GENETIC ANALYSIS OF CHUM SALMON HARVESTED IN THE SOUTH UNIMAK AND SHUMAGIN ISLANDS JUNE FISHERIES, 1993-1996

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EXECUTIVE SUMMARY

- Genetic stock identification was used to estimate the origin of chum salmon *Oncorhynchus keta* harvested in the South Unimak and Shumagin Islands fisheries in June.
- Over 14,000 chum salmon were sampled from fish caught during the June commercial fishery at South Unimak Island from 1993-1996 and the Shumagin Islands from 1994-1996.
- The 1993 South Unimak fishery was stratified into 2 periods, June 13-20 and June 22-29 and the South Unimak and Shumagin Islands 1994-1996 fisheries were stratified into three periods, the opening of the fishery – June 20 (Period 1), June 21-25 (Period 2), and June 26-30 (Period 3). For each fishery, 400 fish were randomly subsampled from the total number of fish collected in each period, proportional to the daily catch. Genetic variation was assayed at 20 allozyme loci on the subsampled fish and used to estimate stock composition for the South Unimak and Shumagin Islands fisheries.
- The allozyme baseline compiled by Seeb et al. (1995) was expanded with allele frequency data for 83 populations from Western Alaska, Canada, China, and Russia. The updated baseline comprised 248 collections of chum salmon that were condensed into 109 pooled population groupings. A multidimensional scaling analysis and simulation study on the pooled population groupings suggested 10 reporting regions could be identified in mixtures: 1) JAPAN; 2) CHINA/SOUTHERN RUSSIA; 3) NORTHERN RUSSIA; 4) NORTHWEST ALASKA SUMMER; 5) FALL YUKON; 6) ALASKA PENINSULA/KODIAK; 7) SUSITNA RIVER; 8) PRINCE WILLIAM SOUND; 9) SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA; and 10) SOUTHERN BRITISH COLUMBIA/WASHINGTON (Figure 1).

- Stock contributions for each period of the June South Unimak fishery samples, 1993-1996, and June Shumagin Islands fishery samples, 1994-1996, were estimated via maximum likelihood. Ninety percent confidence intervals were computed for all regional estimates from 500 bootstrap resamples of the baseline and mixture. Annual contribution estimates were calculated as a weighted average for each year with the contribution estimates for a period weighted by the total catch for that period. Ninety percent confidence intervals were also calculated for the annual contribution estimates.
- Annual contribution estimates indicated that NORTHWEST ALASKA SUMMER was the largest individual contributor to both the South Unimak and Shumagin Islands June fisheries. Annual contributions ranged from 0.40 to 0.65 in the South Unimak fishery, from 0.36 to 0.52 in the Shumagin Islands fishery, and from 0.38 to 0.60 in the two fisheries combined. In two of the three years where both fisheries were sampled, the South Unimak fishery had a larger proportion of NORTHWEST ALASKA SUMMER fish than the Shumagin Islands fishery. Asia was the second largest contributor to these fisheries, followed by ALASKA PENINSULA/KODIAK. Estimates for CHINA/SOUTHERN RUSSIA, FALL YUKON, PRINCE WILLIAM SOUND, and SUSITNA RIVER indicated these reporting groups were a small component or were absent in the fisheries sampled.
- Variation in reporting region contribution was evident within years in each fishery. Reporting regions that made especially strong or small contributions in a year did so in both South Unimak and Shumagin Islands fisheries.
- The Japanese component of the Period 2 stratum of the South Unimak and Shumagin Islands fisheries, 1994-1996, was verified with an independent genetic marker. Period 2 fish were

assayed for variation at the ND5/ND6 region of mitochondrial DNA (mtDNA); the relative contribution of JAPAN was estimated using maximum likelihood and the mtDNA baseline of Park et al. (1993). Estimates based on allozymes and mtDNA for JAPAN were concordant and, in five out of six cases, statistically indistinguishable.

INTRODUCTION

Migratory and local chum salmon *Oncorhynchus keta* are harvested in the South Unimak and Shumagin Islands salmon fisheries in June. The catch of chum salmon in these fisheries may contribute to conservation and allocation problems in certain areas. For example, spawning escapements in certain streams in Norton Sound, the Kuskokwim River, and the Yukon River have sometimes been below historic levels in recent years (Eggers 1995). Stock composition of chum salmon harvested in the South Unimak and Shumagin Islands June fisheries has been estimated using traditional tagging methods (Eggers et al. 1991), and more recently, using genetic stock identification (GSI) (Seeb et al. 1995) in order to begin addressing the potential impact of these fisheries on chum salmon stocks in western Alaska.

Seeb et al. (1995) estimated the origin of 2,000 chum salmon individuals caught in the South Unimak fishery in 1993 and 1994 using GSI. Genetic stock identification is the use of the genetic stock structure of a species (baseline) to estimate the contribution of each stock to a mixture given the frequency of genetic marks in the mixture, and has become an important part of many salmonid management programs (chum salmon: Shaklee and Phelps 1990, Phelps et al. 1994; chinook salmon: Utter et al. 1987, Marshall et al. 1991, Miller et al. 1993; pink salmon: White and Shaklee 1991, White 1996; and sockeye salmon: Wood et al. 1989, Seeb et al. 1996).

Protein variation detected by allozyme electrophoresis has been used to delineate the stock structure of chum salmon around the Pacific Rim (Japan: Winans et al. 1994; Russia: Winans et al. 1994, Wilmot et al. 1994; northwestern and southcentral Alaska: Seeb and Crane, submitted; Southeast Alaska: Kondzela et al. 1994; British Columbia: Kondzela et al. 1994, Phelps et al. 1994; and Washington: Phelps et al. 1994). Altogether, these studies form one of the most comprehensive genetic database for any fish species in terms of the number of populations and genetic markers examined. From these data, Seeb et al. (1995) constructed a genetic baseline of 69 stock groupings from around the Pacific Rim, and used them to estimate stock contribution to eight reporting regions: 1) Japan; 2) Russia; 3) Northwest Alaska Summer; 4) Fall Yukon; 5) Alaska Peninsula/Kodiak Island; 6) Southeast Alaska/Prince William Sound; 7) British Columbia; and 8) Washington. Further, the Japanese component was verified for a portion of the 1994 fishery with an alternative genetic mark using a mitochondrial DNA (mtDNA) marker and the mtDNA baseline of Park et al. (1993).

In this report, we expanded upon the pilot study of Seeb et al. (1995). Fishery sampling included the Shumagin Islands fishery (1994-1996) as well as the South Unimak fishery, 1995-1996. The Pacific Rim baseline was enlarged from 69 to 109 stock groupings including new data from populations from Alaska, Canada, and Asia. Fishery estimates were provided for 10 reporting regions: 1) JAPAN, 2) CHINA/SOUTH RUSSIA, 3) NORTHERN RUSSIA, 4) NORTHWEST ALASKA SUMMER, 5) FALL YUKON, 6) ALASKA PENINSULA/KODIAK, 7) SUSITNA RIVER, 8) PRINCE WILLIAM SOUND, 9) SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, 10) SOUTHERN BRITISH COLUMBIA/WASHINGTON. NORTHWEST ALASKA SUMMER was the largest component of the South Unimak and Shumagin Islands June fisheries in every year sampled and was a larger component of the South Unimak fishery than the Shumagin Islands fishery in two of the three years sampled. Variability in reporting region estimates occurred both within and among years at both locations. Estimates obtained for the Japanese component for a portion of both fisheries were concordant using two different databases, allozymes and mitochondrial DNA.

MATERIALS AND METHODS

Sample Collection

Baseline

Chum salmon were sampled from spawning populations from southcentral and northwestern Alaska to augment those surveyed in Seeb et al. (1995). Emphasis was placed on areas thought to be underrepresented in the previous baseline, including Norton Sound, Koyukuk River, Kuskokwim River, Yukon River, Alaska Peninsula, and Susitna River. Target sample size for baseline collections was 100 fish to maximize the precision of allele frequency estimates (Allendorf and Phelps 1981). Samples of muscle, liver, eye, and heart were dissected from freshly killed fish, placed in labeled cryovials and frozen on dry ice or liquid nitrogen until transferred to –80^{o}C storage.

Fishery

The South Unimak June fishery occurs in the Unimak and Southwestern Districts and the Shumagin Islands June fishery occurs in the Shumagin Islands Section of the Southeastern District (Figure 2). Sampling of chum salmon harvested in these fisheries was conducted at Peter Pan Seafoods, King Cove (1993-1996), and Trident Seafoods, Sand Point (1994-1996). Chum salmon were sampled from tender deliveries; tender operators were interviewed to determine the origin of the catch and, to the extent possible, fish were sampled proportionally to the size of the catches made in different fishing areas (Sarafin et al. 1995; Sarafin 1995a). Muscle, liver, and heart tissues were subsampled from each fish, placed in labeled cryovials, and frozen at -20^{o}C. Tissue samples were shipped to the Anchorage Genetics Laboratory within one week of collection on dry ice, and stored at -80^{o}C.

The South Unimak and Shumagin Islands June commercial fisheries were stratified into three time periods for the 1994-1996 fishery estimates: the opening of the commercial fishery to June 20; June 21 to June 25; and June 26 to June 30 (Seeb et al. 1995). This stratification allowed comparison to stock composition estimates from previous studies (tagging, Eggers et al. 1991; GSI, Seeb et al. 1995) and also to compare estimates from each period across years. For the 1993 South Unimak fishery, the commercial fishery was stratified into two time periods: the opening of the commercial fishery to June 20 and June 21 to June 30 (Seeb et al. 1995). Stock composition estimates were made for the South Unimak and the Shumagin Islands fisheries for each period by randomly subsampling 400 fish proportional to the daily catch rate in each period at each location.

Chum salmon were also sampled from June South Unimak and Shumagin Islands testfisheries 1994-1996, July Shumagin Islands testfisheries 1996-1997, and the post-June South Peninsula commercial fishery 1996-1997. Results from the analysis of these samples will be presented in subsequent reports.

Laboratory Methods

Allozymes

Baseline populations and fishery subsamples were assayed for genetic variation at the following loci: *sAAT-1,2*; mAAT-1*; mAH-3*; ALAT*; ESTD*; G3PDH-2*; GPI-A*; GPI-B1,2*; mIDHP-1*; sIDHP-2*; LDH-A1*; LDH-B2*; sMDH-A1*; sMDH-B1,2*; mMEP-2*; sMEP-1*; MPI*; PEPA*; PEPB-1*;* and *PGDH** using the laboratory protocols of Seeb et al. (1995). We used the genetic nomenclature of the American Fisheries Society (Shaklee et al. 1990).

Mitochondrial DNA

Mitochondrial DNA (mtDNA) was extracted from two baseline populations from Asia (Naiba River, Avakumovka River; obtained from National Marine Fisheries Service, Auke Bay Laboratory) and from the 400 individuals analyzed for the Period 2 subsamples (June 21 - June 25, see above) for the South Unimak fishery and Shumagin Islands fishery 1994-1996. DNA was isolated from heart tissue in 96-well microtiter plates using a high salt precipitation method (modified from Miller et al. 1988 and Sambrook et al. 1989; Gentra Systems, Minneapolis, MN). The primers described in Cronin et al. (1993) were used to amplify the ND5/ND6 region of the mtDNA genome via the polymerase chain reaction (PCR). PCR reactions were conducted in a total volume of 25μl with a final concentration of 2.5 mM $MgCl_2$, 1.0 mM each dNTP, 5% DMSO, and 0.025U/μl Amplitaq DNA polymerase (Perkin Elmer). Cycling conditions included an initial denaturation at 95°C for 2.5 minutes, followed by 25 cycles at 95°C for 1 min 40 sec, 58°C for 1 min 45 sec, and 72°C for 2 min 20 sec. A final extension was performed at 72°C for 5 min. Polymorphisms were detected with the restriction enzyme *AseI*. Sizes of restriction fragments were estimated by comparison with a 100bp DNA Ladder (Gibco-BRL) and lamda DNA digested with BSTE II. Haplotype nomenclature follows that of Park et al. (1993).

Statistical Analysis of Fishery Samples

Allozymes

We used the Pacific Rim baseline described in Seeb et al. (1995), with some modifications. One Russian population, Korf Bay, was deleted because of small sample size (Wood et al. 1987). New population data were incorporated into the baseline following data standardization procedures in Seeb et al. (1995) (Appendix 1, Seeb et al. 1997). Loci used in the baseline analyses were those assayed in the baseline and fishery samples (see above).

Collections sampled at the same location in multiple years were pooled (Shaklee and Phelps 1990). Seeb et al. (1995) further reduced the number of populations in the baseline to improve model efficiency by comparing allele frequencies among populations using a G-Statistic (Sokal and Rohlf 1995). Populations were pooled if no heterogeneity was detected (α<0.01). In order to incorporate additional data from western Alaska and Canada into the baseline, heterogeneity among populations from these regions was re-evaluated using a hierarchical G-statistic analysis (modified from Smouse and Ward 1978). Populations were pooled if no significant differences occurred (Milliken and Johnson 1984, α=0.05). The heterogeneity analysis was performed using *S-Plus version 3.3* analytical software (Mathsoft, Inc., Seattle, WA.).

Potential reporting regions for the maximum likelihood estimates (MLEs) were selected from a multidimensional scaling analysis of Cavalli-Sforza and Edwards chord distances (Cavalli-Sforza and Edwards 1967) calculated among the stock groupings. Distances were calculated using *S-Plus*; the multidimensional scaling analysis was done in NTSYS version 1.80 (Exeter Software, Setauket, NY). Reporting regions were optimized based on simulations where baseline and mixture genotypes were randomly generated from the baseline allele frequencies using Hardy-Weinberg expectations. Each simulated mixture (N=400) was composed 100% of the reporting region under study, with each stock group in the reporting region contributing equally to the mixture. Average estimates of mixture proportions were derived from 100 simulations. Reporting regions were enlarged until approximately 90% of the mixture on average was allocated to the correct region. Simulations were performed using the Statistical Package for Analyzing Mixtures (SPAM95, ADF&G 1997).

Stock contributions for each period of the South Unimak fishery samples, 1993-1996, and Shumagin Islands fishery samples, 1994-1996, were estimated via maximum likelihood (Pella and Milner 1987; Masuda et al. 1991). A conjugate gradient searching algorithm using a square root transformation was employed (Pella et al. 1996). This algorithm provides good performance with large baselines and small stock differences (Pella et al. 1996). The twenty loci assayed in the fishery samples were used in the estimation procedures, with one exception. One locus, *ALAT**, was deleted in the analysis of the Shumagin Islands 1996 fishery due to poor resolution in these samples. Genotypes were removed from the mixture in the estimation procedure if their probability of occurring was $P < 1 \times 10^{-6}$. For these cases, the mixture estimates have an unknown group containing the percent of the mixture that was removed. Further, we deleted any individual missing data at four or more loci. Individual population or stock estimates were first calculated, then summed into regional groupings (allocate-sum procedure, Wood et al. 1987).

Ninety percent confidence intervals for all regional contribution estimates were computed from 500 bootstrap resamples of the baseline and mixture genotypes. For each resample, contribution estimates were generated for all populations and summed to the regional level. The 500 estimates for a region were then sorted from lowest to highest with the 26th and 475th values in the sequence taken respectively as the lower and upper bounds of the 90% confidence interval for that region.

Annual contribution estimates were calculated as a weighted average for each year with the contribution estimates for a period weighted by the total catch for that period. Confidence intervals for the annual contribution estimates were computed from 500 bootstrap resamples of the baseline and mixture genotypes for each year and period. For each resample, contribution estimates were generated for each period within a year and a weighted annual average was calculated as described above. The 500 estimates for each region within a year were then sorted from lowest to highest with the 26th and 475th values in the sequence taken respectively as the lower and upper bounds of the 90% confidence interval for the annual contribution for that region. Annual contribution estimates were also calculated for the combined South Unimak and Shumagin Islands June fishery as a weighted average for each year with the contribution estimates for a fishery weighted by the total catch for that year.

Mitochondrial DNA

Mitochondrial DNA were used to estimate the Japanese and non-Japanese component to the Period 2 stratum of the 1994, 1995, and 1996 South Unimak and Shumagin Islands fishery. Baseline mtDNA data were from Park et al. (1993) and from new data available from Naiba River (Sakhalin Island) and Avakumovka River (Primorye Region, Russia) (ADF&G, unpublished, available upon request). Stock contributions were estimated, and 90% bootstrap confidence intervals were computed in the same manner as the allozyme data.

RESULTS

Fishery Sampling

Approximately 29,000 chum salmon were sampled from test and commercial fisheries during June and July off the South Alaska Peninsula from 1993 to 1997 (Table 1). Almost 15,000 chum salmon were sampled from the South Unimak and Shumagin Islands June fisheries; this report is based on the analysis of these samples. Approximately half of the June commercial catch samples were assayed for genetic variation (Table 1); we intentionally oversampled to ensure that each fishery sampling was representative (Shaklee and Phelps 1990). For each fishery, samples for analysis were randomly selected from the total number collected within each time strata, weighted proportionally to the daily catch (Table 2).

Statistical Analysis of Fishery Samples

Pacific Rim Baseline

The baseline data set for chum salmon was composed of 248 collections (Table 3a). Allele frequency data from 83 collections were added to the baseline used by Seeb et al. (1995), including 68 from western Alaska (this report), 10 from Canada (this report; Wilmot et al. 1994; USFWS unpublished), and five from the Amur River, the Primorye region of Russia, and Sakhalin Island in Asia (Wilmot et al. 1995). The final baseline used in this fishery analysis comprised 109 pooled populations groupings (Table 3a, 3b; Figure 1) (see below).

Populations from western Alaska and Canada were pooled into enlarged stock groupings based on the results of a hierarchical G-Statistic analysis (Appendix 2, Seeb et al. 1997). The 101 collections from summer- and fall-run populations in northwestern Alaska were pooled into 23 stock groupings. No heterogeneity of allele frequencies was detected within the following drainages or regions: lower Noatak River; Norton Sound; Andreafsky River; Anvik River; early-run Koyukuk River; late-run Koyukuk River; early-run Tanana River; upper fall-run Tanana River; Porcupine River; Yukon River-Canadian Mainstem; White River; early-run Kuskokwim River; late-run Kuskokwim River; northern Bristol Bay; Kvichak Bay; Egegik/Ugashik Bay; Meshik/Cinder Rivers; or the Susitna River. Allele frequency heterogeneity was detected within the Noatak River drainage and between the Noatak and Kobuk Rivers. Differences in allele frequencies occurred among rivers draining into the Yukon River; in addition, temporal differences in allele frequencies existed among early- and late-run populations in the Koyukuk and Tanana Rivers.   Temporal differences in allele frequencies also occurred between early- and late-run collections in the Kuskokwim River. Heterogeneity was detected among rivers draining into Bristol Bay.

Comparatively more heterogeneity occurred among populations from the Alaska Peninsula and Kodiak Island. Of the 40 populations sampled in this region, only Sturgeon River (Kodiak Island) and Kitoi Hatchery were pooled (the brood source for Kitoi Hatchery is the Sturgeon River). No allele frequency differences were detected among populations sampled in western Prince William Sound, but heterogeneity did occur among populations in eastern Prince William Sound.

Pooled population groupings in the Pacific Rim baseline (see Appendix 3, Seeb et al. 1997 for baseline allele frequencies) were plotted using a multidimensional scaling analysis (Figure 3). Five non-overlapping groups were apparent: fall-run Yukon River, summer-run populations from northwestern Alaska, Susitna River, northern Russia, and populations from Washington and southern British Columbia. Overlap was observed between populations from Prince William

Sound, the Alaska Peninsula, Kodiak Island, southeastern Alaska, and northern British Columbia. Populations from Japan were well separated from populations from North America. However, some overlap was apparent between Japan and the very divergent populations from the Amur River, Sakhalin Island, and southern Russia.

Ten potential reporting regions were selected from the multidimensional scaling analysis: 1) JAPAN, 2) CHINA/SOUTHERN RUSSIA, 3) NORTHERN RUSSIA, 4) NORTHWEST ALASKA SUMMER, 5) FALL YUKON, 6) ALASKA PENINSULA/KODIAK, 7) SUSITNA RIVER, 8) PRINCE WILLIAM SOUND, 9) SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and 10) SOUTHERN BRITISH COLUMBIA/WASHINGTON. The ability of these reporting regions to be correctly identified in mixtures was evaluated using simulations where each simulated mixture was composed of 100% of a reporting region. Within the region, the individual populations were constrained to contribute equally to the sample (no allowances were made for differential abundances). Mean estimates from 100 simulations indicated that all reporting regions showed at least 90% accuracy with the exception SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA where accuracy dropped to 86% (Table 4). Stock contributions of these 10 reporting regions were estimated for the South Unimak and Shumagin Islands fisheries (see Appendix 4, Seeb et al. 1997 for fishery allele frequencies).

Fishery Estimates

South Unimak Fishery

The annual estimates for the South Unimak fishery indicated that the largest contributor was NORTHWEST ALASKA SUMMER, followed by the combined Asian reporting groups (Table 5, Figure 4). The NORTHWEST ALASKA SUMMER component of the chum salmon harvest was the largest for each year sampled, ranging from an annual low in 1996 (0.40) to a high in 1995 (0.65). The other major individual contributors were JAPAN, NORTHERN RUSSIA, and ALASKA PENINSULA/KODIAK. JAPAN was the second largest contributor in 1993 and 1995, and its contribution was fairly consistent from year to year, ranging from 0.12 to 0.16. NORTHERN RUSSIA was the second largest contributor in 1994 (0.14), and ALASKA PENINSULA/KODIAK was the second largest contributor in 1996 (0.17). However, the contributions of these reporting groups were not consistent from year to year, varying from 0.06 to 0.14 for NORTHERN RUSSIA and 0.03 to 0.17 for ALASKA PENINSULA/KODIAK. Smaller components (0.00 to 0.09) were observed for CHINA/SOUTHERN RUSSIA, FALL YUKON, SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON.

In 1993, reporting region contributions were nearly equivalent between the two time strata, with the exception of ALASKA PENINSULA/KODIAK (Table 5, Figure 5). However, for the other years, variation in reporting region contribution is evident within years. For example, the NORTHWEST ALASKA SUMMER component ranged from 0.48 to 0.71 in 1994; ranged from 0.58 to 0.76 in 1995; and ranged from 0.33 to 0.44 in 1996. Within-year variation is also evident for the other reporting regions with large contributions. In general, if the contribution of the NORTHWEST ALASKA SUMMER increased over time, the proportion of Asia and, to a lesser extent, ALASKA PENINSULA/KODIAK, decreased (Figure 5).

Shumagin Islands Fishery

NORTHWEST ALASKA SUMMER was also the largest component of the Shumagin

Islands fishery, followed by the combined Asian reporting groups (Table 5, Figure 4). Annual estimates for NORTHWEST ALASKA SUMMER ranged from 0.36 in 1996 to 0.52 in 1995. Asian reporting groups were the second largest. The JAPAN component ranged from 0.16 in 1994 to 0.24 in 1996, while the NORTHERN RUSSIA component ranged from 0.05 in 1995 to 0.17 in 1994. ALASKA PENINSULA/KODIAK ranged from 0.08 in 1994 and 1995 to 0.19 in 1996. Smaller components (0.00 to 0.10) were observed for CHINA/SOUTHERN RUSSIA, FALL YUKON, SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON.

Variation in the contribution of reporting regions is evident within years in the Shumagin Islands fishery as well and was most notable in 1995. The contribution of NORTHWEST ALASKA SUMMER decreased from 0.69 in Period 1 to 0.15 in Period 3. Conversely, the JAPAN contribution increased from 0.11 in Period 1 to 0.41 in Period 3; the ALASKA PENINSULA/KODIAK contribution also increased from 0.03 in Period 1 to 0.21 in Period 3. Similar to the South Unimak fishery, changes in the NORTHWEST ALASKA SUMMER component over time were met with a corresponding and opposite change in the Asian and ALASKA PENINSULA/KODIAK component (Figure 6).

Fishery Comparison

NORTHWEST ALASKA SUMMER was the largest contributor to both fisheries (Figure 4). However, in two of the three years in which both locations were sampled, the NORTHWEST ALASKA SUMMER component was significantly larger in the South Unimak fishery than the Shumagin Islands fishery. Reporting regions that make especially large or small contributions in a year seem to do so consistently across fisheries. For example, in 1995, the NORTHWEST ALASKA SUMMER component was the highest over all years sampled in both the South Unimak and Shumagin Islands fishery. Similarly, the largest contribution by NORTHERN RUSSIA was made to both fisheries in 1994, and the largest contribution by ALASKA PENINSULA/KODIAK was made to both fisheries in 1996, while the smallest contribution by NORTHWEST ALASKA SUMMER was made to both fisheries in 1996.

NORTHWEST ALASKA SUMMER was the largest contributor to the combined fishery, with estimates ranging from 0.60 in 1995 to 0.38 in 1996 (Table 5). The contribution of JAPAN and ALASKA/PENINSULA KODIAK to the combined fishery increased from 0.13 in 1994 to 0.21 in 1996 and 0.08 in 1994 to 0.18 in 1996, respectively. The contribution of NORTHERN RUSSIA decreased from 0.15 in 1994 to 0.08 in 1996. The contributions of the remaining reporting groups to the combined fishery were less than 0.09 in every year sampled.

MtDNA Analysis

Mitochondrial DNA variation was analyzed in the South Unimak and Shumagin Islands fisheries, Period 2 stratum 1994-1996 to verify the estimate of the Japanese component given by the allozyme results. Frequencies for the B haplotype, common in Japan (Park et al. 1993), ranged from 0.141 for the South Unimak fishery in 1994 to 0.279 for the Shumagin Islands fishery in 1996 (Table 6). Estimates for JAPAN using mtDNA ranged from 0.11 to 0.25 in the South Unimak fishery and 0.21 to 0.26 in the Shumagin Islands fishery. In every case except South Unimak 1995, the mtDNA estimates for the contribution of JAPAN are within the 90% confidence intervals for the corresponding allozyme estimates (Table 6). For South Unimak 1995, the mtDNA and allozyme estimates were close, 0.25 and 0.20 respectively.

DISCUSSION

Baseline

We expanded upon the baseline used in the Seeb et al. (1995) analysis of the South Unimak fishery by adding populations for previously underrepresented areas. These included fall-run populations from the Canadian portion of the Yukon drainage and the Amur River, Premorye Region of Russia, and Sakhalin Island in Asia. In addition, temporal and geographic coverage was improved for the Alaskan portion of the Yukon River, the Kuskokwim River, the Alaska Peninsula, the Susitna River, and Prince William Sound. Addition of these new populations improves our understanding of population substructure of chum salmon and refines the delineation of reporting groups that can be identified in mixtures.

The addition of new population data from the Alaska Peninsula and Kodiak Island further illustrate the greater heterogeneity observed in this region as compared to northwestern Alaska noted by Seeb and Crane (submitted). The multidimensional scaling analysis of the chum salmon baseline (Figure 3) demonstrated that chum salmon populations from this area are not only very divergent from populations in northwestern Alaska, but are also the most genetically diverse of any area except Sakhalin Island and the Primorye Region of Russia. Seeb and Crane (submitted) attributed this greater observed heterogeneity to multiple recolonization events following the glaciation that occurred in this region during the Pleistocene.

New population data from Alaska further provided additional evidence for the importance of temporal differences in runtiming as an isolating mechanism for chum salmon, already well documented in the Yukon River (Wilmot et al. 1994; Seeb and Crane submitted). Genetic differences were observed between early- and late-run salmon in the Koyukuk River (G-statistic=96.8, DF=42, P<0.0001) and, more notably, the Kuskokwim River (G-statistic=396.0, DF=42, P<0.0001). The magnitude of difference between early- and late-run Kuskokwim River populations is similar to that between summer- and fall-run chum salmon in the Yukon River.

Wilmot et al. (1995) examined eight populations from China and Russia. They found that chum salmon from Sakhalin Island and the Premorye Region of Russia were intermediate between those from Japan and northern Russia. We used five of these populations in the baseline for the analysis of the South Peninsula fishery. Three of the populations analyzed by Wilmot et al. (1995) had samples sizes of less than 40 individuals; we did not incorporate these because baseline populations with very small sample sizes increase imprecision of stock composition estimates (Wood et al. 1987). Similar to Wilmot et al. (1995), the multidimensional scaling analysis in this study demonstrated that these populations overlap more with Japan than northern Russia. Wilmot et al. (1995) attributed the extreme divergence of the Kalininka River due to a genetic bottleneck; this hatchery population was founded from a small number of individuals, while the Heilong (Amur) River is divergent, similar to upper Yukon River populations, because of extremely long distance migrations.

The addition of new populations refined the reporting regions identified by Seeb et al. (1995). JAPAN and NORTHERN RUSSIA (previously termed 'Russia') were the only reporting groups that remained unchanged. The new populations added from China and southern Russia were unique and formed their own reporting group. In simulations of mixtures entirely composed from CHINA/SOUTHERN RUSSIA, there was essentially no misallocation to NORTHERN RUSSIA and 5% misallocation to JAPAN.

The NORTHWEST ALASKA SUMMER reporting region included all populations from

Kotzebue Sound to the Meshik River on the north Alaska Peninsula, excluding fall-run Yukon River. However, SUSITNA RIVER was removed from the Northwest Alaska Summer region and made a separate reporting group. More populations were sampled from the Susitna drainage and consistently showed the unusual allele frequencies previously observed by Okazaki (1982) and Seeb and Crane (submitted) in this river. SUSITNA RIVER is the most highly identifiable reporting region. Populations from the Canadian portion of the Yukon River were not represented in the Seeb et al. (1995) baseline. We incorporated populations sampled in Canada from the Porcupine River, Yukon River mainstem, White River, and Teslin River into the FALL YUKON reporting region. Temporal and geographic coverage was expanded for ALASKA PENINSULA/KODIAK.

More populations were sampled in Prince William Sound allowing the formation of a PRINCE WILLIAM SOUND reporting region, separate from Southeast Alaska as in the previous baseline. Though a small amount of overlap was observed with populations from the Alaska Peninsula in the multidimensional scaling analysis, artificial mixtures made from this reporting group allocated with a high degree of accuracy in the simulation study (93%). Other changes made to the baseline used by Seeb et al. (1995) were combining the genetically similar southern British Columbia and Washington populations into a reporting region and northern British Columbia and southeastern Alaska into a reporting region.

The potential for further refinement of NORTHWEST ALASKA SUMMER into smaller reporting regions is limited; the genetic similarity of chum salmon spawning aggregates in this region is very high. Simulations of the western Alaska portion of the baseline indicated it was clearly not possible to accurately estimate Nushagak River, Togiak River, early-run Kuskokwim

River, and summer-run chum salmon from the lower Yukon River. Correct mean allocations in simulations where reporting groups comprised 100% of the mixture were less than 75%. Seeb and Crane (submitted) attributed the lack of genetic differences among populations to a historical connection between the Kuskokwim and Nushagak drainages. These rivers likely shared a common outlet to the Bering Sea during the Pleistocene, close to the ancient outlet of the Yukon River. Either there has not been enough time since the geographic separation of these drainages for genetic differences to accrue due to drift or low levels of straying are maintaining allele frequency similarities. However, in other fishery applications smaller reporting regions may be possible.

Accuracy of reporting region estimates is dependent on the sample size of the reporting region in the mixture, as well as the degree of stock separation among reporting regions (Wood et al. 1987). Wood et al. (1987) showed through simulations that a sample size of 40 fish for a reporting region in a mixture, or 10% of the mixture in this study, is required to accurately estimate that reporting region's contribution. In less complicated mixtures, where not all Pacific Rim stocks are contributing, finer delineation of reporting regions may be possible. For example, in-river Yukon fisheries could potentially be subdivided (JTC 1997).

Additional marker types, such as microsatellites, might provide further discrimination among populations and refinement of the baseline. Microsatellites are nuclear DNA markers that have extremely high mutation rates, exhibit high levels of heterozygosity, and are useful in revealing population substructure when other marker types exhibit low levels of heterozygosity (Bentzen et al. 1996) or when populations are recently derived (Wright and Bentzen 1994). However, in studies where allozyme loci are variable, estimates of populations subdivision using allozymes are highly concordant with those using microsatellites (chum salmon, Scribner et al. submitted; sockeye salmon, Allendorf et al. submitted; chinook salmon, Scribner et al. 1996; ADF&G, unpublished data).

Fishery

Genetic analysis of the South Unimak and Shumagin Islands fishery, 1993-1996, indicated that a large proportion of chum salmon harvested were NORTHWEST ALASKA SUMMER, with the second largest contribution made by the combined Asian stocks. Annual estimate showed that NORTHWEST ALASKA SUMMER was always the largest single contributor and ranged from 0.40 to 0.65 for the South Unimak fishery and 0.36 to 0.52 in the Shumagin Islands fishery. The NORTHWEST ALASKA SUMMER contribution may be larger in the South Unimak than the Shumagin Islands fishery. Though the data are limited, in two of the three years that both fisheries were sampled, the NORTHWEST ALASKA SUMMER proportion was larger in the South Unimak fishery than the Shumagin Islands fishery. Geiger (1997) used the contribution estimates for NORTHWEST ALASKA SUMMER to obtain harvest rates for NORTHWEST ALASKA SUMMER stocks in the South Unimak and Shumagin Islands fisheries.

Reporting group contribution to these fishery samples varies both among and within years. The contribution of NORTHWEST ALASKA SUMMER was significantly smaller in 1996 than in the other years sampled for both fisheries, while the contribution of ALASKA PENINSULA/KODIAK was twice as large in this year than any other. Reporting region contribution can almost double in size from one time period to another within a year; in 1996, the ALASKA PENINSULA/KODIAK contribution to the South Unimak June fishery increased from 0.14 in Period 2 to 0.31 in Period 3. It is also interesting to note that reporting regions that make especially strong or weak contributions in a year do so in both the South Unimak and Shumagin Islands fisheries. For example, NORTHERN RUSSIA had its largest component in both the 1994 South Unimak and Shumagin Islands fisheries.

Estimates for CHINA/SOUTHERN RUSSIA, FALL YUKON, PRINCE WILLIAM SOUND, and SUSITNA RIVER indicated that these reporting groups were a small component or were absent in the fisheries sampled. Zero was included in the 90% confidence interval of the annual estimate for CHINA/SOUTHERN RUSSIA in every fishery sample except Shumagin Islands 1994. For FALL YUKON, zero was in the 90% confidence interval for half of the fishery samples. Zero was included in the 90% confidence interval for SUSITNA RIVER in every fishery sample except South Unimak 1993, and for PRINCE WILLIAM SOUND in all fishery samples.

Mitochondrial DNA data have not been used routinely in analyses of mixtures of Pacific salmon, though mtDNA markers have been very successful in identifying the origin of striped bass *Morone saxatilis* (Wirgin et al. 1993) and American shad *Alosa sapidissima* (Epifanio et al. 1995). Seeb et al. (1995) reviewed the utility of mtDNA variation for verification of the allozyme estimate for JAPAN using the mtDNA baseline of Park et al. (1993). Park et al. (1993) found clinal variation in mtDNA around the Pacific Rim; frequencies for the B haplotype ranged from a mean of 0.8 in Japan, decreasing in frequency in Russia, to near absence in North America. We used mtDNA as an independent check of the Period 2 allozyme estimate for each fishery sampled from 1994 to 1996. In both the South Unimak and Shumagin Islands fisheries samples, the allozyme and mtDNA estimates were concordant, and in five out of six cases, statistically indistinguishable.

Variation in reporting region contribution may be an indication of abundance or temporal variation in migration timing (Salo 1991). Migration patterns of maturing chum salmon in the north Pacific Ocean were reviewed by Salo (1991). Summer-run chum salmon bound for northwestern Alaska are at their greatest concentrations off the Alaska Peninsula in June, while chum salmon from Japan and eastern Kamchatka and western Bering Sea move from the Gulf of Alaska into the Bering Sea during this month as well (Salo 1991).

The formation of a Pacific Rim baseline for chum salmon has allowed researchers to use GSI techniques to estimate the stock contribution of mixtures of chum salmon in the Bering Sea and North Pacific Ocean. Wilmot et al. (1995, 1996) used the baseline of Seeb et al. (1995) and eight additional populations from China and southern Russia to estimate the origin of chum salmon harvested incidentally in the 1994 and 1995 Bering Sea “B” fishery for walleye pollock *Theragra chalcogramma*. The majority of fish sampled in both years were immature; composition estimates differed substantially for immature and adult chum salmon. Approximately one half of the immatures were Asian in origin while the Northwest Alaska Summer contribution ranged from 23% to 34%. The majority of the adults were from British Columbia, Washington, or Japan.

Urawa et al. (1997) used the baselines of Seeb et al. (1995) and Wilmot et al. (1995, 1996) to determine the composition of chum salmon sampled in the North Pacific Ocean and Gulf of Alaska in January 1996 and the North Pacific Ocean, Bering Sea, and Gulf of Alaska in late June and early July, 1996. Similar to Wilmot et al. (1995, 1996), the majority of fish sampled were immatures. For the North Pacific Ocean and Bering Sea sampling locations, the majority of fish were Asian in origin for both immatures and adults. However, the stock composition of chum salmon sampled in the Gulf of Alaska indicated that the majority of immatures were from

Northwest Alaska Summer, with large contributions also made by British Columbia and Russia. British Columbia and Alaska Peninsula/Kodiak made the largest contribution to the adult sample.

These studies based on GSI support the view that Asian chum salmon have more extensive oceanic migrations than North American chum salmon (Salo 1991). However, Ignell et al. (1997) discussed the fact that their study of the incidence of thermally-marked chum salmon in the Bering Sea pollock "B" trawl fishery and recent GSI studies all indicate that southern Gulf of Alaska populations may be present in the Bering Sea in higher numbers than previously thought from tagging studies. They hypothesized that possible changes in stock composition in the Bering Sea may be due to decadal changes in environmental conditions or population density. Studies such as these, and the continued analysis of chum salmon sampled in the South Peninsula post-June fishery and South Peninsula test fisheries will provide a more detailed understanding of chum salmon migration patterns.

CONCLUSION

We used genetic stock identification techniques and an extensive allozyme baseline of Pacific Rim chum salmon populations to estimate the composition of chum salmon sampled from the June South Unimak Island and Shumagin Islands commercial catch, 1993-1996. NORTHWEST ALASKA SUMMER was the main component of these fisheries and was a larger component of the South Unimak fishery than the Shumagin Islands fishery in two of the three years sampled. Asian populations were the second largest contributor to these fisheries, followed by chum salmon from the ALASKA PENINSUL/KODIAK ISLAND. Estimates for CHINA/SOUTHERN RUSSIA, FALL YUKON, PRINCE WILLIAM SOUND, and SUSITNA RIVER indicated these regions were a small component or were absent in the fisheries sampled. Variation in reporting region contribution was evident within years in each fishery.

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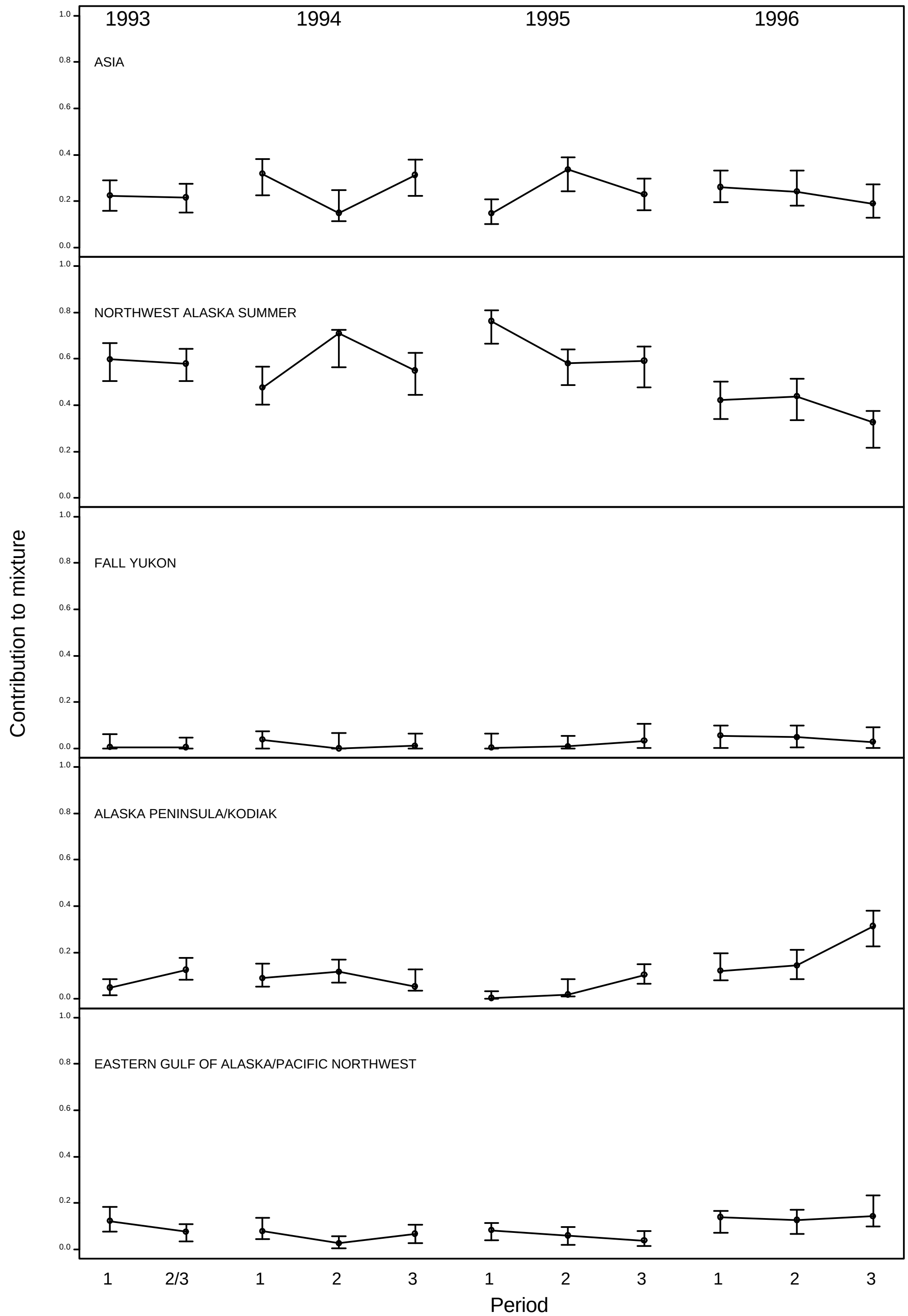

Figure 5. Contribution estimates by period for the South Unimak June fishery, 1993-1996. Reporting groups were enlarged for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, and NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

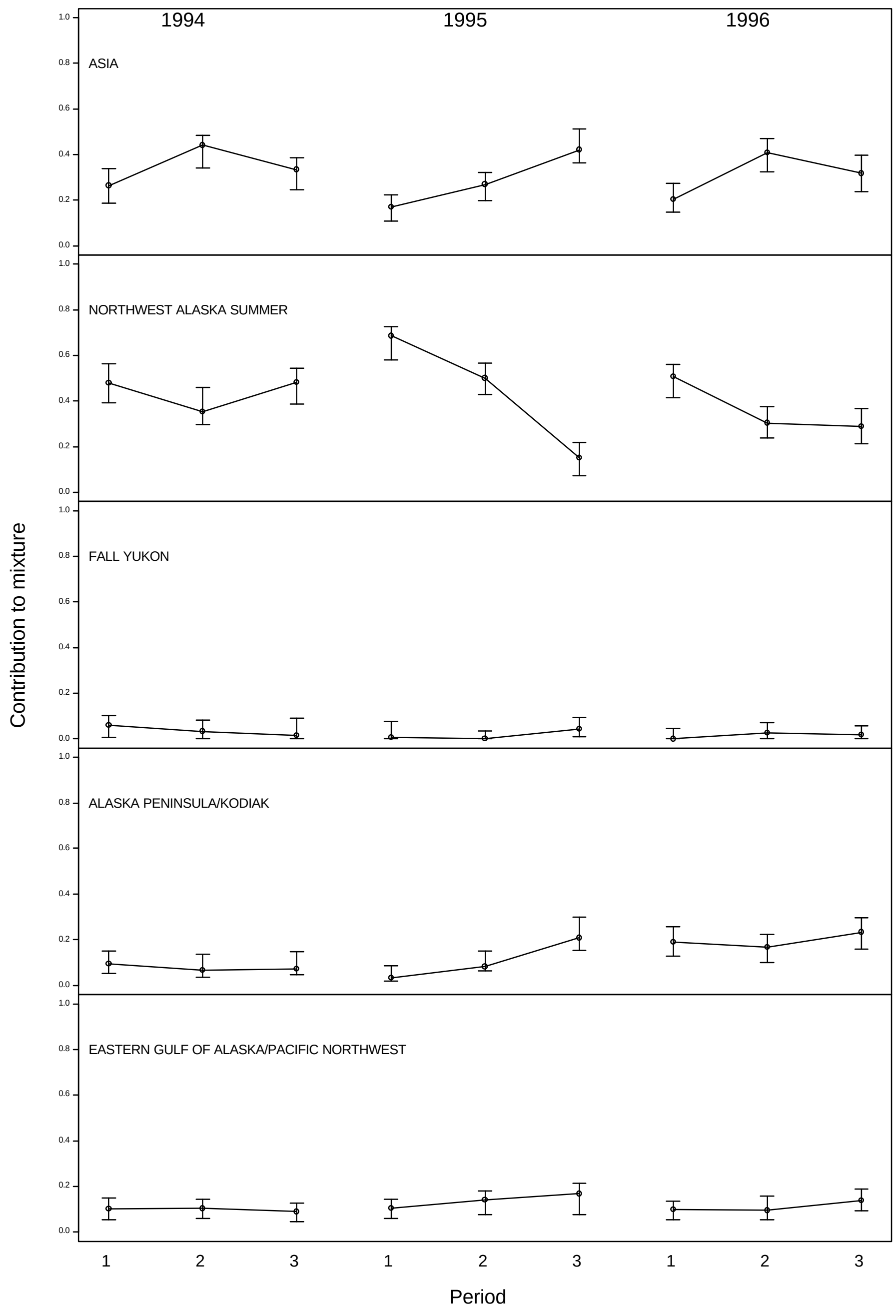

Figure 6. Contribution estimates by period for the Shumagin Islands June fishery, 1994-1996. Reporting groups were enlarged for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, and NORTH RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

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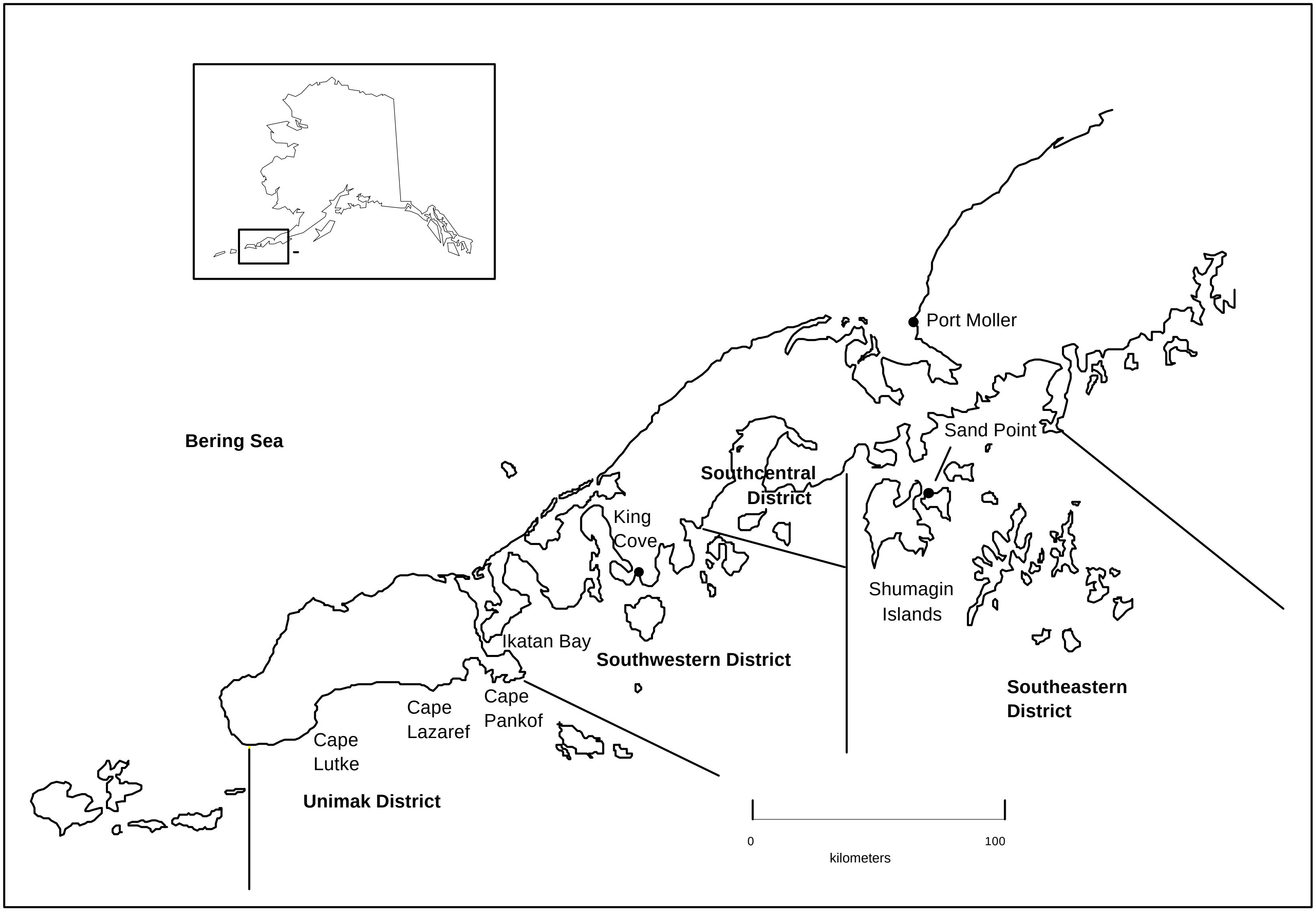
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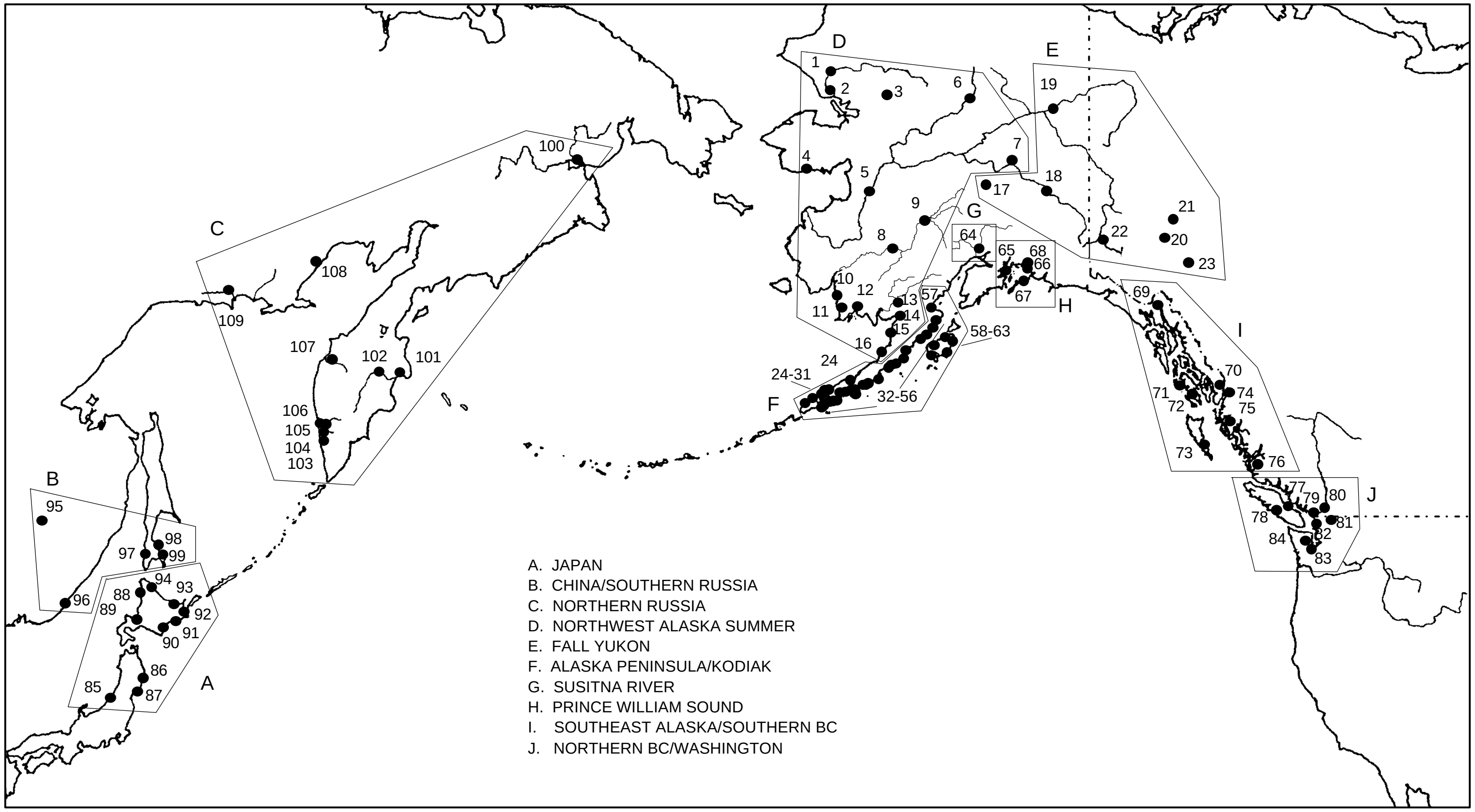

Figure 1. Approximate sampling locations of pooled population groups of chum salmon in the baseline used in the analysis of the South Unimak and Shumagin Islands June fisheries, 1993-1996. Numbers correspond to location names in Table 3a. Reporting regions are delineated.

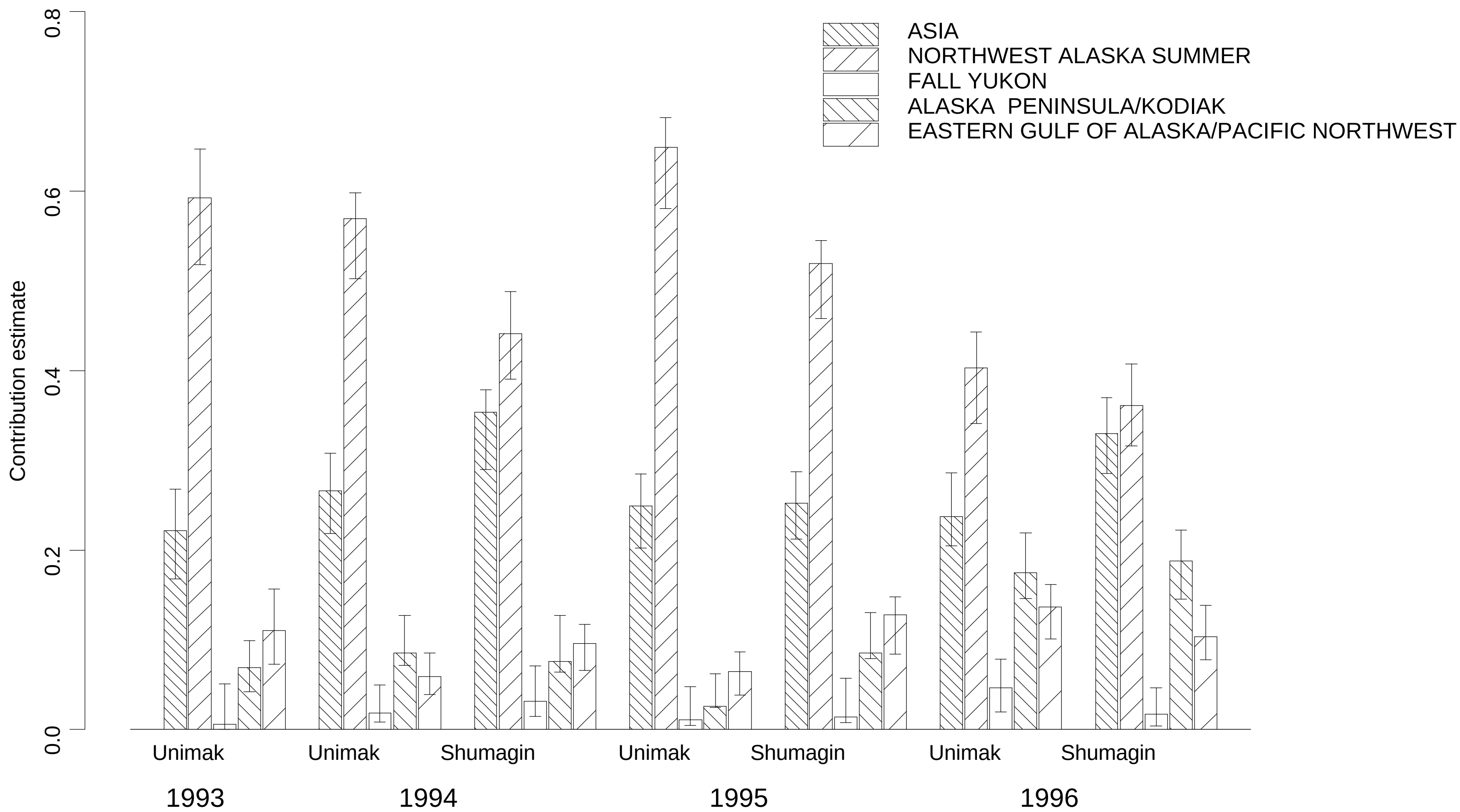

Figure 4. Annual contribution estimates for South Unimak June fishery, 1993-1996 and Shumagin Islands June fishery, 1994-1996. Averages were computed from individual period estimates weighted by catch size for that period. Reporting groups were enlarged for readability: ASIA (JAPAN, CHINA/SOUTHERN RUSSIA, and NORTHERN RUSSIA), NORTHWEST ALASKA SUMMER, FALL YUKON, ALASKA PENINSULA/KODIAK, and EASTERN GULF OF ALASKA/PACIFIC NORTHWEST (SUSITNA RIVER, PRINCE WILLIAM SOUND, SOUTHEAST ALASKA/NORTHERN BRITISH COLUMBIA, and SOUTHERN BRITISH COLUMBIA/WASHINGTON).

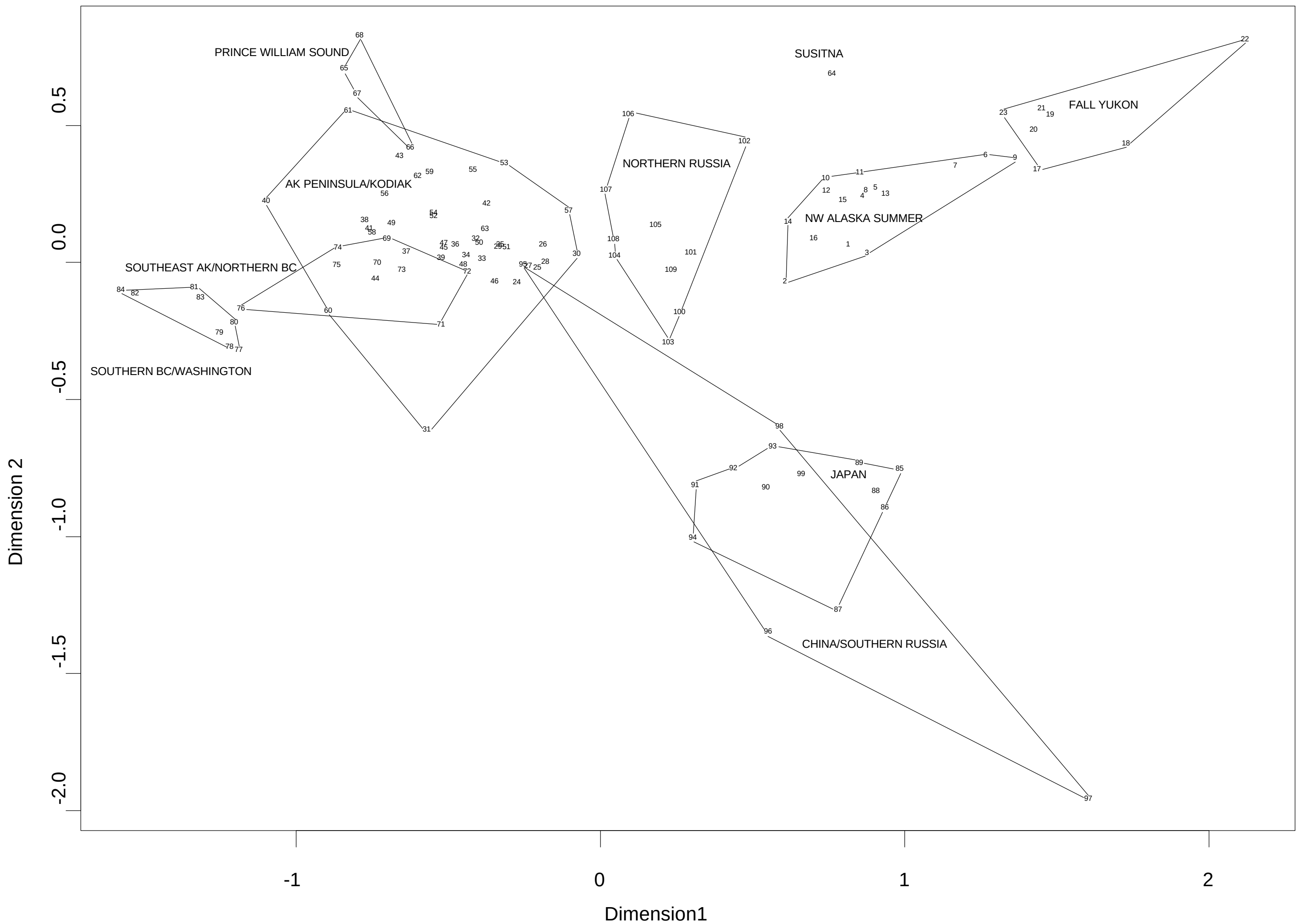

Figure 3. Multidimensional scaling analysis of chum salmon population groupings around the Pacific Rim. Numbers of the population groupings correspond to those in Table 3a. Cavalli-Sforza and Edwards chord distance (Cavalli-Sforza and Edwards 1967) was used.

Table 1. Genetic sampling for chum salmon from the South Unimak and Shumagin Islands June fisheries, 1993-1996 and post-June fisheries, 1996-1997. Sampling was conducted at commercial catch processing facilities and by test fishing. Genetic analysis from commercial catch of the June fisheries only are presented in this report.

Year	Geographic Area	Catch	Test	Total	Catch Subsample
June Fishery					
1993	South Unimak	2622	0	2622	800
1994	Shumagin Islands	1940	1500	3440	1200
	South Unimak	2150	700	2850	1200
1995	Shumagin Islands	1800	900	2700	1150
	South Unimak	2090	600	2690	1200
1996	Shumagin Islands	1740	1299	3039	1200
	SW/Unimak	2268	170	2438	1200
	Total	14610	5169	19779	7950
Post-June Fishery					
1996	Mainland[1]	3240	0	3240	
	Shumagin Islands	2260	510	2770	
1997	Mainland	1127	76	1203	
	Shumagin Islands	900	840	1740	
	Total	7527	1426	8953	

[1]"Mainland" refers to fish caught in Unimak District, Southwestern District, Southcentral District or Southeastern District-Mainland Section waters

Table 2. Daily catch and number of samples analyzed for genetic analysis of South Unimak and Shumagin Islands June fisheries, 1993-1996. Number of fish analyzed is proportional to the daily catch.

			South Unimak				Shumagin Islands			
			Catch		Fish Analyzed		Daily Catch		Fish Analyzed	
Year	Period	Date	N	Proportion	N	Proportion	N	Proportion	N	Proportion
1993	1	13-Jun	37,965	0.13	52	0.13				
		15-Jun	45,075	0.16	64	0.16				
		16-Jun	43,503	0.15	60	0.15				
		17-Jun	38,717	0.14	56	0.14				
		19-Jun	51,147	0.18	72	0.18				
		20-Jun	67,705	0.24	96	0.24				
	Total		284,112		400					
	2	22-Jun	72,862	0.74	297	0.74				
		26-Jun	3,313	0.03	14	0.04				
		27-Jun	12,674	0.13	52	0.13				
		29-Jun	8,980	0.09	37	0.09				
	Total		97,829		400					
1994	1	17-Jun	47,031	0.34	157	0.39				
		18-Jun	24,283	0.18	82	0.21	4,870	0.11	41	0.10
		19-Jun	47,745	0.35	161	0.40	24,170	0.54	182	0.46
		20-Jun	17,957	0.13	0	0.00	15,611	0.35	177	0.44
	Total		137,016		400		44,651		400	
	2	21-Jun	9,983	0.09	0	0.00	5,602	0.08	25	0.06
		22-Jun	26,376	0.24	112	0.28	16,643	0.25	105	0.26
		23-Jun	34,438	0.31	120	0.30	17,718	0.27	100	0.25
		24-Jun	20,153	0.18	85	0.21	11,835	0.18	76	0.19
		25-Jun	19,482	0.18	83	0.21	14,788	0.22	94	0.24
	Total		110,432		400		66,586		400	

Table 2 Continued

	3	26-Jun	19,058	0.15	100	0.25	11,332	0.12	70	0.18
		27-Jun	42,525	0.34	100	0.25	19,911	0.21	100	0.25
		28-Jun	53,844	0.42	140	0.35	28,338	0.29	100	0.25
		29-Jun	9,549	0.08	50	0.13	15,388	0.16	100	0.25
		30-Jun	1,985	0.02	10	0.03	21,539	0.22	30	0.08
	Total		126,961		400		96,508		400	
1995	1	13-Jun	43,419	0.34	110	0.28	9,994	0.10	57	0.14
		14-Jun	5,169	0.04	18	0.05	30,728	0.30	150	0.38
		15-Jun	32,783	0.26	120	0.30	22,839	0.22	0	0.00
		16-Jun	14,103	0.11	51	0.13	12,988	0.13	73	0.18
		17-Jun	10,562	0.08	38	0.10	13,050	0.13	73	0.18
		18-Jun	2,665	0.02	0	0.00	3,811	0.04	0	0.00
		19-Jun	2,453	0.02	9	0.02	1,281	0.01	0	0.00
		20-Jun	14,961	0.12	54	0.14	8,318	0.08	47	0.12
	Total		126,115		400		103,009		400	
	2	21-Jun	28,746	0.18	71	0.18	12,997	0.27	109	0.27
		22-Jun	44,482	0.27	110	0.28	7,891	0.17	66	0.17
		23-Jun	37,005	0.23	91	0.23	7,281	0.15	61	0.15
		24-Jun	33,890	0.21	83	0.21	8,042	0.17	67	0.17
		25-Jun	18,374	0.11	45	0.11	11,569	0.24	97	0.24
	Total		162,497		400		47,780		400	
	3	26-Jun	20,526	0.38	150	0.38	21,745	0.49	120	0.34
		27-Jun	13,499	0.25	111	0.28	4,947	0.11	80	0.23
		28-Jun	8,001	0.15	66	0.17	2,133	0.05	150	0.43
		29-Jun	6,417	0.12	53	0.13	15,512	0.35	0	0.00
		30-Jun	5,252	0.10	20	0.05				
	Total		53,695		400		44,337		350	

Table 2. Continued.

			South Unimak				Shumagin Islands			
			Catch		Fish Analyzed		Daily Catch		Fish Analyzed	
Year	Period	Date	N	Proportion	N	Proportion	N	Proportion	N	Proportion
1996	1	15-Jun	12,692	0.21	83	0.21				
		16-Jun	1,269	0.02	8	0.02				
		17-Jun	8,902	0.14	58	0.14				
		18-Jun	9,873	0.16	64	0.16	14,656	0.21	100	0.25
		19-Jun	14,289	0.23	93	0.23	36,408	0.53	150	0.38
		20-Jun	14,399	0.23	94	0.23	17,430	0.25	150	0.38
		Total	61,424		400		68,494		400	
	2	21-Jun	15,088	0.41	150	0.38	31,848	0.27	108	0.27
		22-Jun	16,640	0.45	148	0.37	41,325	0.36	139	0.35
		23-Jun	191	0.01	0	0.00	20,681	0.18	78	0.20
		24-Jun	2,813	0.08	61	0.15	15,046	0.13	51	0.13
		25-Jun	1,908	0.05	41	0.10	7,212	0.06	24	0.06
		Total	36,640		400		116,112		400	
	3	26-Jun	6,495	0.20	110	0.28	9,124	0.20	125	0.31
		27-Jun	7,501	0.24	127	0.32	9,646	0.21	101	0.25
		28-Jun	5,005	0.16	85	0.21	9,174	0.20	106	0.27
		29-Jun	4,634	0.15	78	0.20	5,108	0.11	67	0.17
		30-Jun	8,190	0.26	0	0.00	12,273	0.27	0	0.00
		Total	31,825		400		45,325		400	

Table 3a. Chum salmon populations used to construct baseline for analysis of the South Unimak and Shumagin Islands June fisheries and source of data. Data sources are designated as follows: 1) Seeb and Crane, submitted, 2) this report, 3) Sarafin (1995b), 4)USFWS (unpublished), 5)Wilmot et al. (1994), 6) Kondzela et al. (1994), 7) Phelps et al. (1994), 8) Winans et al. (1994), 9) Wilmot et al. (1995).

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
NORTHWEST ALASKA SUMMER					
	Kotzebue Sound				
		1 Noatak River	Sikusuilaq Hatchery 1991	100	1
			Sikusuilaq Hatchery 1993	100	1
			Noatak River 1991	100	1
			Total Noatak River	300	
		2 Kelly Lake	Kelly Lake 1991	100	1
		3 Kobuk River	Salmon River 1991	106	1
			Selby Slough 1994	100	2
			Total Kobuk River	206	
	Norton Sound				
		4 Norton Sound	Pilgrim River 1994	90	1
			Snake River 1992	47	1
			Snake River 1993	35	1
			Snake River 1994	24	2
			Snake River 1995	58	2
			Nome River 1991	27	1
			Nome River 1992	13	1
			Nome River 1993	53	1

Table 3a continued

		Nome River 1994	32	2
		Nome River 1995	50	2
		Solomon River 1995	65	2
		Fish River 1994	100	1
		Kwiniuk River 1994	100	1
		Unalakleet River 1992	100	1
		Total Norton Sound:	794	
Yukon River				
	5 Lower River Summer	W. Fk. Andreafsky River 1993	100	1
		E. Fk. Andreafsky River 1993	100	1
		Innoko River 1993	88	1
		Anvik/Beaver Creek 1992	100	1
		Anvik/Beaver Creek 1993	100	1
		Anvik/Yellow River 1992	100	1
		Anvik/Swift River 1992	100	1
		Anvik/Swift River 1993	100	1
		Anvik/Canyon Creek 1993	50	1
		Anvik/Otter Creek 1993	100	1
		Nulato River 1994	100	2
		Koyukuk/Gisasa River 1994	100	2
		Koyukuk/Huslia River 1993	100	1
		Koyukuk/Clear Creek 1995	100	2
		Melozitna River 1994	100	2
		Total Lower River summer	1438	
	6 Koyukuk River Late	Henshaw Creek 1995	62	2
		South Fork Koyukuk River late 1995	100	2
		Total Koyukuk River late	162	
	7 Tanana River Early	Chena River 1992	86	1

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
			Chena River 1994	100	2
			Salcha River 1992	100	1
			Salcha River 1994	100	2
			Total Tanana River early	386	
	Kuskokwim River				
		8 Kuskokwim River early	Kwethluk River 1994	100	1
			Kasigluk River 1994	70	2
			Kisaralik River 1994	100	2
			Tuluksak River 1993	100	1
			Aniak River 1992	100	1
			Holokuk River 1995	48	2
			Oskawalik River 1994	58	2
			George River 1996	100	2
			Kogrukluk River 1992	75	1
			Kogrukluk River 1993	50	1
			Stoney River early	100	2
			Stoney River late	56	2
			Tatlawiksuk River 1994	100	1
			Nunsatuk River 1994	100	2
			4th of July Creek 1994	100	1
			Kuskokwim River at McGrath 1994	100	2
			Total Kuskokwim River early	1357	
		9 Kuskokwim River late	South Fork Kuskokwim-late 1995	100	2
			Big River 1996	100	2
			Total Kuskokwim River late	200	
	Kanektok River				
		10 Kanektok River	Kanektok River 1993	39	1
			Kanektok River 1994	100	2
			Total Kanektok River:	139	

Table 3a. Continued.

Goodnews River				
	11 Goodnews River	Goodnews River 1991	100	1
Bristol Bay				
	12 Togiak River	Togiak River 1993	100	1
		Togiak River 1994	100	1
		Total Togiak River	200	
	13 Nushagak River	Upper Nushagak River 1992	53	1
		Upper Nushagak River 1993	50	1
		Mulchatna River 1994	100	1
		Stuyahok River 1992	31	1
		Stuyahok River 1993	57	1
		Total Nushagak River:	291	
	14 Naknek/Alagnak Rivers	Alagnak River 1992	84	1
		Naknek/Big Creek 1993	80	1
		Total Naknek/Alagnak Rivers	164	
	15 Egegik/Ugashik Bay	Egegik Bay/Whale Mountain Creek 1993	98	1
		Ugashik Bay/Pumice Creek 1993	100	1
		Total Egegik/Ugashik Bay	198	
North Alaska Peninsula				
	16 Meshik/Cinder River	Meshik/Plenty Bear Creek 1993	93	1
		Meshik/Braided Creek 1992	78	1
		Wiggly Creek 1993	100	2

Table 3a. Continued.

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
			Total Meshik/Cinder River	271	
FALL YUKON					
	Yukon River				
		17 Toklat River	Toklat River 1991	60	1
			Toklat River 1992	155	1
			Toklat River 1993	200	2
			Toklat River site a 1994	100	3
			Toklat River site b 1994	100	3
			Toklat/Geiger Creek 1994	100	3
			Toklat/Sushana River 1994	100	3
			Total Toklat River:	815	1
		18 Tanana Late Run	Tanana River (mainstem) 1992	97	1
			Tanana River (mainstem) 1993	100	1
			Bluff Cabin Slough 1992	100	1
			Delta River 1991	100	1
			Delta River 1992	100	1
			Delta River 1994	100	2
			Total Tanana Fall Run:	597	
		19 Porcupine River	Sheenjek River 1992	100	1
			Sheenjek River 1993	64	1
			Fishing Branch 1992	100	4
			Fishing Branch 1994	100	2
			Total Porcupine River	364	
		20 Canadian Yukon Mainstem	Big Creek 1992	100	4
			Big Creek 1995	1	2
			Total Big Creek	101	
		21 Pelly River	Pelly River 1993	84	2

Table 3a continued

	22 White River	Kluane River 1987	135	5
		Kluane River 1992	100	4
		Donjek River 1994	74	2
		Total White River	309	
	23 Teslin River	Teslin River 1989	95	5
		Teslin River 1992	99	4
		Total Teslin River	194	
ALASKA PENINSULA/KODIAK				
North Alaska Peninsula				
	24 Lawrence Valley Creek	Lawrence Valley Creek 1992	100	1
	25 Moffit Creek	Moffitt Creek 1996	100	2
	26 Joshua Green River	Joshua Green River 1992	80	1
		Joshua Green River 1994	100	2
		Total Joshua Green River	180	
	27 Frosty Creek	Frosty Creek 1992	100	1
	28 Alligator Hole	Alligator Hole 1996	100	2
	29 Trader's Cove Creek	Trader's Cove Creek 1992	100	1
	30 St. Catherine's Cove	St. Catherine's Cove 1992	80	1
	31 Peterson Lagoon	Peterson Lagoon 1992	86	1
South Alaska Peninsula				
	32 Little John Lagoon	Little John Lagoon 1992	87	1
	33 Sandy Cove	Sandy Cove 1996	100	2
	34 Russell Creek	Russell Creek 1992	100	1
		Russell Creek 1993	100	2

Table 3a. Continued.

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
			Total Russell Creek:	200	
		35 Delta Creek	Delta Creek 1996	100	2
		36 Belkofski River	Belkofski River 1992	87	1
		37 Volcano Bay	Volcano Bay 1992	64	2
			Volcano Bay 1996	42	2
			Total Volcano Bay	106	
		38 Ruby's Lagoon	Ruby's Lagoon 1996	100	2
		39 Canoe Bay	Canoe Bay 1992	100	1
		40 Zachary Bay	Zachary Bay 1992	80	2
		41 Coleman Creek	Coleman Creek 1996	100	2
		42 Balboa Bay	Foster Creek 1992	100	2
		43 Chichagof Bay	Chichigof Bay 1996	100	2
		44 Stepovak Bay	Stepovak Bay 1992	50	2
		45 Stepovak River	Stepovak River 1993	100	1
	Chignik	46 Ivanoff River	Ivanoff River 1993	94	1
		47 Kiukta Bay	Portage Creek 1993	100	2
		48 Kujulik Bay	North Fork River 1993	72	2
		49 Aniakchak River	North Fork Creek 1993	100	2
		50 Amber Bay	Main Creek	92	2
		51 Chiginigak Bay	Chiginigak River 1993	75	1
		52 Kialagvik Bay	Wide Bay 1993	100	1
		53 Alinchak Bay	E. Bear Bay Creek 1993	100	2
		54 Alagogshak River	Alagoshak River 1993	95	1
		55 Gull Cape Creek	Gull Cape Creek 1993	100	2
	Kodiak Mainland	56 Hallo Bay	Big River 1993	100	1
		57 McNeil River	McNeil River 1994	60	2
			McNeil River 1996	49	2
			Total McNeil River	109	

Table 3a. Continued.

	Kodiak Island				
		58 American River	American River 1992	100	2
			American River 1995	45	2
			Total American River:	145	1
		59 Dog Bay	Dog Bay 1992	100	2
		60 Sukhoi Lagoon	Big Sukhoi Creek 1992	100	1
		61 Sturgeon Lagoon	Sturgeon River 1992	71	1
			Kitoi Hatchery 1993	100	2
			Total: Sturgeon River total:	171	
		62 Uganik River	Uganik River 1992	100	2
		63 Kizhuyak River	Kizhuyak River 1992	88	1
SUSITNA RIVER					
	Susitna River				
		64 Susitna River	Yentna/Lake Creek 1996	100	2
			Susitna/Chunilna River 1993	87	1
			Susitna/Slough 11 1996	100	2
			Susitna/Talkeetna River 1995	50	2
			Total Susitna River	337	
PRINCE WILLIAM SOUND					
	Prince William Sound				
		65 West Prince William Sound	WHN Hatchery 1992	92	1
			Wells River 1996	100	2
			Total West Prince William Sound:	192	

Table 3a. Continued.

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
		66 Olsen Creek	Olsen Creek 1992	100	2
			Olsen Creek 1995	100	2
			Olsen Creek Total:	200	
		67 Constantine Creek	Constantine Creek 1994	100	2
		68 Keta Creek	Keta Creek 1992	100	2
SOUTHEAST AK/NORTHERN BC					
	Southeast Alaska				
		69 Herman Creek	Herman Creek 1987	100	6
			Herman Creek 1990	59	6
			Total Herman Creek:	159	
		70 Southeast Alaska	Fish Creek 1986	100	6
			Fish Creek 1987	50	6
			Fish Creek 1988 (early)	100	6
			Fish Creek 1988 (late)	52	6
			Tombstone River 1986	98	6
			Marten River 1986	105	6
			Keta River 1986	101	6
			Blossom River 1986	101	6
			Wilson River 1986	103	6
			Harding River 1986	95	6
			Total Southeast Alaska:	905	
		71 Port Real Marina	Port Real Marina 1986	100	6
			Port Real Marina 1988	48	6
			Total Port Real Marina:	148	

Table 3a continued

	72 Eastern Prince of Wales Island	Kugel Creek 1986	104	6
		Disappearance Creek 1986	100	6
		Disappearance Creek 1988	100	6
		Lagoon Creek 1986	102	6
		Old Tom Creek 1986	100	6
		Old Tom Creek 1988	53	6
		Cabin Creek 1986	103	6
		Total Eastern Prince of Whales Island:	662	
British Columbia				
	73 Eastern Queen Charlotte Islands	Pallant Creek 1988	100	6
		Lagoon Creek 1989	83	6
		Sedgewick Creek 1989	74	6
		Bag Harbor Creek 1989	89	6
		Surprise Creek 1989	85	6
		Total Eastern Queen Charlotte Islands	431	
	74 Nass River Area	Kshwan River 1988	88	6
		Kitsault River 1988	95	6
		Stagoo Creek 1988	75	6
		Stagoo Creek 1989	53	6
		Total Nass River Area	311	
	75 Kitimat/Mussel River	Kitimat River 1988	92	6
		Kitimat River 1989	100	6
		Mussel River 1989	100	6
		Total Kitimat/Mussel River:	292	
	76 Nekite Channel/River	Nekite Channel 1989	100	6
		Nekite River 1989	97	6
		Total Nekite Channel/River	197	

Table 3a. Continued.

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
SOUTHERN BC/WASHINGTON					
	British Columbia				
		77 East Vancouver Island	Puntledge Hatchery	100	7
			Big Qualicum Hatchery	200	7
			Little Qualicum	100	7
			Nanaimo River	100	7
			Chemainus River	100	7
			Cowichan River	100	7
			Goldstream River	100	7
			Total E. Vancouver Island:	800	
		78 West Vancouver Island	Nitinat River and Hatchery	380	7
			Nahmint River	100	7
			Sarita River	127	7
			Total W. Vancouver Island:	607	
		79 Lower Fraser River	Alouette River	100	7
			Stave River	100	7
			Chilliwack - Vedder Hatchery	100	7
			Chehalis Hatchery	100	7
			Total Lower Fraser River	400	
		80 Upper Fraser River	Chehalis at Harrison Hatchery	100	7
			Weaver River	100	7
			Harrison River	100	7
			Squakum Creek	100	7
			Wahleach Creek	100	7
			Total Upper Fraser River	500	

Table 3a. Continued.

	Washington				
		81 Skagit River	Illabot Creek	98	7
			Dan Creek	153	7
			Total Skagit River:	251	
		82 Bellingham Maritime Hatchery	Bellingham Maritime Hatchery	100	7
		83 Mill Creek	Mill Creek	179	7
		84 Hood Canal Hatchery	Hood Canal Hatchery	450	7
JAPAN					
	Honshu				
		85 Gakko/Miomote Rivers	Gakko River 1989	39	8
			Miomote River 1989	100	8
			Total Gakko/Miomote Rivers	139	
		86 Tsugaruishi River	Tsugaruishi River 1989	100	8
		87 Ohkawa River	Ohkawa River 1989	100	8
	Hokkaido				
		88 Teshio River	Teshio River 1987	97	8
		89 Chitose River	Chitose River 1989	100	8
			Chitose River 1990	80	8
			Total Chitose River:	180	
		90 Tokachi River	Tokachi River 1989	100	8
			Tokachi River 1990	80	8
			Total Tokachi River	180	
		91 Kushiro River	Kushiro River 1989	100	8
		92 Nishibetsu River	Nishibetsu River 1989	100	8
		93 Shari River	Shari River 1989	100	8

Table 3a. Continued.

Reporting Region	Geographic Area	Pooled Population	Population	N	Source
		94 Tokusibetsu River	Tokushibetsu River 1994	42	8
CHINA/SOUTHERN RUSSIA					
	China				
		95 Amur River	Heilong River	48	9
	Russia/Premorye				
		96 Ryzanovka River	Ryzanovka River	51	9
	Russia/Sakhalin				
		97 Kalininka River	Kalininka River	49	9
		98 Naiba River	Naiba River	61	9
		99 Udarnitsa River	Udarnitsa River	98	9
NORTHERN RUSSIA					
	Russia				
		100 Anadyr/Kanchalan Rivers	Anadyr River 1991	104	5
			Kanchalan River 1991	79	8
			Total Anadyr/Kanchalan Rivers:	183	
		101 Nerpichi Lake	Nerpichi Lake	40	8
		102 Kamchatka River	Kamchatka River 1990	80	8
			Kamchatka River 1991	40	8
			Total Kamchatka River:	120	
		103 Utka River	Utka River 1991	79	8
		104 Kikchik River	Kikchik River 1991	40	8
		105 Pymta River	Pymta River 1990	80	8
			Pymta River 1991	79	8
			Total Pymta River	159	
		106 Kol River	Kol River 1990	93	8
		107 Hairusova River	Hairusova River 1990	154	8
		108 Tumani River	Tumani River 1991	66	8
		109 Ola River	Ola River 1990	80	8
			Ola River 1991	80	8
			Total Ola River:	160	

Table 3b. Comparison of 1995 baseline and the baseline used in this study to determine the origin of fish sampled from the South Unimak fishery 1993-1996 and the Shumagin Islands fishery 1994-1996 in June.

Baseline	Number of Reporting Regions	No. of pooled population groups	No. of Collections	No. of Individuals
ADF&G 1995	8	69	166	15,703
This study	10	109	248	22,727

Table 4. Mean estimated contribution for 100 simulations where each region comprises 100% of the mixture (N=400). Shaded cells are correct allocations and should equal 1.00. Standard errors are given immediately beneath a mean contribution estimate.

	Mixture									
Allocation	JAPAN	CHINA/ SOUTHERN RUSSIA	NORTHERN RUSSIA	NW ALASKA SUMMER	FALL YUKON	AK PENINSULA/ KODIAK	SUSITNA RIVER	PWS	SE AK/ NORTHERN BC	SOUTHERN BC/WASH.
JAPAN	0.96	0.05	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	0.022	0.034	0.008	0.007	0.003	0.006	0.001	0.001	0.005	0.001
CHINA/SOUTHERN RUSSIA	0.01	0.90	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.012	0.040	0.010	0.005	0.001	0.005	0.001	0.002	0.004	0.002
NORTHERN RUSSIA	0.01	0.01	0.90	0.01	0.00	0.01	0.00	0.01	0.01	0.00
	0.007	0.013	0.038	0.014	0.003	0.015	0.002	0.014	0.010	0.003
NORTHWEST AK SUMMER	0.01	0.01	0.03	0.90	0.04	0.01	0.00	0.00	0.00	0.00
	0.014	0.014	0.024	0.050	0.037	0.008	0.006	0.003	0.004	0.001
FALL YUKON	0.00	0.00	0.00	0.06	0.95	0.00	0.00	0.00	0.00	0.00
	0.005	0.003	0.004	0.045	0.037	0.003	0.003	0.001	0.001	0.000
AK PENINSULA/KODIAK	0.01	0.01	0.04	0.01	0.00	0.93	0.00	0.04	0.07	0.01
	0.010	0.010	0.024	0.009	0.002	0.033	0.002	0.022	0.037	0.010
SUSITNA RIVER	0.00	0.01	0.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00
	0.002	0.010	0.006	0.010	0.003	0.002	0.008	0.003	0.004	0.001
PRINCE WILLIAM SOUND	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.93	0.01	0.00
	0.001	0.002	0.006	0.001	0.001	0.014	0.002	0.028	0.011	0.005
SE AK/NORTHERN BC	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.86	0.01
	0.003	0.002	0.007	0.002	0.001	0.023	0.001	0.012	0.052	0.015
SOUTHERN BC/WASH.	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.04	0.97
	0.001	0.003	0.005	0.001	0.001	0.009	0.000	0.008	0.032	0.017

Table 5. Estimated contributions of Pacific Rim chum salmon to a.) the South Unimak June fishery 1993-1996, b.) the Shumagin Islands June fishery, 1994-1996, and c.) combined South Unimak and Shumagin Islands June fisheries. Confidence intervals were estimated by 500 bootstrap resamples of the mixture and baseline.

a.

	S Unimak, 1993-1			S Unimak,1993-2,3			S Unimak 1993 Annual		
		90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
JAPAN	0.16	0.09	0.20	0.14	0.09	0.19	0.15	0.10	0.18
CHINA/S RUSSIA	0.01	0.00	0.03	0.01	0.00	0.05	0.01	0.00	0.03
N RUSSIA	0.06	0.02	0.11	0.06	0.01	0.11	0.06	0.03	0.10
NW AK SUMMER	0.60	0.50	0.67	0.58	0.50	0.64	0.59	0.52	0.65
FALL YUKON	0.01	0.00	0.06	0.00	0.00	0.05	0.01	0.00	0.05
AK PEN./KODIAK	0.05	0.02	0.09	0.13	0.08	0.18	0.07	0.04	0.10
SUSITNA RIVER	0.07	0.03	0.12	0.00	0.00	0.02	0.05	0.02	0.09
PWS	0.01	0.00	0.03	0.01	0.00	0.02	0.01	0.00	0.03
SE AK/N BC	0.03	0.00	0.06	0.07	0.03	0.10	0.04	0.02	0.06
S BC/WASH.	0.01	0.00	0.03	0.00	0.00	0.02	0.01	0.00	0.03

	S Unimak, 1994-1			S Unimak,1994-2			S Unimak,1994-3			S Unimak 1994 Annual		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
JAPAN	0.13	0.08	0.17	0.07	0.04	0.12	0.15	0.09	0.19	0.12	0.09	0.14
CHINA/S RUSSIA	0.00	0.00	0.04	0.01	0.00	0.05	0.01	0.00	0.03	0.01	0.00	0.02
N RUSSIA	0.19	0.09	0.24	0.06	0.03	0.15	0.16	0.08	0.21	0.14	0.10	0.18
NW AK SUMMER	0.48	0.40	0.57	0.71	0.56	0.73	0.55	0.45	0.62	0.57	0.50	0.60
FALL YUKON	0.04	0.00	0.07	0.00	0.00	0.07	0.01	0.00	0.06	0.02	0.01	0.05
AK PEN./KODIAK	0.09	0.05	0.15	0.12	0.07	0.17	0.05	0.04	0.13	0.09	0.07	0.13
SUSITNA RIVER	0.00	0.00	0.03	0.01	0.00	0.03	0.01	0.00	0.05	0.01	0.00	0.03
PWS	0.00	0.00	0.04	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
SE AK/N BC	0.04	0.01	0.08	0.02	0.00	0.03	0.03	0.00	0.05	0.03	0.01	0.04
S BC/WASH.	0.03	0.01	0.06	0.00	0.00	0.02	0.03	0.01	0.05	0.02	0.01	0.03

Table 5 continued

Region	S Unimak, 1995-1 Estimate	90% C.I. Lower	90% C.I. Upper	S Unimak,1995-2 Estimate	90% C.I. Lower	90% C.I. Upper	S Unimak,1995-3 Estimate	90% C.I. Lower	90% C.I. Upper	S Unimak 1995 Annual Estimate	90% C.I. Lower	90% C.I. Upper
JAPAN	0.09	0.05	0.13	0.20	0.13	0.24	0.16	0.10	0.20	0.16	0.11	0.17
CHINA/S RUSSIA	0.01	0.00	0.03	0.00	0.00	0.05	0.01	0.00	0.04	0.01	0.00	0.03
N RUSSIA	0.04	0.01	0.10	0.13	0.05	0.17	0.06	0.02	0.13	0.09	0.05	0.12
NW AK SUMMER	0.76	0.66	0.81	0.58	0.49	0.64	0.59	0.48	0.65	0.65	0.58	0.68
FALL YUKON	0.00	0.00	0.06	0.01	0.00	0.06	0.03	0.00	0.11	0.01	0.00	0.05
AK PEN./KODIAK	0.00	0.00	0.03	0.02	0.01	0.08	0.10	0.06	0.15	0.03	0.02	0.06
SUSITNA RIVER	0.02	0.00	0.05	0.00	0.00	0.03	0.01	0.00	0.04	0.01	0.00	0.03
PWS	0.00	0.00	0.02	0.01	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.02
SE AK/N BC	0.04	0.00	0.06	0.03	0.00	0.06	0.03	0.00	0.06	0.04	0.01	0.05
S BC/WASH.	0.02	0.00	0.05	0.02	0.00	0.03	0.00	0.00	0.02	0.02	0.01	0.03

Region	S Unimak, 1996-1 Estimate	90% C.I. Lower	90% C.I. Upper	S Unimak,1996-2 Estimate	90% C.I. Lower	90% C.I. Upper	S Unimak,1996-3 Estimate	90% C.I. Lower	90% C.I. Upper	S Unimak 1996 Annual Estimate	90% C.I. Lower	90% C.I. Upper
JAPAN	0.16	0.11	0.22	0.18	0.12	0.22	0.11	0.07	0.16	0.15	0.12	0.18
CHINA/S RUSSIA	0.02	0.00	0.05	0.01	0.00	0.03	0.01	0.00	0.04	0.01	0.00	0.03
N RUSSIA	0.08	0.02	0.14	0.05	0.02	0.14	0.07	0.02	0.14	0.07	0.04	0.11
NW AK SUMMER	0.42	0.34	0.50	0.44	0.33	0.52	0.33	0.22	0.38	0.40	0.34	0.44
FALL YUKON	0.06	0.00	0.10	0.05	0.00	0.10	0.03	0.00	0.09	0.05	0.02	0.08
AK PEN./KODIAK	0.12	0.08	0.20	0.14	0.09	0.21	0.31	0.23	0.38	0.17	0.15	0.22
SUSITNA RIVER	0.00	0.00	0.01	0.02	0.00	0.04	0.01	0.00	0.05	0.01	0.00	0.02
PWS	0.00	0.00	0.02	0.01	0.00	0.03	0.02	0.00	0.06	0.01	0.00	0.02
SE AK/N BC	0.12	0.04	0.14	0.07	0.01	0.10	0.06	0.02	0.12	0.09	0.04	0.10
S BC/WASH.	0.02	0.00	0.05	0.03	0.01	0.07	0.06	0.02	0.10	0.03	0.02	0.05

Table 5. Continued.
b.

	Shumagin, 1994-1			Shumagin,1994-2			Shumagin, 1994-3			Shumagin 1994 Annual		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
JAPAN	0.09	0.05	0.15	0.22	0.15	0.25	0.15	0.09	0.20	0.16	0.12	0.19
CHINA/S RUSSIA	0.02	0.00	0.05	0.02	0.00	0.05	0.03	0.00	0.05	0.02	0.01	0.04
N RUSSIA	0.15	0.08	0.21	0.21	0.12	0.25	0.16	0.09	0.21	0.17	0.12	0.20
NW AK SUMMER	0.48	0.39	0.56	0.35	0.30	0.46	0.48	0.39	0.54	0.44	0.39	0.49
FALL YUKON	0.06	0.01	0.10	0.03	0.00	0.08	0.02	0.00	0.09	0.03	0.01	0.07
AK PEN./KODIAK	0.09	0.05	0.15	0.07	0.04	0.14	0.07	0.05	0.15	0.08	0.06	0.13
SUSITNA RIVER	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
PWS	0.01	0.00	0.03	0.01	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.01
SE AK/N BC	0.10	0.04	0.13	0.08	0.04	0.12	0.05	0.00	0.08	0.07	0.04	0.09
S BC/WASH.	0.00	0.00	0.03	0.01	0.00	0.03	0.04	0.02	0.07	0.02	0.01	0.04

	Shumagin, 1995-1			Shumagin,1995-2			Shumagin, 1995-3			Shumagin 1995 Annual		
		90% C.I.			90% C.I.			90% C.I.			90% C.I.	
Region	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper	Estimate	Lower	Upper
JAPAN	0.11	0.07	0.15	0.21	0.14	0.25	0.41	0.30	0.46	0.20	0.16	0.22
CHINA/S RUSSIA	0.00	0.00	0.02	0.00	0.00	0.03	0.01	0.00	0.11	0.00	0.00	0.03
N RUSSIA	0.06	0.02	0.10	0.06	0.02	0.11	0.00	0.00	0.05	0.05	0.02	0.07
NW AK SUMMER	0.69	0.58	0.73	0.50	0.43	0.57	0.15	0.07	0.22	0.52	0.46	0.55
FALL YUKON	0.01	0.00	0.08	0.00	0.00	0.04	0.04	0.01	0.09	0.01	0.01	0.06
AK PEN./KODIAK	0.03	0.02	0.09	0.08	0.06	0.15	0.21	0.15	0.30	0.08	0.08	0.13
SUSITNA RIVER	0.01	0.00	0.05	0.01	0.00	0.04	0.00	0.00	0.03	0.01	0.00	0.03
PWS	0.02	0.00	0.04	0.01	0.00	0.03	0.01	0.00	0.05	0.01	0.00	0.03
SE AK/N BC	0.08	0.02	0.10	0.11	0.03	0.14	0.14	0.03	0.17	0.10	0.05	0.10
S BC/WASH.	0.00	0.00	0.03	0.01	0.00	0.04	0.01	0.00	0.05	0.00	0.00	0.03

Table 5 continued

Region	Shumagin, 1996-1 Estimate	90% C.I. Lower	Upper	Shumagin,1996-2 Estimate	90% C.I. Lower	Upper	Shumagin, 1996-3 Estimate	90% C.I. Lower	Upper	Shumagin 1996 Annual Estimate	90% C.I. Lower	Upper
JAPAN	0.19	0.11	0.24	0.28	0.21	0.33	0.19	0.12	0.24	0.24	0.19	0.27
CHINA/S RUSSIA	0.00	0.00	0.04	0.01	0.00	0.04	0.00	0.00	0.02	0.01	0.00	0.03
N RUSSIA	0.02	0.00	0.07	0.11	0.05	0.16	0.13	0.07	0.20	0.09	0.06	0.12
NW AK SUMMER	0.51	0.41	0.56	0.30	0.24	0.38	0.29	0.21	0.37	0.36	0.32	0.41
FALL YUKON	0.00	0.00	0.05	0.03	0.00	0.07	0.02	0.00	0.06	0.02	0.00	0.05
AK PEN./KODIAK	0.19	0.13	0.26	0.17	0.10	0.22	0.23	0.16	0.30	0.19	0.14	0.22
SUSITNA RIVER	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.03	0.00	0.00	0.01
PWS	0.01	0.00	0.03	0.02	0.00	0.05	0.01	0.00	0.02	0.01	0.00	0.03
SE AK/N BC	0.04	0.00	0.08	0.06	0.02	0.10	0.05	0.01	0.09	0.05	0.02	0.08
S BC/WASH.	0.05	0.01	0.08	0.02	0.00	0.05	0.07	0.04	0.12	0.04	0.02	0.06

c.

Region	Combined 1994 Annual Estimate	90% C.I. Lower	Upper	Combined 1995 Annual Estimate	90% C.I. Lower	Upper	Combined 1996 Annual Estimate	90% C.I. Lower	Upper
JAPAN	0.13	0.11	0.15	0.17	0.14	0.19	0.21	0.17	0.23
CHINA/S RUSSIA	0.01	0.01	0.03	0.01	0.00	0.03	0.01	0.00	0.03
N RUSSIA	0.15	0.12	0.18	0.07	0.05	0.09	0.08	0.06	0.11
NW AK SUMMER	0.52	0.48	0.55	0.60	0.55	0.62	0.38	0.34	0.40
FALL YUKON	0.02	0.01	0.05	0.01	0.01	0.04	0.03	0.02	0.05
AK PEN./KODIAK	0.08	0.08	0.12	0.05	0.05	0.08	0.18	0.15	0.21
SUSITNA RIVER	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.01
PWS	0.00	0.00	0.01	0.01	0.00	0.02	0.01	0.01	0.02
SE AK/N BC	0.05	0.02	0.05	0.06	0.03	0.06	0.07	0.04	0.08
S BC/WASH.	0.02	0.01	0.03	0.01	0.01	0.02	0.03	0.03	0.05

Table 6. a. Haplotype frequencies of *AseI* polymorphisms from the ND5/ND6 region of chum salmon mtDNA. Results from chum salmon sampled in the June South Unimak and Shumagin Islands fisheries 1994-1996. b. Estimates of the Japanese component of the June South Unimak and Shumagin Islands fisheries, Period 2, 1994-1996 are given; allozyme results are from Table 5.

a.

	Haplotype Counts					Frequencies	
Fishery Sampling	N	A	B	C	D	A,C,D	B
South Unimak 1994-2	362	0	51	309	2	0.859	0.141
South Unimak 1995-2	392	1	105	286	0	0.732	0.268
South Unimak 1996-2	390	0	82	308	0	0.790	0.210
Shumagin 1994-2	392	0	93	299	0	0.763	0.237
Shumagin 1995-2	393	1	107	285	0	0.728	0.272
Shumagin 1996-2	390	1	109	280	0	0.721	0.279

b.

	Estimated Japanese Component					
	mtDNA			Allozyme		
		90% C.I.			90% C.I.	
Group	Estimate	Lower	Upper	Estimate	Lower	Upper
South Unimak 1994-2	0.11	0.08	0.14	0.07	0.04	0.12
South Unimak 1995-2	0.25	0.21	0.29	0.20	0.13	0.24
South Unimak 1996-2	0.18	0.15	0.22	0.18	0.12	0.22
Shumagin 1994-2	0.21	0.17	0.25	0.22	0.15	0.25
Shumagin 1995-2	0.25	0.21	0.29	0.21	0.14	0.25
Shumagin 1996-2	0.26	0.22	0.30	0.28	0.21	0.33

Appendix 1. Alleles pooled for Pacific Rim baseline and mixture samples for the genetic analysis of the South Peninsula June fishery, 1993-1996.

	Allele								
Locus	1	2	3	4	5	6	7	8	9
sAAT-1,2*	100/113	120/125	65		84/80/95				
mAAT-1*	-100	-120/-110	-70						
mAH-3*	100/140	124	115						
ALAT*	100/fast	93	78						
ESTD*	100	91	110						
G3PDH-2*	100/132	90							
GPI-B1,2*	100	fast	40						
GPI-A*	100	slow	fast						
mIDHP-1*	100	60	140	20	85				
sIDHP-2*	100/65	35	85	25	20	110	28		45
LDH-A1*	100	50	110/0						
LDH-B2*	100/60	fast							
sMDH-A1*	100	200	400	10					
sMDH-B1,2*	100/110	72/85/95	fast>110						
mMEP-2*	100/75	122							
sMEP-1*	100	90							
MPI*	100	94/91/95	110	80/86					
PEPA*	100	90	110						
PEPB-1*	-100	-146	-126	-127	-72/-50				
PGDH*	100	88/84	104/106/110	95					

Appendix 2. Hierarchical heterogeneity analysis of Alaskan portion of chum salmon baseline. Results were used to pool populations to condense the number of populations in the baseline.

Populations	DF	*sAAT-1,2**	DF	*mAAT-1**	DF	*mAH-3**	DF	*ALAT**	DF	*ESTD**	DF	*G3PDH-2**
total	351	1174.2	234	3220.1	234	2378.0	117	1179.0	234	8789.6	117	839.9
among	3	387.7	2	1973.3	2	682.6	1	295.6	2	7092.0	1	20.2
within	348	786.6	232	1246.9	232	1695.0	116	883.4	232	1697.9	116	819.6
Northwest Alaska	213	288.8	142	432.6	142	1487.0	71	342.6	142	1132.0	71	462.8
Among	21	145.1	14	225.0	14	416.5	7	124.7	14	605.8	7	289.2
Within	192	143.7	128	207.6	128	1071.1	64	217.9	128	525.9	64	173.7
Kotzebue Sound	12	18.3	8	11.6	8	14.2	4	8.9	8	1.9	4	4.8
Among	3	15.2	2	0.0	2	4.2	1	7.8	2	0.2	1	3.2
Within	9	3.1	6	11.6	6	10.0	3	1.1	6	1.6	3	1.6
Noatak River	6	3.1	4	11.6	4	9.2	2	1.0	4	0.9	2	1.1
Among	3	2.3	2	10.7	2	8.4	1	0.5	2	0.3	1	1.1
Within	3	0.8	2	0.9	2	0.8	1	0.5	2	0.6	1	0.0
Noatak River	3	0.8	2	0.9	2	0.8	1	0.5	2	0.6	1	0.0
Kobuk River	3	0.1	2	0.0	2	0.8	1	0.2	2	0.7	1	0.5
Norton Sound	18	5.1	12	15.1	12	11.9	6	3.9	12	15.5	6	14.6
Yukon River	81	71.4	54	72.0	54	830.2	27	172.5	54	448.0	27	105.7
Among	33	27.7	22	33.8	22	704.3	11	145.5	22	339.7	11	82.8
Within	48	43.6	32	38.2	32	125.8	16	27.0	32	108.2	16	22.9
Andreafsky River	3	0.0	2	1.6	2	0.2	1	4.4	2	1.3	1	0.1
Anvik River	12	4.9	8	7.4	8	5.5	4	4.4	8	1.1	4	6.2
Koyukuk River	12	11.4	8	3.8	8	48.8	4	2.5	8	4.2	4	4.7
Among	3	7.0	2	1.8	2	45.4	1	0.0	2	3.2	1	4.0
Within	9	4.4	6	2.0	6	3.3	3	2.5	6	1.0	3	0.6
Early	6	3.6	4	1.9	4	1.2	2	0.8	4	1.0	2	0.1
Late	3	0.9	2	0.1	2	2.1	1	1.7	2	0.0	1	0.5
Tanana River	15	23.0	10	23.4	10	69.9	5	14.4	10	100.1	5	11.7
Among	3	16.3	2	11.9	2	4.5	1	3.4	2	93.5	1	0.4
Within	12	6.8	8	11.5	8	65.3	4	11.0	8	6.6	4	11.3
Early	3	0.4	2	3.2	2	0.1	1	0.1	2	0.8	1	2.9
Late	9	6.4	6	8.3	6	65.3	3	10.9	6	5.8	3	8.4
Among	3	1.3	2	8.0	2	63.2	1	3.2	2	5.5	1	4.4
Within	6	5.1	4	0.3	4	2.1	2	7.7	4	0.3	2	4.0
Upper Fall Tanan	6	5.1	4	0.3	4	2.1	2	7.7	4	0.3	2	4.0

Appendix 2 continued

Porcupine River	3	3.4	2	1.6	2	0.1	1	0.0	2	0.3	1	0.0
White River	3	1.0	2	0.4	2	1.4	1	1.4	2	1.3	1	0.2
Kuskokwim River	45	24.1	30	77.0	30	132.4	15	20.6	30	32.8	15	24.3
Among	3	0.2	2	40.6	2	114.8	1	0.6	2	12.4	1	3.1
Within	42	23.9	28	36.4	28	17.5	14	20.0	28	20.4	14	21.2
Early	39	23.5	26	36.4	26	15.5	13	16.0	26	20.1	13	21.0
Late	3	0.4	2	0.0	2	2.0	1	4.0	2	0.3	1	0.2
Bristol Bay	27	24.6	18	22.0	18	71.7	9	10.9	18	26.5	9	22.6
Among	3	2.1	2	4.2	2	36.3	1	4.6	2	1.5	1	9.7
Within	24	22.4	16	17.8	16	35.3	8	6.3	16	24.9	8	12.9
Northern	9	8.5	6	6.4	6	3.1	3	1.3	6	9.0	3	4.2
Among	3	1.6	2	3.9	2	2.1	1	0.4	2	7.5	1	2.2
Within	6	6.9	4	2.5	4	1.0	2	0.9	4	1.5	2	2.0
Nushagak River	6	6.9	4	2.5	4	1.0	2	0.9	4	1.5	2	2.0
Southern	15	13.9	10	11.4	10	32.2	5	5.0	10	16.0	5	8.6
Among	6	10.6	4	9.71	4	31.68	2	0.03	4	8.96	2	6.11
Within	9	3.29	6	1.68	6	0.51	3	4.92	6	6.99	3	2.53
Alagnak/Naknek	3	0.83	2	0.3	2	0.21	1	3.05	2	6.21	1	1.24
Egegik/Ugashik	3	1.23	2	1.38	2	0.3	1	0.05	2	0.25	1	1.18
Meshik/Cinder	3	1.23	2	0	2	0	1	1.82	2	0.53	1	0.11
Sustina River	9	0.3	6	9.9	6	10.7	3	1.2	6	1.3	3	1.7
Among	3	0.1	2	3.5	2	8.0	1	0.2	2	0.1	1	1.5
Within	6	0.2	4	6.4	4	2.7	2	1.0	4	1.2	2	0.2
Susitna River	6	0.2	4	6.4	4	2.7	2	1.0	4	1.2	2	0.2
Gulf of Alaska	135	497.8	90	814.3	90	208.0	45	540.8	90	565.9	45	356.8
Among	9	171.3	6	320.0	6	48.7	3	324.7	6	122.2	3	226.8
Within	126	326.6	84	494.3	84	159.4	42	216.1	84	443.7	42	130.1
North Peninsula	21	29.8	14	47.8	14	10.1	7	24.0	14	39.8	7	32.2
South Peninsula	75	248.1	50	314.6	50	65.0	25	107.3	50	334.5	25	55.6

Appendix 2 continued

Kodiak Island	18	14.7	12	104.7	12	82.2	6	82.3	12	51.8	6	32.3
Among	15	13.5	10	102.7	10	80.9	5	81.0	10	51.8	5	32.2
Within	3	1.2	2	2.0	2	1.3	1	1.3	2	0.0	1	0.1
Sturgeon River	3	1.2	2	2.0	2	1.3	1	1.3	2	0.0	1	0.1
Prince William Sound	12	34.0	8	27.2	8	2.0	4	2.5	8	17.6	4	9.9
Among	3	4.6	2	4.0	2	0.8	1	0.8	2	13.0	1	0.3
Within	9	29.3	6	23.2	6	1.2	3	1.7	6	4.6	3	9.6
East	6	29.3	4	17.1	4	1.2	2	1.7	4	3.3	2	8.9
West	3	0.0	2	6.1	2	0.0	1	0.0	2	1.3	1	0.7

Appendix 2. Continued.

Populations	DF	*GPI-B1,2**	DF	*GPI-A**	DF	*mIDHP-1**	DF	*sIDHP-2**	DF	*LDH-A1**	DF	*LDH-B2**
total	234	324.5	234	147.6	117	1405.0	468	5115.0	234	2047.0	117	60.3
among	2	130.4	2	11.3	1	680.6	4	3162.0	2	993.0	1	0.3
within	232	194.0	232	136.2	116	724.4	464	1953.0	232	1054.0	116	60.0
Northwest Alaska	142	42.7	142	49.3	71	434.3	284	981.1	142	671.3	71	32.7
Among	14	13.0	14	29.4	7	141.7	28	328.4	14	295.8	7	13.3
Within	128	29.7	128	19.9	64	292.6	256	652.7	128	375.5	64	19.4
Kotzebue Sound	8	0.0	8	0.0	4	19.5	16	25.2	8	30.9	4	3.0
Among	2	0.0	2	0.0	1	1.6	4	7.7	2	0.5	1	1.7
Within	6	0.0	6	0.0	3	18.0	12	17.5	6	30.4	3	1.3
Noatak River	4	0.0	4	0.0	2	17.9	8	12.6	4	29.5	2	1.3
Among	2	0.0	2	0.0	1	11.0	4	4.9	2	29.5	1	1.1
Within	2	0.0	2	0.0	1	6.9	4	7.8	2	0.1	1	0.3
Noatak River	2	0.0	2	0.0	1	6.9	4	7.8	2	0.1	1	0.3
Kobuk River	2	0.0	2	0.0	1	0.1	4	4.9	2	0.9	1	0.0
Norton Sound	12	0.0	12	4.1	6	15.8	24	29.1	12	7.5	6	5.4

Appendix 2 continued

Yukon River	54	13.7	54	0.0	27	174.6	108	310.6	54	230.8	27	11.0
Among	22	3.7	22	0.0	11	94.1	44	235.8	22	204.1	11	7.7
Within	32	10.0	32	0.0	16	80.4	64	74.8	32	26.6	16	3.3
Andreafsky River	2	0.0	2	0.0	1	3.0	4	1.5	2	1.1	1	0.0
Anvik River	8	2.4	8	0.0	4	3.6	16	19.5	8	6.1	4	3.3
Koyukuk River	8	3.1	8	0.0	4	9.5	16	19.4	8	6.5	4	0.0
Among	2	0.9	2	0.0	1	1.3	4	5.0	2	1.5	1	0.0
Within	6	2.2	6	0.0	3	8.3	12	14.4	6	5.0	3	0.0
Early	4	2.2	4	0.0	2	5.3	8	8.1	4	2.1	2	0.0
Late	2	0.0	2	0.0	1	2.9	4	6.3	2	2.8	1	0.0
Tanana River	10	4.5	10	0.0	5	64.4	20	32.8	10	12.8	5	0.0
Among	2	3.1	2	0.0	1	3.3	4	4.9	2	1.3	1	0.0
Within	8	1.5	8	0.0	4	61.1	16	27.8	8	11.6	4	0.0
Early	2	1.5	2	0.0	1	18.9	4	1.0	2	0.6	1	0.0
Late	6	0.0	6	0.0	3	42.3	12	26.9	6	11.0	3	0.0
Among	2	0.0	2	0.0	1	41.8	4	23.2	2	8.3	1	0.0
Within	4	0.0	4	0.0	2	0.5	8	3.7	4	2.8	2	0.0
Upper Fall Tanan	4	0.0	4	0.0	2	0.5	8	3.7	4	2.8	2	0.0
Porcupine River	2	0.0	2	0.0	1	0.0	4	1.5	2	0.2	1	0.0
White River	2	0.0	2	0.0	1	0.0	4	0.1	2	0.0	1	0.0
Kuskokwim River	30	9.1	30	8.9	15	23.9	60	158.4	30	29.2	15	0.0
Among	2	0.6	2	0.6	1	11.4	4	70.9	2	16.0	1	0.0
Within	28	8.6	28	8.3	14	12.6	56	87.5	28	13.2	14	0.0
Early	26	8.6	26	8.3	13	12.6	52	77.8	26	7.4	13	0.0
Late	2	0.0	2	0.0	1	0.0	4	9.8	2	5.7	1	0.0

Appendix 2 continued

Bristol Bay	18	6.9	18	6.9	9	58.7	36	113.6	18	64.1	9	0.0
Among	2	3.3	2	3.3	1	39.1	4	68.6	2	2.0	1	0.0
Within	16	3.6	16	3.6	8	19.6	32	45.0	16	62.1	8	0.0
Northern	6	3.6	6	3.6	3	4.5	12	6.1	6	15.1	3	0.0
Among	2	3.6	2	3.6	1	0.8	4	1.5	2	15.0	1	0.0
Within	4	0.0	4	0.0	2	3.7	8	4.7	4	0.1	2	0.0
Nushagak River	4	0.0	4	0.0	2	3.7	8	4.7	4	0.1	2	0.0
Southern	10	0.0	10	0.0	5	15.1	20	38.8	10	47.0	5	0.0
Among	4	0	4	0	2	8.44	8	24.17	4	42.06	2	0
Within	6	0	6	0	3	6.7	12	14.67	6	4.95	3	0
Alagnak/Naknek	2	0	2	0	1	0	4	3.47	2	4.05	1	0
Egegik/Ugashik	2	0	2	0	1	2.07	4	7.84	2	0.42	1	0
Meshik/Cinder	2	0	2	0	1	4.63	4	3.36	2	0.48	1	0
Sustina River	6	0.0	6	0.0	3	0.0	12	15.8	6	13.0	3	0.0
Among	2	0.0	2	0.0	1	0.0	4	9.6	2	6.2	1	0.0
Within	4	0.0	4	0.0	2	0.0	8	6.2	4	6.7	2	0.0
Susitna River	4	0.0	4	0.0	2	0.0	8	6.2	4	6.7	2	0.0
Gulf of Alaska	90	151.3	90	87.0	45	290.1	180	971.9	90	382.7	45	27.3
Among	6	41.3	6	35.0	3	27.7	12	349.5	6	120.1	3	4.0
Within	84	110.0	84	52.0	42	262.3	168	622.5	84	262.5	42	23.2
North Peninsula	14	5.5	14	25.8	7	24.7	28	66.0	14	84.3	7	0.0
South Peninsula	50	77.2	50	10.2	25	102.9	100	298.9	50	109.9	25	21.1
Kodiak Island	12	23.7	12	16.0	6	126.8	24	205.2	12	34.8	6	0.0
Among	10	23.7	10	14.3	5	125.1	20	202.9	10	34.8	5	0.0
Within	2	0.0	2	1.8	1	1.8	4	2.3	2	0.0	1	0.0
Sturgeon River	2	0.0	2	1.8	1	1.8	4	2.3	2	0.0	1	0.0
Prince William Sound	8	3.6	8	0.0	4	7.9	16	52.3	8	33.5	4	2.2
Among	2	0.8	2	0.0	1	7.6	4	5.0	2	17.3	1	0.8
Within	6	2.8	6	0.0	3	0.3	12	47.4	6	16.2	3	1.4
East	4	2.8	4	0.0	2	0.3	8	45.8	4	14.6	2	1.4
West	2	0.0	2	0.0	1	0.0	4	1.6	2	1.6	1	0.0

Appendix 2. Continued.

Populations	DF	*sMDH-A1**	DF	*MDHB-1,2**	DF	*mMEP-2**	DF	*sMEP-1**	DF	*MPI**	DF	*PEPA**
total	351	599.0	351	2056.3	117	1449.1	117	16.0	351	715.7	117	74.2
among	3	23.5	3	640.9	1	225.8	1	1.8	3	170.0	1	8.6
within	348	575.6	348	1415.1	116	1223.3	116	14.2	348	545.7	116	65.6
Northwest Alaska	213	235.8	213	395.1	71	994.4	71	14.2	213	270.0	71	57.9
Among	21	62.2	21	124.1	7	553.0	7	9.4	21	96.6	7	4.9
Within	192	173.6	192	271.1	64	441.4	64	4.8	192	173.4	64	53.0
Kotzebue Sound	12	14.7	12	6.8	4	12.1	4	0.0	12	11.8	4	3.1
Among	3	0.5	3	6.5	1	0.1	1	0.0	3	7.5	1	1.6
Within	9	14.1	9	0.3	3	11.9	3	0.0	9	4.3	3	1.5
Noatak River	6	13.9	6	0.0	2	10.3	2	0.0	6	2.2	2	1.5
Among	3	12.7	3	0.0	1	5.0	1	0.0	3	2.2	1	0.7
Within	3	1.2	3	0.0	1	5.3	1	0.0	3	0.1	1	0.8
Noatak River	3	1.2	3	0.0	1	5.3	1	0.0	3	0.1	1	0.8
Kobuk River	3	0.3	3	0.3	1	1.7	1	0.0	3	2.1	1	0.0
Norton Sound	18	13.1	18	20.6	6	4.1	6	0.0	18	3.8	6	4.5
Yukon River	81	103.3	81	112.8	27	316.2	27	0.0	81	112.5	27	33.1
Among	33	78.3	33	59.0	11	286.1	11	0.0	33	90.1	11	24.3
Within	48	25.0	48	53.8	16	30.0	16	0.0	48	22.4	16	8.8
Andreafsky River	3	2.8	3	1.4	1	0.1	1	0.0	3	0.3	1	2.8
Anvik River	12	10.4	12	9.7	4	10.3	4	0.0	12	4.6	4	2.7
Koyukuk River	12	2.4	12	7.7	4	7.3	4	0.0	12	2.0	4	3.3
Among	3	0.5	3	2.3	1	6.7	1	0.0	3	1.5	1	1.7
Within	9	1.9	9	5.4	3	0.6	3	0.0	9	0.5	3	1.6
Early	6	1.0	6	4.4	2	0.6	2	0.0	6	0.0	2	1.6
Late	3	1.0	3	1.0	1	0.0	1	0.0	3	0.4	1	0.0
Tanana River	15	7.8	15	34.6	5	5.8	5	0.0	15	14.0	5	0.0
Among	3	0.0	3	28.0	1	1.6	1	0.0	3	5.1	1	0.0
Within	12	7.8	12	6.6	4	4.3	4	0.0	12	8.9	4	0.0
Early	3	3.4	3	0.1	1	0.3	1	0.0	3	1.2	1	0.0
Late	9	4.4	9	6.5	3	4.0	3	0.0	9	7.7	3	0.0
Among	3	2.4	3	4.2	1	0.3	1	0.0	3	4.3	1	0.0
Within	6	2.0	6	2.2	2	3.7	2	0.0	6	3.5	2	0.0
Upper Fall Tanan	6	2.0	6	2.2	2	3.7	2	0.0	6	3.5	2	0.0

Appendix 2 continued

Porcupine River	3	1.3	3	0.0	1	0.8	1	0.0	3	0.7	1	0.0
White River	3	0.3	3	0.5	1	5.7	1	0.0	3	0.8	1	0.0
Kuskokwim River	45	24.5	45	60.5	15	65.5	15	0.0	45	15.2	15	5.5
Among	3	1.7	3	24.9	1	47.5	1	0.0	3	0.2	1	0.3
Within	42	22.8	42	35.6	14	18.0	14	0.0	42	15.0	14	5.2
Early	39	20.0	39	35.4	13	16.5	13	0.0	39	14.8	13	5.2
Late	3	2.8	3	0.2	1	1.5	1	0.0	3	0.2	1	0.0
Bristol Bay	27	13.8	27	70.3	9	37.6	9	4.8	27	30.0	9	6.9
Among	3	5.0	3	27.7	1	18.1	1	1.7	3	15.2	1	3.4
Within	24	8.8	24	42.6	8	19.4	8	3.1	24	14.8	8	3.5
Northern	9	1.6	9	8.4	3	11.6	3	3.1	9	3.3	3	3.5
Among	3	0.0	3	2.5	1	9.6	1	1.1	3	3.1	1	2.1
Within	6	1.6	6	5.9	2	2.1	2	2.0	6	0.2	2	1.5
Nushagak River	6	1.6	6	5.9	2	2.1	2	2.0	6	0.2	2	1.5
Southern	15	7.3	15	34.2	5	7.8	5	0.0	15	11.5	5	0.0
Among	6	3.4	6	12.36	2	6.1	2	0	6	9.61	2	0
Within	9	3.88	9	21.83	3	1.72	3	0	9	1.89	3	0
Alagnak/Naknek	3	0.45	3	4.21	1	0.65	1	0	3	0.64	1	0
Egegik/Ugashik	3	3.32	3	9.91	1	0.1	1	0	3	0	1	0
Meshik/Cinder	3	0.11	3	7.71	1	0.97	1	0	3	1.25	1	0
Sustina River	9	4.2	9	0.0	3	6.0	3	0.0	9	0.1	3	0.0
Among	3	0.3	3	0.0	1	0.4	1	0.0	3	0.1	1	0.0
Within	6	3.9	6	0.0	2	5.6	2	0.0	6	0.0	2	0.0
Susitna River	6	3.9	6	0.0	2	5.6	2	0.0	6	0.0	2	0.0

Appendix 2 continued

Gulf of Alaska	135	339.8	135	1020.0	45	228.9	45	0.0	135	275.7	45	7.7
Among	9	71.7	9	334.0	3	61.3	3	0.0	9	56.7	3	1.2
Within	126	268.1	126	686.1	42	167.6	42	0.0	126	219.0	42	6.5
North Peninsula	21	12.9	21	78.8	7	8.1	7	0.0	21	6.5	7	0.0
South Peninsula	75	126.4	75	224.2	25	86.1	25	0.0	75	117.0	25	6.5
Kodiak Island	18	116.4	18	361.4	6	47.4	6	0.0	18	73.9	6	0.0
Among	15	116.3	15	357.7	5	43.9	5	0.0	15	73.9	5	0.0
Within	3	0.1	3	3.7	1	3.5	1	0.0	3	0.0	1	0.0
Sturgeon River	3	0.1	3	3.7	1	3.5	1	0.0	3	0.0	1	0.0
Prince William Sound	12	12.4	12	21.8	4	26.1	4	0.0	12	21.7	4	0.0
Among	3	2.5	3	10.5	1	10.6	1	0.0	3	0.0	1	0.0
Within	9	9.9	9	11.3	3	15.4	3	0.0	9	21.7	3	0.0
East	6	9.9	6	11.2	2	15.4	2	0.0	6	18.9	2	0.0
West	3	0.0	3	0.2	1	0.0	1	0.0	3	2.8	1	0.0

Appendix 2. Continued.

Populations	DF	*PEPB-1**	DF	*PGDH**	DF	Overall	*P*
total	468	1686.6	234	646.5	4797	33.9E+39	0.0000
among	4	290.6	2	71.8	41	16.9E+39	0.0000
within	464	1396.0	232	574.8	4756	17062.0	0.0000
Northwest Alaska	284	856.6	142	206.4	2911	9388.0	0.0000
Among	28	412.7	14	58.1	287	3949.0	0.0000
Within	256	443.9	128	148.2	2624	5438.5	0.0000
Kotzebue Sound	16	41.7	8	2.1	164	230.6	0.0005
Among	4	7.7	2	0.2	41	66.2	0.0077
Within	12	34.0	6	2.0	123	164.5	0.0074
Noatak River	8	23.7	4	1.2	82	141.0	0.0001
Among	4	23.5	2	1.2	41	114.8	0.0000
Within	4	0.3	2	0.0	41	26.2	0.9654
Noatak River	4	0.3	2	0.0	41	26.2	0.9654
Kobuk River	4	10.2	2	0.8	41	23.5	0.9870
Norton Sound	24	9.2	12	12.0	246	195.3	0.9925
Yukon River	108	280.9	54	104.3	1107	3503.0	0.0000
Among	44	218.1	22	69.4	451	2704.0	0.0000
Within	64	62.8	32	34.8	656	799.0	0.0001
Andreafsky River	4	4.1	2	1.8	41	26.2	0.9647
Anvik River	16	11.5	8	2.6	164	116.0	0.9983
Koyukuk River	16	23.9	8	3.4	164	164.0	0.4858
Among	4	13.9	2	0.1	41	96.8	0.0000
Within	12	10.0	6	3.3	123	67.2	1.0000
Early	8	8.8	4	0.5	82	43.3	0.9999
Late	4	1.2	2	2.8	41	23.8	0.9852

Appendix 2 continued

Tanana River	20	18.1	10	23.2	205	460.6	0.0000
Among	4	1.5	2	0.1	41	178.7	0.0000
Within	16	16.6	8	23.1	164	281.9	0.0000
Early	4	11.6	2	0.0	41	46.0	0.2732
Late	12	4.9	6	23.1	123	235.9	0.0000
Among	4	3.8	2	22.6	41	196.4	0.0000
Within	8	1.2	4	0.5	82	39.5	1.0000
Upper Fall Tanan	8	1.2	4	0.5	82	39.5	1.0000
Porcupine River	4	3.2	2	3.3	41	16.4	0.9998
White River	4	2.0	2	0.5	41	15.7	0.9999
Kuskokwim River	60	71.4	30	21.0	615	804.3	0.0000
Among	4	41.5	2	8.7	41	396.0	0.0000
Within	56	29.9	28	12.3	574	408.3	1.0000
Early	52	24.6	26	11.6	533	375.2	1.0000
Late	4	5.3	2	0.7	41	33.1	0.8043
Bristol Bay	36	40.6	18	8.8	369	641.2	0.0000
Among	4	13.8	2	0.3	41	260.0	0.0000
Within	32	26.8	16	8.5	328	381.3	0.0227
Northern	12	8.1	6	1.4	123	106.5	0.8559
Among	4	3.4	2	0.1	41	64.0	0.0122
Within	8	4.7	4	1.3	82	42.5	0.9999
Nushagak River	8	4.7	4	1.3	82	42.5	0.9999
Southern	20	18.7	10	7.1	205	274.8	0.0008
Among	8	8.11	4	5.98	82	187.4	0.0000
Within	12	10.54	6	1.14	123	87.38	0.9937
Alagnak/Naknek	4	2.48	2	0	41	27.83	0.9420
Egegik/Ugashik	4	4.91	2	0.98	41	33.99	0.7729
Meshik/Cinder	4	3.15	2	0.16	41	25.56	0.9718
Sustina River	12	0.0	6	0.0	123	64.1	1.0000
Among	4	0.0	2	0.0	41	30.0	0.8985
Within	8	0.0	4	0.0	82	34.1	1.0000
Susitna River	8	0.0	4	0.0	82	34.1	1.0000

Appendix 2 continued

Gulf of Alaska	180	539.4	90	368.4	1845	7674.0	0.0000
Among	12	47.0	6	221.4	123	2585.0	0.0000
Within	168	492.4	84	147.0	1722	5090.0	0.0000
North Peninsula	28	75.9	14	18.3	287	590.4	0.0000
South Peninsula	100	192.8	50	103.6	1025	2602.0	0.0000
Kodiak Island	24	176.6	12	17.3	246	1568.0	0.0000
Among	20	172.4	10	17.3	205	1544.0	0.0000
Within	4	4.3	2	0.0	41	23.3	0.9884
Sturgeon River	4	4.3	2	0.0	41	23.3	0.9884
Prince William Sound	16	47.2	8	7.9	164	329.6	0.0000
Among	4	10.8	2	3.1	41	92.4	0.0000
Within	12	36.3	6	4.8	123	237.1	0.0000
East	8	33.9	4	4.6	82	220.3	0.0000
West	4	2.4	2	0.2	41	16.8	0.9997

Appendix 3. Allele frequency estimates for pooled population groups of chum salmon from the Pacific Rim. Frequencies were used as the baseline for fishery estimates.

		*sAAT-1,2**						*mAAT-1**		
Population	N	100	120	65	95	125	N	-100	-120	-70
Noatak River	292	0.9572	0.0428	0.0000	0.0000	0.0000	296	0.9899	0.0000	0.0101
Kelly Lake	95	0.9737	0.0263	0.0000	0.0000	0.0000	95	0.9474	0.0000	0.0526
Kobuk River	192	0.9883	0.0117	0.0000	0.0000	0.0000	196	0.9796	0.0000	0.0204
Norton Sound	781	0.9667	0.0333	0.0000	0.0000	0.0000	787	0.9180	0.0083	0.0737
Lower Summer Yukon	1426	0.9614	0.0386	0.0000	0.0000	0.0000	1433	0.9020	0.0014	0.0967
Koyukuk River Late	162	0.9321	0.0679	0.0000	0.0000	0.0000	162	0.8704	0.0000	0.1296
Tanana River Early	381	0.9639	0.0361	0.0000	0.0000	0.0000	383	0.8890	0.0026	0.1084
Kuskokwim River early	1309	0.9681	0.0319	0.0000	0.0000	0.0000	1323	0.9165	0.0030	0.0805
Kuskokwim River late	200	0.9712	0.0288	0.0000	0.0000	0.0000	200	0.9900	0.0000	0.0100
Kanektok River	138	0.9438	0.0562	0.0000	0.0000	0.0000	138	0.8841	0.0036	0.1123
Goodnews River	96	0.9609	0.0365	0.0026	0.0000	0.0000	100	0.9000	0.0000	0.1000
Togiak River	200	0.9425	0.0575	0.0000	0.0000	0.0000	200	0.9025	0.0100	0.0875
Nushagak River	282	0.9495	0.0496	0.0009	0.0000	0.0000	286	0.9248	0.0017	0.0734
Naknek/Alagnak Rivers	164	0.9314	0.0686	0.0000	0.0000	0.0000	164	0.9268	0.0000	0.0732
Egegik/Ugashik Bay	196	0.9375	0.0574	0.0051	0.0000	0.0000	198	0.8939	0.0025	0.1035
Meshik/Cinder River	266	0.9445	0.0555	0.0000	0.0000	0.0000	269	0.9442	0.0000	0.0558
Toklat River	813	0.9373	0.0624	0.0003	0.0000	0.0000	814	0.9072	0.0000	0.0928
Tanana Late Run	597	0.9405	0.0595	0.0000	0.0000	0.0000	596	0.9362	0.0000	0.0638
Porcupine River	364	0.9560	0.0440	0.0000	0.0000	0.0000	360	0.8903	0.0000	0.1097
Canadian Yukon Mainstem	200	0.9512	0.0488	0.0000	0.0000	0.0000	200	0.9250	0.0000	0.0750
Pelly River	83	0.9608	0.0392	0.0000	0.0000	0.0000	84	0.8571	0.0000	0.1429
White River	304	0.9515	0.0485	0.0000	0.0000	0.0000	238	0.9223	0.0000	0.0777
Teslin River	194	0.9665	0.0335	0.0000	0.0000	0.0000	194	0.8969	0.0026	0.1005
Lawrence Valley Creek	100	0.8275	0.1650	0.0075	0.0000	0.0000	100	0.8800	0.0550	0.0650

Appendix 3. Continued.

Moffit Creek	100	0.8250	0.1725	0.0025	0.0000	0.0000	100	0.9350	0.0100	0.0550
Joshua Green River	180	0.8625	0.1278	0.0097	0.0000	0.0000	179	0.8799	0.0391	0.0810
Frosty Creek	98	0.8776	0.1199	0.0026	0.0000	0.0000	99	0.8737	0.0354	0.0909
Alligator Hole	100	0.8700	0.1275	0.0025	0.0000	0.0000	98	0.8673	0.0051	0.1276
Trader's Cove Creek	100	0.9050	0.0950	0.0000	0.0000	0.0000	99	0.9293	0.0505	0.0202
St. Catherine's Cove	79	0.8323	0.1582	0.0095	0.0000	0.0000	80	0.8500	0.0250	0.1250
Peterson Lagoon	85	0.8735	0.1265	0.0000	0.0000	0.0000	86	0.9128	0.0523	0.0349
Little John Lagoon	80	0.9062	0.0906	0.0031	0.0000	0.0000	78	0.8654	0.0897	0.0449
Sandy Cove	100	0.9075	0.0900	0.0025	0.0000	0.0000	100	0.8850	0.0850	0.0300
Russell Creek	199	0.9183	0.0666	0.0151	0.0000	0.0000	200	0.8550	0.0500	0.0950
Delta Creek	98	0.9133	0.0867	0.0000	0.0000	0.0000	100	0.9250	0.0600	0.0150
Belkofski River	87	0.9138	0.0862	0.0000	0.0000	0.0000	86	0.9128	0.0523	0.0349
Volcano Bay	106	0.9623	0.0377	0.0000	0.0000	0.0000	106	0.8774	0.1085	0.0142
Ruby's Lagoon	98	0.8801	0.0867	0.0332	0.0000	0.0000	99	0.9394	0.0101	0.0505
Canoe Bay	100	0.8800	0.1200	0.0000	0.0000	0.0000	99	0.9091	0.0455	0.0455
Zachary Bay	78	0.9263	0.0545	0.0192	0.0000	0.0000	80	0.8812	0.1188	0.0000
Coleman Creek	100	0.8975	0.1025	0.0000	0.0000	0.0000	100	0.7850	0.2100	0.0050
Balboa Bay	100	0.9225	0.0650	0.0125	0.0000	0.0000	100	0.8850	0.0400	0.0750
Chichagof Bay	99	0.9545	0.0429	0.0025	0.0000	0.0000	100	0.6750	0.2650	0.0600
Stepovak Bay	50	0.8600	0.1400	0.0000	0.0000	0.0000	49	0.8571	0.1429	0.0000
Stepovak River	99	0.9343	0.0657	0.0000	0.0000	0.0000	100	0.8200	0.0950	0.0850
Ivanoff River	94	0.9309	0.0665	0.0000	0.0000	0.0027	94	0.9202	0.0372	0.0426
Kiukta Bay	100	0.9375	0.0625	0.0000	0.0000	0.0000	100	0.8650	0.1100	0.0250
Kujulik Bay	71	0.9542	0.0458	0.0000	0.0000	0.0000	72	0.8264	0.1181	0.0556

Appendix 3. Continued.

Aniakchak River	100	0.9200	0.0775	0.0025	0.0000	0.0000	100	0.8350	0.1250	0.0400
Amber Bay	92	0.9158	0.0815	0.0000	0.0000	0.0027	92	0.8315	0.1304	0.0380
Chiginigak Bay	75	0.9200	0.0667	0.0133	0.0000	0.0000	75	0.8533	0.1067	0.0400
Kialagvik Bay	100	0.9550	0.0400	0.0000	0.0000	0.0050	100	0.7300	0.1950	0.0750
Alinchak Bay	95	0.9342	0.0579	0.0079	0.0000	0.0000	99	0.7929	0.1566	0.0505
Alagogshak River	94	0.9468	0.0479	0.0000	0.0000	0.0053	94	0.7819	0.1543	0.0638
Gull Cape Creek	100	0.9775	0.0225	0.0000	0.0000	0.0000	100	0.9600	0.0150	0.0250
Hallo Bay	100	0.9400	0.0600	0.0000	0.0000	0.0000	99	0.7576	0.2020	0.0404
McNeil River	101	0.9827	0.0173	0.0000	0.0000	0.0000	109	0.8211	0.1560	0.0229
American River	145	0.9345	0.0603	0.0052	0.0000	0.0000	143	0.7867	0.1853	0.0280
Dog Bay	100	0.9200	0.0750	0.0050	0.0000	0.0000	100	0.8200	0.1200	0.0600
Sukhoi Lagoon	100	0.9475	0.0525	0.0000	0.0000	0.0000	100	0.8750	0.0250	0.1000
Sturgeon Lagoon	170	0.9309	0.0691	0.0000	0.0000	0.0000	170	0.7794	0.0471	0.1735
Uganik River	88	0.9261	0.0682	0.0057	0.0000	0.0000	88	0.8693	0.0909	0.0398
Kizhuyak River	332	0.9081	0.0919	0.0000	0.0000	0.0000	337	0.9926	0.0015	0.0059
Susitna River	100	0.9225	0.0775	0.0000	0.0000	0.0000	99	0.8990	0.0556	0.0455
West Prince William Sound	192	0.9427	0.0547	0.0026	0.0000	0.0000	191	0.7618	0.2068	0.0314

Appendix 3. Continued.

Population	N	*sAAT-1,2** 100	120	65	95	125	N	*mAAT-1** -100	-120	-70
Olsen Creek	199	0.9020	0.0980	0.0000	0.0000	0.0000	200	0.7725	0.2075	0.0200
Constantine Creek	100	0.9225	0.0775	0.0000	0.0000	0.0000	100	0.8100	0.1850	0.0050
Keta Creek	99	0.9747	0.0227	0.0025	0.0000	0.0000	99	0.6515	0.3333	0.0152
Herman Creek	158	0.9003	0.0997	0.0000	0.0000	0.0000	158	0.6203	0.3101	0.0696
Southeast Alaska	898	0.8783	0.1217	0.0000	0.0000	0.0000	897	0.6878	0.2525	0.0596
Port Real Marina	148	0.8480	0.1520	0.0000	0.0000	0.0000	148	0.8649	0.1318	0.0034
Eastern Prince of Wales Island	655	0.8637	0.1359	0.0000	0.0004	0.0000	659	0.8604	0.1055	0.0341
Eastern Queen Charlotte Islands	428	0.9188	0.0812	0.0000	0.0000	0.0000	431	0.8399	0.1566	0.0035
Nass River Area	309	0.8536	0.1464	0.0000	0.0000	0.0000	311	0.6350	0.2974	0.0675
Kitimat/Mussel River	221	0.8824	0.1176	0.0000	0.0000	0.0000	223	0.6883	0.2489	0.0628
Nekite Channel/River	188	0.9082	0.0891	0.0000	0.0027	0.0000	197	0.7056	0.2310	0.0635
East Vancouver Island	800	0.8966	0.1025	0.0006	0.0003	0.0000	796	0.6413	0.3574	0.0013
West Vancouver Island	606	0.9179	0.0821	0.0000	0.0000	0.0000	600	0.7192	0.2800	0.0008
Lower Fraser River	400	0.8488	0.1506	0.0006	0.0000	0.0000	399	0.6566	0.3421	0.0013
Upper Fraser River	596	0.8549	0.1451	0.0000	0.0000	0.0000	595	0.6941	0.3050	0.0008
Skagit River	251	0.9173	0.0827	0.0000	0.0000	0.0000	249	0.6345	0.3655	0.0000
Bellingham Maritime Hatchery	100	0.8650	0.1350	0.0000	0.0000	0.0000	100	0.4800	0.4950	0.0250
Mill Creek	178	0.8694	0.1306	0.0000	0.0000	0.0000	176	0.7017	0.2727	0.0256
Hood Canal Hatchery	449	0.8909	0.1091	0.0000	0.0000	0.0000	407	0.6450	0.3550	0.0000
Gakko/Miomote Rivers	119	0.9664	0.0336	0.0000	0.0000	0.0000	113	0.9867	0.0000	0.0133

Appendix 3 continued

Tsugaruishi River	78	0.9744	0.0256	0.0000	0.0000	0.0000	77	0.9805	0.0195	0.0000
Ohkawa River	78	0.9744	0.0256	0.0000	0.0000	0.0000	74	0.9459	0.0338	0.0203
Teshio River	80	0.9531	0.0469	0.0000	0.0000	0.0000	73	1.0000	0.0000	0.0000
Chitose River	80	0.9531	0.0469	0.0000	0.0000	0.0000	71	1.0000	0.0000	0.0000
Tokachi River	79	0.9842	0.0158	0.0000	0.0000	0.0000	58	0.9655	0.0000	0.0345
Kushiro River	80	0.9781	0.0219	0.0000	0.0000	0.0000	69	0.9638	0.0072	0.0290
Nishibetsu River	80	0.9875	0.0125	0.0000	0.0000	0.0000	68	0.9485	0.0294	0.0221
Shari River	80	0.9625	0.0375	0.0000	0.0000	0.0000	76	0.9671	0.0197	0.0132
Tokusibetsu River	39	0.9551	0.0321	0.0128	0.0000	0.0000	38	0.9868	0.0132	0.0000
Amur River	46	0.9620	0.0380	0.0000	0.0000	0.0000	46	0.9239	0.0000	0.0761
Ryzanovka River	51	0.9902	0.0098	0.0000	0.0000	0.0000	51	1.0000	0.0000	0.0000
Kalininka River	49	0.9541	0.0459	0.0000	0.0000	0.0000	49	1.0000	0.0000	0.0000
Naiba River	61	0.9344	0.0656	0.0000	0.0000	0.0000	61	0.9754	0.0164	0.0082
Udarnitsa River	98	0.9439	0.0561	0.0000	0.0000	0.0000	98	0.9847	0.0000	0.0153
Anadyr/Kanchalan Rivers	182	0.9135	0.0865	0.0000	0.0000	0.0000	180	0.9694	0.0056	0.0250
Nerpichi Lake	40	0.9125	0.0875	0.0000	0.0000	0.0000	39	0.9744	0.0000	0.0256
Kamchatka River	75	0.9567	0.0433	0.0000	0.0000	0.0000	75	0.8067	0.0867	0.1067
Utka River	79	0.9367	0.0633	0.0000	0.0000	0.0000	76	0.9868	0.0000	0.0132
Kikchik River	40	0.9000	0.1000	0.0000	0.0000	0.0000	40	0.9875	0.0000	0.0125
Pymta River	79	0.9019	0.0981	0.0000	0.0000	0.0000	78	0.9615	0.0000	0.0385
Kol River	90	0.9083	0.0917	0.0000	0.0000	0.0000	76	0.9474	0.0329	0.0197
Hairusova River	115	0.9283	0.0717	0.0000	0.0000	0.0000	31	1.0000	0.0000	0.0000
Tumani River	66	0.8447	0.1553	0.0000	0.0000	0.0000	62	0.9758	0.0242	0.0000
Ola River	80	0.8844	0.1156	0.0000	0.0000	0.0000	77	0.9870	0.0000	0.0130

Appendix 4. Allele frequency estimates for chum salmon sampled from the South Unimak and Shumagin Islands fisheries in June 1993-1996.

		*sAAT-1,2**					*mAAT-1**				*mAH-3**	
Fishery	N	100	120	65	95	N	-100	-120	-70	N	100	124
South Unimak, 1993-1	391	0.9520	0.0428	0.0013	0.0038	390	0.9167	0.0218	0.0615	392	0.5306	0.4694
South Unimak, 1993-2,3	397	0.9421	0.0548	0.0006	0.0025	397	0.9194	0.0214	0.0592	392	0.5357	0.4643
South Unimak, 1994-1	394	0.9239	0.0736	0.0006	0.0019	395	0.9203	0.0278	0.0519	381	0.5066	0.4934
South Unimak, 1994-2	397	0.9427	0.0567	0.0006	0.0000	395	0.9063	0.0152	0.0785	385	0.4857	0.5143
South Unimak, 1994-3	397	0.9414	0.0554	0.0000	0.0031	399	0.9135	0.0163	0.0702	386	0.5104	0.4896
South Unimak, 1995-1	399	0.9530	0.0432	0.0000	0.0038	397	0.9181	0.0164	0.0655	385	0.5104	0.4896
South Unimak, 1995-2	399	0.9536	0.0439	0.0000	0.0025	398	0.9221	0.0138	0.0641	386	0.5285	0.4715
South Unimak, 1995-3	397	0.9433	0.0535	0.0013	0.0019	395	0.9076	0.0089	0.0835	382	0.5223	0.4777
South Unimak, 1996-1	400	0.9225	0.0669	0.0025	0.0081	398	0.9008	0.0302	0.0691	383	0.5418	0.4582
South Unimak, 1996-2	399	0.9273	0.0683	0.0019	0.0025	395	0.9025	0.0354	0.0620	394	0.5178	0.4822
South Unimak, 1996-3	398	0.9102	0.0835	0.0025	0.0038	397	0.8866	0.0529	0.0605	395	0.4962	0.5038
Shumagin, 1994-1	396	0.9482	0.0473	0.0006	0.0038	398	0.9435	0.0163	0.0402	390	0.5192	0.4808
Shumagin, 1994-2	399	0.9392	0.0583	0.0000	0.0025	399	0.9085	0.0263	0.0652	385	0.5000	0.5000
Shumagin, 1994-3	397	0.9452	0.0504	0.0000	0.0044	397	0.9307	0.0239	0.0453	385	0.5078	0.4922
Shumagin, 1995-1	397	0.9496	0.0491	0.0006	0.0006	398	0.9070	0.0188	0.0741	395	0.4886	0.5114
Shumagin, 1995-2	394	0.9435	0.0463	0.0013	0.0089	389	0.9062	0.0308	0.0630	390	0.4833	0.5167
Shumagin, 1995-3	349	0.9334	0.0552	0.0014	0.0100	346	0.9147	0.0520	0.0332	345	0.5159	0.4841
Shumagin, 1996-1	398	0.9340	0.0647	0.0000	0.0013	396	0.9268	0.0354	0.0379	371	0.4596	0.5404
Shumagin, 1996-2	396	0.9318	0.0657	0.0000	0.0025	397	0.9068	0.0441	0.0491	396	0.5126	0.4874
Shumagin, 1996-3	399	0.9248	0.0677	0.0031	0.0044	398	0.9008	0.0616	0.0377	395	0.4911	0.5089

Appendix 4 continued

	*ALAT**				*ESTD**				*G3PDH-2**	
Fishery	N	100	93	78	N	100	91	110	N	100	90
South Unimak, 1993-1	376	0.8790	0.1210	0.0000	392	0.6033	0.3967	0.0000	389	0.8728	0.1272
South Unimak, 1993-2,3	393	0.8461	0.1539	0.0000	397	0.6285	0.3715	0.0000	392	0.8941	0.1059
South Unimak, 1994-1	392	0.8648	0.1352	0.0000	396	0.6578	0.3409	0.0013	386	0.8925	0.1075
South Unimak, 1994-2	390	0.8782	0.1218	0.0000	395	0.6190	0.3810	0.0000	386	0.8964	0.1036
South Unimak, 1994-3	393	0.8550	0.1450	0.0000	398	0.6420	0.3580	0.0000	397	0.8992	0.1008
South Unimak, 1995-1	392	0.8801	0.1199	0.0000	398	0.5314	0.4686	0.0000	399	0.8634	0.1366
South Unimak, 1995-2	397	0.8451	0.1549	0.0000	400	0.6312	0.3688	0.0000	398	0.8832	0.1168
South Unimak, 1995-3	382	0.8730	0.1270	0.0000	397	0.5970	0.4005	0.0025	395	0.9089	0.0911
South Unimak, 1996-1	395	0.8481	0.1519	0.0000	399	0.6817	0.3183	0.0000	396	0.8813	0.1187
South Unimak, 1996-2	383	0.8446	0.1554	0.0000	399	0.6930	0.3070	0.0000	399	0.8935	0.1065
South Unimak, 1996-3	378	0.8519	0.1481	0.0000	397	0.7594	0.2393	0.0013	397	0.8741	0.1259
Shumagin, 1994-1	377	0.8753	0.1247	0.0000	397	0.6385	0.3615	0.0000	397	0.8904	0.1096
Shumagin, 1994-2	387	0.8760	0.1227	0.0013	398	0.6633	0.3367	0.0000	396	0.8939	0.1061
Shumagin, 1994-3	392	0.8686	0.1314	0.0000	397	0.6637	0.3363	0.0000	397	0.8955	0.1045
Shumagin, 1995-1	381	0.8898	0.1102	0.0000	398	0.6030	0.3970	0.0000	392	0.8788	0.1212
Shumagin, 1995-2	380	0.8789	0.1211	0.0000	394	0.6523	0.3464	0.0013	393	0.8957	0.1043
Shumagin, 1995-3	333	0.8018	0.1982	0.0000	349	0.7163	0.2837	0.0000	344	0.9055	0.0945
Shumagin, 1996-1					397	0.6751	0.3249	0.0000	398	0.9083	0.0917
Shumagin, 1996-2					396	0.7109	0.2879	0.0013	395	0.9000	0.1000
Shumagin, 1996-3					398	0.7299	0.2701	0.0000	397	0.9068	0.0932

Appendix 4. Continued.

Fishery	N	*GPI-B1,2** 100	fast	40	N	*GPI-A** 100	slow	fast	N	*mIDHP-1** 100	60	140
South Unimak, 1993-1	393	1.0000	0.0000	0.0000	393	0.9987	0.0000	0.0013	393	0.9338	0.0662	0.0000
South Unimak, 1993-2,3	396	1.0000	0.0000	0.0000	397	0.9987	0.0000	0.0013	396	0.9470	0.0518	0.0013
South Unimak, 1994-1	397	1.0000	0.0000	0.0000	397	0.9987	0.0013	0.0000	395	0.9266	0.0734	0.0000
South Unimak, 1994-2	397	0.9994	0.0006	0.0000	397	0.9950	0.0050	0.0000	396	0.9394	0.0606	0.0000
South Unimak, 1994-3	398	0.9994	0.0006	0.0000	398	1.0000	0.0000	0.0000	397	0.9219	0.0781	0.0000
South Unimak, 1995-1	399	0.9987	0.0000	0.0013	398	0.9987	0.0000	0.0013	399	0.9449	0.0551	0.0000
South Unimak, 1995-2	400	1.0000	0.0000	0.0000	399	1.0000	0.0000	0.0000	400	0.9325	0.0675	0.0000
South Unimak, 1995-3	396	1.0000	0.0000	0.0000	396	0.9987	0.0013	0.0000	397	0.9270	0.0718	0.0013
South Unimak, 1996-1	399	0.9987	0.0000	0.0013	399	0.9987	0.0000	0.0013	399	0.9361	0.0639	0.0000
South Unimak, 1996-2	397	0.9994	0.0000	0.0006	396	1.0000	0.0000	0.0000	397	0.9270	0.0730	0.0000
South Unimak, 1996-3	397	1.0000	0.0000	0.0000	396	1.0000	0.0000	0.0000	398	0.9485	0.0515	0.0000
Shumagin, 1994-1	398	0.9975	0.0025	0.0000	398	1.0000	0.0000	0.0000	397	0.9194	0.0806	0.0000
Shumagin, 1994-2	398	0.9994	0.0006	0.0000	399	0.9987	0.0000	0.0013	400	0.9162	0.0838	0.0000
Shumagin, 1994-3	397	0.9994	0.0006	0.0000	396	0.9987	0.0013	0.0000	397	0.9131	0.0869	0.0000
Shumagin, 1995-1	398	1.0000	0.0000	0.0000	398	1.0000	0.0000	0.0000	398	0.9485	0.0515	0.0000
Shumagin, 1995-2	394	0.9962	0.0038	0.0000	394	0.9975	0.0013	0.0013	393	0.9173	0.0827	0.0000
Shumagin, 1995-3	347	0.9971	0.0022	0.0007	345	1.0000	0.0000	0.0000	349	0.9054	0.0946	0.0000
Shumagin, 1996-1	398	0.9981	0.0019	0.0000	396	1.0000	0.0000	0.0000	396	0.9318	0.0682	0.0000
Shumagin, 1996-2	397	0.9994	0.0000	0.0006	396	0.9987	0.0013	0.0000	398	0.9334	0.0666	0.0000
Shumagin, 1996-3	397	0.9969	0.0031	0.0000	397	1.0000	0.0000	0.0000	397	0.9043	0.0957	0.0000

Appendix 4 continued

Fishery	N	*sIDHP-2** 100	35	85	25	20	110	45
South Unimak, 1993-1	391	0.4910	0.4156	0.0639	0.0281	0.0000	0.0000	0.0013
South Unimak, 1993-2,3	397	0.4647	0.4383	0.0592	0.0340	0.0013	0.0000	0.0025
South Unimak, 1994-1	395	0.4772	0.4025	0.0696	0.0456	0.0013	0.0013	0.0025
South Unimak, 1994-2	397	0.4773	0.4169	0.0730	0.0315	0.0000	0.0000	0.0013
South Unimak, 1994-3	392	0.4872	0.4133	0.0523	0.0459	0.0000	0.0013	0.0000
South Unimak, 1995-1	395	0.4861	0.4190	0.0633	0.0316	0.0000	0.0000	0.0000
South Unimak, 1995-2	394	0.4937	0.3934	0.0609	0.0508	0.0000	0.0013	0.0000
South Unimak, 1995-3	392	0.5077	0.3852	0.0574	0.0485	0.0013	0.0000	0.0000
South Unimak, 1996-1	381	0.4724	0.4383	0.0433	0.0446	0.0013	0.0000	0.0000
South Unimak, 1996-2	390	0.5244	0.3795	0.0603	0.0359	0.0000	0.0000	0.0000
South Unimak, 1996-3	386	0.4896	0.3795	0.0453	0.0855	0.0000	0.0000	0.0000
Shumagin, 1994-1	397	0.4773	0.4156	0.0479	0.0567	0.0000	0.0013	0.0013
Shumagin, 1994-2	389	0.4961	0.3689	0.0746	0.0578	0.0013	0.0000	0.0013
Shumagin, 1994-3	392	0.4885	0.3954	0.0485	0.0612	0.0038	0.0013	0.0013
Shumagin, 1995-1	398	0.4636	0.4234	0.0754	0.0352	0.0025	0.0000	0.0000
Shumagin, 1995-2	391	0.4847	0.3990	0.0767	0.0396	0.0000	0.0000	0.0000
Shumagin, 1995-3	346	0.5173	0.3266	0.0361	0.1185	0.0014	0.0000	0.0000
Shumagin, 1996-1	394	0.5165	0.3591	0.0546	0.0685	0.0013	0.0000	0.0000
Shumagin, 1996-2	396	0.4987	0.3788	0.0354	0.0871	0.0000	0.0000	0.0000
Shumagin, 1996-3	397	0.5277	0.3501	0.0466	0.0743	0.0000	0.0000	0.0013

Appendix 4. Continued.

	*LDH-A1**				*LDH-B2**			*sMDH-A1**			
Fishery	N	100	50	110	N	100	120	N	100	200	-10
South Unimak, 1993-1	393	0.9020	0.0980	0.0000	395	0.9987	0.0013	394	0.9327	0.0660	0.0013
South Unimak, 1993-2,3	398	0.8518	0.1482	0.0000	397	0.9987	0.0013	397	0.9232	0.0756	0.0013
South Unimak, 1994-1	395	0.8418	0.1570	0.0013	398	0.9987	0.0013	397	0.9320	0.0630	0.0050
South Unimak, 1994-2	394	0.8629	0.1371	0.0000	397	0.9975	0.0025	397	0.9458	0.0542	0.0000
South Unimak, 1994-3	393	0.8613	0.1374	0.0013	399	0.9975	0.0025	399	0.9436	0.0551	0.0013
South Unimak, 1995-1	397	0.8086	0.1914	0.0000	399	1.0000	0.0000	398	0.9485	0.0515	0.0000
South Unimak, 1995-2	399	0.8534	0.1441	0.0025	406	0.9975	0.0025	394	0.9239	0.0749	0.0013
South Unimak, 1995-3	394	0.8325	0.1637	0.0038	397	1.0000	0.0000	395	0.9316	0.0684	0.0000
South Unimak, 1996-1	400	0.8238	0.1725	0.0038	399	0.9963	0.0038	395	0.9291	0.0709	0.0000
South Unimak, 1996-2	397	0.8476	0.1499	0.0025	399	1.0000	0.0000	393	0.9389	0.0611	0.0000
South Unimak, 1996-3	396	0.8510	0.1490	0.0000	398	0.9975	0.0025	397	0.9232	0.0756	0.0013
Shumagin, 1994-1	389	0.8535	0.1465	0.0000	397	0.9912	0.0088	393	0.9249	0.0751	0.0000
Shumagin, 1994-2	398	0.8693	0.1281	0.0025	399	0.9962	0.0038	390	0.9436	0.0551	0.0013
Shumagin, 1994-3	395	0.8380	0.1570	0.0051	397	0.9987	0.0013	396	0.9470	0.0530	0.0000
Shumagin, 1995-1	395	0.8367	0.1633	0.0000	398	1.0000	0.0000	396	0.9394	0.0581	0.0025
Shumagin, 1995-2	385	0.8545	0.1442	0.0013	394	0.9975	0.0025	394	0.9086	0.0888	0.0025
Shumagin, 1995-3	344	0.8808	0.1163	0.0029	350	0.9986	0.0014	346	0.9003	0.0983	0.0014
Shumagin, 1996-1	397	0.8703	0.1297	0.0000	398	1.0000	0.0000	391	0.9373	0.0614	0.0013
Shumagin, 1996-2	393	0.8651	0.1323	0.0025	398	0.9950	0.0050	394	0.9277	0.0698	0.0025
Shumagin, 1996-3	393	0.8830	0.1158	0.0013	399	0.9975	0.0025	396	0.9268	0.0732	0.0000

Appendix 4 continued

		*sMDH-B1,2**					*mMEP-2**			*sMEP-1**	
Fishery	N	100	72	50	fast>110	N	100	122	N	100	90
South Unimak, 1993-1	394	0.9911	0.0063	0.0013	0.0013	392	0.7985	0.2015	393	0.9936	0.0064
South Unimak, 1993-2,3	399	0.9831	0.0081	0.0025	0.0063	395	0.8127	0.1873	398	0.9950	0.0050
South Unimak, 1994-1	398	0.9893	0.0094	0.0006	0.0006	387	0.7972	0.2028	395	0.9975	0.0025
South Unimak, 1994-2	395	0.9829	0.0120	0.0038	0.0013	396	0.7778	0.2222	397	0.9975	0.0025
South Unimak, 1994-3	398	0.9893	0.0082	0.0019	0.0006	394	0.8160	0.1840	397	0.9962	0.0038
South Unimak, 1995-1	400	0.9881	0.0056	0.0056	0.0006	398	0.7688	0.2312	399	0.9962	0.0038
South Unimak, 1995-2	400	0.9869	0.0081	0.0044	0.0006	400	0.7950	0.2050	400	0.9975	0.0025
South Unimak, 1995-3	397	0.9824	0.0113	0.0044	0.0019	396	0.7790	0.2210	396	0.9937	0.0063
South Unimak, 1996-1	399	0.9875	0.0088	0.0031	0.0006	399	0.8233	0.1767	399	0.9887	0.0113
South Unimak, 1996-2	398	0.9893	0.0069	0.0038	0.0000	398	0.8216	0.1784	399	0.9950	0.0050
South Unimak, 1996-3	397	0.9798	0.0088	0.0076	0.0038	398	0.8367	0.1633	398	0.9962	0.0038
Shumagin, 1994-1	398	0.9874	0.0063	0.0050	0.0013	386	0.8122	0.1878	392	0.9987	0.0013
Shumagin, 1994-2	399	0.9856	0.0113	0.0025	0.0006	397	0.8174	0.1826	398	0.9937	0.0063
Shumagin, 1994-3	396	0.9899	0.0076	0.0025	0.0000	396	0.8131	0.1869	397	0.9937	0.0063
Shumagin, 1995-1	398	0.9893	0.0075	0.0031	0.0000	396	0.7790	0.2210	397	0.9962	0.0038
Shumagin, 1995-2	394	0.9892	0.0063	0.0044	0.0000	391	0.7954	0.2046	392	0.9923	0.0077
Shumagin, 1995-3	350	0.9743	0.0129	0.0107	0.0021	346	0.8642	0.1358	349	0.9928	0.0072
Shumagin, 1996-1	398	0.9862	0.0088	0.0013	0.0038	391	0.7852	0.2148	398	0.9962	0.0038
Shumagin, 1996-2	398	0.9837	0.0113	0.0038	0.0013	394	0.7957	0.2043	395	0.9962	0.0038
Shumagin, 1996-3	399	0.9875	0.0075	0.0038	0.0013	396	0.8081	0.1919	399	0.9937	0.0063

Appendix 4. Continued.

		*MPI**					*PEPA**		
Fishery	N	100	94	110	80	N	100	90	113
South Unimak, 1993-1	392	0.8967	0.1033	0.0000	0.0000	391	1.0000	0.0000	0.0000
South Unimak, 1993-2,3	397	0.8778	0.1196	0.0000	0.0025	398	0.9975	0.0013	0.0013
South Unimak, 1994-1	396	0.8990	0.0997	0.0013	0.0000	398	0.9975	0.0013	0.0013
South Unimak, 1994-2	395	0.8873	0.1127	0.0000	0.0000	397	0.9987	0.0000	0.0013
South Unimak, 1994-3	395	0.9101	0.0899	0.0000	0.0000	397	1.0000	0.0000	0.0000
South Unimak, 1995-1	399	0.8922	0.1065	0.0000	0.0013	398	0.9987	0.0000	0.0013
South Unimak, 1995-2	399	0.8872	0.1115	0.0013	0.0000	400	0.9988	0.0000	0.0012
South Unimak, 1995-3	396	0.8939	0.1035	0.0025	0.0000	396	1.0000	0.0000	0.0000
South Unimak, 1996-1	399	0.8985	0.0990	0.0013	0.0013	399	1.0000	0.0000	0.0000
South Unimak, 1996-2	398	0.9146	0.0854	0.0000	0.0000	398	1.0000	0.0000	0.0000
South Unimak, 1996-3	398	0.8995	0.1005	0.0000	0.0000	398	1.0000	0.0000	0.0000
Shumagin, 1994-1	398	0.9070	0.0905	0.0013	0.0013	398	0.9987	0.0013	0.0000
Shumagin, 1994-2	397	0.9068	0.0919	0.0013	0.0000	399	1.0000	0.0000	0.0000
Shumagin, 1994-3	397	0.8967	0.1033	0.0000	0.0000	395	0.9987	0.0013	0.0000
Shumagin, 1995-1	398	0.8945	0.1055	0.0000	0.0000	398	0.9975	0.0013	0.0013
Shumagin, 1995-2	394	0.8832	0.1168	0.0000	0.0000	395	1.0000	0.0000	0.0000
Shumagin, 1995-3	349	0.9298	0.0688	0.0014	0.0000	349	1.0000	0.0000	0.0000
Shumagin, 1996-1	398	0.9133	0.0867	0.0000	0.0000	398	1.0000	0.0000	0.0000
Shumagin, 1996-2	396	0.9116	0.0884	0.0000	0.0000	398	0.9987	0.0000	0.0013
Shumagin, 1996-3	398	0.8882	0.1106	0.0013	0.0000	395	0.9949	0.0038	0.0013

Appendix 4 continued

Fishery	N	*PEPB-1** -100	-146	-126	-127	-72	N	*PGDH** 100	88	106	95
South Unimak, 1993-1	391	0.8926	0.0588	0.0448	0.0038	0.0000	394	0.9797	0.0203	0.0000	0.0000
South Unimak, 1993-2,3	396	0.8649	0.0631	0.0707	0.0013	0.0000	398	0.9824	0.0176	0.0000	0.0000
South Unimak, 1994-1	394	0.8744	0.0698	0.0508	0.0038	0.0013	397	0.9710	0.0277	0.0013	0.0000
South Unimak, 1994-2	391	0.8772	0.0780	0.0435	0.0013	0.0000	397	0.9710	0.0290	0.0000	0.0000
South Unimak, 1994-3	396	0.8687	0.0657	0.0631	0.0025	0.0000	399	0.9724	0.0276	0.0000	0.0000
South Unimak, 1995-1	396	0.8914	0.0669	0.0391	0.0025	0.0000	399	0.9724	0.0276	0.0000	0.0000
South Unimak, 1995-2	394	0.8756	0.0584	0.0647	0.0013	0.0000	400	0.9700	0.0300	0.0000	0.0000
South Unimak, 1995-3	393	0.8562	0.0789	0.0636	0.0013	0.0000	397	0.9698	0.0302	0.0000	0.0000
South Unimak, 1996-1	396	0.8409	0.0821	0.0732	0.0038	0.0000	399	0.9774	0.0226	0.0000	0.0000
South Unimak, 1996-2	393	0.8588	0.0789	0.0585	0.0038	0.0000	399	0.9812	0.0188	0.0000	0.0000
South Unimak, 1996-3	390	0.8231	0.1026	0.0654	0.0077	0.0013	398	0.9812	0.0176	0.0013	0.0000
Shumagin, 1994-1	389	0.8728	0.0758	0.0437	0.0064	0.0013	398	0.9673	0.0327	0.0000	0.0000
Shumagin, 1994-2	395	0.8456	0.0696	0.0759	0.0089	0.0000	397	0.9736	0.0264	0.0000	0.0000
Shumagin, 1994-3	384	0.8698	0.0729	0.0521	0.0039	0.0013	397	0.9748	0.0252	0.0000	0.0000
Shumagin, 1995-1	388	0.8943	0.0606	0.0374	0.0064	0.0013	398	0.9611	0.0389	0.0000	0.0000
Shumagin, 1995-2	387	0.8450	0.0775	0.0749	0.0013	0.0013	394	0.9810	0.0190	0.0000	0.0000
Shumagin, 1995-3	344	0.8110	0.0727	0.1134	0.0029	0.0000	350	0.9800	0.0186	0.0014	0.0000
Shumagin, 1996-1	391	0.8645	0.0665	0.0639	0.0051	0.0000	398	0.9837	0.0163	0.0000	0.0000
Shumagin, 1996-2	395	0.8367	0.0709	0.0861	0.0063	0.0000	398	0.9724	0.0264	0.0000	0.0013
Shumagin, 1996-3	395	0.8278	0.0987	0.0671	0.0063	0.0000	399	0.9799	0.0201	0.0000	0.0000