# PROGRESS REPORT OF GENETIC STUDIES OF PACIFIC RIM CHUM SALMON AND PRELIMINARY ANALYSIS OF THE 1993 AND 1994 SOUTH UNIMAK JUNE FISHERIES

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## Table of Contents

## Table of Contents

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF APPENDICES

## EXECUTIVE SUMMARY

- Migrating chum salmon are harvested incidentally in sockeye salmon fisheries during June in the areas of South Unimak Island and Shumagin Islands (South Alaska Peninsula). Numerous tagging studies have shown that these fish originate from throughout the Pacific Rim.
- Detection of genetic differences at the molecular level provides a set of genetic information complementary to more traditional stock identification approaches. A large genetic database collected by allozyme electrophoresis has been developed over the last decade to provide information on migration routes and fishery composition of chum salmon. The data were collected by cooperating researchers throughout the Pacific Rim.
- Genetic data on previously underrepresented spawning populations from Norton Sound, Yukon River, Kuskokwim River, Bristol Bay, the North and South Alaska Peninsula, Kodiak Island, Cook Inlet, and Prince William Sound are presented.
- A comprehensive database including 69 stock groupings representing the entire range of the species was constructed and evaluated for its ability to identify stock of origin in complex mixtures of Asian and North American chum salmon. Eight major reporting regions (Japan; Russia; Northwest Alaska summer run; fall Yukon River; Alaska Peninsula and Kodiak Island; Southeast Alaska and Prince William Sound; British Columbia; and Washington) were identified.

- The origins of 2,000 individuals caught in the South Unimak June fishery during 1993 and 1994 were estimated using a maximum likelihood algorithm. Estimates were made for two periods in 1993 (June 13-20, June 22-29) and three periods in 1994 (June 17-20, June 21-25, June 26-30).
- The Northwest Alaska summer region was the predominant group in all the estimates; its contribution ranged from 0.52 to 0.72 . The Japanese component was also fairly consistent ranging from 0.09 to 0.17. The Russian contribution showed a slightly greater variability ranging from 0.06 to 0.19. Alaska Peninsula to Kodiak populations were consistently present, ranging from 0.04 to 0.13 . Fall Yukon River populations (exclusive of Canadian populations) were likely absent, their estimated contribution statistically indistinguishable from 0.00. Southeast Alaska and Prince William Sound, British Columbia, and Washington groups were consistently present at low levels in all the estimates.
- A subsample of the 1994 fishery collections was assayed for fragment analysis of the ND5/ND6 region of mitochondrial DNA (mtDNA) to provide an independent estimate of the Japanese contribution. The estimated Japanese component was 0.095, indistinguishable from the allozyme estimate of 0.091 for the same time period.
- Analysis of 1994 samples from the Shumagin Islands, continued monitoring of both the South Unimak and Shumagin June fisheries, and expansion of the baseline are planned.

# INTRODUCTION

Chum salmon (*Oncorhynchus keta)* from North America and Asia migrate into the North Pacific Ocean, generally returning to their natal streams to spawn at age three, four or five. The salmon form aggregations composed of numerous stocks and species during their ocean residency and freshwater migrations. Identification of composite stocks in mixtures of chum salmon caught in international waters, in the U.S. Exclusive Economic Zone, and in the major river systems leading to spawning tributaries has been an ongoing challenge for fisheries biologists and management agencies throughout the Pacific Rim.

In Alaska, migrating chum salmon are harvested incidentally in sockeye salmon fisheries during June in the area of South Unimak Island and the Shumagin Islands (South Alaska Peninsula). Numerous tagging studies (e.g. Gilbert and Rich 1925; Aro et al. 1971; Aro 1972; Meyer 1983; Eggers et al. 1991; Eggers 1992) have shown that significant numbers of chum salmon harvested are not of local origin. Tag recoveries have been reported not only from throughout Alaska, but also from Japan, Russia, British Columbia, and Puget Sound (Brannian 1984; Eggers et al. 1991; Eggers 1992).

Incidental catch of chum salmon in the sockeye fisheries may contribute to conservation and allocation problems in certain areas. Spawning escapements in some areas, such as Norton Sound, Kuskowim River, and fall Yukon River have been below historic levels in recent years (Eggers 1995). The potential impacts of the South Unimak June fisheries on these stocks of chum salmon cannot be adequately determined because of the lack of geographic-specific data on stock composition of chum salmon caught as bycatch.

Methods for identifying more specific geographic origins of chum salmon are needed to assist the Board of Fisheries in evaluating alternative proposals to allocate fish and the burden of conservation among fishers.

Detection of genetic differences at the molecular level has become possible within the last 30 years, providing a set of genetic information complementary to more traditional stock identification approaches. These procedures, which examine products of individual genes or the actual genetic material (i.e. DNA) itself, have been the basis of a new era in understanding genetic differences both within and among populations of all organisms including fishes. Genetic stock identification or mixed stock analyses (MSA) using protein variation detected by allozyme electrophoresis was first applied to fisheries problems in the early 1970's (Utter et al. 1974) and has become an important part of many salmonid management programs (e. g. Wishard 1980; Milner et al. 1981; Utter et al. 1987; Kondzela et al. In press; Phelps et al. In press; Winans et al. In press). It was recognized that underlying genetic differences could be extremely valuable to differentiate stocks in mixtures of Pacific salmon (e. g. Milner et al. 1981; Grant et al. 1980; Seeb et al. 1986; Seeb et al. 1990; Winans et al. 1989; Wilmot et al. 1992), and a considerable statistical framework based on maximum likelihood estimates evolved to identify individual stocks within mixtures (Milner et al. 1981; Fournier et al., 1984; Millar 1987, 1990; Pella and Milner 1987; Smouse et al. 1990; Gomulkiewicz et al., 1990; Pella et al. 1994).

Developing a comprehensive database of gene frequencies to identify populations of chum salmon inhabiting the North Pacific Ocean requires international cooperation. A major step toward this goal was taken with the establishment of an inter-agency database which is

maintained by Alaska Department of Fish and Game (ADF&G). This database includes allozyme data for approximately 20 loci from over 200 collections ranging throughout the North Pacific Rim. Data included are reported in this study and include that from Kondzela et al. (In press), Phelps et al. (In press), Wilmot et al. (In press) and Winans et al. (In press).

### *Population Structure of Chum Salmon*

Identification of populations in mixtures relies on the existence of genetic differences among the populations. The genetic structure of chum salmon populations has been studied throughout much of the species range in western North America and Asia (Wishard 1980; Okazaki 1981, 1982; Beacham et al. 1985; Omel'chenko 1985, 1992; Winans et al. 1989, 1990, In press; Salmenkova et al. 1986, 1990, 1992, 1994; Wilmot et al. 1992, In press; Kondzela et al. In press; Phelps et al. In press). Results indicate considerable genetic differentiation among major regional groups. Runs of salmon returning to the same geographic area, but showing temporal differences (e.g. summer versus fall runs), must also be considered potentially distinct (Phelps et al. In press; Wilmot et al. In press). Complementary to the allozyme research, Park et al. (1993) recently identified unique frequencies of mitochondrial DNA (mtDNA) markers that distinguish Japanese chum salmon from all other Pacific Rim stocks. These mtDNA data are augmented by the more limited study of Cronin et al. (1993). Additionally, Taylor et al. (1994) recently surveyed 42 populations of chum salmon from the North Pacific for variability at minisatellite DNA and identified three regional population groups: Japan, Russia/Yukon River, and Southeast Alaska/British Columbia.

Alaskan chum salmon populations also are generally subdivided along expected

geographic lines (Wilmot et al. 1992, In press; Kondzela et al. In press). Wilmot et al. (In press) identified at least two distinct genetic units in the Yukon River corresponding to a fall and summer run. Kondzela et al. (In press) were able to characterize three distinct southeast Alaska island groups as well as a mainland southeast Alaska group.

A secondary objective of many of these studies has been to develop a species-wide database that could be applied to high seas interception fisheries. Authors have attempted with varying success to distinguish the continent of origin of high seas caught chum salmon (Seeb and Seeb 1986; Winans et al. 1989, 1990). However, the success of these early attempts was impaired because baseline data were not available from all potentially contributing populations, particularly those from Asia and Northwest Alaska. In response and as a short term solution, Smouse et al. (1990) specifically developed an algorithm to "fill in" missing baseline information.

In this progress report we expand on earlier attempts by developing a comprehensive data set for populations inhabiting Northwest Alaska. We also construct an updated Pacific Rim database by merging data gathered in this study with those in recent studies (Southeast Alaska, British Columbia: Kondzela et al. In press; Asia: Winans et al. In press; Washington, British Columbia: Phelps et al. In press; Northwest Alaska, Russia: Wilmot et al. In press). Finally, we evaluate the performance of the mixed stock analysis algorithm and provide estimates of the origin of chum salmon caught in the South Unimak June fishery during 1993-1994. Future studies will provide additional baseline information and will more thoroughly analyze the 1993 and 1994 fisheries. Continued monitoring of the fishery is planned.

## MATERIALS AND METHODS

### *Sample Collection*

#### Baseline Populations

From 1991 to 1994, over 90 populations were sampled for genetic analysis in Northwest and Southcentral Alaska (Sarafin 1992; Seeb 1994; Sarafin et al. 1995). Several populations were sampled over multiple years to assess temporal stability of allele frequencies. Laboratory analysis is complete for 64 of these populations at the writing of this progress report (Table 1, Figure 1).

Individuals were collected on or near spawning grounds using beach seines, fish spears, or electroshockers. A goal of 100 individuals per population was set as the appropriate number needed to estimate allele frequencies from randomly mating populations. Actual sample sizes varied depending upon the size of the runs and availability of spawners during the sampling period (Table 1).

Individual tissues (muscle, liver, eye, and heart) were subsampled, placed in 2.0 ml cryotubes, frozen as soon as possible in liquid nitrogen or on dry ice, and remained frozen during storage and shipment to the Anchorage laboratory. Upon arrival in Anchorage, samples were stored at -80° C until subsampled for allozyme or mtDNA analysis.

#### Fishery Admixtures

Collection methods for sampling the fishery followed those for the baseline (Sarafin et al. 1995; Sarafin 1995). In 1993, a pilot study to evaluate the feasibility of sampling the South Unimak June fishery was undertaken to evaluate collecting directly in the processing

plants, quality of tissues obtained, and development of randomized sampling designs. A goal of 400 fish per day from Southeast Unimak (Cape Lazaref to Ikatan Bay) and from Southwest Unimak (Cape Lutke) was established for each fishing period (Figure 2). Tender deliveries were sampled at Peter Pan Seafoods, King Cove, Alaska. A total of 2,622 individual chum salmon were sampled from six open periods during the June 1993 fishery (Table 2, 3).

A larger sampling program was initiated in 1994. Sampling was expanded to include the Shumagin Islands. During 1994 the Southeast and Southwest Unimak fisheries were not distinguished, but were treated as a single site. A sample goal of 400 fish during each fishery opening at each site was established. Additionally, samples were collected during preseason test fishing so data could be collected during the entire traditional time period of the June fishery, June 10-30. Tender deliveries were sampled at Peter Pan Seafoods, King Cove, Alaska, and Trident Seafoods, Sand Point, Alaska. Nearly 6,300 fish were collected in 1994 (Table 2).

### *Laboratory Methods*

Allozyme analyses followed the general protocols outlined in Harris and Hopkinson (1976), May et al. (1979), and Aebersold et al. (1987). Sixty-three loci were resolved (Table 4). We used the genetic nomenclature of the American Fisheries Society (Shaklee et al. 1990). Loci used in population genetic and mixture analyses were selected with the following criteria: 1) data available for most Pacific Rim populations, 2) loci resolvable in mixed fishery samples, and 3) loci either variable in most populations analyzed or variation was regionally based.

Mitochondrial DNA (mtDNA) was extracted from the 400 individuals analyzed for allozymes in the 1994 Period 2 subsample (June 21 -June 25, 1994, see below). MtDNA was isolated from liver tissue using Wizard Minipreps (Promega Corporation, Madison, Wisconsin). Protocols for restriction fragment length polymorphism (RFLP) analysis of mtDNA follow those of Park et al. (1993) and Cronin et al. (1993) with screening limited to the region coding for NADH dehydrogenase subunits 5 and 6 (ND5/ND6). Polymorphisms were detected with the restriction enzyme *AseI*. Haplotype nomenclature follows that of Park et al. (1993) rather than Cronin et al. (1993); the haplotype designators B and C are interchanged between the two studies. Sizes of restriction fragments were estimated by comparison with a pGem DNA size standard (pGem-3 DNA digested separately with *HinfI*, *RsaI*, and *SinI*, Promega Corporation, Madison Wisconsin).

### *Laboratory Analysis of Fishery Samples*

We performed an allozyme analysis on 2,000 fishery samples for this preliminary report. We focused on the South Unimak fishery because it was sampled over two years. No test fishing or Shumagin Island samples were analyzed.

To estimate the stock composition of the incidental chum salmon catch and to determine if the stock composition changes during the South Unimak June fishery, the fishery samples from 1993 and 1994 were subsampled in the following manner: A sample size of 400 was established for each mixed fishery estimate, allowing for a maximum of five mixture estimates. We stratified the 1993 fishery into two periods (June 13-20, June 22-29) and the 1994 fishery into three periods (June 17-20, June 21-25, June 26-30). June 20 was used as

the delimiter for the first period for each year to allow comparison to previous tagging studies (Eggers et al. 1991; Eggers 1992). A total of 400 individuals for each period were randomly selected, proportional to the daily catch rate in each period (Table 3). Subsampling for 1993 was adjusted according to the varying catch rates between Southeast and Southwest Unimak areas. Individual fishery estimates were made for each set of 400 fish; additionally, an estimate was made on the pooled individuals from Periods 2 and 3 in 1994 to allow comparison to the earlier tagging study (Eggers et al. 1991; Eggers 1992).

## *Statistical Analyses*

### Construction of Pacific Rim Database

Populations used to form the baseline data set are listed in Table 1 (see Figure 1 and 3 for sampling locations). A suite of twenty loci was identified across all populations for which complete data were consistently available. Populations not incorporated in the baseline due to missing data include: Tauy River, Magadan River, Avacha River, and Ossora River from Russia; Masuhoro, Shibetsu, Tokoro, and Yurrapu from Japan; and Canadian fall run from the Yukon River (see Wilmot et al. In press; Winans et al. In press).

Data have been standardized among laboratories through a series of coastwide information exchanges including distribution of mobility standards. It was necessary to recalculate allele frequencies at isoloci (paired loci of identical allelic mobility) in a uniform manner. Winans et. al (In press) use a 1-locus model for calculating allele frequencies for *sAAT-1,2**, *mAH-1,2**, *GPI-B1,2**, and *sMDH-B1,2**; Kondzela et. al (In press) and Wilmot

et. al (In press) use a 1-locus model for *mAH-1,2**, *GPI-B1,2**, and *sMDH-B1,2**. For this study all isolocus frequencies were calculated using a 2-locus model under the assumption of equal frequencies at each locus (Appendix 1).

Additionally, some alleles were pooled because not all variant alleles could be standardized among all laboratories. Such pooling may slightly erode the resolving power of MSA estimates; however, it reduces the possibility of laboratory bias in the baseline data. Alleles of similar mobility were pooled for the following loci: *sAAT-1,2*84*, **95*, and **80*; *sAAT-1,2*120* and **125*; *LDH-A1*110* and **0*; *LDH-B2*120* and **115*; *sMDH-B1,2*72*, **85*, **95*; *sMDH-B1,2*50* and **65*; *sMDH-B1,2*115*, **120*, **127*, **129*, **130*, and **145*; *sMDH-B1,2*110* and **100*; and *PGDH*110* and **106*. Alleles that are particularly difficult to score, especially in mixed fishery samples, were pooled with the *100 of the same locus: *sAAT-1,2*113*; *ALAT*103*; *mAH-3*115* and **140; G3PDH-2*132*; and *sIDHP-2*65*. Finally, Kondzela et al. (In press) resolves more variant alleles for *MPI** than others by scoring this locus on both TBE and AC7 gel buffers. Variant alleles scored by Kondzela et al. (In press) were recoded and pooled based on mobilities seen on TBE gel buffer, commonly used by other laboratories to resolve this locus. Kondzela et al. (In press) (mobilities listed are AC7/TBE) **92/*94*, **92/91*, and **86/94* were pooled as Coastwide **94*; **86/86* alleles were pooled as Coastwide **80*.

After standardization, data from nearly 200 populations were available for inclusion in the Pacific Rim data set. Trial analyses of South Unimak June fishery mixtures clearly indicated that populations from Southeast Alaska, British Columbia, and Washington were nearly absent. To reduce the number of stocks in the baseline and improve model

performance, representative populations were chosen from Southeast Alaska, British Columbia, and Washington (Southeast Alaska, northern British Columbia: K. Hofmeister, ADF&G, Douglas; southern British Columbia, Washington: S. R. Phelps, WDFW, Olympia, personal communication).

Heterogeneity among representative populations and adjacent populations was tested using G-Statistics (modified from Weir 1990). Populations were pooled if no heterogeneity was detected ($\alpha < 0.01$). Pooling populations allows greater precision for regional allele frequency estimates as well as improving the performance of the MSA model. Inclusion of populations with nearly identical genetic characteristics causes instability of estimates (Pella and Milner 1987). A comprehensive hierarchical analysis was performed for Northwest Alaska populations testing for heterogeneity among and within regions (see Winans et al. In press; Kondzela et al. In press; Wilmot et al. In press; and Phelps et al. In press, for similar analysis).

Overall population genetic structure was investigated using three methods. Box plots comparing allele frequency distributions for each locus by region (quartiles, ranges, and 95% confidence intervals for the median) were constructed. Cavalli-Sforza and Edwards (1967) chord distance was calculated and used to describe genetic relationships in two ways. First, we derived a tree using the Unweighted Pair-Group Method with Arithmetic Averaging (UPGMA, Sneath and Sokal 1973), which clusters groups based on overall similarity. Secondly, we performed a multidimensional scaling analysis (MDS, Krzanowski and Marriott 1994). This uses distances to group populations in multidimensional space so that the expected distance between populations closely matches the observed distance in

multidimensional space. All computations were performed using *S-Plus* analytical software (Mathsoft, Inc., Seattle, WA.).

**Mixed Fishery Analysis**

Stock contributions of the mixed fishery samples were estimated via maximum likelihood (MLE) (Pella and Milner 1987; Masuda et al. 1991). A conjugate gradient searching algorithm using a square root transformation was employed (Pella et al. 1994). This algorithm provides good performance with large baselines and small stock differences (Pella et al. 1994). The precision (standard error) of the stock composition estimates were estimated by a parametric bootstrap (Efron and Tibshirani 1986), where the observed multilocus genotype frequencies were assumed to be distributed multinomial as were the allele frequencies in the baseline. Used in this manner, the bootstrap accounts for sampling error in the mixture and in the baseline allele frequencies, but does not account for missing populations in the baseline.

One hundred bootstrap iterations were executed to provide sufficiently accurate estimates of standard error (Masuda et al. 1991). Genotypes were removed from the estimation procedure if their probability of occurring was zero. 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).

Simulated mixtures were used to evaluate the accuracy of the stock composition

estimates and to determine optimal reporting regions. These hypothetical mixtures (N=400) were generated using the baseline allele frequencies assuming Hardy-Weinberg equilibrium.

Mitochondrial DNA were used to estimate the Japanese and pooled non-Japanese component to the Period 2 1994 fishery. Baseline mtDNA data were from Park et al. (1993), and the estimated mixture contribution was calculated following Adams and Ward (1973). Specifically, let $p_1$ and $p_2$ be the frequencies of the marker alleles in contributors 1 and 2, respectively, and $p_m$ is the frequency in the mixture. Then the proportional contributions to the mixture are:

$$f_1 = \frac{p_m - p_2}{p_1 - p_2}, \qquad (1)$$

where $f_1$ is the proportional contribution of the first contributor to the mixture and $(1-f_1)$ is the contribution of the second contributor.

# RESULTS

## *Spawning Populations*

We chose a suite of 20 functional loci (22 total loci) (footnoted loci, Table 4) to include in the population and mixed fishery analyses. The following loci were variable in most populations analyzed: *ALAT**, *mAAT-1**, *sAAT-1,2**, *mAH-3**, *ESTD**, *G3PDH-2**, *mIDHP-1**, *sIDHP-2**, *LDH-A1**, *sMDH-A1**, *sMDH-B1,2**, *mMEP-2**, *MPI**, *PEPB-1**, *PGDH**. Variation was regionally based for *GPI-B1,2**, *GPI-A**, *LDH-B2**, *sMEP-1*, and *PEPA**. These loci were used in all the following analyses.

Thirteen locations were sampled over multiple years. No significant differences between years were detected; multiple years at a single location were pooled for further analyses (Table 5) ($\alpha=0.01$). A hierarchical analysis was then performed on all Alaskan populations (Table 6) to assess genetic relationships among stock groupings. Significant heterogeneity existed among and within major regions ($P<0.001$).

Within northwestern Alaska, significant heterogeneity was found within Kotzebue Sound, Yukon River, and Bristol Bay. Within the Yukon River, significant heterogeneity existed between summer and fall runs ($P<0.001$) and between Lower Yukon and Upper Yukon summer run stocks (G-statistic=193.99, df= 36, $P<0.001$). No significant heterogeneity was detected within the Lower Yukon, so populations were pooled. For the fall Yukon River run, heterogeneity existed among the Sheenjek River, Toklat River, and upper Tanana River populations ($P<0.001$). No heterogeneity was found among upper Tanana River populations ($P=0.999$). Therefore, Delta River, Tanana River mainstem, and Bluff

Cabin Slough fall run populations were pooled into a Tanana River fall run grouping.

We also tested for heterogeneity between drainages. The lower Yukon River and Kuskokwim River were homogeneous ($P=0.999$); no overall allele frequency differences were found within or between these subregions. The Lower Yukon River and Kuskokwim River were pooled for all further analyses.

High levels of heterogeneity were present among ($P<0.001$) and within ($P<0.001$) Peninsula and Kodiak groups. Most populations have unique allele frequencies, especially on the North Peninsula and Kodiak. Only two North Peninsula populations, Frosty Creek and St. Catherine's Cove ($P=0.562$), could be pooled, and no Kodiak populations could be pooled ($P<0.001$). However, on the South Peninsula, Little John Lagoon and Russell Creek Hatchery ($P=0.825$); Belkofski River and Canoe Bay ($P=0.261$); and Chiginagak River, Wide Bay/Kialagvik River, and Alagogshak River ($P=0.537$) were pooled.

Trends in allele frequency variation for all Pacific Rim stock groupings were analyzed using box plots for each region using the unpooled baseline frequencies (Appendix 2). Three loci (*mAH-3**, *ESTD**, and *LDH-A1**) exhibited extreme allele frequency fluctuations across the range of chum salmon. The allele frequency of *mAH-3* 100* ranged from approximately 0.80 to 0.20 around the Pacific Rim. Fall Yukon chum salmon exhibited high **100* frequencies, while Asian, other Northwest Alaskan summer, Alaska Peninsula/Kodiak, and southeastern Alaskan populations have intermediate allele frequencies, and British Columbia and Washington have low **100* frequencies. Populations from Washington to around the Alaska Peninsula/Kodiak have low *ESTD*91* frequencies, while Fall Yukon River populations have extremely high **91* frequencies. Asian populations were intermediate.

*LDH-A1** has a similar pattern as *ESTD**, though allele frequency differences are not as large.

Two loci, *sIDHP-2** and *sMEP-1**, provide discriminating power with alleles absent in some regions and present in others. For example, *sIDHP-2*25* is absent in Yukon River fall and Upper Yukon summer run populations, present in low frequencies in other Northwest Alaskan summer populations ($<0.01$), and becomes increasingly common in Bristol Bay (Naknek/Alagnak: 0.025) to the Alaska Peninsula (Joshua Green River: 0.323). It is also present in all other Pacific Rim populations with the exception of one Japanese population. Further, *sMEP-1*90* is present in all except one Japanese population, but is only seen in one stock group each in Northwest Alaska summer, Southeast Alaska/PWS, and British Columbia.

The UPGMA phenogram (Figure 4) show two distinct lineages of chum salmon: one composed of Asian and northwestern Alaskan populations; the second composed of North Peninsula, Gulf of Alaska, and Pacific Northwest populations. Within the Asian/Alaskan group, Japanese populations are distinctive, with Alaskan and Russian populations more similar to each other than either is to the Japanese populations. Within the Alaskan and Russian cluster, Kamchatka River and Chunilna River are divergent. Also, though the Meshik River is located on the North Alaska Peninsula, it groups with Ugashik/Egegik Bay in the Asian/northwestern Alaskan stock group. Within the Peninsula/Gulf of Alaska group, Peterson Lagoon (North Peninsula), Big Sukhoi Creek (Kodiak Island), Sturgeon River (Kodiak Island), and WHN Hatchery (Prince William Sound) are the most divergent. Two major groupings are found on this node; North and South Peninsula populations cluster with

southeastern Alaskan and British Columbian populations north of Nekite River, while British Columbian populations south of and including Nekite River are more similar to Washington.

The MDS is reflective of the UPGMA phenogram (Figure 5). Four non-overlapping stock groups are apparent: Japan, fall Yukon, Northwest Alaska summer, and Russia. Some overlap is observed among Peninsula/Kodiak and Southeast Alaska/PWS stocks.

## *Mixed Stock Analyses*

### Allozyme Results

The goal of the mixed stock analyses (MSA) is to identify population groups at the finest regional level or stock grouping possible while minimizing the bias and maximizing the precision of the estimates. The performance of the MSA model for Pacific Rim chum salmon was investigated through simulation studies for various possible reporting regions. Our goal was to maximize the information content for Alaskan stock groupings. We used a simulated mixture of 100% of the group under study with the individual populations within the group contributing equally (i.e. no adjustments were made for differential abundances).

Simulations were designed by considering the results of the G-statistic, UPGMA, and MDS analysis. The following possible reporting regions were studied: Kotzebue Sound, Norton Sound, Yukon River summer/Kuskokwim River and Bay/Togiak, fall Yukon, Bristol Bay (including Meshik, excluding Togiak), Alaska Peninsula/Chignik, and Kodiak Island. Only the fall Yukon group showed at least 90% accuracy, so stock groupings were enlarged.

A revised set of pooled regions was constructed which reduced the total reporting

groups. The groups were reduced to a Northwest Alaska summer complex (including Kotzebue Sound, Norton Sound, Yukon River Summer/Kuskokwim River and Bay/Togiak, Bristol Bay) and an Alaska Peninsula/Chignik/Kodiak complex. To reduce bias and maximize heterogeneity among reporting regions, Chunilna Creek, a Susitna River tributary that clusters with Northwest Alaska, was placed in the Northwest Alaska summer group. Similarly, Meshik River was placed within the Northwest Alaska summer group, rather than with other North Peninsula populations. The 100% simulations were again performed and showed at least 90% accuracy. Five additional reporting regions were identified from outside Northwest Alaska. The finalized reporting regions for the MLE were: Japan, Russia, Northwest Alaska summer, fall Yukon, Peninsula/Kodiak, Southeast Alaska (including Prince William Sound-WHN population), British Columbia, and Washington. All reporting regions showed at least 90% accuracy with the exception of Southeast Alaska/PWS and British Columbia where accuracy dropped to 83% and 87%, respectively (Table 7).

We also studied the accuracy and bias among mixtures of western Alaska and Asian groupings. Populations from the fall Yukon River run, Southeast Alaska/Prince William Sound, British Columbia, and Washington were excluded. Twenty-one simulations generating a mixture size of 400 fish were performed where each mixture was specified for the three regions (Asia, Northwest Alaska, Peninsula/Kodiak) and then uniformly distributed within each region (Figure 6). A total of 100 mixture estimates were calculated for each of the 21 design points. Figure 7 is a vector plot of the difference between the true mixtures and the mean of the 100 estimates. The length and direction of each vector show the magnitude and direction of the bias of the estimates at each design point. From Figure 7, it

is clear that little bias occurs for the interior points (all regional contributions are greater than zero), and that the bias increases as the mixture reaches the extreme points (at least one regional contribution is zero).

MLEs were calculated for the samples collected from the South Unimak June fishery during 1993 and 1994 (Table 8, Fig. 8). The Northwest Alaska summer region was the predominant group in all the estimates; its contribution ranged from 0.721 in the second period in 1994 (1994-2) to 0.515 in 1994-1. The Japanese component was also fairly consistent ranging from a high of 0.169 in 1993-1 to a low of 0.091 in 1994-2. The Russian contribution showed a slightly greater variability ranging from a high of 0.189 in 1994-1 to a low of 0.057 in 1993-1. Alaska Peninsula to Kodiak populations were consistently present, ranging from 0.042 to 0.133. Fall Yukon River populations were likely absent, their estimated contribution statistically indistinguishable from 0.00. However, it should be noted that Canadian fall Yukon River populations were not included in the baseline. The Southeast Alaska/Prince William Sound, British Columbia, and Washington groups appeared to be consistently present at low levels.

**MtDNA Results**

A total of 362 individuals from the 1994 South Unimak June fishery (Period 2) were successfully assayed for fragment analysis of the ND5/ND6 region (Table 9). Two haplotypes (*B* and *C*) previously described by Park et al. (1993) were observed. In addition, a new haplotype (*D*) was observed in two fish. The majority of individuals (85.4%) expressed haplotype *C*; haplotype *B* was found in 14.1% of the individuals. Two major

chum salmon groups are identifiable: a Japanese and a pooled non-Japanese component which includes Russian populations. The estimated Japanese component for the Period 2 1994 (June 21-25) South Unimak June fishery was 0.095. This agrees very closely with the allozyme result of 0.091 for the same collection.

# DISCUSSION

## *Genetic Relationships Among Chum Salmon*

Relationships among northwestern Alaskan chum salmon groups described in this study reveal the most complete picture to date of their evolutionary history. First, we present new data on many areas in Northwest Alaska (particularly Norton and Kotzebue Sounds, Alaska Peninsula, and Kodiak Island) that had not been previously described; and second, we were able to draw upon the wealth of genetic data available from around the Pacific Rim. The results presented here indicate that considerable regional differentiation exists among chum salmon populations.

We found a close relationship among Lower Yukon, Kuskokwim, Norton Sound, and Upper Bristol Bay summer chum salmon populations. Wilmot et al. (In press) described a similar relationship among Lower Yukon, Kuskokwim, and Nushagak River populations. They hypothesize that Bristol Bay was recolonized by chum salmon from the Yukon/Kuskokwim region, which was not covered with ice during the last glaciation. However, they do not consider populations north of the Yukon River. Norton Sound was also part of the Beringian Refugium during the Wisconsin glaciation (McPhail and Lindsey 1970). This also explains the close genetic affinity of Norton Sound populations to those of the Yukon-Kuskokwim Delta. The pattern closely parallels geography as some of the Yukon River tributaries (e.g. Anvik River) have their headwaters near the headwaters of Norton Sound drainages.

Kotzebue Sound populations have diverged slightly from this core Northwest Alaska

summer group. Apparently, these populations are sufficiently separated geographically to allow differentiation. Within Kotzebue Sound, no genetic differences were detected between the Noatak River mainstem population and the two Sikusuilaq Hatchery populations examined. Kelly Lake, located in the upper Noatak River drainage, is extremely dissimilar to the other, more coastal, Kotzebue Sound populations. This is one of the few known lake spawning populations of chum salmon. Apparently changes in spawning behavior have led to the differentiation and isolation of this group.

Results presented here also indicate divergence within the Yukon River. Significant differentiation was found between the upper Yukon River summer runs (Chena and Salcha Rivers) and the coastal northwestern summer complex. In addition, the significant divergence between the Yukon River summer and fall runs described by Wilmot et al. (In press) is supported by this study. Fall Yukon River populations (represented by the Toklat, Tanana, and Sheenjek Rivers in this study) are an identifiable group and are reported as a separate region in the admixture analysis. Temporal isolation likely provides a significant barrier to gene flow among these populations resulting in the observed differentiation. Similar differentiation, also attributable to temporal isolation, has been reported between Washington fall and summer runs (Phelps et al. In press), between northern and more southerly Honshu Island populations in Japan (Okazaki 1982), and, perhaps, between the fall spawners inhabiting Prince of Wales and Queen Charlotte Islands and the summer spawners inhabiting Southeast Alaska and northern British Columbia (Kondzela et al. In press).

A clear genetic discontinuity between populations was observed on the North Alaska Peninsula. The discontinuity is located between the Meshik River and the Lawrence Valley

Creek populations. Half of the polymorphic loci had significant frequency differences between these two populations (overall G-statistic=250.28, df=23, $P<0.001$). The Meshik River, which flows into Port Heiden, clearly grouped with the Egegik and Ugashik Bay populations. Ugashik Bay is located approximately 80 km northeast along the Peninsula from Port Heiden. Lawrence Valley Creek which flows into Herendeen Bay is located in the opposite direction, farther west (approximately 150 km) along the Alaska Peninsula from the Meshik River. The Lawrence River is closely allied with other North and South Peninsula populations and shows a clear genetic affinity to the Gulf of Alaska/Pacific Northwest group of chum salmon.

Wilmot et al. (In press) also examined populations from the Meshik River and Herendeen Bay and found a genetic discontinuity between them. However, their data suggest a close relationship between the Alaska Peninsula and populations from Russia. Our data do not support this hypothesis. Rather, our data suggest a close relationship between northwestern Alaskan stocks and Russian stocks and support the hypothesis that Peninsula stocks are part of a Gulf of Alaska/Pacific Northwest complex. The differences between the studies are likely attributed to the lack of representative populations from the South Alaska Peninsula, Kodiak Island, and eastern Pacific populations in the Wilmot et al. (In press) analysis.

Chum salmon also survived the Wisconsin Glaciation in the Pacific Refugium, primarily the Columbia River (McPhail and Lindsey 1970). Genetic relationships among Pacific Rim chum salmon presented in this study indicate that recolonization of deglaciated streams from British Columbia to the Northern Alaskan Peninsula probably occurred from the

Pacific Refugium. However, it appears likely that Kvichak Bay, Egegik Bay, Ugashik Bay, and Port Heiden are derived from strays from the Beringian Refugium.

Given a scenario of a Pacific source for recolonization of glaciated areas in Southcentral Alaska, one would expect Susitna River stocks to cluster with other Gulf of Alaska stocks. However, Chunilna Creek, a tributary to the Talkeetna River slightly upstream to the confluence with the Susitna River, is genetically more similar to northwestern Alaska populations with an absence of *sIDHP*25* and little variation at *PEPB-1**. Both the UPGMA and MDS analyses support this relationship. It is possible that colonization of this population occurred through inland dispersal via a connection between the Nenana, a tributary of the Tanana (Yukon) River, and the Chulitna, a tributary of the Susitna Rivers. Headwaters of the Chulitna and Nenana Rivers are close in the area of Broad Pass. An examination of additional populations from the Susitna drainage and Cook Inlet would provide further insights into the distribution of these major races of chum salmon as well as locate a possible zone of contact between the groups.

It is possible that the Northwest Alaska and Gulf of Alaska groups come in contact not only on the Alaska Peninsula and Susitna drainages, but also in the upper reaches of the Yukon River tributaries in Canada. Wilmot et al. (In press) examined several Canadian Yukon River fall runs, the Kluane and Teslin Rivers, and found them to be quite distinct from other Yukon River fall chum salmon. They hypothesize that the Kluane and Teslin populations may have come from the Alsek River, a Southeast Alaska drainage.

### *Mixed Stock Analyses*

The significant genetic diversity among chum salmon populations described above can be utilized as an accurate stock identification tool. In this study, we apply the MSA approach to the analysis of the South Unimak June fishery, a fishery likely composed of chum salmon originating from both the Asian and North American continents. These estimates are also utilized in a companion study (Eggers 1995) to estimate harvest rates and stock-specific vulnerability indices in the South Unimak June fishery.

A basic requirement of MSA using genetic data is that all major contributing populations are represented in the baseline. To a large extent, this assumption can be met by the extensive genetic information provided in this study and in the recently published literature. We were unable to include the Canadian fall Yukon River populations reported in Wilmot et al. (In press) due to incomplete data, but they will be added in future analyses as data become available. Their contribution must be inferred from the results for the United States fall Yukon populations. Some of these populations (i.e. Teslin and Kluane Rivers) represent a divergent lineage within the Yukon River, possibly of Southeast Alaska origin (Wilmot et al. In press).

In Asia, we also know that Russian populations may not be adequately surveyed. Key areas that are missing are the Amur River and Sakhalin Island. This might explain the result that approximately 5% of each mixture sample contained genotypes not adequately explained by our baseline. Moreover, the Russian samples in the baseline possess the smallest sample sizes and may contain a high sampling error relative to other areas of the Pacific Rim.

The simulation study indicates that estimates of approximately 60% Northwest Alaska summer, 25% Asian, and 10% Peninsula/Kodiak probably possess little bias. This can be seen by noting the lengths of the vectors in the vicinity of the shaded region on Figure 7. This conclusion is only valid, however, if the baseline is exhaustive in its coverage of all major genetic lineages of the Pacific Rim that might contribute to the mixture. Similarly, the bootstrap can be used as a means of evaluating bias, but like the simulations, the bootstrap will only provide a reliable estimate of bias if the baseline is exhaustive. We will attempt to evaluate bias in the future along with how best to treat unexplainable genotypes.

Finally, it would be worthwhile to resample hatchery stocks in Japan. Waples (1991) discusses the temporal instability of chinook salmon hatchery allele frequencies which may have ramifications for mixture analyses (see Phelps et al. In press and references therein). This trend has not been observed in recent chum salmon population surveys (Phelps et al. In press; Winans et al. In press; this study, Sikusuilaq Hatchery allele frequencies are not divergent), possibly attributable to the large numbers of chum salmon that are used for broodstock (Phelps et al. In press). However, since Japanese chum salmon are entirely represented in the baseline by hatchery populations, it is important to continue to assess stability of allele frequencies over time.

The significant genetic diversity among chum salmon populations described above can be utilized as an accurate stock identification tool. We took a conservative approach to identifying regional reporting units. Dividing the Northwest Alaska region into smaller groupings may be possible in the future as additional markers are identified. One such marker, *mAAT-2**, may be particularly useful, but was absent for Southeast Alaska, British

Columbia, and Washington populations. Other larger regions may also lend themselves to subdivision in different applications. For example, Winans et al. (In press) reported seven identifiable groups of Russian and Japanese populations.

The use of DNA-level analyses (both mitochondrial and nuclear) in MSA of Pacific salmon has been extolled by many authors (Hallerman and Beckmann 1988; Cronin et al. 1993; Park et al. 1993; Taylor et al. 1994). The preponderance of studies published to date have described spawning populations, but have not included actual analyses of mixture samples. The distribution of mtDNA haplotypes in chum salmon provide an ideal application.

Park et al. (1993) first described the high frequency of the mtDNA ND5/ND6 *B* haplotype from Japanese fish and suggested that this marker could be useful in stock identification studies. They surveyed 798 fish from Japan to Washington and reported that the frequency of *B* averaged 0.80 in Japan, but dropped precipitously in Russian populations to 0.13, and was absent in British Columbia and Washington populations. Cronin et al. (1993) also report data for this marker in a limited survey of 50 individuals originating from Northwest Alaska to Washington. They observed the *B* haplotype in only a single individual from the Yukon River (their C7 haplotype). Forty eight of their 50 individuals (0.96) expressed the C haplotype.

We chose to use the mtDNA marker to provide an independent estimate of the proportion of Japanese chum salmon in the Unimak area fishery during Period 2. Combining the allozyme and mtDNA into a single database was impossible due to the limited mtDNA baseline information. The two independent estimates for Period 2 in 1994 are statistically indistinguishable (0.091 and 0.095 for the allozyme and mtDNA, respectively).

Numerous potential applications of the genetic database exist. Studies of migration routes and timing of Pacific Rim chum salmon are clearly possible. Seeb and Seeb (1986) attempted to utilize MSA to identify the continent of origin of container-loads of chum salmon confiscated by the National Marine Fisheries Service. Their study was based on limited Asian data. Their estimates were likely biased, but they did indicate the presence of North American chum salmon within the samples. Winans et al. (1989) utilized an expanded database to estimate the origin of chum salmon intercepted in highseas drift net fisheries targeting squid. Future applications include analysis of chum salmon intercepted in the Bering Sea trawl fisheries as the bycatch of chum salmon in this fishery has increased markedly in the last several years.

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Table 1. Populations used to construct Pacific Rim chum salmon baseline and source of data. Numbers preceding population names correspond to sampling locations in Figures 1 and 3. Asterisks following population names from Southeast Alaska, British Columbia*, and Washington stocks indicate these populations are representative of their region. G-statistics used to pool populations can be found in Table 6.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| NW ALASKA SUMMER | **Kotzebue Sound** | | | |
| | Noatak River | (1) Sikusuilaq Hatchery 1991 | 100 | this study |
| | | (1) Sikusuilaq Hatchery 1993 | 100 | this study |
| | | (2) Noatak River 1991 | 100 | this study |
| | | Total Noatak River | 300 | |
| | Kelly Lake | (3) Kelly Lake 1991 | 100 | this study |
| | Salmon River | (4) Salmon River 1991 | 106 | this study |
| | **Norton Sound** | | | |
| | Pilgrim River | (5) Pilgrim River 1994 | 90 | this study |
| | Norton Sound | (6) Snake River 1992 | 47 | this study |
| | | (6) Snake River 1993 | 35 | this study |
| | | (7) Nome River 1991 | 27 | this study |
| | | (7) Nome River 1992 | 13 | this study |
| | | (7) Nome River 1993 | 53 | this study |
| | | (8) Kwiniuk River 1994 | 100 | this study |
| | | (9) Fish River 1994 | 100 | this study |
| | | (10) Unalakleet River 1992 | 100 | this study |
| | | Total Norton Sound: | 475 | |
| | **Yukon River: Summer Run** | | | |
| | Chena River | (20) Tanana/Chena River 1992 | 86 | this study |
| | Salcha River | (21) Tanana/Salcha River 1992 | 100 | this study |
| | Lower Yukon/Kuskokwim | (11) W. Fk. Andreafsky River 1993 | 100 | this study |
| | | (12) E. Fk. Andreafsky River 1993 | 100 | this study |
| | | (13) Innoko River 1993 | 88 | this study |
| | | (14) Anvik/Beaver Creek 1992 | 100 | this study |
| | | (14) Anvik/Beaver Creek 1993 | 100 | this study |
| | | (15) Anvik/Canyon Creek 1993 | 50 | this study |
| | | (16) Anvik/Otter Creek 1992 | 100 | this study |
| | | (17) Anvik/Swift River 1992 | 100 | this study |
| | | (17) Anvik/Swift River 1993 | 100 | this study |
| | | (18) Anvik/Yellow River 1992 | 100 | this study |
| | | (19) Huslia River 1993 | 100 | this study |
| | **Kuskokwim/Goodnews Bay** | | | |
| | | (27) Kwethluk River 1994 | 100 | this study |
| | | (28) Tuluksak River 1993 | 100 | this study |
| | | (29) Aniak River 1992 | 100 | this study |

Table 1. Continued.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| NW ALASKA SUMMER | | (30) Kogrukluk River 1992 | 75 | this study |
| | | (30) Kogrukluk River 1993 | 50 | this study |
| | | (31) Tatlawiksuk River 1994 | 100 | this study |
| | | (32) 4th of July Creek 1994 | 100 | this study |
| | | Total Lower Yukon/Kuskokwim: | 1663 | |
| | Kanektok/Goodnews/Togiak Rivers | (33) Kanektok River 1993 | 39 | this study |
| | | (34) Goodnews River 1991 | 100 | this study |
| | Bristol Bay | (35) Togiak River 1993 | 100 | this study |
| | | (35) Togiak River 1994 | 100 | this study |
| | | Total Kanektok/Goodnews/Togiak Rivers: | 339 | |
| | Nushagak River | (36) Upper Nushagak River 1992 | 53 | this study |
| | | (36) Upper Nushagak River 1993 | 50 | this study |
| | | (37) Mulchatna River 1994 | 100 | this study |
| | | (38) Stuyahok River 1992 | 31 | this study |
| | | (38) Stuyahok River 1993 | 57 | this study |
| | | Total Nushagak River: | 291 | |
| | Naknek/Alagnak Rivers | (39) Alagnak River 1992 | 84 | this study |
| | | (40) Naknek/Big Creek 1993 | 80 | this study |
| | | Total Naknek/Alagnak Rivers | 164 | |
| | Egegik/Ugashik Bay | (41) Egegik Bay/King Salmon R./Whale Mountain Creek 1993 | 98 | this study |
| | | (42) Ugashik Bay/King Salmon R./Pumice Creek 1993 | 100 | this study |
| | | | 198 | |
| | North Alaska Peninsula | | | |
| | Meshik River | (43a) Meshik/Plenty Bear Creek 1993 | 93 | this study |
| | | (43b) Meshik/Braided Creek 1992 | 78 | this study |
| | | Total Meshik River: | 171 | |
| | Cook Inlet | | | |
| | Chunilna Creek | (63) Susitna/Chunilna Creek 1993 | 87 | this study |
| FALL YUKON | Yukon River: Fall Run | | | |
| | Toklat River | (22) Toklat River 1991 | 60 | this study |
| | | (22) Toklat River 1992 | 155 | this study |
| | | Total Toklat River: | 215 | |
| | Tanana Fall Run | (23) Tanana River (mainstem) 1992 | 97 | this study |
| | | (23) Tanana River (mainstem) 1993 | 100 | this study |
| | | (24) Bluff Cabin Slough 1992 | 100 | this study |
| | | (25) Delta River 1991 | 100 | this study |
| | | (25) Delta River 1992 | 100 | this study |
| | | Total Tanana Fall Run: | 497 | |

Table 1. Continued.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| FALL YUKON | | (26) Sheenjek River 1992 | 100 | this study |
| | Sheenjek River | (26) Sheenjek River 1993 | 64 | this study |
| | | Total Sheenjek River: | 164 | |
| PENINSULA/KODIAK | North Alaska Peninsula | | | |
| | Lawrence Valley Creek | (44) Lawrence Valley Creek 1992 | 100 | this study |
| | Joshua Green River | (45) Joshua Green River 1992 | 80 | this study |
| | Frosty/St. Catherine's Cove | (46) Frosty Creek 1992 | 100 | this study |
| | | (47) St. Catherine's Cove 1992 | 80 | this study |
| | | Total Frosty/St. Catherine's Cove | 180 | |
| | Trader's Cove Creek | (48) Traders Cove Creek 1992 | 100 | this study |
| | Peterson Lagoon | (49) Peterson Lagoon 1992 | 86 | this study |
| | South Alaska Peninsula | | | |
| | Littlejohn/Russell Creek | (50) Little John Lagoon 1992 | 87 | this study |
| | | (51) Russell Creek 1993 | 100 | this study |
| | | Total Littlejohn/Russell Creek: | 187 | |
| | Belkofski/Canoe Bay | (52) Belkofski River 1992 | 87 | this study |
| | | (53) Canoe [illegible] 1992 | 100 | this study |
| | | Total Belkofski/Canoe Bay: | 187 | |
| | Stepovak River | (54) Stepovak River 1993 | 100 | this study |
| | Chignik | | | |
| | Ivanoff River | (55) Ivanoff River 1993 | 94 | this study |
| | Chiginagak/Mainland | (56) Chiginagak River 1993 | 75 | this study |
| | Mainland District | (57) Wide Bay/Kilagvik River 1993 | 100 | this study |
| | | (58) Algogshak River 1993 | 95 | this study |
| | | Total Chiginigak/Mainland | 270 | |
| | Big River | (59) Hallo Bay/Big River 1993 | 100 | this study |
| | Kodiak | | | |
| | Big Sukhoi Creek | (60) Sukhoi Lagoon/Big Sukhoi Creek 1992 | 100 | this study |
| | Sturgeon River | (61) Sturgeon Lagoon/Sturgeon River 1992 | 71 | this study |
| | Kizhuyak River | (62) Kizhuyak River 1992 | 88 | this study |

Table 1. Continued.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| SE ALASKA/PWS | **Prince William Sound** | | | |
| | WHN Hatchery | (64) WHN Hatchery 1992 | 92 | this study |
| | **Lynn Canal** | | | |
| | Herman Creek | (65) Herman Creek 1987 | 100 | Kondzela et al. In press |
| | | (65) Herman Creek 1990 | 59 | Kondzela et al. In press |
| | | Total Herman Creek: | 159 | |
| | Southeast Alaska | (66) Fish Creek 1986* | 100 | Kondzela et al. In press |
| | | (66) Fish Creek 1987* | 50 | Kondzela et al. In press |
| | | (66) Fish Creek 1988 (early)* | 100 | Kondzela et al. In press |
| | | (66) Fish Creek 1988 (late)* | 52 | Kondzela et al. In press |
| | | (66) Tombstone River 1986 | 98 | Kondzela et al. In press |
| | | (66) Marten River 1986 | 105 | Kondzela et al. In press |
| | | (67) Keta River 1986* | 101 | Kondzela et al. In press |
| | | (67) Blossom River 1986 | 101 | Kondzela et al. In press |
| | | (67) Wilson River 1986 | 103 | Kondzela et al. In press |
| | | (68) Harding River 1986* | 95 | Kondzela et al. In press |
| | | Total Southeast Alaska: | 905 | |
| | **Prince of Whales Island** | | | |
| | Port Real Marina | (69) Port Real Marina 1986* | 100 | Kondzela et al. In press |
| | | (69) Port Real Marina 1988* | 48 | Kondzela et al. In press |
| | | Total Port Real Marina: | 148 | |
| | Eastern Prince of Whales Island | (70) Kugel Creek 1986 | 104 | Kondzela et al. In press |
| | | (70) Disappearance Creek 1986* | 100 | Kondzela et al. In press |
| | | (70) Disappearance Creek 1988* | 100 | Kondzela et al. In press |
| | | (70) Lagoon Creek 1986 | 102 | Kondzela et al. In press |
| | | (70) Old Tom Creek 1986 | 100 | Kondzela et al. In press |
| | | (70) Old Tom Creek 1988 | 53 | Kondzela et al. In press |
| | | (70) Cabin Creek 1986 | 103 | Kondzela et al. In press |
| | | Total Eastern Prince of Whales Island: | 662 | |
| BRITISH COLUMBIA | **British Columbia** | | | |
| | Eastern Queen Charlotte Islands | (71) Pallant Creek 1988* | 100 | Kondzela et al. In press |
| | | (71) Lagoon Creek 1989 | 83 | Kondzela et al. In press |
| | | (71) Sedgewick Creek 1989 | 74 | Kondzela et al. In press |
| | | (71) Bag Harbor Creek 1989 | 89 | Kondzela et al. In press |
| | | (71) Surprise Creek 1989 | 85 | Kondzela et al. In press |
| | | Total Eastern Queen Charlotte Islands | 431 | |
| | Nass River Area | (72) Kshwan River 1988 | 88 | Kondzela et al. In press |
| | | (72) Kitsault River 1988 | 95 | Kondzela et al. In press |
| | | (72) Stagoo Creek 1988* | 75 | Kondzela et al. In press |
| | | (72) Stagoo Creek 1989* | 53 | Kondzela et al. In press |

Table 1. Continued.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| BRITISH COLUMBIA | | Total Nass River Area | 311 | |
| | Kitimat/Mussel River | (73) Kitimat River 1988* | 92 | Kondzela et al. In press |
| | | (73) Kitimat River 1989* | 100 | Kondzela et al. In press |
| | | (73) Mussel River 1989 | 100 | Kondzela et al. In press |
| | | Total Kitimat/Mussel River: | 292 | |
| | Nekite Channel/River | (74) Nekite Channel 1989 | 100 | Kondzela et al. In press |
| | | (74) Nekite River 1989 | 97 | Kondzela et al. In press |
| | | Total Nekite Channel/River | 197 | |
| | East Vancouver Island | (75) Puntledge Hatchery | 100 | Phelps et al. In press |
| | | (75) Big Qualicum Hatchery* | 200 | Phelps et al. In press |
| | | (75) Little Qualicum | 100 | Phelps et al. In press |
| | | (75) Nanaimo River | 100 | Phelps et al. In press |
| | | (75) Chemainus River | 100 | Phelps et al. In press |
| | | (75) Cowichan River | 100 | Phelps et al. In press |
| | | (75) Goldstream River | 100 | Phelps et al. In press |
| | | Total E. Vancouver Island: | 800 | |
| | West Vancouver Island | (76) Nitinat River and Hatchery* | 380 | Phelps et al. In press |
| | | (76) Nahmint River | 100 | Phelps et al. In press |
| | | (76) Sarita River | 127 | Phelps et al. In press |
| | | Total W. Vancouver Island: | 607 | |
| | Lower Fraser River | (77) Alouette River | 100 | Phelps et al. In press |
| | | (77) Stave River | 100 | Phelps et al. In press |
| | | (77) Chilliwack - Vedder Hatchery | 100 | Phelps et al. In press |
| | | (77) Chehalis Hatchery* | 100 | Phelps et al. In press |
| | | Total Lower Fraser River | 400 | |
| | Upper Fraser River | (78) Chehalis at Harrison Hatchery* | 100 | Phelps et al. In press |
| | | (78) Weaver River | 100 | Phelps et al. In press |
| | | (78) Harrison River | 100 | Phelps et al. In press |
| | | (78) Squakum Creek | 100 | Phelps et al. In press |
| | | (78) Wahleach Creek | 100 | Phelps et al. In press |
| | | Total Upper Fraser River | 500 | |
| WASHINGTON | Puget Sound | | | |
| | Skagit River | (79) Illabot Creek | 98 | Phelps et al. In press |
| | | (79) Dan Creek* | 153 | Phelps et al. In press |
| | | Total Skagit River: | 251 | |
| | Bellingham Maritime Hatchery | (80) Bellingham Maritime Hatchery | 100 | Phelps et al. In press |
| | Mill Creek | (81) Mill Creek | 179 | Phelps et al. In press |

Table 1. Continued.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| WASHINGTON | Hood Canal Hatchery | (82) Hood Canal Hatchery | 450 | Phelps et al. In press |
| JAPAN | Honshu | | | |
| | Gakko/Miomote Rivers | (83) Gakko River 1989 | 39 | Winans et al. In press |
| | | (84) Miomote River 1989 | 100 | Winans et al. In press |
| | | Total Gakko/Miomote Rivers | 139 | |
| | Tsugaruishi River | (85) Tsugaruishi River 1989 | 100 | Winans et al. In press |
| | Ohkawa River | (86) Ohkawa River 1989 | 100 | Winans et al. In press |
| | Hokkaido | | | |
| | Teshio River | (87) Teshio River 1987 | 97 | Winans et al. In press |
| | Chitose River | (88) Chitose River 1989 | 100 | Winans et al. In press |
| | | (88) Chitose River 1990 | 80 | Winans et al. In press |
| | | Total Chitose River: | 180 | |
| | Tokachi River | (89) Tokachi River 1989 | 100 | Winans et al. In press |
| | | (89) Tokachi River 1990 | 80 | Winans et al. In press |
| | | Total Tokachi River | 180 | |
| | Kushiro River | (90) Kushiro River 1989 | 100 | Winans et al. In press |
| | Nishibetsu River | (91) Nishibetsu River 1989 | 100 | Winans et al. In press |
| | Shari River | (92) Shari River 1989 | 100 | Winans et al. In press |
| | Tokusibetsu River | (93) Tokushibetsu River 1994 | 42 | Winans et al. In press |
| RUSSIA | Northern Russia | | | |
| | Anadyr/Kanchalan Rivers | (94) Anadyr River 1991 | 104 | Winans et al. In press |
| | | (94) Anadyr River 1991 | 80 | Wilmot et al. In press |
| | | (95) Kanchalan River 1991 | 79 | Wilmot et al. In press |
| | | Total Anadyr/Kanchalan Rivers: | 263 | |
| | Korf Bay | (96) Korf Bay 1991 | 18 | Winans et al. In press |
| | Kamchatka Peninsula | | | |
| | Nerpichi Lake | (97) Nerpichi Lake | 40 | Winans et al. In press |
| | Kamchatka River | (98) Kamchatka River 1990 | 80 | Winans et al. In press |
| | | (98) Kamchatka River 1991 | 40 | Winans et al. In press |
| | | Total Kamchatka River: | 120 | |
| | Utka River | (99) Utka River 1991 | 79 | Winans et al. In press |

Table 1. Continued.

| Reporting Region | Pooled Population | Population | N | Data Source |
|---|---|---|---|---|
| RUSSIA | | | | |
| | Kikchik River | (100) Kikchik River 1991 | 40 | Winans et al. In press |
| | Pymta River | (101) Pymta River 1990 | 80 | Winans et al. In press |
| | | (101) Pymta River 1991 | 79 | Winans et al. In press |
| | | Total Pymta River | 159 | |
| | Kol River | (102) Kol River 1990 | 93 | Winans et al. In press |
| | Hairusova River | (103) Hairusova River 1990 | 154 | Winans et al. In press |
| | Southern Russia | | | |
| | Tumani River | (104) Tumani River 1991 | 66 | Winans et al. In press |
| | Ola River | (105) Ola River 1990 | 80 | Winans et al. In press |
| | | (105) Ola River 1991 | 80 | Winans et al. In press |
| | | Total Ola River: | 160 | |

*Klownik River was selected as a representative stock. Due to missing loci, this population was not included. The next most southerly population, Nekite River, was used instead. The closest population to the north of Klownik River was a representative stock.

Table 2. Genetic sampling for chum salmon from the South Unimak and Shumagin Islands June fisheries, 1993 and 1994, by Alaska Department of Fish and Game. Sampling was conducted at commercial catch processing facilities and by test fishing. The subsamples reported in this study were taken from the commercial catch collections only.

| Year | Geographic Area | Catch (N) | Test (N) | Total (N) | Catch Subsample (N) |
|---|---|---|---|---|---|
| 1993 | Southwest Unimak (Cape Lutke) | 940 | 0 | 940 | 800[1] |
| | Southeast Unimak (Cape Lazaref to Ikatan Bay) | 1,682 | 0 | 1,682 | |
| | Total 1993 | 2,622 | 0 | 2,622 | 800 |
| 1994 | Shumagin Islands | 1,940 | 1,500[2] | 3,440 | 0 |
| | Southwest and Southeast Unimak (Cape Lutke, Cape Lazaref to Ikatan Bay) | 2,150 | 700[3] | 2,850 | 1,200 |
| | Total 1994 | 4,090 | 2,200 | 6,290 | 1,200 |
| All years | Total | 6,712 | 2,200 | 8,912 | 2,000 |

[1] Both areas were pooled together, and then a subsample was drawn.

[2] Test fishing dates: June 9, 10, 13, 14

[3] Test fishing dates: June 13, 14, 16, 17

Table 3. Daily catch and number of genetic samples collected during 1993 and 1994 South Unimak June fishery. Number of fish subsampled for mixed fishery analysis was proportional to daily catch. Subsampling for 1993 was adjusted for the varying catch rates between Southwest Unimak (L) and Southeast Unimak (U) areas. These areas were not distinguished during 1994 sampling.

| Year | Period | Date | Daily Catch | % Total Catch | Genetic Samples | Subsample Goal | Subsample | % Mixture |
|---|---|---|---|---|---|---|---|---|
| 1993 | 1 | June 13 | 37,965 | 13% | 319 | 52 | U: 15<br>L: 37 | 13% |
| | | June 15 | 45,075 | 16% | 165 | 64 | U: 64 | 16% |
| | | June 16 | 43,503 | 15% | 206 | 60 | U: 60 | 15% |
| | | June 17 | 38,717 | 14% | 124 | 56 | U: 21<br>L: 35 | 14% |
| | | June 19 | 51,147 | 18% | 370 | 72 | U: 55<br>L: 17 | 18% |
| | | June 20 | 67,705 | 24% | 404 | 96 | U: 28<br>L: 68 | 24% |
| | | Total | 284,112 | 100% | 1,588 | 400 | 400 | 100% |
| | 2 | June 22 | 67,705 | 75% | 509 | 297 | U: 149<br>L: 148 | 74% |
| | | June 26 | 3,313 | 3% | 345 | 14 | U: 14 | 4% |
| | | June 27 | 12,674 | 13% | 95 | 52 | U: 52 | 13% |
| | | June 29 | 8,980 | 9% | 85 | 37 | U: 37 | 9% |
| | | Total | 97,829 | 100% | 1,034 | 400 | 400 | 100% |
| 1994 | 1 | June 17 | 46,792 | 34% | 400 | 136 | 157 | 39% |
| | | June 18 | 24,283 | 18% | 110 | 72 | 82 | 20% |
| | | June 19 | 47,745 | 35% | 430 | 140 | 161 | 40% |
| | | June 20* | 17,957 | 13% | 80 | 52 | 0 | 0% |
| | | Total | 136,777 | 100% | 1,020 | | 400 | 100% |
| | 2 | June 21* | 9,983 | 9% | 44 | 36 | 0 | 0% |
| | | June 22 | 26,376 | 24% | 206 | 96 | 112 | 28% |
| | | June 23 | 34,438 | 31% | 120 | 125 | 120 | 30% |
| | | June 24 | 20,153 | 18% | 100 | 73 | 85 | 21% |
| | | June 25 | 19,482 | 18% | 100 | 70 | 83 | 21% |
| | | Total | 110,432 | 100% | 570 | 400 | 400 | 100% |
| | 3 | June 26 | 19,058 | 15% | 100 | 60 | 100 | 25% |
| | | June 27 | 42,525 | 34% | 100 | 134 | 100 | 25% |
| | | June 28 | 53,844 | 42% | 140 | 170 | 140 | 35% |
| | | June 29 | 9,549 | 8% | 100 | 30 | 50 | 13% |
| | | June 30* | 1,985 | 2% | 120 | 6 | 10 | 3% |
| | | Total | 126,961 | 100% | 560 | 400 | 400 | 100% |

*Genetic samples collected June 20 and June 21, 1994 were not usable due to improper shipping; tissues were missing from 70 of the samples collected on June 30.

Table 4. Stain protocol used to resolve enzyme coding loci in Alaska chum salmon samples. Footnoted[1] loci were used in the mixed fishery analysis. Enzyme nomenclature follows Shaklee et al. (1990), and locus abbreviations are given.

| Enzyme or Protein | Enzyme Number | Locus | Tissue | Buffer |
|---|---|---|---|---|
| Aspartate aminotransferase | 2.6.1.1 | *sAAT-1,2*[1] | H | ACE7.2 TBE |
| | | *sAAT-3** | E | TBCLE |
| | | *mAAT-1*[1] | H,M | ACE7.2 |
| | | *mAAT-2** | L,H | ACN6, ACE7.2 |
| Aconitate hydratase | 4.2.1.3 | *mAH-1,2** | H | ACE7.2 |
| | | *mAH-3*[1] | H | ACE7.2 |
| | | *mAH-4** | H | ACE7.2 |
| | | *sAH** | L | ACE7.2 |
| Alanine aminotransferase | 2.6.1.2 | *ALAT*[1] | M | TBE |
| Creatine kinase | 2.7.3.2 | *CK-A1** | M | TBCLE |
| | | *CK-A2** | M | TBCLE |
| | | *CK-B** | E | TBCLE |
| | | *CK-C1** | E | TBCLE |
| | | *CK-C2** | E | TBCLE |
| Esterase-D | 3.1.1.- | *ESTD*[1] | H | TBE |
| | | *ESTD-2** | H | TBE |
| Fumarate hydratase | 4.2.1.2 | *FH** | M | ACE7.2 |
| beta-N-Acetylgalactosaminidase | 3.2.53 | *bGALA** | H | ACE7.2 |
| Glyceraldehyde-3-phosphate dehydrogenase | 1.2.1.12 | *GAPDH-1** | H | ACE7.2 |
| | | *GAPDH-2** | H | ACE7.2 |

Table 4. Continued.

| Enzyme or Protein | Enzyme Number | Locus | Tissue | Buffer |
|---|---|---|---|---|
| | | *GAPDH-3** | H | ACE7.2 |
| N-Acetyl-beta-glucosaminidase | 3.2.1.53 | *bGLUA** | L | ACN6 |
| Glycerol-3-phosphate dehydrogenase | 1.1.1.8 | *G3PDH-1** | H | ACE7.2 |
| | | *G3PDH-2**[1] | H | ACE7.2 |
| | | *G3PDH-3** | H | ACE7.2 |
| Glucose-6-phosphate isomerase | 5.3.19 | *GPI-B1,2**[1] | M | TBCLE |
| | | *GPIA**[1] | M | TBCLE |
| Hydroxyacylglutathione hydrolase[2] | 3.1.2.6 | *HAGH** | H | TBE |
| L-Idditol dehydrogenase | 1.1.1.14 | *IDDH-1** | L | TBCL |
| | | *IDDH-2** | L | TBCL |
| Isocitrate dehydrogenase (NADP+) | 1.1.1.42 | *mIDHP-1**[1] | M,H | ACE7.2 |
| | | *mIDHP-2** | M,H | ACE7.2 |
| | | *sIDHP-1** | L | ACE7.2 |
| | | *sIDHP-2**[1] | L | ACE7.2 |
| L-Lactate dehydrogenase | 1.1.1.27 | *LDHA-1**[1] | M | TBCLE, ACE7.2 |
| | | *LDHA-2** | M | TBCL, ACE7.2 |
| | | *LDHB-1** | E | TBCLE |
| | | *LDHB-2**[1] | E,L | TBCLE TBCL |
| | | *LDHC** | E | TBCLE |
| Malate dehydrogenase | 1.1.1.37 | *sMDH-A1**[1] | L | ACN6 |

Table 4. Continued.

| Enzyme or Protein | Enzyme Number | Locus | Tissue | Buffer |
|---|---|---|---|---|
| | | *sMDH-A2** | L<br>H | ACN6<br>AC5.85 |
| | | *sMDH-B1,2**[1] | H | ACE7.2<br>AC5.85 |
| | | *mMDH-1** | H | ACE7.2<br>AC5.85 |
| Malic enzyme (NADP+) | 1.1.1.40 | *sMEP-1**[1] | M | ACE7.2 |
| | | *mMEP-1** | M | ACE7.2 |
| | | *mMEP-2**[1] | M | ACE7.2 |
| Mannose-6-phosphate isomerase | 5.3.1.8 | *MPI**[1] | H | TBE |
| Dipeptidase | 3.4.-.- | *PEPA**[1] | M,H | TBE |
| Tripeptide aminopeptidase | 3.4.-.- | *PEPB-1**[1] | H | TBE,<br>AC5.85 |
| Proline dipeptidase | 3.4.13.9 | *PEPD** | M | ACE7.2 |
| Peptidase-LT | 3.4.-.- | *PEP-LT** | L | ACE7.2 |
| Phosphogluconate dehydrogenase | 1.1.1.44 | *PGDH**[1] | H,L | ACE7.2 |
| Phosphoglucomutase | 5.4.2.2 | *PGM-1** | H,M | ACE7.2 |
| | | *PGM-2** | H,M | ACE7.2 |
| Superoxide dismutase | 1.15.1.1 | *sSOD-1** | L | TBCL |
| Triose-phosphate isomerase | 5.3.1.1 | *TPI-1** | E | TBCLE |
| | | *TPI-2** | E | TBCLE |
| | | *TPI-3** | E | TBCLE |
| | | *TPI-4** | E | TBCLE |

[2]*HAGH** and *FDGH** (Formaldehyde dehydrogenase, E.C. 1.2.1.1) appear to be identical.

Table 5. Heterogeneity statistics comparing multiple year samples. Loci incorporated in the mixture model were used for this analysis.

| Population | G-Statistic | df | P |
|---|---|---|---|
| Sikusuilaq Hatchery 1991, 1993 | 17.68 | 20 | 0.6086 |
| Snake River River 1992, 1993 | 26.98 | 18 | 0.0793 |
| Nome River 1991 1992, 1993 | 59.32 | 40 | 0.0251 |
| Beaver Creek 1992, 1993 | 28.52 | 20 | 0.0976 |
| Swift River 1992, 1993 | 24.01 | 23 | 0.4032 |
| Toklat River 1991, 1992 | 18.54 | 18 | 0.4208 |
| Delta River 1991, 1992 | 15.62 | 16 | 0.4798 |
| Tanana River Mainstem 1992, 1993 | 17.65 | 17 | 0.4111 |
| Sheenjek River 1992, 1993 | 20.22 | 16 | 0.2103 |
| Togiak River 1993, 1994 | 36.63 | 23 | 0.0355 |
| Upper Nushagak River 1992, 1993 | 20.33 | 22 | 0.5622 |
| Stuyahok River 1992, 1993 | 28.58 | 20 | 0.0963 |
| Meshik River 1992, 1993 | 31.21 | 19 | 0.0383 |

Table 6. Hierarchial G-statistic analysis for Alaska chum salmon.

| Source of Variation | DF | *ALAT* | DF | *mAAT1* | DF | *mAH3* | DF | *sAAT1,2* | DF | *ESTD* | DF | *G3PDH2* | DF | *GPIB1,2* | DF | *GPIA* | DF | *mIDHP1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Among Regions | 3 | 197.8 | 6 | 735.4 | 3 | 550.9 | 6 | 214.8 | 3 | 3272.3 | 3 | 39.1 | 6 | 58.6 | 6 | 7.2 | 3 | 331.7 |
| Within Regions | 58 | 200.1 | 116 | 389.0 | 58 | 314.0 | 116 | 300.7 | 58 | 291.7 | 58 | 249.2 | 116 | 59.5 | 116 | 62.5 | 58 | 316.6 |
| NW Alaska | 36 | 76.6 | 72 | 188.4 | 36 | 184.3 | 72 | 138.0 | 36 | 155.1 | 36 | 171.3 | 72 | 17.1 | 72 | 31.8 | 36 | 161.8 |
| Among | 6 | 49.9 | 12 | 114.4 | 6 | 90.4 | 12 | 69.4 | 6 | 98.0 | 6 | 100.6 | 12 | 8.2 | 12 | 19.1 | 6 | 85.2 |
| Within | 30 | 26.7 | 60 | 74.1 | 30 | 93.9 | 60 | 68.6 | 30 | 57.2 | 30 | 70.6 | 60 | 8.9 | 60 | 12.7 | 30 | 76.5 |
| Kotzebue | 3 | 4.3 | 6 | 11.6 | 3 | 13.7 | 6 | 12.4 | 3 | 1.7 | 3 | 2.0 | 6 | 0.0 | 6 | 0.0 | 3 | 19.3 |
| Among ( + Kelly, Salmon) | 2 | 3.9 | 4 | 10.7 | 2 | 12.9 | 4 | 11.6 | 2 | 1.1 | 2 | 2.0 | 4 | 0.0 | 4 | 0.0 | 2 | 12.4 |
| Within (Noatak River) | 1 | 0.5 | 2 | 0.9 | 1 | 0.8 | 2 | 0.8 | 1 | 0.6 | 1 | 0.0 | 2 | 0.0 | 2 | 0.0 | 1 | 6.9 |
| Norton Sound | 5 | 3.8 | 10 | 17.1 | 5 | 9.5 | 10 | 4.5 | 5 | 13.5 | 5 | 14.4 | 10 | 0.0 | 10 | 3.4 | 5 | 11.3 |
| Among ( + Pilgrim) | 1 | 0.2 | 2 | 2.8 | 1 | 0.1 | 2 | 1.5 | 1 | 0.0 | 1 | 11.0 | 2 | 0.0 | 2 | 0.4 | 1 | 9.3 |
| Within (Snake/Nome/Kwiniuk/Fish/Unalakleet.) | 4 | 3.6 | 8 | 14.3 | 4 | 9.5 | 8 | 3.0 | 4 | 13.5 | 4 | 3.4 | 8 | 0.0 | 8 | 3.1 | 4 | 2.0 |
| Lower Yukon/Kuskokwim | 12 | 8.0 | 24 | 25.0 | 12 | 12.5 | 24 | 26.3 | 12 | 13.6 | 12 | 19.9 | 24 | 6.8 | 24 | 6.1 | 12 | 9.3 |
| Among | 1 | 0.1 | 2 | 0.4 | 1 | 0.5 | 2 | 3.2 | 1 | 1.6 | 1 | 2.1 | 2 | 1.6 | 2 | 2.2 | 1 | 0.1 |
| Within | 11 | 8.0 | 22 | 24.6 | 11 | 12.0 | 22 | 23.1 | 11 | 12.0 | 11 | 17.7 | 22 | 5.2 | 22 | 3.9 | 11 | 9.2 |
| Lower Yukon | 7 | 5.5 | 14 | 15.1 | 7 | 7.5 | 14 | 6.5 | 7 | 5.3 | 7 | 13.0 | 14 | 5.2 | 14 | 0.0 | 7 | 5.3 |
| Kuskokwim River | 4 | 2.5 | 8 | 9.4 | 4 | 4.5 | 8 | 16.6 | 4 | 6.7 | 4 | 4.8 | 8 | 0.0 | 8 | 3.9 | 4 | 3.9 |
| Yukon Summer (Chena, Salcha) | 1 | 2.7 | 2 | 2.9 | 1 | 0.3 | 2 | 0.1 | 1 | 0.7 | 1 | 9.0 | 2 | 0.0 | 2 | 0.0 | 1 | 11.0 |
| Kanektok/ Goodnews/Togiak | 2 | 0.5 | 4 | 5.0 | 2 | 1.1 | 4 | 5.1 | 2 | 4.5 | 2 | 2.9 | 4 | 2.1 | 4 | 3.2 | 2 | 0.0 |
| Bristol Bay | 7 | 7.4 | 14 | 12.5 | 7 | 56.9 | 14 | 20.3 | 7 | 23.1 | 7 | 22.5 | 14 | 0.0 | 14 | 0.0 | 7 | 25.6 |
| Among ( + Meshik) | 3 | 3.4 | 6 | 8.3 | 3 | 55.3 | 6 | 11.4 | 3 | 15.2 | 3 | 18.1 | 6 | 0.0 | 6 | 0.0 | 3 | 19.8 |
| Within | 4 | 4.0 | 8 | 4.2 | 4 | 1.5 | 8 | 9.0 | 4 | 8.0 | 4 | 4.4 | 8 | 0.0 | 8 | 0.0 | 4 | 5.8 |
| Nushagak | 2 | 0.9 | 4 | 2.5 | 2 | 1.0 | 4 | 6.9 | 2 | 1.5 | 2 | 2.0 | 4 | 0.0 | 4 | 0.0 | 2 | 3.7 |
| Naknek/Alagnak | 1 | 3.1 | 2 | 0.3 | 1 | 0.2 | 2 | 0.8 | 1 | 6.2 | 1 | 1.2 | 2 | 0.0 | 2 | 0.0 | 1 | 0.0 |
| Egegik/Ugashik Bay | 1 | 0.1 | 2 | 1.4 | 1 | 0.3 | 2 | 1.2 | 1 | 0.3 | 1 | 1.2 | 2 | 0.0 | 2 | 0.0 | 1 | 2.1 |
| Yukon Fall | 4 | 19.6 | 8 | 11.8 | 4 | 50.3 | 8 | 11.2 | 4 | 12.2 | 4 | 4.5 | 8 | 0.0 | 8 | 0.0 | 4 | 16.8 |
| Among ( +Toklat, Sheenjek) | 2 | 10.1 | 4 | 11.5 | 2 | 48.5 | 4 | 6.1 | 2 | 11.8 | 2 | 1.5 | 4 | 0.0 | 4 | 0.0 | 2 | 16.3 |
| Within (Tanana Fall Run) | 2 | 9.6 | 4 | 0.2 | 2 | 1.8 | 4 | 5.1 | 2 | 0.4 | 2 | 3.0 | 4 | 0.0 | 4 | 0.0 | 2 | 0.5 |
| Peninsula/Kodiak | 18 | 103.9 | 36 | 188.8 | 18 | 79.4 | 36 | 151.5 | 18 | 124.4 | 18 | 73.5 | 36 | 42.3 | 36 | 30.8 | 18 | 138.0 |
| Among | 3 | 50.8 | 6 | 82.8 | 3 | 29.7 | 6 | 75.8 | 3 | 46.0 | 3 | 29.9 | 6 | 21.7 | 6 | 19.9 | 3 | 28.8 |
| Within | 15 | 53.2 | 30 | 106.0 | 15 | 49.6 | 30 | 75.7 | 15 | 78.5 | 15 | 43.6 | 30 | 20.6 | 30 | 10.9 | 15 | 109.2 |
| N. Peninsula | 5 | 10.7 | 10 | 24.3 | 5 | 8.5 | 10 | 21.4 | 5 | 31.0 | 5 | 29.8 | 10 | 4.5 | 10 | 4.9 | 5 | 22.8 |
| Among ( + Lawr., Joshua, Traders, Peterson) | 4 | 9.8 | 8 | 23.0 | 4 | 7.4 | 8 | 17.6 | 4 | 30.3 | 4 | 29.8 | 8 | 2.8 | 8 | 3.3 | 4 | 20.6 |
| Within (Frosty/St. Catherine's) | 1 | 0.9 | 2 | 1.3 | 1 | 1.2 | 2 | 3.8 | 1 | 0.7 | 1 | 0.1 | 2 | 1.6 | 2 | 1.7 | 1 | 2.2 |
| S. Peninsula | 4 | 15.8 | 8 | 18.2 | 4 | 7.7 | 8 | 28.8 | 4 | 5.2 | 4 | 1.5 | 8 | 7.3 | 8 | 0.0 | 4 | 12.0 |
| Among ( + Stepovak) | 2 | 4.7 | 4 | 11.5 | 2 | 5.5 | 4 | 20.4 | 2 | 5.1 | 2 | 0.2 | 4 | 5.3 | 4 | 0.0 | 2 | 7.6 |
| Within | 2 | 11.1 | 4 | 6.7 | 2 | 2.2 | 4 | 8.4 | 2 | 0.1 | 2 | 1.3 | 4 | 2.0 | 4 | 0.0 | 2 | 4.4 |
| Little John/Russell | 1 | 0.8 | 2 | 6.4 | 1 | 0.0 | 2 | 6.1 | 1 | 0.0 | 1 | 0.1 | 2 | 1.7 | 2 | 0.0 | 1 | 0.2 |
| Belkofski/Canoe | 1 | 10.3 | 2 | 0.3 | 1 | 2.2 | 2 | 2.3 | 1 | 0.1 | 1 | 1.1 | 2 | 0.3 | 2 | 0.0 | 1 | 4.2 |
| Chignik/Mainland | 4 | 4.4 | 8 | 39.4 | 4 | 5.4 | 8 | 18.7 | 4 | 6.7 | 4 | 4.1 | 8 | 5.5 | 8 | 0.0 | 4 | 10.8 |
| Among ( + Big) | 2 | 3.0 | 4 | 31.4 | 2 | 4.5 | 4 | 5.8 | 2 | 5.3 | 2 | 2.2 | 4 | 1.5 | 4 | 0.0 | 2 | 2.8 |
| Within (Chiginagak/Wide Bay/Alagogshak) | 2 | 1.4 | 4 | 8.0 | 2 | 0.9 | 4 | 12.9 | 2 | 1.4 | 2 | 2.0 | 4 | 4.0 | 4 | 0.0 | 2 | 8.0 |
| Kodiak | 2 | 22.2 | 4 | 24.1 | 2 | 28.0 | 4 | 6.7 | 2 | 35.6 | 2 | 8.1 | 4 | 3.4 | 4 | 5.9 | 2 | 63.7 |
| Total | 61 | 397.9 | 122 | 1124.4 | 61 | 864.9 | 122 | 515.49 | 61 | 3564 | 61 | 288.34 | 122 | 118.08 | 122 | 69.68 | 61 | 648.3 |

Table 6. Continued.

| Source of Variation | DF | *sIDHP2* | DF | *LDHA1* | DF | *LDHB2* | DF | *MPI* | DF | *sMDHA1* | DF | *sMDHB1,2* | DF | *sMEP1* | DF | *mMEP2* | DF | *PEPA* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Among Regions | 12 | 1548.9 | 6 | 373.3 | 3 | 2.5 | 6 | 66.1 | 9 | 55.3 | 9 | 305.1 | 3 | 1.0 | 3 | 479.1 | 3 | 15.2 |
| Within Regions | 232 | 686.2 | 116 | 333.9 | 58 | 24.1 | 116 | 229.6 | 174 | 288.4 | 174 | 575.8 | 58 | 7.3 | 58 | 222.4 | 58 | 28.6 |
| NW Alaska | 144 | 369.8 | 72 | 142.2 | 36 | 18.3 | 72 | 101.1 | 108 | 90.9 | 108 | 185.0 | 36 | 7.3 | 36 | 155.0 | 36 | 28.6 |
| Among | 24 | 189.5 | 12 | 44.3 | 6 | 5.7 | 12 | 47.8 | 18 | 30.2 | 18 | 72.4 | 6 | 3.1 | 6 | 95.6 | 6 | 8.2 |
| Within | 120 | 180.2 | 60 | 97.9 | 30 | 12.6 | 60 | 53.3 | 90 | 60.6 | 90 | 112.6 | 30 | 4.1 | 30 | 59.3 | 30 | 20.3 |
| Kotzebue | 12 | 22.2 | 6 | 29.5 | 3 | 2.3 | 6 | 7.4 | 9 | 14.7 | 9 | 3.2 | 3 | 0.0 | 3 | 10.6 | 3 | 2.3 |
| Among ( + Kelly, Salmon) | 8 | 14.4 | 4 | 29.5 | 2 | 2.0 | 4 | 7.4 | 6 | 13.5 | 6 | 3.2 | 2 | 0.0 | 2 | 5.2 | 2 | 1.5 |
| Within (Noatak River) | 4 | 7.8 | 2 | 0.1 | 1 | 0.3 | 2 | 0.1 | 3 | 1.2 | 3 | 0.0 | 1 | 0.0 | 1 | 5.3 | 1 | 0.8 |
| Norton Sound | 20 | 18.2 | 10 | 8.1 | 5 | 3.6 | 10 | 3.2 | 15 | 11.4 | 15 | 23.1 | 5 | 0.0 | 5 | 4.2 | 5 | 3.4 |
| Among ( + Pilgrim) | 4 | 2.6 | 2 | 0.0 | 1 | 0.3 | 2 | 0.2 | 3 | 1.4 | 3 | 7.0 | 1 | 0.0 | 1 | 0.1 | 1 | 0.4 |
| Within (Snake/Nome/Kwiniuk/Fish/Unalakleet.) | 16 | 15.5 | 8 | 8.1 | 4 | 3.3 | 8 | 2.9 | 12 | 9.9 | 12 | 16.0 | 4 | 0.0 | 4 | 4.2 | 4 | 3.1 |
| Lower Yukon/Kuskokwim | 48 | 53.5 | 24 | 13.4 | 12 | 6.8 | 24 | 10.2 | 36 | 21.2 | 36 | 31.9 | 12 | 0.0 | 12 | 25.4 | 12 | 8.9 |
| Among | 4 | 2.2 | 2 | 0.7 | 1 | 1.6 | 2 | 0.3 | 3 | 0.6 | 3 | 2.5 | 1 | 0.0 | 1 | 10.9 | 1 | 2.9 |
| Within | 44 | 51.3 | 22 | 12.6 | 11 | 5.2 | 22 | 9.8 | 33 | 20.6 | 33 | 29.4 | 11 | 0.0 | 11 | 14.4 | 11 | 6.1 |
| Lower Yukon | 28 | 39.1 | 14 | 8.6 | 7 | 5.2 | 14 | 8.9 | 21 | 13.6 | 21 | 22.4 | 7 | 0.0 | 7 | 11.9 | 7 | 2.9 |
| Kuskokwim River | 16 | 12.2 | 8 | 4.1 | 4 | 0.0 | 8 | 0.9 | 12 | 7.0 | 12 | 7.0 | 4 | 0.0 | 4 | 2.5 | 4 | 3.2 |
| Yukon Summer (Chena, Salcha) | 4 | 0.1 | 2 | 0.1 | 1 | 0.0 | 2 | 1.4 | 3 | 3.6 | 3 | 0.0 | 1 | 0.0 | 1 | 0.8 | 1 | 0.0 |
| Kanektok/ Goodnews/Togiak | 8 | 1.8 | 4 | 5.3 | 2 | 0.0 | 4 | 4.0 | 6 | 0.1 | 6 | 6.8 | 2 | 0.0 | 2 | 10.6 | 2 | 0.0 |
| Bristol Bay | 28 | 84.6 | 14 | 41.5 | 7 | 0.0 | 14 | 27.1 | 21 | 9.6 | 21 | 47.7 | 7 | 4.1 | 7 | 7.8 | 7 | 5.7 |
| Among ( + Meshik) | 12 | 68.6 | 6 | 36.9 | 3 | 0.0 | 6 | 26.3 | 9 | 4.3 | 9 | 27.7 | 3 | 2.1 | 3 | 5.0 | 3 | 4.2 |
| Within | 16 | 16.0 | 8 | 4.6 | 4 | 0.0 | 8 | 0.8 | 12 | 5.3 | 12 | 20.0 | 4 | 2.0 | 4 | 2.8 | 4 | 1.5 |
| Nushagak | 8 | 4.7 | 4 | 0.1 | 2 | 0.0 | 4 | 0.2 | 6 | 1.6 | 6 | 5.9 | 2 | 2.0 | 2 | 2.1 | 2 | 1.5 |
| Naknek/Alagnak | 4 | 3.5 | 2 | 4.1 | 1 | 0.0 | 2 | 0.6 | 3 | 0.5 | 3 | 4.2 | 1 | 0.0 | 1 | 0.7 | 1 | 0.0 |
| Egegik/Ugashik Bay | 4 | 7.8 | 2 | 0.4 | 1 | 0.0 | 2 | 0.0 | 3 | 3.3 | 3 | 9.9 | 1 | 0.0 | 1 | 0.1 | 1 | 0.0 |
| Yukon Fall | 16 | 27.3 | 8 | 3.0 | 4 | 0.0 | 8 | 19.9 | 12 | 16.2 | 12 | 3.0 | 4 | 0.0 | 4 | 7.5 | 4 | 0.0 |
| Among ( +Toklat, Sheenjek) | 8 | 24.7 | 4 | 1.2 | 2 | 0.0 | 4 | 15.1 | 6 | 14.2 | 6 | 1.2 | 2 | 0.0 | 2 | 3.7 | 2 | 0.0 |
| Within (Tanana Fall Run) | 8 | 2.6 | 4 | 1.8 | 2 | 0.0 | 4 | 4.8 | 6 | 2.1 | 6 | 1.9 | 2 | 0.0 | 2 | 3.8 | 2 | 0.0 |
| Peninsula/Kodiak | 72 | 289.1 | 36 | 188.7 | 18 | 5.8 | 36 | 108.6 | 54 | 181.3 | 54 | 387.8 | 18 | 0.0 | 18 | 59.9 | 18 | 0.0 |
| Among | 12 | 114.6 | 6 | 76.9 | 3 | 2.6 | 6 | 34.0 | 9 | 78.0 | 9 | 176.3 | 3 | 0.0 | 3 | 37.5 | 3 | 0.0 |
| Within | 60 | 174.5 | 30 | 111.8 | 15 | 3.2 | 30 | 74.6 | 45 | 103.3 | 45 | 211.5 | 15 | 0.0 | 15 | 22.4 | 15 | 0.0 |
| N. Peninsula | 20 | 65.7 | 10 | 81.1 | 5 | 0.0 | 10 | 4.8 | 15 | 16.9 | 15 | 50.6 | 5 | 0.0 | 5 | 6.2 | 5 | 0.0 |
| Among ( + Lawr., Joshua, Traders, Peterson) | 16 | 61.7 | 8 | 76.6 | 4 | 0.0 | 8 | 3.8 | 12 | 15.0 | 12 | 48.2 | 4 | 0.0 | 4 | 5.6 | 4 | 0.0 |
| Within (Frosty/St. Catherine's) | 4 | 4.0 | 2 | 4.5 | 1 | 0.0 | 2 | 1.0 | 3 | 1.9 | 3 | 2.4 | 1 | 0.0 | 1 | 0.5 | 1 | 0.0 |
| S. Peninsula | 16 | 38.3 | 8 | 21.7 | 4 | 0.0 | 8 | 7.6 | 12 | 14.0 | 12 | 16.3 | 4 | 0.0 | 4 | 5.2 | 4 | 0.0 |
| Among ( + Stepovak) | 8 | 30.8 | 4 | 20.5 | 2 | 0.0 | 4 | 7.4 | 6 | 7.4 | 6 | 10.0 | 2 | 0.0 | 2 | 4.9 | 2 | 0.0 |
| Within | 8 | 7.4 | 4 | 1.1 | 2 | 0.0 | 4 | 0.2 | 6 | 6.6 | 6 | 6.3 | 2 | 0.0 | 2 | 0.2 | 2 | 0.0 |
| Little John/Russell | 4 | 4.4 | 2 | 1.0 | 1 | 0.0 | 2 | 0.1 | 3 | 2.0 | 3 | 2.0 | 1 | 0.0 | 1 | 0.0 | 1 | 0.0 |
| Belkofski/Canoe | 4 | 3.1 | 2 | 0.1 | 1 | 0.0 | 2 | 0.1 | 3 | 4.6 | 3 | 4.3 | 1 | 0.0 | 1 | 0.2 | 1 | 0.0 |
| Chignik/Mainland | 16 | 16.9 | 8 | 2.0 | 4 | 3.2 | 8 | 26.8 | 12 | 15.2 | 12 | 28.4 | 4 | 0.0 | 4 | 4.8 | 4 | 0.0 |
| Among ( + Big) | 8 | 7.5 | 4 | 0.5 | 2 | 1.1 | 4 | 22.5 | 6 | 14.4 | 6 | 25.9 | 2 | 0.0 | 2 | 3.3 | 2 | 0.0 |
| Within (Chiginagak/Wide Bay/Alagogshak) | 8 | 9.4 | 4 | 1.6 | 2 | 2.1 | 4 | 4.3 | 6 | 0.7 | 6 | 2.5 | 2 | 0.0 | 2 | 1.4 | 2 | 0.0 |
| Kodiak | 8 | 53.7 | 4 | 7.0 | 2 | 0.0 | 4 | 35.3 | 6 | 57.2 | 6 | 116.2 | 2 | 0.0 | 2 | 6.2 | 2 | 0.0 |
| Total | 244 | 2235.1 | 122 | 707.28 | 61 | 26.57 | 122 | 295.72 | 183 | 343.7 | 183 | 880.88 | 61 | 8.29 | 61 | 701.49 | 61 | 43.82 |

Table 6. Continued.

| Source of Variation | DF | *PEPB1* | DF | *PGDH* | Overall Chi-Squared | DF | P-Value |
|---|---|---|---|---|---|---|---|
| Among Regions | 12 | 346.9 | 3 | 134.3 | 8669.5 | 108 | 0.000 |
| Within Regions | 232 | 395.3 | 58 | 126.4 | 4871.6 | 2088 | 0.000 |
| NW Alaska | 144 | 213.7 | 36 | 68.8 | 2505.0 | 1296 | 0.000 |
| Among | 24 | 81.3 | 6 | 30.2 | 1243.0 | 216 | 0.000 |
| Within | 120 | 132.4 | 30 | 38.6 | 1207.7 | 1080 | 0.004 |
| Kotzebue | 12 | 41.7 | 3 | 2.0 | 200.8 | 108 | 0.000 |
| Among ( + Kelly, Salmon) | 8 | 41.4 | 2 | 2.0 | 174.6 | 72 | 0.000 |
| Within (Noatak River) | 4 | 0.3 | 1 | 0.0 | 26.2 | 36 | 0.886 |
| Norton Sound | 20 | 8.9 | 5 | 13.0 | 174.5 | 180 | 0.602 |
| Among ( + Pilgrim) | 4 | 0.2 | 1 | 0.4 | 38.0 | 36 | 0.378 |
| Within (Snake/Nome/Kwiniuk/Fish/Unalakleet.) | 16 | 8.7 | 4 | 12.6 | 136.5 | 144 | 0.659 |
| Lower Yukon/Kuskokwim | 48 | 33.5 | 12 | 14.5 | 346.6 | 432 | 0.999 |
| Among | 4 | 0.7 | 1 | 1.5 | 35.5 | 36 | 0.491 |
| Within | 44 | 32.9 | 11 | 13.1 | 301.1 | 396 | 1.000 |
| Lower Yukon | 28 | 22.4 | 7 | 5.4 | 203.8 | 252 | 0.989 |
| Kuskokwim River | 16 | 10.5 | 4 | 7.6 | 107.3 | 144 | 0.990 |
| Yukon Summer (Chena, Salcha) | 4 | 11.1 | 1 | 0.0 | 43.8 | 36 | 0.173 |
| Kanektok/ Goodnews/Togiak | 8 | 2.6 | 2 | 0.7 | 56.2 | 72 | 0.915 |
| Bristol Bay | 28 | 34.5 | 7 | 8.4 | 439.4 | 252 | 0.000 |
| Among ( + Meshik) | 12 | 22.4 | 3 | 6.2 | 335.1 | 108 | 0.000 |
| Within | 16 | 12.1 | 4 | 2.2 | 103.3 | 144 | 0.996 |
| Nushagak | 8 | 4.7 | 2 | 1.3 | 42.5 | 72 | 0.998 |
| Naknek/Alagnak | 4 | 2.5 | 1 | 0.0 | 27.8 | 36 | 0.833 |
| Egegik/Ugashik Bay | 4 | 4.9 | 1 | 1.0 | 34.0 | 36 | 0.565 |
| Yukon Fall | 16 | 12.0 | 4 | 12.8 | 228.1 | 144 | 0.000 |
| Among ( +Toklat, Sheenjek) | 8 | 10.1 | 2 | 11.8 | 187.8 | 72 | 0.000 |
| Within (Tanana Fall Run) | 8 | 1.9 | 2 | 0.9 | 40.3 | 72 | 0.999 |
| Peninsula/Kodiak | 72 | 169.6 | 18 | 44.8 | 2368.0 | 648 | 0.000 |
| Among | 12 | 35.1 | 3 | 12.8 | 953.2 | 108 | 0.000 |
| Within | 60 | 134.4 | 15 | 32.1 | 1340.2 | 540 | 0.000 |
| N. Peninsula | 20 | 59.6 | 5 | 10.5 | 453.3 | 180 | 0.000 |
| Among ( + Lawr., Joshua, Traders, Peterson) | 16 | 58.3 | 4 | 5.6 | 419.3 | 144 | 0.000 |
| Within (Frosty/St. Catherine's) | 4 | 1.3 | 1 | 4.9 | 34.0 | 36 | 0.562 |
| S. Peninsula | 16 | 17.7 | 4 | 9.4 | 226.6 | 144 | 0.000 |
| Among ( + Stepovak) | 8 | 10.6 | 2 | 5.5 | 157.5 | 72 | 0.000 |
| Within | 8 | 7.1 | 2 | 3.8 | 68.7 | 72 | 0.587 |
| Little John/Russell | 4 | 3.2 | 1 | 0.0 | 28.1 | 36 | 0.825 |
| Belkofski/Canoe | 4 | 4.0 | 1 | 3.8 | 41.0 | 36 | 0.261 |
| Chignik/Mainland | 16 | 19.6 | 4 | 4.5 | 216.5 | 144 | 0.000 |
| Among ( + Big) | 8 | 12.6 | 2 | 1.8 | 146.2 | 72 | 0.000 |
| Within (Chiginagak/Wide Bay/Alagogshak) | 8 | 7.0 | 2 | 2.7 | 70.2 | 72 | 0.537 |
| Kodiak | 8 | 37.6 | 2 | 7.7 | 518.5 | 72 | 0.000 |
| Total | 244 | 742.21 | 61 | 260.72 | | | |

Table 7. Mean estimated contribution for 100 simulations where each region comprises 100% of the mixture (N=400)[1]. Shaded cells are correct allocations and should equal 1.000.

| Estimated Region | 100% Simulation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Japan | Russia | NW Alaska Summer | Fall Yukon | Peninsula/ Kodiak | SE Alaska/ PWS | British Columbia | Washington |
| Japan | **0.966** | 0.007 | 0.009 | 0.001 | 0.006 | 0.003 | 0.002 | 0.000 |
| Russia | 0.007 | **0.924** | 0.015 | 0.001 | 0.016 | 0.014 | 0.007 | 0.000 |
| NW Alaska Summer | 0.015 | 0.031 | **0.944** | 0.035 | 0.007 | 0.004 | 0.001 | 0.000 |
| Fall Yukon | 0.002 | 0.002 | 0.027 | **0.962** | 0.000 | 0.001 | 0.000 | 0.000 |
| Peninsula/Kodiak | 0.007 | 0.025 | 0.004 | 0.001 | **0.949** | 0.058 | 0.021 | 0.002 |
| SE Alaska/PWS | 0.002 | 0.005 | 0.000 | 0.000 | 0.009 | **0.831** | 0.052 | 0.004 |
| British Columbia | 0.001 | 0.005 | 0.001 | 0.000 | 0.011 | 0.075 | **0.869** | 0.042 |
| Washington | 0.000 | 0.001 | 0.000 | 0.000 | 0.002 | 0.013 | 0.046 | **0.951** |
| Total | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.999 | 0.998 | 0.999 |

[1]Mean estimates not summing to 1.000 are caused by randomly generated genotypes that cannot be explained by a randomly generated baseline.

Table 8. Estimated contributions of Pacific Rim chum salmon to the South Unimak June fishery in 1993 and 1994. Standard deviations were computed by a parametric bootstrap.

| Year | Sample | Date | N | Japan | | Russia | | Northwest Alaska Summer | | Fall Yukon | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Estimate | S.D. | Estimate | S.D. | Estimate | S.D. | Estimate | S.D. |
| 1993 | 1 | June 13-20 | 399 | 0.169 | 0.046 | 0.057 | 0.072 | 0.621 | 0.101 | 0.000 | 0.011 |
| | 2 | June 22 -29 | 398 | 0.147 | 0.043 | 0.066 | 0.074 | 0.569 | 0.101 | 0.009 | 0.007 |
| 1994 | 1 | June 17-20 | 395 | 0.131 | 0.041 | 0.189 | 0.065 | 0.515 | 0.091 | 0.000 | 0.001 |
| | 2 | June 21-25 | 396 | 0.091 | 0.031 | 0.064 | 0.086 | 0.721 | 0.104 | 0.000 | 0.000 |
| | 3 | June 26-30 | 398 | 0.157 | 0.039 | 0.152 | 0.071 | 0.544 | 0.076 | 0.021 | 0.016 |
| Pooled | 2,3 | June 21-30 | 794 | 0.123 | 0.025 | 0.118 | 0.082 | 0.614 | 0.095 | 0.011 | 0.011 |

| Year | Sample | Date | N | Alaska Peninsula to Kodiak | | Prince William Sd and SE Alaska | | British Columbia | | Washington | | Unknown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Estimate | S.D. | Estimate | S.D. | Estimate | S.D. | Estimate | S.D. | |
| 1993 | 1 | June 13-20 | 399 | 0.042 | 0.028 | 0.064 | 0.048 | 0.035 | 0.018 | 0.009 | 0.010 | 0.003 |
| | 2 | June 22 -29 | 398 | 0.133 | 0.046 | 0.045 | 0.022 | 0.031 | 0.013 | 0.000 | 0.007 | 0.000 |
| 1994 | 1 | June 17-20 | 395 | 0.075 | 0.045 | 0.025 | 0.013 | 0.040 | 0.023 | 0.022 | 0.017 | 0.003 |
| | 2 | June 21-25 | 396 | 0.104 | 0.050 | 0.017 | 0.006 | 0.002 | 0.007 | 0.000 | 0.006 | 0.000 |
| | 3 | June 26-30 | 398 | 0.053 | 0.044 | 0.039 | 0.006 | 0.030 | 0.021 | 0.000 | 0.005 | 0.005 |
| Pooled | 2,3 | June 21-30 | 794 | 0.079 | 0.040 | 0.033 | 0.012 | 0.018 | 0.009 | 0.000 | 0.004 | 0.003 |

Table 9. Haplotype frequencies of *AseI* polymorphisms from the NADH5/6 region of chum salmon mtDNA. a. Results from chum salmon sampled in the 1994 South Unimak June fishery. Fragment lengths in base pairs are given. b. Frequencies from spawning populations are from Park et al. (1993). Results from the South Unimak, Period 2, 1994 fishery are shown. Estimated Japanese component from allozyme data are from Table 8.

a.

| Haplotype | Fragment Size (BP) | Observed (N) | Haplotype Frequency |
|---|---|---|---|
| A | 1400, 1000 | | 0.000 |
| B | 900, 750, 500, 250 | 51 | 0.141 |
| C | 1400, 750, 250 | 309 | 0.854 |
| D | 1650, 750 | 2 | 0.005 |
| Total | | 362 | 1.000 |

b.

| Source | N | Haplotype Frequencies | | Estimated Japanese Component | |
|---|---|---|---|---|---|
| | | A,C,D | B | mtDNA | Allozyme |
| Spawning populations | | | | | |
| Japan | 254 | 0.20 | 0.80 | | |
| Other | | | | | |
| Russia | 153 | 0.87 | 0.13 | | |
| NW Alaska | 132 | 0.93 | 0.07 | | |
| British Columbia, Washington | 259 | 1.00 | 0.00 | | |
| Mean (other) | 544 | 0.93 | 0.07 | | |
| Fishery sampling | | | | | |
| Unimak, 1994-Period 2 | 365 | 0.86 | 0.14 | 0.095 | 0.091 |

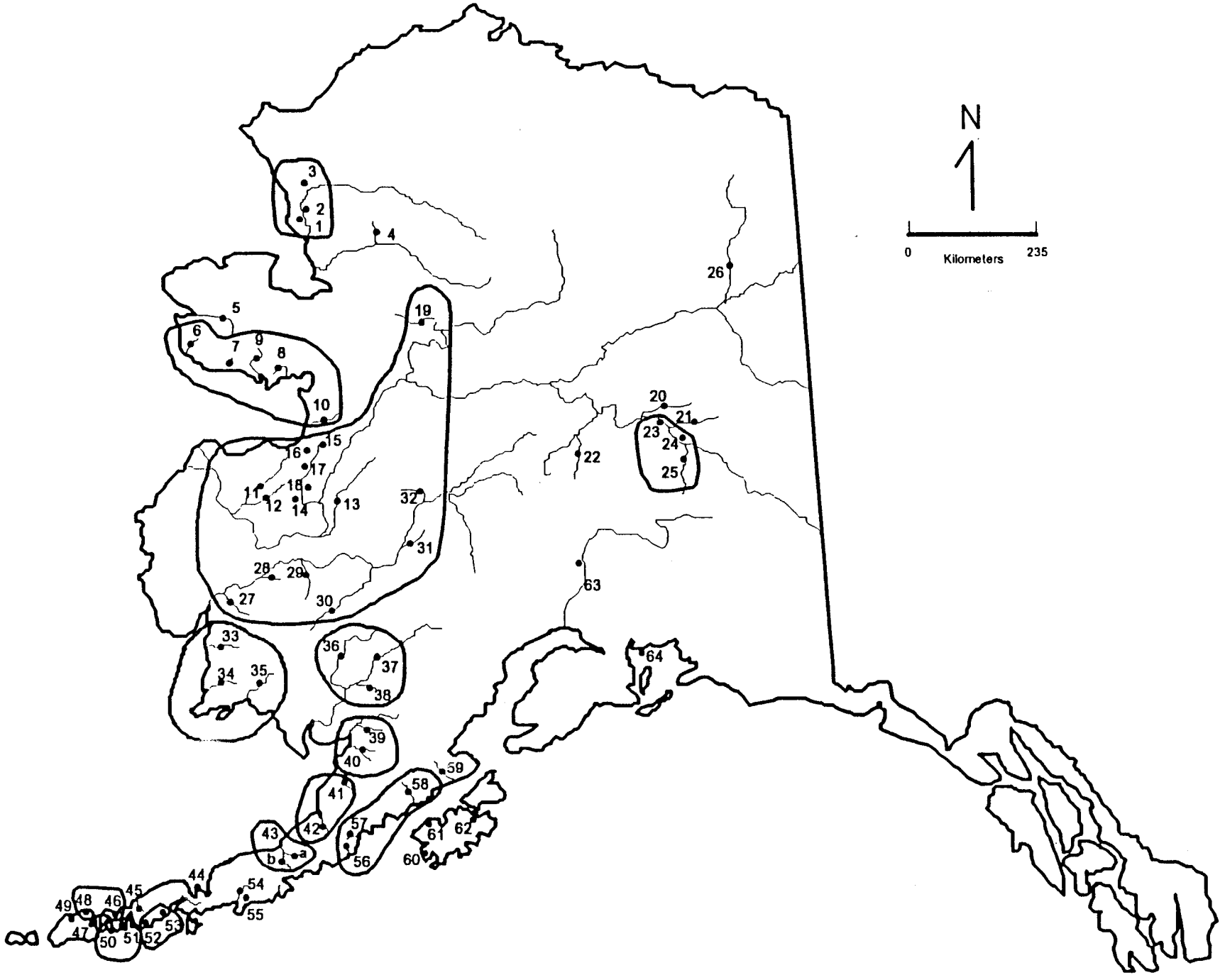



Figure 1. Sampling locations of Alaskan populations included in Pacific Rim baseline for chum salmon. Numbers correspond to population names in Table 1. Populations that could be pooled (see Table 6 for heterogeneity statistics) are circled.

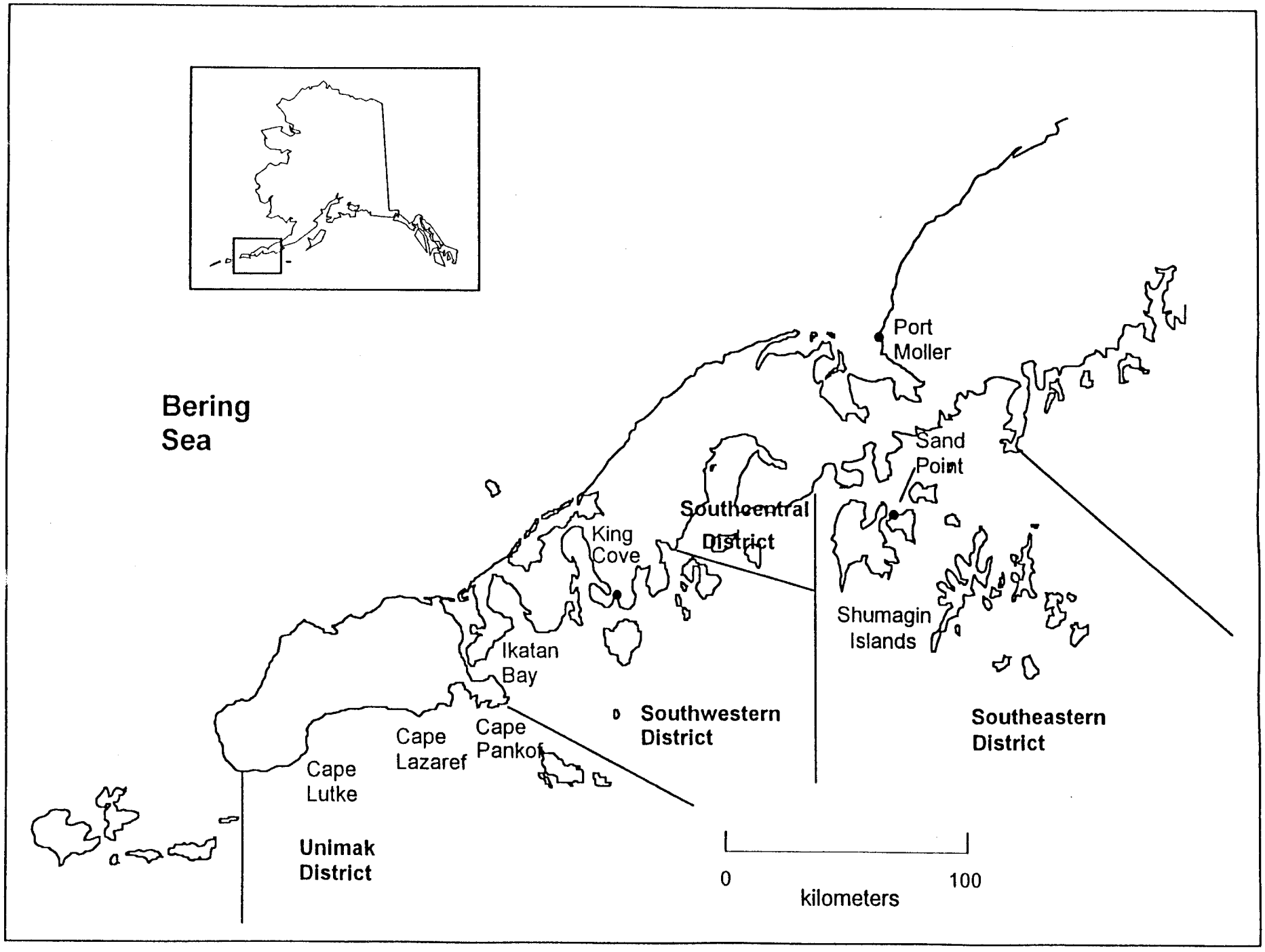



Figure 2. Map of south Alaska Peninsula fishery management districts.

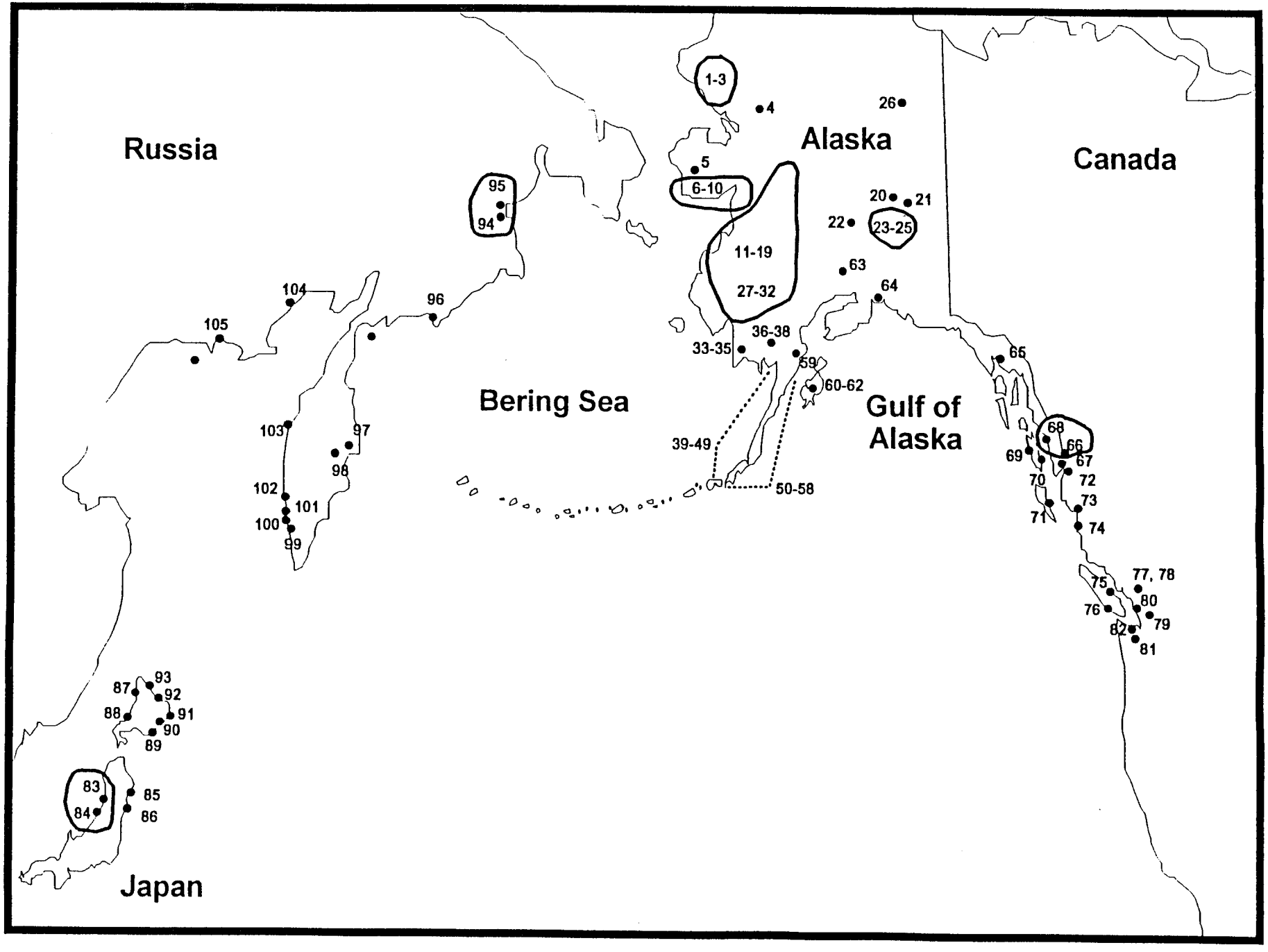



Figure 3. Sampling locations of chum salmon populations included in Pacific Rim baseline. Population numbers correspond to numbers in Table 1.

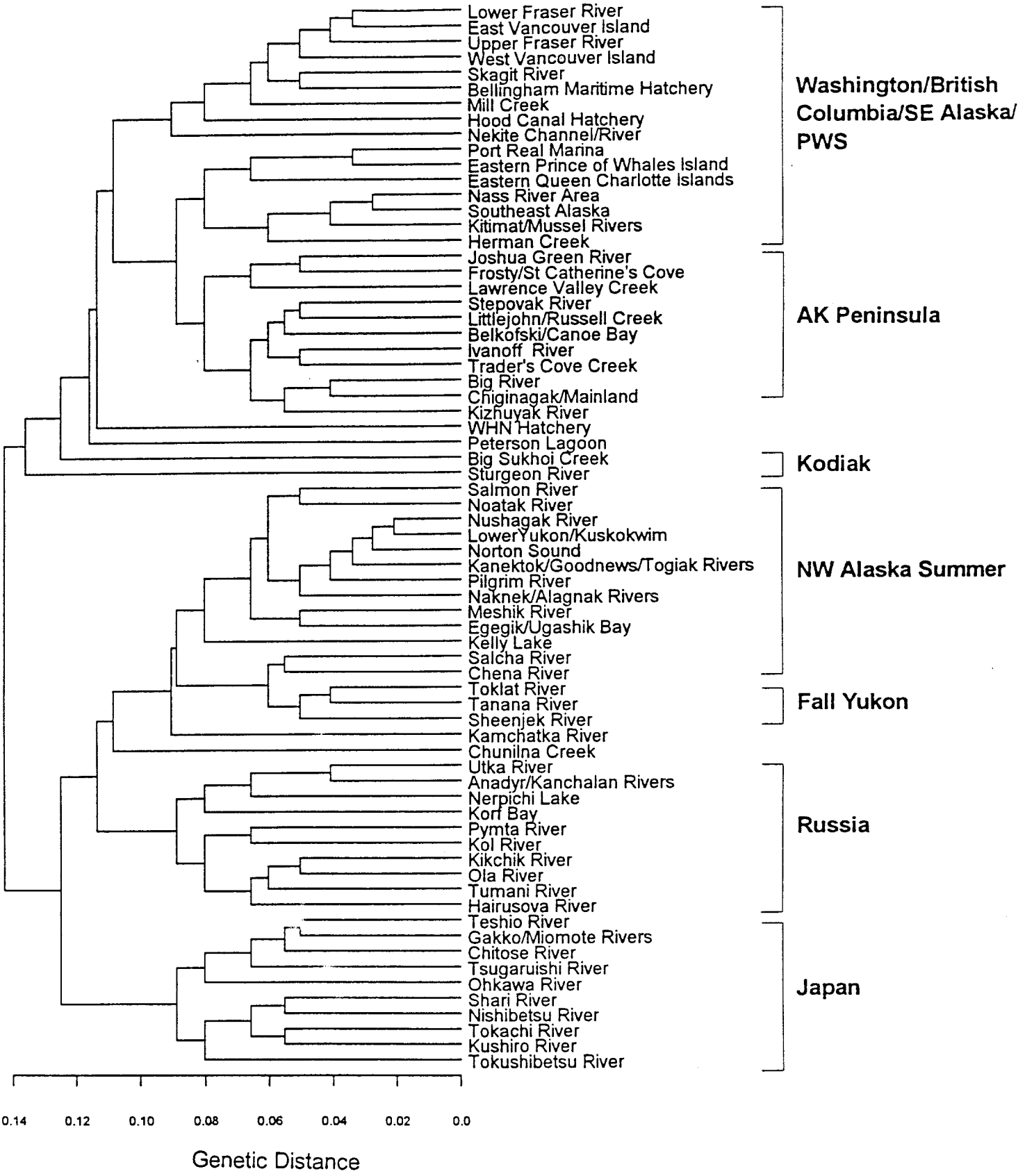



Figure 4. UPGMA phenogram showing genetic relationships among stock groupings of chum salmon around the Pacific Rim. Cavalli-Sforza and Edwards distances (1967) used to construct the tree are calculated from allele frequencies of the 20 loci used in the mixture model.

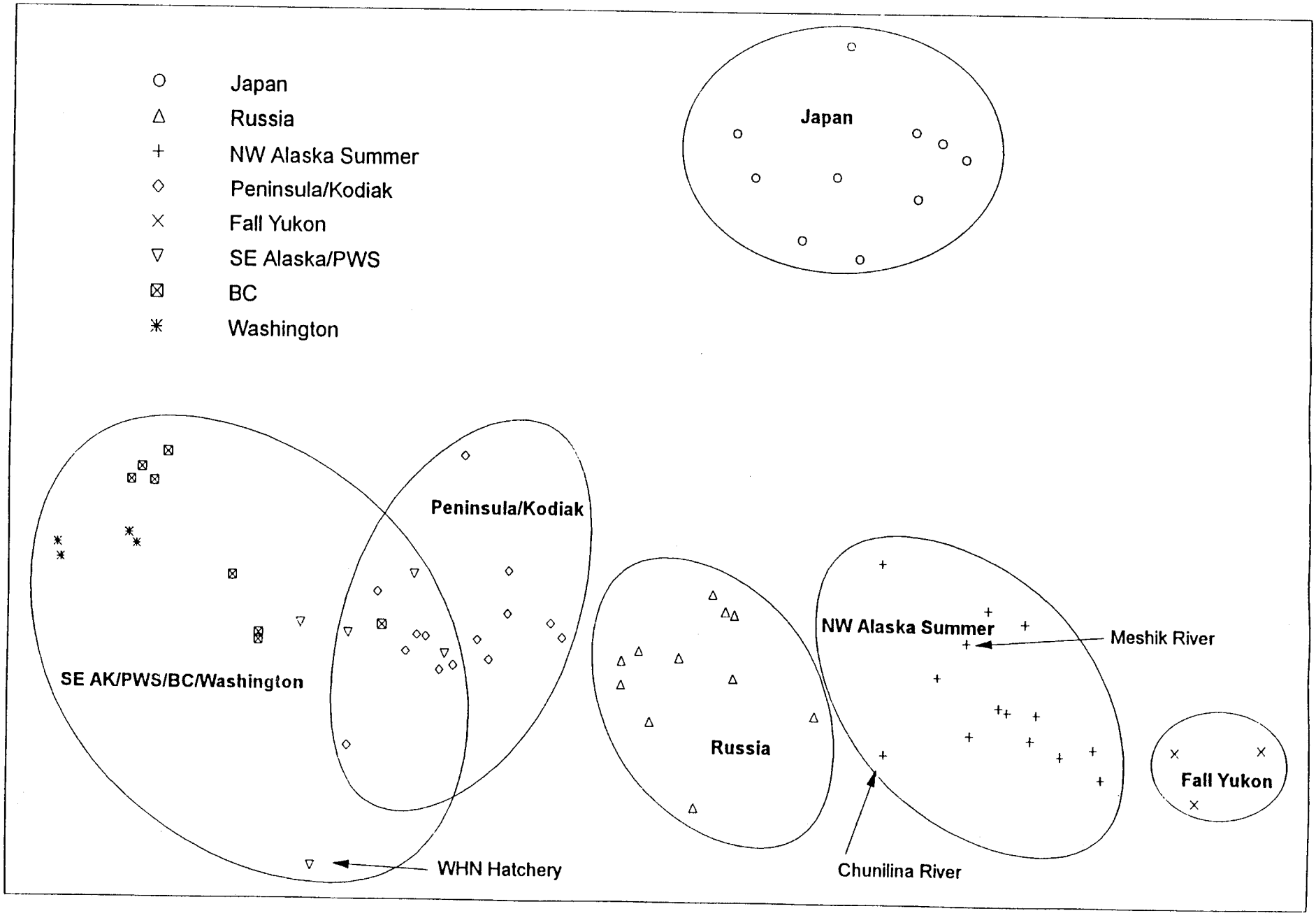



Figure 5. Multidimensional scaling plot of Pacific Rim chum salmon. Japan, Russia, NW Alaska Summer, and Fall Yukon chum salmon are clearly defined groups.

# Design Points

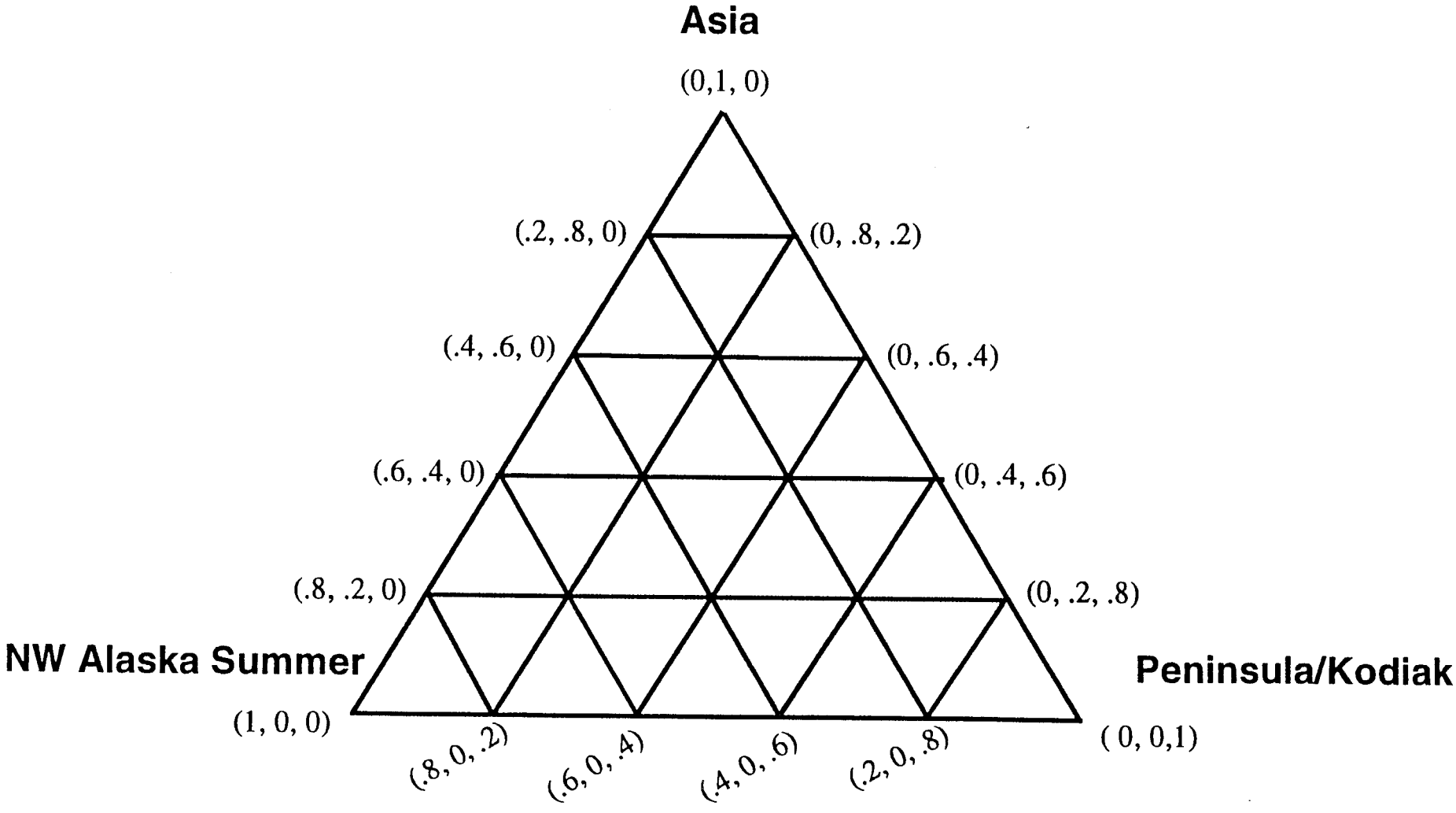



Figure 6. Simulation design for mixtures of Asian, Northwest Alaska summer, and Alaska Peninsula/Kodiak Island chum salmon.

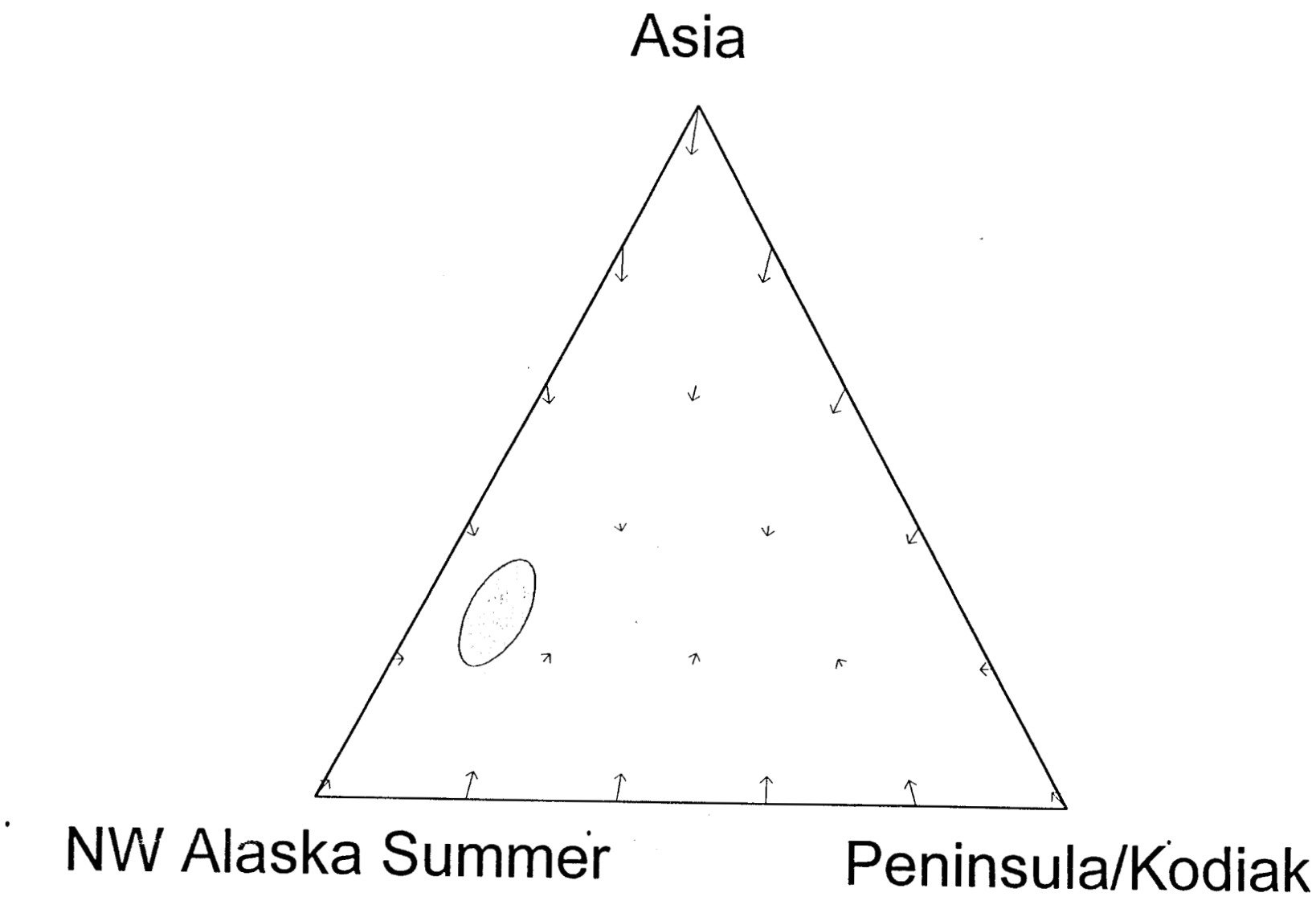



Figure 7. Vector plot of the difference between the true mixture and the mean of 100 fishery estimates from 21 simulated mixtures shown in Figure 6. The length and direction of each vector show the magnitued and direction of the bias. The shaded region shows approximately where the estimated mixture contributions lie.

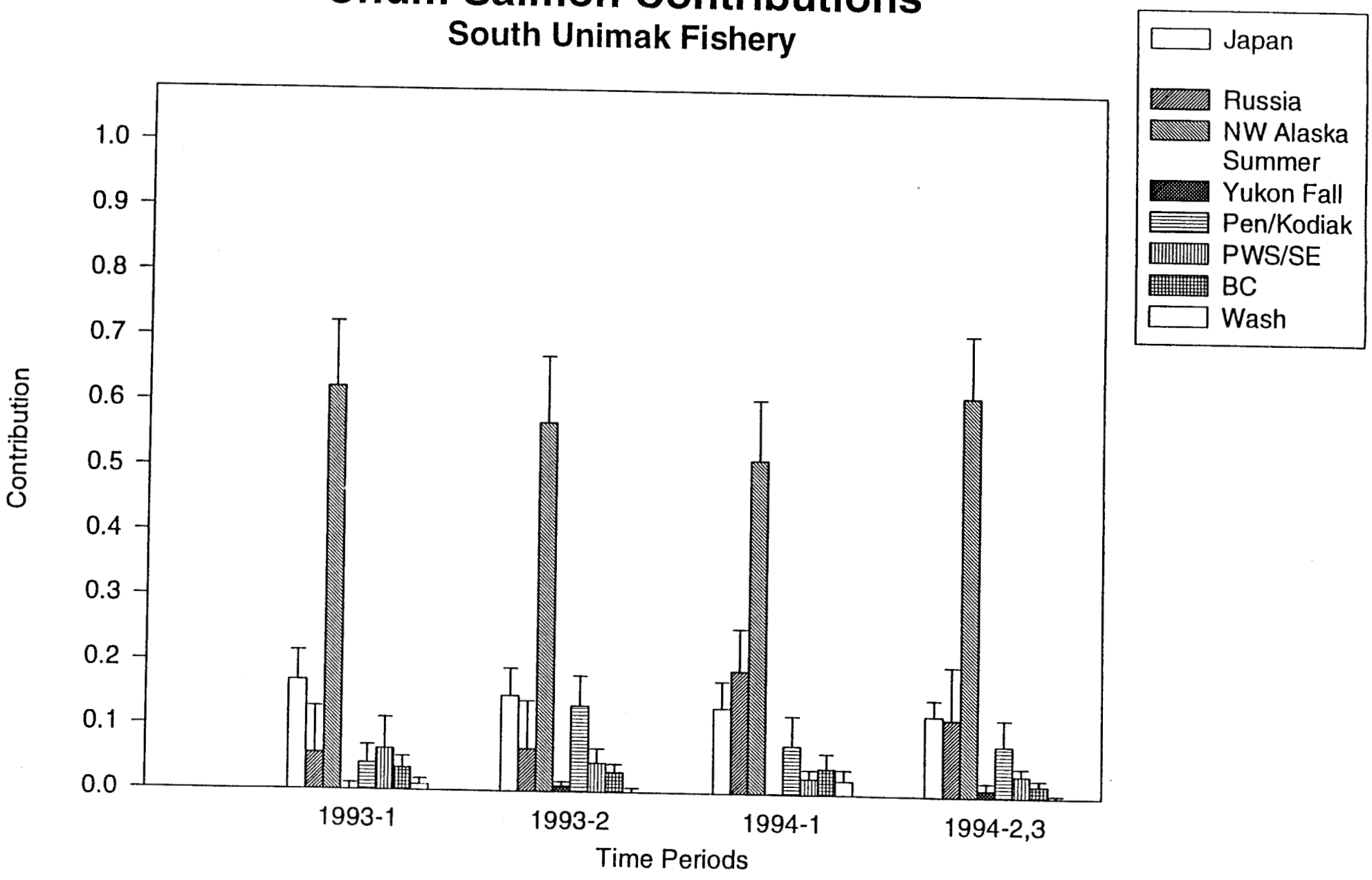



Figure 8. Estimated regional contributions of chum salmon to the South Unimak June fishery, 1993-1994. Standard errors are shown.

Appendix 1. Allele frequency estimates for loci used in mixture analysis of Pacific Rim chum salmon.

| | | *sAAT-1,2** | | | | | *mAAT-1** | | |
|---|---|---|---|---|---|---|---|---|---|
| Population | N | 100 | 120 | 65 | 95 | N | -100 | -120 | -70 |
| Gakko/Miomote Rivers | 119 | 0.9664 | 0.0336 | 0.0000 | 0.0000 | 113 | 0.9867 | 0.0000 | 0.0133 |
| Chitose River | 80 | 0.9531 | 0.0469 | 0.0000 | 0.0000 | 71 | 1.0000 | 0.0000 | 0.0000 |
| Kushiro River | 80 | 0.9781 | 0.0219 | 0.0000 | 0.0000 | 69 | 0.9638 | 0.0072 | 0.0290 |
| Nishibetsu River | 80 | 0.9875 | 0.0125 | 0.0000 | 0.0000 | 68 | 0.9485 | 0.0294 | 0.0221 |
| Ohkawa River | 78 | 0.9744 | 0.0256 | 0.0000 | 0.0000 | 74 | 0.9459 | 0.0338 | 0.0203 |
| Shari River | 80 | 0.9625 | 0.0375 | 0.0000 | 0.0000 | 76 | 0.9671 | 0.0197 | 0.0132 |
| Tsugaruishi River | 78 | 0.9744 | 0.0256 | 0.0000 | 0.0000 | 77 | 0.9805 | 0.0195 | 0.0000 |
| Tokushibetsu River | 39 | 0.9551 | 0.0321 | 0.0128 | 0.0000 | 38 | 0.9868 | 0.0132 | 0.0000 |
| Tokachi River | 79 | 0.9842 | 0.0158 | 0.0000 | 0.0000 | 58 | 0.9655 | 0.0000 | 0.0345 |
| Teshio River | 80 | 0.9531 | 0.0469 | 0.0000 | 0.0000 | 73 | 1.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 182 | 0.9135 | 0.0865 | 0.0000 | 0.0000 | 180 | 0.9694 | 0.0056 | 0.0250 |
| Kol River | 90 | 0.9083 | 0.0917 | 0.0000 | 0.0000 | 76 | 0.9474 | 0.0329 | 0.0197 |
| Kamchatka River | 75 | 0.9567 | 0.0433 | 0.0000 | 0.0000 | 75 | 0.8067 | 0.0867 | 0.1067 |
| Hairusova River | 115 | 0.9283 | 0.0717 | 0.0000 | 0.0000 | 31 | 1.0000 | 0.0000 | 0.0000 |
| Ola River | 80 | 0.8844 | 0.1156 | 0.0000 | 0.0000 | 77 | 0.9870 | 0.0000 | 0.0130 |
| Tumani River | 66 | 0.8447 | 0.1553 | 0.0000 | 0.0000 | 62 | 0.9758 | 0.0242 | 0.0000 |
| Utka River | 79 | 0.9367 | 0.0633 | 0.0000 | 0.0000 | 76 | 0.9868 | 0.0000 | 0.0132 |
| Kikchik River | 40 | 0.9000 | 0.1000 | 0.0000 | 0.0000 | 40 | 0.9875 | 0.0000 | 0.0125 |
| Pymta River | 79 | 0.9019 | 0.0981 | 0.0000 | 0.0000 | 78 | 0.9615 | 0.0000 | 0.0385 |
| Nerpichi Lake | 40 | 0.9125 | 0.0875 | 0.0000 | 0.0000 | 39 | 0.9744 | 0.0000 | 0.0256 |
| Korf Bay | 18 | 0.9306 | 0.0694 | 0.0000 | 0.0000 | 16 | 1.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1508 | 0.9637 | 0.0363 | 0.0000 | 0.0000 | 1529 | 0.9032 | 0.0010 | 0.0958 |
| Chiginagak/Mainland | 269 | 0.9442 | 0.0520 | 0.0037 | 0.0000 | 269 | 0.7825 | 0.1561 | 0.0613 |
| Kanektok/Goodnews/Togiak Rivers | 334 | 0.9491 | 0.0501 | 0.0007 | 0.0000 | 338 | 0.8964 | 0.0074 | 0.0962 |
| Norton Sound | 462 | 0.9659 | 0.0341 | 0.0000 | 0.0000 | 468 | 0.9188 | 0.0085 | 0.0726 |
| Nushagak River | 282 | 0.9495 | 0.0496 | 0.0009 | 0.0000 | 286 | 0.9248 | 0.0017 | 0.0734 |
| Littlejohn/Russell Creek | 179 | 0.9190 | 0.0712 | 0.0098 | 0.0000 | 178 | 0.8539 | 0.0674 | 0.0787 |
| Belkofski/Canoe Bay | 187 | 0.8957 | 0.1043 | 0.0000 | 0.0000 | 185 | 0.9108 | 0.0486 | 0.0405 |
| Frosty/St Catherine's Cove | 177 | 0.8573 | 0.1370 | 0.0056 | 0.0000 | 179 | 0.8631 | 0.0307 | 0.1061 |
| Egegik/Ugashik Bay | 196 | 0.9375 | 0.0574 | 0.0051 | 0.0000 | 198 | 0.8939 | 0.0025 | 0.1035 |
| Naknek/Alagnak Rivers | 164 | 0.9314 | 0.0686 | 0.0000 | 0.0000 | 164 | 0.9268 | 0.0000 | 0.0732 |
| Tanana River | 497 | 0.9406 | 0.0594 | 0.0000 | 0.0000 | 497 | 0.9356 | 0.0000 | 0.0644 |
| Noatak River | 292 | 0.9572 | 0.0428 | 0.0000 | 0.0000 | 296 | 0.9899 | 0.0000 | 0.0101 |
| Kelly Lake | 95 | 0.9737 | 0.0263 | 0.0000 | 0.0000 | 95 | 0.9474 | 0.0000 | 0.0526 |
| Salmon River | 93 | 0.9892 | 0.0108 | 0.0000 | 0.0000 | 100 | 0.9800 | 0.0000 | 0.0200 |
| Pilgrim River | 90 | 0.9778 | 0.0222 | 0.0000 | 0.0000 | 90 | 0.9278 | 0.0000 | 0.0722 |
| Chena River | 85 | 0.9647 | 0.0353 | 0.0000 | 0.0000 | 85 | 0.9294 | 0.0000 | 0.0706 |
| Salcha River | 98 | 0.9694 | 0.0306 | 0.0000 | 0.0000 | 98 | 0.9031 | 0.0102 | 0.0867 |
| Toklat River | 213 | 0.9237 | 0.0751 | 0.0012 | 0.0000 | 214 | 0.9182 | 0.0000 | 0.0818 |
| Sheenjek River | 164 | 0.9451 | 0.0549 | 0.0000 | 0.0000 | 163 | 0.8742 | 0.0000 | 0.1258 |
| Meshik River | 167 | 0.9386 | 0.0614 | 0.0000 | 0.0000 | 170 | 0.9441 | 0.0000 | 0.0559 |
| Lawrence Valley Creek | 100 | 0.8275 | 0.1650 | 0.0075 | 0.0000 | 100 | 0.8800 | 0.0550 | 0.0650 |
| Joshua Green River | 80 | 0.8781 | 0.1156 | 0.0062 | 0.0000 | 79 | 0.9051 | 0.0316 | 0.0633 |
| Trader's Cove Creek | 100 | 0.9050 | 0.0950 | 0.0000 | 0.0000 | 99 | 0.9293 | 0.0505 | 0.0202 |
| Peterson Lagoon | 85 | 0.8735 | 0.1265 | 0.0000 | 0.0000 | 86 | 0.9128 | 0.0523 | 0.0349 |
| Stepovak River | 99 | 0.9343 | 0.0657 | 0.0000 | 0.0000 | 100 | 0.8200 | 0.0950 | 0.0850 |
| Ivanoff River | 94 | 0.9309 | 0.0691 | 0.0000 | 0.0000 | 94 | 0.9202 | 0.0372 | 0.0426 |
| Big River | 100 | 0.9400 | 0.0600 | 0.0000 | 0.0000 | 99 | 0.7576 | 0.2020 | 0.0404 |
| Big Sukhoi Creek | 100 | 0.9475 | 0.0525 | 0.0000 | 0.0000 | 100 | 0.8750 | 0.0250 | 0.1000 |
| Sturgeon River | 70 | 0.9179 | 0.0821 | 0.0000 | 0.0000 | 70 | 0.8000 | 0.0286 | 0.1714 |
| Kizhuyak River | 88 | 0.9261 | 0.0682 | 0.0057 | 0.0000 | 88 | 0.8693 | 0.0909 | 0.0398 |
| Chunilna Creek | 84 | 0.9048 | 0.0952 | 0.0000 | 0.0000 | 87 | 0.9828 | 0.0000 | 0.0172 |
| WHN Hatchery | 92 | 0.9429 | 0.0543 | 0.0027 | 0.0000 | 91 | 0.7582 | 0.2308 | 0.0110 |
| Eastern Prince of Whales Island | 655 | 0.8637 | 0.1359 | 0.0000 | 0.0004 | 659 | 0.8604 | 0.1055 | 0.0341 |
| Southeast Alaska | 898 | 0.8783 | 0.1217 | 0.0000 | 0.0000 | 897 | 0.6878 | 0.2525 | 0.0596 |
| Eastern Queen Charlotte Islands | 428 | 0.9188 | 0.0812 | 0.0000 | 0.0000 | 431 | 0.8399 | 0.1566 | 0.0035 |
| Nass River Area | 309 | 0.8536 | 0.1464 | 0.0000 | 0.0000 | 311 | 0.6350 | 0.2974 | 0.0675 |
| Kitimat/Kussel Rivers | 221 | 0.8824 | 0.1176 | 0.0000 | 0.0000 | 223 | 0.6883 | 0.2489 | 0.0628 |
| Nekite Channel/River | 188 | 0.9082 | 0.0891 | 0.0000 | 0.0027 | 197 | 0.7056 | 0.2310 | 0.0635 |
| Port Real Marina | 148 | 0.8480 | 0.1520 | 0.0000 | 0.0000 | 148 | 0.8649 | 0.1318 | 0.0034 |
| Herman Creek | 158 | 0.9003 | 0.0997 | 0.0000 | 0.0000 | 158 | 0.6203 | 0.3101 | 0.0696 |
| Hood Canal Hatchery | 449 | 0.8909 | 0.1091 | 0.0000 | 0.0000 | 407 | 0.6450 | 0.3550 | 0.0000 |
| Mill Creek | 178 | 0.8694 | 0.1306 | 0.0000 | 0.0000 | 176 | 0.7017 | 0.2727 | 0.0256 |
| Bellingham Maritime Hatchery | 100 | 0.8650 | 0.1350 | 0.0000 | 0.0000 | 100 | 0.4800 | 0.4950 | 0.0250 |
| Skagit River | 251 | 0.9173 | 0.0827 | 0.0000 | 0.0000 | 249 | 0.6345 | 0.3655 | 0.0000 |
| West Vancouver Island | 606 | 0.9179 | 0.0821 | 0.0000 | 0.0000 | 600 | 0.7192 | 0.2800 | 0.0008 |
| East Vancouver Island | 800 | 0.8966 | 0.1025 | 0.0006 | 0.0003 | 796 | 0.6413 | 0.3574 | 0.0013 |
| Lower Fraser River | 400 | 0.8488 | 0.1506 | 0.0006 | 0.0000 | 399 | 0.6566 | 0.3421 | 0.0013 |
| Upper Fraser River | 596 | 0.8549 | 0.1451 | 0.0000 | 0.0000 | 595 | 0.6941 | 0.3050 | 0.0008 |

Appendix 1. Continued.

| Population | *mAH3** N | 100 | 124 | *ALAT** N | 100 | 93 | 78 |
|---|---|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 109 | 0.5917 | 0.4083 | 117 | 0.8333 | 0.1667 | 0.0000 |
| Chitose River | 38 | 0.3947 | 0.6053 | 75 | 0.8267 | 0.1733 | 0.0000 |
| Kushiro River | 80 | 0.4562 | 0.5438 | 80 | 0.8125 | 0.1875 | 0.0000 |
| Nishibetsu River | 78 | 0.5513 | 0.4487 | 71 | 0.8873 | 0.1127 | 0.0000 |
| Ohkawa River | 79 | 0.5316 | 0.4684 | 78 | 0.7692 | 0.2308 | 0.0000 |
| Shari River | 77 | 0.4805 | 0.5195 | 80 | 0.7812 | 0.2188 | 0.0000 |
| Tsugaruishi River | 78 | 0.6410 | 0.3590 | 80 | 0.8312 | 0.1688 | 0.0000 |
| Tokushibetsu River | 38 | 0.5263 | 0.4737 | 38 | 0.6974 | 0.3026 | 0.0000 |
| Tokachi River | 79 | 0.5127 | 0.4873 | 78 | 0.7436 | 0.2564 | 0.0000 |
| Teshio River | 33 | 0.5606 | 0.4394 | 39 | 0.7692 | 0.2308 | 0.0000 |
| Anadyr/Kanchalan Rivers | 161 | 0.4037 | 0.5963 | 165 | 0.8545 | 0.1455 | 0.0000 |
| Kol River | 75 | 0.6400 | 0.3600 | 90 | 0.8278 | 0.1667 | 0.0056 |
| Kamchatka River | 72 | 0.7569 | 0.2431 | 70 | 0.8786 | 0.1214 | 0.0000 |
| Hairusova River | 42 | 0.6667 | 0.3333 | 41 | 0.9024 | 0.0976 | 0.0000 |
| Ola River | 63 | 0.6111 | 0.3889 | 80 | 0.7875 | 0.2125 | 0.0000 |
| Tumani River | 63 | 0.5000 | 0.5000 | 64 | 0.8281 | 0.1719 | 0.0000 |
| Utka River | 34 | 0.4412 | 0.5588 | 68 | 0.8309 | 0.1691 | 0.0000 |
| Kikchik River | 38 | 0.6447 | 0.3553 | 40 | 0.8000 | 0.2000 | 0.0000 |
| Pymta River | 78 | 0.6731 | 0.3269 | 75 | 0.8067 | 0.1933 | 0.0000 |
| Nerpichi Lake | 25 | 0.5000 | 0.5000 | 40 | 0.8500 | 0.1500 | 0.0000 |
| Korf Bay | 16 | 0.5312 | 0.4688 | 17 | 0.9118 | 0.0882 | 0.0000 |
| LowerYukon/Kuskokwim | 1424 | 0.4716 | 0.5284 | 1519 | 0.8884 | 0.1116 | 0.0000 |
| Chiginagak/Mainland | 259 | 0.3822 | 0.6178 | 266 | 0.8440 | 0.1560 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 332 | 0.5105 | 0.4895 | 333 | 0.9024 | 0.0976 | 0.0000 |
| Norton Sound | 378 | 0.4841 | 0.5159 | 456 | 0.8542 | 0.1458 | 0.0000 |
| Nushagak River | 273 | 0.4469 | 0.5531 | 286 | 0.8951 | 0.1049 | 0.0000 |
| Littlejohn/Russell Creek | 174 | 0.4253 | 0.5747 | 180 | 0.8694 | 0.1306 | 0.0000 |
| Belkofski/Canoe Bay | 181 | 0.4171 | 0.5829 | 177 | 0.8164 | 0.1836 | 0.0000 |
| Frosty/St Catherine's Cove | 176 | 0.5000 | 0.5000 | 177 | 0.7090 | 0.2910 | 0.0000 |
| Egegik/Ugashik Bay | 188 | 0.6170 | 0.3830 | 198 | 0.8737 | 0.1263 | 0.0000 |
| Naknek/Alagnak Rivers | 158 | 0.4684 | 0.5316 | 162 | 0.8704 | 0.1296 | 0.0000 |
| Tanana River | 430 | 0.8535 | 0.1465 | 487 | 0.9148 | 0.0852 | 0.0000 |
| Noatak River | 274 | 0.5182 | 0.4818 | 289 | 0.8512 | 0.1488 | 0.0000 |
| Kelly Lake | 93 | 0.6398 | 0.3602 | 100 | 0.8300 | 0.1700 | 0.0000 |
| Salmon River | 87 | 0.4598 | 0.5402 | 92 | 0.8967 | 0.1033 | 0.0000 |
| Pilgrim River | 85 | 0.4941 | 0.5059 | 90 | 0.8667 | 0.1333 | 0.0000 |
| Chena River | 84 | 0.7024 | 0.2976 | 85 | 0.9412 | 0.0588 | 0.0000 |
| Salcha River | 95 | 0.7263 | 0.2737 | 99 | 0.9747 | 0.0253 | 0.0000 |
| Toklat River | 208 | 0.7212 | 0.2788 | 213 | 0.9343 | 0.0657 | 0.0000 |
| Sheenjek River | 163 | 0.6994 | 0.3006 | 164 | 0.9634 | 0.0366 | 0.0000 |
| Meshik River | 165 | 0.6636 | 0.3364 | 169 | 0.8550 | 0.1450 | 0.0000 |
| Lawrence Valley Creek | 97 | 0.5515 | 0.4485 | 100 | 0.7700 | 0.2300 | 0.0000 |
| Joshua Green River | 71 | 0.5282 | 0.4718 | 80 | 0.7625 | 0.2375 | 0.0000 |
| Trader's Cove Creek | 96 | 0.5000 | 0.5000 | 99 | 0.8232 | 0.1768 | 0.0000 |
| Peterson Lagoon | 81 | 0.4136 | 0.5864 | 84 | 0.7381 | 0.2619 | 0.0000 |
| Stepovak River | 97 | 0.5155 | 0.4845 | 100 | 0.8700 | 0.1300 | 0.0000 |
| Ivanoff River | 93 | 0.4570 | 0.5430 | 93 | 0.8495 | 0.1505 | 0.0000 |
| Big River | 97 | 0.3557 | 0.6443 | 94 | 0.8936 | 0.1064 | 0.0000 |
| Big Sukhoi Creek | 97 | 0.6289 | 0.3711 | 98 | 0.7551 | 0.2449 | 0.0000 |
| Sturgeon River | 66 | 0.5379 | 0.4621 | 71 | 0.6408 | 0.3592 | 0.0000 |
| Kizhuyak River | 88 | 0.3580 | 0.6420 | 86 | 0.8663 | 0.1337 | 0.0000 |
| Chunilna Creek | 73 | 0.5753 | 0.4247 | 85 | 0.9353 | 0.0647 | 0.0000 |
| WHN Hatchery | 84 | 0.4107 | 0.5893 | 92 | 0.9620 | 0.0380 | 0.0000 |
| Eastern Prince of Whales Island | 359 | 0.4401 | 0.5599 | 524 | 0.8235 | 0.1765 | 0.0000 |
| Southeast Alaska | 649 | 0.3852 | 0.6148 | 732 | 0.8081 | 0.1919 | 0.0000 |
| Eastern Queen Charlotte Islands | 294 | 0.2925 | 0.7075 | 427 | 0.8618 | 0.1382 | 0.0000 |
| Nass River Area | 246 | 0.4207 | 0.5793 | 421 | 0.8848 | 0.1152 | 0.0000 |
| Kitimat/Mussel Rivers | 24 | 0.2500 | 0.7500 | 223 | 0.8072 | 0.1928 | 0.0000 |
| Nekite Channel/River | 125 | 0.2240 | 0.7760 | 188 | 0.9468 | 0.0532 | 0.0000 |
| Port Real Marina | 62 | 0.4435 | 0.5565 | 108 | 0.8194 | 0.1806 | 0.0000 |
| Herman Creek | 89 | 0.6124 | 0.3876 | 158 | 0.8797 | 0.1203 | 0.0000 |
| Hood Canal Hatchery | 448 | 0.3527 | 0.6473 | 448 | 0.8917 | 0.1083 | 0.0000 |
| Mill Creek | 179 | 0.3436 | 0.6564 | 179 | 0.8631 | 0.1369 | 0.0000 |
| Bellingham Maritime Hatchery | 99 | 0.4293 | 0.5707 | 100 | 0.7600 | 0.2400 | 0.0000 |
| Skagit River | 251 | 0.3825 | 0.6175 | 251 | 0.8048 | 0.1952 | 0.0000 |
| West Vancouver Island | 494 | 0.2490 | 0.7510 | 605 | 0.8281 | 0.1719 | 0.0000 |
| East Vancouver Island | 756 | 0.3095 | 0.6905 | 800 | 0.7981 | 0.1994 | 0.0025 |
| Lower Fraser River | 378 | 0.3439 | 0.6561 | 400 | 0.8125 | 0.1875 | 0.0000 |
| Upper Fraser River | 565 | 0.3611 | 0.6389 | 597 | 0.8040 | 0.1960 | 0.0000 |

Appendix 1. Continued.

| Population | *ESTD** N | 100 | 91 | 110 | *G3PDH-2** N | 100 | 90 |
|---|---|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 119 | 0.5882 | 0.4118 | 0.0000 | 117 | 0.9829 | 0.0171 |
| Chitose River | 77 | 0.6169 | 0.3831 | 0.0000 | 74 | 0.9730 | 0.0270 |
| Kushiro River | 80 | 0.7750 | 0.2250 | 0.0000 | 80 | 0.9812 | 0.0188 |
| Nishibetsu River | 80 | 0.7188 | 0.2812 | 0.0000 | 75 | 0.9467 | 0.0533 |
| Ohkawa River | 72 | 0.7639 | 0.2361 | 0.0000 | 75 | 0.9667 | 0.0333 |
| Shari River | 80 | 0.6875 | 0.3125 | 0.0000 | 77 | 0.9545 | 0.0455 |
| Tsugaruishi River | 80 | 0.6375 | 0.3625 | 0.0000 | 79 | 1.0000 | 0.0000 |
| Tokushibetsu River | 40 | 0.7250 | 0.2750 | 0.0000 | 37 | 0.9730 | 0.0270 |
| Tokachi River | 80 | 0.7500 | 0.2375 | 0.0125 | 77 | 0.9675 | 0.0325 |
| Teshio River | 80 | 0.6125 | 0.3875 | 0.0000 | 40 | 0.9750 | 0.0250 |
| Anadyr/Kanchalan Rivers | 170 | 0.6912 | 0.3088 | 0.0000 | 182 | 0.9176 | 0.0824 |
| Kol River | 90 | 0.9444 | 0.0556 | 0.0000 | 90 | 0.8611 | 0.1389 |
| Kamchatka River | 75 | 0.7667 | 0.2333 | 0.0000 | 74 | 0.8716 | 0.1284 |
| Hairusova River | 106 | 0.9387 | 0.0613 | 0.0000 | 31 | 0.8710 | 0.1290 |
| Ola River | 80 | 0.8312 | 0.1688 | 0.0000 | 78 | 0.8141 | 0.1859 |
| Tumani River | 65 | 0.8923 | 0.1077 | 0.0000 | 64 | 0.8047 | 0.1953 |
| Utka River | 63 | 0.7698 | 0.2302 | 0.0000 | 78 | 0.9167 | 0.0833 |
| Kikchik River | 40 | 0.9250 | 0.0750 | 0.0000 | 39 | 0.8974 | 0.1026 |
| Pymta River | 79 | 0.9241 | 0.0759 | 0.0000 | 78 | 0.9103 | 0.0897 |
| Nerpichi Lake | 40 | 0.8125 | 0.1875 | 0.0000 | 40 | 0.9125 | 0.0875 |
| Korf Bay | 18 | 0.7778 | 0.2222 | 0.0000 | 18 | 0.8333 | 0.1667 |
| LowerYukon/Kuskokwim | 1512 | 0.4795 | 0.5205 | 0.0000 | 1500 | 0.8543 | 0.1457 |
| Chiginagak/Mainland | 269 | 0.8699 | 0.1301 | 0.0000 | 261 | 0.8659 | 0.1341 |
| Kanektok/Goodnews/Togiak Rivers | 336 | 0.5506 | 0.4494 | 0.0000 | 332 | 0.8705 | 0.1295 |
| Norton Sound | 468 | 0.4744 | 0.5256 | 0.0000 | 458 | 0.8854 | 0.1146 |
| Nushagak River | 280 | 0.4607 | 0.5393 | 0.0000 | 279 | 0.8513 | 0.1487 |
| Littlejohn/Russell Creek | 178 | 0.9410 | 0.0590 | 0.0000 | 178 | 0.8596 | 0.1404 |
| Belkofski/Canoe Bay | 182 | 0.9560 | 0.0440 | 0.0000 | 175 | 0.8714 | 0.1286 |
| Frosty/St Catherine's Cove | 178 | 0.9073 | 0.0927 | 0.0000 | 172 | 0.8547 | 0.1453 |
| Egegik/Ugashik Bay | 197 | 0.4975 | 0.5025 | 0.0000 | 195 | 0.9333 | 0.0667 |
| Naknek/Alagnak Rivers | 163 | 0.5951 | 0.4049 | 0.0000 | 162 | 0.9105 | 0.0895 |
| Tanana River | 496 | 0.2298 | 0.7702 | 0.0000 | 497 | 0.8642 | 0.1358 |
| Noatak River | 285 | 0.6158 | 0.3842 | 0.0000 | 285 | 0.8912 | 0.1088 |
| Kelly Lake | 94 | 0.6383 | 0.3617 | 0.0000 | 91 | 0.8626 | 0.1374 |
| Salmon River | 99 | 0.5859 | 0.4141 | 0.0000 | 98 | 0.9082 | 0.0918 |
| Pilgrim River | 90 | 0.4778 | 0.5222 | 0.0000 | 90 | 0.7889 | 0.2111 |
| Chena River | 85 | 0.4118 | 0.5882 | 0.0000 | 82 | 0.7744 | 0.2256 |
| Salcha River | 100 | 0.4550 | 0.5450 | 0.0000 | 97 | 0.8918 | 0.1082 |
| Toklat River | 215 | 0.2628 | 0.7372 | 0.0000 | 212 | 0.8396 | 0.1604 |
| Sheenjek River | 164 | 0.3262 | 0.6738 | 0.0000 | 164 | 0.8537 | 0.1463 |
| Meshik River | 163 | 0.5123 | 0.4877 | 0.0000 | 161 | 0.8820 | 0.1180 |
| Lawrence Valley Creek | 99 | 0.9343 | 0.0657 | 0.0000 | 100 | 0.9450 | 0.0550 |
| Joshua Green River | 79 | 0.8987 | 0.1013 | 0.0000 | 71 | 0.9366 | 0.0634 |
| Trader's Cove Creek | 93 | 0.9140 | 0.0860 | 0.0000 | 94 | 0.8457 | 0.1543 |
| Peterson Lagoon | 86 | 1.0000 | 0.0000 | 0.0000 | 83 | 0.9639 | 0.0361 |
| Stepovak River | 100 | 0.9800 | 0.0200 | 0.0000 | 97 | 0.8660 | 0.1340 |
| Ivanof River | 93 | 0.9086 | 0.0914 | 0.0000 | 94 | 0.8404 | 0.1596 |
| Big River | 98 | 0.9235 | 0.0765 | 0.0000 | 97 | 0.8918 | 0.1082 |
| Big Sukhoi Creek | 100 | 1.0000 | 0.0000 | 0.0000 | 98 | 0.8061 | 0.1939 |
| Sturgeon River | 71 | 1.0000 | 0.0000 | 0.0000 | 66 | 0.7121 | 0.2879 |
| Kizhuyak River | 88 | 0.9091 | 0.0909 | 0.0000 | 87 | 0.8448 | 0.1552 |
| Chunilna Creek | 86 | 0.7035 | 0.2965 | 0.0000 | 87 | 0.5862 | 0.4138 |
| WHN Hatchery | 92 | 1.0000 | 0.0000 | 0.0000 | 91 | 0.6813 | 0.3187 |
| Eastern Prince of Whales Island | 661 | 0.8495 | 0.1505 | 0.0000 | 647 | 0.7720 | 0.2280 |
| Southeast Alaska | 903 | 0.9408 | 0.0587 | 0.0006 | 886 | 0.8166 | 0.1834 |
| Eastern Queen Charlotte Islands | 431 | 0.9060 | 0.0940 | 0.0000 | 425 | 0.8588 | 0.1412 |
| Nass River Area | 311 | 0.9614 | 0.0386 | 0.0000 | 302 | 0.8311 | 0.1689 |
| Kitimat/Mussel Rivers | 223 | 0.9641 | 0.0359 | 0.0000 | 217 | 0.8594 | 0.1406 |
| Nekite Channel/River | 197 | 0.9721 | 0.0279 | 0.0000 | 193 | 0.8860 | 0.1140 |
| Port Real Marina | 148 | 0.8412 | 0.1588 | 0.0000 | 146 | 0.8014 | 0.1986 |
| Herman Creek | 158 | 0.9430 | 0.0570 | 0.0000 | 154 | 0.8312 | 0.1688 |
| Hood Canal Hatchery | 449 | 1.0000 | 0.0000 | 0.0000 | 449 | 0.8274 | 0.1726 |
| Mill Creek | 179 | 1.0000 | 0.0000 | 0.0000 | 178 | 0.9410 | 0.0590 |
| Bellingham Maritime Hatchery | 100 | 1.0000 | 0.0000 | 0.0000 | 100 | 0.8850 | 0.1150 |
| Skagit River | 251 | 1.0000 | 0.0000 | 0.0000 | 249 | 0.8574 | 0.1426 |
| West Vancouver Island | 606 | 0.9909 | 0.0091 | 0.0000 | 558 | 0.9588 | 0.0412 |
| East Vancouver Island | 800 | 0.9925 | 0.0075 | 0.0000 | 798 | 0.9524 | 0.0476 |
| Lower Fraser River | 400 | 0.9975 | 0.0025 | 0.0000 | 397 | 0.9232 | 0.0768 |
| Upper Fraser River | 600 | 1.0000 | 0.0000 | 0.0000 | 596 | 0.9270 | 0.0730 |

Appendix 1. Continued.

| Population | GPI-B1,2* N | 100 | 145 | 40 | GPI-A* N | 100 | 95 | 105 |
|---|---|---|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 119 | 0.9937 | 0.0063 | 0.0000 | 119 | 1.0000 | 0.0000 | 0.0000 |
| Chitose River | 80 | 0.9938 | 0.0062 | 0.0000 | 77 | 1.0000 | 0.0000 | 0.0000 |
| Kushiro River | 80 | 1.0000 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Nishibetsu River | 80 | 1.0000 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Ohkawa River | 80 | 1.0000 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Shari River | 80 | 1.0000 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tsugaruishi River | 80 | 1.0000 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tokushibetsu River | 40 | 1.0000 | 0.0000 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Tokachi River | 80 | 1.0000 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Teshio River | 80 | 1.0000 | 0.0000 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 182 | 1.0000 | 0.0000 | 0.0000 | 104 | 1.0000 | 0.0000 | 0.0000 |
| Kol River | 90 | 1.0000 | 0.0000 | 0.0000 | 90 | 1.0000 | 0.0000 | 0.0000 |
| Kamchatka River | 75 | 1.0000 | 0.0000 | 0.0000 | 68 | 1.0000 | 0.0000 | 0.0000 |
| Hairusova River | 51 | 1.0000 | 0.0000 | 0.0000 | 38 | 1.0000 | 0.0000 | 0.0000 |
| Ola River | 80 | 0.9906 | 0.0031 | 0.0062 | 77 | 0.9935 | 0.0065 | 0.0000 |
| Tumani River | 66 | 1.0000 | 0.0000 | 0.0000 | 65 | 0.9846 | 0.0154 | 0.0000 |
| Utka River | 79 | 1.0000 | 0.0000 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 1.0000 | 0.0000 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Pymta River | 79 | 0.9937 | 0.0063 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 1.0000 | 0.0000 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Korf Bay | 18 | 1.0000 | 0.0000 | 0.0000 | 18 | 1.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1525 | 0.9997 | 0.0003 | 0.0000 | 1529 | 0.9997 | 0.0000 | 0.0003 |
| Chiginagak/Mainland | 269 | 0.9981 | 0.0019 | 0.0000 | 269 | 1.0000 | 0.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 337 | 0.9985 | 0.0015 | 0.0000 | 337 | 0.9941 | 0.0045 | 0.0015 |
| Norton Sound | 471 | 1.0000 | 0.0000 | 0.0000 | 459 | 0.9989 | 0.0000 | 0.0011 |
| Nushagak River | 286 | 1.0000 | 0.0000 | 0.0000 | 286 | 1.0000 | 0.0000 | 0.0000 |
| Littlejohn/Russell Creek | 180 | 0.9917 | 0.0069 | 0.0014 | 180 | 1.0000 | 0.0000 | 0.0000 |
| Belkofski/Canoe Bay | 186 | 0.9852 | 0.0148 | 0.0000 | 186 | 1.0000 | 0.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 179 | 0.9986 | 0.0014 | 0.0000 | 178 | 0.9972 | 0.0028 | 0.0000 |
| Egegik/Ugashik Bay | 197 | 1.0000 | 0.0000 | 0.0000 | 197 | 1.0000 | 0.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 162 | 1.0000 | 0.0000 | 0.0000 | 162 | 1.0000 | 0.0000 | 0.0000 |
| Tanana River | 490 | 1.0000 | 0.0000 | 0.0000 | 468 | 1.0000 | 0.0000 | 0.0000 |
| Noatak River | 294 | 1.0000 | 0.0000 | 0.0000 | 294 | 1.0000 | 0.0000 | 0.0000 |
| Kelly Lake | 97 | 1.0000 | 0.0000 | 0.0000 | 97 | 1.0000 | 0.0000 | 0.0000 |
| Salmon River | 100 | 1.0000 | 0.0000 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 1.0000 | 0.0000 | 0.0000 | 90 | 1.0000 | 0.0000 | 0.0000 |
| Chena River | 85 | 1.0000 | 0.0000 | 0.0000 | 85 | 1.0000 | 0.0000 | 0.0000 |
| Salcha River | 98 | 1.0000 | 0.0000 | 0.0000 | 98 | 1.0000 | 0.0000 | 0.0000 |
| Toklat River | 212 | 1.0000 | 0.0000 | 0.0000 | 212 | 1.0000 | 0.0000 | 0.0000 |
| Sheenjek River | 164 | 1.0000 | 0.0000 | 0.0000 | 164 | 1.0000 | 0.0000 | 0.0000 |
| Meshik River | 169 | 1.0000 | 0.0000 | 0.0000 | 169 | 1.0000 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 100 | 1.0000 | 0.0000 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Joshua Green River | 80 | 0.9969 | 0.0031 | 0.0000 | 80 | 0.9938 | 0.0062 | 0.0000 |
| Trader's Cove Creek | 100 | 0.9975 | 0.0025 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Peterson Lagoon | 84 | 1.0000 | 0.0000 | 0.0000 | 84 | 1.0000 | 0.0000 | 0.0000 |
| Stepovak River | 99 | 0.9949 | 0.0051 | 0.0000 | 99 | 1.0000 | 0.0000 | 0.0000 |
| Ivanoff River | 93 | 0.9973 | 0.0027 | 0.0000 | 93 | 1.0000 | 0.0000 | 0.0000 |
| Big River | 97 | 1.0000 | 0.0000 | 0.0000 | 97 | 1.0000 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 100 | 0.9925 | 0.0075 | 0.0000 | 100 | 0.9850 | 0.0000 | 0.0150 |
| Sturgeon River | 71 | 1.0000 | 0.0000 | 0.0000 | 71 | 0.9930 | 0.0000 | 0.0070 |
| Kizhuyak River | 86 | 0.9971 | 0.0029 | 0.0000 | 86 | 0.9942 | 0.0058 | 0.0000 |
| Chunilna Creek | 87 | 1.0000 | 0.0000 | 0.0000 | 87 | 1.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 92 | 1.0000 | 0.0000 | 0.0000 | 92 | 1.0000 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 656 | 1.0000 | 0.0000 | 0.0000 | 655 | 0.9779 | 0.0137 | 0.0084 |
| Southeast Alaska | 904 | 1.0000 | 0.0000 | 0.0000 | 903 | 0.9989 | 0.0011 | 0.0000 |
| Eastern Queen Charlotte Islands | 431 | 0.9994 | 0.0006 | 0.0000 | 427 | 1.0000 | 0.0000 | 0.0000 |
| Nass River Area | 309 | 1.0000 | 0.0000 | 0.0000 | 305 | 1.0000 | 0.0000 | 0.0000 |
| Kitimat/Mussel Rivers | 221 | 1.0000 | 0.0000 | 0.0000 | 147 | 1.0000 | 0.0000 | 0.0000 |
| Nekite Channel/River | 179 | 1.0000 | 0.0000 | 0.0000 | 195 | 1.0000 | 0.0000 | 0.0000 |
| Port Real Marina | 142 | 1.0000 | 0.0000 | 0.0000 | 144 | 0.9896 | 0.0069 | 0.0035 |
| Herman Creek | 159 | 1.0000 | 0.0000 | 0.0000 | 159 | 0.9906 | 0.0094 | 0.0000 |
| Hood Canal Hatchery | 202 | 1.0000 | 0.0000 | 0.0000 | 202 | 1.0000 | 0.0000 | 0.0000 |
| Mill Creek | 179 | 1.0000 | 0.0000 | 0.0000 | 179 | 1.0000 | 0.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 1.0000 | 0.0000 | 0.0000 | 100 | 0.9950 | 0.0000 | 0.0050 |
| Skagit River | 162 | 1.0000 | 0.0000 | 0.0000 | 251 | 0.9980 | 0.0000 | 0.0020 |
| West Vancouver Island | 303 | 0.9983 | 0.0017 | 0.0000 | 385 | 1.0000 | 0.0000 | 0.0000 |
| East Vancouver Island | 473 | 1.0000 | 0.0000 | 0.0000 | 472 | 1.0000 | 0.0000 | 0.0000 |
| Lower Fraser River | 202 | 1.0000 | 0.0000 | 0.0000 | 202 | 1.0000 | 0.0000 | 0.0000 |
| Upper Fraser River | 401 | 0.9988 | 0.0000 | 0.0012 | 402 | 0.9988 | 0.0012 | 0.0000 |

Appendix 1. Continued.

| | | *mIDHP-1** | | | | |
|---|---|---|---|---|---|---|
| Population | N | 100 | 60 | 140 | 20 | 85 |
| Gakko/Miomote Rivers | 119 | 0.9580 | 0.0378 | 0.0000 | 0.0000 | 0.0042 |
| Chitose River | 77 | 0.9675 | 0.0325 | 0.0000 | 0.0000 | 0.0000 |
| Kushiro River | 80 | 0.8562 | 0.1438 | 0.0000 | 0.0000 | 0.0000 |
| Nishibetsu River | 80 | 0.7312 | 0.2688 | 0.0000 | 0.0000 | 0.0000 |
| Ohkawa River | 80 | 0.9812 | 0.0188 | 0.0000 | 0.0000 | 0.0000 |
| Shari River | 80 | 0.7688 | 0.2312 | 0.0000 | 0.0000 | 0.0000 |
| Tsugaruishi River | 78 | 0.9808 | 0.0192 | 0.0000 | 0.0000 | 0.0000 |
| Tokushibetsu River | 40 | 0.7625 | 0.2375 | 0.0000 | 0.0000 | 0.0000 |
| Tokachi River | 80 | 0.9000 | 0.1000 | 0.0000 | 0.0000 | 0.0000 |
| Teshio River | 79 | 0.9114 | 0.0886 | 0.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 180 | 0.5944 | 0.4056 | 0.0000 | 0.0000 | 0.0000 |
| Kol River | 91 | 0.8791 | 0.1209 | 0.0000 | 0.0000 | 0.0000 |
| Kamchatka River | 75 | 0.9533 | 0.0467 | 0.0000 | 0.0000 | 0.0000 |
| Hairusova River | 106 | 0.9198 | 0.0802 | 0.0000 | 0.0000 | 0.0000 |
| Ola River | 80 | 0.8938 | 0.1062 | 0.0000 | 0.0000 | 0.0000 |
| Tumani River | 66 | 0.9167 | 0.0833 | 0.0000 | 0.0000 | 0.0000 |
| Utka River | 77 | 0.5779 | 0.4221 | 0.0000 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 0.8750 | 0.1250 | 0.0000 | 0.0000 | 0.0000 |
| Pymta River | 79 | 0.9367 | 0.0633 | 0.0000 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 0.7625 | 0.2375 | 0.0000 | 0.0000 | 0.0000 |
| Korf Bay | 18 | 0.8333 | 0.1667 | 0.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1524 | 0.9869 | 0.0131 | 0.0000 | 0.0000 | 0.0000 |
| Chiginagak/Mainland | 269 | 0.9257 | 0.0743 | 0.0000 | 0.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 338 | 0.9852 | 0.0148 | 0.0000 | 0.0000 | 0.0000 |
| Norton Sound | 464 | 0.9720 | 0.0280 | 0.0000 | 0.0000 | 0.0000 |
| Nushagak River | 286 | 0.9773 | 0.0227 | 0.0000 | 0.0000 | 0.0000 |
| Littlejohn/Russell Creek | 180 | 0.8833 | 0.1167 | 0.0000 | 0.0000 | 0.0000 |
| Belkofski/Canoe Bay | 184 | 0.8723 | 0.1277 | 0.0000 | 0.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 180 | 0.9278 | 0.0722 | 0.0000 | 0.0000 | 0.0000 |
| Egegik/Ugashik Bay | 197 | 0.9239 | 0.0761 | 0.0000 | 0.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 164 | 0.9573 | 0.0427 | 0.0000 | 0.0000 | 0.0000 |
| Tanana River | 496 | 0.9929 | 0.0071 | 0.0000 | 0.0000 | 0.0000 |
| Noatak River | 294 | 0.9728 | 0.0272 | 0.0000 | 0.0000 | 0.0000 |
| Kelly Lake | 99 | 0.9141 | 0.0859 | 0.0000 | 0.0000 | 0.0000 |
| Salmon River | 96 | 0.9375 | 0.0625 | 0.0000 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Chena River | 86 | 0.9128 | 0.0872 | 0.0000 | 0.0000 | 0.0000 |
| Salcha River | 99 | 0.9848 | 0.0152 | 0.0000 | 0.0000 | 0.0000 |
| Toklat River | 215 | 0.9628 | 0.0372 | 0.0000 | 0.0000 | 0.0000 |
| Sheenjek River | 164 | 0.9909 | 0.0091 | 0.0000 | 0.0000 | 0.0000 |
| Meshik River | 171 | 0.9269 | 0.0731 | 0.0000 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 100 | 0.8550 | 0.1450 | 0.0000 | 0.0000 | 0.0000 |
| Joshua Green River | 80 | 0.9625 | 0.0375 | 0.0000 | 0.0000 | 0.0000 |
| Trader's Cove Creek | 100 | 0.9500 | 0.0500 | 0.0000 | 0.0000 | 0.0000 |
| Peterson Lagoon | 86 | 0.9593 | 0.0407 | 0.0000 | 0.0000 | 0.0000 |
| Stepovak River | 100 | 0.8000 | 0.2000 | 0.0000 | 0.0000 | 0.0000 |
| Ivanoff River | 94 | 0.8989 | 0.1011 | 0.0000 | 0.0000 | 0.0000 |
| Big River | 100 | 0.8900 | 0.1100 | 0.0000 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 100 | 0.7450 | 0.2550 | 0.0000 | 0.0000 | 0.0000 |
| Sturgeon River | 71 | 0.9930 | 0.0070 | 0.0000 | 0.0000 | 0.0000 |
| Kizhuyak River | 88 | 0.9432 | 0.0568 | 0.0000 | 0.0000 | 0.0000 |
| Chunilna Creek | 87 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 91 | 0.8516 | 0.1484 | 0.0000 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 652 | 0.9663 | 0.0337 | 0.0000 | 0.0000 | 0.0000 |
| Southeast Alaska | 901 | 0.9040 | 0.0960 | 0.0000 | 0.0000 | 0.0000 |
| Eastern Queen Charlotte Islands | 431 | 0.9814 | 0.0186 | 0.0000 | 0.0000 | 0.0000 |
| Nass River Area | 311 | 0.8714 | 0.1286 | 0.0000 | 0.0000 | 0.0000 |
| Kitimat/Mussel Rivers | 223 | 0.8632 | 0.1345 | 0.0022 | 0.0000 | 0.0000 |
| Nekite Channel/River | 195 | 0.8641 | 0.1359 | 0.0000 | 0.0000 | 0.0000 |
| Port Real Marina | 147 | 0.9150 | 0.0850 | 0.0000 | 0.0000 | 0.0000 |
| Herman Creek | 159 | 0.9088 | 0.0912 | 0.0000 | 0.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 0.6904 | 0.3096 | 0.0000 | 0.0000 | 0.0000 |
| Mill Creek | 179 | 0.8575 | 0.1425 | 0.0000 | 0.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 0.8350 | 0.1650 | 0.0000 | 0.0000 | 0.0000 |
| Skagit River | 250 | 0.8700 | 0.1300 | 0.0000 | 0.0000 | 0.0000 |
| West Vancouver Island | 605 | 0.9537 | 0.0463 | 0.0000 | 0.0000 | 0.0000 |
| East Vancouver Island | 800 | 0.9344 | 0.0650 | 0.0006 | 0.0000 | 0.0000 |
| Lower Fraser River | 400 | 0.9162 | 0.0812 | 0.0000 | 0.0025 | 0.0000 |
| Upper Fraser River | 594 | 0.9125 | 0.0875 | 0.0000 | 0.0000 | 0.0000 |

Appendix 1. Continued.

| | | sIDHP-2* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Population | N | 100 | 35 | 85 | 25 | 20 | 110 | 28 | 45 |
| Gakko/Miomote Rivers | 116 | 0.6379 | 0.3017 | 0.0129 | 0.0474 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Chitose River | 77 | 0.5779 | 0.3636 | 0.0195 | 0.0390 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kushiro River | 79 | 0.5253 | 0.3608 | 0.0063 | 0.1076 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Nishibetsu River | 80 | 0.5688 | 0.3312 | 0.0188 | 0.0812 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Ohkawa River | 80 | 0.6062 | 0.3312 | 0.0125 | 0.0000 | 0.0500 | 0.0000 | 0.0000 | 0.0000 |
| Shari River | 80 | 0.5000 | 0.3688 | 0.0250 | 0.1062 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tsugaruishi River | 80 | 0.6250 | 0.3312 | 0.0062 | 0.0250 | 0.0125 | 0.0000 | 0.0000 | 0.0000 |
| Tokushibetsu River | 40 | 0.5500 | 0.3250 | 0.0375 | 0.0875 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tokachi River | 79 | 0.5316 | 0.3797 | 0.0380 | 0.0506 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Teshio River | 80 | 0.5688 | 0.3875 | 0.0062 | 0.0375 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 182 | 0.4231 | 0.4368 | 0.1044 | 0.0302 | 0.0000 | 0.0000 | 0.0000 | 0.0055 |
| Kol River | 78 | 0.5513 | 0.2821 | 0.1026 | 0.0641 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kamchatka River | 75 | 0.4667 | 0.4467 | 0.0800 | 0.0067 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Hairusova River | 106 | 0.5094 | 0.2783 | 0.0708 | 0.1415 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Ola River | 80 | 0.5500 | 0.2438 | 0.0750 | 0.1312 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tumani River | 66 | 0.5530 | 0.2273 | 0.1439 | 0.0758 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Utka River | 77 | 0.4026 | 0.4545 | 0.1104 | 0.0325 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 0.5375 | 0.2000 | 0.0750 | 0.1875 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Pymta River | 79 | 0.5633 | 0.2405 | 0.0823 | 0.1139 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 0.5625 | 0.2500 | 0.1625 | 0.0250 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Korf Bay | 18 | 0.4167 | 0.3333 | 0.0833 | 0.1667 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1523 | 0.4714 | 0.4567 | 0.0680 | 0.0039 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Chiginagak/Mainland | 263 | 0.3973 | 0.3574 | 0.0190 | 0.2243 | 0.0019 | 0.0000 | 0.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 333 | 0.4474 | 0.4715 | 0.0751 | 0.0060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Norton Sound | 468 | 0.4519 | 0.4840 | 0.0609 | 0.0032 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Nushagak River | 281 | 0.4448 | 0.4893 | 0.0641 | 0.0018 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Littlejohn/Russell Creek | 177 | 0.4237 | 0.2712 | 0.0537 | 0.2514 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Belkofski/Canoe Bay | 186 | 0.5511 | 0.2446 | 0.0108 | 0.1909 | 0.0027 | 0.0000 | 0.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 180 | 0.3861 | 0.3694 | 0.0611 | 0.1833 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Egegik/Ugashik Bay | 197 | 0.5076 | 0.3680 | 0.0736 | 0.0508 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 163 | 0.4601 | 0.4785 | 0.0368 | 0.0245 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tanana River | 497 | 0.5020 | 0.4567 | 0.0412 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Noatak River | 285 | 0.5754 | 0.3825 | 0.0351 | 0.0070 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kelly Lake | 97 | 0.6340 | 0.3351 | 0.0155 | 0.0155 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Salmon River | 93 | 0.5645 | 0.4301 | 0.0054 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 0.4222 | 0.5333 | 0.0389 | 0.0056 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Chena River | 84 | 0.5595 | 0.3690 | 0.0714 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Salcha River | 99 | 0.5707 | 0.3636 | 0.0657 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Toklat River | 215 | 0.5488 | 0.4070 | 0.0442 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Sheenjek River | 164 | 0.3750 | 0.5762 | 0.0488 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Meshik River | 167 | 0.5240 | 0.3772 | 0.0299 | 0.0689 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 99 | 0.5051 | 0.3737 | 0.0354 | 0.0859 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Joshua Green River | 78 | 0.3269 | 0.3077 | 0.0385 | 0.3269 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Trader's Cove Creek | 98 | 0.4133 | 0.3418 | 0.0153 | 0.2296 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Peterson Lagoon | 84 | 0.3690 | 0.4881 | 0.0060 | 0.1369 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Stepovak River | 96 | 0.4896 | 0.3385 | 0.0260 | 0.1458 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Ivanoff River | 93 | 0.3548 | 0.3710 | 0.0054 | 0.2688 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Big [illegible]ver | 99 | 0.3737 | 0.3333 | 0.0303 | 0.2626 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Big [illegible]ukhoi Creek | 99 | 0.3889 | 0.2929 | 0.1364 | 0.1818 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Sturgeon River | 71 | 0.4085 | 0.2465 | 0.2183 | 0.1268 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kizhuyak River | 88 | 0.5284 | 0.3466 | 0.0057 | 0.1193 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Chunilna Creek | 87 | 0.4483 | 0.3793 | 0.1149 | 0.0575 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 92 | 0.5870 | 0.2283 | 0.1196 | 0.0598 | 0.0054 | 0.0000 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 634 | 0.4109 | 0.2674 | 0.0994 | 0.2224 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Southeast Alaska | 858 | 0.4330 | 0.3432 | 0.0472 | 0.1766 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Eastern Queen Charlotte Islands | 385 | 0.2844 | 0.3325 | 0.1364 | 0.2468 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Nass River Area | 255 | 0.4235 | 0.3255 | 0.0549 | 0.1961 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kitimat/Mussel Rivers | 129 | 0.4031 | 0.4070 | 0.0620 | 0.1279 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Nekite Channel/River | 71 | 0.2887 | 0.5211 | 0.0282 | 0.1620 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Port Real Marina | 140 | 0.3929 | 0.3143 | 0.0964 | 0.1964 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Herman Creek | 146 | 0.5514 | 0.3219 | 0.0205 | 0.1027 | 0.0000 | 0.0034 | 0.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 0.6214 | 0.2294 | 0.0924 | 0.0557 | 0.0000 | 0.0000 | 0.0011 | 0.0000 |
| Mill Creek | 179 | 0.4832 | 0.3492 | 0.1257 | 0.0419 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 0.5950 | 0.2150 | 0.1000 | 0.0850 | 0.0000 | 0.0000 | 0.0050 | 0.0000 |
| Skagit River | 251 | 0.6255 | 0.2669 | 0.0359 | 0.0637 | 0.0000 | 0.0000 | 0.0080 | 0.0000 |
| West Vancouver Island | 605 | 0.4430 | 0.3000 | 0.0860 | 0.1620 | 0.0000 | 0.0074 | 0.0017 | 0.0000 |
| East Vancouver Island | 796 | 0.6118 | 0.2845 | 0.0433 | 0.0597 | 0.0000 | 0.0000 | 0.0006 | 0.0000 |
| Lower Fraser River | 398 | 0.6445 | 0.2211 | 0.0653 | 0.0641 | 0.0000 | 0.0025 | 0.0025 | 0.0000 |
| Upper Fraser River | 592 | 0.5938 | 0.2770 | 0.0490 | 0.0802 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Appendix 1. Continued.

| Population | *LDH-A1** | | | | *LDH-B2** | | | |
|---|---|---|---|---|---|---|---|---|
| | N | 100 | 50 | 110 | N | 100 | 120 | 60 |
| Gakko/Miomote Rivers | 118 | 0.8517 | 0.1483 | 0.0000 | 119 | 1.0000 | 0.0000 | 0.0000 |
| Chitose River | 77 | 0.8247 | 0.1558 | 0.0195 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Kushiro River | 80 | 0.9562 | 0.0438 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Nishibetsu River | 80 | 0.8375 | 0.1625 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Ohkawa River | 80 | 0.8688 | 0.1312 | 0.0000 | 80 | 0.9812 | 0.0000 | 0.0188 |
| Shari River | 80 | 0.7188 | 0.2812 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tsugaruishi River | 80 | 0.8375 | 0.1500 | 0.0125 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tokushibetsu River | 40 | 0.9125 | 0.0875 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Tokachi River | 80 | 0.8938 | 0.1062 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Teshio River | 80 | 0.8500 | 0.1375 | 0.0125 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 180 | 0.9556 | 0.0444 | 0.0000 | 183 | 0.9973 | 0.0027 | 0.0000 |
| Kol River | 90 | 0.7833 | 0.2167 | 0.0000 | 91 | 0.9835 | 0.0165 | 0.0000 |
| Kamchatka River | 75 | 0.8533 | 0.1467 | 0.0000 | 75 | 0.9867 | 0.0133 | 0.0000 |
| Hairusova River | 106 | 0.8962 | 0.1038 | 0.0000 | 154 | 0.9773 | 0.0227 | 0.0000 |
| Ola River | 80 | 0.7812 | 0.2188 | 0.0000 | 80 | 0.9875 | 0.0125 | 0.0000 |
| Tumani River | 66 | 0.8258 | 0.1742 | 0.0000 | 66 | 0.9621 | 0.0379 | 0.0000 |
| Utka River | 79 | 0.9304 | 0.0696 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 0.7750 | 0.2250 | 0.0000 | 40 | 0.9625 | 0.0375 | 0.0000 |
| Pymta River | 79 | 0.8608 | 0.1392 | 0.0000 | 79 | 1.0000 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 0.8875 | 0.1125 | 0.0000 | 40 | 0.9750 | 0.0250 | 0.0000 |
| Korf Bay | 18 | 0.9167 | 0.0833 | 0.0000 | 18 | 0.9722 | 0.0278 | 0.0000 |
| LowerYukon/Kuskokwim | 1521 | 0.8064 | 0.1936 | 0.0000 | 1530 | 0.9993 | 0.0007 | 0.0000 |
| Chiginagak/Mainland | 267 | 0.9569 | 0.0431 | 0.0000 | 269 | 0.9981 | 0.0019 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 336 | 0.8557 | 0.1443 | 0.0000 | 338 | 1.0000 | 0.0000 | 0.0000 |
| Norton Sound | 467 | 0.8126 | 0.1874 | 0.0000 | 472 | 0.9989 | 0.0011 | 0.0000 |
| Nushagak River | 286 | 0.7850 | 0.2150 | 0.0000 | 286 | 1.0000 | 0.0000 | 0.0000 |
| Littlejohn/Russell Creek | 178 | 0.8876 | 0.1124 | 0.0000 | 180 | 1.0000 | 0.0000 | 0.0000 |
| Belkofski/Canoe Bay | 185 | 0.9676 | 0.0324 | 0.0000 | 186 | 1.0000 | 0.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 179 | 0.8659 | 0.1341 | 0.0000 | 180 | 1.0000 | 0.0000 | 0.0000 |
| Egegik/Ugashik Bay | 189 | 0.7487 | 0.2513 | 0.0000 | 198 | 1.0000 | 0.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 162 | 0.8611 | 0.1389 | 0.0000 | 164 | 1.0000 | 0.0000 | 0.0000 |
| Tanana River | 497 | 0.7022 | 0.2978 | 0.0000 | 496 | 1.0000 | 0.0000 | 0.0000 |
| Noatak River | 288 | 0.7812 | 0.2188 | 0.0000 | 295 | 0.9966 | 0.0034 | 0.0000 |
| Kelly Lake | 98 | 0.9388 | 0.0612 | 0.0000 | 92 | 1.0000 | 0.0000 | 0.0000 |
| Salmon River | 100 | 0.8200 | 0.1800 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 0.8167 | 0.1833 | 0.0000 | 90 | 1.0000 | 0.0000 | 0.0000 |
| Chena River | 85 | 0.7647 | 0.2353 | 0.0000 | 86 | 1.0000 | 0.0000 | 0.0000 |
| Salcha River | 100 | 0.7500 | 0.2500 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Toklat River | 214 | 0.7313 | 0.2687 | 0.0000 | 215 | 1.0000 | 0.0000 | 0.0000 |
| Sheenjek River | 163 | 0.7117 | 0.2883 | 0.0000 | 164 | 1.0000 | 0.0000 | 0.0000 |
| Meshik River | 162 | 0.9012 | 0.0988 | 0.0000 | 171 | 1.0000 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 99 | 0.9394 | 0.0606 | 0.0000 | 99 | 1.0000 | 0.0000 | 0.0000 |
| Joshua Green River | 80 | 0.9000 | 0.1000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Trader's Cove Creek | 100 | 0.9200 | 0.0800 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Peterson Lagoon | 84 | 0.6310 | 0.3690 | 0.0000 | 85 | 1.0000 | 0.0000 | 0.0000 |
| Stepovak River | 100 | 0.8950 | 0.1050 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Ivanoff River | 93 | 0.9462 | 0.0538 | 0.0000 | 94 | 1.0000 | 0.0000 | 0.0000 |
| Big River | 97 | 0.9485 | 0.0515 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 100 | 0.9450 | 0.0550 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Sturgeon River | 71 | 0.9859 | 0.0141 | 0.0000 | 71 | 1.0000 | 0.0000 | 0.0000 |
| Kizhuyak River | 87 | 0.9425 | 0.0517 | 0.0057 | 88 | 1.0000 | 0.0000 | 0.0000 |
| Chunilna Creek | 87 | 0.9483 | 0.0517 | 0.0000 | 87 | 1.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 91 | 0.8242 | 0.1758 | 0.0000 | 92 | 1.0000 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 652 | 0.9701 | 0.0299 | 0.0000 | 661 | 0.9849 | 0.0151 | 0.0000 |
| Southeast Alaska | 901 | 0.9739 | 0.0261 | 0.0000 | 905 | 0.9972 | 0.0028 | 0.0000 |
| Eastern Queen Charlotte Islands | 431 | 0.9408 | 0.0568 | 0.0023 | 431 | 0.9455 | 0.0545 | 0.0000 |
| Nass River Area | 311 | 0.9695 | 0.0305 | 0.0000 | 311 | 0.9904 | 0.0096 | 0.0000 |
| Kitimat/Mussel Rivers | 222 | 0.9752 | 0.0248 | 0.0000 | 223 | 0.9978 | 0.0022 | 0.0000 |
| Nekite Channel/River | 196 | 0.9898 | 0.0000 | 0.0102 | 197 | 1.0000 | 0.0000 | 0.0000 |
| Port Real Marina | 148 | 0.9764 | 0.0236 | 0.0000 | 148 | 0.9797 | 0.0203 | 0.0000 |
| Herman Creek | 159 | 0.9591 | 0.0409 | 0.0000 | 158 | 1.0000 | 0.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 1.0000 | 0.0000 | 0.0000 | 449 | 1.0000 | 0.0000 | 0.0000 |
| Mill Creek | 179 | 1.0000 | 0.0000 | 0.0000 | 179 | 0.9944 | 0.0056 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 1.0000 | 0.0000 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Skagit River | 251 | 1.0000 | 0.0000 | 0.0000 | 251 | 0.9980 | 0.0020 | 0.0000 |
| West Vancouver Island | 606 | 0.9992 | 0.0008 | 0.0000 | 606 | 1.0000 | 0.0000 | 0.0000 |
| East Vancouver Island | 800 | 0.9931 | 0.0069 | 0.0000 | 800 | 0.9975 | 0.0025 | 0.0000 |
| Lower Fraser River | 400 | 0.9988 | 0.0012 | 0.0000 | 400 | 1.0000 | 0.0000 | 0.0000 |
| Upper Fraser River | 600 | 0.9917 | 0.0083 | 0.0000 | 600 | 1.0000 | 0.0000 | 0.0000 |

Appendix 1. Continued.

| | | sMDH-A1* | | | | | sMDH-B1,2* | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Population | N | 100 | 200 | 400 | -10 | N | 100 | 72 | 50 | 130 |
| Gakko/Miomote Rivers | 119 | 0.8235 | 0.1723 | 0.0000 | 0.0042 | 119 | 0.9916 | 0.0042 | 0.0042 | 0.0000 |
| Chitose River | 77 | 0.8961 | 0.1039 | 0.0000 | 0.0000 | 80 | 0.9938 | 0.0031 | 0.0031 | 0.0000 |
| Kushiro River | 80 | 0.9125 | 0.0875 | 0.0000 | 0.0000 | 80 | 0.9594 | 0.0156 | 0.0250 | 0.0000 |
| Nishibetsu River | 80 | 0.9188 | 0.0812 | 0.0000 | 0.0000 | 80 | 0.9812 | 0.0094 | 0.0094 | 0.0000 |
| Ohkawa River | 80 | 0.8812 | 0.1188 | 0.0000 | 0.0000 | 80 | 0.9906 | 0.0000 | 0.0094 | 0.0000 |
| Shari River | 40 | 0.8375 | 0.1625 | 0.0000 | 0.0000 | 40 | 0.9688 | 0.0250 | 0.0062 | 0.0000 |
| Tsugaru Ishi River | 80 | 0.9188 | 0.0812 | 0.0000 | 0.0000 | 80 | 0.9938 | 0.0000 | 0.0031 | 0.0031 |
| Tokushibetsu River | 40 | 0.8750 | 0.1250 | 0.0000 | 0.0000 | 40 | 0.9812 | 0.0062 | 0.0125 | 0.0000 |
| Tokachi River | 80 | 0.9125 | 0.0875 | 0.0000 | 0.0000 | 80 | 0.9375 | 0.0281 | 0.0344 | 0.0000 |
| Teshio River | 40 | 0.7875 | 0.2125 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 182 | 0.9863 | 0.0137 | 0.0000 | 0.0000 | 1820 | 0.9945 | 0.0027 | 0.0014 | 0.0014 |
| Kol River | 77 | 0.9805 | 0.0195 | 0.0000 | 0.0000 | 91 | 0.9945 | 0.0000 | 0.0000 | 0.0055 |
| Kamchatka River | 75 | 0.9733 | 0.0267 | 0.0000 | 0.0000 | 75 | 0.9800 | 0.0167 | 0.0000 | 0.0033 |
| Hairusova River | 98 | 0.9745 | 0.0255 | 0.0000 | 0.0000 | 153 | 0.9984 | 0.0016 | 0.0000 | 0.0000 |
| Ola River | 80 | 0.9812 | 0.0188 | 0.0000 | 0.0000 | 80 | 0.9844 | 0.0156 | 0.0000 | 0.0000 |
| Tumani River | 66 | 0.9545 | 0.0455 | 0.0000 | 0.0000 | 66 | 0.9962 | 0.0000 | 0.0000 | 0.0038 |
| Utka River | 78 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 79 | 0.9968 | 0.0032 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 0.9875 | 0.0125 | 0.0000 | 0.0000 | 40 | 0.9812 | 0.0125 | 0.0062 | 0.0000 |
| Pymta River | 78 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 79 | 0.9905 | 0.0095 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 40 | 0.9750 | 0.0250 | 0.0000 | 0.0000 |
| Korf Bay | 18 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 18 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1523 | 0.9524 | 0.0460 | 0.0000 | 0.0016 | 1524 | 0.9951 | 0.0038 | 0.0007 | 0.0005 |
| Chiginagak/Mainland | 269 | 0.9480 | 0.0520 | 0.0000 | 0.0000 | 269 | 0.9796 | 0.0195 | 0.0000 | 0.0009 |
| Kanektok/Goodnews/Togiak Rivers | 336 | 0.9554 | 0.0446 | 0.0000 | 0.0000 | 338 | 0.9933 | 0.0059 | 0.0007 | 0.0000 |
| Norton Sound | 468 | 0.9615 | 0.0363 | 0.0011 | 0.0011 | 469 | 0.9957 | 0.0011 | 0.0032 | 0.0000 |
| Nushagak River | 285 | 0.9561 | 0.0439 | 0.0000 | 0.0000 | 283 | 0.9929 | 0.0044 | 0.0018 | 0.0009 |
| Littlejohn/Russell Creek | 177 | 0.9548 | 0.0424 | 0.0028 | 0.0000 | 180 | 0.9778 | 0.0167 | 0.0000 | 0.0056 |
| Belkofski/Canoe Bay | 185 | 0.9514 | 0.0486 | 0.0000 | 0.0000 | 187 | 0.9840 | 0.0080 | 0.0027 | 0.0053 |
| Frosty/St Catherine's Cove | 179 | 0.9330 | 0.0670 | 0.0000 | 0.0000 | 178 | 0.9775 | 0.0084 | 0.0014 | 0.0126 |
| Egegik/Ugashik Bay | 198 | 0.9444 | 0.0556 | 0.0000 | 0.0000 | 198 | 0.9912 | 0.0000 | 0.0000 | 0.0088 |
| Naknek/Alagnak Rivers | 163 | 0.9479 | 0.0521 | 0.0000 | 0.0000 | 164 | 0.9893 | 0.0015 | 0.0061 | 0.0030 |
| Tanana River | 496 | 0.9456 | 0.0544 | 0.0000 | 0.0000 | 497 | 0.9995 | 0.0005 | 0.0000 | 0.0000 |
| Noatak River | 291 | 0.9124 | 0.0876 | 0.0000 | 0.0000 | 293 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kelly Lake | 98 | 0.9796 | 0.0204 | 0.0000 | 0.0000 | 95 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Salmon River | 100 | 0.9100 | 0.0900 | 0.0000 | 0.0000 | 99 | 0.9975 | 0.0025 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 0.9500 | 0.0500 | 0.0000 | 0.0000 | 90 | 0.9917 | 0.0083 | 0.0000 | 0.0000 |
| Chena River | 86 | 0.9651 | 0.0349 | 0.0000 | 0.0000 | 86 | 0.9913 | 0.0087 | 0.0000 | 0.0000 |
| Salcha River | 99 | 0.9192 | 0.0808 | 0.0000 | 0.0000 | 100 | 0.9900 | 0.0100 | 0.0000 | 0.0000 |
| Toklat River | 215 | 0.9140 | 0.0860 | 0.0000 | 0.0000 | 215 | 0.9988 | 0.0012 | 0.0000 | 0.0000 |
| Sheenjek River | 164 | 0.8841 | 0.1159 | 0.0000 | 0.0000 | 164 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Meshik River | 169 | 0.9231 | 0.0769 | 0.0000 | 0.0000 | 170 | 0.9882 | 0.0000 | 0.0088 | 0.0029 |
| Lawrence Valley Creek | 98 | 0.8980 | 0.0969 | 0.0000 | 0.0051 | 100 | 0.9600 | 0.0050 | 0.0100 | 0.0250 |
| Joshua Green River | 80 | 0.9625 | 0.0375 | 0.0000 | 0.0000 | 80 | 0.9719 | 0.0219 | 0.0062 | 0.0000 |
| Trader's Cove Creek | 100 | 0.9750 | 0.0250 | 0.0000 | 0.0000 | 99 | 0.9747 | 0.0051 | 0.0202 | 0.0000 |
| Peterson Lagoon | 85 | 0.9412 | 0.0588 | 0.0000 | 0.0000 | 85 | 0.9647 | 0.0088 | 0.0000 | 0.0265 |
| Stepovak River | 100 | 0.9100 | 0.0900 | 0.0000 | 0.0000 | 100 | 0.9850 | 0.0150 | 0.0000 | 0.0000 |
| Ivanoff River | 93 | 0.9086 | 0.0806 | 0.0108 | 0.0000 | 94 | 0.9707 | 0.0186 | 0.0053 | 0.0053 |
| Big River | 99 | 0.9798 | 0.0202 | 0.0000 | 0.0000 | 100 | 0.9400 | 0.0600 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 99 | 0.7424 | 0.1768 | 0.0051 | 0.0758 | 100 | 0.9975 | 0.0025 | 0.0000 | 0.0000 |
| Sturgeon River | 71 | 0.9296 | 0.0704 | 0.0000 | 0.0000 | 70 | 0.8357 | 0.0071 | 0.1571 | 0.0000 |
| Kizhuyak River | 88 | 0.9432 | 0.0398 | 0.0170 | 0.0000 | 88 | 0.9830 | 0.0142 | 0.0028 | 0.0000 |
| Chunilna Creek | 87 | 0.9310 | 0.0690 | 0.0000 | 0.0000 | 87 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 92 | 0.9674 | 0.0326 | 0.0000 | 0.0000 | 92 | 0.9565 | 0.0353 | 0.0000 | 0.0082 |
| Eastern Prince of Whales Island | 456 | 0.9331 | 0.0669 | 0.0000 | 0.0000 | 459 | 0.9788 | 0.0158 | 0.0000 | 0.0054 |
| Southeast Alaska | 585 | 0.9752 | 0.0248 | 0.0000 | 0.0000 | 783 | 0.9872 | 0.0105 | 0.0006 | 0.0016 |
| Eastern Queen Charlotte Islands | 429 | 0.9021 | 0.0979 | 0.0000 | 0.0000 | 431 | 0.9664 | 0.0278 | 0.0000 | 0.0058 |
| Nass River Area | 310 | 0.9661 | 0.0339 | 0.0000 | 0.0000 | 311 | 0.9727 | 0.0233 | 0.0032 | 0.0008 |
| Kitimat/Mussel Rivers | 221 | 0.9751 | 0.0249 | 0.0000 | 0.0000 | 223 | 0.9888 | 0.0101 | 0.0011 | 0.0000 |
| Nekite Channel/River | 196 | 0.9745 | 0.0255 | 0.0000 | 0.0000 | 197 | 0.9987 | 0.0000 | 0.0000 | 0.0013 |
| Port Real Marina | 108 | 0.9074 | 0.0926 | 0.0000 | 0.0000 | 108 | 0.9606 | 0.0370 | 0.0000 | 0.0023 |
| Herman Creek | 119 | 0.9790 | 0.0210 | 0.0000 | 0.0000 | 159 | 0.9796 | 0.0204 | 0.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 0.9866 | 0.0134 | 0.0000 | 0.0000 | 449 | 0.9950 | 0.0050 | 0.0000 | 0.0000 |
| Mill Creek | 179 | 0.9749 | 0.0251 | 0.0000 | 0.0000 | 179 | 0.9888 | 0.0112 | 0.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 99 | 0.9747 | 0.0253 | 0.0000 | 0.0000 | 100 | 0.9900 | 0.0100 | 0.0000 | 0.0000 |
| Skagit River | 249 | 0.9819 | 0.0181 | 0.0000 | 0.0000 | 251 | 0.9980 | 0.0020 | 0.0000 | 0.0000 |
| West Vancouver Island | 605 | 0.9719 | 0.0281 | 0.0000 | 0.0000 | 605 | 0.9930 | 0.0066 | 0.0004 | 0.0000 |
| East Vancouver Island | 800 | 0.9938 | 0.0062 | 0.0000 | 0.0000 | 800 | 0.9975 | 0.0019 | 0.0000 | 0.0006 |
| Lower Fraser River | 400 | 0.9912 | 0.0088 | 0.0000 | 0.0000 | 400 | 0.9906 | 0.0081 | 0.0012 | 0.0000 |
| Upper Fraser River | 600 | 0.9867 | 0.0133 | 0.0000 | 0.0000 | 598 | 0.9925 | 0.0075 | 0.0000 | 0.0000 |

Appendix 1. Continued.

| Population | mMEP-2* N | 100 | 122 | sMEP-1* N | 100 | 90 |
|---|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 119 | 0.9034 | 0.0966 | 119 | 0.9244 | 0.0756 |
| Chitose River | 76 | 0.9211 | 0.0789 | 75 | 0.9867 | 0.0133 |
| Kushiro River | 80 | 0.9125 | 0.0875 | 80 | 0.9812 | 0.0188 |
| Nishibetsu River | 80 | 0.7938 | 0.2062 | 80 | 0.9750 | 0.0250 |
| Ohkawa River | 80 | 0.9250 | 0.0750 | 80 | 0.9125 | 0.0875 |
| Shari River | 80 | 0.9062 | 0.0938 | 80 | 0.9938 | 0.0062 |
| Tsugaruishi River | 79 | 0.9367 | 0.0633 | 79 | 0.9684 | 0.0316 |
| Tokushibetsu River | 40 | 0.8125 | 0.1875 | 40 | 1.0000 | 0.0000 |
| Tokachi River | 80 | 0.9125 | 0.0875 | 80 | 0.9875 | 0.0125 |
| Teshio River | 80 | 0.8875 | 0.1125 | 80 | 0.9812 | 0.0188 |
| Anadyr/Kanchalan Rivers | 103 | 0.7039 | 0.2961 | 104 | 1.0000 | 0.0000 |
| Kol River | 90 | 0.7389 | 0.2611 | 91 | 1.0000 | 0.0000 |
| Kamchatka River | 75 | 0.7733 | 0.2267 | 76 | 1.0000 | 0.0000 |
| Hairusova River | 107 | 0.7991 | 0.2009 | 68 | 1.0000 | 0.0000 |
| Ola River | 80 | 0.8750 | 0.1250 | 80 | 1.0000 | 0.0000 |
| Tumani River | 64 | 0.8281 | 0.1719 | 65 | 1.0000 | 0.0000 |
| Utka River | 79 | 0.8228 | 0.1772 | 79 | 1.0000 | 0.0000 |
| Kikchik River | 36 | 0.8056 | 0.1944 | 40 | 1.0000 | 0.0000 |
| Pymta River | 79 | 0.7025 | 0.2975 | 79 | 1.0000 | 0.0000 |
| Nerpichi Lake | 40 | 0.7000 | 0.3000 | 40 | 1.0000 | 0.0000 |
| Korf Bay | 18 | 0.6667 | 0.3333 | 18 | 1.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1521 | 0.7817 | 0.2183 | 1405 | 1.0000 | 0.0000 |
| Chiginagak/Mainland | 261 | 0.9119 | 0.0881 | 268 | 1.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 334 | 0.7096 | 0.2904 | 337 | 1.0000 | 0.0000 |
| Norton Sound | 465 | 0.7054 | 0.2946 | 466 | 1.0000 | 0.0000 |
| Nushagak River | 285 | 0.7702 | 0.2298 | 286 | 0.9983 | 0.0017 |
| Littlejohn/Russell Creek | 180 | 0.8583 | 0.1417 | 179 | 1.0000 | 0.0000 |
| Belkofski/Canoe Bay | 186 | 0.8575 | 0.1425 | 146 | 1.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 179 | 0.8631 | 0.1369 | 179 | 1.0000 | 0.0000 |
| Egegik/Ugashik Bay | 196 | 0.7985 | 0.2015 | 197 | 1.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 162 | 0.7747 | 0.2253 | 162 | 1.0000 | 0.0000 |
| Tanana River | 497 | 0.9105 | 0.0895 | 497 | 1.0000 | 0.0000 |
| Noatak River | 291 | 0.6821 | 0.3179 | 295 | 1.0000 | 0.0000 |
| Kelly Lake | 96 | 0.7656 | 0.2344 | 101 | 1.0000 | 0.0000 |
| Salmon River | 98 | 0.6837 | 0.3163 | 98 | 1.0000 | 0.0000 |
| Pilgrim River | 90 | 0.6944 | 0.3056 | 90 | 1.0000 | 0.0000 |
| Chena River | 85 | 0.8588 | 0.1412 | 86 | 1.0000 | 0.0000 |
| Salcha River | 100 | 0.8900 | 0.1100 | 98 | 1.0000 | 0.0000 |
| Toklat River | 214 | 0.9112 | 0.0888 | 213 | 1.0000 | 0.0000 |
| Sheenjek River | 164 | 0.9421 | 0.0579 | 164 | 1.0000 | 0.0000 |
| Meshik River | 163 | 0.8282 | 0.1718 | 169 | 1.0000 | 0.0000 |
| Lawrence Valley Creek | 96 | 0.8854 | 0.1146 | 97 | 1.0000 | 0.0000 |
| Joshua Green River | 80 | 0.8562 | 0.1438 | 80 | 1.0000 | 0.0000 |
| Trader's Cove Creek | 99 | 0.9091 | 0.0909 | 100 | 1.0000 | 0.0000 |
| Peterson Lagoon | 83 | 0.9157 | 0.0843 | 84 | 1.0000 | 0.0000 |
| Stepovak River | 100 | 0.9150 | 0.0850 | 100 | 1.0000 | 0.0000 |
| Ivanoff River | 93 | 0.9516 | 0.0484 | 90 | 1.0000 | 0.0000 |
| Big River | 95 | 0.9263 | 0.0737 | 96 | 1.0000 | 0.0000 |
| Big Sukhoi Creek | 100 | 0.9500 | 0.0500 | 100 | 1.0000 | 0.0000 |
| Sturgeon River | 70 | 0.9857 | 0.0143 | 71 | 1.0000 | 0.0000 |
| Kizhuyak River | 87 | 0.9310 | 0.0690 | 87 | 1.0000 | 0.0000 |
| Chunilna Creek | 83 | 0.8072 | 0.1928 | 83 | 1.0000 | 0.0000 |
| WHN Hatchery | 85 | 0.7941 | 0.2059 | 92 | 1.0000 | 0.0000 |
| Eastern Prince of Whales Island | 654 | 0.9480 | 0.0520 | 612 | 1.0000 | 0.0000 |
| Southeast Alaska | 890 | 0.8843 | 0.1157 | 897 | 0.9978 | 0.0022 |
| Eastern Queen Charlotte Islands | 427 | 0.8899 | 0.1101 | 430 | 1.0000 | 0.0000 |
| Nass River Area | 308 | 0.8718 | 0.1282 | 309 | 1.0000 | 0.0000 |
| Kitimat/Mussel Rivers | 221 | 0.8507 | 0.1493 | 221 | 0.9977 | 0.0023 |
| Nekite Channel/River | 192 | 0.8333 | 0.1667 | 195 | 1.0000 | 0.0000 |
| Port Real Marina | 148 | 0.9324 | 0.0676 | 108 | 1.0000 | 0.0000 |
| Herman Creek | 159 | 0.9403 | 0.0597 | 157 | 1.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 0.7773 | 0.2227 | 414 | 1.0000 | 0.0000 |
| Mill Creek | 178 | 0.7725 | 0.2275 | 175 | 1.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 99 | 0.7576 | 0.2424 | 99 | 1.0000 | 0.0000 |
| Skagit River | 251 | 0.7251 | 0.2749 | 244 | 1.0000 | 0.0000 |
| West Vancouver Island | 606 | 0.7904 | 0.2096 | 545 | 1.0000 | 0.0000 |
| East Vancouver Island | 800 | 0.7812 | 0.2188 | 747 | 1.0000 | 0.0000 |
| Lower Fraser River | 400 | 0.8275 | 0.1725 | 367 | 1.0000 | 0.0000 |
| Upper Fraser River | 600 | 0.8492 | 0.1508 | 541 | 1.0000 | 0.0000 |

Appendix 1. Continued.

| Population | MPI* N | 100 | 94 | 110 | 80 | PEPA* N | 100 | 90 | 113 |
|---|---|---|---|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 119 | 0.9496 | 0.0504 | 0.0000 | 0.0000 | 119 | 1.0000 | 0.0000 | 0.0000 |
| Chitose River | 79 | 0.9873 | 0.0127 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Kushiro River | 70 | 0.9929 | 0.0071 | 0.0000 | 0.0000 | 78 | 1.0000 | 0.0000 | 0.0000 |
| Nishibetsu River | 80 | 0.9562 | 0.0438 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Ohkawa River | 80 | 0.9750 | 0.0250 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Shari River | 80 | 0.9812 | 0.0188 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tsugaruishi River | 79 | 0.9304 | 0.0696 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tokushibetsu River | 40 | 0.9875 | 0.0125 | 0.0000 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Tokachi River | 79 | 0.9241 | 0.0570 | 0.0190 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Teshio River | 80 | 0.9625 | 0.0375 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Anadyr/Kanchalan Rivers | 183 | 0.9044 | 0.0956 | 0.0000 | 0.0000 | 182 | 1.0000 | 0.0000 | 0.0000 |
| Kol River | 90 | 0.8833 | 0.1167 | 0.0000 | 0.0000 | 90 | 0.9944 | 0.0056 | 0.0000 |
| Kamchatka River | 75 | 0.8933 | 0.1067 | 0.0000 | 0.0000 | 75 | 0.9867 | 0.0133 | 0.0000 |
| Hairusova River | 152 | 0.8947 | 0.1053 | 0.0000 | 0.0000 | 132 | 0.9924 | 0.0038 | 0.0038 |
| Ola River | 80 | 0.8812 | 0.1188 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Tumani River | 66 | 0.8864 | 0.1136 | 0.0000 | 0.0000 | 66 | 1.0000 | 0.0000 | 0.0000 |
| Utka River | 79 | 0.8924 | 0.1076 | 0.0000 | 0.0000 | 76 | 0.9934 | 0.0000 | 0.0066 |
| Kikchik River | 40 | 0.8750 | 0.1250 | 0.0000 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Pymta River | 78 | 0.8462 | 0.1538 | 0.0000 | 0.0000 | 79 | 0.9937 | 0.0000 | 0.0063 |
| Nerpichi Lake | 38 | 0.8947 | 0.1053 | 0.0000 | 0.0000 | 40 | 1.0000 | 0.0000 | 0.0000 |
| Korf Bay | 18 | 0.9167 | 0.0833 | 0.0000 | 0.0000 | 18 | 1.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1514 | 0.8682 | 0.1318 | 0.0000 | 0.0000 | 1523 | 0.9967 | 0.0000 | 0.0033 |
| Chiginagak/Mainland | 269 | 0.7918 | 0.2082 | 0.0000 | 0.0000 | 269 | 1.0000 | 0.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 333 | 0.8934 | 0.1066 | 0.0000 | 0.0000 | 331 | 1.0000 | 0.0000 | 0.0000 |
| Norton Sound | 467 | 0.8822 | 0.1178 | 0.0000 | 0.0000 | 463 | 0.9989 | 0.0000 | 0.0011 |
| Nushagak River | 282 | 0.8369 | 0.1631 | 0.0000 | 0.0000 | 286 | 0.9965 | 0.0000 | 0.0035 |
| Littlejohn/Russell Creek | 178 | 0.8820 | 0.1180 | 0.0000 | 0.0000 | 180 | 1.0000 | 0.0000 | 0.0000 |
| Belkofski/Canoe Bay | 178 | 0.8539 | 0.1461 | 0.0000 | 0.0000 | 183 | 1.0000 | 0.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 178 | 0.8933 | 0.1067 | 0.0000 | 0.0000 | 178 | 1.0000 | 0.0000 | 0.0000 |
| Egegik/Ugashik Bay | 195 | 0.9000 | 0.1000 | 0.0000 | 0.0000 | 197 | 1.0000 | 0.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 161 | 0.8727 | 0.1273 | 0.0000 | 0.0000 | 162 | 1.0000 | 0.0000 | 0.0000 |
| Tanana River | 495 | 0.9273 | 0.0727 | 0.0000 | 0.0000 | 446 | 1.0000 | 0.0000 | 0.0000 |
| Noatak River | 291 | 0.9210 | 0.0790 | 0.0000 | 0.0000 | 294 | 0.9983 | 0.0000 | 0.0017 |
| Kelly Lake | 96 | 0.8854 | 0.1146 | 0.0000 | 0.0000 | 91 | 0.9945 | 0.0000 | 0.0055 |
| Salmon River | 96 | 0.9583 | 0.0417 | 0.0000 | 0.0000 | 92 | 1.0000 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 0.8944 | 0.1056 | 0.0000 | 0.0000 | 90 | 1.0000 | 0.0000 | 0.0000 |
| Chena River | 86 | 0.9244 | 0.0756 | 0.0000 | 0.0000 | 82 | 1.0000 | 0.0000 | 0.0000 |
| Salcha River | 98 | 0.9541 | 0.0459 | 0.0000 | 0.0000 | 98 | 1.0000 | 0.0000 | 0.0000 |
| Toklat River | 210 | 0.8595 | 0.1405 | 0.0000 | 0.0000 | 199 | 1.0000 | 0.0000 | 0.0000 |
| Sheenjek River | 163 | 0.9110 | 0.0890 | 0.0000 | 0.0000 | 164 | 1.0000 | 0.0000 | 0.0000 |
| Meshik River | 162 | 0.9444 | 0.0556 | 0.0000 | 0.0000 | 169 | 1.0000 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 100 | 0.8600 | 0.1400 | 0.0000 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Joshua Green River | 77 | 0.9156 | 0.0844 | 0.0000 | 0.0000 | 80 | 1.0000 | 0.0000 | 0.0000 |
| Trader's Cove Creek | 97 | 0.9124 | 0.0876 | 0.0000 | 0.0000 | 99 | 1.0000 | 0.0000 | 0.0000 |
| Peterson Lagoon | 85 | 0.8882 | 0.1118 | 0.0000 | 0.0000 | 83 | 1.0000 | 0.0000 | 0.0000 |
| Stepovak River | 100 | 0.7950 | 0.2050 | 0.0000 | 0.0000 | 99 | 1.0000 | 0.0000 | 0.0000 |
| Ivanoff River | 93 | 0.9194 | 0.0753 | 0.0054 | 0.0000 | 93 | 1.0000 | 0.0000 | 0.0000 |
| Big River | 98 | 0.8265 | 0.1735 | 0.0000 | 0.0000 | 98 | 1.0000 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 97 | 0.7062 | 0.2938 | 0.0000 | 0.0000 | 100 | 1.0000 | 0.0000 | 0.0000 |
| Sturgeon River | 70 | 0.9429 | 0.0571 | 0.0000 | 0.0000 | 70 | 1.0000 | 0.0000 | 0.0000 |
| Kizhuyak River | 88 | 0.7841 | 0.2102 | 0.0057 | 0.0000 | 88 | 1.0000 | 0.0000 | 0.0000 |
| Chunilna Creek | 82 | 0.9573 | 0.0427 | 0.0000 | 0.0000 | 87 | 1.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 90 | 0.7722 | 0.2278 | 0.0000 | 0.0000 | 92 | 1.0000 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 453 | 0.8951 | 0.1049 | 0.0000 | 0.0000 | 551 | 1.0000 | 0.0000 | 0.0000 |
| Southeast Alaska | 580 | 0.9078 | 0.0862 | 0.0000 | 0.0060 | 835 | 0.9994 | 0.0006 | 0.0000 |
| Eastern Queen Charlotte Islands | 430 | 0.9279 | 0.0721 | 0.0000 | 0.0000 | 224 | 1.0000 | 0.0000 | 0.0000 |
| Nass River Area | 310 | 0.8903 | 0.0968 | 0.0000 | 0.0129 | 234 | 0.9979 | 0.0021 | 0.0000 |
| Kitimat/Mussel Rivers | 223 | 0.9193 | 0.0785 | 0.0000 | 0.0022 | 167 | 1.0000 | 0.0000 | 0.0000 |
| Nekite Channel/Rive: | 197 | 0.9518 | 0.0482 | 0.0000 | 0.0000 | 96 | 1.0000 | 0.0000 | 0.0000 |
| Port Real Marina | 107 | 0.8879 | 0.1121 | 0.0000 | 0.0000 | 140 | 1.0000 | 0.0000 | 0.0000 |
| Herman Creek | 117 | 0.8632 | 0.1368 | 0.0000 | 0.0000 | 156 | 1.0000 | 0.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 0.8719 | 0.1281 | 0.0000 | 0.0000 | 196 | 1.0000 | 0.0000 | 0.0000 |
| Mill Creek | 179 | 0.7430 | 0.2570 | 0.0000 | 0.0000 | 59 | 1.0000 | 0.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 0.9100 | 0.0900 | 0.0000 | 0.0000 | 99 | 0.9949 | 0.0000 | 0.0051 |
| Skagit River | 251 | 0.8207 | 0.1793 | 0.0000 | 0.0000 | 251 | 0.9920 | 0.0000 | 0.0080 |
| West Vancouver Island | 602 | 0.9244 | 0.0756 | 0.0000 | 0.0000 | 329 | 1.0000 | 0.0000 | 0.0000 |
| East Vancouver Island | 800 | 0.9038 | 0.0956 | 0.0000 | 0.0006 | 455 | 1.0000 | 0.0000 | 0.0000 |
| Lower Fraser River | 400 | 0.8975 | 0.1025 | 0.0000 | 0.0000 | 161 | 1.0000 | 0.0000 | 0.0000 |
| Upper Fraser River | 600 | 0.8758 | 0.1242 | 0.0000 | 0.0000 | 333 | 0.9925 | 0.0000 | 0.0075 |

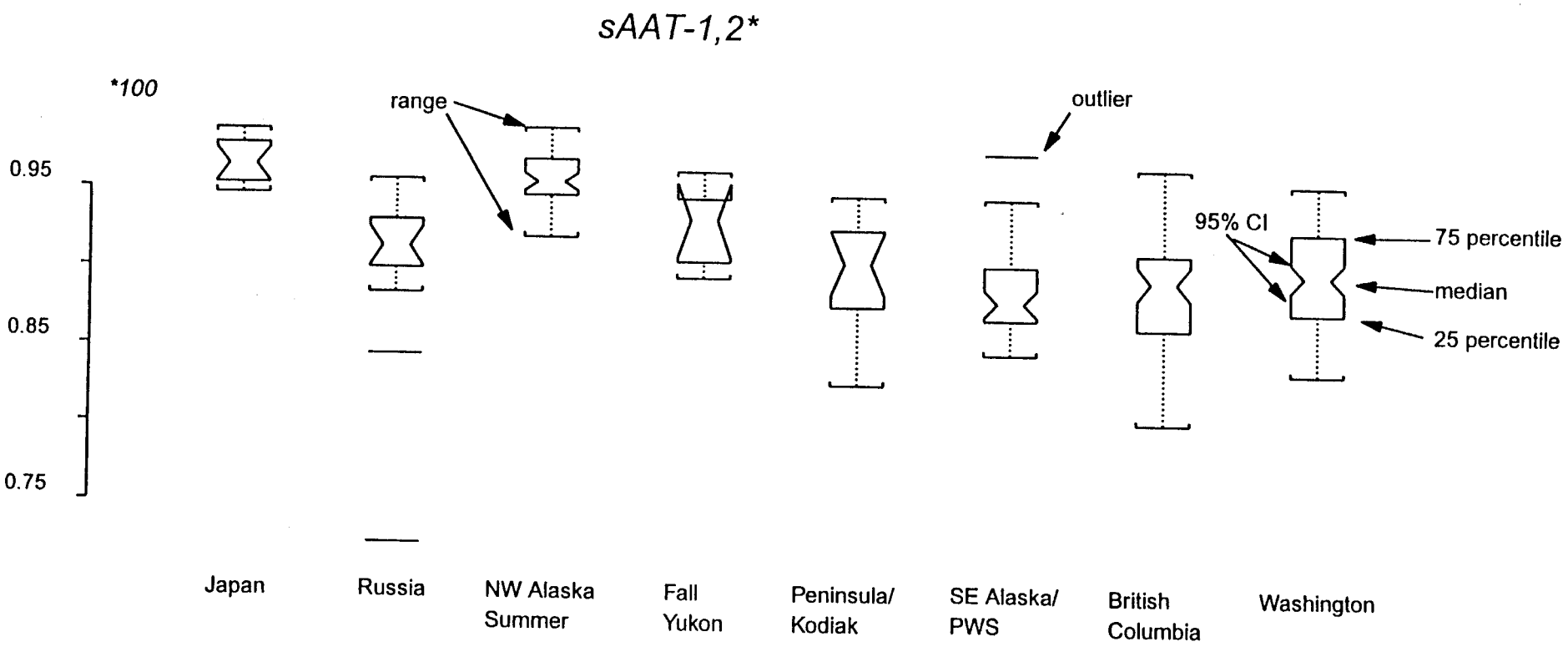
Appendix 1. Continued.

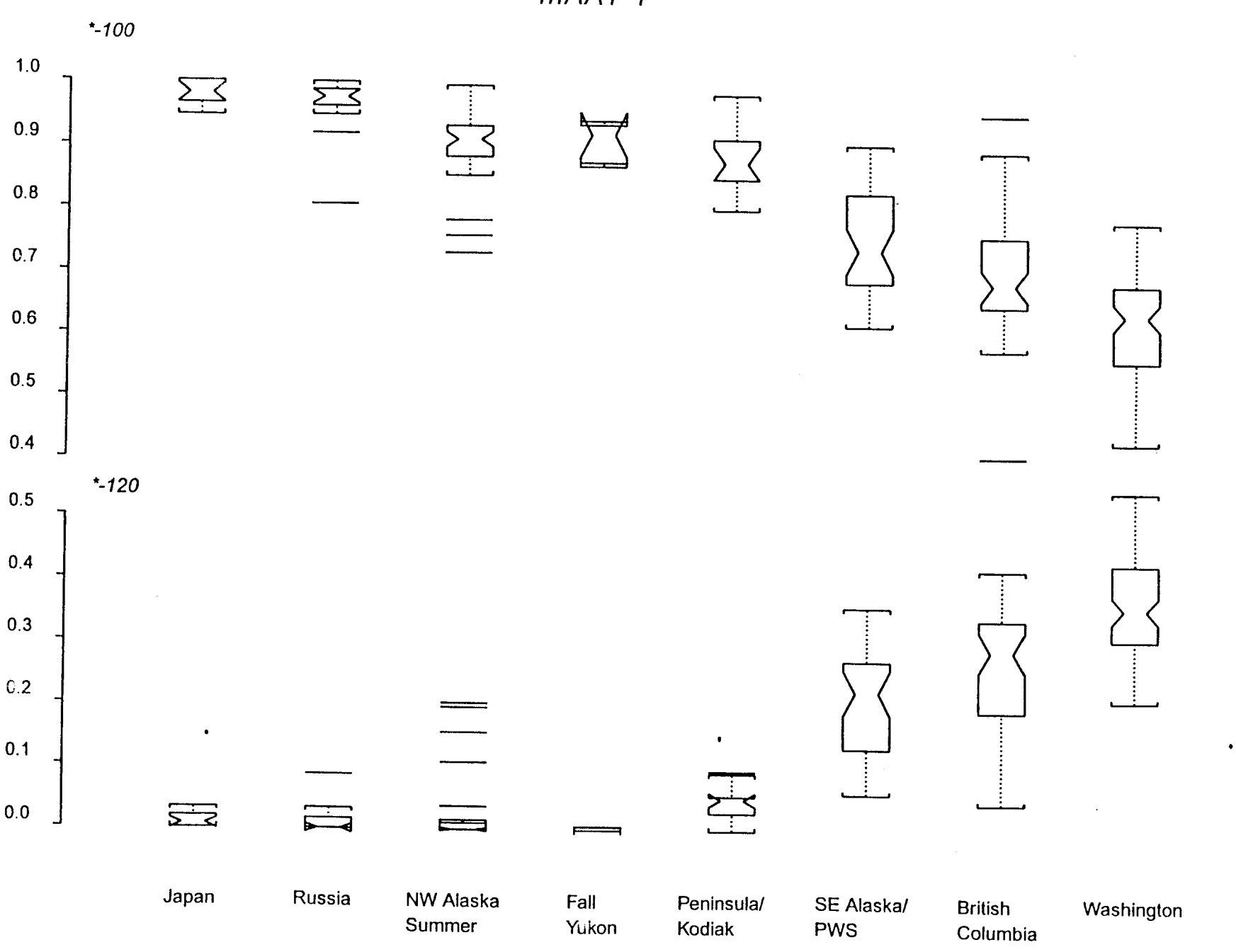
| Population | N | *PEPB-1** -100 | -146 | -126 | -127 | -72 |
|---|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 119 | 0.6933 | 0.0168 | 0.2857 | 0.0042 | 0.0000 |
| Chitose River | 76 | 0.6842 | 0.0395 | 0.2763 | 0.0000 | 0.0000 |
| Kushiro River | 80 | 0.8438 | 0.0000 | 0.1562 | 0.0000 | 0.0000 |
| Nishibetsu River | 80 | 0.7875 | 0.0000 | 0.2062 | 0.0062 | 0.0000 |
| Ohkawa River | 80 | 0.6125 | 0.0000 | 0.3875 | 0.0000 | 0.0000 |
| Shari River | 80 | 0.8750 | 0.0000 | 0.1250 | 0.0000 | 0.0000 |
| Tsugaruishi River | 79 | 0.7468 | 0.0063 | 0.2468 | 0.0000 | 0.0000 |
| Tokushibetsu River | 39 | 0.6923 | 0.0128 | 0.2821 | 0.0128 | 0.0000 |
| Tokachi River | 80 | 0.7375 | 0.0000 | 0.2625 | 0.0000 | 0.0000 |
| Teshio River | 80 | 0.7000 | 0.0125 | 0.2812 | 0.0062 | 0.0000 |
| Anadyr/Kanchalan Rivers | 181 | 0.8895 | 0.0829 | 0.0276 | 0.0000 | 0.0000 |
| Kol River | 90 | 0.9500 | 0.0444 | 0.0056 | 0.0000 | 0.0000 |
| Kamchatka River | 75 | 0.9533 | 0.0267 | 0.0200 | 0.0000 | 0.0000 |
| Hairusova River | 141 | 0.8511 | 0.1206 | 0.0071 | 0.0213 | 0.0000 |
| Ola River | 80 | 0.8375 | 0.0875 | 0.0750 | 0.0000 | 0.0000 |
| Tumani River | 66 | 0.8864 | 0.0833 | 0.0303 | 0.0000 | 0.0000 |
| Utka River | 76 | 0.8882 | 0.0789 | 0.0329 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 0.8000 | 0.1625 | 0.0375 | 0.0000 | 0.0000 |
| Pymta River | 79 | 0.9114 | 0.0506 | 0.0380 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 0.9375 | 0.0500 | 0.0125 | 0.0000 | 0.0000 |
| Korf Bay | 18 | 0.8056 | 0.1944 | 0.0000 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1506 | 0.9180 | 0.0687 | 0.0133 | 0.0000 | 0.0000 |
| Chiginagak/Mainland | 266 | 0.8026 | 0.1786 | 0.0188 | 0.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 337 | 0.9392 | 0.0504 | 0.0104 | 0.0000 | 0.0000 |
| Norton Sound | 464 | 0.9300 | 0.0614 | 0.0086 | 0.0000 | 0.0000 |
| Nushagak River | 280 | 0.9250 | 0.0518 | 0.0196 | 0.0000 | 0.0036 |
| Littlejohn/Russell Creek | 180 | 0.8139 | 0.1583 | 0.0250 | 0.0000 | 0.0028 |
| Belkofski/Canoe Bay | 186 | 0.8333 | 0.1532 | 0.0081 | 0.0054 | 0.0000 |
| Frosty/St Catherine's Cove | 175 | 0.8229 | 0.1371 | 0.0400 | 0.0000 | 0.0000 |
| Egegik/Ugashik Bay | 194 | 0.9278 | 0.0670 | 0.0026 | 0.0026 | 0.0000 |
| Naknek/Alagnak Rivers | 164 | 0.9390 | 0.0549 | 0.0061 | 0.0000 | 0.0000 |
| Tanana River | 497 | 0.8310 | 0.1469 | 0.0221 | 0.0000 | 0.0000 |
| Noatak River | 289 | 0.9221 | 0.0554 | 0.0225 | 0.0000 | 0.0000 |
| Kelly Lake | 84 | 0.7917 | 0.1071 | 0.1012 | 0.0000 | 0.0000 |
| Salmon River | 99 | 0.9646 | 0.0354 | 0.0000 | 0.0000 | 0.0000 |
| Pilgrim River | 89 | 0.9213 | 0.0674 | 0.0112 | 0.0000 | 0.0000 |
| Chena River | 86 | 0.8140 | 0.1512 | 0.0349 | 0.0000 | 0.0000 |
| Salcha River | 100 | 0.8900 | 0.1100 | 0.0000 | 0.0000 | 0.0000 |
| Toklat River | 211 | 0.7820 | 0.1896 | 0.0284 | 0.0000 | 0.0000 |
| Sheenjek River | 164 | 0.8293 | 0.1646 | 0.0061 | 0.0000 | 0.0000 |
| Meshik River | 164 | 0.8872 | 0.0976 | 0.0152 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 98 | 0.8112 | 0.1786 | 0.0102 | 0.0000 | 0.0000 |
| Joshua Green River | 77 | 0.9026 | 0.0909 | 0.0065 | 0.0000 | 0.0000 |
| Trader's Cove Creek | 96 | 0.7083 | 0.2760 | 0.0156 | 0.0000 | 0.0000 |
| Peterson Lagoon | 80 | 0.7438 | 0.1375 | 0.1188 | 0.0000 | 0.0000 |
| Stepovak River | 98 | 0.8571 | 0.1224 | 0.0204 | 0.0000 | 0.0000 |
| Ivanoff River | 89 | 0.8427 | 0.1292 | 0.0281 | 0.0000 | 0.0000 |
| Big River | 95 | 0.7789 | 0.2211 | 0.0000 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 99 | 0.7374 | 0.1566 | 0.1061 | 0.0000 | 0.0000 |
| Sturgeon River | 70 | 0.9500 | 0.0429 | 0.0071 | 0.0000 | 0.0000 |
| Kizhuyak River | 86 | 0.8023 | 0.1686 | 0.0291 | 0.0000 | 0.0000 |
| Chunilna Creek | 87 | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 87 | 0.7644 | 0.2299 | 0.0057 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 455 | 0.7505 | 0.1659 | 0.0451 | 0.0385 | 0.0000 |
| Southeast Alaska | 576 | 0.7795 | 0.1354 | 0.0365 | 0.0486 | 0.0000 |
| Eastern Queen Charlotte Islands | 429 | 0.6608 | 0.2634 | 0.0664 | 0.0082 | 0.0012 |
| Nass River Area | 308 | 0.7857 | 0.1201 | 0.0422 | 0.0519 | 0.0000 |
| Kitimat/Mussel Rivers | 218 | 0.7592 | 0.1743 | 0.0229 | 0.0436 | 0.0000 |
| Nekite Channel/River | 196 | 0.7143 | 0.1939 | 0.0714 | 0.0102 | 0.0102 |
| Port Real Marina | 108 | 0.7315 | 0.1481 | 0.0648 | 0.0556 | 0.0000 |
| Herman Creek | 118 | 0.7754 | 0.1441 | 0.0508 | 0.0297 | 0.0000 |
| Hood Canal Hatchery | 448 | 0.5692 | 0.2266 | 0.0982 | 0.1038 | 0.0022 |
| Mill Creek | 178 | 0.7051 | 0.1180 | 0.0955 | 0.0815 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 0.7300 | 0.1450 | 0.0750 | 0.0500 | 0.0000 |
| Skagit River | 249 | 0.7871 | 0.1064 | 0.0763 | 0.0301 | 0.0000 |
| West Vancouver Island | 601 | 0.5907 | 0.2787 | 0.1148 | 0.0150 | 0.0008 |
| East Vancouver Island | 798 | 0.6184 | 0.2105 | 0.1429 | 0.0257 | 0.0025 |
| Lower Fraser River | 398 | 0.6256 | 0.2098 | 0.1319 | 0.0314 | 0.0013 |
| Upper Fraser River | 595 | 0.6756 | 0.1471 | 0.1185 | 0.0588 | 0.0000 |

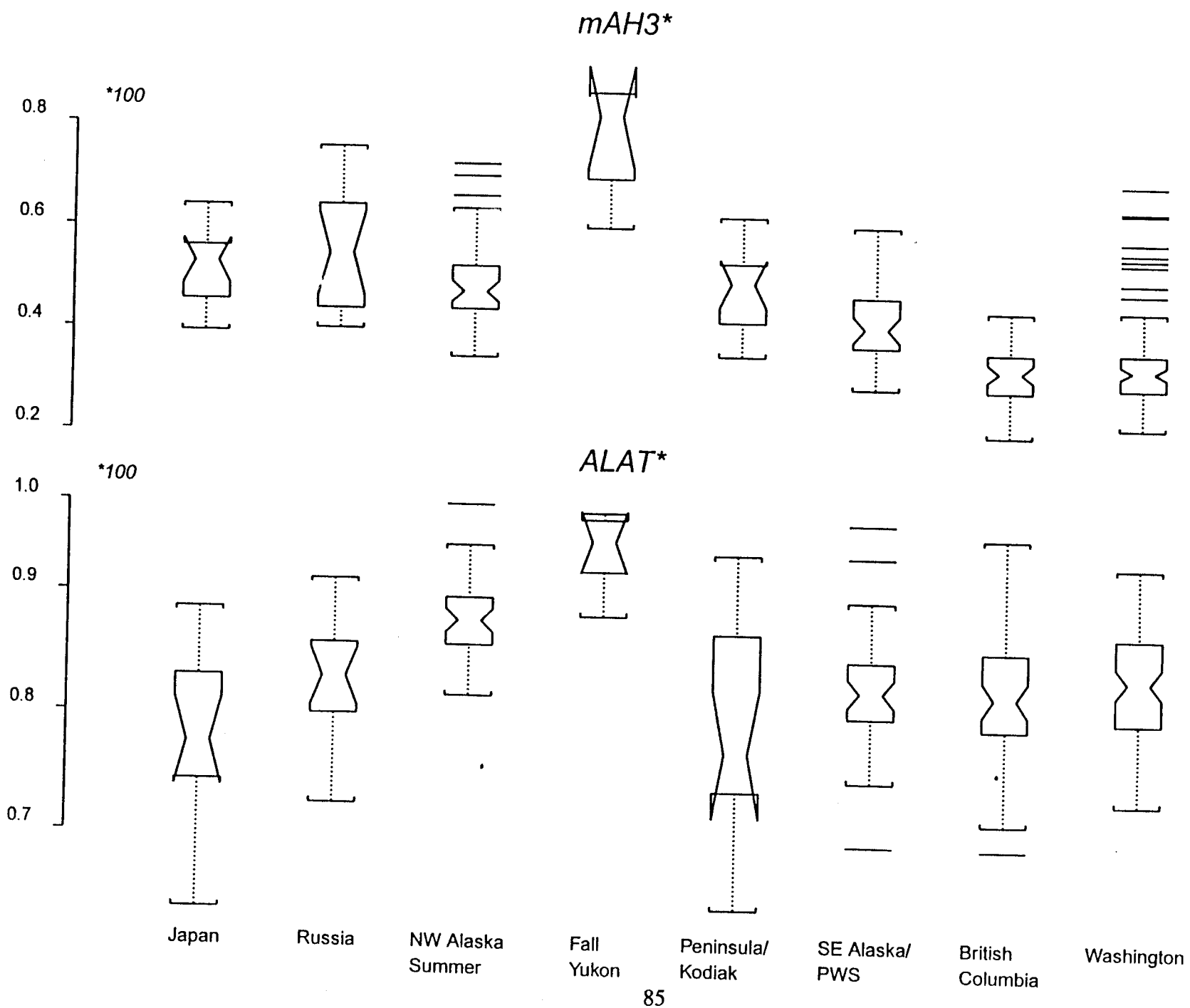
Appendix 1. Continued.

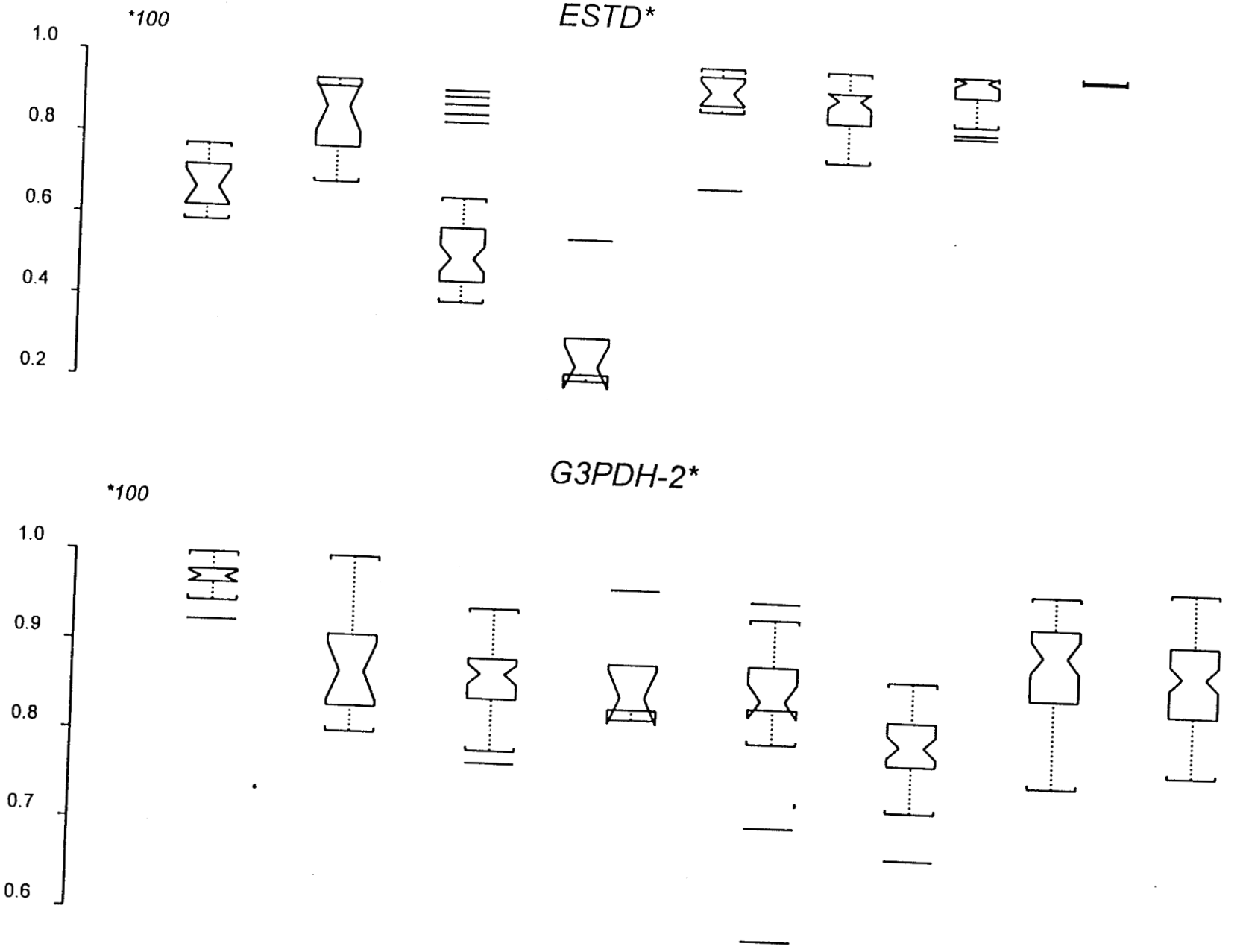
| Population | N | PGDH* 100 | 88 | 106 | 95 |
|---|---|---|---|---|---|
| Gakko/Miomote Rivers | 119 | 0.9748 | 0.0168 | 0.0084 | 0.0000 |
| Chitose River | 80 | 0.9562 | 0.0438 | 0.0000 | 0.0000 |
| Kushiro River | 80 | 0.9938 | 0.0062 | 0.0000 | 0.0000 |
| Nishibetsu River | 79 | 0.9937 | 0.0063 | 0.0000 | 0.0000 |
| Ohkawa River | 80 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Shari River | 80 | 0.9688 | 0.0312 | 0.0000 | 0.0000 |
| Tsugaruishi River | 80 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tokushibetsu River | 40 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tokachi River | 80 | 0.9938 | 0.0062 | 0.0000 | 0.0000 |
| Teshio River | 80 | 0.9500 | 0.0438 | 0.0062 | 0.0000 |
| Anadyr/Kanchalan Rivers | 182 | 0.9725 | 0.0275 | 0.0000 | 0.0000 |
| Kol River | 91 | 0.8736 | 0.1209 | 0.0000 | 0.0055 |
| Kamchatka River | 75 | 0.9200 | 0.0800 | 0.0000 | 0.0000 |
| Hairusova River | 130 | 0.9846 | 0.0154 | 0.0000 | 0.0000 |
| Ola River | 80 | 0.9438 | 0.0562 | 0.0000 | 0.0000 |
| Tumani River | 66 | 0.9697 | 0.0303 | 0.0000 | 0.0000 |
| Utka River | 79 | 0.9810 | 0.0190 | 0.0000 | 0.0000 |
| Kikchik River | 40 | 0.9625 | 0.0375 | 0.0000 | 0.0000 |
| Pymta River | 79 | 0.9557 | 0.0443 | 0.0000 | 0.0000 |
| Nerpichi Lake | 40 | 0.9625 | 0.0250 | 0.0000 | 0.0125 |
| Korf Bay | 18 | 0.9722 | 0.0278 | 0.0000 | 0.0000 |
| LowerYukon/Kuskokwim | 1530 | 0.9542 | 0.0458 | 0.0000 | 0.0000 |
| Chiginagak/Mainland | 269 | 0.9944 | 0.0056 | 0.0000 | 0.0000 |
| Kanektok/Goodnews/Togiak Rivers | 337 | 0.9644 | 0.0356 | 0.0000 | 0.0000 |
| Norton Sound | 466 | 0.9796 | 0.0204 | 0.0000 | 0.0000 |
| Nushagak River | 286 | 0.9633 | 0.0367 | 0.0000 | 0.0000 |
| Littlejohn/Russell Creek | 180 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Belkofski/Canoe Bay | 185 | 0.9919 | 0.0081 | 0.0000 | 0.0000 |
| Frosty/St Catherine's Cove | 180 | 0.9917 | 0.0083 | 0.0000 | 0.0000 |
| Egegik/Ugashik Bay | 198 | 0.9773 | 0.0227 | 0.0000 | 0.0000 |
| Naknek/Alagnak Rivers | 164 | 0.9817 | 0.0183 | 0.0000 | 0.0000 |
| Tanana River | 497 | 0.9437 | 0.0563 | 0.0000 | 0.0000 |
| Noatak River | 295 | 0.9644 | 0.0356 | 0.0000 | 0.0000 |
| Kelly Lake | 97 | 0.9794 | 0.0206 | 0.0000 | 0.0000 |
| Salmon River | 99 | 0.9798 | 0.0202 | 0.0000 | 0.0000 |
| Pilgrim River | 90 | 0.9722 | 0.0278 | 0.0000 | 0.0000 |
| Chena River | 86 | 0.9651 | 0.0349 | 0.0000 | 0.0000 |
| Salcha River | 100 | 0.9650 | 0.0350 | 0.0000 | 0.0000 |
| Toklat River | 215 | 0.9814 | 0.0186 | 0.0000 | 0.0000 |
| Sheenjek River | 164 | 0.9604 | 0.0396 | 0.0000 | 0.0000 |
| Meshik River | 169 | 0.9527 | 0.0473 | 0.0000 | 0.0000 |
| Lawrence Valley Creek | 99 | 0.9949 | 0.0051 | 0.0000 | 0.0000 |
| Joshua Green River | 80 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Trader's Cove Creek | 100 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Peterson Lagoon | 86 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Stepovak River | 100 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Ivanoff River | 94 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Big River | 100 | 0.9950 | 0.0050 | 0.0000 | 0.0000 |
| Big Sukhoi Creek | 100 | 0.9650 | 0.0350 | 0.0000 | 0.0000 |
| Sturgeon River | 71 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Kizhuyak River | 88 | 0.9830 | 0.0170 | 0.0000 | 0.0000 |
| Chunilna Creek | 87 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| WHN Hatchery | 91 | 0.9066 | 0.0934 | 0.0000 | 0.0000 |
| Eastern Prince of Whales Island | 661 | 0.9939 | 0.0061 | 0.0000 | 0.0000 |
| Southeast Alaska | 905 | 0.9895 | 0.0099 | 0.0006 | 0.0000 |
| Eastern Queen Charlotte Islands | 431 | 0.9640 | 0.0360 | 0.0000 | 0.0000 |
| Nass River Area | 311 | 0.9904 | 0.0096 | 0.0000 | 0.0000 |
| Kitimat/Mussel Rivers | 216 | 0.9884 | 0.0116 | 0.0000 | 0.0000 |
| Nekite Channel/River | 196 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Port Real Marina | 148 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Herman Creek | 159 | 0.9969 | 0.0031 | 0.0000 | 0.0000 |
| Hood Canal Hatchery | 449 | 0.9777 | 0.0223 | 0.0000 | 0.0000 |
| Mill Creek | 179 | 1.0000 | 0.0000 | 0.0000 | 0.0000 |
| Bellingham Maritime Hatchery | 100 | 0.9950 | 0.0050 | 0.0000 | 0.0000 |
| Skagit River | 251 | 0.9841 | 0.0139 | 0.0020 | 0.0000 |
| West Vancouver Island | 605 | 0.9959 | 0.0033 | 0.0000 | 0.0008 |
| East Vancouver Island | 799 | 0.9987 | 0.0013 | 0.0000 | 0.0000 |
| Lower Fraser River | 400 | 0.9925 | 0.0062 | 0.0000 | 0.0012 |
| Upper Fraser River | 600 | 0.9933 | 0.0067 | 0.0000 | 0.0000 |

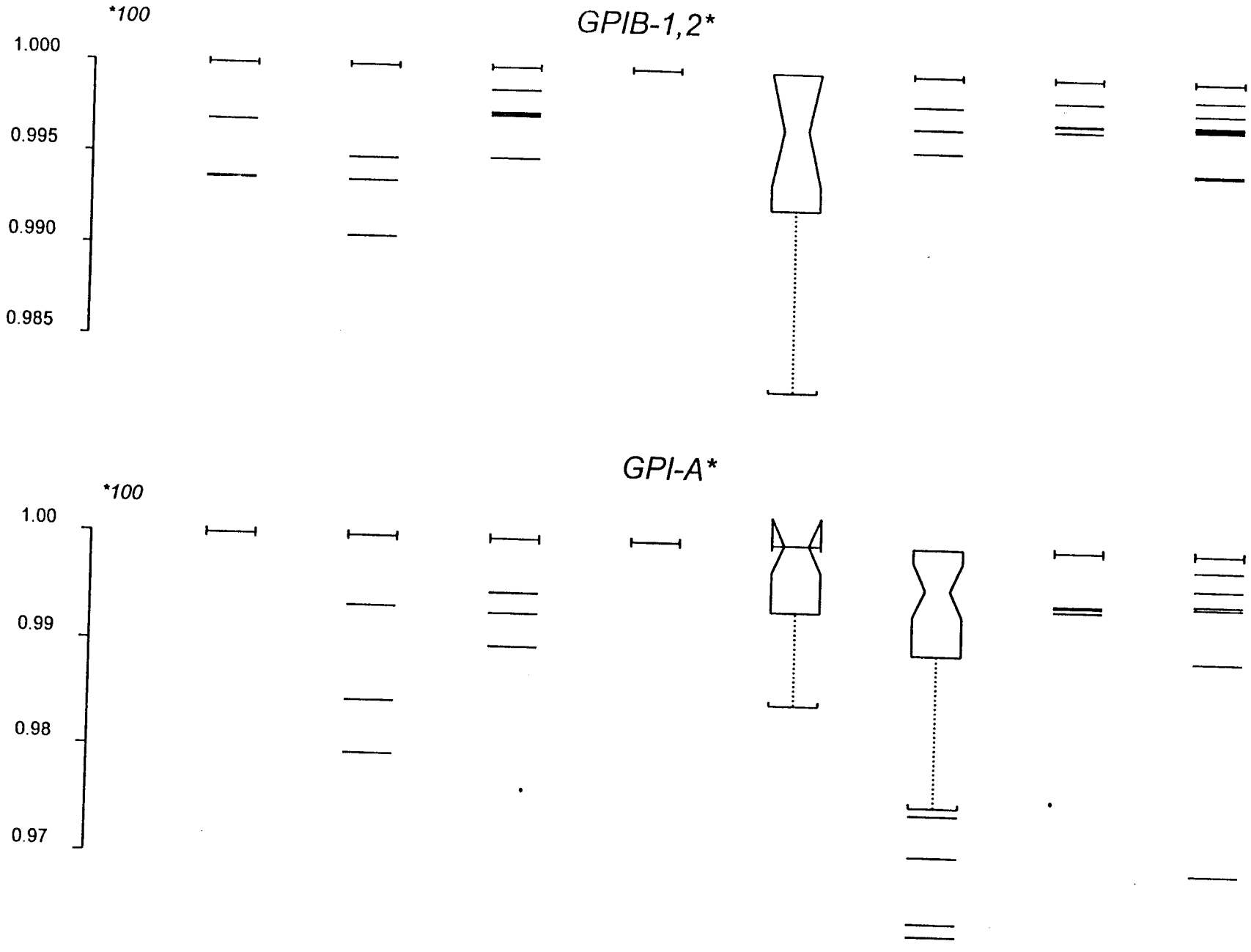
Appendix 2. Box plots (quartiles, ranges, and 95% confidence intervals for the median) for allele frequency distributions among populations in each reporting region of the mixture analysis.

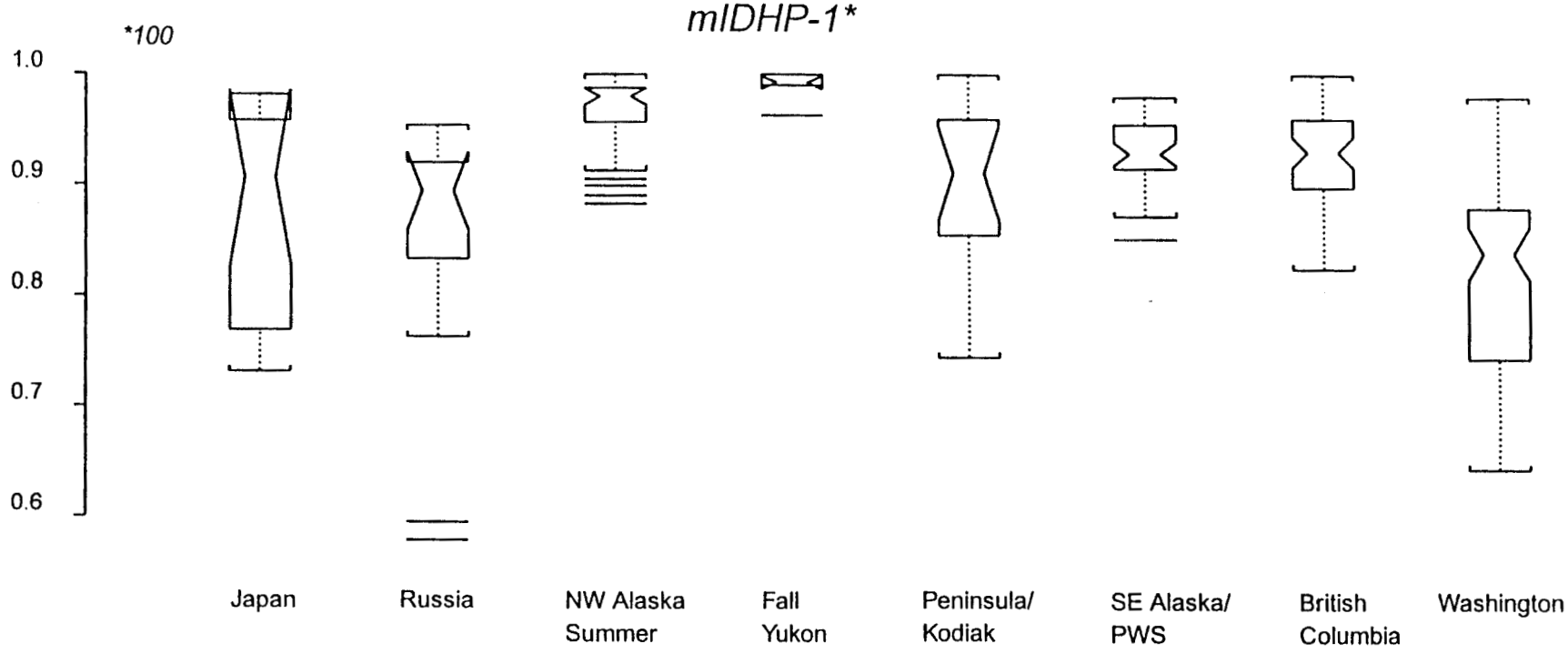


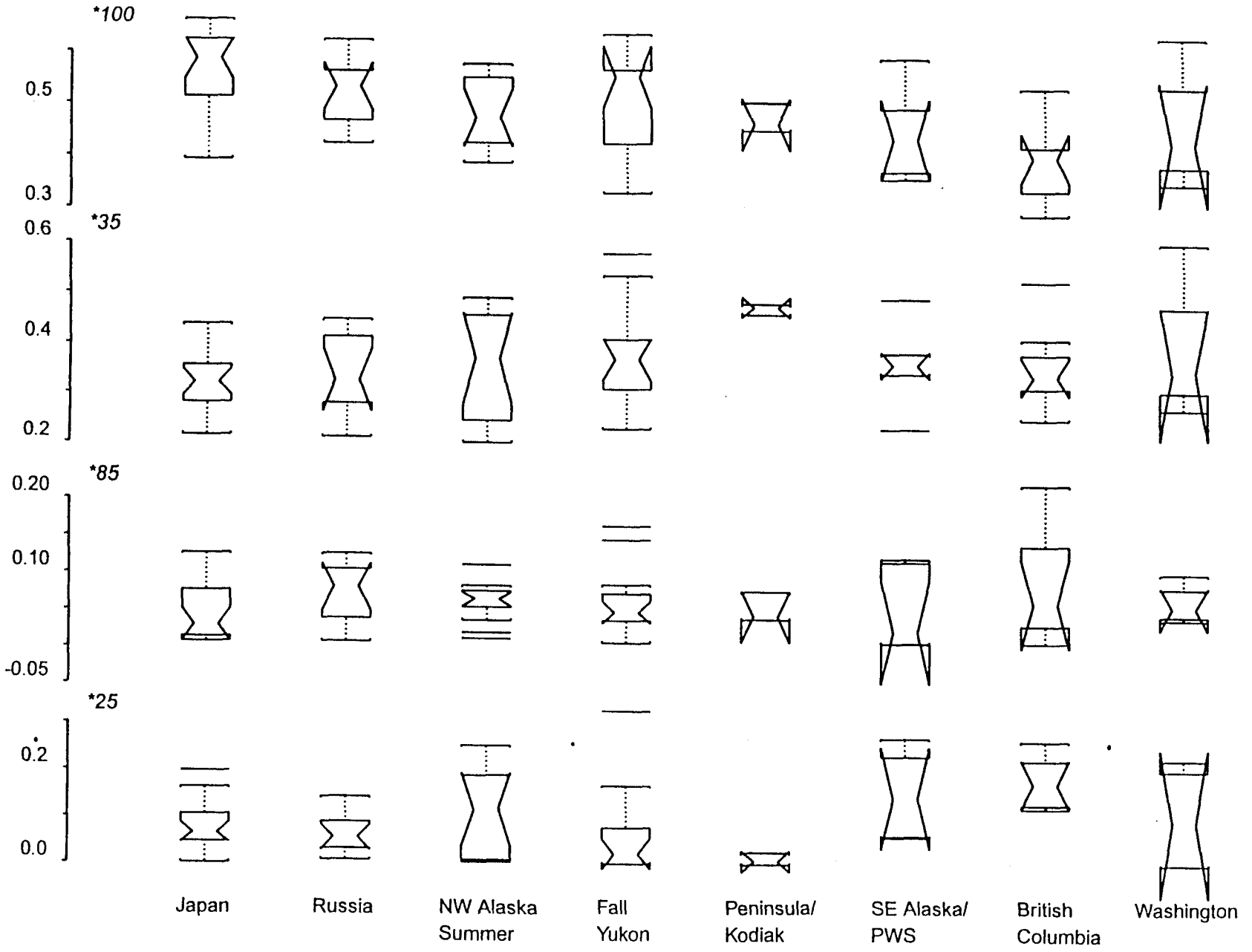

mAAT-1*
*-100
1.0
0.9
0.8
0.7
0.6
0.5
0.4
*-120
0.5
0.4
0.3
0.2
0.1
0.0
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington


mAH3*
*100
0.8
0.6
0.4
0.2
ALAT*
*100
1.0
0.9
0.8
0.7
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington

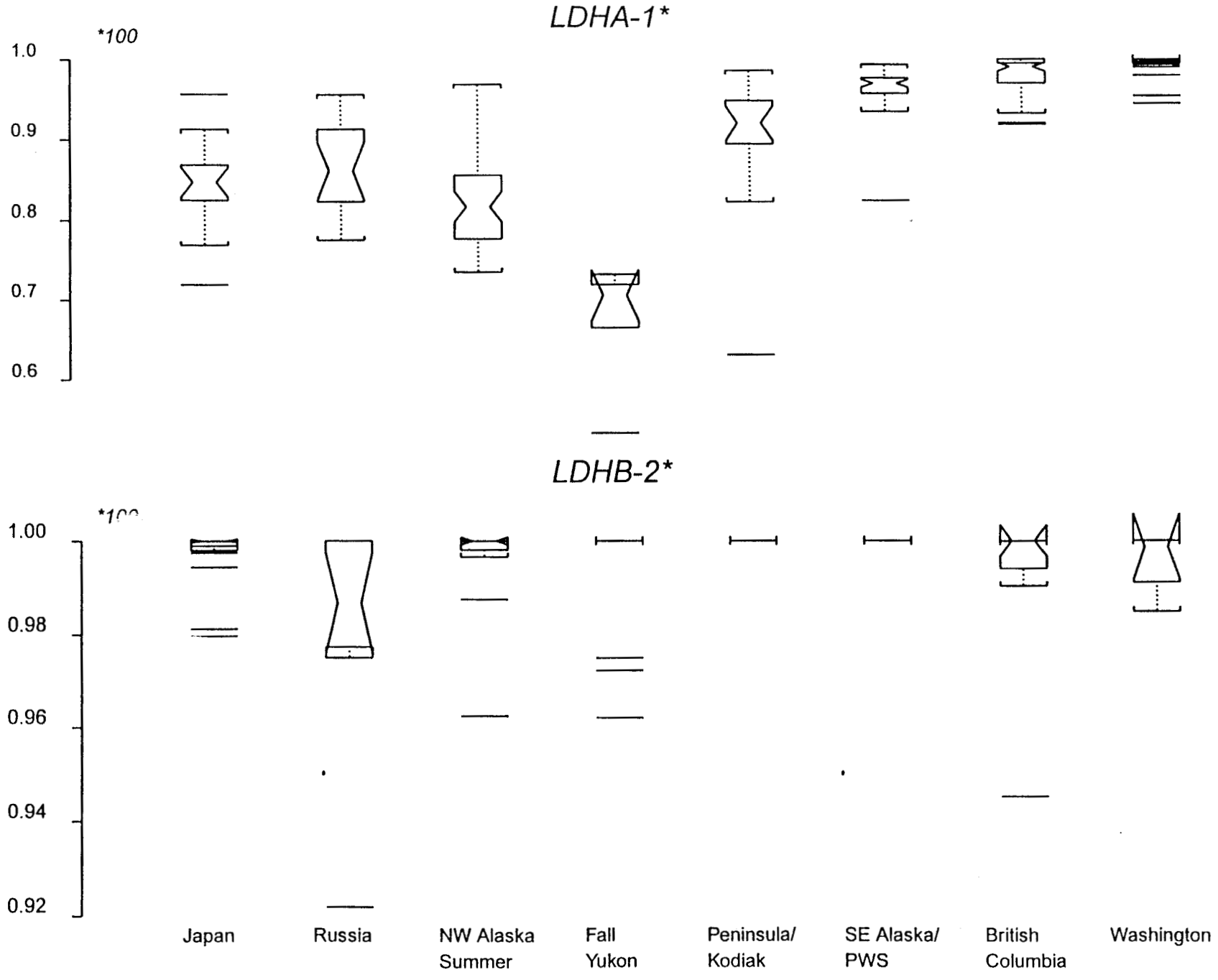

*100
ESTD*
1.0
0.8
0.6
0.4
0.2
*100
G3PDH-2*
1.0
0.9
0.8
0.7
0.6
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington

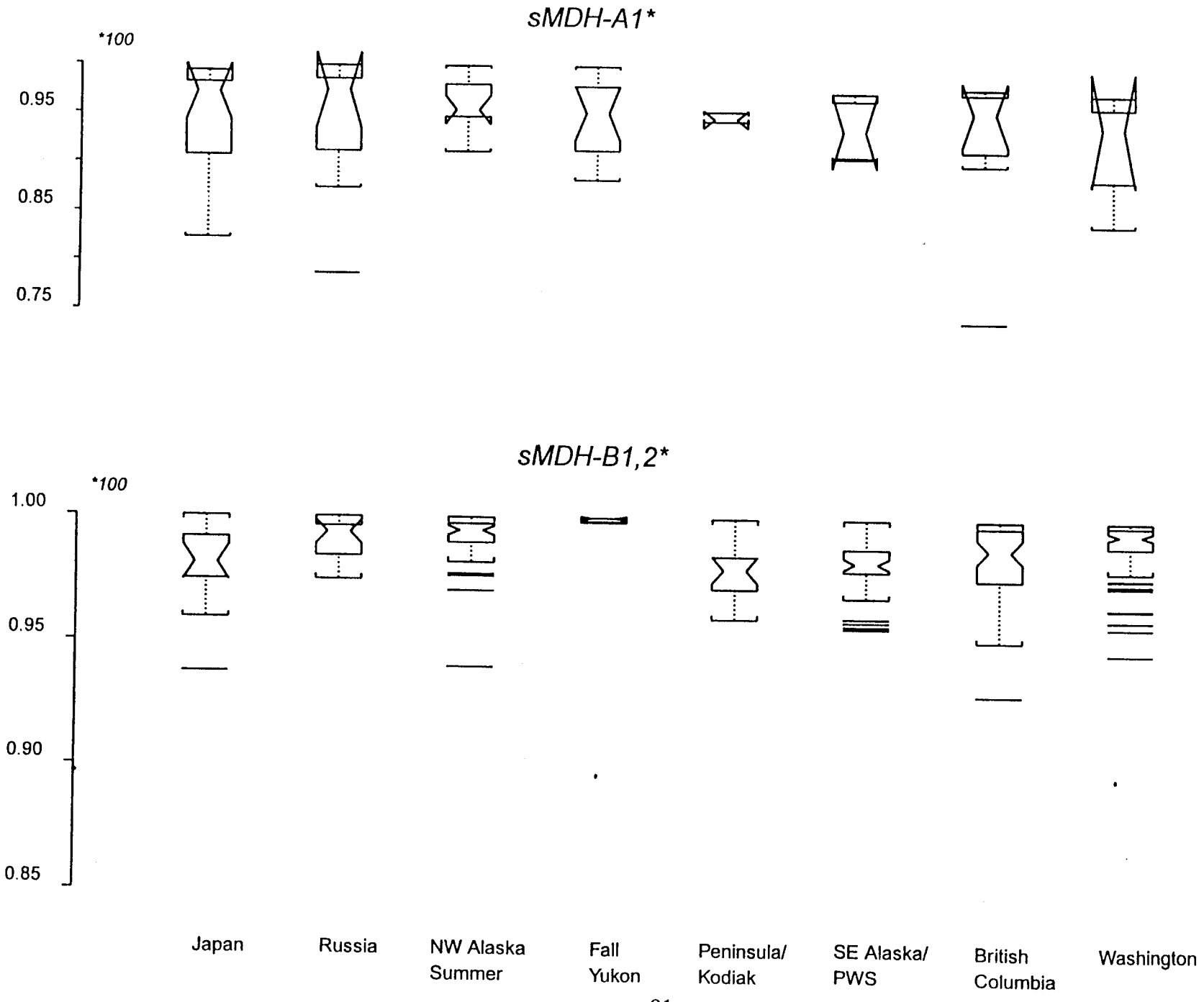

*100
GPIB-1,2*
1.000
0.995
0.990
0.985
*100
GPI-A*
1.00
0.99
0.98
0.97
Japan
Russia
N.W. Alaska
Summer
Fall
Yukon
Peninsula/
Kodiak
SE Alaska/
PWS
British
Columbia
Washington

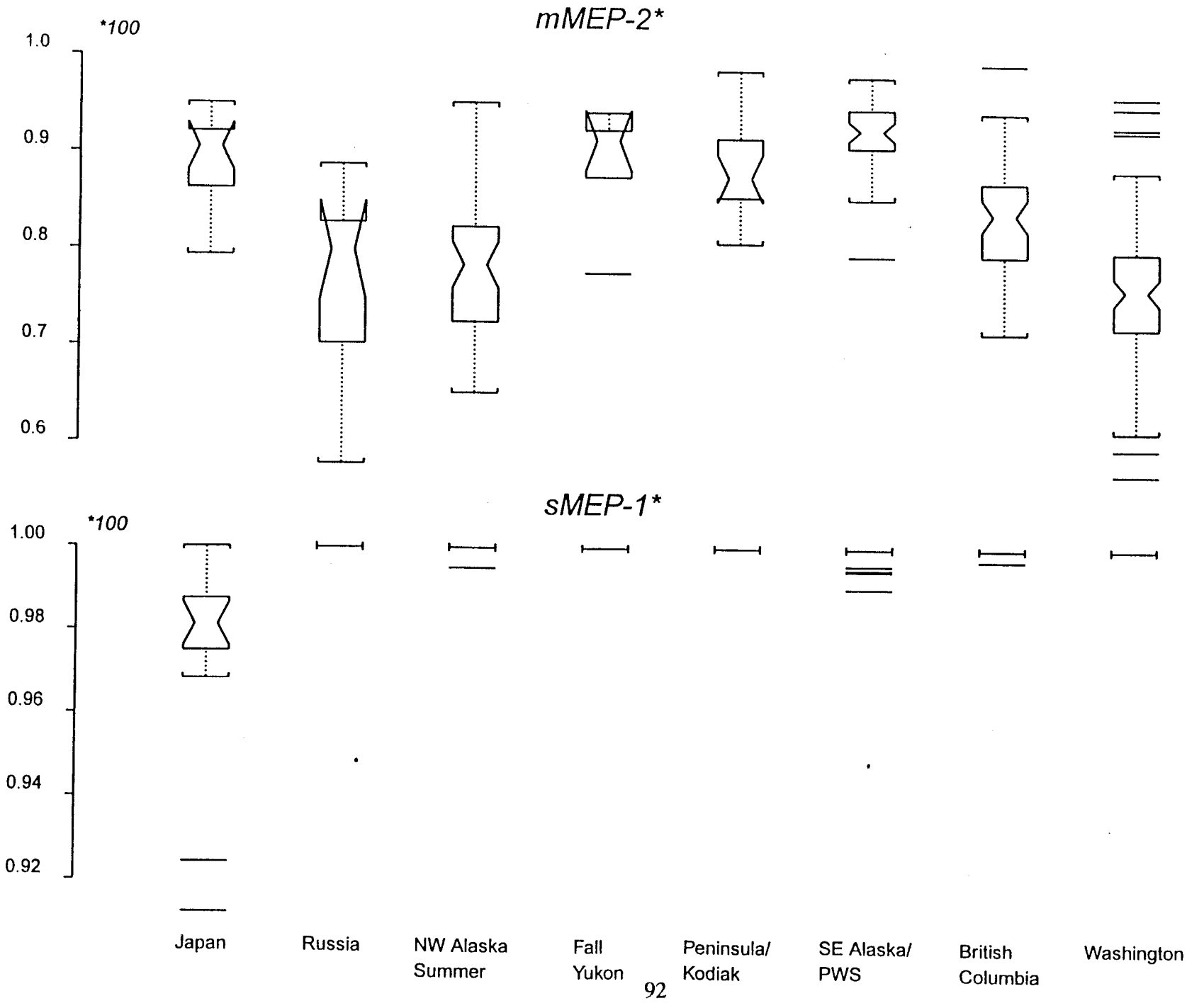

mIDHP-1*
*100
1.0
0.9
0.8
0.7
0.6
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington

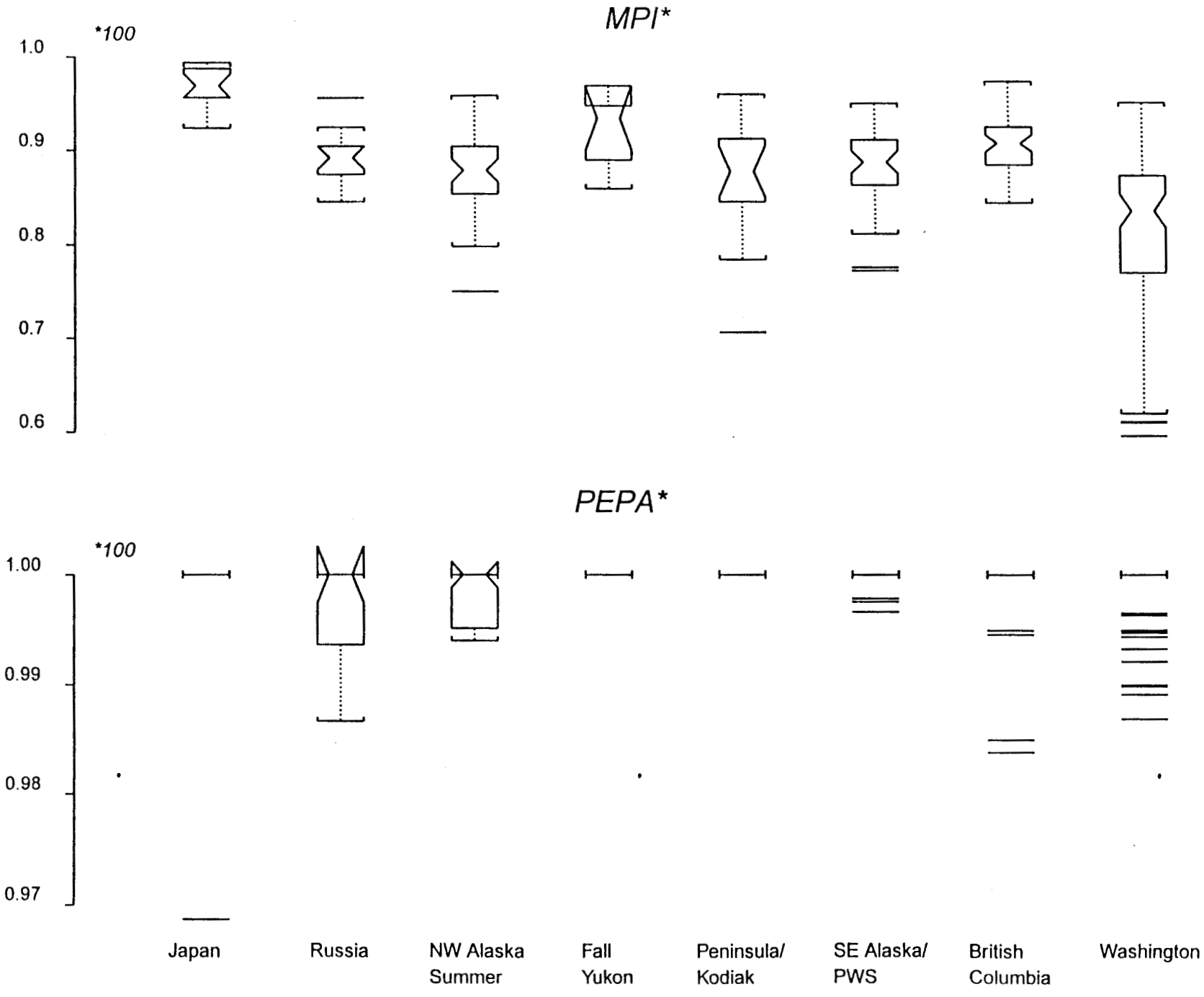

sIDHP-2*
*100
0.5
0.3
*35
0.6
0.4
0.2
*85
0.20
0.10
-0.05
*25
0.2
0.0
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington

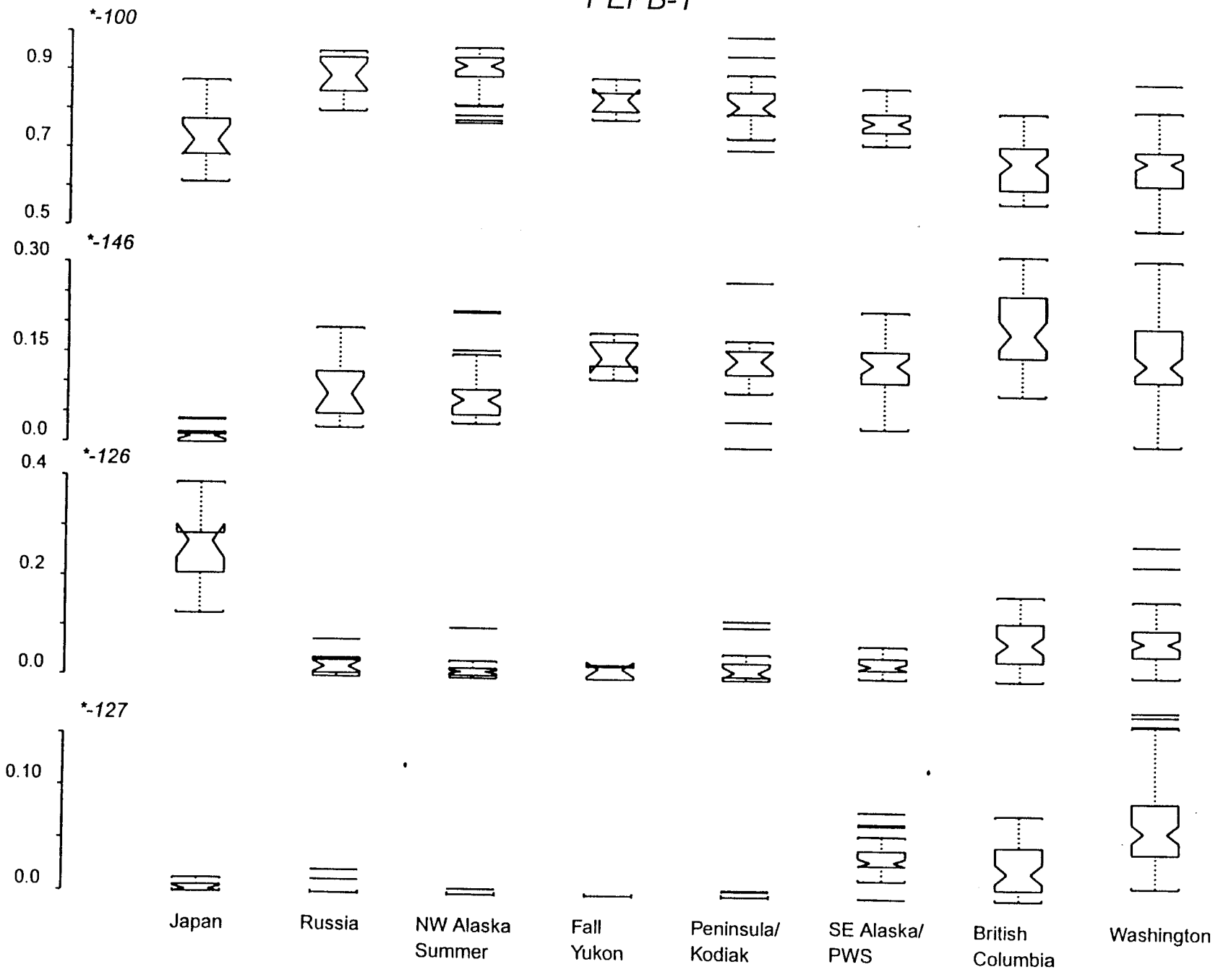
Appendix 2. Continued.

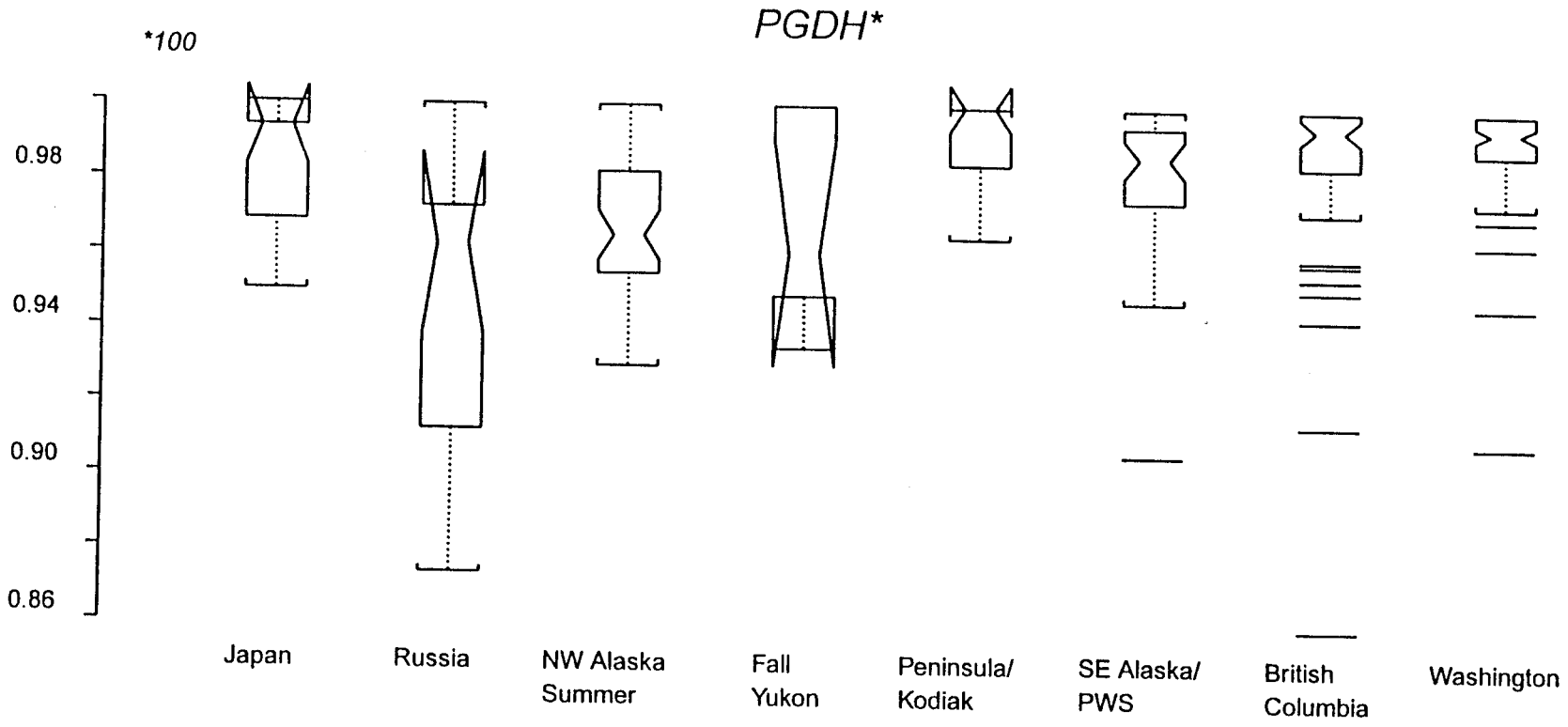



sMDH-A1*
*100
0.95
0.85
0.75
sMDH-B1,2*
*100
1.00
0.95
0.90
0.85
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington


mMEP-2*
*100
1.0
0.9
0.8
0.7
0.6
sMEP-1*
*100
1.00
0.98
0.96
0.94
0.92
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington


MPI*
*100
1.0
0.9
0.8
0.7
0.6
PEPA*
*100
1.00
0.99
0.98
0.97
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington


PEPB-1*
*-100
0.9
0.7
0.5
*-146
0.30
0.15
0.0
*-126
0.4
0.2
0.0
*-127
0.10
0.0
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington


PGDH*
*100
0.98
0.94
0.90
0.86
Japan
Russia
NW Alaska Summer
Fall Yukon
Peninsula/ Kodiak
SE Alaska/ PWS
British Columbia
Washington

Appendix 3. Glossary of genetic terms used in this report (modified from Park et al. 1994).

**accuracy** closeness of an estimate to the true value.

**allele** alternative form of a gene.

**allozyme** variant proteins produced by allelic forms of a locus, commonly resolved by protein electrophoresis.

**bias** a measure of accuracy; for this study, a measure of consistent over- or underestimation of a mixture component.

**bootstrap** a nonparametric statistical resampling (with replacement) procedure used to estimate sample variance.

**DNA** deoxyribonucleic acid, genetic material forming the basis for heredity and blueprint for protein and RNA formation.

**electrophoresis** the separation of macromolecules in the presence of an electric current. Electrophoresis is routinely used to separate proteins (based on net charge) and DNA fragments (based on size).

**enzyme** proteins that catalyze specific cellular reactions.

**G-statistic** log likelihood statistic used to test independence of alleles among populations; specifically, the G-statistic tests if allele frequencies estimates are nondistinguishable.

**gene** a nucleic acid sequence that encodes a product (protein or RNA molecule) and functions as a heredity unit.

**genotype** genetic constitution of the organism at a particular locus.

**genetic distance** an estimate of pairwise genetic similarity or dissimilarity between two populations. Distances can be computed from allele frequency differences averaged over multiple loci, from haplotype frequency differences, or from the number of DNA sequence differences.

**haplotype** an individual's genotype at a haploid locus (e.g., mtDNA).

**heterogeneity** detectable differences in allele frequency estimates among populations.

**homogeneity** allele frequency differences among populations are not detectable.

Appendix 3. Continued.

**isolocus** two loci sharing an allele of indistinguishable electrophoretic mobility.

**isozyme** an alternative form of an enzyme.

**locus** the position on a chromosome where the gene for a particular trait resides; locus may be occupied by any one of the alleles for the gene.

**precision** the amount of variability in an estimate (estimate standard error).

**Maximum likelihood** a mathematical function that measures the likelihood of observed data (the mixture genotype frequencies) given a set of parameters (mixture and baseline composition).

**mitochondrial DNA (mtDNA)** DNA contained in the mitochondria of a cell.

**MSA** mixed stock analysis identifies the stock group components contributing to a mixture. Can use genetic data, commonly referred to as genetic stock identification (GSI), parasite frequencies, scale pattern analysis, tagging data etc.

**polymorphism** detectable variation exists at a locus or in a specific DNA sequence.

**restriction enzyme** any one of many enzymes that cleave DNA molecules at a specific sequence of bases called a recognition site.

**RFLP** restriction fragment length polymorphism variations occurring within a sp- es in the length of DNA fragments generated by a restriction enzyme.

**UPGMA** unweighted pair group method using arithmetic averaging joins related groups based on the average genetic distance of all members of one cluster to all members of the other cluster.

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