Genetic Stock Composition Analysis of Chum Salmon from the Prohibited Species Catch of the 2023 Bering Sea Walleye Pollock Trawl Fishery

Preliminary Report

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Executive Summary[1]

This report provides genetic stock composition results of chum salmon (*Oncorhynchus keta*) prohibited species catch (PSC), referred herein as "bycatch", samples collected from the 2023 walleye pollock (*Gadus chalcogrammus*) B-season fishery in the Bering Sea. Samples were genotyped for 84 single nucleotide polymorphism markers from which stock contributions were estimated using a range-wide chum salmon baseline developed by the Alaska Department of Fish and Game. The chum salmon bycatch in the B-season was 111,698 fish, substantially lower than the 10-year average of 314,981 fish. In addition to the drastic reduction in overall bycatch, the proportion of Western Alaska fish in the bycatch was 8.3%, reduced from the long-term average of 15.4%. An estimated 9,246 (8,025-10,481) chum salmon originating from Western Alaska were captured as bycatch, which was lower than the long-term mean of 40,892 chum salmon from 2011 to 2022. The overall proportion of the Upper/Middle Yukon reporting group remained relatively stable from the previous year at 2.3%; however, with the decrease in total bycatch numbers, the estimated number of Upper/Middle Yukon fish decreased from 4,618 (3,258-6,282) in 2022 to 2,540 (1,857-3,403) in 2023. Similarly, the proportion of the Southwest Alaska reporting group decreased from 3.6% in 2022 to 2.0% in 2023 with an estimated 2,245 (1,498-3,073) fish. In aggregate, Western Alaska, Upper/Middle Yukon, and Southwest Alaska comprised 12.6% of the chum salmon bycatch which when multiplied by the total bycatch expands to 14,032 chum salmon. The Northeast Asia reporting group comprised the largest proportion of the bycatch (52.5%). The Eastern Gulf of Alaska/Pacific Northwest reporting group, which has often been one of the largest contributors in past years, decreased in relative proportion in 2023, only comprising 18.7% of the bycatch. The Southeast Asia reporting group comprised a similar proportion of the bycatch as in previous years (16.3%). Consistent with historic trends, the highest proportion and number of Western Alaska chum salmon are from mixtures in the eastern portion of the pollock fishing grounds, near the Alaska Peninsula (Cluster 1 area). The average bycatch location of the catcher processor and mothership sectors shifted drastically northwest in 2023, however, the shoreside sector bycatch on average came from the same location as it has historically. Because of the differences in fleet distributions, the Western Alaska reporting group makes up a larger proportion of the shoreside sector bycatch. Areas with the highest rates of bycatch (chum per metric ton of pollock), within the most northwestern fishing grounds (Cluster 4 area), appear to occur on chum salmon mixtures that have higher proportions of Asia and the lowest proportion of Alaska origin fish. New data from four individual hauls/deliveries from within the Cluster 1 area during the Late time period demonstrate that chum salmon are for the most part well mixed and that schools of fish are not composed of a single reporting group.

[1] *Disclaimer* - These represent preliminary analyses of the 2023 chum salmon genetic data. All estimates are subject to change. Numerous plots in this report display fishery information. All data are non-confidential. Data are aggregated and any data point with fewer than three unique vessels has been removed.

Catch Summary

Temporal Trends

The chum salmon prohibited species catch (PSC), referred to as "bycatch" throughout this report, in the Bering Sea walleye pollock trawl fishery was 112,303 fish in 2023 (Fig. 1). This was 204,534 fish fewer than the 10-year average of 316,837 (122,974 sd). As is typical, over 99.0% of the chum salmon bycatch (111,698 fish) occurred in the B-season (between June and October).

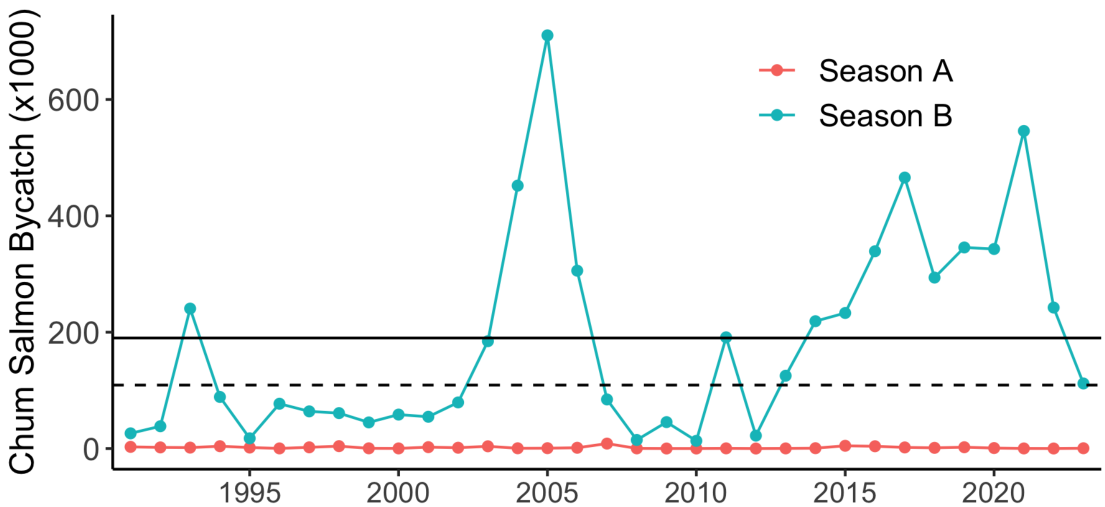

Figure 1: Chum salmon prohibited species catch (PSC) for the A- and B-seasons from the Bering Sea pollock-directed trawl fisheries. The solid horizontal line represents the mean PSC and the dashed line represents the median PSC from 1991 to 2022.

Within the B-season, the chum salmon bycatch was bimodal, characterized by two peaks. The first smaller peak occurred in July (statistical week 30), while the second larger peak occurred in late August (statistical week 34; Fig. 2 top panel). Relative to prior years, few chum salmon were caught before statistical week 27 (~July 3) or after week 40 (~October 7). Overall, the timing of the bycatch lay mid-way between the range of prior years, with 50% of the bycatch occurring prior to week 32 (Fig. 2 bottom panel).

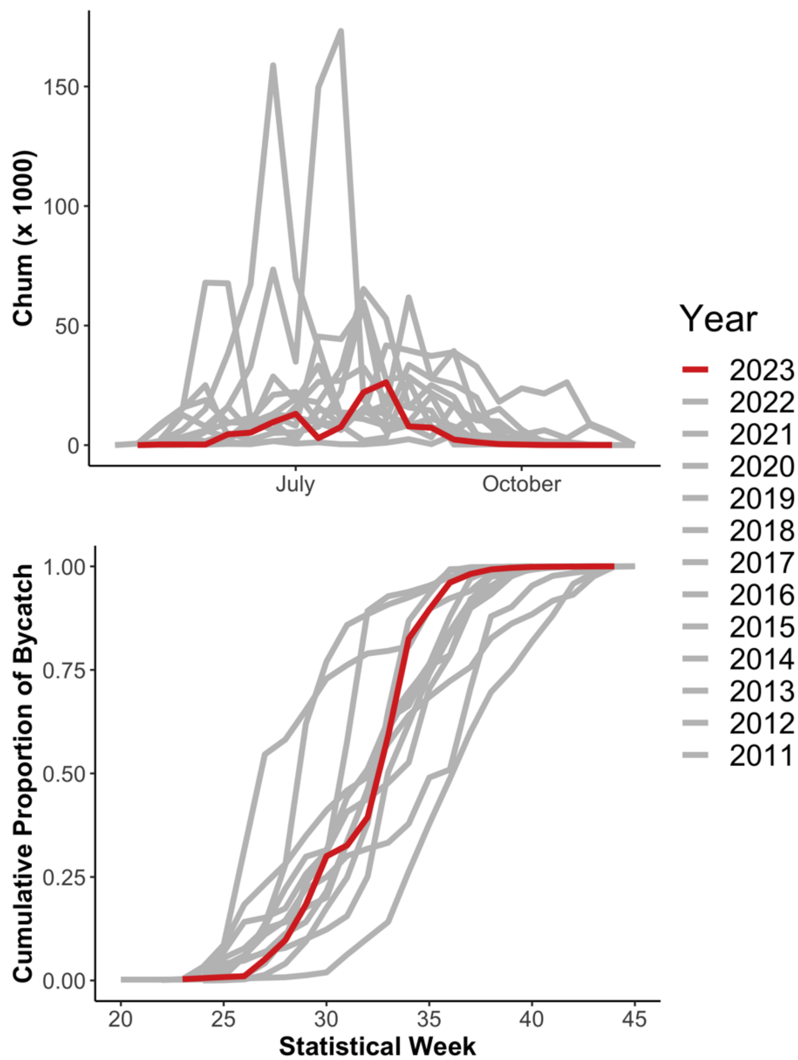

Figure 2: Number of chum salmon caught during the B-season (top) and cumulative proportion of chum salmon catch (bottom) from the Bering Sea pollock trawl fishery by statistical week for years 2011 to 2023.

Spatial Trends

The geographical distribution of the 2023 chum salmon bycatch was similar to the average spatial location of prior years (Fig. 3). Of the spatial clusters previously defined by the Alaska Fisheries Science Center (AFSC) Auke Bay Laboratory (ABL) Genetics Program the highest number of chum salmon bycatch were encountered in Clusters 1 and 3; with the highest bycatch coming from Alaska Department of Fish and Game (ADF&G) statistical area 655430.

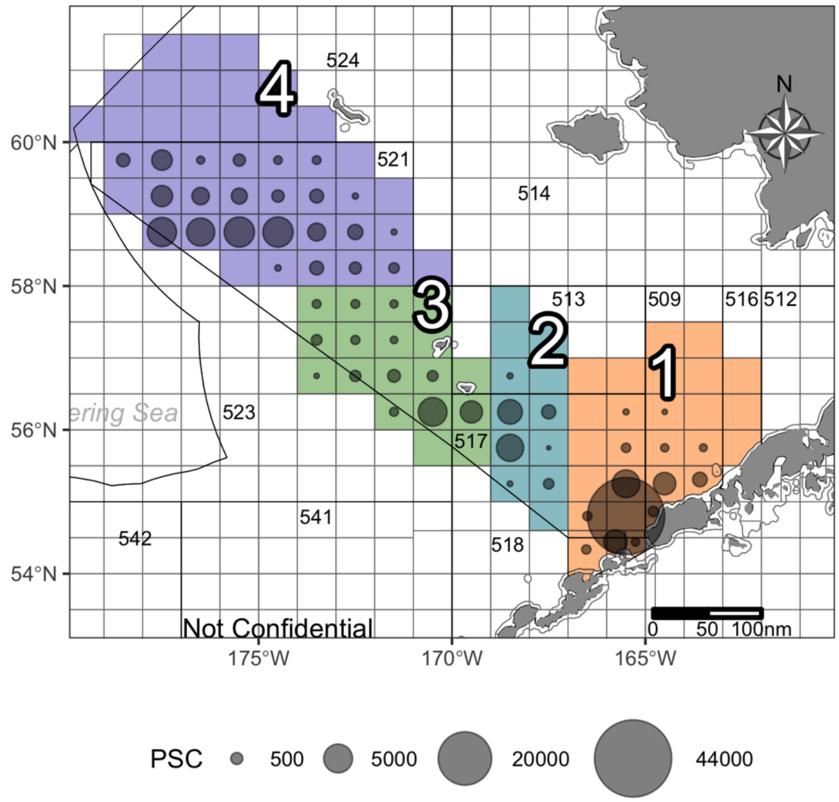

Figure 3: Spatial distribution of chum salmon bycatch caught in the 2023 Bering Sea B-season pollock fishery. ADF&G statistical areas are highlighted based on the four geographic strata assigned in prior genetic analyses.

To evaluate bycatch hotspots, areas where there were large catches of chum salmon relative to total pollock catch, bycatch rates - number of chum salmon per metric ton of pollock harvested (chum/mt. pollock) – were calculated for each of the ADF&G statistical areas (Fig. 4). The average bycatch rate was 0.15 chum/mt. pollock, with a low of 0.001 and a high of 1.49 chum/mt. pollock. Despite the large bycatch numbers from statistical area 655430, the overall rate of bycatch (0.38 chum/mt. pollock) was similar to other areas along the Alaska Peninsula. The three highest rates of bycatch by ADF&G statistical area were in Cluster 4, averaging 0.95 (0.47 sd) chum/mt. pollock.

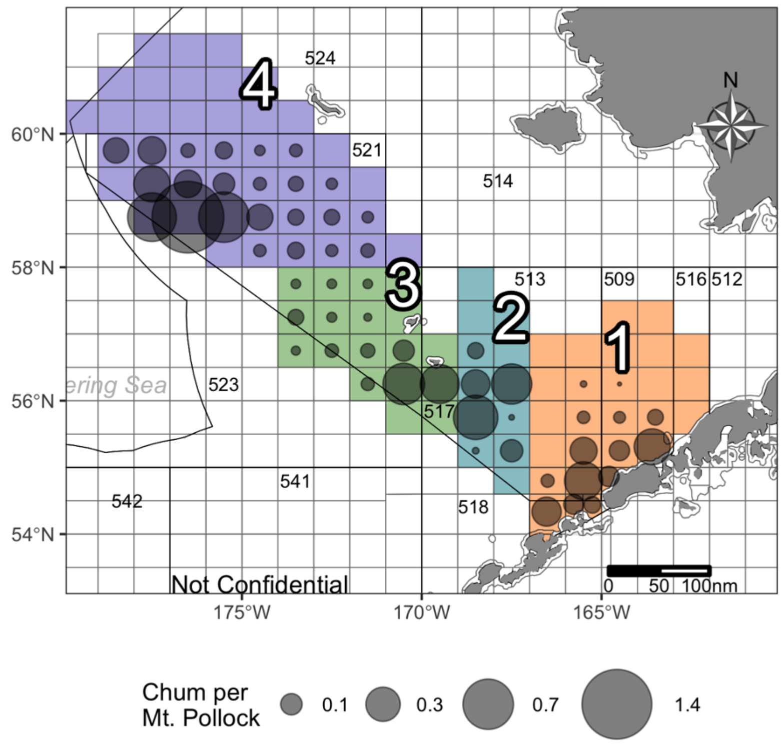

Figure 4: Spatial distribution of chum salmon bycatch rates, calculated as total chum salmon bycatch divided by total metric tons of pollock harvested, in the 2023 Bering Sea B-season pollock fishery. ADF&G statistical areas are highlighted based on the four geographic strata assigned in prior genetic analyses.

To evaluate shifts in the distribution of the chum salmon bycatch the centroid (center of the bycatch) was calculated for each year by sector. The spatial arrangement of the centroid was investigated for associations with a variety of environmental covariates including the Pacific Decadal Oscillation (PDO), warm pool, sea ice extent, and eastern Bering Sea surface temperature (shown Fig. 5). Climate data were downloaded from NOAA's Physical Science Laboratory climate indices data repository[2].

In 2023, the average location of the catcher-processor and mothership sector bycatch shifted further northwest compared to prior years, while the shoreside sector was not substantially different (Fig. 5; left column). The mean Eastern Bering Sea temperature in 2023 was 4.57°C, slightly cooler than the average over the last 12 years (4.79°C). As reported last year, it appears that in years with lower sea surface temperatures in the Eastern Bering Sea, the centroid of the mothership and shoreside sectors are farther east on the shelf (Fig. 5); however, very few cold years (2011-2013) contribute to this observation and they all occur early in the time series.

[2] https://psl.noaa.gov/data/climateindices/

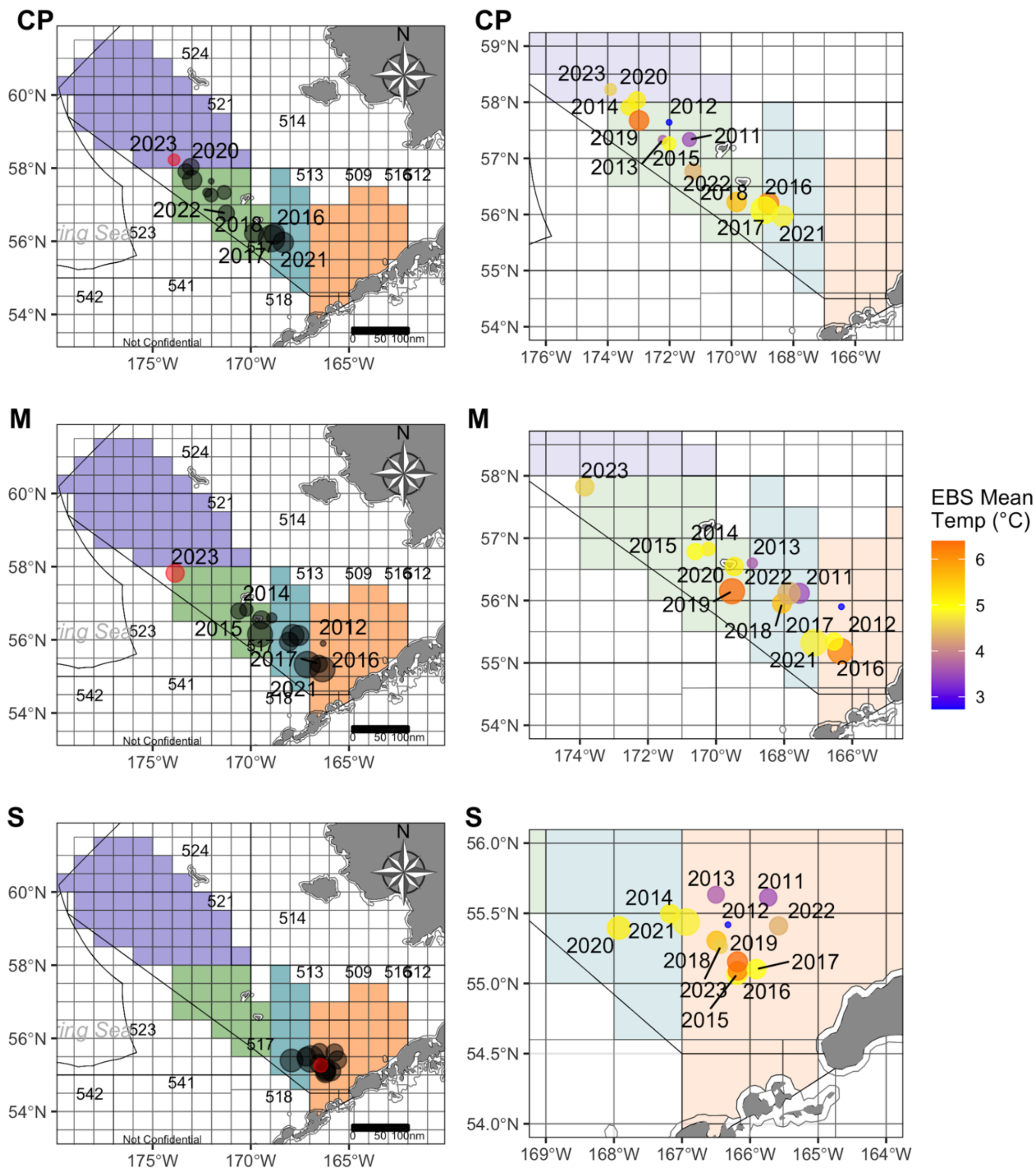

Figure 5: Change in the spatial distribution of chum salmon bycatch as measured by the centroid of the bycatch by sector; catcher-processor (CP), mothership (M) and shoreside (S). Point sizes reflect the relative size of the bycatch. The left column highlights the most recent year, 2023 (red), across all cluster areas, and the right column zooms into the spatial extent of each fishing sector, with points colored by the mean sea surface temperature (°C).

Bycatch Genotyping Summary

Data from the AFSC Fisheries Monitoring and Analysis North Pacific Observer Program (Observer Program), total chum salmon bycatch, and genetic sample information were downloaded from the AFSC schema in the Alaska Fisheries Information Network (AKFIN) database. The ABL Genetics Program received 3,596 genetic samples from the Bering Sea and Aleutian Islands (BSAI) and 711 samples from the Gulf of Alaska (GOA) that were collected by the Observer Program in 2023. Due to the accelerated time frame of this reporting cycle, the GOA chum salmon samples will not be presented in this report, but will be evaluated in the annual technical memorandum. While previous reporting indicated that nearly all chum bycatch samples from the GOA are from the Eastern Gulf of Alaska/Pacific Northwest (EGOA/PNW) reporting group, these estimates have not been reevaluated since 2018.

After inventorying the genetic samples, the ABL Genetics Program determined that there was sufficient capacity to genotype all of the samples that were received. DNA from 3,423 genetic samples, 95.2% of the total genetic samples collected by the Observer Program, was extracted and amplified for the 84 single nucleotide polymorphism (SNP) locus GT-seq panel (see Appendix II). Of those samples that were not included in the analyses, a small number were moldy and others arrived in late February after laboratory processing. Samples that were not genotyped for greater than 80.0% of the GT-seq panel (minimum of 68 loci) were omitted from analyses. Of the 3,423 samples amplified, 3,277 were of adequate quality to estimate stock compositions (95.7% of the total sample).

A subset of samples (5.6%) was re-amplified and genotyped for quality control (QC). The scores of these QC samples were compared with the scores from the originally genotyped samples to estimate the genotyping error rates. The average agreement over loci was 99.2%, and the average agreement among individuals was also high (99.7%), indicating high genotyping accuracy and correct sample organization. This ensured that the GT-seq assay was consistent and provided confidence that the mixtures we analyzed contained the correct genetic samples.

Genetic Stock Composition

Stock composition analyses for the 2023 chum salmon samples were performed with the Bayesian conditional mixed stock analysis (MSA) approach with bootstrapping over reporting groups implemented in the R package *rubias* (Moran and Anderson 2019). Mixture genotypes were compared to an updated version of the Western Salmon Stock Identification Program (WASSIP) baseline [DeCovich et al. (2012); data provided by ADF&G] in which populations were grouped into regional reporting groups that were consistent with prior analyses based on the Fisheries and Oceans Canada (DFO) chum salmon microsatellite baseline (Beacham et al. 2009). Details about the estimation method and baseline are in Appendix II.

Overall Trends

Western Alaska comprised 8.3% of the bycatch which was substantially lower than both the prior year (21.1%) and the long-term average (15.3% from 2011-2022), but similar to years 2020 and 2021 (8.0% and 8.9%, respectively). Both SW Alaska and the Upper/Middle Yukon comprised relatively minor portions of the bycatch, 2.0 and 2.3%, respectively (Table 1). Consistent with prior years, Asia stocks comprised a substantial fraction (68.8%)

Table 1: Regional stock composition estimates of chum salmon from the 2023 Bering Sea, B-season pollock fishery (PSC = 111,698; n = 3,277). The estimated number of chum salmon bycatch, the 95% CI for the estimated number, mean proportion, 95% credible intervals, P = 0 statistic (the probability that the estimated proportion is 0), and the Gelman-Rubin shrink factor (SF; convergence diagnostic).

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	18,221	16,771-19,718	0.163	0.150	0.177	0.00	1.00
NE Asia	58,604	56,573-60,593	0.525	0.506	0.542	0.00	1.00
W Alaska	9,246	8,025-10,481	0.083	0.072	0.094	0.00	1.00
Up/Mid Yukon	2,540	1,857-3,403	0.023	0.017	0.030	0.00	1.00
SW Alaska	2,245	1,498-3,073	0.020	0.013	0.028	0.00	1.00
E GOA/PNW	20,839	19,322-22,402	0.187	0.173	0.201	0.00	1.00

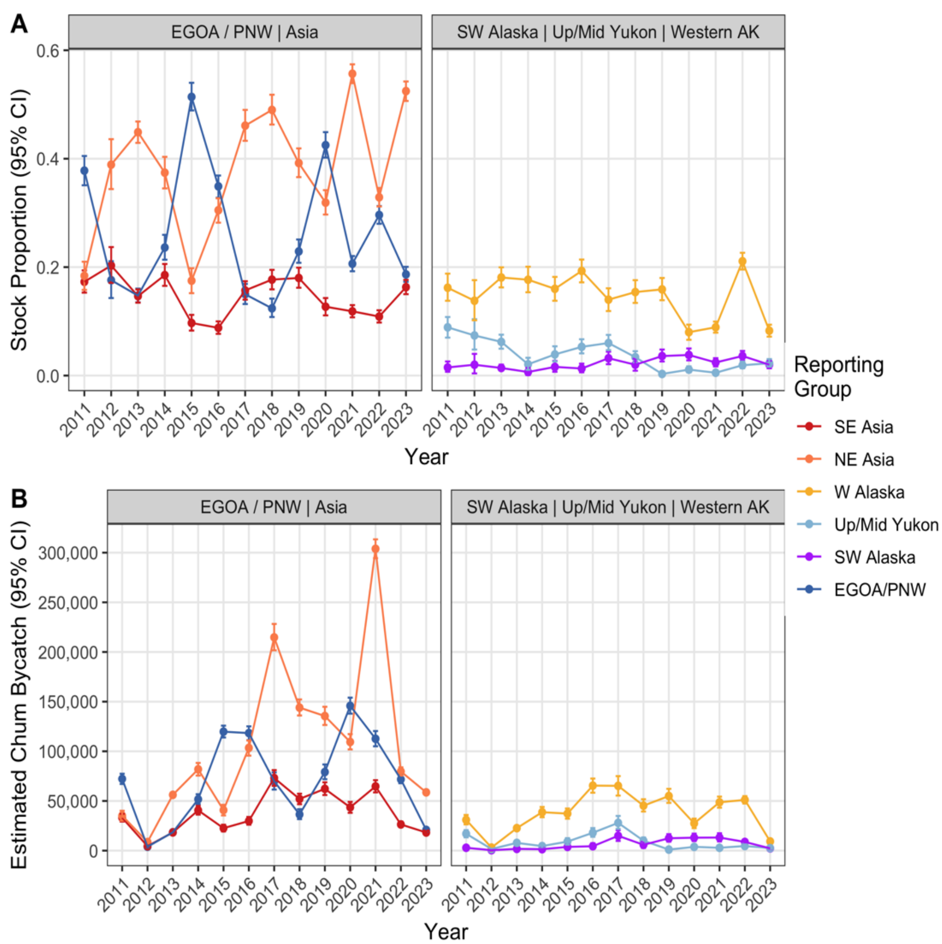

Figure 6: Annual bycatch estimates of B-season chum salmon PSC from 2011 to 2023. (A) stock proportions with 95% credible intervals, (B) estimated number of chum salmon with 95% credible intervals.

of the chum salmon bycatch in the 2023 B-season. The contribution from the NE Asia reporting group (52.5%) was higher than last year, but similar to 2021. The SE Asia reporting group (16.3%) was higher than the previous year (9.8%) and comprised about the same proportion of the bycatch as the EGOA/PNW reporting group (18.7%), which was lower than in 2022 (28.0%).

There is a clear cyclical pattern of contribution between the NE Asia and EGOA/PNW reporting groups (Fig. 6) with a strong negative correlation (r = -0.85). Additionally, the two stocks have comprised an increasing proportion of the bycatch through time, starting at a low of 56.2% in 2011 to a high of 76.3% in 2021.

Temporal Trends

The B-season was divided into Early (pre-week 30), Middle (weeks 30-34), and Late (post-week 34) time periods to evaluate whether regional group contributions changed through the season.

As is fairly typical, the majority of the bycatch occurred in the Middle time period with a shift in the catch composition among the time periods for several reporting groups (Fig. 7). The Western Alaska reporting group was highest in the Early and Middle time periods (9.1% and 9.6%, respectively) dropping to 4.6% by the Late time period. The SW Alaska reporting group demonstrated a similar decrease in contribution to the bycatch from the Early to the Middle time period, decreasing from 4.4% to 1.6%.

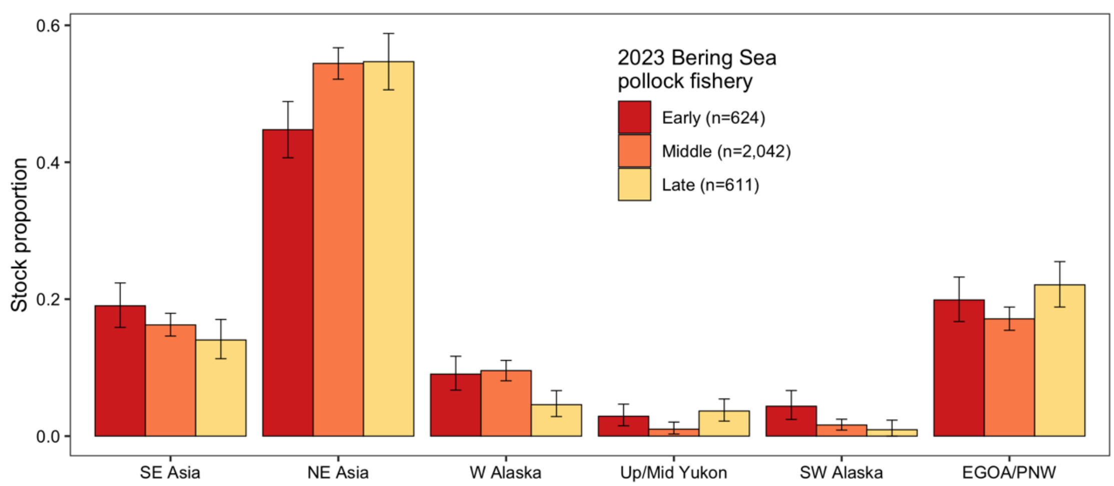

Figure 7: Stock composition estimates for the chum salmon bycatch from the Early, Middle, and Late time periods of the 2023 Bering Sea, B-season pollock fishery. Sample sizes for each mixture are provided in the figure legend.

The Upper/Middle Yukon reporting group comprised a low of 1.0% in the Middle period and a high of 3.7% in the Late period. The EGOA/PNW reporting group similarly comprised a low of 17.1% in the Middle period and a high of 22.1% in the Late period. Consistent with prior years, the SE Asia reporting group decreased in relative contribution to the bycatch from the Early (19.0%) to Late time period (14. 0%). The NE Asia reporting group increased from a low of 44.8% in the Early period to a high of 54.4% and 54.7% in the Middle and Late time periods, respectively.

While there is substantial intra-year variability in the stock compositions among the three time periods, several general trends are observed (Fig. 8). Typically, SE Asia comprises a larger proportion of earlier bycatch, whereas NE Asia comprises a smaller proportion of early bycatch. Western Alaska typically comprises a smaller proportion of the late bycatch, although there is substantial variability among years in both the Early and Middle Periods. The highest proportion of the Upper/Middle Yukon reporting group typically occurs in the Early period. Of the six reporting groups, SW Alaska typically has the lowest contribution and variability among the time periods with proportions that display a minor decrease from the Early period to the Middle and Late periods. The EGOA/PNW reporting group increases in relative proportion from the Early and Middle periods to the Late period. It should be noted that the boxplot (Fig. 8) compares the annual mean estimate and ignores the uncertainty (credible intervals) that surround the point estimates. It is not uncommon for means to differ, but credible intervals to overlap (e.g., SE Asia in all time periods in 2023; Fig. 7).

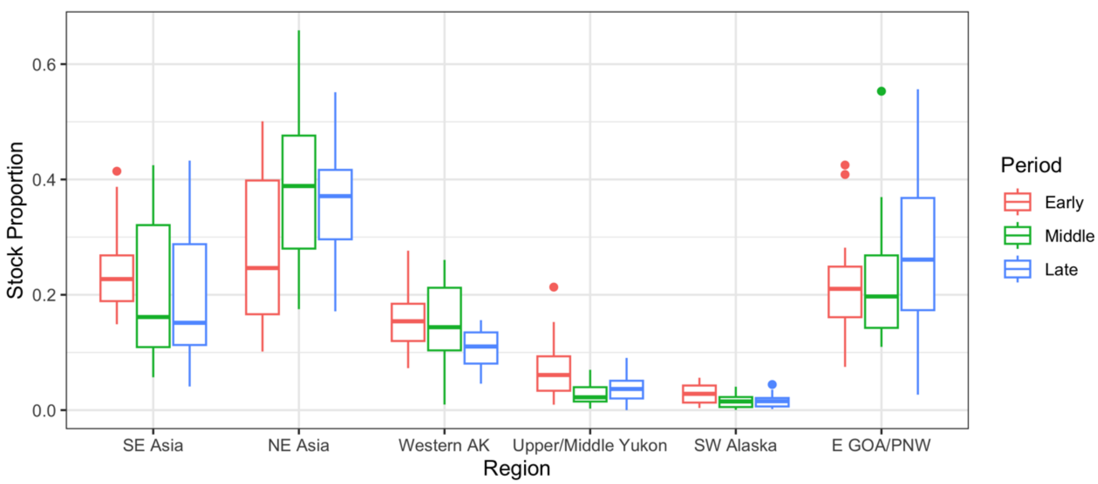

Figure 8: Boxplot of mean stock composition estimates for the chum salmon bycatch from the Early, Middle, and Late time periods from the 2011-2023 Bering Sea, B-season pollock fishery.

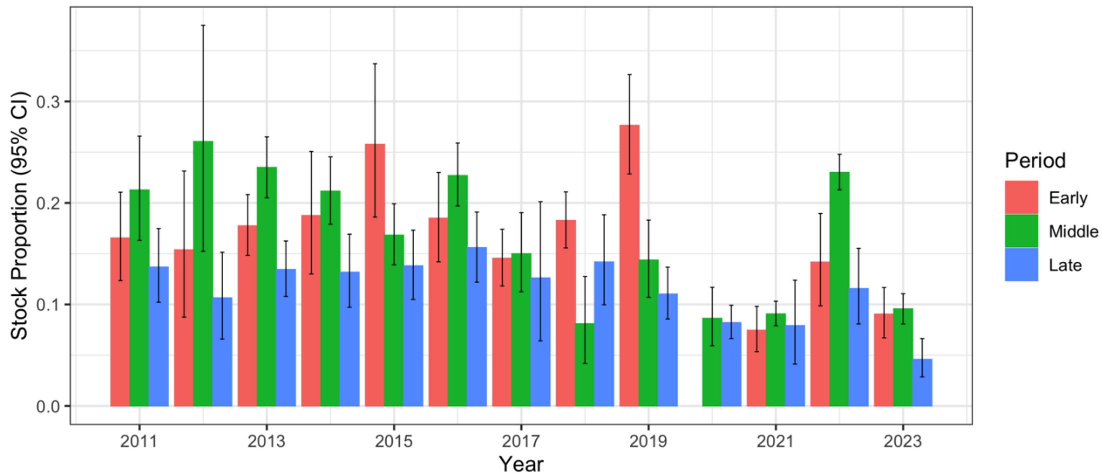

Figure 9: Mean stock composition estimates for the Western Alaska reporting group from the Early, Middle, and Late time periods from the 2011-2023 Bering Sea, B-season pollock fishery.

The Western Alaska reporting group is used as a more detailed example of variability in stock composition estimates between and within years (Fig. 9). The credible intervals from 2011 to 2023 substantially overlap for some year and period combinations due to low sample sizes. However, in 8 of the last 13 years, the estimates from the Early or Middle time periods were greater than the Late period (non-overlapping credible intervals), supporting the pattern that the Western Alaska contributes lower proportions in the Late period (Fig. 8).

Spatial Trends

Analyses where the bycatch has been divided into mixtures based on longitude, with 170°W as the dividing line have historically shown that the relative contribution of the Western Alaska, Upper/Middle Yukon, SW Alaska, and EGOA/PNW reporting groups generally increases closer to the Alaska Peninsula (east of 170°W). In 2023, this was true for the Western Alaska, SW Alaska, and EGOA/PNW reporting groups, whereas the 95% credible intervals for the Upper/Middle Yukon overlapped (Fig. 10).

The relative contribution of the Asia reporting groups, alternatively, are generally larger for mixtures west of 170°W. This was true for both of the Asia reporting groups in 2023. The SE Asia reporting group comprised 26.6% of the bycatch west of 170°W and 10.2% of the bycatch east of 170°W. The NE Asia reporting group comprised 61.3% of the bycatch west of 170°W and 47.2% of the bycatch east of 170°W (Fig. 10).

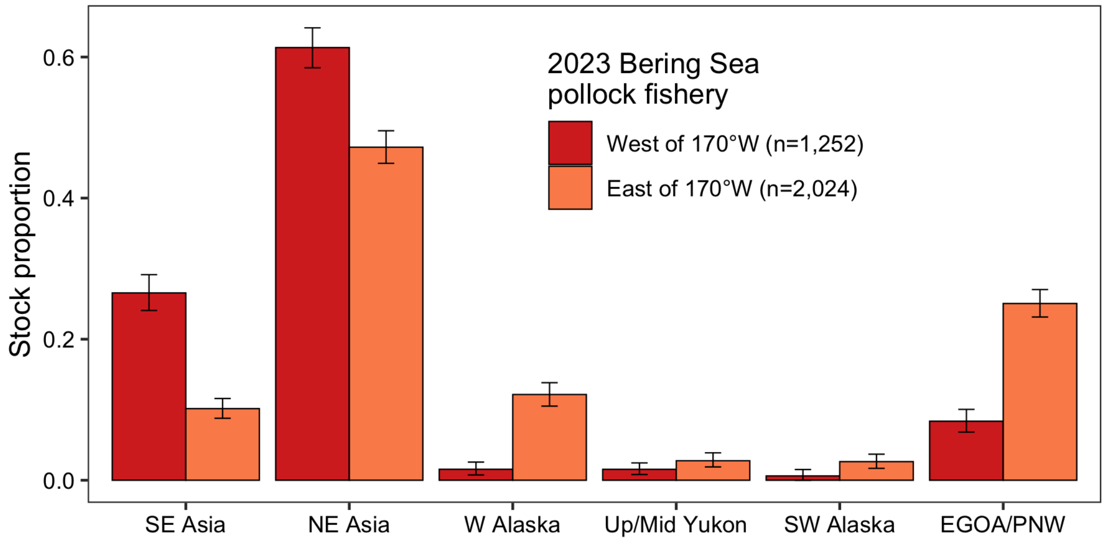

Figure 10: Stock composition estimates for the chum salmon bycatch from the 2023 Bering Sea, B-season pollock fishery from the U.S. waters of the Bering Sea west of $170^{\circ}W$ *and the southeastern Bering Sea east of* $170^{\circ}W$.

Spatiotemporal Trends

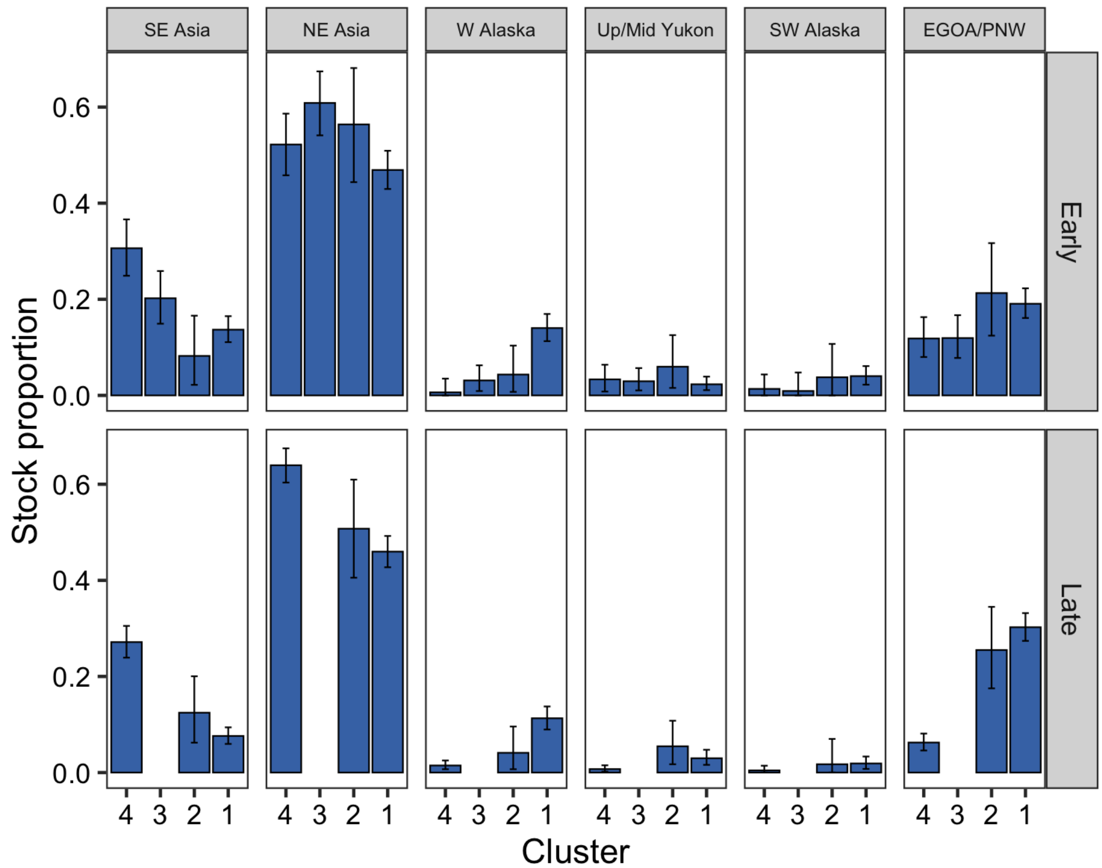

Figure 11: Stock composition estimates for the chum salmon collected from four spatial clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2023 Bering Sea, B-season pollock fishery. Clusters are ordered from west (Cluster 4) to east (Cluster 1).

The ABL Genetics Program has previously separated the Bering Sea into finer-scale spatial strata: 4 clusters of ADF&G statistical areas based on the zones defined in Haynie and Pfeiffer (2013) to evaluate economic and climate drivers of the fishery. Temporal stratification (Early and Late time periods) was also incorporated to evaluate the spatiotemporal stock specific contributions (Fig. 11). Too few chum salmon were caught in Cluster 3 during the Late period for stock composition analysis.

Stock composition estimates were mostly consistent with historic trends. The Asia component primarily decreases from west to east and from early to late (Fig. 11; left two panels). The Western Alaska contribution increases from west to east. The EGOA/PNW contribution increases from west to east and from Early to Late, particularly in Clusters 1 and 2, near the Alaska Peninsula. (Fig. 11; right panel).

In the Early period, the Western Alaska contribution increases from an average of 1.9% (1.8% sd) in Clusters 4 and 3 to 14.0% in Cluster 1. Similarly, in the Late time period, the Western Alaska contribution increases from 1.5% in Cluster 4 to 11.3% in Cluster 1. The EGOA/PNW contribution increases from Early to Late in Clusters 2 (21.3% to 25.5%) and Cluster 1 (19.1% to 30.2%) and from west to east. In the Early period, the proportion of the EGOA/PNW stock group increases from 11.8% in Cluster 4 to 19.1% in Cluster 1; in the Late period, it increases from 6.2% in Cluster 4 to 30.2% in Cluster 1. In both the Early and late time periods, the 95% credible intervals of the EGOA/PNW stock overlap for Clusters 1 and 2.

In order to evaluate the consistency of the spatiotemporal trends in the Western Alaska reporting group we compared the Early and Late estimates for Clusters 1 through 4 from 2011 to 2023 (Fig. 12). The finer scale strata result in smaller collections of genetic samples and increases estimate uncertainty (larger credible intervals).

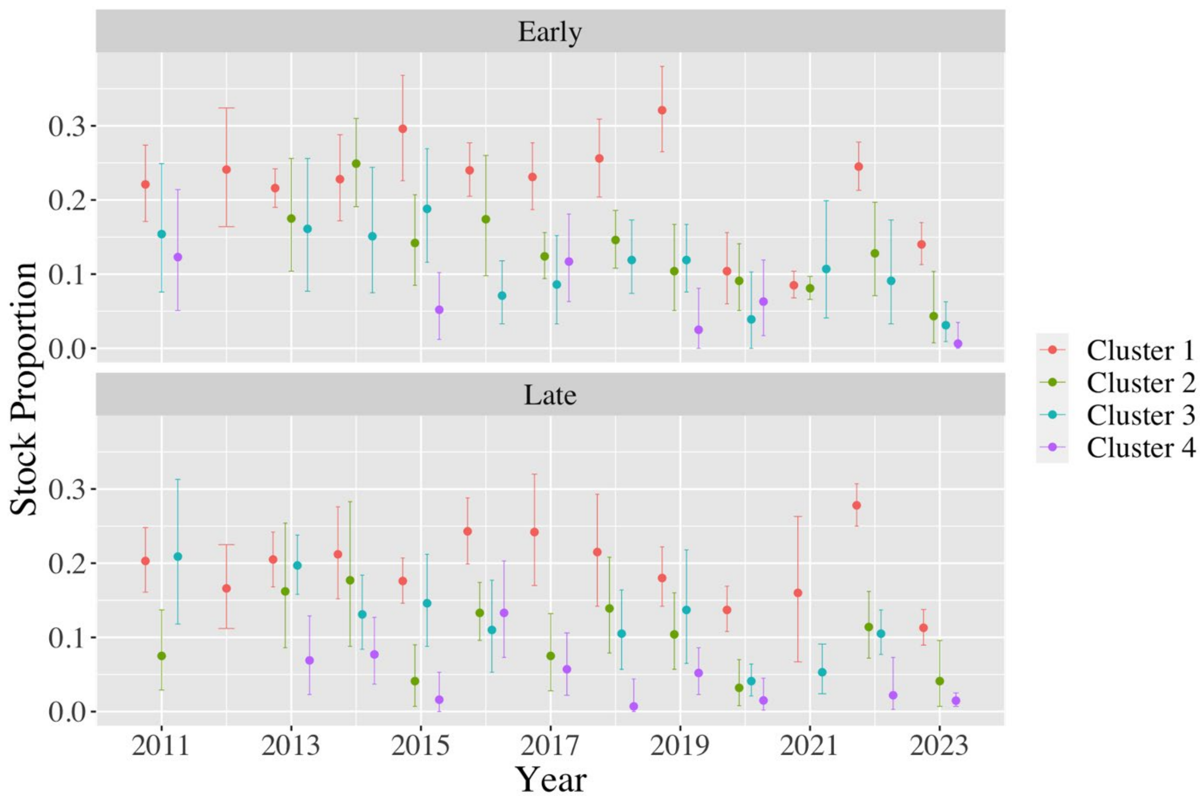

Figure 12: Western Alaska stock composition estimates for the chum salmon collected from four spatial clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2011 - 2023 Bering Sea, B-season pollock fishery. Clusters are ordered from east (Cluster 1) to west (Cluster 4).

Although there is some interannual variability, the Western Alaska proportion of chum salmon is predominately higher from Cluster 1 than the other Clusters. In the Early time period, the estimate for Cluster 1 was significantly higher (non-overlapping credible intervals) than Cluster 3 in 6 of 12 comparisons, with only a single year (2021) where the point estimate for Cluster 3 was larger than Cluster 1. In the Late period, Western Alaska mean estimates in Cluster 1 exceeded those in Cluster 3 in all years except 2011. The total number of chum salmon caught in Cluster 1 vastly exceeds those in Cluster 3 and as a result, despite the slight overlap in credible intervals for the proportions, the estimated number of Western Alaska chum salmon in Cluster 1 early is higher than that of Cluster 3 early in all years but 2020 (Fig. 13). In the late period, the estimated number of Western Alaska chum salmon bycatch in Cluster 1 exceeds that of Cluster 3 in 7 of the 10 years where estimates were possible.

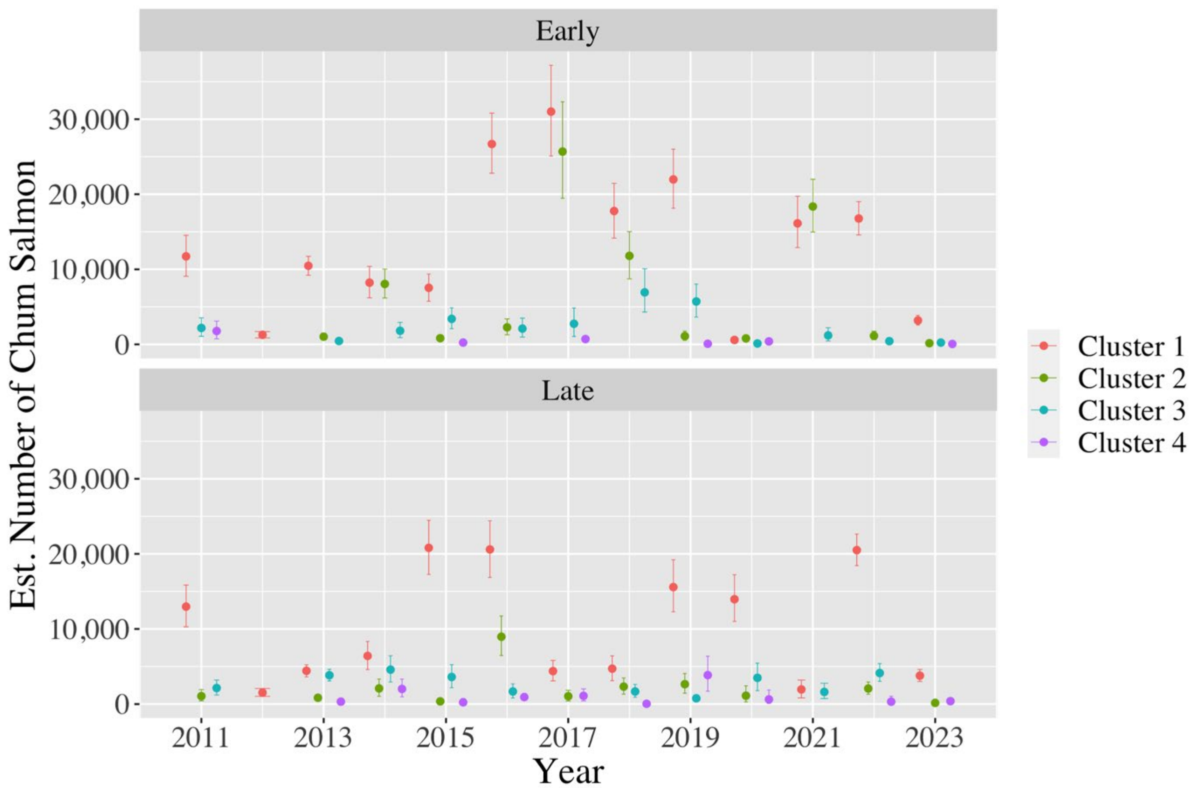

Figure 13: Estimated number of Western Alaska chum salmon bycatch from four spatial Clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2011 - 2023 Bering Sea, B-season pollock fishery. Clusters are ordered from east (Cluster 1) to west (Cluster 4) .

Sector Trends

Reporting group contributions to the 2023 chum salmon bycatch from each fishing sector were generally consistent with historic patterns. The shoreside sector caught 59.8% of the total bycatch; the catcher-processor and mothership sectors caught 23.1% and 17.1%, respectively (Fig. 14). The Western Alaska regional group comprised a larger proportion of the shoreside sectors bycatch (11.6%) than the catcher-processor (1.9%) and mothership (4.0%) sectors. The total number of Western Alaska chum salmon caught by the shoreside sector (7,736) was substantially larger than the number caught by the catcher-processor (486) or mothership (763) sectors. The overall proportion of the Upper/Middle Yukon group was similarly low across sectors (all credible intervals overlapped); however, the estimated number of Upper/Middle Yukon chum salmon bycatch from the shoreside sector was on average 1,639 more fish than from the catcher-processor and mothership sectors. Additionally, despite the overlapping credible intervals of stock proportions from the SW Alaska reporting group, the shoreside sector caught on average 1,544 more SW Alaska origin chum salmon than the other sectors due to the larger shoreside sector bycatch.

As is typical, the catcher-processor sector fished further to the northwest and encountered most chum salmon bycatch in Clusters 2-4, resulting in a higher proportion of both Asia regional groups than the shoreside sector. The proportion of Asia reporting groups to the mothership sector bycatch is often intermediate to the catcher-processor and shoreside sectors. However, in 2023 the bycatch from the mothership sector was more similar to the catcher-processor sector, likely because the average location of the mothership sector bycatch occurred much further west than usual (Fig. 5).

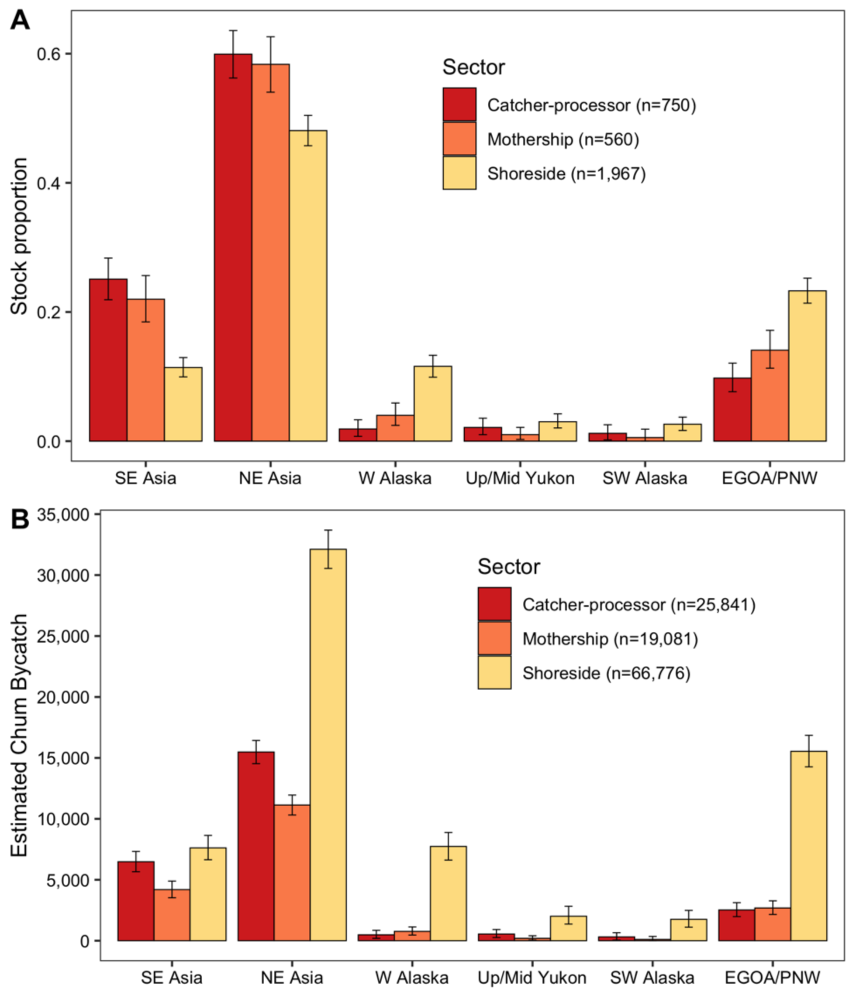

Figure 14: Stock composition estimates for the chum salmon bycatch from the 2023 Bering Sea, B-season pollock fishery from the catcher-processor, shoreside, and mothership fishing sectors. Sample sizes for mixture analysis given in legend. Proportions in top panel; numbers of fish in bottom panel.

Individual Haul / Deliveries

There were four individual hauls/deliveries that had adequate sample sizes to evaluate their stock composition (Fig. 15). Three analyses were for single hauls and one analysis consisted of a delivery of 4 separate hauls that spanned two ADF&G statistical areas. All hauls were delivered and processed within 3 days of one another and the majority of the pollock catch and associated bycatch came from the same ADF&G groundfish statistical area. All hauls were compared to estimates from the spatiotemporal analysis they most closely matched (Cluster 1 Late).

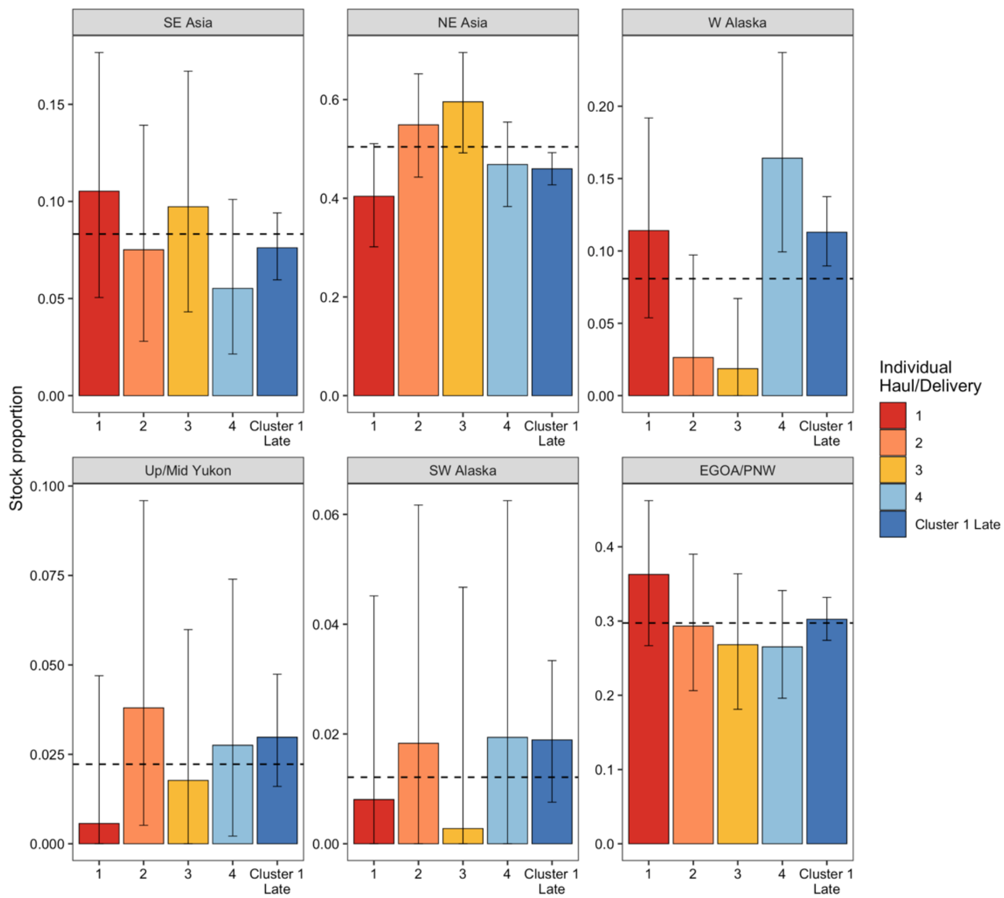

Figure 15: Stock composition estimates for four individual haul/deliveries from the 2023 Bering Sea, B-season pollock fishery compared to the most similar spatiotemporal analysis (Cluster 1 Late). The dashed line denotes the average stock proportion of the individual hauls for each regional group. Note difference in scales among regional groups.

Generally, individual hauls had stock compositions similar to samples aggregated over multiple ADF&G groundfish statistical areas and weeks, e.g., Cluster 1 Late. There was some variation in the composition among hauls. For example, haul 3 had a smaller proportion of Western Alaska chum salmon than haul 4. Most estimates, however, were characterized by large credible intervals that limited confidence in mean estimate differences. The stock contribution estimates from the 2023 individual hauls/deliveries support previous estimates (e.g., Kondzela et al. 2017) that suggest regional groups of chum salmon are well mixed even at the small spatiotemporal scale of individual hauls/deliveries.

Kotzebue Sound

In spite of the declines observed for other Coastal Western Alaska regions, commercial harvest data suggest that Kotzebue Sound chum salmon populations may be less affected by the driver of these declines. The total number of salmon fishing permits for Kotzebue Sound is down relative to the highs in the early 1980s, however, the number of chum salmon harvested in recent years have been some of the largest commercial harvests on record (Fig. 16). From the ADF&G commercial harvest summary, the 2022 harvest was the 8^{th} highest on record[3]. Exceptions to the large harvests in recent years are the low catches in 2020, 2021, and 2023. In 2023, the total harvest fell below the long-term average, but the harvest per permit was slightly above the long-term average.

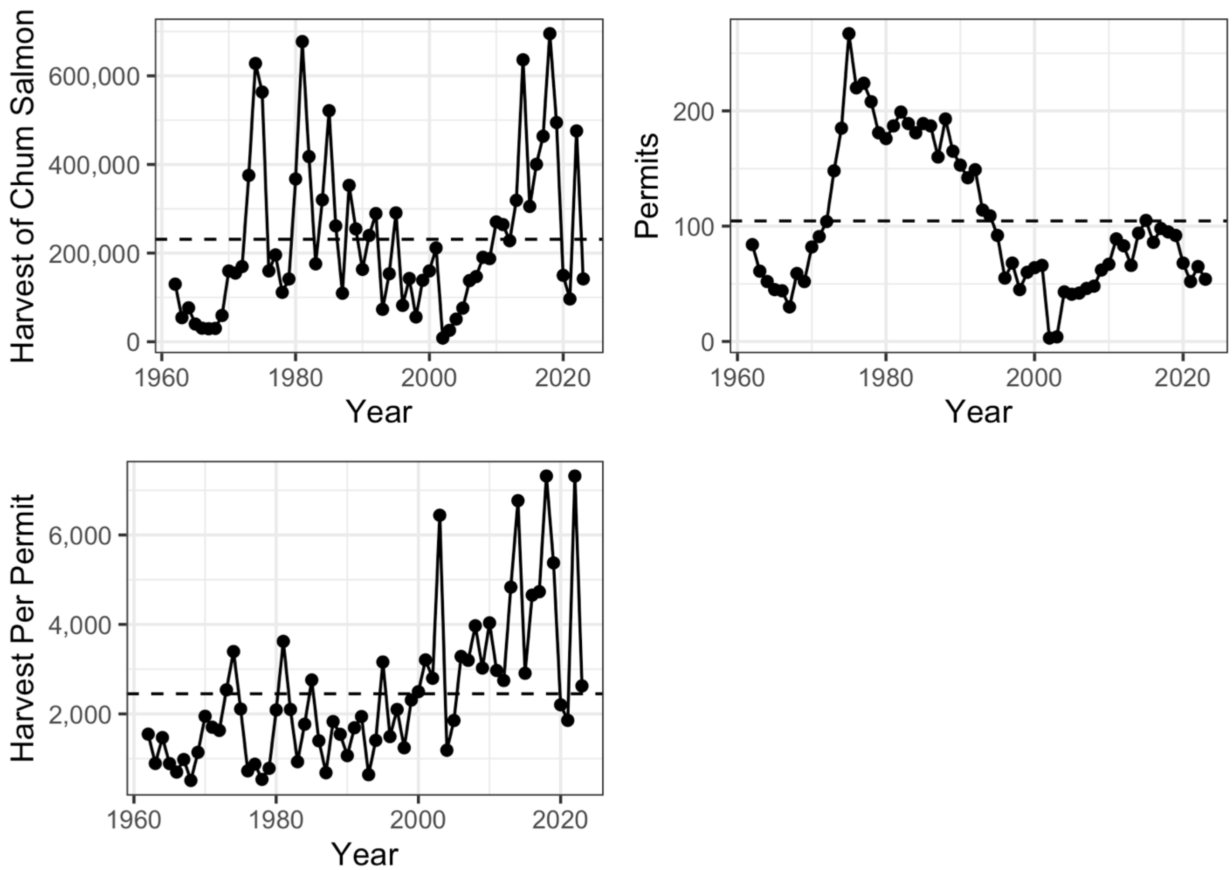

Figure 16: Kotzebue District chum salmon commercial catch, 1962 - 2023. Long-term means are denoted with a horizontal dashed line[3].

3 https://www.adfg.alaska.gov/static/fishing/PDFs/commercial/norton_kotzebue/2022_kotzebue_salmon_summary.pdf

In 2020, the ABL Genetics Program switched from use of the 11 loci microsatellite panel and coastwide baseline to the WASSIP 84-SNP loci panel and baseline that permits an evaluation of Kotzebue Sound as a reporting group distinct from the rest of Western Alaska (DeCovich et al. 2012). The Kotzebue reporting group consists of 11 collections representing 9 populations: Kelly River, Noatak River, Kobuk River (3 collections), Inmachuk River, Serpentine River, Nuluk River, American River, Agiapuk River, and Belt Creek.

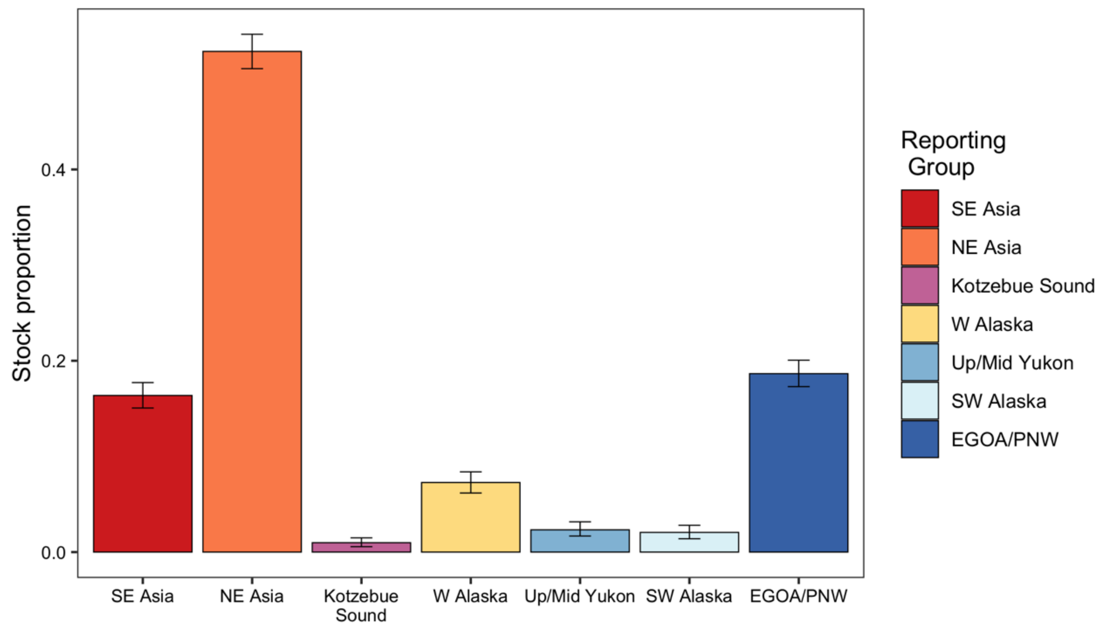

Figure 17: Stock composition estimates for the chum salmon bycatch from the 2023 Bering Sea, B-season pollock fishery with Kotzebue Sound reporting group.

In 2023, Kotzebue Sound represented a small 1.0% (0.6% - 1.5%) proportion of the B-season bycatch (Fig. 17), which when multiplied by the total bycatch of 111,698 for the B-season, provides an estimate of 1,095 chum salmon (95% CI of 630-1,660 fish). With the collections from Kotzebue Sound pulled out of the Western Alaska reporting group, the contribution of Western Alaska to the B-season bycatch dropped from 8.3% to 7.3%. When multiplied by the total bycatch for the B-season, the total number of Western Alaska chum salmon bycatch decreased from 9,246 (8,025-10,481) to 8,123 (6,898-9,370) chum salmon.

The contribution of Kotzebue Sound to the bycatch between 2020 to 2023, was compared over the period in which the ABL genetics program has used the WASSIP SNP baseline (Fig. 18). The contribution from Kotzebue Sound was low in all four years, with an increase between 2020 and 2022, and a drop in 2023. In 2020, the contribution from Kotzebue Sound was 2.4% (1.6% - 3.3%), nearly doubling to 4.4% (3.6% - 5.4%) by 2022, and then dropping to 1% (0.6% - 1.5%) in 2023. The increasing contribution of the Kotzebue Sound reporting group to the bycatch between 2020 and 2022 may reflect the same increase in the commercial harvest per permit between 2021 and 2022 (Fig. 16). Similarly, in 2023, the drop in harvest per permit coincides with the lower contribution to the bycatch.

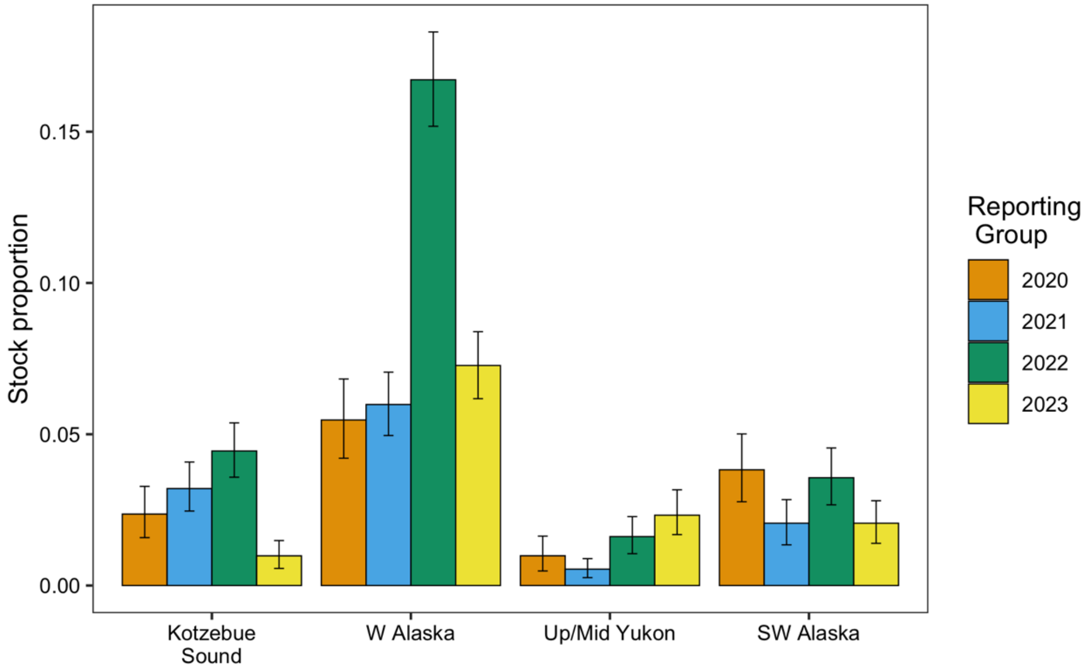

Figure 18: Comparison of stock composition estimates for Alaska reporting groups (with Kotzebue Sound separated from Western Alaska) from chum salmon bycatch in the Bering Sea, B-season pollock fishery from 2020 to 2023.

Summary of Coastal Western Alaska, Upper/Middle Yukon stocks

There was a marked reduction in both the proportion and number of chum salmon from the Western Alaska reporting group. In 2023, 9,246 (8,025-10,481) Western Alaska chum salmon were caught in the pollock fishery during the B-season. Additionally, 2,540 (1,857-3,403) Upper/Middle Yukon and 2,245 (1,498-3,073) Southwest Alaska chum salmon were caught. Combined, these three reporting groups accounted for 12.6% of the total bycatch, equivalent to 14,032 chum salmon.

The highest proportion of chum salmon from Western Alaska was encountered east of 170°W, specifically within Cluster 1 as has been the historic trend. Both the Upper/Middle Yukon and SW Alaska reporting groups contribute relatively little to the overall bycatch, with no strong spatial or temporal trends.

As a result of different fleet distributions, the relative proportion of Western Alaska chum salmon encountered by the catcher-processor, mothership, and shoreside sectors differed substantially. In 2023, bycatch from the catcher-processor and mothership sectors was caught farther west than in prior years. Because of these spatial differences in chum salmon bycatch distribution, the Western Alaska reporting group comprised a larger proportion of the shoreside sector bycatch (11.6%) than the mothership and catcher-processor sectors (4.0% and 1.9%, respectively). The relative proportions of Upper/Middle

Yukon and SW Alaska reporting groups were similar across sectors, averaging 2.1% and 1.5% for each reporting group, respectively.

With a greater proportion of Western Alaska chum salmon in their bycatch and a larger overall bycatch, the shoreside sector caught substantially more Western Alaska chum salmon (7,736) than either the mothership (763) or the catcher-processor (486) sectors.

This was the second year for which estimates were made for the Kotzebue Sound area. In 2022, Kotzebue Sound comprised 4.4% of the B-season bycatch (10,772 estimated chum salmon); however, in 2023 that proportion dropped significantly to 1.0% (1,095 chum salmon). Stock estimates from 2020 to 2022 suggest that Kotzebue Sound may represent an increasing relative proportion of the Bering Sea chum salmon bycatch, although the contribution reduction in 2023 indicates that the relative contribution to the bycatch fluctuates, possibly mirroring the harvest per permit (an index of abundance).

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References

Beacham, T. D., J. R. Candy, K. D. Le, and M. Wetklo. 2009. "Population Structure of Chum Salmon (Oncorhynchus Keta) Across the Pacific Rim, Determined from Microsatellite Analysis." *Fishery Bulletin* 107 (2): 244–60. https://www.scopus.com/inward/record.uri?eid=2-s2.0-66449109194&partnerID=40&md5=d8c61db8fb8c005dd23c77e9ec439f4c.

Campbell, S. A., N. R. AND Harmon. 2015. "Genotyping-in-Thousands by Sequencing (GT-Seq): A Cost Effective SNP Genotyping Method Based on Custom Amplicon Sequencing." *Molecular Ecology Resources,* 15 (4): 855–867.

DeCovich, N., T. H. Dann, S. D. Rogers Olive, H. L. Liller, E. K. C. Fox, J. R. Jasper, E. L. Chenoweth, C. Habicht, and W. D. Templin. 2012. "Chum Salmon Baseline for the Western Alaska Salmon Stock Identification Program." Special Publication 12-26. Alaska Department of Fish; Game.

Gelman, AND Rubin, A. 1992. "Inference from Iterative Simulation Using Multiple Sequences." *Statistical Science* 7: 457–511.

Gray, A. AND C. Marvin AND C. Kondzela AND T. McCraney AND J. R. Guyon. 2010. "Genetic Stock Composition Analysis of Chum Salmon Bycatch Samples from the 2009 Bering Sea Trawl Fisheries." Report to the North Pacific Fishery Management Council. 605 W. 4th Ave., Anchorage, Alaska, 99510: NOAA.

Haynie, Alan C., and Lisa Pfeiffer. 2013. "Climatic and Economic Drivers of the Bering Sea Walleye Pollock (Theragra Chalcogramma) Fishery: Implications for the Future." *Canadian Journal of Fisheries and Aquatic Sciences* 70 (6): 841–53. https://doi.org/10.1139/cjfas-2012-0265.

Kondzela, C. M., J. A. Whittle, S. C. Vulstek, Hv. T. Nguyen, and J. R. Guyon. 2017. "Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2015 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries." U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-345, 64 p.

Magoč, T. and S. L. Salzberg. 2011. FLASH: fast length adjustment of short reads to improve genome assemblies. Bioinformatics 27(21):2957-2963. https://doi.org/10.1093/bioinformatics/btr507

Moran, B. M., and E. C. Anderson. 2019. "Bayesian Inference from the Conditional Genetic Stock Identification Model." *Canadian Journal of Fisheries and Aquatic Sciences* 76 (4): 551–60. https://doi.org/10.1139/cjfas-2018-0016.

Munro, A. R., C. Habicht, T. H. Dann, D. M. Eggers, W. D. Templin, M. J. Witteveen, T. T. Baker, K. G. Howard, J. R. Jasper, S. D. Rogers Olive, H. L. Liller, E. L. Chenoweth, and E. C. Volk. 2012. Harvest and harvest rates of chum salmon stocks in fisheries of the Western Alaska Salmon Stock Identification Program (WASSIP), 2007–2009. Alaska Department of Fish and Game Special Publication No. 12-25, Anchorage.

Plummer, N. AND Cowles, M. AND Best. 2006. “CODA: Convergence Diagnosis and Output Analysis for MCMC.” *R News* 6: 7–11.

Appendix I - GSI Estimates

Regional stock composition estimates of chum salmon samples from the 2023 Bering Sea, B-season pollock trawl fishery. The estimated number of chum salmon bycatch, the 95% CI for the estimated number, mean proportion, 95% credible intervals, P = 0 statistic (the probability that the estimated proportion is 0), and the Gelman-Rubin shrink factor (SF; convergence diagnostic).

B-season (PSC = 111,698; n = 3277)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	18,221	16,771-19,718	0.163	0.150	0.177	0.00	1.00
NE Asia	58,604	56,573-60,593	0.525	0.506	0.542	0.00	1.00
W Alaska	9,246	8,025-10,481	0.083	0.072	0.094	0.00	1.00
Up/Mid Yukon	2,540	1,857-3,403	0.023	0.017	0.030	0.00	1.00
SW Alaska	2,245	1,498-3,073	0.020	0.013	0.028	0.00	1.00
E GOA/PNW	20,839	19,322-22,402	0.187	0.173	0.201	0.00	1.00

East of 170° (PSC = 68,361; n = 2024)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	6,942	6,009-7,923	0.102	0.088	0.116	0.00	1.00
NE Asia	32,281	30,714-33,872	0.472	0.449	0.495	0.00	1.00
W Alaska	8,311	7,186-9,455	0.122	0.105	0.138	0.00	1.00
Up/Mid Yukon	1,891	1,291-2,659	0.028	0.019	0.039	0.00	1.00
SW Alaska	1,804	1,155-2,527	0.026	0.017	0.037	0.00	1.00
E GOA/PNW	17,129	15,820-18,482	0.251	0.231	0.270	0.00	1.00

West of 170° (PSC = 43,337; n = 1252)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	11,510	10,431-12,631	0.266	0.241	0.291	0.00	1.00
NE Asia	26,583	25,343-27,797	0.613	0.585	0.641	0.00	1.00
W Alaska	674	325-1,116	0.016	0.008	0.026	0.00	1.00
Up/Mid Yukon	672	352-1,065	0.016	0.008	0.025	0.00	1.00
SW Alaska	267	0-659	0.006	0.000	0.015	0.04	1.00
E GOA/PNW	3,628	2,959-4,355	0.084	0.068	0.100	0.00	1.00

Early (PSC = 20,204; n = 624)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	3,845	3,208-4,520	0.190	0.159	0.224	0.00	1.00
NE Asia	9,042	8,213-9,873	0.448	0.407	0.489	0.00	1.00
W Alaska	1,829	1,356-2,356	0.091	0.067	0.117	0.00	1.00
Up/Mid Yukon	587	305-943	0.029	0.015	0.047	0.00	1.00
SW Alaska	882	492-1,345	0.044	0.024	0.067	0.00	1.00
E GOA/PNW	4,017	3,380-4,693	0.199	0.167	0.232	0.00	1.00

Middle (PSC = 71,954; n = 2042)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	11,686	10,512-12,908	0.162	0.146	0.179	0.00	1.00
NE Asia	39,167	37,506-40,813	0.544	0.521	0.567	0.00	1.00
W Alaska	6,885	5,809-7,954	0.096	0.081	0.111	0.00	1.00
Up/Mid Yukon	728	215-1,471	0.010	0.003	0.020	0.00	1.01
SW Alaska	1,164	634-1,774	0.016	0.009	0.025	0.00	1.00
E GOA/PNW	12,322	11,118-13,560	0.171	0.155	0.188	0.00	1.00

Late (PSC = 19,540; n = 611)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	2,742	2,209-3,329	0.140	0.113	0.170	0.00	1.00
NE Asia	10,686	9,883-11,491	0.547	0.506	0.588	0.00	1.00
W Alaska	896	559-1,298	0.046	0.029	0.066	0.00	1.00
Up/Mid Yukon	715	427-1,060	0.037	0.022	0.054	0.00	1.00
SW Alaska	181	0-455	0.009	0.000	0.023	0.03	1.00
E GOA/PNW	4,316	3,683-4,980	0.221	0.189	0.255	0.00	1.00

Cluster 1 Early (PSC = 22,794; n = 679)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	3,117	2,528-3,759	0.137	0.111	0.165	0.00	1.00
NE Asia	10,692	9,791-11,603	0.469	0.430	0.509	0.00	1.00
W Alaska	3,194	2,572-3,863	0.140	0.113	0.169	0.00	1.00
Up/Mid Yukon	527	250-891	0.023	0.011	0.039	0.00	1.00
SW Alaska	914	509-1,392	0.040	0.022	0.061	0.00	1.00
E GOA/PNW	4,347	3,672-5,079	0.191	0.161	0.223	0.00	1.00

Cluster 1 Late (PSC = 33,501; n = 1011)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	2,550	1,997-3,152	0.076	0.060	0.094	0.00	1.00
NE Asia	15,401	14,313-16,496	0.460	0.427	0.492	0.00	1.00
W Alaska	3,784	3,003-4,608	0.113	0.090	0.138	0.00	1.00
Up/Mid Yukon	997	537-1,588	0.030	0.016	0.047	0.00	1.01
SW Alaska	633	254-1,118	0.019	0.008	0.033	0.00	1.00
E GOA/PNW	10,132	9,180-11,118	0.302	0.274	0.332	0.00	1.00

Cluster 2 Early (PSC = 3,679; n = 77)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	302	81-610	0.082	0.022	0.166	0.00	1.00
NE Asia	2,074	1,633-2,506	0.564	0.444	0.681	0.00	1.00
W Alaska	159	27-381	0.043	0.007	0.104	0.00	1.00
Up/Mid Yukon	219	57-461	0.060	0.016	0.125	0.00	1.00
SW Alaska	138	0-394	0.038	0.000	0.107	0.04	1.00
E GOA/PNW	783	458-1,166	0.213	0.124	0.317	0.00	1.00

Cluster 2 Late (PSC = 3,613; n = 105)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	450	225-724	0.125	0.062	0.200	0.00	1.00
NE Asia	1,833	1,465-2,203	0.507	0.405	0.610	0.00	1.00
W Alaska	148	25-346	0.041	0.007	0.096	0.00	1.00
Up/Mid Yukon	197	63-390	0.055	0.017	0.108	0.00	1.00
SW Alaska	62	0-253	0.017	0.000	0.070	0.24	1.00
E GOA/PNW	921	633-1,246	0.255	0.175	0.345	0.00	1.00

Cluster 3 Early (PSC = 7,616; n = 235)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	1,539	1,136-1,972	0.202	0.149	0.259	0.00	1.00
NE Asia	4,635	4,121-5,136	0.609	0.541	0.674	0.00	1.00
W Alaska	237	69-477	0.031	0.009	0.063	0.00	1.00
Up/Mid Yukon	224	79-433	0.029	0.010	0.057	0.00	1.00
SW Alaska	70	0-363	0.009	0.000	0.048	0.41	1.00
E GOA/PNW	909	593-1,272	0.119	0.078	0.167	0.00	1.00

Cluster 4 Early (PSC = 9,396; n = 247)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	2,877	2,340-3,442	0.306	0.249	0.366	0.00	1.00
NE Asia	4,905	4,304-5,510	0.522	0.458	0.586	0.00	1.00
W Alaska	59	0-328	0.006	0.000	0.035	0.23	1.00
Up/Mid Yukon	313	75-600	0.033	0.008	0.064	0.00	1.00
SW Alaska	127	0-409	0.014	0.000	0.044	0.13	1.00
E GOA/PNW	1,112	751-1,531	0.118	0.080	0.163	0.00	1.00

Cluster 4 Late (PSC = 26,167; n = 767)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	7,105	6,256-7,986	0.272	0.239	0.305	0.00	1.00
NE Asia	16,733	15,793-17,656	0.639	0.604	0.675	0.00	1.00
W Alaska	384	182-658	0.015	0.007	0.025	0.00	1.00
Up/Mid Yukon	189	52-395	0.007	0.002	0.015	0.00	1.00
SW Alaska	118	0-374	0.005	0.000	0.014	0.12	1.00
E GOA/PNW	1,635	1,202-2,124	0.062	0.046	0.081	0.00	1.00

Catcher-processor (PSC = 25,841; n = 750)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	6,482	5,660-7,326	0.251	0.219	0.284	0.00	1.00
NE Asia	15,484	14,530-16,429	0.599	0.562	0.636	0.00	1.00
W Alaska	486	193-855	0.019	0.007	0.033	0.00	1.00
Up/Mid Yukon	548	260-920	0.021	0.010	0.036	0.00	1.00
SW Alaska	313	51-656	0.012	0.002	0.025	0.00	1.00
E GOA/PNW	2,524	1,979-3,123	0.098	0.077	0.121	0.00	1.00

Mothership (PSC = 19,081; n = 560)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	4,193	3,525-4,893	0.220	0.185	0.256	0.00	1.00
NE Asia	11,134	10,311-11,948	0.584	0.540	0.626	0.00	1.00
W Alaska	763	467-1,129	0.040	0.024	0.059	0.00	1.00
Up/Mid Yukon	193	51-407	0.010	0.003	0.021	0.00	1.00
SW Alaska	107	0-355	0.006	0.000	0.019	0.13	1.00
E GOA/PNW	2,688	2,156-3,274	0.141	0.113	0.172	0.00	1.00

Shoreside (PSC = 66,776; n = 1967)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	7,617	6,647-8,639	0.114	0.100	0.129	0.00	1.00
NE Asia	32,114	30,548-33,688	0.481	0.457	0.504	0.00	1.00
W Alaska	7,736	6,617-8,881	0.116	0.099	0.133	0.00	1.00
Up/Mid Yukon	2,010	1,365-2,824	0.030	0.020	0.042	0.00	1.00
SW Alaska	1,754	1,110-2,486	0.026	0.017	0.037	0.00	1.00
E GOA/PNW	15,541	14,266-16,851	0.233	0.214	0.252	0.00	1.00

Appendix II - GSI Methods

Sequencing libraries are prepared using the Genotyping-in-Thousands by Sequencing (GT-seq) protocol (Campbell et al. 2015). PCR is performed on extracted DNA with primers that amplify 84 SNP loci in the WASSIP chum panel (DeCovich et al. 2012; Table A1). These PCR products are then indexed in a barcoding PCR, normalized using SequalPrep plates (Invitrogen) and each 96-well plate is subsequently pooled. Next, a double-sided bead size selection is performed using AMPure XP beads (Beckman Coulter), using ratios of beads to library of 0.5x to remove non-target larger fragments and then 1.2x to retain the desired amplicon. Libraries are sequenced on a MiSeq (Illumina) using a single 150-cycle lane run with 2×75 bp paired-end (PE) chemistry. PE reads for each individual are joined with FLASH2 (Magoč & Salzberg, 2011; https://github.com/dstreett/FLASH2). Merged reads are genotyped with the R package GTscore (McKinney; https://github.com/gjmckinney/GTscore). Individuals with low quality multilocus genotypes (<80% of loci scored) are discarded. As quality control measures 5% of all project individuals were re-genotype.

Mixtures were created by separating sampled fish into spatial and temporal groups from observer data from the AKFIN database. Genetic stock identification was performed with the conditional genetic stock identification model in the R package rubias (Moran and Anderson 2019). As described previously (Gray et al. 2010), with minor changes to regional group names, baseline populations were grouped into six regions: Southeast Asia (SE Asia), Northeast Asia (NE Asia), Western Alaska (W Alaska), Upper/Middle Yukon (Up/Mid Yukon), Southwest Alaska (SW Alaska), and the Eastern GOA/Pacific Northwest (EGOA/PNW). For population names and reporting group see Table A2. For all estimates, the Dirichlet prior parameters for the stock proportions were defined by region to be $1/(GC_g)$, where C_g is the number of baseline populations in region g, and G is the number of regions. To ensure convergence to the posterior distribution, six separate Markov Chain Monte Carlo (MCMC) chains of 100,000 iterations (burn-in of 50,000) of the non-bootstrapped model were run, which each chain starting at disparate values of stock proportions; configured such that for each chain 95% of the mixture came from a single designated reporting group (with probability equally distributed among the populations within that reporting group) and the remaining 5% equally distributed among remaining reporting groups. The convergence of chains for each reporting group estimate was assessed with the Gelman-Rubin statistic (Gelman 1992) estimated with the gelman.diag function in the coda library (Plummer 2006) within R. Once chain convergence was confirmed, inference was conducted with the conditional genetic stock identification model with bootstrapping over reporting groups (MCMC chains of 100,000 iterations, burn-in of 50,000, 100 bootstrap iterations).

The stock composition estimates were summarized by the mean, standard deviation, median, 95% credible interval (2.5th and 97.5th percentile of the MCMC iterates in the posterior output), and $P = 0$, which is the probability that a stock composition estimate is effectively zero (Munro et al. 2012). The $P = 0$ statistic is the frequency of the last half of the MCMC iterates of each chain for which the individual regional contribution to the mixture was less than a threshold of $0.5E^{-6}$. This statistic may be more useful than the credible interval for assessing the presence or absence of minor stocks.

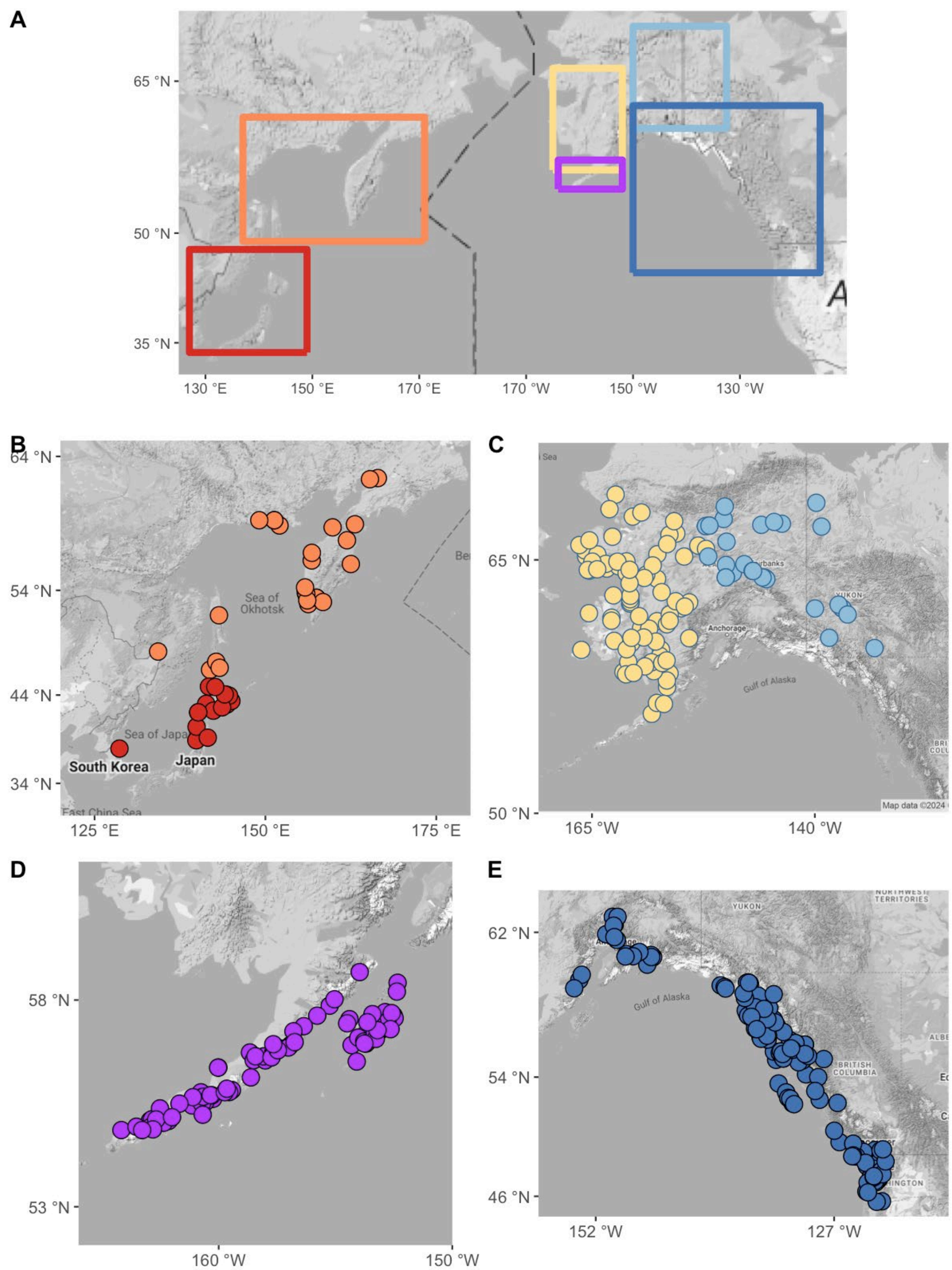

Figure A1: Six reporting groups of baseline chum salmon populations used in this report, circles represent individual populations represented in the baseline. (A) Range wide distribution of the six reporting groups. (B) SE Asia (red) and NE Asia (orange),

(C) W Alaska (Yellow) and Up/Mid Yukon (Mid Blue), (D) SW Alaska (light blue), and (E) EGOA/PNW (dark blue) reporting group.

Appendix II Table 1A: Single nucleotide polymorphisms included in the 84-SNP panel used for stock composition analysis of chum salmon bycatch samples from the 2023 Bering Sea B-season pollock trawl fishery.

Locus	Ploidy	SNPpos	Allele1	Allele2	Probe1	Probe2	Primer	Primer Conc. (uM)
Oke_ACOT-100	2	1	C	G	CTTCCGCTCTCTACTCC	TTCCGCTCTGTACTCC	TCAGGGACGATAAAGGGATCATCTT	0.2000
Oke_ATP5L-105	2	1	C	G	AGTATATTGAGATGAATCCCAC	ATATTGAGATGAATGCCAC	GTGCACACCAATCCATTTCTGAAT	0.2500
Oke_AhR1-78	2	1	G	A	CAGCCTCGGTGCCAT	TCAGCCTCAGTGCCAT	AGCAGAACCAGCACCTACAG	0.2000
Oke_CATB-60	2	1	C	T	CAGGAACGGGTATGAG	CAGGAACGAGTATGAG	GCTTCTATGGGTCCTACTACCGTAT	0.2500
Oke_CD81-108	2	1	G	T	TCCGGCATGTCCCAG	TCCGGCATTTCCCAG	CAGTATCATCATACAGCACAGATACAACA	0.2500
Oke_CD81-173	2	1	A	C	CAGTCACAGAGAGTCAC	AGTCACAGCGAGTCAC	GATGACTGGAGTCAGCTTGCA	0.2000
Oke_CKS-389	2	1	G	A	AAATGAATGATAATGTGTTCTG	AAATGAATGATAATATGTTCTG	GGGCCATTCTCTGAGTTCAGT	0.2500
Oke_CKS1-94	2	1	G	T	TCTGGATAAATTTGTGTATTC	TTCTGGATAAATTTTTGTATTC	TCTTCGACATGTTTAATCGAACAGAAGT	0.2500
Oke_DCXR-87	2	1	A	T	CCTGTTTGTTGAAACCGTA	CCTGTTTGTTGTAACCGTA	GTCACCCAGAACAATAGAATGAGTCT	0.2500
Oke_FANK1-166	2	1	C	T	CTACAGCCCGGCTGTG	CTACAGCCCAGCTGTG	ACTCACGTGTGGTAGAGACAGA	0.2500
Oke_FBXL5-61	2	1	G	A	TCTGAGGGAAACTGC	TCTGAGGAAAACTGC	TGGTGTGTAACGTCAGTGACTTAAG	0.3000
Oke_GHII-3129	2	1	G	A	CAGGGCGACTCTAT	ACAGGGCAACTCTAT	GTCAAGCTGATACCACTCAAATCTCA	0.3000
Oke_GPDH-191	2	1	T	A	CGGAGCCACTTCCAGTA	CGGAGCCACTACCAGTA	CCTGTACCTATAGGGCAACTTCAC	0.2000
Oke_GPH-105	2	1	T	G	CCAGTAATTGGTATTTTGA	CCAGTAATTGGTCTTTTGA	CAGATCAACCCTGGAAAAATATCTGATGT	0.2500
Oke_HP-182	2	1	A	C	AGAAAAGGTGAGCTAGTATG	AAAAGGTGAGCTCGTATG	CCGATGACTCCAAAGAAGTTGCT	0.2500
Oke_IL8r2-406	2	1	T	G	AAACACAAAACCCC	AAACACAAACCCCC	GGATGGACATTCACAGTCTGGTT	0.2000
Oke_KPNA2-87	2	1	T	A	ACAGAACAGAAACAGTG	AACAGAACAGTAACAGTG	AGGCAGCCAGGTAAGTCAGTA	0.1875
Oke_LAMP2-186	2	1	A	G	CTAACTTTACAAAGACACTGC	AACTTTACAAAGGCACTGC	TTCTAGCCATGACCCAATGAAAGG	0.2500
Oke_MLRN-63	2	1	G	A	CTGGTGATTGACGATCC	CTGGTGATTAACGATCC	CCATTTCAGCATTGCCAGATTTGAAA	0.2500
Oke_Moesin-160	2	1	T	G	CATTTTGTAATTCTAATTTTAAGC	ATTTTGTAATTCTAATGTTAAGC	TTTCAGCAAATGAAGAGAACATCAAACTG	0.2500
Oke_NUPR1-70	2	1	G	T	CTATGAGGACGGGTCACA	ACTATGAGGACTGGTCACA	AGACGGTGAACTCTGCTGTAGA	0.3000
Oke_PPA2-635	2	1	C	T	TTGCCTCCCCCGCTC	TTATTGCCTCTCCCGCTC	ACACAACTGACCATATTGACTTTCGA	0.2500
Oke_RFC2-618	2	1	G	A	CAGCTCCTGGACTCA	CAGCTCCTAGACTCA	GACAATGTGTTAGTGTAGGCTTCACT	0.2000
Oke_RH1op-245	2	1	C	T	AGTGGTGAAGCCTC	TAGTGGTAAAGCCTC	TGGCCGATCTCTTCATGGTAATC	0.2500
Oke_RS27-81	2	1	G	A	TGTCCAGGCGTCATGA	TGTCCAGGCATCATGA	GCAACAAAGTGGACTATCACATTGAA	0.3000
Oke_RSPRY1-106	2	1	A	T	TAGTCTCTTTACATAATCTC	TAGTCTCTTTACTTAATCTC	GTCCTCCCTATTCTTCCACTTACCT	0.2500
Oke_TCP1-78	2	1	A	G	ATACTGCTCCAGAGACG	CTGCTCCAGGGACG	CTCCAGGGCATCAGCAAATG	0.2000
Oke_Tf-278	2	1	C	A	ATTTTACAGTTGACATTCAA	TTTTACAGTTGAAATTCAA	GCCACAATTGTAATTCTAGATCCAGAGT	0.2500
Oke_U1008-83	2	1	A	G	CCGTTCTCTTCTTGGACAC	CGTTCTCTTCCTGGACAC	GTCACCAAACATCCTGCGAATG	0.3000
Oke_U1010-251	2	1	A	G	ATAGAGGTGAGCATTGACAT	TAGAGGTGAGCACTGACAT	CACCTCAATCAATCAAATGTATTTATAAAGCCA	0.1875
Oke_U1012-241	2	1	C	G	ATGGAAAAAGAACTGTTTACT	ATGGAAAAAGAACTCTTTACT	GCAGAGGTTATACCCATTTTAGATGCA	0.2500
Oke_U1015-255	2	1	A	G	CAAACACACACAGAGCC	AACACACGCAGAGCC	CAGAGTGCAGAGTAATACGCATACA	0.2500
Oke_U1016-154	2	1	C	T	CCATGTTTGCGGTATGT	CCATGTTTGCAGTATGT	GCAGGTTGCTAAGTCATGTTACACA	0.3000
Oke_U1017-52	2	1	C	T	AGAGAGTTGTCGTTCATC	AGAGAGTTGTCATTCATC	TGGCAATGGGATGTCAAGTTATGA	0.3000
Oke_U1018-50	2	1	C	T	CTGGGCACGTACAGCT	CTGGGCACATACAGCT	TCCAGGTTGCTGACAATGTAAAAGT	0.3000
Oke_U1022-139	2	1	A	G	CTGGAACATGAAGCAAA	TGGAACATGGAGCAAA	AACATTAAAACTGTGGTTTTGACCTCTTG	0.2500
Oke_U1023-147	2	1	A	C	CATCAGGGAAAGCCTACAAA	AGGGAAAGCCGACAAA	TCTTAAAATGGAGAGAGCGATTAATGAAGG	0.2500
Oke_U1024-113	2	1	A	G	CCAGAAACAACTTAATTAT	CAGAAACAACTCAATTAT	CATGCTGGTGAATTATTGGACAATGT	0.2500
Oke_U1025-135	2	1	G	T	ACTTAGTCTATTTGTAACTTT	ACTTAGTCTATTTTTAACTTT	GGCTAGGGTTCTATTTGGACCAT	0.2500
Oke_U2007-190	2	1	C	G	CTAAAAGCTGAGAATAAAT	AAAGCTGACAATAAAT	ACAGGCTGTGATGAGTTAACAATGTAAA	0.2500
Oke_U2011-107	2	1	G	T	TTCTGTGAGAGATTTAG	TTTCTGTGAGATATTTAG	CCGTTTCTGTCAGACTCTGGTAAA	0.1250
Oke_U2015-151	2	1	C	T	AATTGATCACGATCATTC	ATTGATCACAATCATTC	GCATTTTATCCTCAAACTTTTCAACTGACA	0.2500

Appendix II Table A1 continued

Locus	Ploidy	SNPpos	Allele1	Allele2	Probe1	Probe2	Primer	Primer Conc. (uM)
Oke_U2025-86	2	1	G	A	ACTTTTTTGTCGTTTTTTT	ACTTTTTTGTCATTTTTTT	AAATCCCCATGGAGAAACACAATGA	0.2000
Oke_U2029-79	2	1	C	T	AGGTGTACTGAAGAGAC	AGGTGTACTAAAGAGAC	GGTTTGATTTCGTCGCGATTTGA	0.2500
Oke_U2032-74	2	1	G	A	CAATAAAGTGCTAGGTGTCC	CAATAAAGTGCTAAGTGTCC	GCTATTCCAATGTAAATCCTGTACTGTGT	0.2000
Oke_U2034-55	2	1	C	T	ATGTCAAATCACGCTGATG	ATGTCAAATCACACTGATG	GGGAAGAAAAGCCTACCATAAACAG	0.2500
Oke_U2035-54	2	1	G	A	CACCAATAACGTCCTAATC	CACCAATAACATCCTAATC	CGCCAATAACGCTCCAACAAC	0.2500
Oke_U2041-84	2	1	G	T	CAGATCCGGTGTATGC	ACAGATCCTGTGTATGC	CCAGACCATGTGCTTGTTTGTCATA	0.2500
Oke_U2043-51	2	1	G	A	TCTGGAGGCGTATTGG	CTGGAGGCATATTGG	CACAAACCTACTACAGACAGCAGTT	0.2000
Oke_U2048-91	2	1	A	C	CAGCCTCATAAGATGTTTA	CAGCCTCATAAGCTGTTTA	AGTTGGGTCTTAAAGATGATCATTTGCT	0.2000
Oke_U2050-101	2	1	C	T	AATTGATCTACAGCTGCACG	AATTGATCTACAACTGCACG	CTCTGAGTGTCACAATCACATATCGT	0.2000
Oke_U2053-60	2	1	C	T	CACACATATGAGATGCC	CACACATATAAGATGCC	TCTGCTTTTGTCGTCTCACCAA	0.1875
Oke_U2054-58	2	1	C	T	ATGCCCAATTACGTCAGCA	TGCCCAATTACATCAGCA	CGTCTCATTCAGCTCTTTGATGTC	0.2000
Oke_U2056-90	2	1	G	T	CGAAGTGATGAAGGTGACAA	CGAAGTGATGAATGTGACAA	CCATCACGTCACCATTACACTGT	0.1875
Oke_U2057-80	2	1	A	G	CACGTTTTCTCTTTTCTC	ACGTTTTCTCCTTTCTC	GCAGTTGTCATGGCAGTAAGG	0.2500
Oke_U212-87	2	1	C	A	CTTGTGACATTCCTCTCT	CTTGTGACATTACTCTCT	TTGATTCATACTCAAGGTGAGCAGATT	0.2500
Oke_U302-195	2	1	C	A	TTGTCAAAGGAATCATTT	TGTCAAAGGAATAATTT	GACCCTCAGCTATTTTAAGAACCTCAA	0.2500
Oke_U504-228	2	1	A	G	TGGCTCAAACTTG	TTGGCTCGAACTTG	CTTAACTCAGTCACACCAACTCACT	0.2500
Oke_U506-110	2	1	C	T	TTGTAAGTTGTGGCTAAAA	TTGTAAGTTGTGACTAAAA	CGTGGTTGGTTTCATTGACTCTCA	0.2000
Oke_U507-286	2	1	T	G	CTGCTGTTCATAAAAGTA	CTGCTGTTCATACAAGTA	TGGTCATAGCTTGCACTGTACAAA	0.3000
Oke_U509-219	2	1	C	T	CCTCTCTGCAGGGCT	CCCTCTCTACAGGGCT	GCACCCCACCTGGCTT	0.1250
Oke_arf-319	2	1	T	C	CTGTGTGAATTGCCTC	CTGTGTGAACTGCCTC	TGCAGAAACTGATCATTGGTAGTGG	0.1875
Oke_azin1-90	2	1	C	T	CCTTTATCTGAGGAACTG	CCTTTATCTGAAGAACTG	GGGAATAGTGTCATTTGGGATGCAT	0.2500
Oke_brd2-118	2	1	C	T	ATGACGAAGCTCTCC	ATGACGAAACTCTCC	CTCAAGCCCTCCACACTCA	0.2000
Oke_brp16-65	2	1	C	T	ACGTTGCCTGTCCAC	ACGTTGCCTATCCAC	TCCACGTCACTCAGCATGATG	0.2500
Oke_ccd16-77	2	1	A	C	CCAGCCCCCTCTGAAA	AGCCCCCGCTGAAA	TGTCTTCAGAATCCAATGCTTTCCT	0.1875
Oke_e2ig5-50	2	1	C	T	CATCTTTGTATCTGTGCCATT	TCATCTTTGTATCTATGCCATT	GCACTGCTCATTCTGTCACATG	0.2500
Oke_eif4g1-43	2	1	G	T	CTGAGATTCTTCATCTTTTAC	TGAGATTCTTCATATTTTAC	GCACCCAACAGTTCATCATGTAAGT	0.2500
Oke_f5-71	2	1	C	T	CAGGTGCGTGCAGTAA	TCAGGTGCATGCAGTAA	CTCAAATTTCCCTTTGACATCAATTCATCA	0.2500
Oke_gdh1-62	2	1	C	T	TTCTGTGTCCCGTGACCT	CTGTGTCCCATGACCT	CCACGTGATACAGGGAGATGTG	0.2000
Oke_glrx1-78	2	1	C	T	TGGGCATTTAGAGTTTATT	TGGGCATTTAGAATTTATT	CGCTCCGTCCAGTGATGTC	0.2500
Oke_il-1racp-67	2	1	G	A	CGTACGAGATGTAGATGT	CGTACGAGATATAGATGT	AATTGCTCCTCCTCGCTATTTCTC	0.2000
Oke_mgll-49	2	1	A	T	ATTTATGGGTGTTCCCC	TTATGGGAGTTCCCC	ACATTGTAATCTGTATTAGTCCAATGCAGAC	0.2500
Oke_nc2b-148	2	1	A	C	TTTAGTTCTAGTCAAAAGTAG	TAGTTCTAGTCCAAAGTAG	CCAGCCTATTTCCTTTAGTGCATATGA	0.2500
Oke_pgap-111	2	1	C	T	AGCTAGCAGGCTAAAG	AGCTAGCAAGCTAAAG	TGCAGATCTCAATTTGAACGACCTAT	0.2000
Oke_psmd9-57	2	1	C	T	CATTGGCGGTGTAACG	TCATTGGCAGTGTAACG	ACTGTAGTGACTGCATTTCATATTGCT	0.2000
Oke_rab5a-117	2	1	C	T	CAGCTGTTTTTCTTGTAGCCT	AGCTGTTTTTCTTATAGCCT	GGGAATAACAGTCATTGCAGCATTT	0.2000
Oke_ras1-249	2	1	T	G	CACCAAGGTAAAAAT	CCAAGGGAAAAAT	GGATGACTAAGAGCGACTGTATGTG	0.2500
Oke_serpin-140	2	1	A	T	CAAGAACTGACCTTAGACAC	AAGAACTGACCTTTGACAC	TCCACAGTGAGTAATAAAGTTGCACAT	0.2000
Oke_slc1a3a-86	2	1	C	T	CCCAACGCGGTGATG	CCCAACGCAGTGATG	TGTCTTCATCTGTGGACTCCTACA	0.3000
Oke_sylc-90	2	1	A	T	ATATCTTTGAGACTAGATTAA	CTTTGAGACAAGATTAA	TTGAGGAAACCACTGGTCTTACAAG	0.1875
Oke_thic-84	2	1	C	T	ATGGAATGACAGCAATGT	ATGGAATGACAACAATGT	GCTGCTGTCTTAAACCACATTCTACA	0.2500
Oke_u200-385	2	1	G	T	CATTATCTCCCTGAATGTA	CATTATCTCCATGAATGTA	CCCATAATTTTGCAACCCTAGTCACA	0.2000
Oke_u217-172	2	1	T	C	CACTCTTACAAAAACA	CACTCTTACGAAAACA	GGATGGAAGAAGTTAGTTGTGTCAGA	0.3000

Appendix II Table A2: Chum salmon populations in the Alaska Department of Fish and Game (ADF&G) single nucleotide baseline. The baseline consists of 42,071 chum salmon from 382 populations arranged into six genetic reporting groups used in this report.

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Abashiri River	SE Asia	79	Ozerki Hatchery - Bistraya River broodstock	NE Asia	93
Chitose River	SE Asia	108	Palana River	NE Asia	140
Gakko River	SE Asia	78	Paratunka River	NE Asia	94
Kushiro River	SE Asia	79	Penzhina River	NE Asia	43
Namdae River	SE Asia	90	Pymta River	NE Asia	147
Nishibetsu River	SE Asia	80	Tauy River	NE Asia	41
Sasanai River	SE Asia	77	Tym River	NE Asia	53
Shari River	SE Asia	75	Udarnitza River	NE Asia	44
Shinzunai River	SE Asia	80	Utka River	NE Asia	40
Teshio River	SE Asia	78	Vorovskaya River	NE Asia	101
Tokachi River	SE Asia	78	Beaver Creek	W Alaska	110
Tokoro River	SE Asia	69	Upper Nushagak River	W Alaska	97
Tokushibetsu River	SE Asia	80	Agiapuk River	W Alaska	114
Tsugaruishi River	SE Asia	80	Alagnak River	W Alaska	176
Yurappu River - early	SE Asia	80	American River	W Alaska	86
Yurappu River - late	SE Asia	80	Andreafsky River	W Alaska	180
Amur River	NE Asia	90	Aniak River	W Alaska	92
Belogolovaya River	NE Asia	45	Yellow River	W Alaska	80
Bistraya River	NE Asia	66	Swift River	W Alaska	94
Bolshaya River	NE Asia	93	Belt Creek	W Alaska	69
Hailula River	NE Asia	48	Big River	W Alaska	94
Hairusova River	NE Asia	85	Black River	W Alaska	93
Kalininka River	NE Asia	89	Blue Violet Creek - Meshik	W Alaska	74
Kamchatka River	NE Asia	49	Whale Mountain Creek	W Alaska	95
Kanchalan River	NE Asia	77	Big Creek	W Alaska	69
Kol River	NE Asia	123	Pumice Creek	W Alaska	189
Kulkuty River	NE Asia	49	California Creek	W Alaska	88
Magadan (Magadanka River?)	NE Asia	77	Chuilnak River	W Alaska	92
Naiba - Sakhalin Island	NE Asia	54	Clear Creek	W Alaska	94
Oklan River	NE Asia	75	Dakli River	W Alaska	53
Ola River	NE Asia	78	Eldorado River	W Alaska	122
Ossora River	NE Asia	87	Fish River	W Alaska	92

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
George River	W Alaska	95	Osviak River	W Alaska	121
Gisasa River	W Alaska	106	Otter Creek	W Alaska	61
Goodnews River	W Alaska	275	Pikmiktalik River	W Alaska	95
Henshaw Creek - early	W Alaska	94	Pilgrim River	W Alaska	75
Holokuk River	W Alaska	103	Rodo River	W Alaska	69
Huslia River	W Alaska	95	Salmon River	W Alaska	95
Inmachuk River	W Alaska	91	Kobuk River - Selby Slough	W Alaska	90
Iowithla River	W Alaska	95	Serpentine River	W Alaska	82
Kaltag River	W Alaska	92	South Fork Koyukuk River - Early	W Alaska	90
Kanektok River	W Alaska	94	South Fork Kuskokwim River	W Alaska	95
Kasigluk River	W Alaska	68	Shaktoolik River	W Alaska	94
Kelly River (Noatak R)	W Alaska	95	Snake River	W Alaska	172
Kobuk River - at Kiana	W Alaska	95	Solomon River	W Alaska	144
Kisaralik River	W Alaska	93	Stony River	W Alaska	150
Klutuspak Creek	W Alaska	70	Stuyahok River	W Alaska	281
Kobuk River - Salmon River (Mile 4)	W Alaska	99	Sunshine Creek	W Alaska	47
Kogrukluk River	W Alaska	95	Takotna River	W Alaska	136
Kokwok River	W Alaska	131	Tatlawiksuk River	W Alaska	243
Koyuk River	W Alaska	43	Togiak River	W Alaska	262
Kwethluk River	W Alaska	143	Tolstoi Creek	W Alaska	95
Kwiniuk River	W Alaska	94	Tozitna River	W Alaska	92
Mekoryuk River	W Alaska	104	Tubutulik River	W Alaska	135
Hot Springs Creek	W Alaska	174	Tuluksak River	W Alaska	92
Melozitna River	W Alaska	91	Unalakleet River	W Alaska	237
Mulchatna River	W Alaska	91	Ungalik River	W Alaska	147
Necons River	W Alaska	133	Wandering Creek	W Alaska	50
Niukluk River	W Alaska	93	Windy Fork Kuskokwim River	W Alaska	93
Noatak River	W Alaska	92	Innoko River	W Alaska	85
Nome River	W Alaska	94	American River - NE Kodiak	SW Alaska	95
Nulato River	W Alaska	189	Dog Bay Creek	SW Alaska	95
Nuluk River	W Alaska	48	Alligator Hole	SW Alaska	183
Nunsatuk River	W Alaska	92	Main Creek	SW Alaska	85

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Barling Bay Creek - early	SW Alaska	92	Braided Creek - Meshik	SW Alaska	94
Barling Bay Creek - late	SW Alaska	78	Midway Creek	SW Alaska	94
Barling Bay Creek - middle	SW Alaska	288	Moffett Creek	SW Alaska	95
Bear Bay Creek	SW Alaska	187	Nakalilok River	SW Alaska	95
Belkofski River	SW Alaska	87	Natalia Bay Creek	SW Alaska	95
Big River	SW Alaska	95	Cape Seniavin	SW Alaska	96
Big Sukhoi	SW Alaska	189	Northeast Creek	SW Alaska	94
Canoe Bay River	SW Alaska	186	Sapsuk River	SW Alaska	144
Chichagof Bay	SW Alaska	180	Right Head Moller Bay	SW Alaska	95
Coal Creek	SW Alaska	94	Ocean Beach	SW Alaska	78
Coleman Creek	SW Alaska	95	Olds River	SW Alaska	93
Coxcomb Creek	SW Alaska	89	Pass Creek	SW Alaska	94
Deadman River	SW Alaska	95	Pauls Lake	SW Alaska	45
Deer Valley	SW Alaska	91	Peterson Lagoon	SW Alaska	181
Delta Creek	SW Alaska	95	Portage Creek	SW Alaska	190
Dog Salmon Creek	SW Alaska	65	NE Portage Creek	SW Alaska	94
Dry Bay River	SW Alaska	71	Right Head Moller Bay	SW Alaska	94
Eagle Harbor	SW Alaska	94	Rough Creek	SW Alaska	77
Foster Creek	SW Alaska	182	Ruby's Lagoon	SW Alaska	92
Frosty Creek	SW Alaska	190	Rudy Creek	SW Alaska	93
Hidden Basin Creek	SW Alaska	95	Russel Creek	SW Alaska	280
Ilnik River	SW Alaska	49	Russian Creek	SW Alaska	185
Ivanof River	SW Alaska	181	Sandy Cove	SW Alaska	186
Joshua Green River	SW Alaska	92	Shoe Creek	SW Alaska	95
Kaiugnak Lagoon	SW Alaska	93	Sitkinak Island	SW Alaska	93
Karluk Lagoon	SW Alaska	83	Smokey Hollow Creek	SW Alaska	86
Kiavak Portage	SW Alaska	76	Spiridon River	SW Alaska	89
Kizhuyak River	SW Alaska	174	Saint Catherine Cove	SW Alaska	171
Kujulik River	SW Alaska	93	Stepovak Bay	SW Alaska	143
Lawrence Valley Creek	SW Alaska	190	Stepovak River	SW Alaska	94
Little John Lagoon	SW Alaska	172	Sturgeon River	SW Alaska	109
Meshik River	SW Alaska	78	Traders Cove	SW Alaska	76

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Uganik River	SW Alaska	175	Porcupine River	Up/Mid Yukon	92
Volcano Bay	SW Alaska	95	Pelly River	Up/Mid Yukon	84
Kitoi Bay Hatchery	SW Alaska	194	Salcha River - Early	Up/Mid Yukon	150
Plenty Bear Creek - Meshik	SW Alaska	138	Salcha River - Late	Up/Mid Yukon	45
Aniakchak River	SW Alaska	94	South Fork Koyukuk River - Late	Up/Mid Yukon	92
Kialagvik Creek	SW Alaska	177	Sheenjek River	Up/Mid Yukon	266
AlagogshakCreek	SW Alaska	94	Tanana River	Up/Mid Yukon	95
Chiginagak Bay River	SW Alaska	159	Tatchun River	Up/Mid Yukon	176
North Fork Creek	SW Alaska	71	Teslin River	Up/Mid Yukon	178
Amber Bay	SW Alaska	89	Toklat River	Up/Mid Yukon	182
Gull Cape Creek	SW Alaska	186	Toklat River - Sushana River	Up/Mid Yukon	94
Wiggly Creek - Cinder River	SW Alaska	177	24 Mile - Chilkat River	EGOA/PNW	85
West Kiliuda Creek	SW Alaska	87	Admiralty Creek	EGOA/PNW	64
Zachary Bay	SW Alaska	76	Akwe River	EGOA/PNW	103
Zachar River	SW Alaska	66	Alouette River	EGOA/PNW	95
Seventeenmile Slough	Up/Mid Yukon	90	Alsek River	EGOA/PNW	84
Big Creek	Up/Mid Yukon	100	Pybus Bay	EGOA/PNW	59
Black River - fall	Up/Mid Yukon	88	Bag Harbor (Haida Gwaii)	EGOA/PNW	49
Bluff Cabin Creek	Up/Mid Yukon	99	Beartrap Creek	EGOA/PNW	582
Big Salt River	Up/Mid Yukon	69	Big Mission Creek	EGOA/PNW	56
Chandalar River	Up/Mid Yukon	148	Big Qualicum River	EGOA/PNW	72
Chena River	Up/Mid Yukon	254	Black Bay	EGOA/PNW	128
Clearwater Creek	Up/Mid Yukon	78	Brown's Peak Creek	EGOA/PNW	94
Delta River	Up/Mid Yukon	149	Carmen Lake	EGOA/PNW	67
Donjek River	Up/Mid Yukon	60	Carroll Creek - Summer run	EGOA/PNW	201
Fishing Branch	Up/Mid Yukon	477	Chilkat River - mainstem	EGOA/PNW	76
Henshaw Creek - late	Up/Mid Yukon	60	Chunilna Creek	EGOA/PNW	83
Jim River	Up/Mid Yukon	278	Coco Harbor	EGOA/PNW	99
Kantishna River	Up/Mid Yukon	94	Constantine Creek	EGOA/PNW	499
Kluane River	Up/Mid Yukon	163	Conuma River	EGOA/PNW	96
Middle Fork Koyukuk River	Up/Mid Yukon	178	Cruz Cove	EGOA/PNW	50
Minto Slough	Up/Mid Yukon	169	Dewatto River - fall run	EGOA/PNW	74

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Disappearance Creek - fall run	EGOA/PNW	310	Kalama Creek	EGOA/PNW	56
Donkey Bay	EGOA/PNW	98	Karta River	EGOA/PNW	56
Dosewillips River - summer run	EGOA/PNW	88	Keta River	EGOA/PNW	45
Dry Bay Creek	EGOA/PNW	94	Keta Creek	EGOA/PNW	95
East Alsek River	EGOA/PNW	85	Kitasoo Creek	EGOA/PNW	169
Ecstall	EGOA/PNW	50	Kitimat River	EGOA/PNW	104
Elwha River	EGOA/PNW	93	Kitwanga River	EGOA/PNW	74
Fish Creek - summer	EGOA/PNW	187	Klahini River - Unuk River	EGOA/PNW	50
Fish Creek - early	EGOA/PNW	131	Klehini River	EGOA/PNW	92
Fish Creek - late	EGOA/PNW	49	Lagoon Creek - fall run	EGOA/PNW	172
Ford Arm Lake - fall	EGOA/PNW	95	Lake Creek	EGOA/PNW	95
Gail Creek	EGOA/PNW	94	Lauras Creek	EGOA/PNW	95
Game Creek	EGOA/PNW	44	Little Creek - fall run	EGOA/PNW	95
Gastineau	EGOA/PNW	40	Lilliwaup Creek - summer	EGOA/PNW	45
Goldstream River	EGOA/PNW	95	Lilliwaup Creek - fall	EGOA/PNW	92
Grays River - fall run	EGOA/PNW	93	Long Bay	EGOA/PNW	159
Gunnuk Creek Hatchery	EGOA/PNW	95	Lover's Cove	EGOA/PNW	50
Hamilton Creek - fall run	EGOA/PNW	78	Little Qualicum River	EGOA/PNW	98
Hamma Hamma River	EGOA/PNW	197	Lower Skagit River - fall run	EGOA/PNW	91
Harding River	EGOA/PNW	58	Little Susitna River	EGOA/PNW	134
Harris River	EGOA/PNW	65	DIPAC Macaulay Salmon Hatchery - Andrew Creek	EGOA/PNW	294
Herman Creek	EGOA/PNW	94	Mace Creek (Haida Gwaii)	EGOA/PNW	48
Heerman Creek	EGOA/PNW	47	Medvejie Hatchery - Andrew Creek Stock	EGOA/PNW	147
Hidden Falls Hatchery - summer run	EGOA/PNW	95	Mill Creek	EGOA/PNW	82
Hidden Inlet	EGOA/PNW	82	Mole River	EGOA/PNW	89
Hood Bay	EGOA/PNW	133	McNeil River	EGOA/PNW	108
Humpback Creek	EGOA/PNW	94	Nahmint River	EGOA/PNW	96
I-205 Seeps - fall run	EGOA/PNW	72	Nakat Inlet - summer	EGOA/PNW	95
Inch Creek	EGOA/PNW	181	Nakwasina River	EGOA/PNW	93
Iniskin River	EGOA/PNW	94	Nanaimo River	EGOA/PNW	77
Jimmycomelately Creek - summer run	EGOA/PNW	92	North Arm Creek	EGOA/PNW	132
Johns Creek - summer run	EGOA/PNW	92	North Creek - fall run	EGOA/PNW	95