GENETIC STOCK IDENTIFICATION OF

ALASKA CHINOOK SALMON

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EXECUTIVE SUMMARY

The origins of chinook salmon captured as bycatch in fisheries targeting groundfish in the Gulf of Alaska and Bering Sea/Aleutian Islands is a management and conservation concern for the State of Alaska. Mixed-stock analysis using genetic data has been successfully used to identify stock components of chinook salmon mixtures in Washington and British Columbia and may be an ideal tool for identifying stock of origin of bycaught-chinook salmon in Alaskan waters. Though populations of chinook salmon from California to British Columbia have been genetically well characterized, data describing Alaskan populations are limited. In this study we report genetic data from spawning populations of chinook salmon throughout Alaska to better identify populations that may be contributing to bycatch in the Gulf of Alaska and the Bering Sea.

For this report we have completed genetic analysis on 22 of 47 populations sampled to date. Based on heterogeneity and distance analyses, at least four unique genetic lineages were identified: Southeast Alaska, Chilkat River, Southcentral Alaska, and Northwest Alaska. In year two of this study we will complete genetic analysis of all populations, use simulation studies to evaluate the performance of the genetic model for mixed stock analysis, and assess the impact of hatchery practices in Southeast Alaska.

INTRODUCTION

Chinook salmon originating in North America and Asia form aggregations composed of numerous populations during their ocean residency in the North Pacific. Identification of components of these admixtures of chinook salmon caught in international waters, in the U.S. Exclusive Economic Zone, and in the large river systems leading to spawning tributaries, has been the focus of many research studies throughout the Pacific Rim.

During their ocean residency, chinook salmon are caught incidentally by trawl vessels targeting a variety of groundfish species in the Bering Sea/Aleutian Islands (BS/AI) and Gulf of Alaska (GOA). This bycatch is of particular concern to the State of Alaska. Between 1991 and 1994, chinook salmon bycatch in these fisheries has ranged from 13,973 to 37,592 in the GOA, and from 35,776 to 45,905 in the BS/AI (David Ackley, Alaska Department of Fish and Game, Juneau, pers. comm.). Incidental catch of chinook salmon has occurred in domestic groundfish trawl fisheries targeting several flatfish and rockfish species, as well as Atka mackerel, pollock, Pacific cod, and sablefish.

Incidental catch of chinook salmon in the groundfish fisheries exacerbates chinook salmon allocation issues and may promote chinook conservation problems in certain areas of Alaska. Additionally considerable attention has recently been focused on the severe depletion of certain chinook salmon stocks originating in California, Oregon, and Washington (Nehlsen et al. 1991; Waples et al. 1991; Mathews and Waples 1991; Utter et al. 1993). Because of the lack of geographically-specific data on stock composition of chinook salmon caught as bycatch in the groundfish fisheries, the potential impacts of the groundfish fisheries on chinook salmon stocks cannot be adequately determined. Methods for identifying more

specific geographic origins of chinook salmon caught incidentally in the groundfish fisheries are needed to address concerns regarding conservation and allocation of chinook salmon.

Most chinook salmon caught incidentally in the domestic groundfish fisheries probably originate from a large number of river systems in Alaska, British Columbia, and the Pacific Northwest, and to a lesser extent from Asia. However, no recent, definitive data are available to estimate the proportions of chinook salmon from different areas in the total chinook bycatch, and the amount of interannual variability in stock composition of chinook salmon taken as bycatch in the groundfish fisheries is unknown. Myers and Rogers (1988) estimated the stock origins of chinook salmon caught incidentally by foreign and joint venture groundfish vessels operating in the eastern Bering Sea portion of the U. S. Exclusive Economic Zone based upon scale pattern analyses. Origins of chinook were generally only specified to broad regions such as western or central Alaska, and estimates were based on scale samples collected in 1979, 1981, and 1982.

Purpose

Mixed stock analyses (MSA) using proteins detected by allozyme electrophoresis has become an important part of many salmonid management programs (e. g. Milner and Teel 1979; Utter et al. 1987; Shaklee et al. 1990; Utter et al. 1993). The underlying genetic differences among stocks can be used to differentiate groups in mixtures of Pacific salmon (e.g. Milner and Teel 1979; Grant et al. 1980; Seeb et al. 1986; Gall et al. 1989; Seeb et al. 1990, Seeb et al. 1995), and a statistical framework based on maximum likelihood estimates evolved to identify individual stocks within mixtures (Milner et al. 1981; Fournier et al. 1984;

Millar 1987; Pella and Milner 1987; Smouse et al. 1990; Gomulkiewicz et al. 1990; Masuda et al. 1991; Pella et al. 1994).

The genetic structure of chinook salmon populations has been studied throughout much of the species range in western North America (e.g. Gharrett et al. 1987; Reisenbichler and Phelps 1987; Utter et al. 1989; Beacham et al. 1989; Winans 1989; Bartley and Gall 1990). Utter et al. (1989) identified 65 genetically distinct population units from California to British Columbia based upon genetic variation at 25 polymorphic allozyme loci. Gharrett et al. (1987) studied Alaska populations ranging from Norton Sound to Southeast Alaska from collections made in 1982 through 1984. They found that chinook salmon from western Alaska were distinct from a rather heterogeneous set of populations from southeastern Alaska. Beacham et al. (1989), studying Canadian populations from the Yukon River, found that riverine populations from the Yukon River drainage showed substantial subdivision. Wilmot et al. (1992) identified a distinct separation between upper and lower Yukon River stocks. However, many areas are clearly underrepresented in the Alaska baseline. A complete data set, including Alaska populations, is necessary for the success of this approach, particularly in light of suggestions to designate major portions of the North Pacific as critical habitat for endangered stocks.

The objectives of this study are to extend the existing allozyme data for Alaska wild and hatchery chinook salmon, to more accurately characterize individual stocks in bycatch mixtures, and to evaluate the use of these data to identify stock components of the trawl bycatch in the Bering Sea/Aleutian Islands and Gulf of Alaska areas. The results presented here cover the first year of a two-year study.

APPROACH

Sample Collection

A total of 47 populations and approximately 4000 individuals (Appendix 1) have been collected by Alaska Department of Fish and Game (ADF&G) and cooperating agencies. Results from 22 populations are presented in this progress report (Table 1, Figure 1).

Since much of the baseline genetic data for chinook salmon in Northwest Alaska are from a mixed origin (e.g. Gharrett et al. 1987), we attempted to sample 100 adults from each population on the spawning grounds or 150 juveniles if a sufficient number of adults could not be obtained. Individual tissues (muscle, liver, eye, and heart) were excised from the carcasses, placed in 2.0 ml cryotubes, and frozen as soon as possible in liquid nitrogen or on dry ice. Samples were stored in -80° C until subsampled for allozyme analysis. Archive tissues are being maintained -80° C for all collections.

Laboratory Analysis

Protein extracts were prepared from the tissues and electrophoresed following the general protocols outlined in Harris and Hopkinson (1974), May et al. (1979), and Aebersold et al. (1985) by ADF&G Genetics staff. Allozyme phenotypes were scored and entered directly onto personal computer workstations connected to a local and wide-area network and backed-up nightly onto tape. We used the enzyme nomenclature adopted by the American Fisheries Society (Shaklee et al. 1990). Data collected for this project will be contributed to an inter-agency coastwide database for chinook salmon currently maintained by National Marine Fisheries Service (NMFS), Seattle, WA. To assist in standardizing data, we made exchange visits to all genetics laboratories contributing to the coastwide database (Washington

Department of Fish and Wildlife, NMFS-Seattle, WA, and NMFS-Auke Bay, AK).

Statistical Analysis

Individual genotypic data were summarized into allelic frequencies (Table 3). Tests for departure from Hardy-Weinberg equilibrium were made for all loci with the exception of three loci listed below, and observed and expected heterozygosity calculated. We followed the coastwide standard for *GPI-B2**, *GPIr** and *sMEP-2** where only homozygote phenotypes were scored. Expected frequencies were calculated for these three loci assuming Hardy-Weinberg equilibrium (Table 3).

Geographic and temporal heterogeneity among collections were evaluated with hierarchical G-tests (modified from Weir 1990) and F-statistic analyses (Chakraborty 1980) to test for divergence within and among major southcentral and western Alaska river systems. The collections were arranged into a hierarchy based on geography (Figure 2). Individual collections were grouped by drainage or close proximity, then drainages were grouped by regions within the state.

Genetic distances were calculated and used to describe genetic relationships in two ways. First, we performed a clustering analysis using the unweighted pair group method with arithmetic averages (UPGMA; Sneath and Sokal 1973) using Nei's unbiased genetic distances (Nei 1978). Secondly, we used multidimensional scaling (MDS, Krzanowski and Marriott 1994) with Cavalli-Sforza and Edwards chord distance (Cavalli-Sforza and Edwards 1964) to group populations in multidimensional space so that resulting interpopulation distances in multidimensional space closely match the observed distances. All analyses were performed using S-PLUS software package (Version 3.2, MathSoft Inc., Seattle, WA).

FINDINGS

The gene products of 66 enzyme-encoding loci were detected (Table 2). Polymorphisms in at least one collection were observed at 38 of the 66 loci (Table 3). *PEPB1** was resolved well only on a high pH buffer which precluded resolution of the **-350* allele.

Tests for conformation to Hardy Weinberg expectations were conducted. Of 437 possible tests, ten tests did not conform to Hardy-Weinberg expectation. These were *ADA-1**, Ayakulik River 1993; *GAPDH-2**, Little Port Walter Hatchery-Chickamin 1993; *sIDHP-1** and *PEPB-1**, Unalakleet River 1992; *PEPB-1**, Unalakleet River 1993; *TPI-4**, Deception Creek 1991; *sAAT-4**, Kanektok River 1992; *sAAT-3**, Kogrukluk River 1993; and *sAAT-3** and *PGK-2**, Little Port Walter Hatchery-Unuk. No single population had more significant tests than expected by chance, and no single locus had more significant tests than any other. Observed heterozygosity ranged from 0.024 to 0.054; expected heterozygosity ranged from 0.024 to 0.055 (N=66 loci, except for the Farragut River 1993 Juvenile collection which was computed over 60 loci).

A minimum sample size of 30 individuals in a collection was established for inclusion in statistical analyses evaluating genetic relationships within and among populations. Six collections, Big Boulder Creek 1992, Big Boulder Creek 1993, King Salmon River 1992, Klutina River 1991, Takotna River 1992, and Unalakleet River 1992 had sample sizes below that threshold. However, no heterogeneity was observed between Big Boulder Creek 1992 and 1993, nor between Unalakleet River 1992 and 1993 (Table 4), therefore multiple-year collections from these locations were pooled and included in the analysis. The remaining

three collections (King Salmon River 1992, Klutina River 1991, Takotna River 1992) were not included in the analysis, but allelic frequencies are reported (Table 3). A fourth collection, Farragut River juveniles 1993, was not included in the analysis because of missing loci.

Two other multiple-year collections made in the same river system were also combined. No heterogeneity was observed between Kanektok River in 1992 and 1993 nor between Kogrukluk River in 1992 and 1993 ($\alpha = 0.01$, Table 4).

Hierarchical likelihood ratio tests revealed significant heterogeneity among the Southeast, Southcentral, and Northwestern regions (Table 5). Significant heterogeneity was observed among drainages within each of the three regions. Significant heterogeneity was also observed between Whitman Lake Hatchery and Little Port Walter Hatchery broodstocks both derived from the Chickamin River in Southeast Alaska. No heterogeneity was observed within a drainage in any other region of the state.

Results from the gene diversity analysis (Table 6) show that within population variation accounted for most of the variability observed, while divergence among drainages within regions accounted for 2.34% of the variability, and divergence among regions accounted for 3.69% of the variability.

The genetic relationships among populations of Alaskan chinook salmon are depicted by a UPGMA phenogram (Figure 3). The topology of this phenogram closely resembles the geographic-distribution hierarchy (Figure 2) applied to the heterogeneity analysis. Two distinct genetic units are apparent, one comprised of Southeast Alaska populations and one comprised of all remaining populations. Within Southeast Alaska, chinook from the Chilkat

River drainage segregate from all other populations. Southcentral populations from Kodiak and Cook Inlet are separate from all populations north of the Alaska peninsula and from Deception Creek. Deception Creek is a tributary of the Susitna River in Southcentral Alaska, which, interestingly, clusters with the northwestern Alaska populations. Within the Northwest Alaska group, Bristol Bay populations cluster together and are closely related to Goodnews and Kuskokwim Bay populations. The most divergent northwestern Alaska population is the Unalakleet River in Norton Sound.

Multidimensional scaling examines the entire set of interpopulation genetic distances as opposed to working on a pair-by-pair basis as in the UPGMA clustering method. The results of MDS (Figure 4) support population groupings derived by UPGMA; the Chilkat River drainage, Southeast Alaska, Southcentral Alaska and northwestern Alaska segregate into definite groups.

EVALUATION

The success of MSA to identify stock components in a mixed fishery depends on the accurate characterization of potentially contributing stocks and the magnitude of allele frequency differences among them (Pella and Milner 1987). The goal of this project is to improve characterization of Alaska chinook salmon in order to use MSA to estimate origin of chinook salmon bycatch in the GOA and BS/A. Allele frequency differences detected among 22 Alaskan populations described in this study should allow improved estimation of origin for Alaska chinook salmon.

Patterns of genetic relationships in this study closely match those of Gharrett et al. (1987) and, with one exception, generally reflect geographical proximity. Southeastern Alaskan and northwestern Alaskan stocks are clearly divergent from one another. Within Southeastern Alaska populations, tributaries of the Chilkat River are divergent from all other Southeastern stocks. Gharrett et al. (1987) discussed how the Chilkat River may have been colonized via a headwater transfer event following deglaciation. Our report provides additional evidence to support this hypothesis. The alleles *sAAT-1,2*85* and *TPI-3*96* occur in most other Southeastern Alaska populations, but they are absent from the Chilkat River and all other Alaskan populations analyzed. Within northwestern Alaska populations, genetic differences appear to occur between Kuskokwim/Goodnews/Bristol Bay populations and the Unalakleet River.

We also observed another potentially identifiable group, Southcentral Alaska, containing a Cook Inlet population and two Kodiak Island populations. However, Deception Creek, a tributary of the Susitna River which flows into Cook Inlet, showed a closer genetic

relationship to northwestern Alaska than to Southcentral Alaska. Gharrett et al. (1987) observed this relationship with chinook salmon from Indian River, a tributary of the Susitna River; Seeb et al. (1995) observed a similar relationship among chum salmon from Chunilna River. Both Indian River and Chunilna River are part of the Susitna River drainage. Seeb et al. (1995) hypothesized that chum salmon recolonization after the last glaciation occurred from the Bering Refugium instead of from the Pacific Refugium. This pattern may be repeated in chinook salmon.

Simulation studies will be performed to determine the identifiable genetic units of chinook salmon both within Alaska and among Alaskan and other Pacific Northwest and British Columbia populations. Potential genetic units in Alaska, based on the heterogeneity and distance analyses, include Southeast Alaska, Chilkat River, Southcentral Alaska, and Northwest Alaska. Alaskan populations should be distinguishable from many southern British Columbia and Pacific Northwest populations. For example, some alleles (e.g. *mSOD*50*) are found in Alaskan populations that are not seen in more southerly populations surveyed by Utter et al. (1989). Likewise, *sSOD-1*580* occurred at a low frequency in approximately one third of the more southerly populations (Utter et al. 1989), but was only observed in one Southeastern hatchery stock in this study. Further, differences in allele frequencies are apparent at several loci (i.e. *sAAT-3**, *MPI**, *sSOD-1*) when the data from this study are compared to Utter et al. 1989.

We observed heterogeneity between two broodstocks, Little Port Walter and Whitman Lake, which were both derived from the Chickamin River. Significant allele frequency changes in hatchery stocks over time will necessitate routine genetic sampling to assess

potential genetic impacts on wild stocks and to obtain accurate allele frequency estimates for mixed fishery applications. This is especially critical because hatchery stocks have been shown to contribute up to 30% of Southeast Alaska fisheries (McGee et al. 1990).

Chinook salmon bycatch can have negative affects on a broad range of users of chinook salmon and groundfish resources. These incidental catches may have detrimental effects on directed commercial, sport and subsistence chinook salmon fisheries. In addition, management actions which may be taken to limit incidental catch of chinook salmon may impact the groundfish industry. Similarly, many sectors of the fishing industry may benefit from successful efforts to manage chinook bycatch. The data collected in this study can be used to accurately identify the contribution of Alaskan populations in bycatch or other highseas samples.

CONCLUSION AND FUTURE DIRECTION

We have made progress in genetically characterizing spawning populations of chinook salmon. Previously, only the Yukon River and Southeast Alaska had been examined adequately; allele frequencies for Northwestern and Southcentral populations published to date were of mixed origin. The results of this study have been extremely encouraging; they indicate that at least four Alaskan lineages can be readily identifiable in a mixture.

In year two of this study (Project NA46FDO356) we began examining populations for DNA markers. These markers offer the potential of further fine scale differentiation among populations, and they do not require cryopreservation of sample material. However, additional development and standardization of these markers will be required before they could be incorporated into a Pacific Rim analysis.

We plan to continue collecting allozyme data from the remaining collections, focusing on areas still not well described. These include the Copper River, Kenai Peninsula, Bristol Bay, and Upper Kuskokwim River. We will continue sampling efforts on the Alaska Peninsula and Cook Inlet and continue to characterize Southeast hatchery stocks.

We will continue to standardize allele mobilities reported in this study against those used in the coastwide database for chinook salmon. After incorporation of Alaskan allele frequencies in the existing coastwide database, simulations will be performed to determine identifiable genetic units of chinook salmon. We will also evaluate the impact of fluctuating allele frequencies of hatchery populations on mixture analyses. Allele frequencies for new populations and the results of simulation analyses will be presented in a final report of Projects NA26FDO157-01 and NA46FDO356, with completion anticipated in December 1995.

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Table 1. Collection location, life history stage of samples (A=adult, J=juvenile), sample size, and collection year of chinook salmon populations analyzed to date. Map reference numbers refer to Figure 1.

Location	Life Stage	N	Year	Map Ref. #
Southeast				
Chickamin River				
Little Port Walter Hatchery	A	100	1993	1
Whitman Lake Hatchery	A	100	1992	2
Unuk River				
Little Port Walter Hatchery	A	100	1993	1
Farragut River	J	38	1993	3
Farragut River	A	55	1993	3
King Salmon River	A	14	1992	4
Chilkat River				
Big Boulder Creek	A	21	1992	5
Big Boulder Creek	A	25	1993	5
Kelsall River	A	45	1992	6
Tahini River	A	69	1992	7
Central				
Copper River				
Klutina River	A	23	1991	8
Kasilof River				
Crooked Creek Hatchery	A	87	1992	9
Susitna River				
Deception Creek	A	103	1991	10
Kodiak Island				
Karluk River	A	67	1993	11
Ayakulik River	A	100	1993	12

Location	Life Stage	N	Year	Map Ref. #
Bristol Bay				
Nushagak River				
Stuyahok River	A	36	1993	13
Upper Nushagak River	A	53	1993	14
Togiak River	A	63	1993	15
Northwest				
Goodnews River	A	40	1993	16
Kanektok River	A	31	1992	17
Kanektok River	A	47	1993	17
Kuskokwim River				
Tuluksak River	A	50	1993	18
Kogrukluk River	A	50	1992	19
Kogrukluk River	A	50	1993	19
Takotna River	A	13	1992	20
Unalakleet River	A	24	1992	21
Unalakleet River	A	71	1993	21

Table 2. Buffers and tissues used to resolve loci screened in chinook salmon. Enzyme nomenclature follows Shaklee et al. (1990), and locus abbreviations are given.

Enzyme or Protein	Enzyme Number	Locus	Tissue	Buffer[1]
Aspartate aminotransferase	2.6.1.1	*sAAT-1,2**	H	ACEN6.8,TC4
		*sAAT-3**	E	TG
		*sAAT-4**	L	ACE6.8
		*mAAT-1**	H,M	ACE6.8, TC4
		*mAAT-2**	H,M	ACE6.8,TC4
		*mAAT-3**	H,M	ACE6.8,TC4
Adenosine deaminase	3.5.4.4	*ADA-1**	H,M	TG, TC4
		*ADA-2**	H,M	TG, TC4
Aconitate hydratase	4.2.1.3	*sAH**	L	ACEN6.8
Alanine aminotransferase	2.6.1.2	*ALAT**	M	TG
Creatine kinase	2.7.3.2	*CK-B**	E	TG
		*CK-C1**	E	TG
		*CK-C2**	E	TG
Fumarate hydratase	4.2.1.2	*FH**	M	ACE6.8
Glyceraldehyde-3-phosphate dehydrogenase	1.2.1.12	*GAPDH-1**	H,M	ACEN6.8
		*GAPDH-2**	H	ACEN6.8
		*GAPDH-4**	E	ACE6.8
		*GAPDH-5**	E	ACE6.8
Glycerol-3-phosphate dehydrogenase	1.1.1.8	*G3PDH-1**	H	ACEN6.8
		*G3PDH-2**	H	ACEN6.8
		*G3PDH-3**	H	ACEN6.8
		*G3PDH-4**	H	ACEN6.8
Glucose-6-phosphate isomerase	5.3.19	*GPI-B1**	M	TG

Table 2. Continued.

Enzyme or Protein	Enzyme Number	Locus	Tissue	Buffer[1]
		*GPI-B2**	M	TG
		GPI-A	M	TG
		*GPIr**	M	TG
Hydroxyacylglutathione hydrolase	3.1.2.6	*HAGH**	H	TG
L-Iditol dydrogenase	1.1.1.14	*IDDH-1**	L	TBCL
		*IDDH-2**	L	TBCL
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*mIDHP-1**	M,H	ACE6.8, TC4
		*mIDHP-2**	M,H	ACE6.8, TC4
		*sIDHP-1**	M,H,L, E	TC4, ACE6.8
		*sIDHP-2**	M,H,L, E	TC4, ACE6.8
L-Lactate dehydrogenase	1.1.1.27	*LDH-A1**	M	TG
		*LDH-A2**	M	TG
		*LDH-B1**	E	TG
		*LDH-B2**	E, L	TG
		*LDH-C**	E	TG, ACE6.8
Malate dehydrogenase	1.1.1.37	*sMDH-A1,2**	H,M	ACEN6.8, ACE6.8
		*sMDH-B1,2**	H,M	ACEN6.8, ACE6.8
		*mMDH-1**	H,M	ACEN6.8, ACE6,8
		*mMDH-2**	H,M	ACEN6.8, ACE6.8

Table 2. Continued.

Enzyme or Protein	Enzyme Number	Locus	Tissue	Buffer[1]
		*mMDH-3**	H,M	ACEN6.8, ACE6.8
Malic enzyme (NADP+)	1.1.1.40	*sMEP-1**	H,L	TC4, ACE6.8
		*sMEP-2**	H,L	TC4, ACE6.8
		*mMEP-1**	H	TC4
Mannose-6-phosphate isomerase	5.3.1.8	*MPI**	H	TG
Dipeptidase	3.4.-.-	*PEPA**	E	TG
Tripeptide aminopeptidase	3.4.-.-	*PEPB-1**	H,M	TG, TC4
Peptidase-C	3.4.-.-	*PEPC*	E	TG
Proline dipeptidase	3.4.13.9	*PEPD**	M,H	TC4, ACEN6.8
Peptidase-LT	3.4.-.-	*PEP-LT**	H,M	TG
Phosphogluconate dehydrogenase	1.1.1.44	*PGDH**	L, H	ACE7.2
Phosphoglucomutase	5.4.2.2	*PGM-1**	H,M	TG
		*PGM-2**	H.M	TG
Phosphoglycerate kinase	2.7.2.3	*PGK-1**	M	ACE6.8
		*PGK-2**	M,E	ACE6.8
Superoxide dismutase	1.15.1.1	*mSOD-1*	H	TG, TC4
		*sSOD-1**	H	TG, TC4
Triose-phosphate isomerase	5.3.1.1	*TPI-1**	E,H	TG
		*TPI-2**	E,H	TG
		*TPI-3**	E,H	TG
		*TPI-4**	E,H	TG

[1]ACE6.8 = amine-citric acid-EDTA buffer, pH 6.8; ACEN6.8 = amine-citric acid-EDTA-NAD buffer, pH 6.8; TBCL = Tris-citric acid gel buffer, lithium hydroxide-boric acid electrode buffer, pH 8.5; TC4 = Tris-citric acid buffer, pH 5.95; TG = Tris-glycine buffer, pH 8.5

Table 3. Allele frequencies for Alaskan chinook salmon analyzed in this study.

	*sAAT-1,2**			*sAAT-3**			*sAAT-4**			
Population	N	100	85	N	100	90	N	100	130	63
Big Boulder Creek 1992	21	1.000	0.000	21	0.976	0.024	20	0.950	0.000	0.050
Big Boulder Creek 1993	25	1.000	0.000	25	0.880	0.120	25	0.980	0.000	0.020
pooled	46	1.000	0.000	46	0.924	0.076	45	0.967	0.000	0.033
Kelsall River 1993	45	1.000	0.000	42	0.988	0.012	43	0.907	0.000	0.093
Tahini River 1992	68	1.000	0.000	63	0.992	0.008	37	0.932	0.014	0.054
King Salmon River 1992	14	1.000	0.000	14	0.964	0.036	14	0.571	0.000	0.429
Whitman Lake-Chickamin River 1993	100	0.982	0.018	98	0.934	0.066	95	0.905	0.021	0.074
Little Port Walter-Chickamin River 1993	99	0.997	0.003	98	0.995	0.005	79	0.943	0.000	0.057
Farragut River Adults 1993	50	0.985	0.015	43	0.942	0.058	47	0.851	0.000	0.149
Farrugut River Juveniles 1993	36	1.000	0.000	38	1.000	0.000	37	0.757	0.014	0.230
Little Port Walter-Unuk River 1993	99	0.997	0.003	98	0.888	0.112	91	0.852	0.005	0.143
Klutina River 1991	20	1.000	0.000	15	0.767	0.233	20	0.850	0.000	0.150
Deception Creek 1991	93	1.000	0.000	81	0.815	0.185	87	0.989	0.000	0.011
Crooked Creek 1992	82	1.000	0.000	71	0.817	0.183	79	0.816	0.000	0.184
Ayakulik River 1993	98	1.000	0.000	98	0.929	0.071	95	0.726	0.000	0.274
Karluk River 1993	67	1.000	0.000	57	0.965	0.035	64	0.750	0.000	0.250
Nushagak River 1993	53	1.000	0.000	53	0.736	0.264	50	0.950	0.000	0.050
Stuyahok River 1993	36	1.000	0.000	36	0.819	0.181	35	0.957	0.000	0.043
Togiak River 1993	62	1.000	0.000	60	0.800	0.200	61	0.984	0.000	0.016
Goodnews River 1993	40	1.000	0.000	39	0.769	0.231	39	0.987	0.000	0.013
Kanektok River 1992	27	1.000	0.000	28	0.750	0.250	26	0.942	0.000	0.058
Kanektok River 1993	46	1.000	0.000	45	0.811	0.189	46	0.935	0.000	0.065
pooled	73	1.000	0.000	73	0.788	0.212	72	0.938	0.000	0.062
Kogrukluk River 1992	50	1.000	0.000	47	0.798	0.202	49	0.980	0.000	0.020
Kogrukluk River 1993	50	1.000	0.000	49	0.786	0.214	50	0.980	0.000	0.020
pooled	100	1.000	0.000	96	0.792	0.208	99	0.980	0.000	0.020
Tuluksak River 1993	50	1.000	0.000	49	0.776	0.224	48	0.979	0.000	0.021
Takotna River 1992	13	1.000	0.000	8	0.688	0.312	12	0.958	0.000	0.042
Unalakleet River 1992	23	1.000	0.000	23	0.826	0.174	20	0.950	0.000	0.050
Unalakleet River 1993	69	1.000	0.000	70	0.850	0.150	55	0.900	0.000	0.100
pooled	92	1.000	0.000	93	0.844	0.156	75	0.913	0.000	0.087

Table 3. Continued.

Population	mAAT-1*					mAAT-2*			mAAT-3*		
	N	-100	-77	-104	***	N	-100	-125	N	100	-450
Big Boulder Creek 1992	21	1.000	0.000	0.000	0.000	21	0.691	0.309	21	1.000	0.000
Big Boulder Creek 1993	25	1.000	0.000	0.000	0.000	25	0.859	0.141	25	1.000	0.000
pooled	46	1.000	0.000	0.000	0.000	46	0.767	0.233	46	1.000	0.000
Kelsall River 1993	44	1.000	0.000	0.000	0.000	44	0.698	0.302	44	1.000	0.000
Tahini River 1992	68	1.000	0.000	0.000	0.000	68	0.668	0.332	68	1.000	0.000
King Salmon River 1992	14	1.000	0.000	0.000	0.000	14	0.733	0.267	14	1.000	0.000
Whitman Lake-Chickamin River 1993	100	0.975	0.000	0.025	0.000	100	1.000	0.000	99	1.000	0.000
Little Port Walter-Chickamin River 1993	100	1.000	0.000	0.000	0.000	100	1.000	0.000	100	1.000	0.000
Farragut River Adults 1993	50	0.990	0.000	0.010	0.000	50	0.859	0.141	50	1.000	0.000
Farrugut River Juveniles 1993	38	1.000	0.000	0.000	0.000	38	1.000	0.000	38	1.000	0.000
Little Port Walter-Unuk River 1993	99	0.990	0.000	0.010	0.000	99	1.000	0.000	99	1.000	0.000
Klutina River 1991	20	1.000	0.000	0.000	0.000	20	1.000	0.000	20	1.000	0.000
Deception Creek 1991	101	1.000	0.000	0.000	0.000	101	1.000	0.000	101	1.000	0.000
Crooked Creek 1992	80	1.000	0.000	0.000	0.000	80	1.000	0.000	80	1.000	0.000
Ayakulik River 1993	98	1.000	0.000	0.000	0.000	99	1.000	0.000	99	1.000	0.000
Karluk River 1993	67	1.000	0.000	0.000	0.000	67	1.000	0.000	67	1.000	0.000
Nushagak River 1993	53	1.000	0.000	0.000	0.000	53	1.000	0.000	53	1.000	0.000
Stuyahok River 1993	36	1.000	0.000	0.000	0.000	36	1.000	0.000	36	0.986	0.014
Togiak River 1993	62	1.000	0.000	0.000	0.000	62	1.000	0.000	62	1.000	0.000
Goodnews River 1993	40	1.000	0.000	0.000	0.000	40	1.000	0.000	40	1.000	0.000
Kanektok River 1992	27	0.981	0.019	0.000	0.000	27	1.000	0.000	27	1.000	0.000
Kanektok River 1993	46	1.000	0.000	0.000	0.000	46	1.000	0.000	46	1.000	0.000
pooled	73	0.993	0.007	0.000	0.000	73	1.000	0.000	73	1.000	0.000
Kogrukluk River 1992	50	1.000	0.000	0.000	0.000	50	1.000	0.000	50	1.000	0.000
Kogrukluk River 1993	50	1.000	0.000	0.000	0.000	50	1.000	0.000	50	1.000	0.000
pooled	100	1.000	0.000	0.000	0.000	100	1.000	0.000	100	1.000	0.000
Tuluksak River 1993	50	1.000	0.000	0.000	0.000	50	1.000	0.000	50	1.000	0.000
Takotna River 1992	13	1.000	0.000	0.000	0.000	13	1.000	0.000	13	1.000	0.000
Unalakleet River 1992	24	0.979	0.000	0.000	0.021	24	1.000	0.000	24	1.000	0.000
Unalakleet River 1993	69	1.000	0.000	0.000	0.000	68	1.000	0.000	69	1.000	0.000
pooled	93	0.995	0.000	0.000	0.005	92	1.000	0.000	93	1.000	0.000

Table 3. Continued.

Population	*ADA-1**			*ADA-2**			*sAH**				
	N	100	83	N	100	94	N	100	86	108	69
Big Boulder Creek 1992	21	1.000	0.000	21	1.000	0.000	21	0.952	0.048	0.000	0.000
Big Boulder Creek 1993	25	1.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000	0.000
pooled	46	1.000	0.000	46	1.000	0.000	46	0.978	0.022	0.000	0.000
Kelsall River 1993	45	1.000	0.000	45	1.000	0.000	45	1.000	0.000	0.000	0.000
Tahini River 1992	68	1.000	0.000	69	1.000	0.000	68	1.000	0.000	0.000	0.000
King Salmon River 1992	13	0.808	0.192	14	1.000	0.000	14	0.750	0.250	0.000	0.000
Whitman Lake-Chickamin River 1993	100	0.945	0.055	95	1.000	0.000	99	0.848	0.152	0.000	0.000
Little Port Walter-Chickamin River 1993	98	0.934	0.066	99	1.000	0.000	99	0.924	0.076	0.000	0.000
Farragut River Adults 1993	50	1.000	0.000	50	1.000	0.000	50	0.930	0.070	0.000	0.000
Farrugut River Juveniles 1993	38	0.895	0.105	38	1.000	0.000	38	0.921	0.079	0.000	0.000
Little Port Walter-Unuk River 1993	99	0.995	0.005	99	1.000	0.000	98	0.903	0.097	0.000	0.000
Klutina River 1991	20	0.800	0.200	20	1.000	0.000	20	1.000	0.000	0.000	0.000
Deception Creek 1991	100	0.815	0.185	100	1.000	0.000	90	0.978	0.022	0.000	0.000
Crooked Creek 1992	82	0.915	0.085	82	1.000	0.000	82	1.000	0.000	0.000	0.000
Ayakulik River 1993	99	0.985	0.015	99	1.000	0.000	95	1.000	0.000	0.000	0.000
Karluk River 1993	64	0.961	0.039	66	1.000	0.000	67	0.985	0.015	0.000	0.000
Nushagak River 1993	52	0.856	0.144	53	0.991	0.009	52	0.885	0.115	0.000	0.000
Stuyahok River 1993	36	0.889	0.111	36	1.000	0.000	36	0.917	0.083	0.000	0.000
Togiak River 1993	62	0.831	0.169	62	1.000	0.000	61	0.934	0.066	0.000	0.000
Goodnews River 1993	40	0.838	0.162	40	0.988	0.012	39	0.885	0.115	0.000	0.000
Kanektok River 1992	28	0.857	0.143	28	0.982	0.018	29	0.931	0.017	0.017	0.034
Kanektok River 1993	46	0.935	0.065	47	1.000	0.000	46	0.989	0.011	0.000	0.000
pooled	74	0.905	0.095	75	0.993	0.007	75	0.967	0.013	0.007	0.013
Kogrukluk River 1992	49	0.827	0.173	50	1.000	0.000	50	0.930	0.070	0.000	0.000
Kogrukluk River 1993	50	0.780	0.220	50	1.000	0.000	50	0.940	0.060	0.000	0.000
pooled	99	0.803	0.197	100	1.000	0.000	100	0.935	0.065	0.000	0.000
Tuluksak River 1993	46	0.880	0.120	45	1.000	0.000	50	0.960	0.040	0.000	0.000
Takotna River 1992	12	0.958	0.042	12	0.958	0.042	13	0.885	0.038	0.000	0.077
Unalakleet River 1992	24	0.854	0.146	24	1.000	0.000	23	0.848	0.152	0.000	0.000
Unalakleet River 1993	60	0.842	0.158	62	1.000	0.000	67	0.948	0.052	0.000	0.000
pooled	84	0.845	0.155	86	1.000	0.000	90	0.922	0.078	0.000	0.000

Table 3. Continued.

Population	*ALAT**				*GAPDH-2**			*GPI-A**				
	N	100	90	104	N	100	22	N	100	105	93	85
Big Boulder Creek 1992	14	1.000	0.000	0.000	21	1.000	0.000	21	1.000	0.000	0.000	0.000
Big Boulder Creek 1993	24	1.000	0.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000	0.000
pooled	38	1.000	0.000	0.000	46	1.000	0.000	46	1.000	0.000	0.000	0.000
Kelsall River 1993	45	1.000	0.000	0.000	45	0.989	0.011	45	0.978	0.022	0.000	0.000
Tahini River 1992	69	1.000	0.000	0.000	66	1.000	0.000	68	0.949	0.051	0.000	0.000
King Salmon River 1992	14	1.000	0.000	0.000	14	1.000	0.000	14	1.000	0.000	0.000	0.000
Whitman Lake-Chickamin River 1993	99	0.960	0.040	0.000	100	0.975	0.025	99	0.960	0.030	0.000	0.010
Little Port Walter-Chickamin River 1993	96	0.974	0.026	0.000	98	0.811	0.189	96	0.995	0.005	0.000	0.000
Farragut River Adults 1993	50	0.950	0.050	0.000	50	0.990	0.010	50	0.980	0.020	0.000	0.000
Farrugut River Juveniles 1993	38	0.921	0.079	0.000	38	1.000	0.000	38	1.000	0.000	0.000	0.000
Little Port Walter-Unuk River 1993	98	0.862	0.138	0.000	99	0.995	0.005	99	0.949	0.051	0.000	0.000
Klutina River 1991	20	0.950	0.050	0.000	20	1.000	0.000	19	1.000	0.000	0.000	0.000
Deception Creek 1991	96	0.995	0.005	0.000	97	1.000	0.000	95	1.000	0.000	0.000	0.000
Crooked Creek 1992	79	0.962	0.038	0.000	82	1.000	0.000	82	1.000	0.000	0.000	0.000
Ayakulik River 1993	99	0.818	0.182	0.000	98	1.000	0.000	98	1.000	0.000	0.000	0.000
Karluk River 1993	66	0.902	0.098	0.000	64	1.000	0.000	67	1.000	0.000	0.000	0.000
Nushagak River 1993	52	0.952	0.048	0.000	53	1.000	0.000	51	1.000	0.000	0.000	0.000
Stuyahok River 1993	36	0.972	0.028	0.000	36	1.000	0.000	29	1.000	0.000	0.000	0.000
Togiak River 1993	60	0.958	0.033	0.008	50	1.000	0.000	60	1.000	0.000	0.000	0.000
Goodnews River 1993	33	0.985	0.015	0.000	40	1.000	0.000	40	0.988	0.000	0.012	0.000
Kanektok River 1992	27	0.926	0.074	0.000	27	1.000	0.000	28	0.982	0.000	0.018	0.000
Kanektok River 1993	43	0.942	0.058	0.000	45	1.000	0.000	45	1.000	0.000	0.000	0.000
pooled	70	0.936	0.064	0.000	72	1.000	0.000	73	0.993	0.000	0.007	0.000
Kogrukluk River 1992	47	0.915	0.085	0.000	50	1.000	0.000	49	0.990	0.010	0.000	0.000
Kogrukluk River 1993	48	0.906	0.094	0.000	49	1.000	0.000	50	1.000	0.000	0.000	0.000
pooled	95	0.911	0.089	0.000	99	1.000	0.000	99	0.995	0.005	0.000	0.000
Tuluksak River 1993	47	0.894	0.106	0.000	50	1.000	0.000	50	1.000	0.000	0.000	0.000
Takotna River 1992	13	0.885	0.115	0.000	11	1.000	0.000	13	1.000	0.000	0.000	0.000
Unalakleet River 1992	24	1.000	0.000	0.000	23	1.000	0.000	24	1.000	0.000	0.000	0.000
Unalakleet River 1993	71	0.972	0.028	0.000	71	1.000	0.000	71	0.979	0.000	0.021	0.000
pooled	95	0.979	0.021	0.000	94	1.000	0.000	95	0.984	0.000	0.016	0.000

Table 3. Continued.

Population	*GPI-B2**			*GPIr**			*HAGH**			
	N	100	60	24	N	100	***	N	100	143	78
Big Boulder Creek 1992	21	1.000	0.000	0.000	21	1.000	0.000	21	0.976	0.024	0.000
Big Boulder Creek 1993	25	1.000	0.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000
pooled	46	1.000	0.000	0.000	46	1.000	0.000	46	0.989	0.011	0.000
Kelsall River 1993	45	1.000	0.000	0.000	45	1.000	0.000	45	0.989	0.011	0.000
Tahini River 1992	68	1.000	0.000	0.000	69	1.000	0.000	64	1.000	0.000	0.000
King Salmon River 1992	14	0.293	0.707	0.000	14	1.000	0.000	14	1.000	0.000	0.000
Whitman Lake-Chickamin River 1993	100	1.000	0.000	0.000	100	1.000	0.000	99	0.944	0.056	0.000
Little Port Walter-Chickamin River 1993	95	1.000	0.000	0.000	96	1.000	0.000	97	0.845	0.155	0.000
Farragut River Adults 1993	50	1.000	0.000	0.000	50	1.000	0.000	50	0.980	0.020	0.000
Farrugut River Juveniles 1993	38	1.000	0.000	0.000	38	1.000	0.000	38	0.974	0.026	0.000
Little Port Walter-Unuk River 1993	96	0.898	0.102	0.000	97	1.000	0.000	92	0.984	0.016	0.000
Klutina River 1991	19	1.000	0.000	0.000	20	1.000	0.000	20	1.000	0.000	0.000
Deception Creek 1991	95	1.000	0.000	0.000	97	1.000	0.000	96	0.995	0.000	0.005
Crooked Creek 1992	82	1.000	0.000	0.000	82	0.890	0.110	60	1.000	0.000	0.000
Ayakulik River 1993	98	1.000	0.000	0.000	98	1.000	0.000	98	1.000	0.000	0.000
Karluk River 1993	67	1.000	0.000	0.000	67	1.000	0.000	67	0.993	0.000	0.007
Nushagak River 1993	52	1.000	0.000	0.000	48	1.000	0.000	52	0.990	0.010	0.000
Stuyahok River 1993	35	1.000	0.000	0.000	35	1.000	0.000	36	1.000	0.000	0.000
Togiak River 1993	63	1.000	0.000	0.000	63	1.000	0.000	63	1.000	0.000	0.000
Goodnews River 1993	40	1.000	0.000	0.000	40	1.000	0.000	39	1.000	0.000	0.000
Kanektok River 1992	28	0.982	0.000	0.018	28	1.000	0.000	31	1.000	0.000	0.000
Kanektok River 1993	45	1.000	0.000	0.000	45	1.000	0.000	47	1.000	0.000	0.000
pooled	73	0.993	0.000	0.007	73	1.000	0.000	78	1.000	0.000	0.000
Kogrukluk River 1992	49	1.000	0.000	0.000	49	1.000	0.000	49	1.000	0.000	0.000
Kogrukluk River 1993	50	1.000	0.000	0.000	50	1.000	0.000	49	1.000	0.000	0.000
pooled	99	1.000	0.000	0.000	99	1.000	0.000	98	1.000	0.000	0.000
Tuluksak River 1993	50	1.000	0.000	0.000	50	1.000	0.000	50	1.000	0.000	0.000
Takotna River 1992	13	1.000	0.000	0.000	13	1.000	0.000	13	1.000	0.000	0.000
Unalakleet River 1992	24	1.000	0.000	0.000	24	1.000	0.000	24	1.000	0.000	0.000
Unalakleet River 1993	71	1.000	0.000	0.000	71	1.000	0.000	63	1.000	0.000	0.000
pooled	95	1.000	0.000	0.000	95	1.000	0.000	87	1.000	0.000	0.000

Table 3. Continued.

Population	*IDDH-1**			*sIDHP-1**				*sIDHP-2**					
	N	100	***	N	100	94	129	N	100	127	***	50	83
Big Boulder Creek 1992	21	0.952	0.048	21	0.762	0.238	0.000	21	0.833	0.000	0.000	0.167	0.000
Big Boulder Creek 1993	25	0.940	0.060	25	0.860	0.140	0.000	25	0.880	0.000	0.000	0.120	0.000
pooled	46	0.946	0.054	46	0.815	0.185	0.000	46	0.859	0.000	0.000	0.141	0.000
Kelsall River 1993	45	0.989	0.011	44	0.784	0.216	0.000	45	0.911	0.000	0.000	0.089	0.000
Tahini River 1992	38	0.908	0.092	69	0.884	0.116	0.000	65	0.923	0.000	0.000	0.077	0.000
King Salmon River 1992	14	0.964	0.036	14	0.929	0.071	0.000	14	1.000	0.000	0.000	0.000	0.000
Whitman Lake-Chickamin River 1993	97	0.881	0.119	100	0.910	0.090	0.000	99	0.980	0.000	0.000	0.020	0.000
Little Port Walter-Chickamin River 1993	45	1.000	0.000	100	0.720	0.280	0.000	100	1.000	0.000	0.000	0.000	0.000
Farragut River Adults 1993	50	0.850	0.150	50	0.910	0.090	0.000	50	0.940	0.000	0.000	0.060	0.000
Farrugut River Juveniles 1993	38	0.829	0.171	38	0.816	0.184	0.000	38	0.868	0.000	0.000	0.132	0.000
Little Port Walter-Unuk River 1993	96	0.917	0.083	99	0.874	0.126	0.000	98	1.000	0.000	0.000	0.000	0.000
Klutina River 1991	19	0.974	0.026	20	0.875	0.125	0.000	20	1.000	0.000	0.000	0.000	0.000
Deception Creek 1991	89	0.994	0.006	98	0.985	0.000	0.015	90	1.000	0.000	0.000	0.000	0.000
Crooked Creek 1992	74	0.912	0.088	82	1.000	0.000	0.000	82	1.000	0.000	0.000	0.000	0.000
Ayakulik River 1993	91	0.934	0.066	98	1.000	0.000	0.000	98	1.000	0.000	0.000	0.000	0.000
Karluk River 1993	64	0.820	0.180	67	1.000	0.000	0.000	67	0.985	0.000	0.000	0.015	0.000
Nushagak River 1993	48	0.958	0.042	53	0.991	0.009	0.000	53	0.953	0.000	0.000	0.047	0.000
Stuyahok River 1993	34	0.926	0.074	36	1.000	0.000	0.000	36	0.958	0.000	0.000	0.042	0.000
Togiak River 1993	58	0.957	0.043	63	1.000	0.000	0.000	62	0.960	0.000	0.000	0.032	0.008
Goodnews River 1993	38	0.934	0.066	39	1.000	0.000	0.000	39	0.962	0.013	0.000	0.013	0.013
Kanektok River 1992	28	0.982	0.018	28	1.000	0.000	0.000	28	0.982	0.000	0.000	0.018	0.000
Kanektok River 1993	43	0.953	0.047	46	1.000	0.000	0.000	46	0.978	0.022	0.000	0.000	0.000
pooled	71	0.965	0.035	74	1.000	0.000	0.000	74	0.980	0.014	0.000	0.007	0.000
Kogrukluk River 1992	49	0.949	0.051	50	1.000	0.000	0.000	50	0.990	0.000	0.000	0.010	0.000
Kogrukluk River 1993	50	0.970	0.030	49	1.000	0.000	0.000	50	0.960	0.000	0.000	0.040	0.000
pooled	99	0.960	0.040	99	1.000	0.000	0.000	100	0.975	0.000	0.000	0.025	0.000
Tuluksak River 1993	50	0.970	0.030	49	1.000	0.000	0.000	50	0.870	0.000	0.000	0.120	0.010
Takotna River 1992	11	0.955	0.045	13	1.000	0.000	0.000	13	0.962	0.000	0.000	0.038	0.000
Unalakleet River 1992	24	0.917	0.083	24	0.917	0.000	0.083	24	0.979	0.000	0.000	0.021	0.000
Unalakleet River 1993	66	0.962	0.038	71	0.937	0.000	0.063	71	0.937	0.000	0.007	0.049	0.007
pooled	90	0.950	0.050	95	0.932	0.000	0.068	95	0.947	0.000	0.005	0.042	0.005

Table 3. Continued.

Population	*LDH-B2**			*sMDHB-1,2**					*mMDH-1**		
	N	100	71	N	100	121	70	83	N	-100	-900
Big Boulder Creek 1992	21	1.000	0.000	21	1.000	0.000	0.000	0.000	21	1.000	0.000
Big Boulder Creek 1993	25	1.000	0.000	25	1.000	0.000	0.000	0.000	25	1.000	0.000
pooled	46	1.000	0.000	46	1.000	0.000	0.000	0.000	46	1.000	0.000
Kelsall River 1993	45	1.000	0.000	45	1.000	0.000	0.000	0.000	45	1.000	0.000
Tahini River 1992	68	1.000	0.000	68	1.000	0.000	0.000	0.000	68	1.000	0.000
King Salmon River 1992	14	1.000	0.000	14	1.000	0.000	0.000	0.000	14	1.000	0.000
Whitman Lake-Chickamin River 1993	100	1.000	0.000	99	0.955	0.000	0.045	0.000	100	1.000	0.000
Little Port Walter-Chickamin River 1993	98	1.000	0.000	100	0.965	0.000	0.035	0.000	100	1.000	0.000
Farragut River Adults 1993	50	1.000	0.000	50	1.000	0.000	0.000	0.000	50	1.000	0.000
Farrugut River Juveniles 1993	38	1.000	0.000	38	1.000	0.000	0.000	0.000	38	1.000	0.000
Little Port Walter-Unuk River 1993	100	1.000	0.000	99	0.990	0.000	0.010	0.000	99	1.000	0.000
Klutina River 1991	20	1.000	0.000	20	0.988	0.012	0.000	0.000	23	1.000	0.000
Deception Creek 1991	81	1.000	0.000	98	1.000	0.000	0.000	0.000	98	1.000	0.000
Crooked Creek 1992	77	1.000	0.000	82	0.994	0.006	0.000	0.000	82	0.994	0.006
Ayakulik River 1993	98	1.000	0.000	98	1.000	0.000	0.000	0.000	98	1.000	0.000
Karluk River 1993	59	1.000	0.000	67	1.000	0.000	0.000	0.000	66	0.985	0.015
Nushagak River 1993	50	0.990	0.010	53	0.976	0.000	0.000	0.024	52	0.990	0.010
Stuyahok River 1993	36	1.000	0.000	36	0.993	0.007	0.000	0.000	36	1.000	0.000
Togiak River 1993	62	1.000	0.000	63	0.992	0.008	0.000	0.000	62	1.000	0.000
Goodnews River 1993	40	1.000	0.000	40	0.981	0.019	0.000	0.000	40	1.000	0.000
Kanektok River 1992	28	1.000	0.000	28	1.000	0.000	0.000	0.000	28	1.000	0.000
Kanektok River 1993	45	1.000	0.000	46	1.000	0.000	0.000	0.000	46	1.000	0.000
pooled	73	1.000	0.000	74	1.000	0.000	0.000	0.000	74	1.000	0.000
Kogrukluk River 1992	49	1.000	0.000	49	0.985	0.015	0.000	0.000	49	1.000	0.000
Kogrukluk River 1993	49	1.000	0.000	50	0.980	0.000	0.000	0.020	50	1.000	0.000
pooled	98	1.000	0.000	99	0.982	0.008	0.000	0.010	99	1.000	0.000
Tuluksak River 1993	50	1.000	0.000	50	1.000	0.000	0.000	0.000	50	1.000	0.000
Takotna River 1992	13	1.000	0.000	13	0.981	0.000	0.019	0.000	13	1.000	0.000
Unalakleet River 1992	24	1.000	0.000	24	1.000	0.000	0.000	0.000	24	1.000	0.000
Unalakleet River 1993	71	1.000	0.000	70	0.996	0.004	0.000	0.000	70	1.000	0.000
pooled	95	1.000	0.000	94	0.997	0.003	0.000	0.000	94	1.000	0.000

Table 3. Continued.

Population	*mMDH-2**			*sMEP-1**				*sMEP-2**		
	N	100	200	N	100	92	86	N	100	78
Big Boulder Creek 1992	21	0.976	0.024	21	0.071	0.929	0.000	21	1.000	0.000
Big Boulder Creek 1993	24	0.958	0.042	25	0.020	0.980	0.000	25	0.800	0.200
pooled	45	0.967	0.033	46	0.043	0.957	0.000	46	0.853	0.147
Kelsall River 1993	45	1.000	0.000	44	0.114	0.886	0.000	45	1.000	0.000
Tahini River 1992	68	1.000	0.000	69	0.036	0.964	0.000	69	0.880	0.120
King Salmon River 1992	14	1.000	0.000	14	0.000	1.000	0.000	14	1.000	0.000
Whitman Lake-Chickamin River 1993	99	0.944	0.056	95	0.242	0.758	0.000	98	0.798	0.202
Little Port Walter-Chickamin River 1993	70	0.971	0.029	98	0.102	0.898	0.000	99	0.899	0.101
Farragut River Adults 1993	50	0.960	0.040	48	0.240	0.760	0.000	50	0.859	0.141
Farrugut River Juveniles 1993	38	0.934	0.066	37	0.257	0.743	0.000	38	1.000	0.000
Little Port Walter-Unuk River 1993	99	0.970	0.030	99	0.172	0.828	0.000	100	0.827	0.173
Klutina River 1991	20	0.850	0.150	20	0.000	1.000	0.000	20	0.684	0.316
Deception Creek 1991	98	1.000	0.000	98	0.015	0.985	0.000	99	0.667	0.333
Crooked Creek 1992	82	0.915	0.085	81	0.099	0.895	0.006	81	0.542	0.458
Ayakulik River 1993	98	0.990	0.010	98	0.005	0.995	0.000	99	0.611	0.389
Karluk River 1993	66	0.985	0.015	67	0.000	1.000	0.000	65	0.608	0.392
Nushagak River 1993	53	0.962	0.038	53	0.009	0.991	0.000	53	0.611	0.389
Stuyahok River 1993	36	0.972	0.028	36	0.000	1.000	0.000	36	0.667	0.333
Togiak River 1993	62	0.927	0.073	62	0.008	0.992	0.000	62	0.664	0.336
Goodnews River 1993	40	0.938	0.062	38	0.000	1.000	0.000	39	0.774	0.226
Kanektok River 1992	28	0.946	0.054	30	0.017	0.983	0.000	28	0.577	0.423
Kanektok River 1993	46	0.913	0.087	46	0.000	0.989	0.011	44	0.787	0.213
pooled	74	0.926	0.074	76	0.007	0.987	0.007	72	0.688	0.312
Kogrukluk River 1992	49	0.939	0.061	49	0.010	0.990	0.000	49	0.714	0.286
Kogrukluk River 1993	49	0.949	0.051	50	0.000	1.000	0.000	50	0.755	0.245
pooled	98	0.944	0.056	99	0.005	0.995	0.000	99	0.734	0.266
Tuluksak River 1993	50	0.960	0.040	50	0.000	1.000	0.000	50	0.800	0.200
Takotna River 1992	11	0.955	0.045	11	0.045	0.955	0.000	11	0.574	0.426
Unalakleet River 1992	24	1.000	0.000	24	0.000	1.000	0.000	24	0.796	0.204
Unalakleet River 1993	69	0.957	0.043	71	0.007	0.993	0.000	67	0.633	0.367
pooled	93	0.968	0.032	95	0.005	0.995	0.000	91	0.669	0.331

Table 3. Continued.

Population	*mMEP-1**				*MPI**				*PEPA**		
	N	100	150	50	N	100	109	85	N	100	90
Big Boulder Creek 1992	21	1.000	0.000	0.000	21	0.690	0.310	0.000	21	1.000	0.000
Big Boulder Creek 1993	25	1.000	0.000	0.000	25	0.840	0.160	0.000	25	1.000	0.000
pooled	46	1.000	0.000	0.000	46	0.772	0.228	0.000	46	1.000	0.000
Kelsall River 1993	45	1.000	0.000	0.000	45	0.744	0.256	0.000	45	1.000	0.000
Tahini River 1992	69	1.000	0.000	0.000	66	0.689	0.311	0.000	68	1.000	0.000
King Salmon River 1992	14	1.000	0.000	0.000	13	0.885	0.115	0.000	14	0.679	0.321
Whitman Lake-Chickamin River 1993	100	1.000	0.000	0.000	100	0.795	0.190	0.015	100	0.975	0.025
Little Port Walter-Chickamin River 1993	100	1.000	0.000	0.000	98	0.939	0.061	0.000	96	0.990	0.010
Farragut River Adults 1993	29	1.000	0.000	0.000	50	0.870	0.130	0.000	50	0.980	0.020
Farrugut River Juveniles 1993					38	0.908	0.092	0.000	38	0.974	0.026
Little Port Walter-Unuk River 1993	100	1.000	0.000	0.000	96	0.797	0.203	0.000	97	0.928	0.072
Klutina River 1991	20	1.000	0.000	0.000	20	1.000	0.000	0.000	19	1.000	0.000
Deception Creek 1991	100	1.000	0.000	0.000	94	0.995	0.005	0.000	81	0.981	0.019
Crooked Creek 1992	82	1.000	0.000	0.000	82	0.951	0.049	0.000	82	0.982	0.018
Ayakulik River 1993	98	1.000	0.000	0.000	96	0.885	0.115	0.000	98	1.000	0.000
Karluk River 1993	67	1.000	0.000	0.000	63	0.833	0.167	0.000	59	1.000	0.000
Nushagak River 1993	53	0.991	0.000	0.009	53	0.934	0.066	0.000	53	0.981	0.019
Stuyahok River 1993	36	1.000	0.000	0.000	36	0.972	0.028	0.000	36	0.958	0.042
Togiak River 1993	62	1.000	0.000	0.000	62	0.903	0.097	0.000	62	0.992	0.008
Goodnews River 1993	40	1.000	0.000	0.000	40	0.925	0.075	0.000	40	0.962	0.038
Kanektok River 1992	28	1.000	0.000	0.000	29	0.966	0.034	0.000	28	0.982	0.018
Kanektok River 1993	47	1.000	0.000	0.000	47	0.936	0.064	0.000	46	0.946	0.054
pooled	75	1.000	0.000	0.000	76	0.947	0.053	0.000	74	0.959	0.041
Kogrukluk River 1992	50	1.000	0.000	0.000	50	0.910	0.090	0.000	48	0.938	0.062
Kogrukluk River 1993	50	1.000	0.000	0.000	50	0.950	0.050	0.000	49	0.959	0.041
pooled	100	1.000	0.000	0.000	100	0.930	0.070	0.000	97	0.948	0.052
Tuluksak River 1993	50	1.000	0.000	0.000	49	0.898	0.102	0.000	49	0.939	0.061
Takotna River 1992	11	1.000	0.000	0.000	12	0.917	0.083	0.000	13	1.000	0.000
Unalakleet River 1992	24	1.000	0.000	0.000	24	0.979	0.021	0.000	23	0.978	0.022
Unalakleet River 1993	71	0.993	0.007	0.000	70	0.900	0.100	0.000	70	0.957	0.043
pooled	95	0.995	0.005	0.000	94	0.920	0.080	0.000	93	0.962	0.038

Table 3. Continued.

Population	*PEPB1**				*PEPD-2**			*PEP-LT**		
	N	100	130	71	70	N	100	83	N	100	110
Big Boulder Creek 1992	21	0.905	0.071	0.000	0.024	21	1.000	0.000	21	0.929	0.071
Big Boulder Creek 1993	25	0.940	0.060	0.000	0.000	25	1.000	0.000	24	0.958	0.042
pooled	46	0.924	0.065	0.000	0.011	46	1.000	0.000	45	0.944	0.056
Kelsall River 1993	45	0.900	0.100	0.000	0.000	45	1.000	0.000	45	0.956	0.044
Tahini River 1992	68	0.926	0.074	0.000	0.000	68	1.000	0.000	65	0.962	0.038
King Salmon River 1992	9	1.000	0.000	0.000	0.000	14	1.000	0.000	14	1.000	0.000
Whitman Lake-Chickamin River 1993	95	0.937	0.053	0.000	0.011	100	1.000	0.000	100	1.000	0.000
Little Port Walter-Chickamin River 1993	93	0.946	0.054	0.000	0.000	99	1.000	0.000	97	0.979	0.021
Farragut River Adults 1993	50	0.980	0.020	0.000	0.000	48	1.000	0.000	50	0.950	0.050
Farrugut River Juveniles 1993	38	0.974	0.026	0.000	0.000				38	0.987	0.013
Little Port Walter-Unuk River 1993	99	0.995	0.005	0.000	0.000	99	1.000	0.000	97	0.892	0.108
Klutina River 1991	20	0.925	0.075	0.000	0.000	23	1.000	0.000	20	1.000	0.000
Deception Creek 1991	94	0.899	0.085	0.000	0.016	101	0.990	0.010	98	0.995	0.005
Crooked Creek 1992	81	0.951	0.049	0.000	0.000	82	0.970	0.030	82	1.000	0.000
Ayakulik River 1993	98	0.995	0.005	0.000	0.000	98	1.000	0.000	98	1.000	0.000
Karluk River 1993	64	0.992	0.008	0.000	0.000	66	1.000	0.000	67	1.000	0.000
Nushagak River 1993	53	0.925	0.066	0.000	0.009	53	1.000	0.000	50	1.000	0.000
Stuyahok River 1993	36	0.903	0.069	0.000	0.028	36	1.000	0.000	36	1.000	0.000
Togiak River 1993	59	0.873	0.085	0.000	0.042	62	1.000	0.000	62	0.992	0.008
Goodnews River 1993	39	0.821	0.115	0.064	0.000	40	1.000	0.000	38	0.974	0.026
Kanektok River 1992	30	0.917	0.067	0.017	0.000	22	1.000	0.000	26	1.000	0.000
Kanektok River 1993	45	0.967	0.022	0.011	0.000	45	1.000	0.000	43	1.000	0.000
pooled	75	0.947	0.040	0.013	0.000	67	1.000	0.000	69	1.000	0.000
Kogrukluk River 1992	48	0.958	0.042	0.000	0.000	47	1.000	0.000	49	1.000	0.000
Kogrukluk River 1993	50	0.920	0.080	0.000	0.000	50	1.000	0.000	50	1.000	0.000
pooled	98	0.939	0.061	0.000	0.000	97	1.000	0.000	99	1.000	0.000
Tuluksak River 1993	50	0.920	0.080	0.000	0.000	48	1.000	0.000	46	1.000	0.000
Takotna River 1992	12	0.917	0.083	0.000	0.000	12	1.000	0.000	13	1.000	0.000
Unalakleet River 1992	23	0.739	0.261	0.000	0.000	24	1.000	0.000	24	1.000	0.000
Unalakleet River 1993	60	0.675	0.325	0.000	0.000	61	1.000	0.000	60	1.000	0.000
pooled	83	0.693	0.307	0.000	0.000	85	1.000	0.000	84	1.000	0.000

Table 3. Continued.

Population	*PGK-2**			*PGM-2**			*sSOD-1**			
	N	100	90	74	N	100	136	N	-100	-260	580
Big Boulder Creek 1992	21	0.000	1.000	0.000	21	1.000	0.000	20	0.875	0.125	0.000
Big Boulder Creek 1993	25	0.000	1.000	0.000	25	1.000	0.000	25	0.860	0.140	0.000
pooled	46	0.000	1.000	0.000	46	1.000	0.000	45	0.867	0.133	0.000
Kelsall River 1993	45	0.000	1.000	0.000	45	1.000	0.000	45	0.778	0.222	0.000
Tahini River 1992	68	0.000	1.000	0.000	69	1.000	0.000	67	0.799	0.201	0.000
King Salmon River 1992	5	0.200	0.800	0.000	12	1.000	0.000	14	0.929	0.071	0.000
Whitman Lake-Chickamin River 1993	100	0.110	0.890	0.000	100	1.000	0.000	100	0.845	0.145	0.010
Little Port Walter-Chickamin River 1993	97	0.036	0.964	0.000	100	1.000	0.000	97	0.845	0.155	0.000
Farragut River Adults 1993	50	0.100	0.900	0.000	50	1.000	0.000	49	0.888	0.112	0.000
Farrugut River Juveniles 1993	37	0.000	1.000	0.000	38	1.000	0.000	37	0.797	0.203	0.000
Little Port Walter-Unuk River 1993	98	0.066	0.934	0.000	99	1.000	0.000	98	0.893	0.107	0.000
Klutina River 1991	20	0.025	0.975	0.000	20	1.000	0.000	20	1.000	0.000	0.000
Deception Creek 1991	98	0.051	0.872	0.077	98	1.000	0.000	96	0.984	0.016	0.000
Crooked Creek 1992	87	0.000	0.966	0.034	81	1.000	0.000	82	1.000	0.000	0.000
Ayakulik River 1993	97	0.000	0.969	0.031	98	1.000	0.000	98	1.000	0.000	0.000
Karluk River 1993	66	0.000	0.962	0.038	66	1.000	0.000	66	1.000	0.000	0.000
Nushagak River 1993	53	0.009	0.991	0.000	53	0.981	0.019	51	0.922	0.078	0.000
Stuyahok River 1993	36	0.000	1.000	0.000	36	1.000	0.000	36	0.931	0.069	0.000
Togiak River 1993	62	0.000	1.000	0.000	63	1.000	0.000	62	0.984	0.016	0.000
Goodnews River 1993	40	0.000	1.000	0.000	40	1.000	0.000	40	0.962	0.038	0.000
Kanektok River 1992	28	0.018	0.982	0.000	28	0.982	0.018	29	0.931	0.069	0.000
Kanektok River 1993	43	0.000	1.000	0.000	45	1.000	0.000	47	0.947	0.053	0.000
pooled	71	0.007	0.993	0.000	73	0.993	0.007	76	0.941	0.059	0.000
Kogrukluk River 1992	50	0.000	1.000	0.000	49	1.000	0.000	48	0.979	0.021	0.000
Kogrukluk River 1993	50	0.000	1.000	0.000	50	1.000	0.000	50	0.980	0.020	0.000
pooled	100	0.000	1.000	0.000	99	1.000	0.000	98	0.980	0.020	0.000
Tuluksak River 1993	50	0.000	1.000	0.000	50	1.000	0.000	50	0.920	0.080	0.000
Takotna River 1992	13	0.000	1.000	0.000	11	1.000	0.000	12	1.000	0.000	0.000
Unalakleet River 1992	24	0.000	1.000	0.000	24	1.000	0.000	23	0.913	0.087	0.000
Unalakleet River 1993	71	0.000	1.000	0.000	71	1.000	0.000	71	0.880	0.120	0.000
pooled	95	0.000	1.000	0.000	95	1.000	0.000	94	0.888	0.112	0.000

Table 3. Continued.

Population	*mSOD**			*TPI-3**			*TPI-4**			Heterozygosity	
	N	100	50	N	100	96	N	100	104	Observed	Expected
Big Boulder Creek 1992	21	1.000	0.000	21	1.000	0.000	21	0.976	0.024	0.037	0.036
Big Boulder Creek 1993	25	1.000	0.000	25	1.000	0.000	24	0.979	0.021	0.029	0.027
pooled	46	1.000	0.000	46	1.000	0.000	45	0.978	0.022	0.033	0.031
Kelsall River 1993	45	1.000	0.000	45	1.000	0.000	45	0.978	0.022	0.034	0.035
Tahini River 1992	68	1.000	0.000	68	1.000	0.000	68	1.000	0.000	0.030	0.031
King Salmon River 1992	14	1.000	0.000	14	1.000	0.000	14	0.964	0.036	0.045	0.044
Whitman Lake-Chickamin River 1993	99	1.000	0.000	98	0.949	0.051	97	1.000	0.000	0.054	0.052
Little Port Walter-Chickamin River 1993	99	1.000	0.000	99	1.000	0.000	99	1.000	0.000	0.036	0.036
Farragut River Adults 1993	50	0.990	0.010	50	0.950	0.050	50	1.000	0.000	0.044	0.044
Farrugut River Juveniles 1993				38	0.921	0.079	38	1.000	0.000	0.054	0.055
Little Port Walter-Unuk River 1993	99	0.985	0.015	99	0.975	0.025	99	1.000	0.000	0.049	0.047
Klutina River 1991	20	0.950	0.050	20	1.000	0.000	20	0.975	0.025	0.035	0.037
Deception Creek 1991	98	0.852	0.148	99	1.000	0.000	99	0.828	0.172	0.031	0.032
Crooked Creek 1992	79	0.981	0.019	82	1.000	0.000	82	0.878	0.122	0.032	0.033
Ayakulik River 1993	98	0.995	0.005	97	1.000	0.000	96	0.927	0.073	0.024	0.024
Karluk River 1993	66	0.992	0.008	66	1.000	0.000	66	0.932	0.068	0.028	0.027
Nushagak River 1993	53	0.953	0.047	53	1.000	0.000	53	0.868	0.132	0.039	0.039
Stuyahok River 1993	36	0.972	0.028	36	1.000	0.000	36	0.889	0.111	0.030	0.030
Togiak River 1993	61	0.943	0.057	62	1.000	0.000	62	0.927	0.073	0.032	0.032
Goodnews River 1993	40	0.938	0.062	40	1.000	0.000	40	0.850	0.150	0.039	0.041
Kanektok River 1992	27	0.944	0.056	29	1.000	0.000	29	0.931	0.069	0.034	0.032
Kanektok River 1993	47	0.883	0.117	45	1.000	0.000	45	0.900	0.100	0.030	0.030
pooled	74	0.905	0.095	74	1.000	0.000	74	0.912	0.088	0.031	0.031
Kogrukluk River 1992	49	0.898	0.102	46	1.000	0.000	49	0.888	0.112	0.035	0.034
Kogrukluk River 1993	50	0.850	0.150	50	1.000	0.000	50	0.940	0.060	0.034	0.034
pooled	99	0.874	0.126	96	1.000	0.000	99	0.914	0.086	0.034	0.034
Tuluksak River 1993	47	0.968	0.032	50	1.000	0.000	50	0.950	0.050	0.033	0.033
Takotna River 1992	11	0.955	0.045	11	1.000	0.000	11	0.955	0.045	0.034	0.035
Unalakleet River 1992	23	0.913	0.087	24	1.000	0.000	24	0.896	0.104	0.038	0.044
Unalakleet River 1993	59	0.958	0.042	61	1.000	0.000	67	0.888	0.112	0.042	0.044
pooled	82	0.945	0.055	85	1.000	0.000	91	0.890	0.110	0.041	0.044

Table 4. Log-likelihood ratio analysis of interannual collections of chinook salmon.

Collection	G-statistic	d.f.	*P*
Big Boulder Creek 1992 Big Boulder Creek 1993	22.48	17	0.167
Kanektok River 1992 Kanektok River 1993	41.97	27	0.033
Kogrukluk River 1992 Kogrukluk River 1993	22.12	19	0.278
Unalakleet River 1992 Unalakleet River 1993	31.58	23	0.109

Table 5. Log-likelihood hierarchical analysis of chinook salmon within and among regions in Alaska.

Collection	G-statistic	d.f.	*P*
Alaska	5012	1062	0.000
Among Regions	2667	118	0.000
Within Regions	2346	944	0.000
Southeast	1272	345	0.000
Among Drainages (+ Unuk and Farragut)	964	177	0.000
Within Drainages	308	177	0.000
Chilkat	95	118	0.941
Chickamin Strain	213	59	0.000
Southcentral	579	177	0.000
Among Drainages (+ Deception and Crooked)	545	118	0.000
Within Drainages	34	59	0.996
Kodiak Island	34	59	0.996
Northwest	495	413	0.003
Among Drainages (+ Unalakleet)	252	118	0.000
Within Drainages	244	295	0.986
Nushagak	73	118	1.000
Kuskokwim	171	177	0.613

Table 6. Gene diversity analysis (Chakraborty 1980) among Alaskan stocks of chinook salmon.

Source	Gene diversity	Coefficient of Gene Differentiation
Within subpopulations	H_S = 0.0436	G_{ST} = 0.9313
Among subpopulations within drainages	H_{DS} = 0.0004	$G_{DS(T)}$ = 0.0084
Among drainages within region	H_{DR} = 0.0010	$G_{DR(T)}$ = 0.0234
Among regions	H_{RT} = 0.0016	G_{RT} = 0.0369
Total Gene Diversity	H_T = 0.0436	

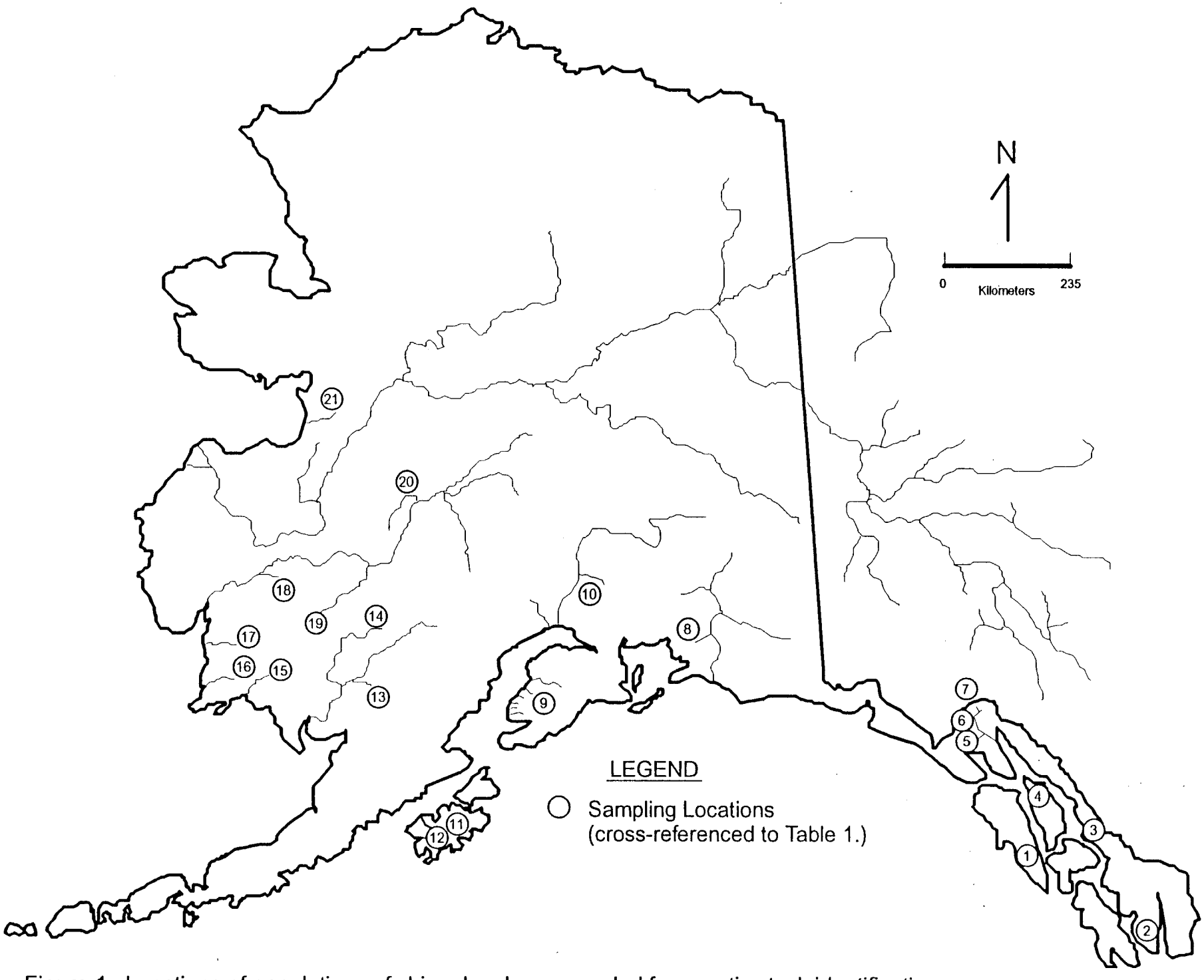

Figure 1. Locations of populations of chinook salmon sampled for genetic stock identification.

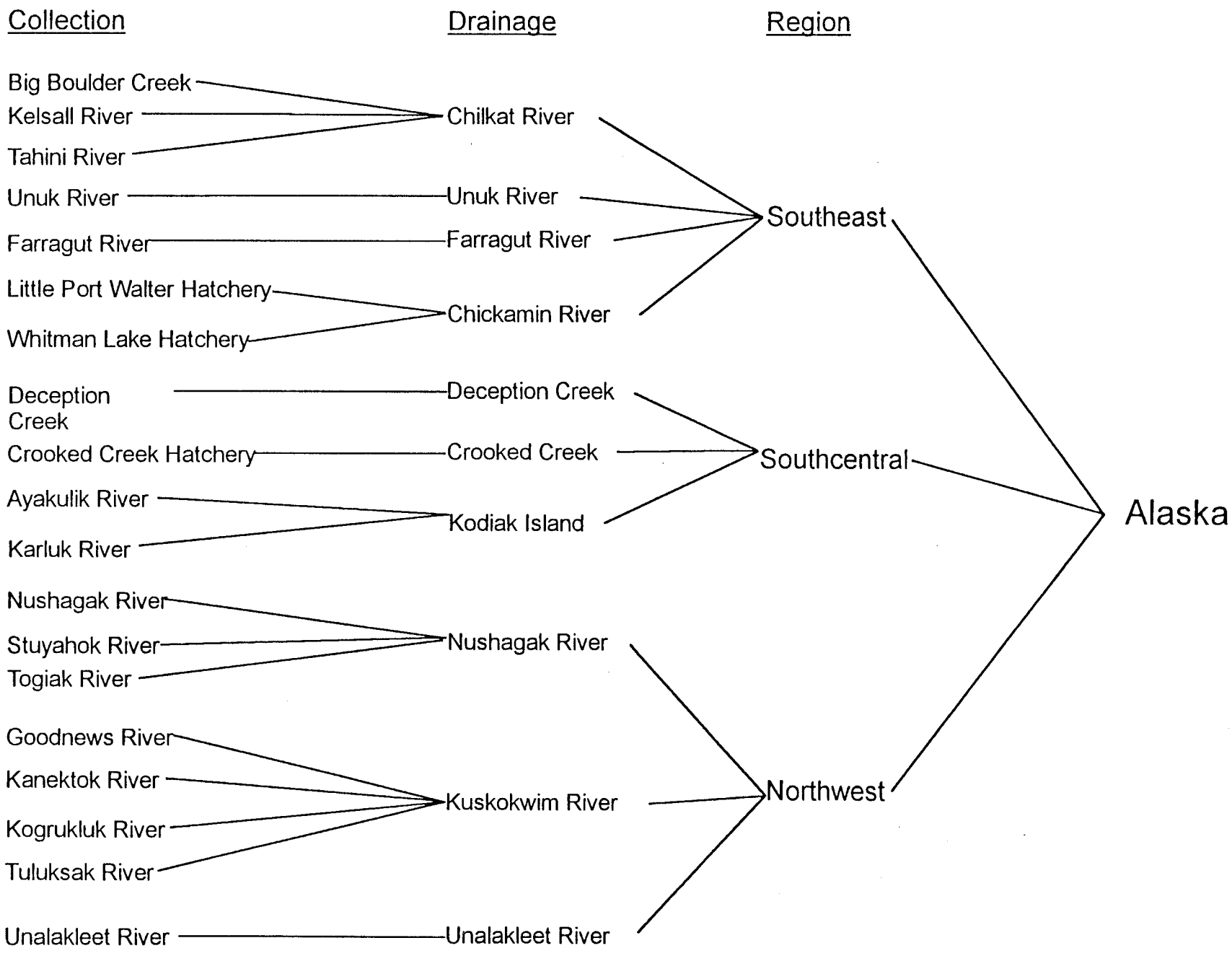

Figure 2. Populations of chinook salmon were subdivided into a hierarchy based on region and drainage.

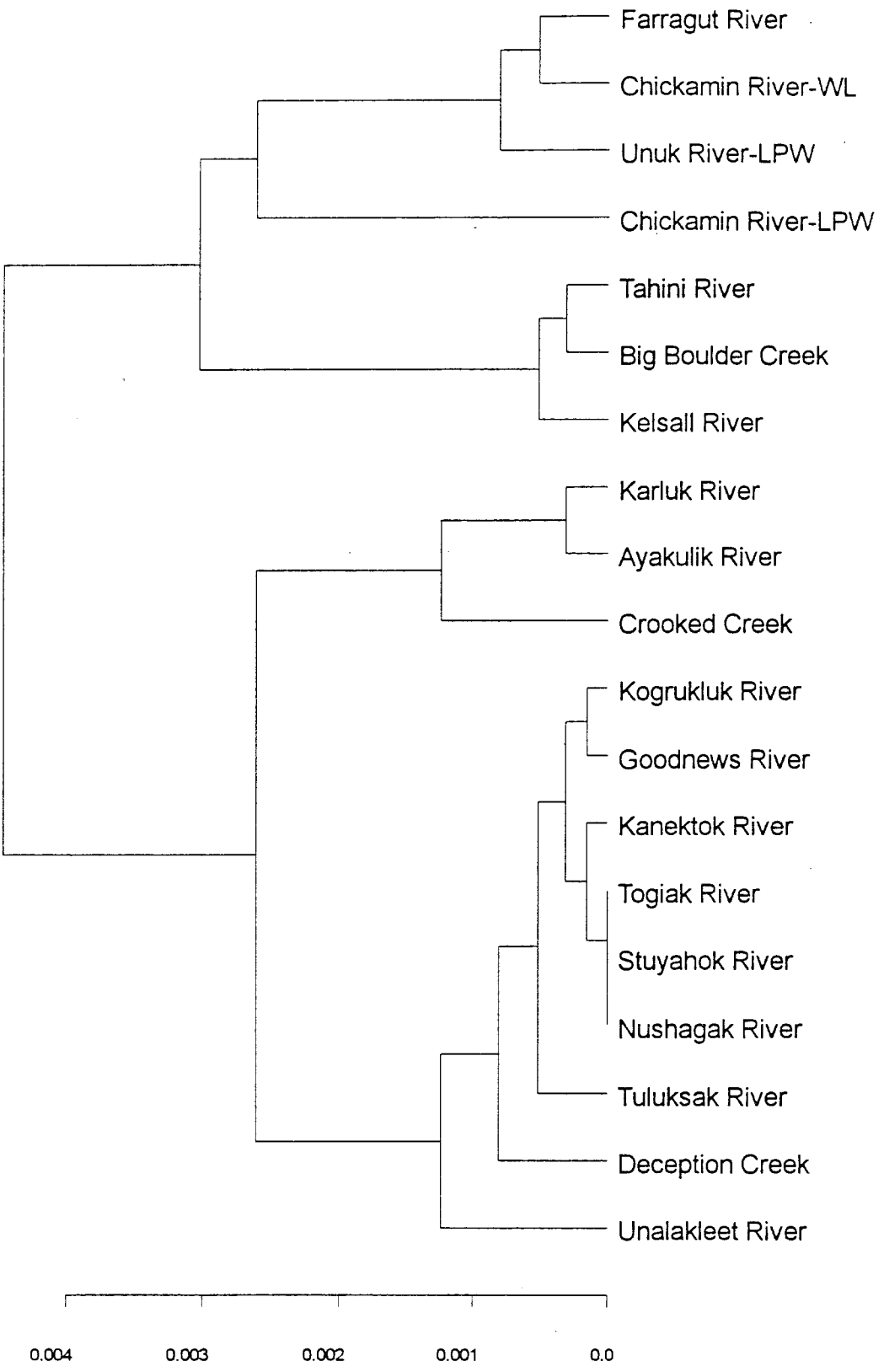

Figure 3. UPGMA phenogram of Alaskan populations of chinook salmon analyzed to date. Nei's unbiased genetic distance was used.

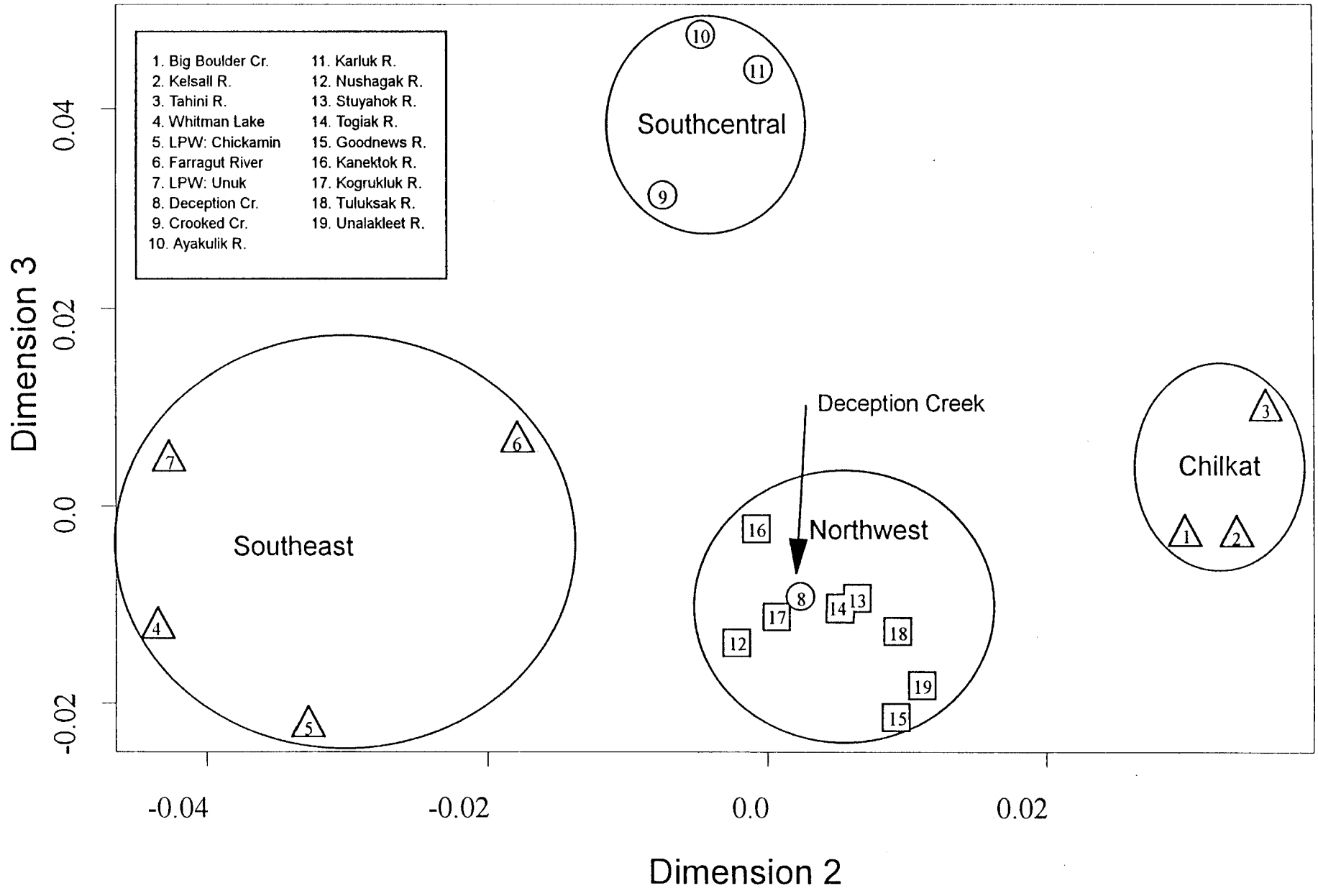

Figure 4. Multidimensional scaling plot using Cavalli -Sforza and Edwards genetic distance of chinook salmon populations analyzed to date.

Appendix 1. Collections of Alaskan chinook salmon sampled for genetic analysis. Both analyzed and unanalyzed collections are given.

Location	Life Stage	N	Year
Southeast			
Tamgass Hatchery (Chickamin/Unuk cross)	A	53	1994
Tamgass Hatchery (Chickamin/Unuk cross)	J	200	1994
Chickamin River			
Little Port Walter Hatchery	A	100	1993
Whitman Lake Hatchery	A	100	1992
Whitman Lake Hatchery	A	55	1994
Whitman Lake Hatchery	J	200	1994
Medvejie Hatchery	A	10	1994
Neets Bay Hatchery	J	200	1994
Unuk River			
Deer Mountain Hatchery	A	14	1991
Deer Mountain Hatchery	A	100	1992
Deer Mountain Hatchery	J	200	1994
Deer Mountain Hatchery	A	53	1994
Little Port Walter Hatchery	A	100	1993
Unuk River	J	150	1994
Andrew Creek			
Crystal Lake Hatchery	A	100	1992
Crystal Lake Hatchery	J	150	1994

Location	Life Stage	N	Year
Hidden Falls Hatchery	A	60	1994
Hidden Falls Hatchery	J	150	1994
Medvejie Hatchery	A	16	1994
Farragut River	J	38	1993
Farragut River	A	55	1993
Farragut River	J	85	1994
King Salmon River			
King Salmon River[1]	A	20	1991
King Salmon River	A	14	1992
Little Port Walter Hatchery	A	100	1993
Snettisham Hatchery	A	5	1992
Chilkat River			
Big Boulder Creek[1]	A	39	1991
Big Boulder Creek	A	21	1992
Big Boulder Creek	A	25	1993
Big Boulder Creek	A	32	1994
Kelsall River[1]	A	111	1991
Kelsall River	A	45	1992
Tahini River[1]	A	69	1991
Tahini River	A	69	1992
Central			
Copper River			
Gulkana River	A	2	1991

Location	Life Stage	N	Year
Gulkana River	J	150[2]	1994
Klutina River	A	23	1991
Anchor River	J	162	1993
Stariski Creek	J	152	1993
Deep Creek	J	151	1993
Ninilchik River	J	150	1993
Kasilof River			
Crooked Creek Hatchery	A	87	1992
Kasilof River	J	160	1993
Kenai River	J	150	1993
Susitna River			
Deception Creek	A	103	1991
Kodiak Island			
Karluk River	A	67	1993
Ayakulik River	A	100	1993
Bristol Bay			
Nushagak River			
Stuyahok River	A	36	1993
Stuyahok River	A	51	1994
Upper Nushagak River	A	3	1992
Upper Nushagak River	A	53	1993
Upper Nushagak River	A	100	1994
Togiak River	A	63	1993

Location	Life Stage	N	Year
Togiak River	A	100	1994
Lewis Point (mixed origin)	A	100	1993
Northwest			
Goodnews River	J	102[2]	1994
Goodnews River	A	40	1993
Goodnews River	J	99[2]	1993
Kanektok River	A	31	1992
Kanektok River	A	47	1993
Kanektok River	J	100	1993
Kuskokwim River			
Tuluksak River	A	50	1993
Tuluksak River	A	100	1994
Kogrukluk River	A	50	1992
Kogrukluk River	A	50	1993
Takotna River	A	13	1992
Takotna River	A	98	1994
Yukon River			
North Klondike River	J	150[2]	1993
McQueston River	J	224[2]	1992
Blind Creek	J	192[2]	1992
Nordenskiold River	J	69[2]	1992
Takhini River			
Whitehorse Fish Hatchery	J	150[2]	1993

Location	Life Stage	N	Year
Stoney Creek	J	185[2]	1992
Sidney Creek	J	167[2]	1992
Unalakleet River	A	24	1992
Unalakleet River	A	71	1993

[1]Samples cannot be used for allozyme electrophoresis due to poor quality.

[2]Numbers are approximate.

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