, 46°-52°N in mid-June, and north of 52°N in mid-July. An additional significant estimate, for 46°-52°N in mid-June, was based on the same sample as for sub-area 5 in mid-June, so it adds no further information. Unlike the results for immature age 1.2

fish, there was no marked difference between relative abundance of Asian fish in the North Pacific Ocean and Bering Sea, although the number of strata and size of the samples do not permit a definite conclusion. Estimates for sub-area 5 in June and July were 5.5% and 22.8%, respectively, while the Asian estimate for sub-area 8 in July was 7.9%. The estimates from samples pooled across high seas regions, however, were 5.4% and 2.8% for the region 46^{o}-52^{o}N in June and July, respectively, while that for north of 52^{o}N in July was 10.6%.

All but one of the estimates for western Alaska were statistically significant. Western Alaska was the predominant stock in all combinations of sub-area and month and high seas region and month. For both of these levels of stratification, western Alaska estimates were higher for Bering Sea than for North Pacific areas.

No statistically significant estimates for the central Alaska stock-complex were obtained. As was found for immature age 1.2 fish, point estimates were higher for the North Pacific region 46^{o}-52^{o}N than for the area north of 52^{o}N (14.8% and 11.0% for 46^{o}-52^{o}N in June and July, respectively, as compared to 1.1% for the Bering Sea in July).

Similar to the results for immature age 1.2 fish, southeast Alaska/ British Columbia was the second most abundant North American stock-group in the study area. Ten of the 14 stratum-estimates for this group were statistically significant, and for three strata this group apparently predominated in the population. Also similar to results for the age 1.2

fish, this stock-group was in higher relative abundance in the North Pacific Ocean than in the Bering Sea (Table 23b and c).

DISCUSSION

Our results from the scale pattern analysis of age 1.2 and 1.3 immature chinook salmon sampled in 1980 compare well with results of tagging experiments and previous scale pattern analysis. Both Major et al. (1977) and tagging results include information for all freshwater and ocean age groups, while the present study included analysis of only age 1.2 and 1.3 fish.

Direct evidence from recoveries of externally and coded-wire tagged chinook suggests that the North Pacific Ocean sector of our study area has a stock mixture represented to some extent by all five of the production regions considered in this study, although the number of recoveries is far too small to permit quantitative estimates. Tagging information for the Bering Sea indicates the predominance of the western Alaska stocks, but also the presence of central Alaska, Oregon, and possibly British Columbia stocks. The present study confirms the occurrence of these stocks in the western North Pacific Ocean and Bering Sea regions.

Mixing proportion point estimates by month/sub-area for the North Pacific Ocean and Bering Sea regions in June and July as obtained by Major et al. (1977) and in the present study are compared in Table 24. The western Alaska point estimates from Major et al. (1977) are the mean corrected proportional estimates for the period 1966-72. Estimates for Asia attributed to their study were calculated as 1.0 minus the corrected estimate for western Alaska (the authors did not present corrected estimates for Asia in their report). The estimated proportions of "Other North American stocks" (i.e., other than western Alaska) obtained in the present study for month/sub-area strata ranged from 0.8% to 65.6%, and averaged 28.2%. Major et al. (1977) did not establish categories for those stocks in their study, so fish in their high seas samples that were of "other North American" origin would have been classified to either the Asia or western Alaska categories. Therefore, direct comparison of Major's et al. (1977) and our results is not recommended. Nevertheless, some general similarities in results are apparent.

Both studies detected higher incidences of Asian fish in the North Pacific Ocean region than in the Bering sea, although there are exceptions to this trend when results for individual month/sub-area strata are examined. Both studies show that chinook in the Bering Sea subareas, especially sub-area 10, are predominantly of western Alaska origin. Both studies also showed a general decrease in estimates for Asia from west to east and a general increase in estimates for western Alaska from west to east, for the Bering Sea sub-areas.

SUMMARY AND CONCLUSIONS

Overall conclusions of this study are summarized according to high seas regions: LBDN fishery area (south of 46^{o}N), pre-1978 mothership fishery area in the North Pacific Ocean (46^{o}-52^{o}N), and pre-1978 mothership fishery area in the Bering Sea (north of 52^{o}N).

LBDN Area (South of 46°N)

There were very few samples available for areas south of 46°N (Figs. 7-10). Estimates could only be made for age 1.2 immature chinook in one stratum for each of the four levels of stratification (Table 19-22), and they were based on generally small sample sizes relative to strata representing areas farther north. Our estimates for the entire region suggest that Asian, western Alaska, and southeast Alaska/British Columbia fish comprised 12.8%, 45.6%, and 41.6% of the population in June, respectively. The estimates for western Alaska and southeast Alaska/British Columbia were statistically significant.

Northern North Pacific Ocean (46°-52°N)

Asian fish were predominant in the population of age 1.2 immature chinook in the region 46°-52°N in both June and July, comprising about 40% of the population in both months. Western Alaska fish made up the second most abundant stock group (33% in June and 19% in July), followed by southeast Alaska/British Columbia (14% in June, 23% in July) and central Alaska fish (13% in June, 19% in July). Washington/Oregon/California age 1.2 fish were not detected except in three fine strata, and we conclude that their relative abundance in 1980 was very low. One tag return (No. 12, Fig. 1) indicates that the stock-group does occur in the region. Statistically significant estimates by INPFC area indicate occurrence of Asian age 1.2 fish as far east as area W8048, and tag recoveries put the eastward known limit at about 172°W. North American chinook were detected in statistically significant proportions as far west as areas E7046, E7048, and E7050.

Relative abundance of Asian fish in this region was much lower for age 1.3 fish than for age 1.2 fish (estimates for age 1.3 fish were only 5.4% and 2.8% in June and July, respectively, compared to about 40% in both months for age 1.2 fish). The predominant stock group in the age 1.3 population was western Alaska, followed closely by southeast Alaska/British Columbia. Central Alaska fish were not detected in statistically significant proportions, and no non-zero estimates were obtained for age 1.3 Washington/Oregon/California fish.

Bering Sea (North of 52^{o}N)

Western Alaska fish are by far the most abundant stock-group in the Bering Sea population of age 1.2 immatures in July (no estimates could be made for north of 52^{o}N in June). The overall regional estimate for western Alaska was 84.2% (Table 22), and estimates for sub-areas 6, 8, and 10 in July were 79.7%, 82.7%, and 89.7%, respectively. Asian fish were found to comprise nearly the entire remainder of the population, as estimates for central Alaska and southeast Alaska/British Columbia stock-groups were very low and not statistically significant. As was the case for other regions of the entire study area, age 1.2 fish of Washington/Oregon/California origin were not detected in the Bering Sea.

Western Alaska fish also predominated in the Bering Sea population of age 1.3 immature chinook in July, constituting 55.2% of the population. The second most abundant stock-group was apparently southeast Alaska/British Columbia, which made up nearly one-third of the population according to results from the entire sample pooled over the whole region. Estimates for central Alaska indicated that the stock was either not present or was present in very low relative abundance. There was no indication that Washington/Oregon/California age 1.3 immature chinook occurred in the population.

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LITERATURE CITED

Alaska Department of Fish and Game. 1981. Preliminary forecasts and projections for 1981 Alaskan salmon fisheries. ADF&G, Div. Comm. Fish., Info. Leaf. 190. 37 pp.

Alaska Department of Fish and Game. 1982a. Annual management report, Bristol Bay Area - 1981. 175 pp.

Alaska Department of Fish and Game. 1982b. 1982 cumulative Alaska commercial salmon catch by management area, date, and species (preliminary data). ADF&G, Div. Comm. Fish., Box 3-2000, Juneau, AK 99802. Compiled 28-Oct-82.

Anonymous. 1981. Proposed management plan for southeast Alaska chinook salmon runs in 1981. Alaska Dept. Fish Game, Fish. Manag. Div., Southeast region, Juneau, AK 99801. 31 pp.

Canadian Department of Fisheries and Oceans. 1982. British Columbia catch statistics by area and type of gear (as reported on sales slips received by the Department) 1981. Can. Dept. Fish. Oceans, Div. Fish. Mgt., Pacific region. 223 pp.

Cook, Rodney C. 1982. Estimating the mixing proportion of salmonids with scale pattern recognition applied to sockeye salmon (Oncorhynchus nerka), in and around the Japanese landbased driftnet fishery. Ph.D. dissertation, University of Washington. 264 pp.

Cook, R. C., K. W. Myers, R. V. Walker, and C. K. Harris. 1981. The mixing proportion of Asian and Alaskan sockeye salmon in and around the landbased driftnet fishery area, 1972-1976. (Document submitted to annual meeting of the INPFC, Vancouver, Canada, November 1981.) 81 pp. Fish. Res. Inst., University of Washington, Seattle.

Dahlberg, Michael L. 1982. Report of the incidence of coded-wire tagged salmonids in catches of foreign commercial and research Auke Bay Lab., P.O. Box 155, Auke Bay, AK 99821.)

Fraser, F. J., P. J. Starr, and A. Y. Fedorenka. 1982. A review of the chinook and coho salmon of the Fraser River. Can. Tech. Rep. Fish. Aquat. Sci. 1126. 130 pp.

Fredin, R. A., and D. D. Worlund. 1974. Catches of sockeye salmon of Bristol Bay origin by the Japanese mothership salmon fishery, 1956-70. Int. N. Pac. Fish. Comm., Bull. 30. 80 pp.

Kissner, P. D., Jr. 1983. A study of chinook salmon in southeast Alaska. Alaska Dept. Fish Game, Div. Sport Fish, Fed. Aid Fish Rest. Anad. Fish Studies, Vol. 23. 53 pp. (Proj. AFS41-10).

Major, Richard L., Sueto Murai, and Julaine Lyons. 1977. Scale studies to identify Asian and western Alaskan chinook salmon. Int. N. Pac. Fish. Comm., Ann. Rep. for 1975. Pp. 68-71.

Major, R. L., J. Ito, S. Ito, and H. Godfrey. 1978. Distribution and origin of chinook salmon (Oncorhynchus tshawytscha) in offshore waters of the North Pacific Ocean. Int. N. Pac. Fish. Comm., Bull. 38. 54 pp.

McBride, D. N., and J. A. Wilcock. 1983. Alaska chinook salmon (Oncorhynchus tshawytscha Walbaum) catch and escapement, 1961-1980, with age, size, with sex composition estimates. Alaska Dept. Fish Game, Div. Comm. Fish, Info. Leaf. 212. 181 pp.

Pacific Fishery Management Council. 1981. Proposed plan for managing the 1981 salmon fisheries off the coast of California, Oregon and Washington. Portland, OR.

Solazzi, M. F., and J. T. Martin. 1982. An introduction to chinook salmon planning. Oregon Dept. Fish. Wildl., Info. Rept. 82-3. 125 pp.

Wertheimer, Alex C. and Michael L. Dahlberg. 1983. Report of incidence of coded-wire tagged salmonids in catches of foreign commercial and research vessels operating in the North Pacific Ocean and Bering Sea during 1982-1983. (Document submitted to annual meeting of the INPFC, Anchorage, Alaska, November 1983. 14 pp. Northwest and Alaska Fisheries Center, Natl. Mar. Fish. Serv., Natl. Oceanic Atmos. Admin., Auke Bay Lab., P.O. Box 155, Auke Bay, AK 99821.)

FIGURES AND TABLES

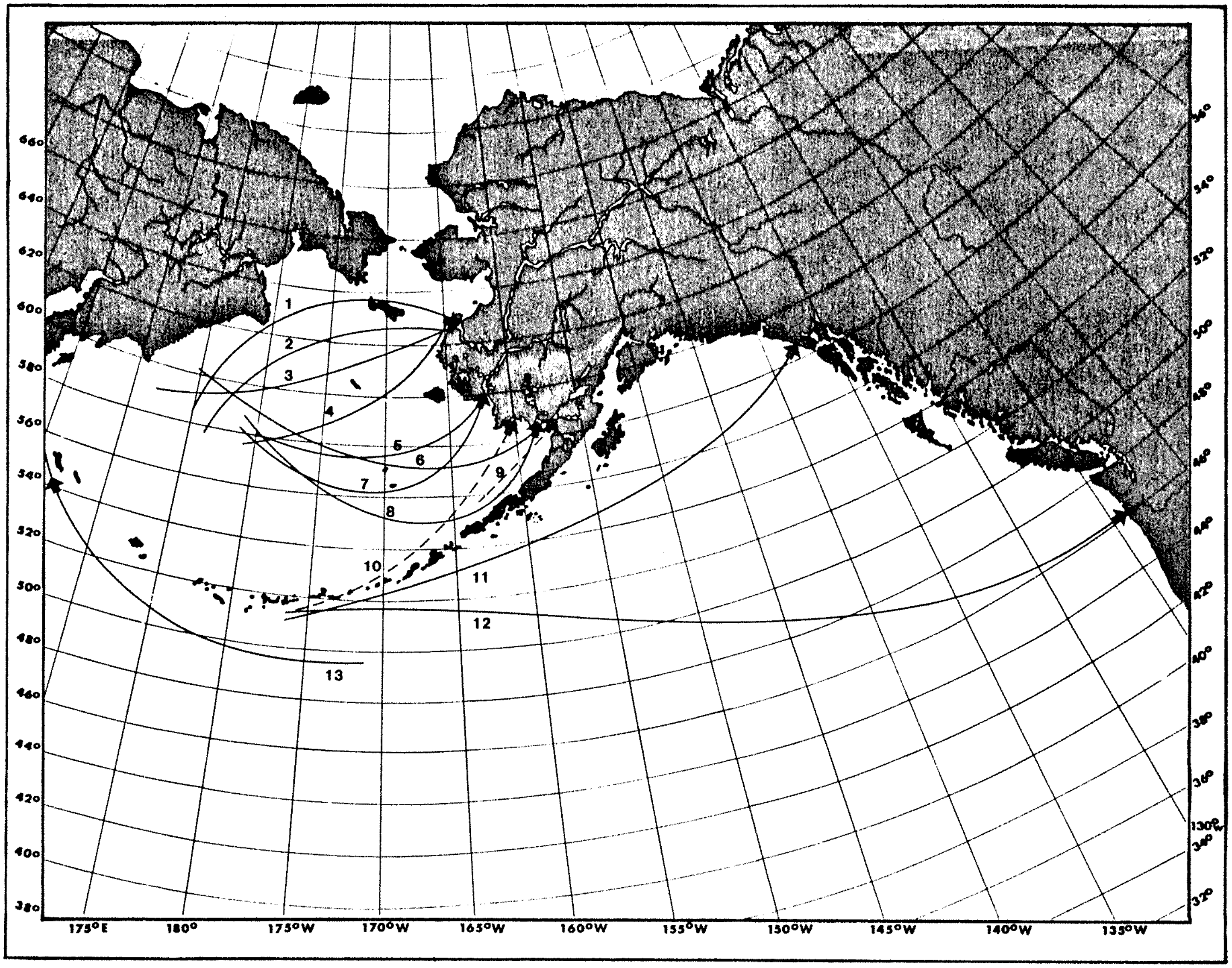

Fig. 1. Coastal tag recoveries of chinook salmon released in the Bering Sea and North Pacific Ocean (W of 155°W) 1956 to 1982. Dashed lines indicate maturing fish, solid lines denote immature fish at the time of release. Recovery details are as follows: individual recovery number, indicated by the arrows on this figure, (n); month and day of release (m/d:); ocean age at release and recovery, in known (release age - recovery age). (1) 7/18: no ages; (2) 7/04: .2-.3; (3) 7/18: .3-.5; (4) 6/18: no ages; (5) 7/30: .2-.4; (6) 7/19: .2-.4; (7) 6/19: .2-.4; (8) 6/20: .3-?' (9) 6/24: .3-.3; (10) 6/09: .3-.3; (11) 7/19: .2-.3; (12) 8/11: no ages; (13) 8/11: .2-.3; fish recovered in Kamchatka River.

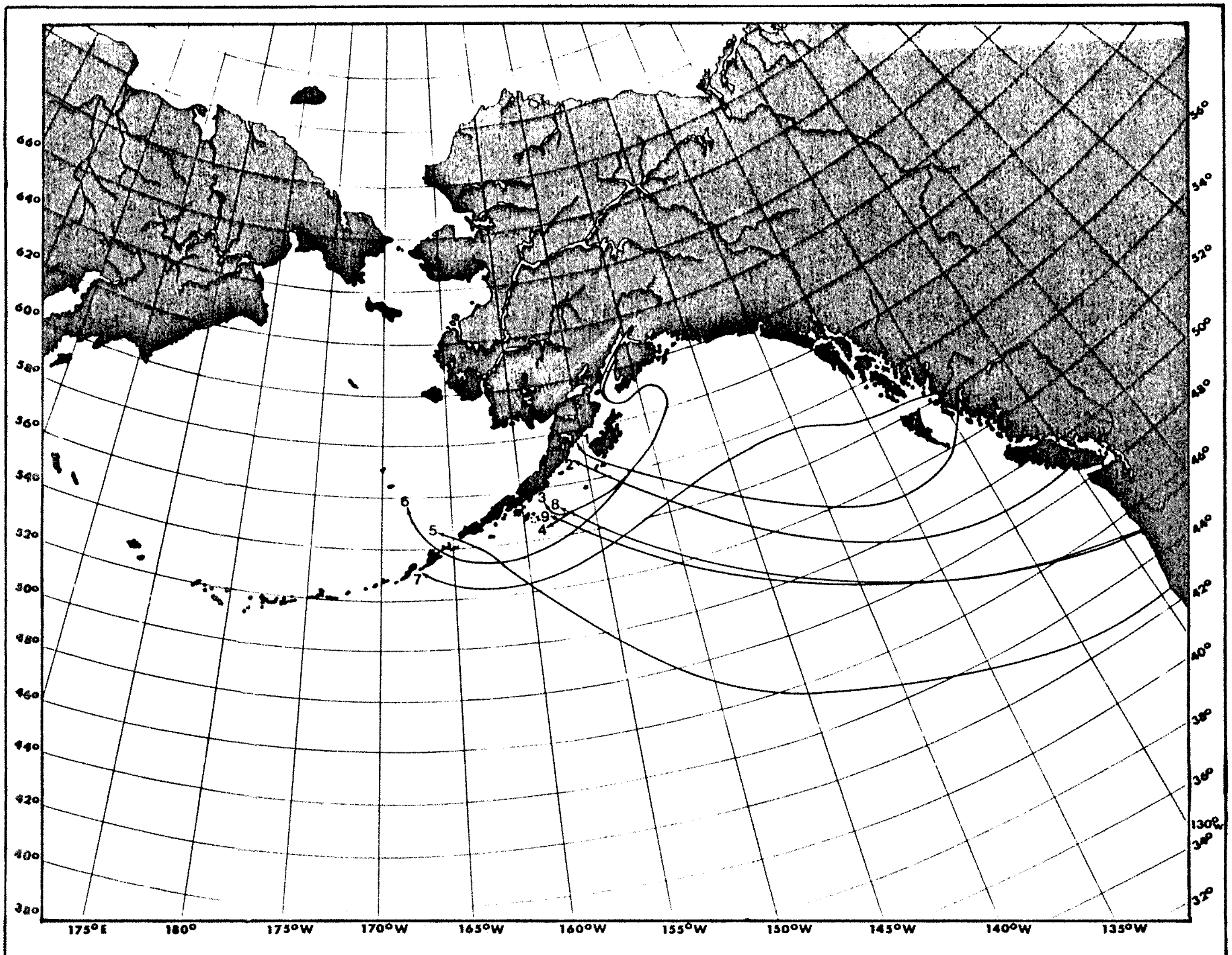

Fig. 2. Coded wire tag recoveries of chinook salmon released in coastal areas as juveniles and recovered on the high seas (W of 155°W) from foreign commercial and research vessels 1980-1983. Release and recovery information are as follows: individual recovery number indicated by the arrows on this figure (n); hatchery release site, last month and year when fish were released (m/y), month and year of recovery (m/y). (1) Kitimat River, B.C., 5/80, 2/83; (2) Little Nitinat River, B.C., 5/81, 3/83; (3) Ship Creek, AK, 5/80, 11/81; (4) Crooked Creek, AK, 3/81,10/82; (5) Elk River, OR, 9/80, 5/82; (6) Crooked Creek, AK, 3/81, 11/82, (7) Babine River, B.C., 7/79, 6/82; (8) Salmon River, OR, 10/80, 11/82; (9) Salmon River, OR, 8/81, 11/82. (Information from Dahlberg, 1982; Wertheimer and Dahlberg, 1983.)

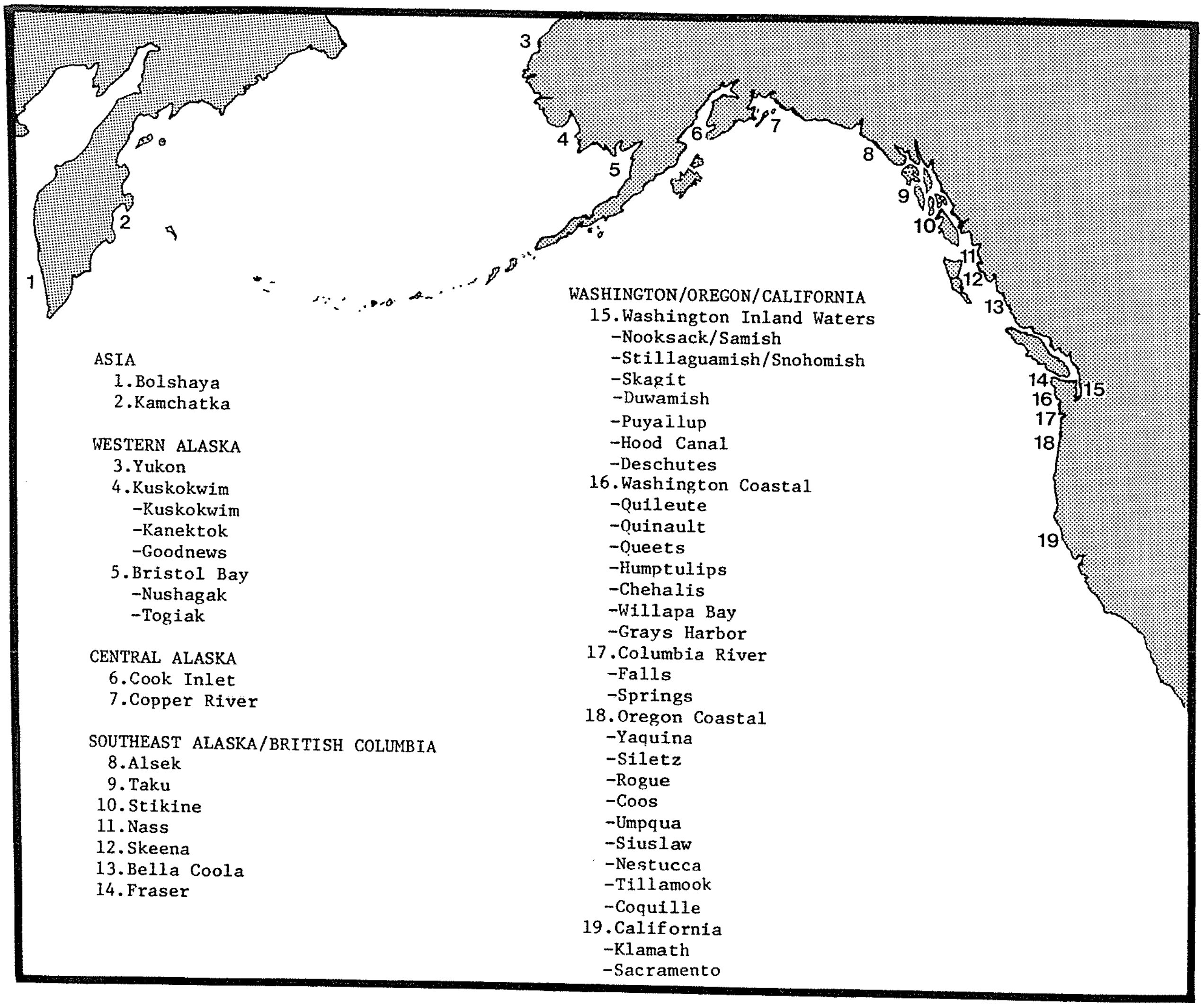

Figure 3. Map showing the five standard regions (Asia, Western Alaska, Central Alaska, Southeast Alaska/British Columbia, and Washington/Oregon/California) and nineteen sub-regions. Standards for some sub-regions were composed of the stocks listed below the sub-region name.

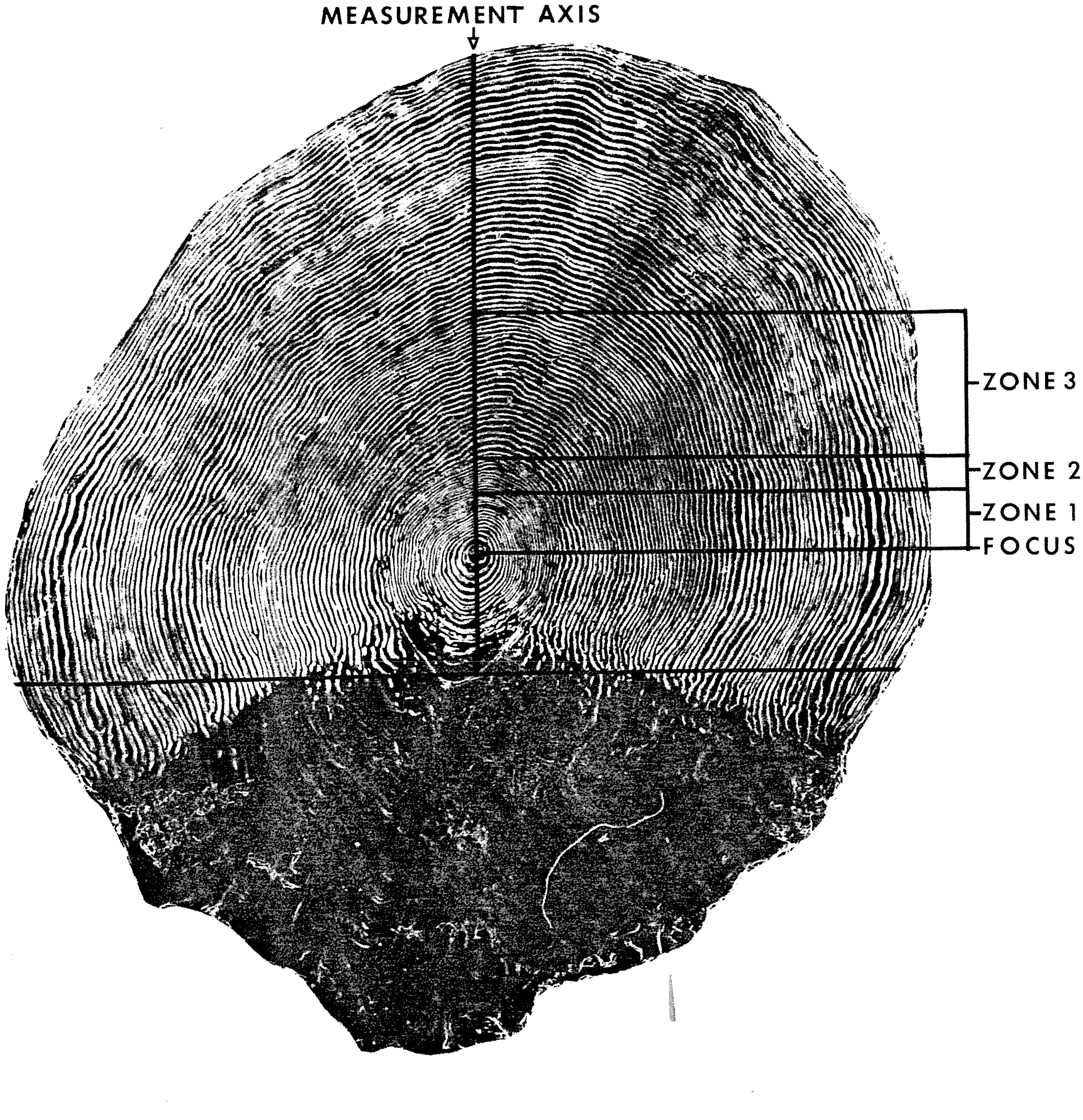

Fig. 4. Age 1.3 chinook salmon scale from the Kalama River, Washington, (4/4/81) showing the measurement axis and life history zones measured for the scale pattern analysis. Measurement axis = perpendicular to sculptured field; Zone 1 = distance from center of focus to outer edge of last circulus in freshwater annulus; Zone 2 = distance from outer edge of last circulus in freshwater annulus to outer edge of last freshwater circulus; Zone 3 = distance from the outer edge of the last freshwater circulus to the outer edge of the last circulus in the first ocean annulus.

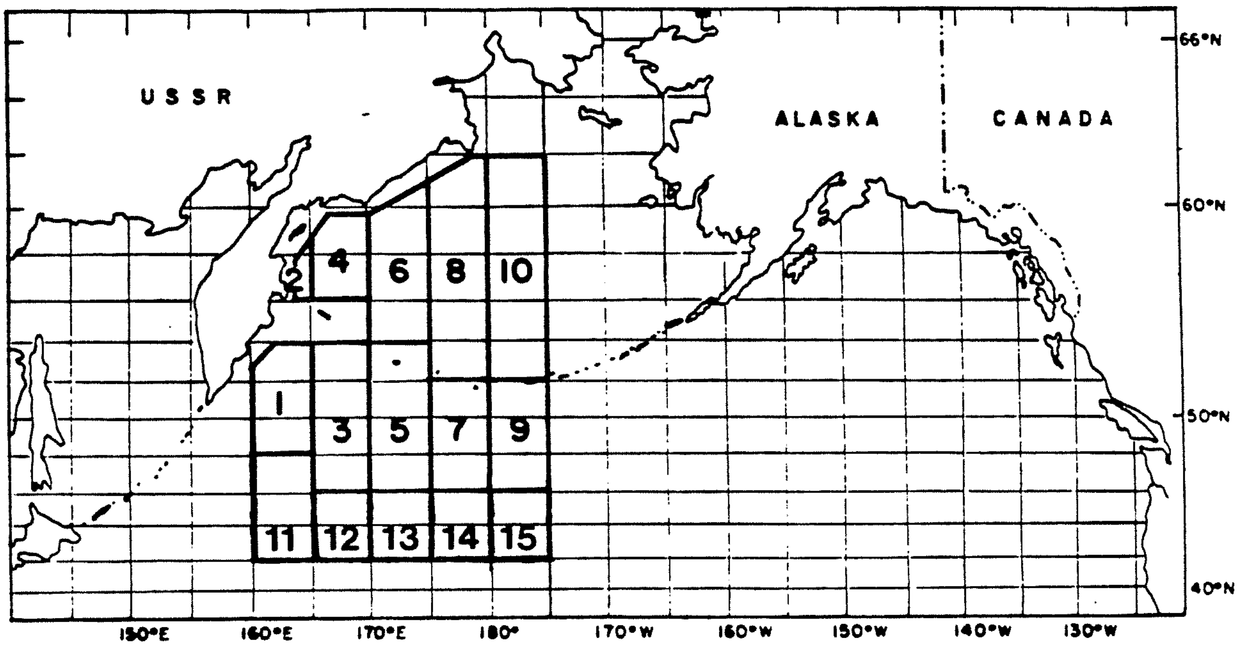

Figure 5. Designated sub-areas (1-10; after Fredin and Worlund, 1974) of the Japanese mothership salmon fishery, and additional sub-areas (11-15), defined in the present report for the landbased drift-net fishery.

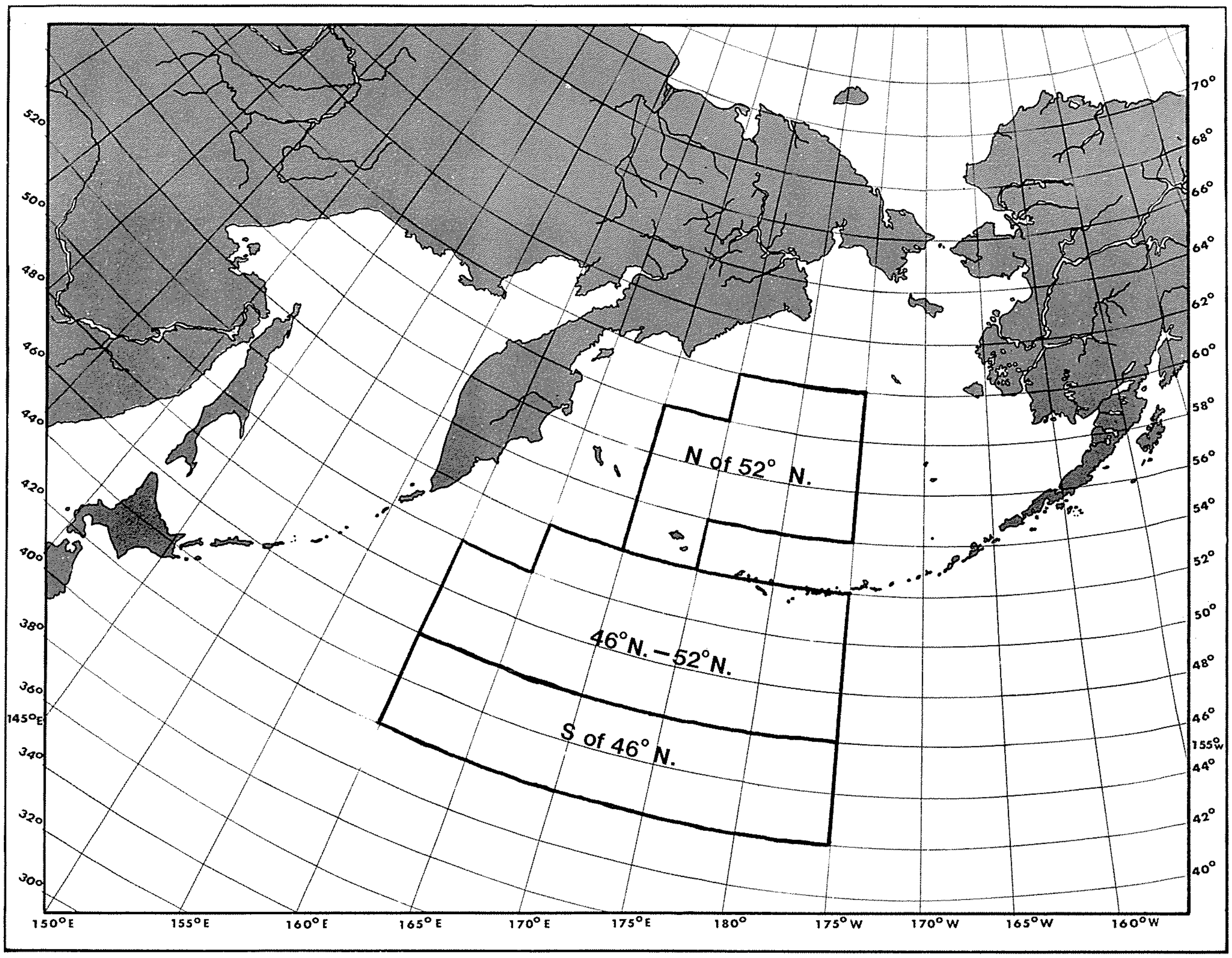

Figure 6. High seas regions corresponding to the Japanese landbased driftnet fishery area (S of 46°N), northern North Pacific Ocean (46°N-52°N), and Bering Sea (N of 52°N) over which "unknowns" were pooled.

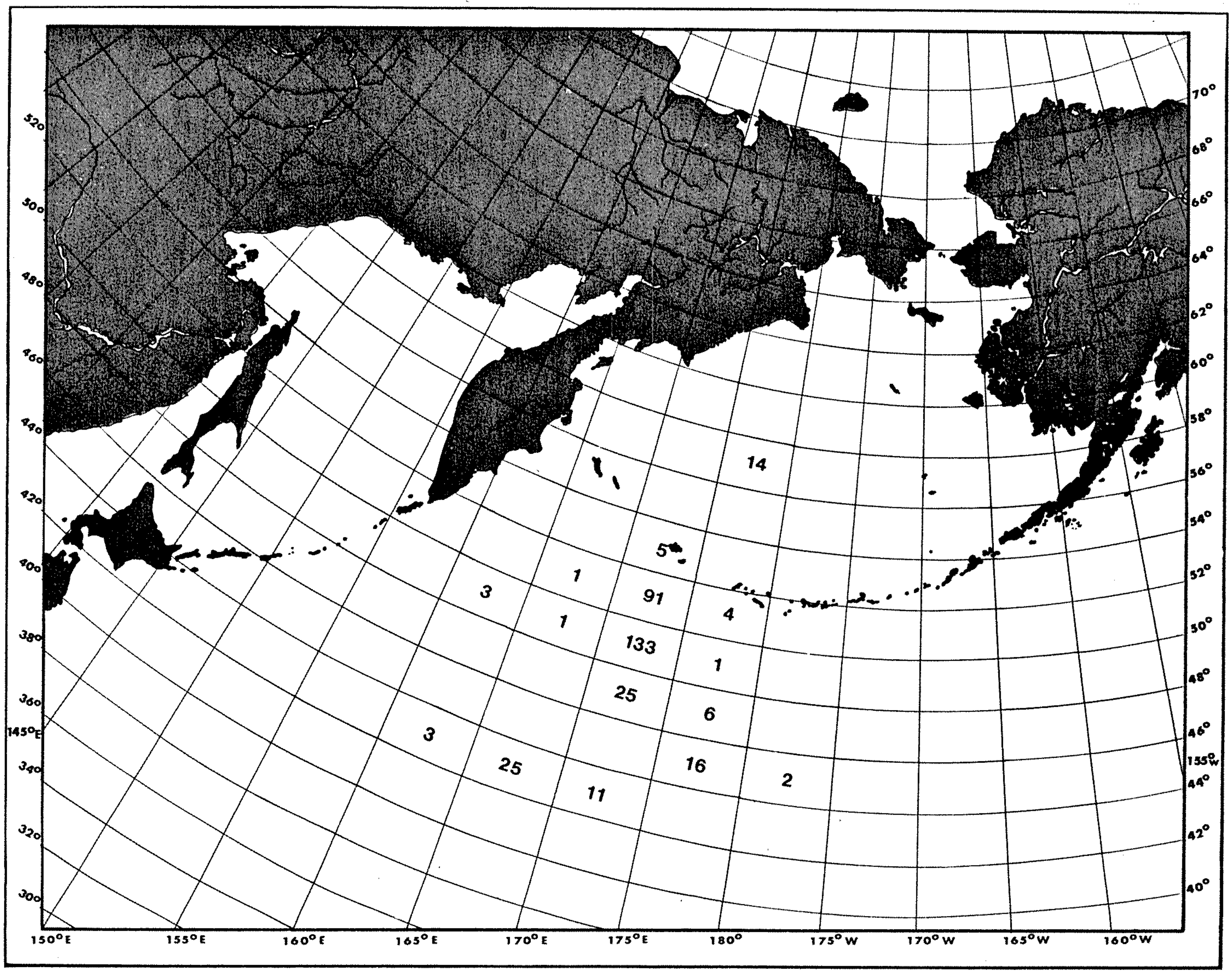

Fig. 7. Distribution of measured unknown origin scale samples of immature age 1.2 chinook salmon collected during June 1980 and stratified by 2° x 5° INPFC areas.

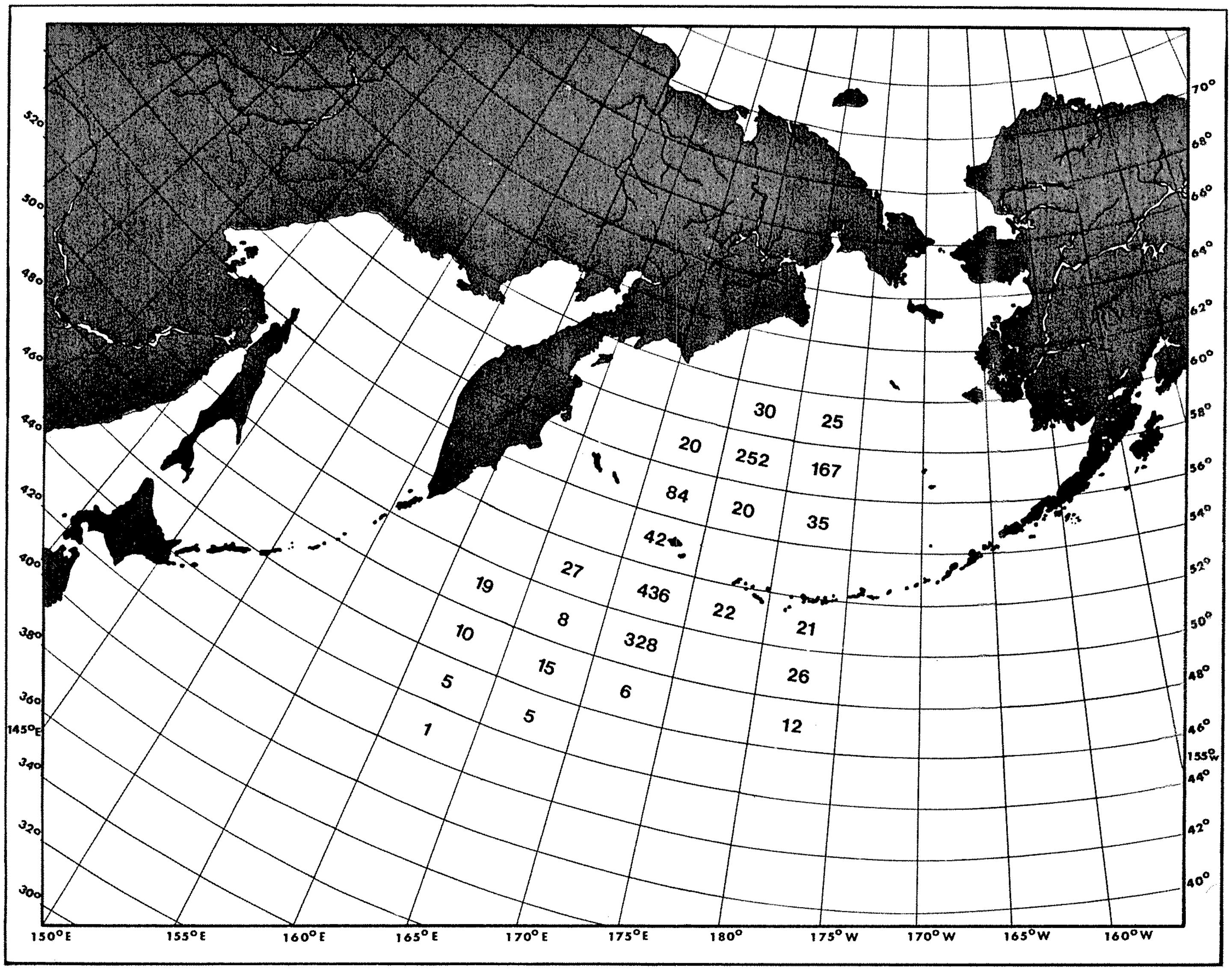

Fig. 8. Distribution of measured unknown origin scale samples of immature age 1.2 chinook salmon collected during July 1980 and stratified by $2^{o} \times 5^{o}$ INPFC areas.

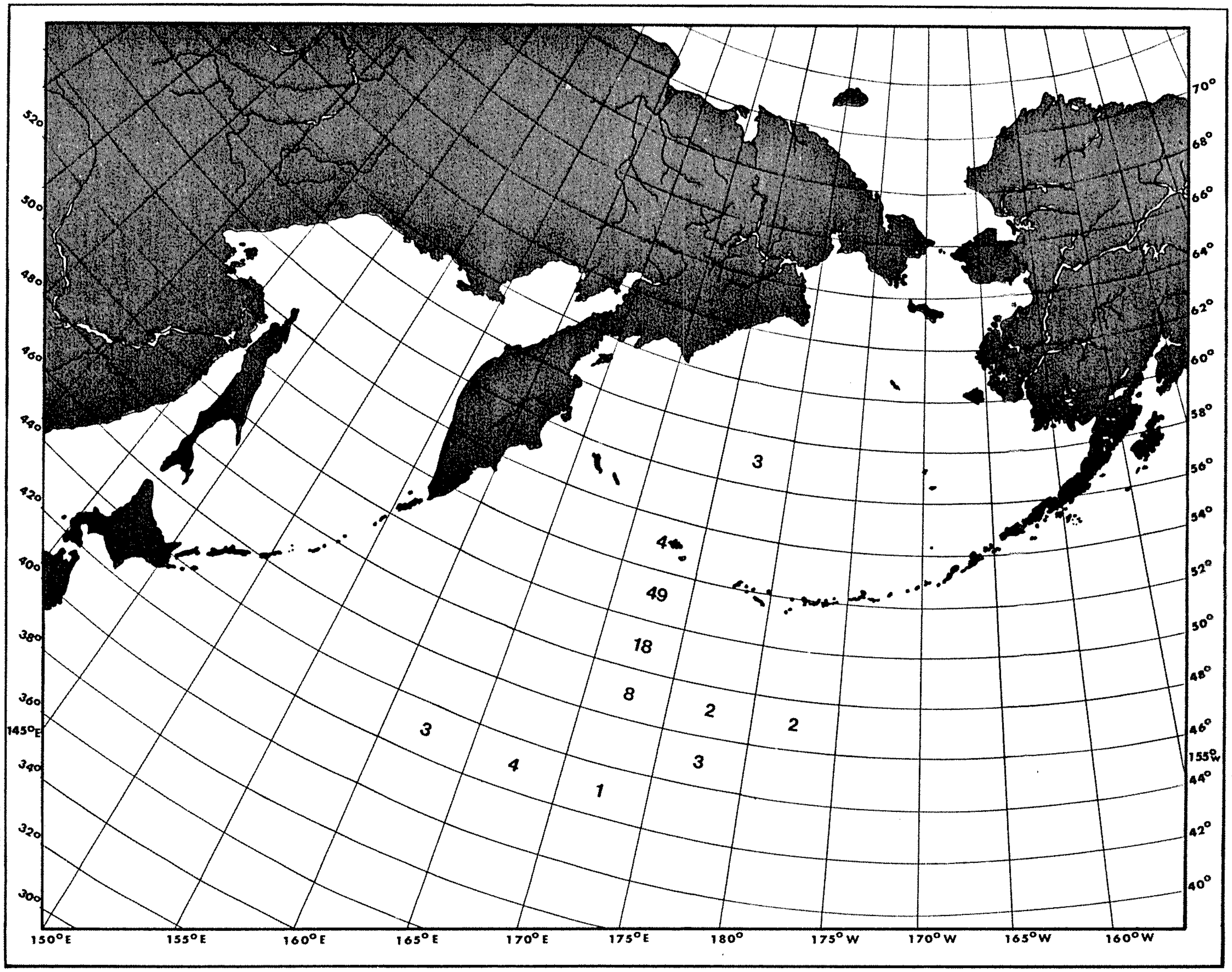

Fig. 9. Distribution of measured unknown origin scale samples of immature age 1.3 chinook salmon collected during June 1980 and stratified by $2^{o} x 5^{o}$ INPFC areas.

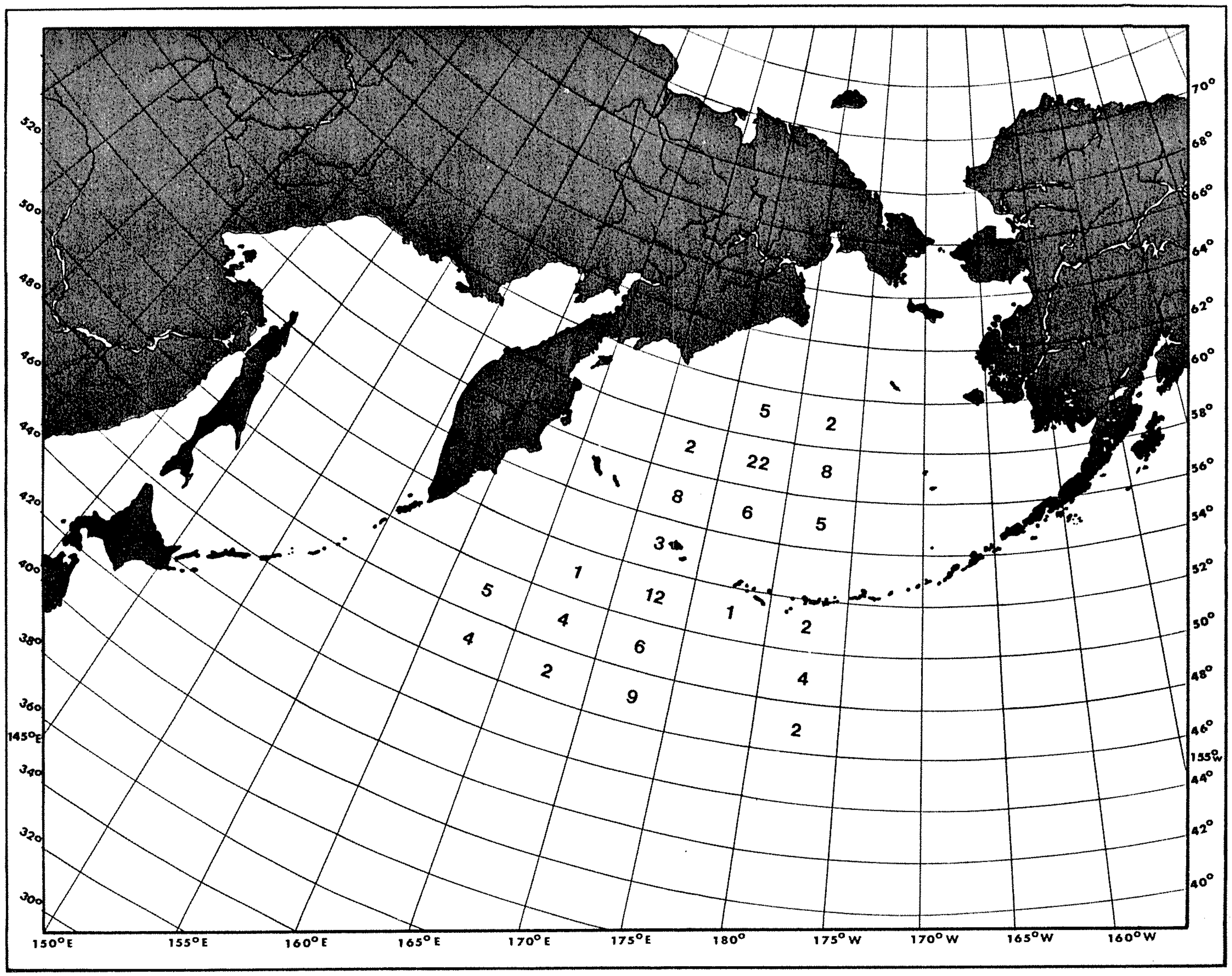

Fig. 10. Distribution of measured unknown origin scale samples of immature age 1.3 chinook salmon collected during July 1980 and stratified by $2^{o} \times 5^{o}$ INPFC areas.

Table 1. Age composition of chinook sampled on the high seas by personnel of the Japanese mothership fishery and of Japanese research vessels in 1980; Japan Fishery Agency age determinations. Proportional age composition of the total aged sample is shown in parentheses.

INPFC	Age groups											Total	No.	Total
area	0.2	0.3	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	Other	aged	regenerated	sample
E6042	0	0	0	0	7	0	3	0	0	0	0	10	3	13
E6044	0	0	0	0	8	0	3	0	1	0	0	12	8	20
E6046	0	0	0	0	20	0	5	0	1	0	0	26	24	50
E6048	0	0	0	0	33	0	6	0	1	0	0	40	11	51
E6542	0	0	0	0	27	0	4	0	0	0	0	31	5	36
E6544	0	0	0	0	5	0	0	0	0	0	0	5	5	10
E6546	0	0	0	0	18	0	1	0	0	0	0	19	12	31
E6548	0	0	0	0	13	0	3	0	0	0	0	16	5	21
E6550	0	0	0	0	40	1	2	0	0	0	0	43	27	70
E6552	0	0	0	0	5	0	0	0	0	0	0	5	3	8
E7042	0	0	0	0	15	0	2	1	1	0	0	19	3	22
E7044	0	0	0	0	2	0	3	0	0	0	0	5	7	12
E7046	0	0	1	0	74	0	39	0	0	0	0	114	67	181
E7048	0	0	0	0	771	4	57	0	1	0	0	833	395	1,228
E7050	0	0	1	0	925	8	112	0	5	0	0	1,051	534	1,585
E7052	0	0	0	0	62	1	8	0	0	0	0	71	44	115
E7054	0	0	1	0	112	0	12	0	0	0	0	125	91	216
E7056	0	0	2	0	26	2	2	0	0	0	0	32	31	63
E7542	0	0	0	0	3	0	0	0	0	0	0	3	2	5
E7544	0	0	0	0	32	0	4	0	0	0	0	36	11	47
E7546	0	0	2	0	13	0	4	0	0	0	0	19	9	28
E7548	0	0	0	0	1	1	0	0	0	0	0	2	4	6
E7550	0	0	0	0	35	1	3	0	0	0	0	39	18	57
E7554	0	0	0	0	32	0	11	0	0	0	0	43	23	66
E7556	0	0	1	0	409	3	37	0	0	0	0	450	309	759
W8042	0	0	0	0	0	0	1	0	0	0	0	1	2	3
W8044	0	0	0	0	3	0	2	0	0	0	0	5	0	5
W8046	0	0	0	0	12	0	3	0	0	0	0	15	11	26
W8048	0	0	0	0	35	0	4	0	0	0	0	39	27	66
W8050	0	0	0	0	34	2	4	0	0	0	0	40	22	62
W8054	0	0	0	0	47	0	4	0	0	0	0	51	23	74
W8056	0	0	1	1	265	1	12	0	0	0	0	280	192	472
W8058	0	0	3	0	38	0	4	0	0	0	0	45	23	68
Total	0	0	12	1	3,122	24	355	1	10	0	0	3,525	1,951	5,476
			(0.0034)	(.0003)	(.8857)	(.0068)	(.1007)	(.0003)	(.0028)					

Table 2. Age composition of chinook sampled on the high seas by personnel of the Japanese mothership fishery and of Japanese research vessels in 1980; Fisheries Research Institute age determinations. Proportional age composition of the total aged sample is shown in parentheses.

INPFC	Age groups											Total	No.	Total
area	0.2	0.3	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	Other	aged	regenerated	sample
E6042	0	0	0	0	5	0	3	0	0	0	0	8	5	13
E6044	0	0	0	0	7	0	2	0	1	0	0	10	10	20
E6046	0	0	0	0	17	0	5	0	1	0	0	23	27	50
E6048	0	0	0	0	26	0	5	0	1	0	0	32	19	51
E6542	0	0	0	0	26	0	4	0	0	0	0	30	6	36
E6544	0	0	0	0	5	0	0	0	0	0	0	5	5	10
E6546	0	0	0	0	15	0	2	0	0	0	0	17	14	31
E6548	0	0	0	0	10	0	4	0	0	0	0	14	7	21
E6550	0	0	0	0	32	1	1	0	0	0	0	34	36	70
E6552	0	0	0	0	1	0	1	0	0	0	0	2	6	8
E7042	0	0	0	0	13	0	3	1	1	0	0	18	4	22
E7044	0	0	0	0	1	0	1	0	0	0	0	2	10	12
E7046	0	1	0	0	60	1	27	0	1	0	1	91	90	181
E7048	20	1	0	0	580	13	41	0	0	0	0	655	573	1,228
E7050	21	4	2	1	719	11	74	0	3	0	2	837	748	1,585
E7052	1	0	0	0	53	1	8	0	0	0	0	63	52	115
E7054	1	1	1	0	91	2	8	0	0	0	0	104	112	216
E7056	0	0	1	0	23	2	1	0	0	0	0	27	36	63
E7542	0	0	0	0	3	0	0	0	0	0	0	3	2	5
E7544	0	0	0	0	31	0	4	0	0	0	0	35	12	47
E7546	0	0	2	0	8	0	3	0	0	0	0	13	15	28
E7548	0	0	0	0	1	0	0	0	0	0	0	1	5	6
E7550	1	0	0	0	31	1	2	0	0	0	0	35	22	57
E7554	0	1	0	0	23	0	6	0	1	0	0	31	35	66
E7556	9	3	1	0	293	4	26	0	0	0	1	337	422	759
W8042	0	0	0	0	0	0	1	0	0	0	0	1	2	3
W8044	0	0	0	0	3	0	2	0	0	0	0	5	0	5
W8046	0	0	0	0	12	0	4	0	0	0	0	16	10	26
W8048	0	0	0	0	26	2	4	0	0	0	1	33	33	66
W8050	0	0	0	0	27	2	2	0	0	0	0	31	31	62
W8054	0	0	0	0	36	0	5	0	1	0	0	42	32	74
W8056	3	0	0	1	179	2	8	0	0	0	0	193	279	472
W8058	1	0	1	0	27	0	2	0	0	0	0	31	37	68
Total	57 (.0205)	11 (.0040)	8 (.0029)	2 (.0007)	2,384 (.8579)	42 (.0151)	259 (.0932)	1 (.0004)	10 (.0036)	0	5 (.0018)	2,779	2,697	5,476

Table 3. Chinook salmon run size estimates, 1981-1982, used in the formation of brood year standards for a) Asia, b) Western Alaska, c) Central Alaska, d) Southeast Alaska/British Columbia, and e) Washington/Oregon/California.

Stock	1981	1982
a) Asian chinook salmon commercial catch estimates.[1]		
Kamchatka River	116,700	--
Bolshaya River	9,000	--
b) Western Alaska chinook salmon total run size estimates.		
Yukon River[2]	410,000	223,000
Kuskokwim River[2]	215,000	199,000
Kanektok River[2]	43,000	32,500
Goodnews Bay[2]	14,300	13,000
Nushagak River[3]	356,369	462,000
Togiak River[3]	51,748	57,400
c) Central Alaska chinook salmon commercial, subsistance and sport catch estimates.		
Cook Inlet[4]	37,412	50,435
Copper River[5]	24,782	54,680
d) Southeast Alaska/British Columbia chinook salmon terminal and in-river commercial, subsistance, and sport catch and escapement estimates.		
Alsek River[6]	4,113	4,824
Taku River[6]	17,153	8,488
Stikine River[6]	27,547	23,675
Nass River[7]	20,787	18,878
Skeena River[7]	55,048	42,627
Bella Coola River[7]	9,087	14,850
Fraser River[8]	84,888	124,692

Table 3. Chinook salmon run size estimates, 1981-1982, used in the formation of brood year standards for a) Asia, b) Western Alaska, c) Central Alaska, d) Southeast Alaska/British Columbia, and e) Washington/Oregon/California - cont'd.

Stock	1981	1982
e) Washington/Oregon/California chinook salmon terminal and in-river commercial (treaty and non-treaty) and sport catch and escapement estimates.		
Washington Inland Waters[9]	426,900	454,971
Washington Coast[10]	71,170	65,046
Columbia River - spring chinook[11]	140,350	136,300
Columbia River - fall chinook[11]	241,500	291,600
Oregon Coast[12]	188,170	184,773
California[13]	411,721	342,961

[1]Unofficial commercial catch statistics.

[2]Based on harvest, an escapement index and an educated guess as to probable exploitation rate (pers. comm., R. I. Regnart, ADF&G, Div. Comm. Fish., Dec. 16, 1982).

[3]Based on commercial and subsistence catch and escapement estimates (ADF&G, 1982a, 1982b; McBride and Wilcock, 1983; pers. comm., S. R. Behnke, ADF&G, Subsist. Div., Dec. 22, 1982; pers. comm., W. A. Bucher, ADF&G, Div. Comm. Fish., Dec. 22, 1982).

[4]ADF&G, 1981, 1982b; McBride and Wilcock, 1983; pers. comm., S. C. Hammarstrom, ADF&G, Div. Sport Fish., Jan. 25, 1983; pers. comm., P. H. Ruesch, ADF&G, Div. Comm. Fish., Jan. 25, 1983.

[5]ADF&G, 1981; McBride and Wilcock, 1983; pers. comm., M. F. Merritt, ADF&G, Div. Comm. Fish., Jan. 20, 1983; pers. comm., W. D. Potterville and F. T. Williams, ADF&G, Div. Sport Fish., Jan. 21, 1983.

[6]Anon., 1981; Can. Dept. Fish. Oceans, 1982; Kissner, 1983; pers. comm., P. D. Kissner, Jr., ADF&G, Div. Sport Fish., 1983; pers. comm., D. N. McBride, ADF&G, Div. Comm. Fish., 1983; pers. comm., D. J. Reid, Can. Dept. Fish. Oceans, Econ. and Stat. Branch, 1983.

[7]Pers. comm., P. J. Starr, Can. Dept. Fish. Oceans, 1983.

[8]Can. Dept. Fish. Oceans, 1981; Fraser et al. 1982; pers. comm., P. J. Starr, Can. Dept. Fish. Oceans, 1983.

[9]Pers. comm., L. Stearn, Wash. Dept. Fish., Jan. 17, 1983.

[10]Pers. comm., M. Barker, Wash. Dept. Fish., Feb. 9, 1983.

[11]Pacific Fish. Mgt. Council, 1981; pers. comm., J. Galbreath, Ore. Dept. Fish. Wildl., Dec., 1982.

[12]Solazzi and Martin, 1982; pers. comm., R. Berry, Ore. Dept. Fish. Wildl., Jan. 24, 1983; pers. comm., A. McGie, Ore. Dept. Fish. Wildl., Jan. 24, 1983.

[13]Pers. comm., W. Harper, U.S. Fish Wildl. Serv., Nov. 1982; pers. comm., P. Hubbell, Calif. Dept. Fish Game, Dec., 1982, Jan., 1982.

Table 4. Age composition of Asian chinook salmon scale samples.

Stock: Kamchatka River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	171	.01	.01	.00	.02	.77	.19	.01	.00
1982	--	-	-	-	-	-	-	-	-

Stock: Bolshaya River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	178	.01	.02	.00	.00	.46	.43	.09	.00
1982	--	-	-	-	-	-	-	-	-

Table 5. Age composition of Western Alaska chinook salmon scale samples.

Stock: Yukon River (Emmonak fishery)

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	794	.00	.00	.00	.07	.20	.71	.02	.00
1982	1064	.00	.00	.00	.10	.23	.50	.10	.07

Stock: Kuskokwim River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981[1]	669	.00	.00	.00	.10	.32	.57	.01	.00
1982[2]	407	.00	.01	.01	.12	.19	.59	.06	.02

[1]Bethel and Kwegooyuk fisheries.
[2]Bethel and Kwegooyuk fisheries and Aniak sonar sampling site.

Stock: Kanektok River (Quinhagak fishery)

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	312	.00	.00	.00	.60	.18	.20	.01	.01
1982	209	.00	.01	.00	.09	.59	.24	.03	.04

Stock: Goodnews Bay

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	124	.00	.00	.00	.57	.17	.26	.00	.00
1982	64	.00	.02	.00	.09	.64	.20	.02	.03

Table 5. Age composition of Western Alaska chinook salmon scale samples - cont'd.

Stock: Nushagak River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	654	.00	.00	.00	.25	.33	.41	.01	.00
1982	501	.00	.00	.01	.04	.47	.42	.04	.02

Stock: Togiak River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	127	.00	.00	.00	.40	.23	.35	.01	.02
1982	217	.00	.00	.01	.11	.56	.23	.03	.06

Table 6. Age composition of Central Alaska chinook salmon scale samples.

Stock: Cook Inlet

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981[1]	1215	.00	.00	.00	.18	.40	.35	.02	.05
1982[2]	749	.00	.00	.00	.29	.37	.31	.01	.02

[1]Tyonek fishery, Kenai R., Deep Cr., Anchor R., Ninilchik R.
[2]Tyonek fishery.

Stock: Copper River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	153	.00	.00	.00	.05	.44	.44	.00	.07
1982	1399	.00	.00	.00	.06	.52	.23	.00	.19

Table 7. Age composition of Southeast Alaska and British Columbia chinook salmon scale samples.

Stock: Fraser River

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	356	.14	.35	.04	.16	.29	.03	.00	.00
1982	779	.15	.34	.01	.17	.27	.02	.00	.02

Stock: Nass River

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	94	.04	.14	.06	.10	.31	.31	.00	.04
1982	105	.00	.00	.00	.26	.60	.14	.00	.00

Stock: Skeena River

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	129	.01	.11	.07	.13	.28	.40	.00	.00
1982	161	.01	.01	.04	.18	.44	.30	.01	.02

Stock: Bella Coola River (Atnarko)

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	125	.03	.29	.13	.08	.29	.18	.00	.01
1982	219	.06	.24	.13	.15	.22	.16	.00	.04

Stock: Alsek River

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	63	.00	.00	.03	.14	.41	.37	.00	.05
1982	178	.01	.00	.02	.14	.43	.40	.00	.00

Table 7. Age composition of Southeast Alaska and British Columbia chinook salmon scale samples - cont'd.

Stock: Taku River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	919	.00	.00	.00	.23	.30	.36	.00	.11
1982	114	.00	.00	.00	.02	.16	.81	.01	.00

Stock: Stikine River

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981	613	.00	.03	.02	.04	.29	.58	.01	.03
1982	435	.00	.00	.00	.05	.15	.76	.02	.02

Table 8. Age composition of Washington, Oregon, and California chinook salmon scale samples.

Stock: Washington Inland Waters

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981[1]	506	.14	.70	.05	.07	.03	.00	.00	.01
1982[2]	761	.30	.42	.09	.12	.06	.00	.00	.02

[1]Nooksack/Samish, Skagit, Stillaguamish/Snohomish, Duwamish, Hood Canal.
[2]Nooksack/Samish, Skagit, Stillaguamish/Snohomish, Duwamish, Hood Canal, Puyallup, Deschutes.

Stock: Washington Coast

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981[1]	827	.16	.42	.34	.01	.01	.00	.00	.06
1982[2]	1529	.17	.31	.44	.01	.01	.00	.00	.06

[1]Quileute, Quinault, Queets, Humptulips, Chehalis, Willapa Bay.
[2]Quileute, Quinault, Queets, Humptulips, Chehalis.

Stock: Columbia River - fall chinook

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	338	.30	.37	.11	.02	.01	.00	.00	.19
1982	--	-	-	-	-	-	-	-	-

Stock: Columbia River - spring chinook

Year	Total number readable	0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
		Percent composition of readable scales — Age							
1981	338	.01	.03	.02	.59	.36	.01	.00	.00
1982	480	.00	.00	.00	.43	.45	.01	.00	.00

Table 8. Age composition of Washington, Oregon and California chinook salmon scale samples - cont'd.

Stock: Oregon Coast

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981[1]	547	.24	.41	.25	.00	.01	.01	.00	.08
1982[2]	361	.12	.35	.30	.02	.01	.05	.00	.14

[1]Yaquina, Rogue.
[2]Siuslaw, Nestucca, Tillamook, Yaquina, Coos, Coquille.

Stock: California

Year	Total number readable	Percent composition of readable scales							
		Age							
		0.2	0.3	0.4	1.2	1.3	1.4	1.5	Other
1981[1]	566	.42	.20	.02	.02	.05	.00	.00	.29
1982[2]	1506	.31	.43	.01	.03	.00	.00	.00	.22

[1]Klamath and Sacramento.
[2]Klamath.

Table 9. Composition of brood year 1975 standard used to classify age 1.3 immature chinook caught in 1980. A Washington/ Oregon/California standard could not be constructed due to insufficient numbers of age 1.4 and 1.5 chinook salmon.

Region	Stock	Return year	Age class	Sample size needed	Final sample size
Asia	Kamchatka	1981	1.4	170	33
	Bolshaya	1981	1.4	30	72
Asia Total				200	105
Western Alaska	Nushagak	1981	1.4	46	46
		1982	1.5	6	6
	Togiak	1981	1.4	6	6
	Kuskokwim	1981	1.4	38	38
		1982	1.5	4	4
	Kanektok	1981	1.4	2	2
	Goodnews	1981	1.4	2	2
	Yukon	1981	1.4	90	90
		1982	1.5	6	6
Western Alaska Total				200	200
Central Alaska	Cook Inlet	1981	1.4	106	105
		1982	1.5	4	4
	Copper River	1981	1.4	90	29
Central Alaska Total				200	138
Southeast Alaska/ British Columbia	Fraser	1981	1.4	8	6
	Nass	1981	1.4	22	22
	Skeena	1981	1.4	76	49
		1982	1.5	2	2
	Bella Coola	1981	1.4	6	6
	Alsek	1981	1.4	6	6
	Taku	1981	1.4	22	22
	Stikine	1981	1.4	56	56
		1982	1.5	2	2
Southeast Alaska/British Columbia Total				200	171

Table 10. Composition of brood year 1976 standard used to classify age 1.2 immature chinook salmon caught in 1980.

Region	Stock	Return year	Age class	Sample size needed	Final sample size
Asia	Kamchatka	1981	1.3	192	127
	Bolshaya	1981	1.3	8	8
Asia Total				200	135
Western Alaska	Nushagak	1981	1.3	32	32
		1982	1.4	54	54
	Togiak	1981	1.3	4	4
		1982	1.4	4	4
	Kuskokwim	1981	1.3	18	18
		1982	1.4	32	32
	Kanektok	1981	1.3	2	2
		1982	1.4	2	2
	Yukon	1981	1.3	22	22
		1982	1.4	30	30
Western Alaska Total				200	200
Central Alaska	Cook Inlet	1981	1.3	56	56
		1982	1.4	58	58
	Copper River	1981	1.3	40	36
		1982	1.4	46	45
Central Alaska Total				200	195
Southeast Alaska/ British Columbia	Fraser	1981	1.3	44	44
		1982	1.4	4	4
	Nass	1981	1.3	12	12
		1982	1.4	4	4
	Skeena	1981	1.3	28	28
		1982	1.4	24	24
	Bella Coola	1981	1.3	4	4
		1982	1.4	4	4
	Alsek	1981	1.3	4	4
		1982	1.4	4	4
	Taku	1981	1.3	10	10
		1982	1.4	12	12
	Stikine	1981	1.3	14	14
		1982	1.4	32	32
Southeast Alaska/British Columbia Total				200	200

Table 10. Composition of brood year 1976 standards - cont'd.

Region	Stock	Return year	Age class	Sample size needed	Final sample size
Washington/Oregon/ California	California	1981	1.3	42	21
	Oregon Coast	1981	1.3	4	4
		1982	1.4	18	15
	Columbia R. Springs	1981	1.3	100	94
		1982	1.4	2	2
	Columbia R. Falls	1981	1.3	4	2
	Washington Coast	1981	1.3	2	2
		1982	1.4	2	0
	Washington Inland Waters	1981	1.3	26	11
Washington/Oregon/California Total				200	151

Table 11. Scale characters used in the scale pattern analysis of 1980 immature age 1.2 and 1.3 Japanese mothership and research vessel-caught chinook.

Character No.	Description[a]
1	Size Zone 1
2	Size Zone 2
3	Size Zone 3
4	Size Zone 1 + size Zone 2
5	Size Zone 2 + size Zone 3
6	Size Zone 1 + size Zone 2 + size Zone 3
7	No. circuli Zone 1 + no. circuli Zone 2 + no. circuli Zone 3
8	Size Zone 2/(size Zone 1 + size Zone 2 + size Zone 3)
9	(Size Zone 1 + size Zone 2 + size Zone 3)/(no. circuli Zone 1 + no. circuli Zone 2 + no. Zone 3)
10	(Size Zone 1 + size Zone 2)/(size Zone 1 + size Zone 2 + size Zone 3)
11	(Size Zone 2 + size Zone 3)/(size Zone 1 + size Zone 2 + size Zone 3)
12	No. circuli Zone 1
13	No. circuli Zone 2
14	No. circuli Zone 3
15	No. circuli Zone 1 + no. circuli Zone 2
16	No. circuli Zone 2 + no. circuli Zone 3
17	Size Zone 1/no. circuli Zone 1
18	Size Zone 2/no. circuli Zone 2
19	Size Zone 3/no. circuli Zone 3
20	(Size Zone 1 + size Zone 2)/(no. circuli Zone 1 + no. circuli Zone 2)
21	(Size Zone 2 + size Zone 3)/(no. circuli Zone 2 + no. circuli Zone 3)
22	Distance C1 to C3 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
23	Distance C4 to C6 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
24	Distance C7 to C9 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
25	Distance C10 to C12 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
26	Distance C13 to C15 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
27	Distance C16 to C18 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
28	Distance C19 to C21 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
29	Distance C22 to C24 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
30	Distance C25 to C27 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
31	Distance C28 to C30 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
32	Distance C31 to C33 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
33	Distance C34 to C36 in Zones 2+3/(size Zone 1 + size Zone 2 + size Zone 3)
34	Distance C1 to C9 in Zones 2+3
35	Distance C10 to C18 in Zones 2+3
36	Distance C19 to C27 in Zones 2+3
37	Distance C28 to C36 in Zones 2+3
38	Radius of focus
39	Distance C2-C4 in Zone 1
40	Distance C5-C7 in Zone 1
41	Distance C8-C10 in Zone 1
42	Distance C11-C13 in Zone 1

Table 11. Scale characters used in the scale pattern analysis of 1980 immature age 1.2 and 1.3 Japanese mothership and research vessel-caught chinook-continued.

Character No.	Description[a]
43	Distance C14-C16 in Zone 1
44	Distance C2-C4 in Zone 1/(size Zone 1 + size Zone 2 + size Zone 3)
45	Distance C5-C7 in Zone 1/(size Zone 1 + size Zone 2 + size Zone 3)
46	Distance C8-C10 in Zone 1/(size Zone 1 + size Zone 2 + size Zone 3)
47	Distance C11-C13 in Zone 1/(size Zone 1 + size Zone 2 + size Zone 3)
48	Distance C14-C16 in Zone 1/(size Zone 1 + size Zone 2 + size Zone 3)
49	Distance C1 to C3 in Zones 2+3
50	Distance C4 to C6 in Zones 2+3
51	Distance C7 to C9 in Zones 2+3
52	Distance C10 to C12 in Zones 2+3
53	Distance C13 to C15 in Zones 2+3
54	Distance C16 to C18 in Zones 2+3
55	Distance C19 to C21 in Zones 2+3
56	Distance C22 to C24 in Zones 2+3
57	Distance C25 to C27 in Zones 2+3
58	Distance C28 to C30 in Zones 2+3
59	Distance C31 to C33 in Zones 2+3
60	Distance C34 to C36 in Zones 2+3

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

Zone 2: The area 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 area 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.

C_n: The incremental distance from the outer edge of the previous circulus (C_{n-1}) to the outer edge of circulus n.

Table 12. The scale characters used in five, four, three, and two-way discriminant analyses of immature age 1.2 and 1.3 chinook salmon are indicated by asterisks.

Age-maturity group classified	Number of regions included	Regional combinations used to classify unknowns[1]	Scale characters (by number) used to classify unknowns[2]																		
			3	5	6	7	9	11	12	14	16	18	19	26	27	31	36	38	56	57	58
1.2 immatures of unknown origin	5	A/W/C/SEBC/WOC	*			*		*			*			*			*				
	4	A/W/C/SEBC						*		*	*						*			*	*
	3	A/W/C	*							*	*						*			*	*
		A/W/SEBC	*							*					*		*		*		*
		A/C/SEBC						*	*	*	*	*			*						
	2	A/W	*	*	*											*				*	*
		W/C					*						*				*				
		W/SEBC					*						*				*				
1.3 immatures of of unknown origin	4	A/W/C/SEBC		*		*				*			*				*	*			
	3	A/W/SEBC		*		*				*			*				*			*	

[1] Asia = A
Western Alaska = W
Central Alaska = C
Southeast Alaska/British Columbia = SEBC
Washington/Oregon/California = WOC

[2] Scale characters are described in Table 11.

Table 13. Decision array for the five-way regional classification of brood year 1976 age 1.3 and 1.4 chinook salmon of Asian, Western Alaska, Central Alaska, Southeast Alaska/British Columbia, and Washington/Oregon/California (Wash/Or/Calif) origin. Overall classification accuracy was 70.0 percent.

Calculated decision	Correct decision (%)				
	Asia	Western Alaska	Central Alaska	Southeast Alaska/ British Columbia	Wash/Or/Calif
Asia	110(81.5)	7(3.5)	18(9.2)	10(5.0)	0(0)
Western Alaska	9(6.7)	154(77.0)	28(14.4)	5(2.5)	1(0.7)
Central Alaska	8(5.9)	31(15.5)	104(53.3)	47(23.5)	1(0.7)
Southeast Alaska/ British Columbia	8(5.9)	7(3.5)	45(23.1)	108(54.0)	22(14.6)
Wash/Or/Calif	0(0)	1(0.5)	0(0)	30(15.0)	127(84.1)
Total	135	200	195	200	151

Table 14. Decision array for the four-way classification of brood year 1976 age 1.3 and 1.4 chinook salmon of Asian, Western Alaska, Central Alaska and Southeast Alaska/British Columbia (S.E. Alaska/B.C.) origin. Overall classification accuracy was 68.4 percent.

	Correct decision (%)			
Calculated decision	Asia	Western Alaska	Central Alaska	S.E. Alaska/ B.C.
Asia	105(77.8)	8(4.0)	20(10.3)	15(7.5)
Western Alaska	10(7.4)	157(78.5)	24(12.3)	5(2.5)
Central Alaska	11(8.1)	29(14.5)	101(51.8)	49(24.5)
S.E. Alaska/ B.C.	9(6.7)	6(3.0)	50(25.6)	131(65.5)
Total	135	200	195	200

Table 15. Decision arrays for the three three-way regional classifications of brood year 1976 age 1.3 and 1.4 chinook salmon of a) Asian, Western Alaska, and Southeast Alaska/British Columbia (S.E. Alaska/B.C.) origin, b) Asian, Western Alaska, and Central Alaska origin, and c) Asian, Central Alaska, and S.E. Alaska/B.C. origin. Overall classification accuracies were 85.0, 76.2 and 75.4 percent, respectively.

a) Asia vs. Western Alaska vs. S.E. Alaska/B.C.

Calculated	Correct decision (%)		
decision	Asia	Western Alaska	S.E. Alaska/B.C.
Asia	116(85.9)	15(7.5)	15(7.5)
Western Alaska	12(8.9)	167(83.5)	14(7.0)
S.E. Alaska/B.C.	7(5.2)	18(9.0)	171(85.5)
Total	135	200	200

b) Asia vs. Western Alaska vs. Central Alaska

Calculated	Correct decision (%)		
decision	Asia	Western Alaska	Central Alaska
Asia	105(77.8)	15(7.5)	28(14.4)
Western Alaska	12(8.9)	156(78.0)	25(12.8)
Central Alaska	18(13.3)	29(14.5)	142(72.8)
Total	135	200	195

c) Asia vs. Central Alaska vs. S.E. Alaska/B.C.

Calculated	Correct decision (%)		
decision	Asia	Central Alaska	S.E. Alaska/B.C.
Asia	113(83.7)	20(10.3)	12(6.0)
Central Alaska	16(11.9)	133(68.5)	40(20.0)
S.E. Alaska/B.C.	6(4.4)	42(21.5)	148(74.0)
Total	135	195	200

Table 16. Decision arrays for the three two-way regional classifications of brood year 1976 age 1.3 and 1.4 chinook salmon of a) Asian and Western Alaska origin, b) Western Alaska and Central Alaska origin, and c) Western Alaska and Southeast Alaska/British Columbia origin. Overall classification accuracies were 89.0, 81.3, and 90.3 percent, respectively.

a) Asia vs. Western Alaska

Calculated decision	Correct decision (%)	
	Asia	Western Alaska
Asia	120(88.9)	22(11.0)
Western Alaska	15(11.1)	178(89.0)
Total	135	200

b) Western Alaska vs. Central Alaska

Calculated decision	Correct decision (%)	
	Western Alaska	Central Alaska
Western Alaska	163(81.5)	37(19.0)
Central Alaska	37(18.5)	158(81.0)
Total	200	195

c) Western Alaska vs. Southeast Alaska/British Columbia

Calculated decision	Correct decision (%)	
	Western Alaska	Southeast Alaska/ British Columbia
Western Alaska	180(90.0)	19(9.5)
Southeast Alaska/ British Columbia	20(10.0)	181(90.5)
Total	200	200

Table 17. Decision array for the four-way regional classification of brood year 1975 age 1.4 and 1.5 chinook salmon of Asia, Western Alaska, Central Alaska, and Southeast Alaska/British Columbia (S.E. Alaska/B.C.) origin. Overall classification accuracy was 79.3 percent.

Calculated decision	Correct decision (%)			
	Asia	Western Alaska	Central Alaska	S.E. Alaska/ B.C.
Asia	94(89.5)	0(0.0)	13(9.5)	1(0.6)
Western Alaska	0(0.0)	162(81.0)	15(10.9)	14(8.2)
Central Alaska	11(10.5)	20(10.0)	93(67.9)	21(12.3)
S.E. Alaska/B.C.	0(0.0)	18(9.0)	16(11.7)	135(78.9)
Total	105	200	137	171

Table 18. Decision array for the three-way classification of brood year 1975 age 1.4 and 1.5 chinook salmon of Asian, Western Alaska, and Southeast Alaska/British Columbia (S.E. Alaska/B.C.) origin. Overall accuracy was 87.5 percent.

Calculated decision	Correct decision (%)		
	Asia	Western Alaska	S.E. Alaska/B.C.
Asia	99(94.3)	3(1.5)	7(4.1)
Western Alaska	3(2.9)	169(84.5)	21(12.3)
S.E. Alaska/B.C.	3(2.9)	28(14.0)	143(83.6)
TOTAL	105	200	171

Table 19. Mixing proportion estimates for age 1.2 immature chinook salmon by 10-day period and International North Pacific Fishery Commission (INPFC) areas. Data are in percentages with 90% confidence intervals in parentheses.

10-day period	Area	Sample size	Asia	Western Alaska	Central Alaska	Southeast Alaska/ British Columbia	Washington/ Oregon/California
June 1-10	E7046	25	53.9(18.6-89.2)	40.4(4.5-76.4)	1.3(0-50.0)	4.4(0-36.7)	0
June 21-30	E6542	25	21.0(0-44.7)	42.6(14.6-70.7)	0	36.3(9.6-63.1)	0
	E7048	112	47.2(29.5-64.8)	19.7(4.8-34.5)	7.9(0-36.8)	25.3(1.6-49.0)	0
	E7050	64	26.4(6.1-46.7)	43.7(16.7-70.6)	11.5(0-54.6)	18.2(0-56.3)	0.2(0-10.8)
July 1-10	E7048	33	28.5(4.9-52.0)	0	51.3(14.4-88.3)	20.2(0-51.1)	0
	E7050	29	25.6(2.6-48.6)	17.3(0-38.9)	0	57.1(31.4-82.8)	0
	E7054	60	13.9(0-30.4)	70.7(49.0-92.3)	15.4(0-36.6)	0	0
	E7556	141	10.5(0-21.3)	78.9(63.8-94.0)	10.6(0-25.1)	0	0
	W8056	65	4.2(0-17.5)	91.5(71.5-100.0)	4.2(0-23.2)	0	0
July 11-20	E7048	51	47.9(28.4-67.5)	15.3(0-31.6)	0	36.8(18.2-55.3)	0
	E7050	122	43.6(26.9-60.3)	16.9(3.3-30.5)	5.6(0-34.4)	33.9(9.4-58.4)	0
	E7052	42	18.8(0-40.5)	48.7(20.5-76.9)	0.4(0-46.5)	32.0(0-69.5)	0
	E7556	106	19.8(10.0-29.6)	80.2(70.4-90.0)	0	0	0
	W8048	26	29.7(4.6-54.7)	30.3(4.4-56.3)	0	40.0(13.6-66.4)	0
	W8054	35	0	100.0	0	0	0
	W8056	102	6.3(0-17.8)	81.5(64.4-98.6)	12.2(0-29.0)	0	0
July 21-31	E6550	26	38.6(4.8-72.5)	21.3(0-52.7)	25.7(0-88.5)	14.4(0-60.9)	0
	E7048	244	40.6(28.0-53.2)	11.2(1.1-21.3)	30.3(6.2-54.3)	17.9(0-36.2)	0
	E7050	285	43.8(32.1-55.6)	26.7(16.0-37.4)	6.7(0-26.4)	22.8(7.3-38.3)	0
	E7558	30	0	100.0	0	0	0

Table 20. Mixing proportion estimates for age 1.2 immature chinook salmon by month and International North Pacific Fishery Commission (INPFC) area. Data are in percentages with 90% confidence intervals in parentheses.

Month	Area	Sample size	Asia	Western Alaska	Central Alaska	Southeast Alaska/ British Columbia	Washington/ Oregon/California
June	E6542	25	21.0(0-44.7)	42.6(14.6-70.7)	0	36.3(9.6-63.1)	0
	E7046	25	53.9(18.6-89.2)	40.4(4.5-76.4)	1.3(0-50.0)	4.4(0-36.7)	0
	E7048	133	45.6(29.4-61.8)	21.9(7.7-36.2)	11.7(0-38.9)	20.8(0-42.1)	0
	E7050	91	18.3(2.8-33.8)	58.2(33.7-82.7)	14.5(0-52.1)	8.1(0-37.1)	0.8(0-8.5)
July	E6550	27	42.1(8.3-75.8)	20.1(0-50.5)	24.2(0-84.9)	13.6(0-58.4)	0
	E7048	328	44.3(32.8-55.8)	10.1(1.3-18.9)	26.5(5.3-47.6)	19.1(2.9-35.3)	0
	E7050	436	43.7(33.5-53.9)	23.1(14.2-31.9)	7.9(0-25.3)	25.4(11.5-39.2)	0
	E7052	42	18.8(0-40.5)	48.7(20.5-76.9)	0.4(0-46.5)	32.0(0-69.5)	0
	E7054	84	13.4(0-27.4)	78.4(56.4-100.0)	3.7(0-36.3)	4.5(0-23.1)	0
	E7556	252	15.9(6.7-25.1)	78.7(66.3-91.1)	5.4(0-16.9)	0	0
	E7558	30	0	100.0	0	0	0
	W8048	26	29.7(4.6-54.7)	30.3(4.4-56.3)	0	40.0(13.6-66.4)	0
	W8054	35	0	100.0	0	0	0
	W8056	167	11.3(1.4-21.3)	84.6(67.6-100.0)	2.9(0-28.5)	1.2(0-14.3)	0
	W8058	25	0	84.8(60.4-100.0)	15.2(0-39.6)	0	0

Table 21. Mixing proportion estimates for age 1.2 immature chinook salmon by 10-day period or month and sub-areas. Data are in percentages with 90% confidence intervals in parentheses.

Time period	Sub-area	Sample size	Asia	Western Alaska	Central Alaska	Southeast Alaska/ British Columbia	Washington/ Oregon/California
June 1-10	5	33	40.7(17.0-64.3)	37.4(13.2-61.6)	0	22.0(1.2-42.7)	0
June 11-20	5	40	6.8(0-25.7)	53.6(27.2-80.0)	39.6(10.8-68.4)	0	0
June 21-30	5	181	44.5(30.4-58.6)	25.4(12.6-38.2)	8.9(0-32.5)	21.2(2.7-39.7)	0
	12	25	21.0(0-44.7)	42.6(14.6-70.7)	0	36.3(9.6-63.1)	0
July 1-10	5	62	50.3(26.5-74.1)	4.4(0-20.6)	30.6(0-73.1)	14.7(0-46.9)	0
	6	60	13.9(0-30.4)	70.7(49.0-92.3)	15.4(0-36.6)	0	0
	8	141	10.5(0-21.3)	78.9(63.8-94.0)	10.6(0-25.1)	0	0
	10	74	2.5(0-14.5)	94.5(75.8-100.0)	3.0(0-20.9)	0	0
July 11-20	5	221	40.4(27.6-53.1)	21.8(10.6-32.9)	7.0(0-29.7)	30.8(12.2-49.5)	0
	6	36	4.6(0-19.7)	92.4(71.6-100.0)	0	3.0(0-18.5)	0
	8	126	16.4(3.5-29.2)	72.4(50.5-94.4)	6.8(0-38.5)	3.6(0-25.5)	0.8(0-6.5)
	9	39	29.7(9.1-50.2)	37.0(14.9-59.2)	0	33.3(12.3-54.3)	0
	10	137	9.1(0-18.5)	90.8(78.5-100.0)	0	0.1(0-8.6)	0
July 21-31	3	28	35.0(2.9-67.1)	23.3(0-54.6)	31.3(0-93.5)	10.4(0-54.7)	0
	5	529	42.3(32.8-51.8)	19.6(11.5-27.6)	17.6(0.6-34.6)	20.5(7.5-33.5)	0
	8	35	1.4(0-15.2)	95.4(74.9-100.0)	0	3.2(0-19.2)	0
June	5	254	41.6(29.6-53.7)	34.2(22.2-46.3)	9.7(0-30.1)	14.4(0-29.2)	0
	12	25	21.0(0-44.7)	42.6(14.6-70.7)	0	36.3(9.6-63.1)	0
July	3	50	19.3(0-41.2)	15.1(0-37.6)	51.9(0-100.0)	13.7(0-53.1)	0
	5	812	42.4(34.0-50.8)	19.0(12.0-26.0)	15.7(0.6-30.8)	22.9(11.2-34.6)	0
	6	104	16.2(4.6-27.8)	79.7(65.3-94.0)	0	4.1(0-14.0)	0
	8	302	12.9(4.4-21.4)	82.7(70.9-94.5)	4.4(0-15.4)	0	0
	9	59	25.1(5.2-45.1)	43.7(20.0-67.4)	3.4(0-42.5)	27.7(0-59.0)	0
	10	227	9.5(1.6-17.5)	89.7(79.1-100.0)	0	0.8(0-8.2)	0

Table 22. Mixing proportion estimates for age 1.2 immature chinook salmon by 10-day period or month, and by high seas region (S 46°N, 46°N-52°N). Data are in percentages with 90% confidence intervals in parentheses.

Time period	Area	Sample size	Asia	Western Alaska	Central Alaska	Southeast Alaska/ British Columbia	Washington/ Oregon/California
June 1-10	46°N-52°N	35	37.8(15.1-60.5)	42.2(18.2-66.2)	0	20.0(0.2-39.8)	0
June 11-20	46°N-52°N	41	6.4(0-24.9)	55.6(29.4-81.7)	38.0(9.6-66.4)	0	0
June 21-30	S 46°N	41	9.1(0-24.6)	48.0(25.7-70.3)	0	42.9(21.2-64.6)	0
	46°N-52°N	189	43.4(29.6-57.3)	22.9(10.6-35.3)	12.5(0-36.2)	21.1(2.6-39.7)	0
July 1-10	46°N-52°N	117	28.8(13.0-44.6)	16.0(1.3-30.7)	36.7(2.6-70.8)	18.5(0-44.2)	0
	N 52°N	275	9.1(0.7-17.4)	81.3(69.2-93.4)	9.6(0-21.2)	0	0
July 11-20	46°N-52°N	241	40.8(28.4-53.2)	19.4(8.9-29.8)	7.1(0-29.3)	32.7(14.3-51.1)	0
	N 52°N	341	11.8(4.7-18.8)	83.3(73.9-92.7)	0	4.9(0-11.8)	0
July 21-31	46°N-52°N	572	40.5(31.4-49.7)	19.6(11.7-27.5)	19.8(3.0-36.6)	20.0(7.2-32.8)	0
	N 52°N	59	12.0(0-26.2)	85.8(68.1-100.0)	0	2.1(0-14.1)	0
June	S 46°N	57	12.8(0-27.0)	45.6(26.6-64.5)	0	41.6(23.2-60.0)	0
	46°N-52°N	265	40.4(28.6-52.2)	32.7(20.9-44.4)	12.8(0-33.2)	14.2(0-29.0)	0
July	46°N-52°N	930	39.1(31.3-47.0)	19.1(12.4-25.8)	18.7(3.8-33.5)	23.1(11.7-34.6)	0
	N 52°N	675	13.1(6.7-19.5)	84.2(72.3-96.2)	1.0(0-19.5)	1.6(0-10.9)	0

Table 23. Mixing proportion estimates for age 1.3 immature chinook salmon by 10-day period or month and by a) INPFC area, b) Japanese mothership fishery sub-areas, and c) high seas regions (S of 46°N, 46°N-52°N, and N of 52°N). Data are in percentages with 90% confidence intervals in parentheses.

Time period	Area	Sample size	Asia	Western Alaska	Central Alaska	Southeast Alaska/ British Columbia
a) INPFC area						
June	E7050	49	7.8(0.0-19.4)	36.9(12.9-60.9)	9.0(0.0-33.1)	46.4(20.2-72.5)
b) Japanese mothership sub-areas						
June 11-20	Area 5	30	26.4(7.4-45.4)	46.4(20.3-72.5)	0	27.2(2.2-52.2)
June 21-30	Area 5	36	6.4(0.0-20.4)	34.3(6.5-62.1)	24.4(0.0-56.9)	34.8(5.6-64.0)
June	Area 5	79	5.5(0.0-13.8)	42.8(23.0-62.5)	11.7(0.0-31.6)	40.1(19.5-60.6)
July	Area 5	30	22.8(4.6-40.9)	50.6(24.2-77.0)	0	26.6(1.4-51.8)
	Area 8	33	7.9(0.0-19.6)	80.5(56.6-100.0)	0	11.6(0.0-34.1)
c) High seas regions						
June 11-20	46°N - 52°N	30	26.4(7.4-45.4)	46.4(20.3-72.5)	0	27.2(2.2-52.2)
June 21-30	46°N - 56°N	34	6.2(0.0-21.2)	32.6(4.1-61.1)	32.3(0.0-67.4)	28.9(0.0-58.0)
July 1-10	46°N - 52°N	27	5.8(0.0-21.0)	14.1(0.0-40.5)	18.6(0.0-54.8)	61.6(25.6-97.5)
	N of 52°N	29	14.7(0.0-33.3)	61.2(28.9-93.5)	5.7(0.0-34.4)	18.5(0.0-46.0)
July 11-20	N of 52°N	26	22.6(3.3-42.0)	55.2(26.9-83.5)	0	22.2(0 -48.5)
June	46°N - 52°N	77	5.4(0.0-13.9)	42.3(22.3-62.2)	14.8(0.0-35.6)	37.6(17.0-58.1)
July	46°N - 52°N	52	2.8(0.0-11.0)	46.7(22.2-71.2)	11.0(0.0-35.0)	39.5(14.4-64.5)
	N of 52°N	61	10.6(0.0-21.7)	55.2(32.4-77.9)	1.1(0.0-20.1)	33.1(11.1-55.2)

Table 24. Mixing proportion estimates, in percent, for Asia, western Alaska and "other North American stocks" by Major et al. (1977) and the present study made in Japanese mothership sub-areas 3, 5, 9, 6, 8 and 10 for June and July.

				Mixing proportion estimates		
Month	Sub-area	Investigator	Sample size	Asia	Western Alaska	Other North American stocks
June	5	Major et al.[1]	59-314	65(48-74)	35(26-52)	NA
		FRI[2]	254	41.6	34.2	24.2
		FRI[3]	79	5.5	42.8	51.8
	3	Major et al.[1]	51-362	82(74-89)	18(11-26)	NA
		FRI[2]	50	19.3	15.1	65.6
		FRI[3]	-	-	-	-
	5	Major et al.[1]	34-50	90(80-97)	10(3-20)	NA
		FRI[2]	812	42.4	19.0	38.6
		FRI[3]	30	22.8	50.6	26.6
July	9	Major et al.[1]	115	18(1 est.)	82(1 est.)	NA
		FRI[2]	59	25.1	43.7	31.2
		FRI[3]	-	-	-	-
	6	Major et al.[1]	59-108	33(6-74)	67(26-94)	NA
		FRI[2]	104	16.0	79.7	4.3
		FRI[3]	-	-	-	-
	8	Major et al.[1]	45-182	31(0-58)	69(42-100)	NA
		FRI[2]	302	12.9	82.7	4.4
		FRI[3]	33	7.9	80.5	11.6
	10	Major et al.[1]	27-303	9(0-35)	91(65-100)	NA
		FRI[2]	227	9.5	89.7	0.8
		FRI[3]	-	-	-	-

[1]Sample size equals the range of sample sizes for 1966-1972. Percent composition estimates are average corrected estimates, 1966-1970, for all ocean age groups (ranges are in parentheses). Asian estimates were calculated by subtracting the corrected western Alaska estimate from one. Some erroneous values in Major et al. (1977) were corrected by Major (pers. comm., October 1983).

[2]Includes only one estimate for immature age 1.2 chinook in 1980.

[3]Includes only one estimate for immature age 1.3 chinook in 1980.

NA = no estimates of relative abundance for other N. American stocks were made.

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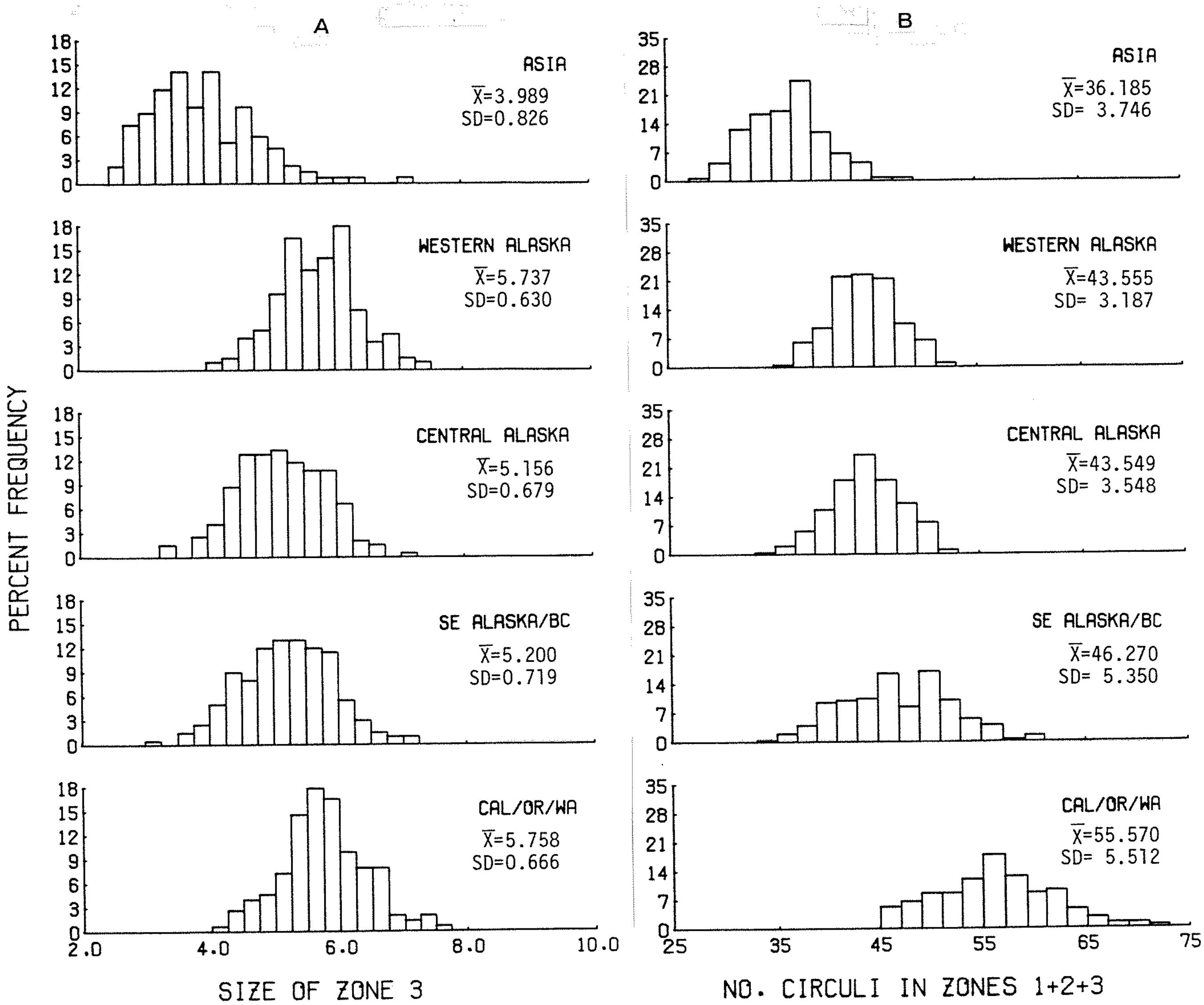
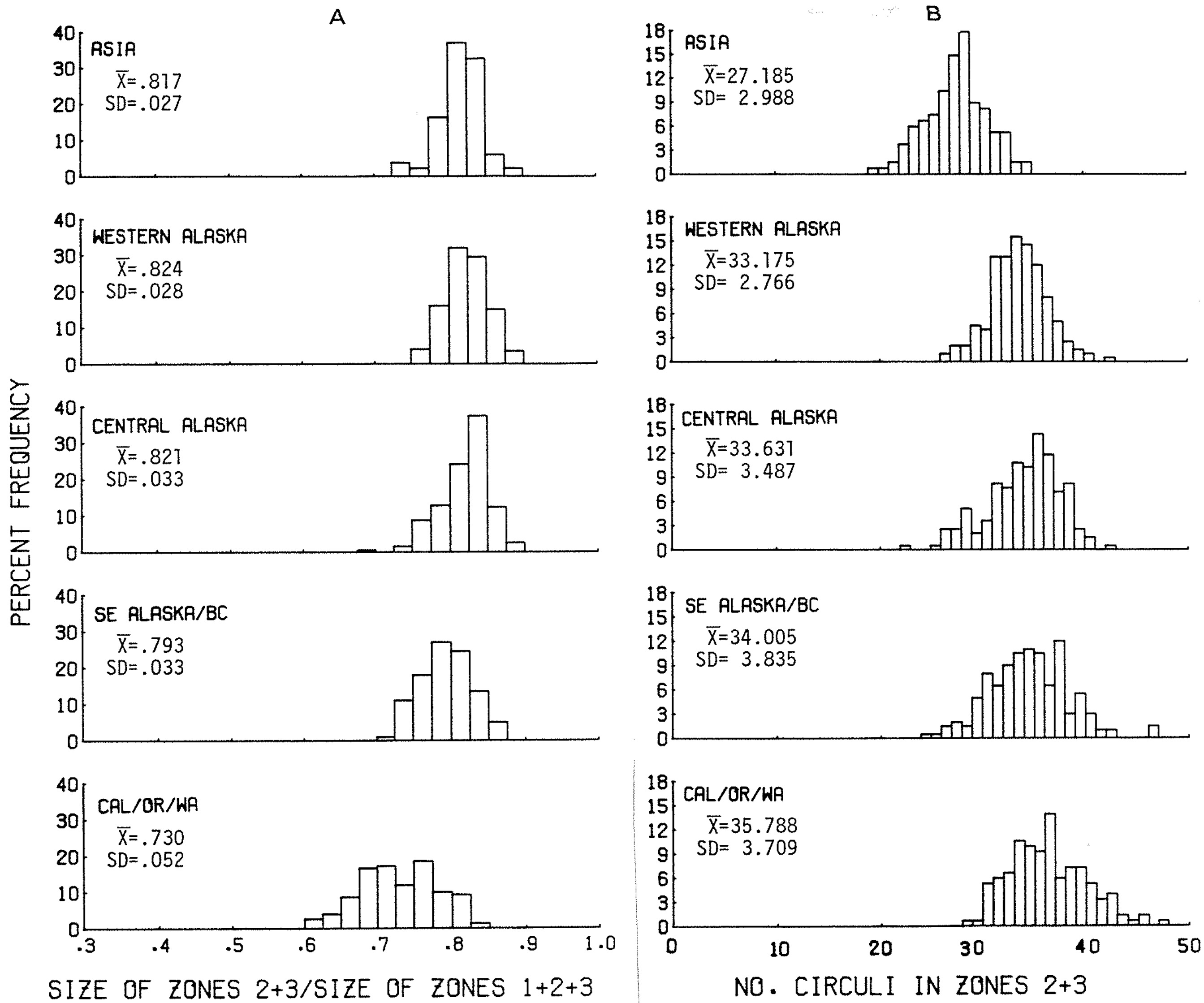
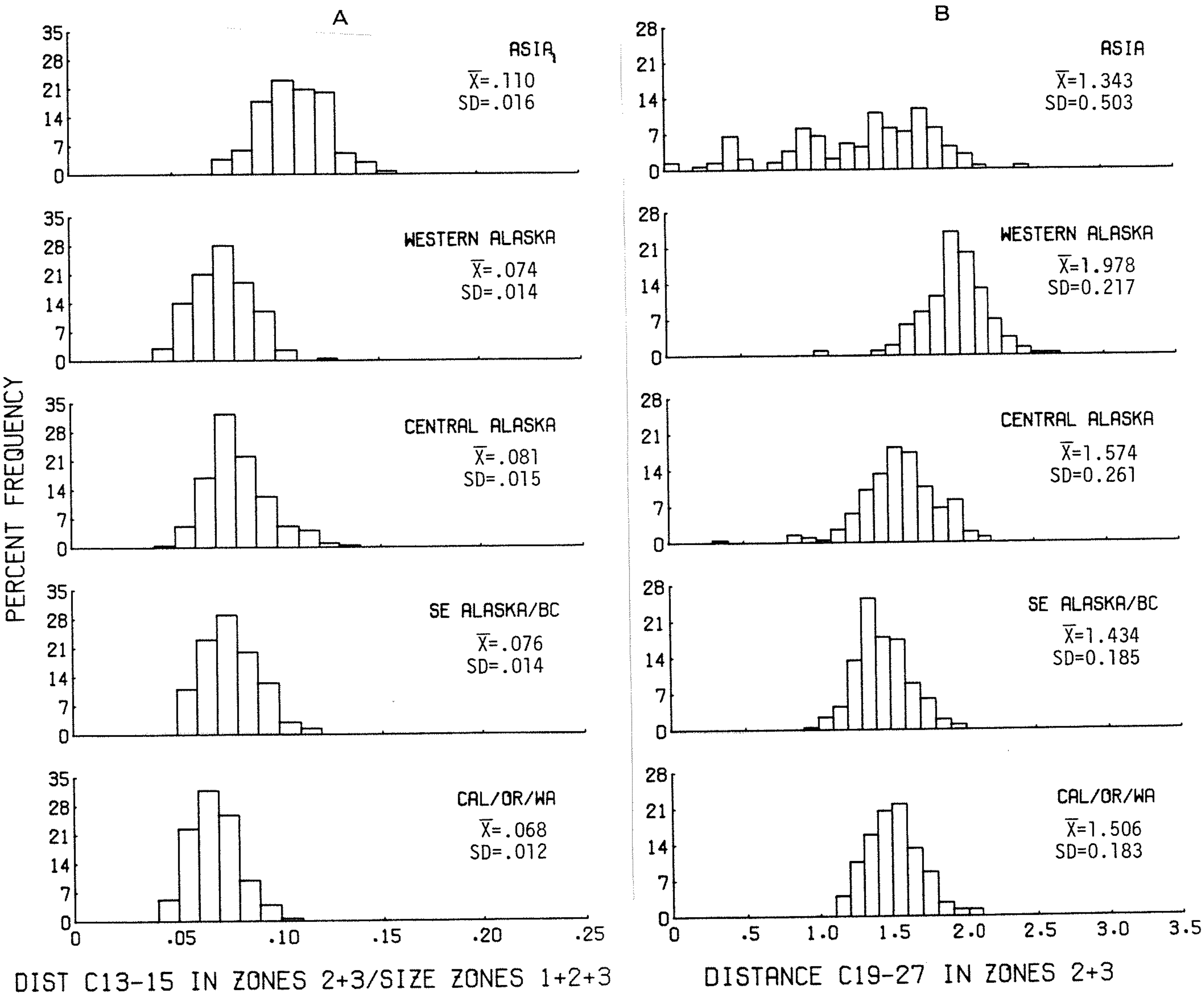
APPENDIX FIGURES



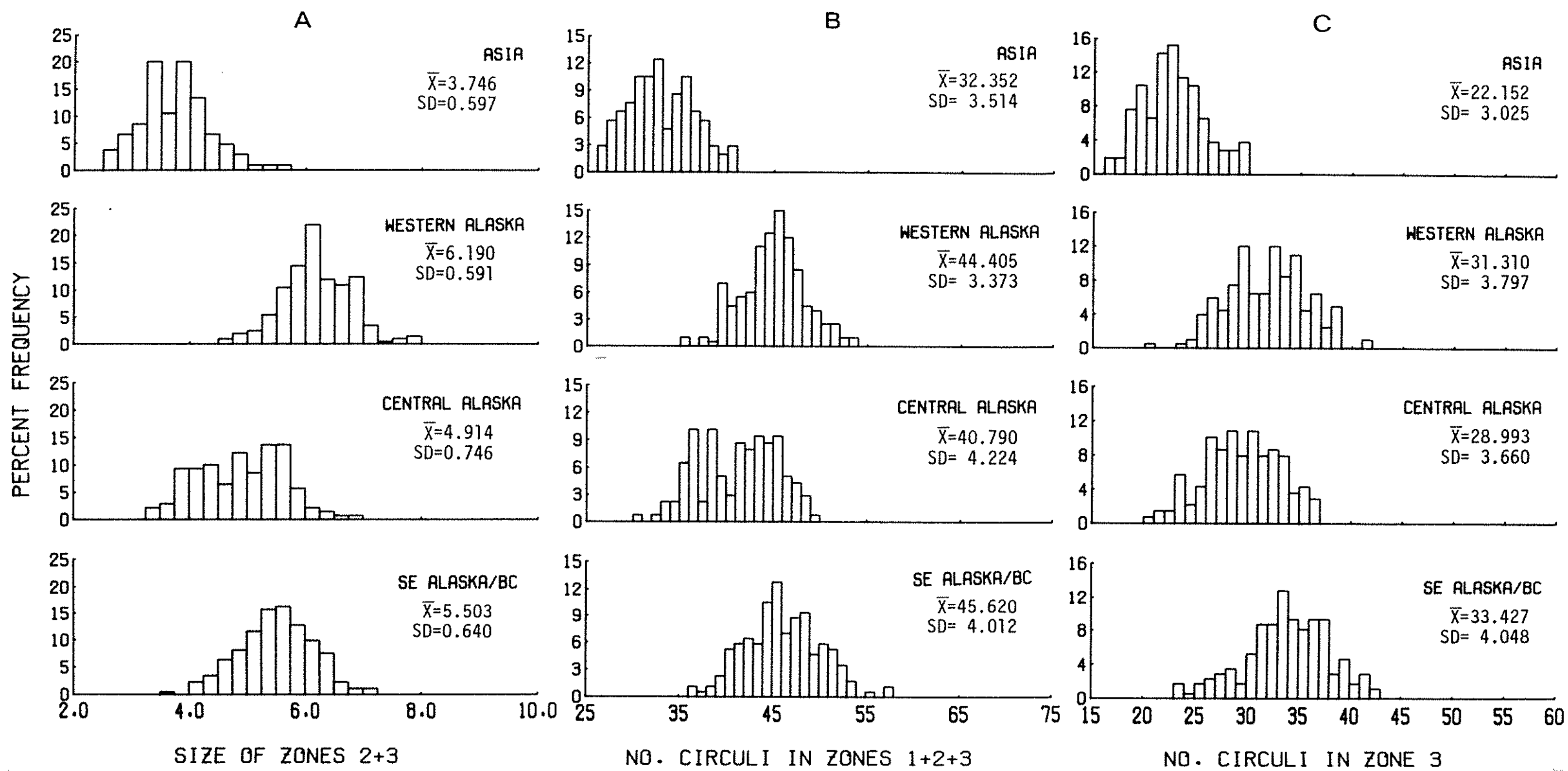
Appendix Fig.1. Regional means ($\bar{X}$), standard deviations (S), and frequency distributions of scale characters used in the five-way analysis of immature age 1.2 chinook salmon (Oncorhynchus tshawytscha) from Asia, Western Alaska, Central Alaska, Southeast Alaska/British Columbia and Washington/Oregon/ California in 1980. Characters are A) the size of the first ocean zone and B) the number of circuli through the first ocean annulus. All measurements are in inches at 100X.



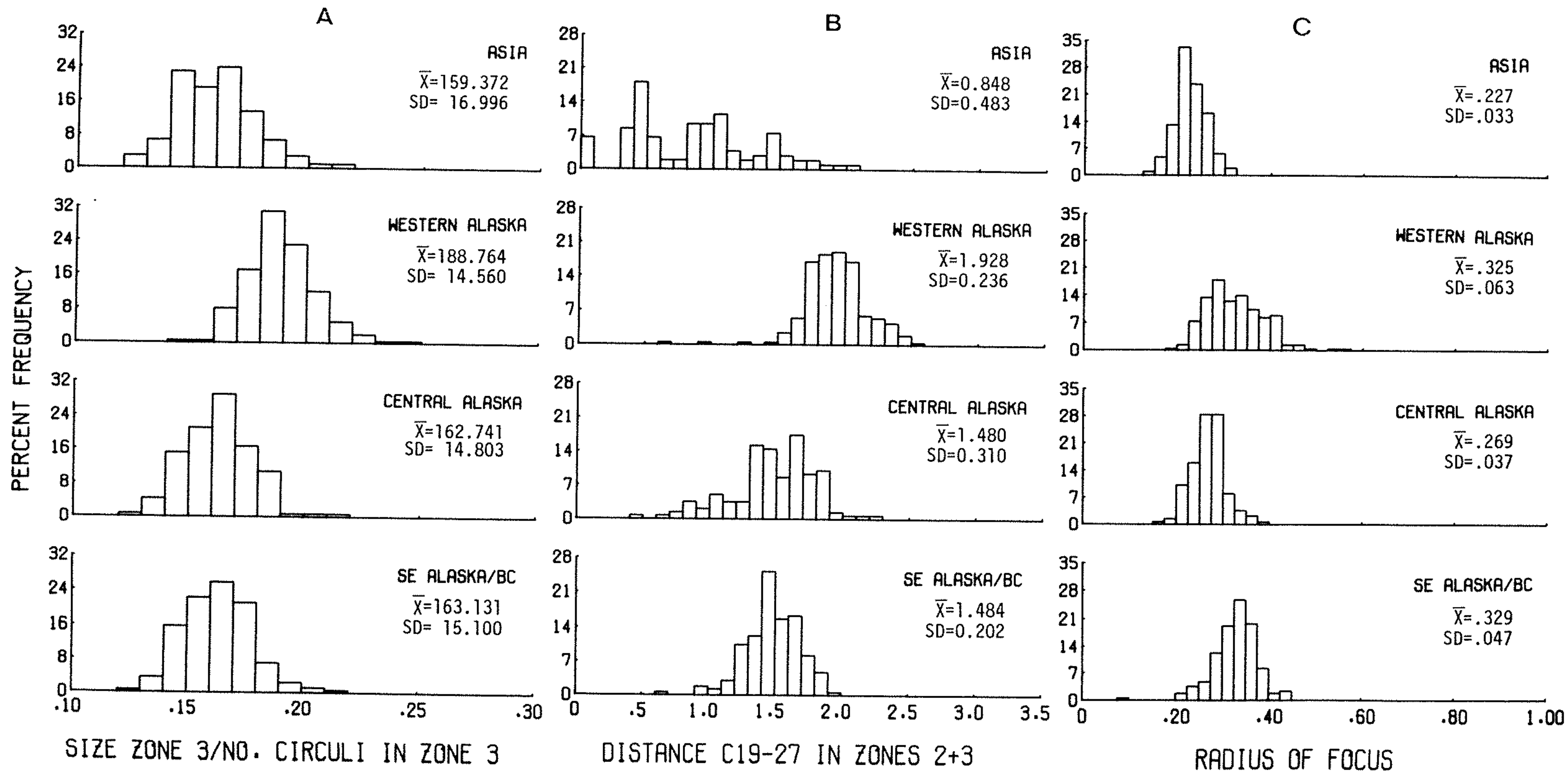
Appendix Fig. 2. Regional means ($\bar{X}$), standard deviations (S), and frequency distributions of scale characters used in the five-way analysis of immature age 1.2 chinook salmon (Oncorhynchus tshawytscha) from Asia, Western Alaska, Central Alaska, Southeast Alaska/British Columbia and Washington/Oregon/California in 1980. Characters are A) the distance from the end of the freshwater annulus to the end of the first ocean annulus divided by the distance from the focus through the end of the first ocean zone and B) the number of circuli from the end of the freshwater annulus to the end of the first ocean annulus. All measurements are in inches at 100X.



Appendix Fig. 3. Regional means ($\bar{X}$), standard deviations (S), and frequency distributions of scale characters used in the five-way analysis of immature age 1.2 chinook salmon (Oncorhynchus tshawytscha) from Asia, Western Alaska, Central Alaska, Southeast Alaska/British Columbia and Washington/Oregon/California in 1980. Characters are A) the distance between circuli 13 and 15, beginning from the end of the freshwater annulus, divided by the distance from the focus through the first ocean annulus and B) the distance between circuli 19 and 27, beginning from the end of the freshwater annulus. All measurements are in inches at 100X.



Appendix Fig. 4. Regional means ($\bar{X}$), standard deviations (S), and frequency distributions of scale characters used in the four-way analysis of immature age 1.3 chinook salmon (Oncorhynchus tshawytscha) from Asia, Western Alaska, Central Alaska, and Southeast Alaska/British Columbia in 1980. Characters are A) distance from the end of the freshwater annulus through the first ocean annulus, B) number of circuli from focus through the first ocean annulus, and C) number of circuli in the first ocean zone. All measurements are in inches at 100X.



Appendix Fig. 5. Regional means ($\bar{X}$) standard deviations (S), and frequency distributions of scale characters used in the four-way analysis of immature age 1.3 chinook salmon (Oncorhynchus tshawytscha) from Asia, Western Alaska, Central Alaska and Southeast Alaska/British Columbia in 1980. Characters are A) distance from the end of the plus growth zone through the first ocean annulus divided by the number of circuli in the first ocean zone, B) the distance between circuli 19 and 27, beginning from the end of the freshwater annulus, and C) the radius of the focus. All measurements are in inches at 100X.