

NOT TO BE CITED BY INPFC
DOCUMENT NUMBER

FRI-UW-9114
October 1991

**ORIGINS OF CHINOOK SALMON IN THE JAPANESE
TRADITIONAL LANDBASED DRIFTNET SALMON FISHERY IN
1990 BASED ON SCALE PATTERN ANALYSIS**

by

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Submitted to the
International North Pacific Fisheries Commission
by the
United States National Section

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Davis, N. D. 1991. Origins of chinook salmon in the Japanese traditional landbased driftnet salmon fishery in 1990 based on scale pattern analysis. (INPFC Doc.) FRI-UW-9114. Fish. Res. Inst., Univ. Washington, Seattle. 19 pp.

ORIGINS OF CHINOOK SALMON IN THE JAPANESE TRADITIONAL LANDBASED DRIFTNET SALMON FISHERY IN 1990 BASED ON SCALE PATTERN ANALYSIS

ABSTRACT

Scale pattern analysis was used to determine the continent of origin of age 1.2 and 1.3 chinook salmon (*Oncorhynchus tshawytscha*) of unknown maturity caught in the traditional Japanese landbased salmon fishery in 1990. This study is the first to use scales collected directly from the fishery and the first to use a pooled brood-year standard to determine the continent of origin of chinook salmon in high seas catches. A regional pooled brood-year standard was formed by grouping samples from major stocks in Asia and Alaska on the basis of similarity in their scale patterns, and tests were performed to determine the accuracy of the standard. The pooled standard proved to be highly accurate in test allocations of known origin scales. Mixing proportion estimates, calculated as the mean maximum likelihood estimator from 500 bootstrapped runs, were used to allocate the fishery sample to region of origin. Mixing proportion estimates were applied to reported catches by the traditional landbased driftnet salmon fishery to estimate interceptions of North American chinook. The landbased fishery samples were allocated to four groups (western Kamchatka, eastern Kamchatka, western Alaska, and central Alaska). Mixing proportion estimates indicated that the majority of age 1.2 and 1.3 chinook salmon taken in the landbased fishery was of western Kamchatka origin (.765 and .593, respectively), and that eastern Kamchatka was an important secondary stock (.333) for the age 1.3 fish. Estimated proportions of western Alaska chinook salmon were low for both age 1.2 and 1.3 fish (estimates were both .071), and the estimate for central Alaska for age 1.3 fish (.003) was much lower than for age 1.2 fish (.107). Application of the mixing proportion estimates for Alaskan fish to the entire catch of 45,046 chinook salmon in the traditional landbased driftnet salmon fishery in 1990 indicated that catch of Alaskan chinook salmon was 6,629 fish.

INTRODUCTION

The 1978 renegotiation of the North Pacific Treaty and further revisions in 1986 by the International North Pacific Fisheries Commission (INPFC) included a mandate for research to investigate the stock origins of salmon in the landbased fishery area south of 46° N latitude. However, over the last 36 years of INPFC-related tagging studies, there have been no high seas tag-release or coded-wire tag recovery data that have provided information on the origins of chinook salmon (*Oncorhynchus tshawytscha*) in the traditional landbased driftnet salmon fishery area (Fig. 1, Myers et al. 1990).

In a search for other sources of information on continent of origin of chinook, researchers have studied the distribution of the myxosporean brain parasite *Myxobolus arcticus* that is thought to be an Asian-origin indicating biological tag (Nagasawa and Urawa 1987; Urawa and Nagasawa 1988, 1989; Urawa et al. 1990). Rates of infection of *M. arcticus* in chinook caught on the high seas indicate that more than 50% of the catches southwest of 50° N latitude, 170°W longitude originate in Asia (Urawa and Nagasawa 1989; Urawa et al. 1990).

There have been several scale pattern studies to determine the origins of chinook in offshore waters (Major et al. 1975, 1977a, b; Myers et al. 1984; Ito et al. 1985, 1986; Davis 1990). Samples from the landbased driftnet fishery have never been available, so these

studies have relied upon scales collected from salmon research vessels operating south of 46°N latitude to be representative of the fishery. Scales collected by research vessels have included fish caught east of the commercial fishery area, i.e., east of 174°E longitude. In addition, research vessel catches of chinook are small, making it difficult to acquire scale samples in sufficient numbers to satisfy the minimum 100 scales per stratum recommended by the Sub-Committee on Salmon (Davis 1990, INPFC 1987). For the first time in 1990, the Fisheries Agency of Japan (FAJ) collected chinook salmon scales from the traditional landbased driftnet salmon fishery in their port sampling program. This made possible the calculation of mixing proportion and interception estimates from scales collected from the fishery itself, and the provision of scale samples in sufficient quantity to fulfill sample size requirements.

Recent chinook salmon scale pattern studies have employed brood-year analyses to estimate mixing proportions of chinook salmon caught on the high seas (Myers et al. 1984; Ito et al. 1985; Davis 1990). Brood-year analyses require that the scale pattern data used in the standard and the fishery sample be from fish of the same freshwater age group and year class. This method has been used because annual variation in scale patterns of the stocks within a standard is not known. However, there are disadvantages of using a brood-year analysis to estimate mixing proportions of chinook salmon. The majority of chinook salmon caught in high seas driftnet salmon fisheries are sexually immature age 1.2 and 1.3 fish (Major et al. 1975). Therefore, there is a time delay of one to two years before the stocks of chinook salmon in the fishery will mature and return to their natal rivers to spawn. This time delay makes it impossible to perform in-season analyses of samples from high seas catches. A brood-year analysis also requires that many standard samples be measured because each brood-year in the fishery sample must have a complete set of standards.

If annual variation in scale patterns within regions is small relative to variation in patterns in large geographical regions, then several brood years could be pooled together to form a standard, or one brood year could be used to classify another. Anas and Murai (1969) compared the misclassifications of a function calculated from a pooled brood-year standard to functions calculated from individual years, and they selected the pooled standard as the most appropriate to classify mature sockeye salmon caught at sea. Using non-matching brood-year standards, Major et al. (1975, 1977a,b) classified chinook salmon caught in the Japanese mothership salmon fishery from 1966 to 1972 using one function calculated from scale patterns of mature fish caught in 1968. In recent studies of chum salmon, Bilton and McKinnell (1990a,b) and McKinnell (1990) analyzed standards and unknowns with non-matching brood-years and found that regional differences in scale patterns persisted through time. Although it may be preferable to perform brood-year analyses, unknowns may be accurately identified when allocated by standards that do not match the same brood year as the unknowns (McKinnell 1990).

Using methodologies for scale pattern analyses previously agreed upon by the Sub-Committee on Salmon (INPFC 1987), I analyzed chinook scales collected from Kamchatka and Alaska and from the landbased driftnet fishery to develop a reliable pooled brood-year standard and estimate stock mixing proportions and interceptions of North American chinook salmon caught in the traditional landbased driftnet salmon fishery in 1990.

METHODS

SCALE DATA COLLECTION

Scale pattern data were collected using the Optical Pattern Recognition System (OPRS; BioSonics, Seattle, USA) equipped with a CCD video camera. System parameters were those described by Walker (1987). Scale measurement methodology, ten scale characters, and scale data from brood-years 1981 and 1982 were previously reported (Table 1, Davis 1990).

Data were measured from stocks in Kamchatka and Alaska (Fig. 2). For each stock, descriptive statistics of the ten scale variables were calculated, and if a particular scale had a value for a variable that was equal to or greater than 4.0 standard deviations from the mean it was deleted. Descriptive statistics of scale data collected in the port sample were also calculated and variables having a value greater than or equal to 4.0 standard deviations from the mean were inspected to insure that the value was not a measurement error. If required, scales were remeasured, but, unlike the standards, scales with variables more than 4.0 standard deviations away from the mean that were not measurement errors were retained in the analyses.

AGE DETERMINATIONS

Scale age was designated using the European method, i. e., the number of freshwater annuli on the left of the decimal and number of ocean annuli on the right of the decimal (Koo 1962). To maximize consistency in age interpretation, I checked the age determinations of known-origin and port samples as the scales were measured. In the port sample, ageable scales, i. e., non-regenerated scales and scales that looked as if they were removed from the preferred body area of the fish, totaled 621 (Myers and Campbell 1991). Age 1.2 fish were the dominant age group (64.7%, n=402), and age 1.3 fish were an important secondary group (24.0%, n=149, Table 2). The other age groups combined were 11.3% (n=70) of the port sample, but they were not measured.

CONSTRUCTION OF THE POOLED STANDARD

In order to characterize a stock (generally defined as fish returning to one river), scales from the terminal (river of origin) commercial fishery samples were used if these were available. A minimum of 30 scales was used to characterize a stock, but two exceptions were made in the case of the Vorovskaya and Kikhchik Rivers of the U.S.S.R. that were used because so few stocks other than the Bolshaya River were available from western Kamchatka (Table 3).

Stocks were grouped on the basis of similarities of scale patterns using the methodology of Davis (1990). Distinct groupings among the stocks in brood-years 1980, 1981, and 1983 existed for western Kamchatka (Bolshaya R., Vorovskaya R., and Kikhchik R.), eastern Kamchatka (Kamchatka R.), western Alaska (Unalakleet R., Yukon R., Kuskokwim R., and Bristol Bay stocks), and central Alaska (Susitna R. and Kenai Peninsula stocks). Because these regional groups were distinct for these three brood-years, the pooled standard included brood-years 1980, 1981, and 1983. As previously reported by Davis (1990), data from brood-year 1982 showed similarity in scale patterns between Eastern Kamchatka and Northwestern Alaska, especially the Unalakleet and Yukon Rivers. For this reason, I used data from brood-year 1982 to test the pooled standard. In addition, a

small sample of scales from western and eastern Kamchatka (brood-year 1985) was available to test of the accuracy of the pooled standard (Table 4).

The bootstrapping option of a FORTRAN program written by Russell Millar (Northwest Atlantic Fisheries Center, St. John's, Newfoundland, Canada, pers. comm.) calculated maximum likelihood mixing proportion estimates, and allowed for specifying the weight given to component stocks. I specified that scales be selected with replacement such that each regional component (western Kamchatka, eastern Kamchatka, western Alaska, central Alaska) and each brood-year (1980, 1981, and 1983) be weighted equally to form a pooled standard because the number of scales in the pooled standard was unevenly distributed between regions and brood-years (Table 3). The procedure was repeated 500 times (500 bootstrapped runs). The reported mixing proportion estimate was the mean of 500 bootstrapped runs and the 95% confidence interval comprised 95% (2-tailed) of the 500 maximum likelihood estimates.

TEST OF THE POOLED STANDARD

The purpose of testing the pooled standard was to provide some insight into whether any region might heavily misclassify. The pooled standard was highly accurate in allocating regions from brood-year 1982 and 1985 (accuracy ranged from .856 to 1.000, Table 5). Despite slight incorrect allocations, the pooled standard was considered appropriate to allocate the port samples because of the high accuracies.

CALCULATION OF MIXING PROPORTION ESTIMATES IN THE PORT SAMPLE

Age 1.2 and 1.3 scales in the port sample were allocated using the identical bootstrapping procedure that was used to test the pooled standard with scales of known origin. The reported mixing proportion estimate was the mean maximum likelihood estimate from 500 bootstrapped runs, and the 95% confidence interval comprised 95% of the 500 maximum likelihood estimates.

CALCULATION OF INTERCEPTION ESTIMATES

Extrapolation of mixing proportion estimates from the port sample to interception estimates of the traditional landbased driftnet salmon fishery catch required that I make several assumptions. I assumed that the age composition and scale patterns found in the port sample were representative of the age composition and scale patterns found in the commercial catch. In addition, I averaged the mixing proportion estimates for age 1.2 and 1.3 fish and used the mean as the mixing proportion estimate for all other ages that composed an estimated 11.3% of the commercial catch (ages 1.1, 1.4, 2.1, 2.2, and 2.3, Table 2). Mixing proportion estimates for age 1.2 and 1.3 fish were not stratified by time or area, but were multiplied by the number of fish estimated to be in the fishery because all scales in the port sample were analyzed as one sample and assumed to be representative of the whole landbased driftnet catch. Similarly, interception estimates of other-aged fish were calculated by multiplying the unweighted mean mixing proportion estimate by the total number of fish estimated to be other ages. Total annual interceptions of chinook salmon were calculated by summing interceptions by region of origin, and the total North American interception was estimated by summing the interceptions of western and central Alaskan stocks.

RESULTS

MIXING PROPORTION ESTIMATES

Mixing proportion estimates of age 1.2 and 1.3 chinook salmon taken in the traditional landbased driftnet salmon fishery area indicate that western Kamchatka was the predominant stock (.765 and .593, respectively, Table 6). The proportion of western Alaskan fish is small and stable (.071 for both age groups), and the estimates for western Alaska and central Alaska are non-significant, i. e., the 95% confidence interval includes zero. Mixing proportions for age 1.3 fish were slightly different than the proportions of the age 1.2 fish because of an increase in the proportion of eastern Kamchatka fish in the mixture (increase from .057 to .333) and a decrease in the proportion of central Alaska fish in the mixture (decrease from .107 to .003).

INTERCEPTION ESTIMATES

The total reported chinook catch of the traditional landbased driftnet salmon fishery was 45,046 in 1990 (FAJ 1991). The interception estimate of western Alaskan chinook was 3,198 fish, and the interception estimate of central Alaskan chinook salmon was 3,431 fish (Table 7). The regional stocks contributing the largest number of fish to this fishery were western Kamchatka (32,163 fish) and eastern Kamchatka (6,254 fish, Table 7).

DISCUSSION

Mixing proportion estimates show a clear predominance of western Kamchatka chinook salmon in the 1990 traditional landbased driftnet fishery (Table 6). Central Alaska and eastern Kamchatka chinook salmon were important secondary stocks for age 1.2 and 1.3 fish, respectively. Myers et al. (1984) found that central Alaska fish predominated in the area of the traditional landbased driftnet salmon fishery (south of 46°N and between 160°E and 175°W) in 1975-1980 and that Asian fish predominated in 1981. Ito et al. (1985) found that Asian fish, especially western Kamchatka fish, predominated in the landbased fishery area in 1974 and that western Alaska was an important secondary stock. Davis (1990) also found that western Kamchatka predominated in the vicinity of the landbased fishery area in 1985, and that both eastern Kamchatka and western Alaska were present in equal proportion. The shifting predominance of central Alaska and western Kamchatka in these studies may have several causes. Davis (1990) suggested that these shifts might be attributable to changes in abundance or to changes in migration patterns of regional stocks, and therefore the stocks caught in a particular area might change from time to time. In addition, sample sizes too small to adequately represent the mixture of regional stocks present in the fishery area may lead to variation in mixing proportion estimates.

The estimated proportion of Asian fish is larger in this study than was found by Davis (1990). In that earlier study, mixing proportion estimates for the landbased driftnet fishery area were calculated based on scale samples collected by research vessels operating between 160°E and 175°W (south of 46°N). Therefore, the sample included scales collected east of the current eastern boundary of the fishery (174°E). If the proportion of Asian fish increases further to the west, as one might expect, then Davis's (1990) estimate underestimated the proportion of Asian fish intercepted by this fishery.

To evaluate the magnitude of the interception estimates, I compared these estimates with the 1991 Alaska commercial catches and the average (1981-1987) commercial catches in the U.S.S.R. (Kazarnovskii 1989). However, this was only an approximate comparison because most of the chinook salmon in the fishery sample are likely to have been immature, and although most of the chinook would have matured and returned to coastal fisheries in 1991, some fish will likely return in 1992. Compared to the commercial catch of chinook salmon in western Alaska in 1991 (190,000 chinook salmon, preliminary data, Geiger and Savikko 1991) the estimated interception of 3,198 western Alaskan fish by the traditional landbased driftnet salmon fishery is negligible (Table 7). The inshore commercial catch for Cook Inlet in 1991 was 15,000 chinook salmon (preliminary data, Geiger and Savikko 1991). Estimated interception of 3,431 central Alaskan fish by the landbased fishery was 22.9% of the inshore catch of Cook Inlet, and this is a substantial amount, but it is difficult to evaluate what the interception of 3,431 fish means in terms of the inshore commercial catch of the whole of central Alaska. The estimated interceptions of western and central Alaska chinook salmon in the landbased driftnet fishery in 1990, however, were not statistically significant (Table 7).

Interceptions of western Kamchatka chinook salmon by the landbased driftnet salmon fishery were more substantial than those of Alaska chinook salmon stocks. The average (1981-1987) catch of chinook salmon in western Kamchatka is 18,000 fish (Kazarnovskii 1989). The estimated interceptions of 32,163 chinook salmon of western Kamchatkan origin in the 1990 landbased driftnet fishery were 1.75 times the average inshore catch (Table 7). The estimated 6,254 chinook salmon from eastern Kamchatka that may have been caught in the traditional landbased fishery was only 4% of the average (1981-1987) inshore catch (157,000 fish, Kazarnovskii 1989).

The only previous calculation of interception estimates based on analysis of scales collected from the landbased driftnet fishery area was by Davis (1990). Myers et al. (1984) applied mixing proportions estimates from the North Pacific Ocean portion of the mothership fishery samples to estimate the interception of chinook salmon in the landbased driftnet fishery area. Davis (1990) estimated interceptions by region of origin for the years 1985 to 1989. These data show that chinook salmon catches and interceptions of Alaskan chinook salmon in the traditional landbased driftnet fishery have decreased since 1985 (Table 8). I found that interceptions of North American chinook salmon in the 1990 landbased driftnet fishery were smaller than previous estimates for 1985-1989. The smaller estimates of interception of Alaska chinook salmon in 1990 likely result from the fact that samples were taken directly from the landbased driftnet fishery, which operates further to the south and west than the area (south of 46°N, 160°E-175°W) where previous sampling was conducted (Fig. 1).

One of the main criticisms leveled against the use of scale pattern analysis as a stock identification technique is that new baseline data must be collected each year. If high accuracies and a valid analysis can be done using a pooled brood-year standard, then analyses can be completed in less time than otherwise possible. The pooled standard used in my analysis proved to be highly accurate in test allocations of known origin scales (Table 5). At the Fisheries Research Institute (FRI), School of Fisheries, we plan to continue work on the development of pooled-year models for chinook salmon and other salmonid species. This promising technique would provide fisheries management and enforcement agencies with a quick, easy, and inexpensive technique for determining geographical origin of fish in mixed-stock samples.

ACKNOWLEDGEMENTS

I thank the Fisheries Agency of Japan (Government of Japan) for their special effort in collecting the chinook scale samples from the commercial fishery in their port sampling program at Kushiro and Hanasaki. Assistance was provided by biologists from the U.S.S.R.'s Pacific Scientific Research Institute of Fisheries and Oceanography (TINRO), Fisheries Agency of Japan, Department of Fisheries and Oceans Canada, and Alaska Department of Fish and Game, who supplied scale samples and biological data. I also thank Kate Myers and Robert Walker for their guidance in scale pattern analysis and for review of this report. Funding for this project was provided by the U.S. National Oceanic and Atmospheric Administration (NOAA, Contract No. 50-ABNF100027).

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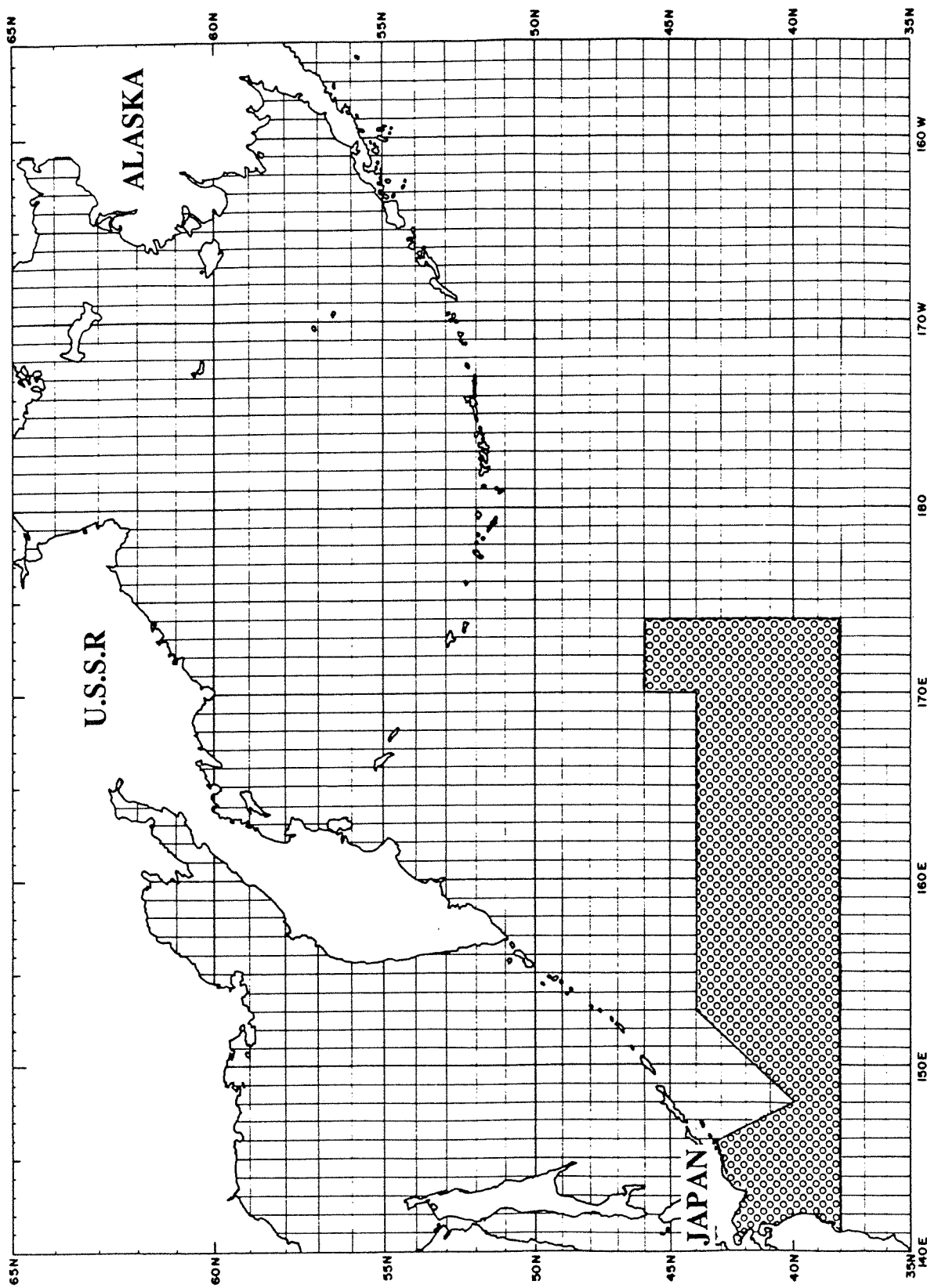


Figure 1. Shaded area indicates the location of the Japanese traditional landbased driftnet salmon fishery since 1986.

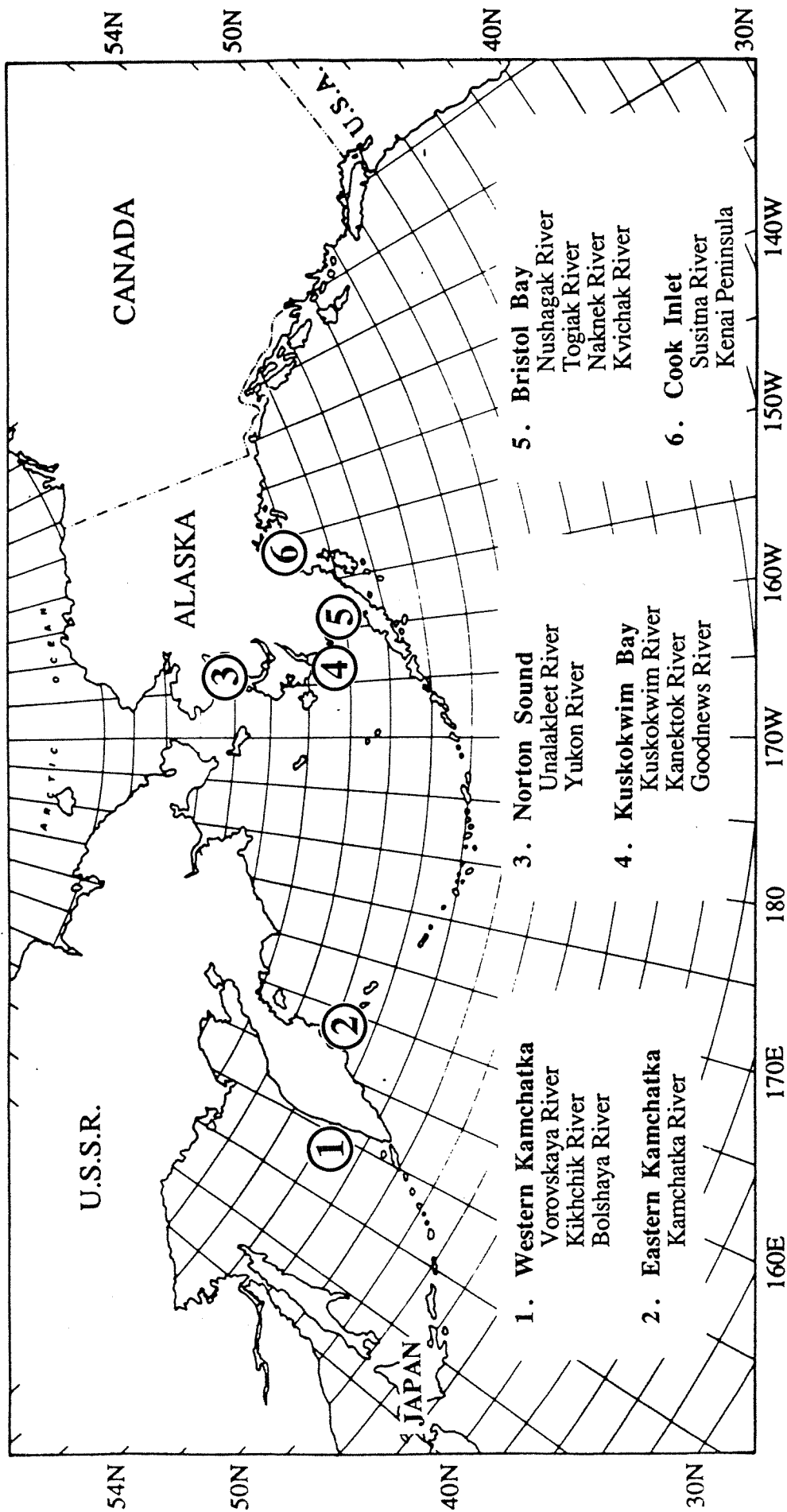


Figure 2. Geographical location of stocks used to construct regional groups and the pooled brood-year standard.

Table 1. Ten chinook scale characters used in the scale pattern analyses.

Scale Character Name	Description
FWSZ	Size of the freshwater zone measured from the center of the focus to the last circulus in the freshwater annulus.
OCSZ	Size of the ocean zone measured from the last circulus in the freshwater annulus to the last circulus in the first ocean annulus.
OCIRCC	Number of circuli in the first ocean zone.
TR1	Size of triplet 1 is the distance from the last circulus in the freshwater annulus to the third circulus in the first ocean zone.
TR2	Size of triplet 2 is the distance between the third and the sixth circulus in the first ocean zone.
TR3	Size of triplet 3 is the distance between the sixth and ninth circulus in the first ocean zone.
TR4	Size of triplet 4 is the distance between the ninth and twelfth circulus in the first ocean zone.
TR5	Size of triplet 5 is the distance between the twelfth and fifteenth circulus in the first ocean zone.
TR6	Size of triplet 6 is the distance between the fifteenth and eighteenth circulus in the first ocean zone.
TR7	Size of triplet 7 is the distance between the eighteenth and twenty-first circulus in the first ocean zone.

Table 2. Estimated percent age composition and estimated catch at age (number) of chinook salmon caught in the traditional landbased driftnet salmon fishery in 1990. The percentage at age is determined from the age composition of the port samples (Myers and Campbell 1991).

	Age				Total		
	1.1	1.2	1.3	1.4	2.1	2.2	2.3
Percent	3.5	64.7	24.0	6.4	0.2	1.0	0.2
Catch	1,577	29,145	10,811	2,883	90	450	90
							45,046

Table 3. Stock composition and sample size of pooled brood-year standard (brood-years 1980, 1981, and 1983) used to allocate chinook salmon caught in the traditional landbased salmon fishery in 1990. Scale pattern data were used in a bootstrapping procedure with replacement such that 201 scales were selected from each regional group and the contribution of each brood-year was evenly weighted. The bootstrapping procedure was repeated 500 times for each analysis.

Regional Group	River-Stock	Brood-year 1980	Brood-year 1981	Brood-year 1983
Western Kamchatka	Bolshaya	105	170	41
	Vorovskaya	0	13	0
	Kikhchik	0	0	19
sub total		<u>105</u>	<u>183</u>	<u>60</u>
Eastern Kamchatka	Kamchatka	143	231	94
Western Alaska	Unalakleet	123	133	54
	Yukon	127	241	119
	Kuskokwim	31	114	59
	Kanektok	60	120	60
	Goodnews	31	119	60
	Nushagak	65	135	34
	Naknek	46	125	61
	Togiak	0	124	50
	Kvichak	0	0	83
sub total		<u>483</u>	<u>1111</u>	<u>580</u>
Central Alaska	Susitna (North District)	99	169	98
	Kenai Peninsula (Central District)	173	297	77
sub total		<u>272</u>	<u>466</u>	<u>175</u>
Total		1003	1991	909

Table 4. Region and component stocks from brood-year 1982 and 1985 used to test the pooled brood-year standard.

Region	River-Stock	Brood-year 1982	Brood-year 1985
Western Kamchatka	Bolshaya	265	27
	Vorovskaya	20	0
	Kikhchik	20	0
sub total		<u>305</u>	<u>27</u>
Eastern Kamchatka	Kamchatka	250	83
Northwestern Alaska	Unalakleet	60	
	Yukon	228	
subtotal		<u>288</u>	
Southwestern Alaska	Kuskokwim	105	
	Kanektok	112	
	Goodnews	101	
	Nushagak	121	
	Naknek	110	
	Togiak	120	
	Kvichak	48	
sub total		<u>717</u>	
Central Alaska	Susitna (North District)	237	
	Kenai Peninsula (Central District)	189	
sub total		<u>426</u>	
Total		1986	110

Table 5. Test of the pooled standard by allocating scales from known stocks (brood-years 1982 and 1985) as if the origin of these stocks was unknown. Maximum likelihood mixing proportion estimates are the mean estimate of 500 bootstrapped runs. The 95% confidence interval (2-tailed) of the mixing proportion estimates from the 500 bootstrapped runs.

Regional Stock	Brood Year	N	Proportion Correctly Allocated to Region	Proportion Correctly Allocated to Continent	Western Kamchatka	Eastern Kamchatka	Western Alaska	Central Alaska
Western Kamchatka	1982	305	.921	.921	.921 (.798-1.00)	.000 (.000-.000)	.000 (.000-.000)	.079 (.000-.202)
	1985	27	1.000	1.000	1.000 (1.00-1.00)	.000 (.000-.000)	.000 (.000-.000)	.000 (.000-.000)
Eastern Kamchatka	1982	250	.969	.989	.020 (.000-.050)	.969 (.915-1.00)	.000 (.000-.005)	.011 (.000-.067)
	1985	83	.993	.993	.000 (.000-.000)	.993 (.938-1.00)	.004 (.000-.041)	.003 (.000-.043)
Northwestern Alaska	1982	288	.972	.972	.011 (.000-.041)	.017 (.000-.101)	.972 (.885-1.00)	.000 (.000-.000)
Southwestern Alaska	1982	717	.856	1.000	.000 (.000-.002)	.000 (.000-.000)	.856 (.773-.937)	.144 (.062-.225)
Central Alaska	1982	426	.991	1.000	.000 (.000-.000)	.000 (.000-.000)	.009 (.000-.049)	.991 (.951-1.00)

Table 6. Provisional maximum likelihood mixing proportion estimates of chinook salmon by age caught in the traditional landbased drifnet salmon fishery in 1990. The mixing proportions estimates are the mean estimates of 500 bootstrapped runs. The 95% confidence interval () comprises 95% (2-tailed) of the mixing proportion estimates from the 500 bootstrapped runs. The mean mixing proportion is the unweighted average proportion of the two age groups.

Port Sample	N	Western Kamchatka	Eastern Kamchatka	Western Alaska	Central Alaska
Age 1.2	304	.765 (.639-.876)	.057 (.001-.120)	.071 (.000-.167)	.107 (.000-.260)
Age 1.3	96	.593 (.471-.710)	.333 (.201-.468)	.071 (.000-.181)	.003 (.000-.047)
unweighted mean mixing proportion		.679	.195	.071	.055

Table 7. Provisional catch estimates (95% confidence intervals) of chinook salmon caught in the Japanese traditional landbased driftnet salmon fishery in 1990.

Age	Western Kamchatka	Eastern Kamchatka	Western Alaska	Central Alaska	Total
1.2	22,296 (18,624-25,531)	1,661 (29-3,497)	2,069 (0-4,867)	3,119 (0-7,578)	29,145
1.3	6,411 (5,092-7,676)	3,600 (2,173-5,060)	768 (0-1,957)	32 (0-508)	10,811
Subtotal	28,707	5,261	2,837	3,151	39,956
All other ages	3,456	993	361	280	5,090
Total	32,163	6,254	3,198	3,431	45,046

Table 8. Provisional estimates of the Japanese traditional landbased driftnet salmon fishery catches of chinook salmon (in thousands of fish) by region of origin. Estimates for the years 1985-1989 are from Davis (1990).

Year	Western Kamchatka	Eastern Kamchatka	Western Alaska	Central Alaska
1985	44	23	23	11
1986	33	18	18	8
1987	32	17	17	8
1988	20	11	11	5
1989	22	12	12	5
1990	32	6	3	4