Genetic Stock Composition Analysis of Chum Salmon from the Prohibited Species Catch of the 2022 Bering Sea Walleye Pollock Trawl Fishery

Preliminary Report

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Executive Summary[1]

We analyzed genetic stock compositions of chum salmon (*Oncorhynchus keta*) prohibited species catch (PSC) samples collected from the 2022 walleye pollock (*Gadus chalcogrammus*) 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 PSC was 242,375 fish, slightly lower than the 10-year average of 294,818. Despite the reduction in overall bycatch, the proportion of Western Alaska fish in the bycatch was the largest in the time series (21.1%). An estimated 51,092 (47,380-54,865) chum salmon originating from the Western Alaska reporting group were encountered as bycatch which was slightly greater than the long-term mean of 47,867 chum salmon from 2014 to 2021. The overall proportion of the Upper/Middle Yukon reporting group increased from 0.5% in 2021 to 1.9% in 2022 and the estimated number of Upper/Middle Yukon fish increased from 2,854 (1,324-4,778) in 2021 to 4,618 (3,258-6,282) in 2022. While the proportion of the Southwest Alaska reporting group increased from 2.4% in 2021 to 3.6% in 2022, the estimated number of fish decreased from 13,176 (9,225-17,521) in 2021 to 8,749 (6,641-11,009) in 2022. In aggregate, the Western Alaska, Upper/Middle Yukon, and Southwest Alaska reporting groups comprised 26.6% (23.6-29.8%) of the chum salmon bycatch. Both the Eastern Gulf of Alaska / Pacific Northwest (EGOA/PNW) and North East Asia reporting groups comprised similar proportions of the bycatch (29.6 and 32.9% respectively). Consistent with historic trends, the highest proportion and number of Western Alaska chum salmon are from the eastern portion of the pollock fishing grounds, near the Alaska Peninsula (Cluster 1). The average bycatch location of the shoreside sector was the furthest east since systematic sampling of the bycatch began in 2011 and further on the shelf than in prior years. The Western Alaska reporting group makes up a larger proportion of the PSC in the shoreside and motherships sectors, which fish further east than the catcher-processor sector.

[1] *Disclaimer* - These represent preliminary analyses of the 2022 chum salmon genetic data. All estimates are subject to change. Numerous plots in this report display fishery information. All data are non-confidential. Data have been 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 242,375 fish in 2022 (Fig. 1). This was 52,443 fewer chum salmon than the 10-year average of 294,818 (SD 153,671). As is typical, over 99% of the bycatch of chum salmon occurred in the B-season (between June and October).

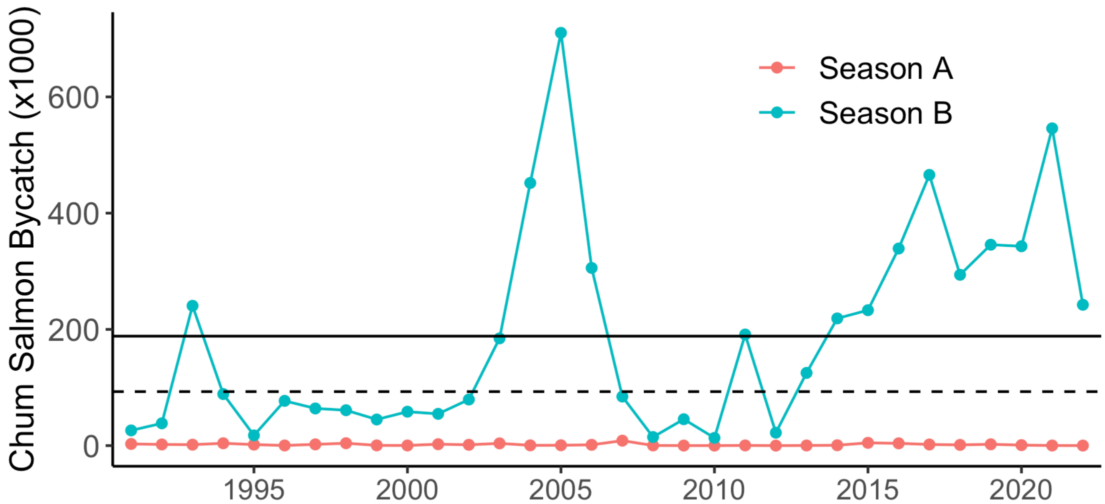

Fig. 1: Chum salmon prohibited species catch (PSC) for the A- and B-seasons from the Bering Sea pollock-directed trawl fisheries. The solid horizontal line represents the mean PSC and the dashed line represents the median PSC from 1991 to 2021.

Within the B-season, the chum salmon bycatch was characterized by a single major peak occurring in statistical week 33 (Fig. 2 top panel) with a gradual increase leading up to and gradual decrease after the peak. Fewer chum salmon were caught before statistical week 27 and after week 37 compared to previous years. Overall, the timing of the bycatch was intermediate compared to prior years, with 50% of the bycatch occuring prior to week 33 (Fig. 2 bottom panel).

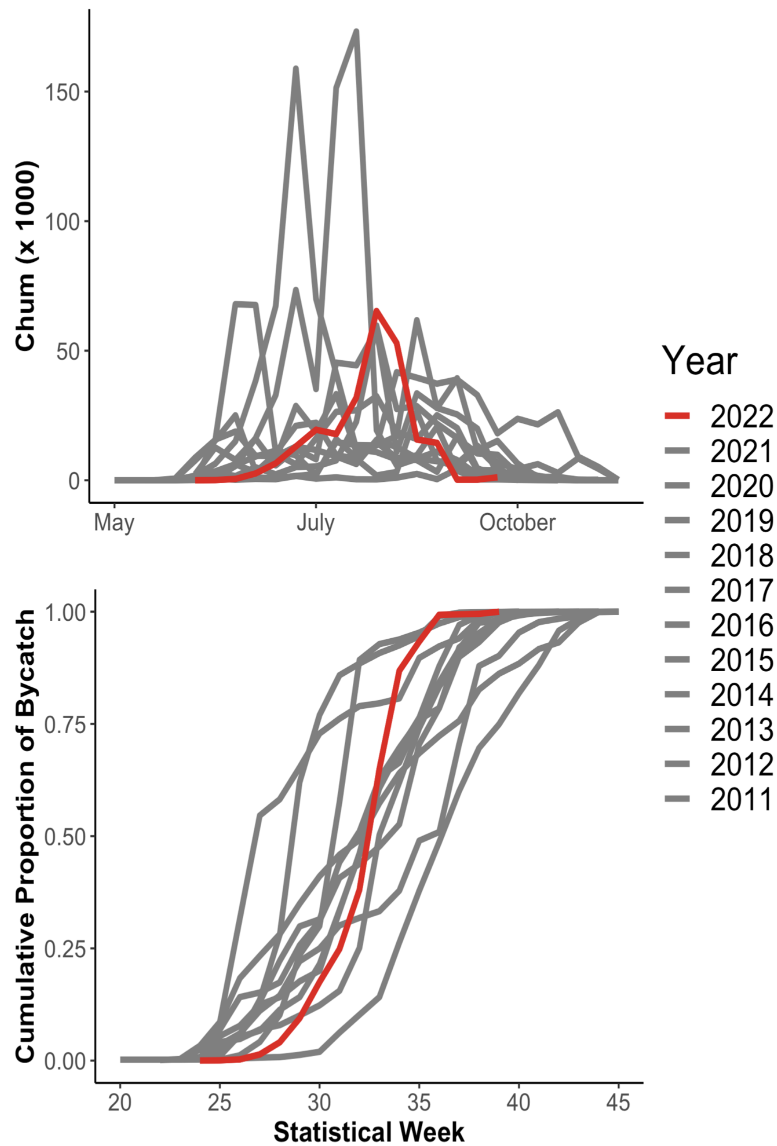

Fig. 2: Number of chum salmon caught during the B-season (top) and cumulative proportion of chum salmon catch (bottom) from the Bering Sea pollock trawl fishery by statistical week for years 2011 to 2022.

Spatial Trends

The geographical distribution of the 2022 chum salmon bycatch was similar to the average spatial location of prior years (Figs. 3, 4). Of the spatial clusters previously defined by the Alaska Fisheries Science Center (AFSC) Auke Bay Laboratory (ABL) Genetics Program, the highest rates of PSC occurred in clusters 1 and 3, with the highest bycatch coming from Alaska Department of Fish and Game (ADF&G) statistical area 645501 (Fig. 3 largest circle).

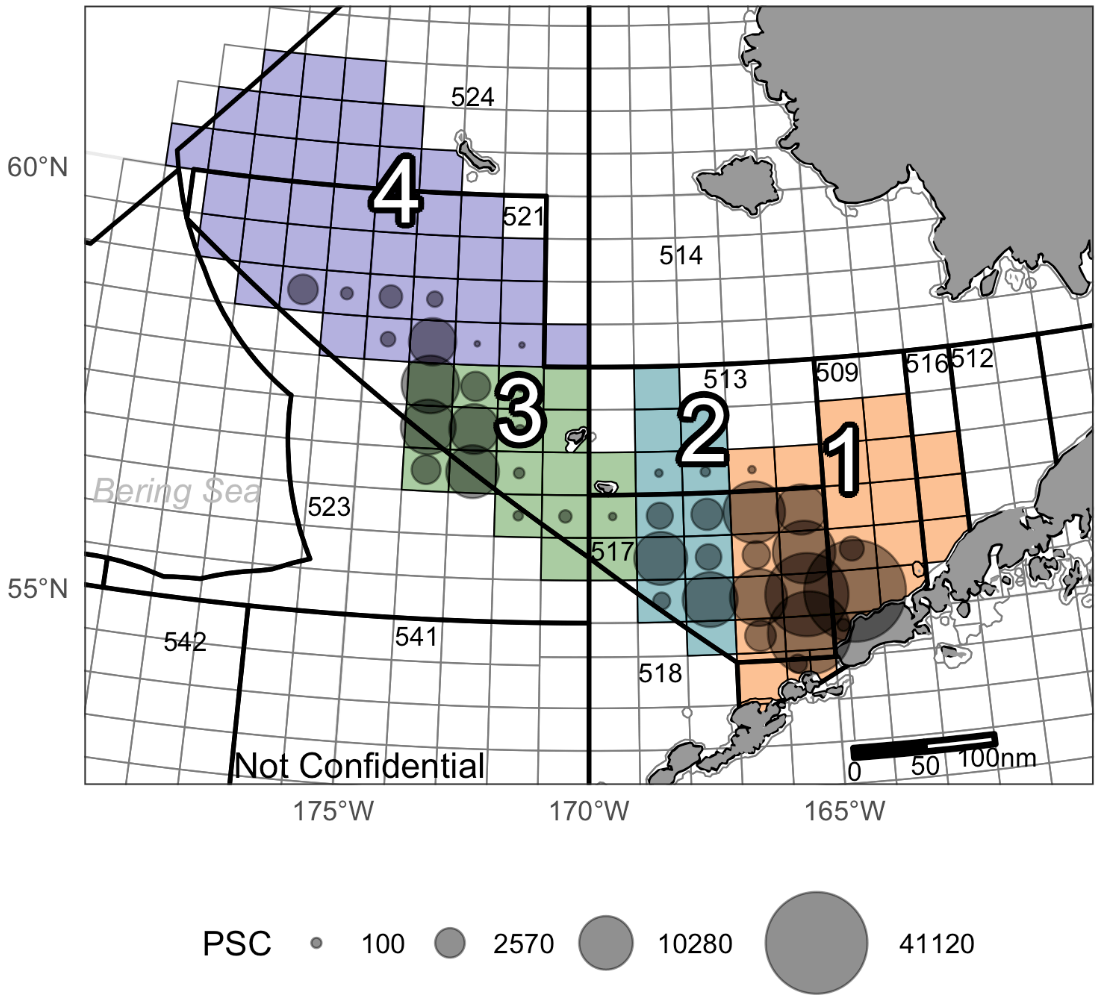

Fig. 3: Spatial distribution of chum salmon bycatch caught in the 2022 Bering Sea B-season pollock fishery. ADF&G statistical areas are highlighted based on the four geographic strata assigned in prior genetic analyses.

To evaluate shifts in the distribution of the chum salmon bycatch, the centroid (geographic center of the bycatch) was calculated for each year by fishing 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). Climate data were downloaded from NOAA's Physical Science Laboratory climate indices data repository. The centroid of the chum salmon bycatch for the catcher-processor and mothership sectors are in the geographic center relative to prior years. It also appears that in years with lower sea surface temperatures in the eastern Bering Sea, the centroid of the mothership and shoreside sectors are further northeast on the shelf (Fig. 4).

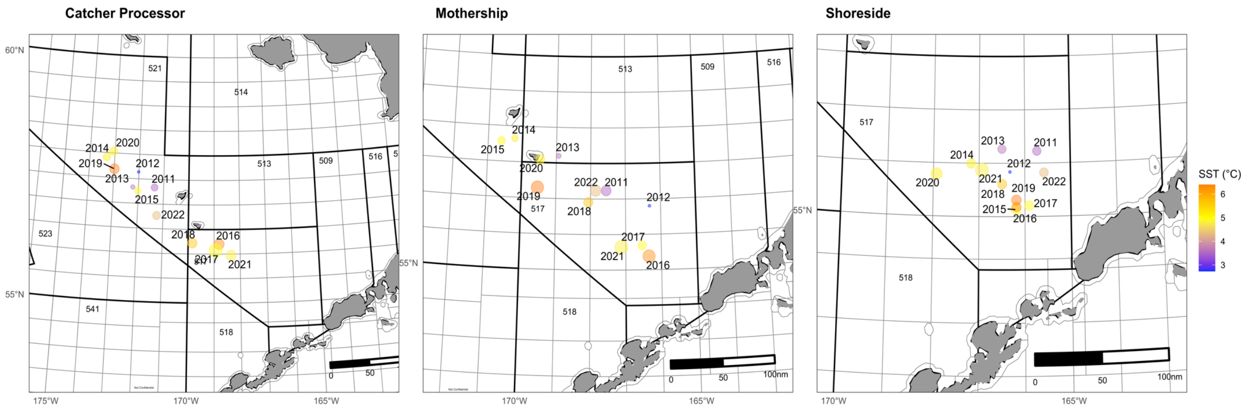

Fig. 4: Change in the spatial distribution of chum salmon bycatch as measured by the geographic centroid of the bycatch by sector; catcher-processor, mothership, and shoreside. Point sizes reflect the relative size of the bycatch and point colors reflect the mean sea surface temperature (°C).

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 7,188 genetic samples from the Bering Sea and Aleutian Islands (BSAI) and 278 samples from the Gulf of Alaska (GOA) that were collected by the Observer Program in 2022. Due to the small number of samples and the accelerated time frame of this reporting cycle, the GOA chum salmon samples were not analyzed. Previous reporting indicated that nearly all chum bycatch samples from the GOA are from the EGOA/PNW reporting group. After inventorying the genetic samples, a 1-in-2 sub-sample was conducted for genotyping. DNA from 3,454 genetic samples, 48% of the total genetic samples collected by the Observer Program, was extracted and amplified for the 84-SNP locus GTseq panel (See Appendix II Table A1). Samples that were not genotyped for greater than 80% of the GTseq panel (minimum of 68 loci) were omitted from analyses. Of the 3,454 samples amplified, 3,346 were of adequate quality to include (48.05% of the total samples, 97% of genotyped samples).

We re-amplified and genotyped 3.7% of samples 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 98%, and the average agreement among individuals was also high (99%), indicating high genotyping accuracy and correct sample organization.

Genetic Stock Composition

Stock composition analyses for the 2022 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 the WASSIP baseline (DeCovich et al. 2012; See Appendix II Figure A1, Table A2) 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). The reporting groups for baseline populations were: 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 Gulf of Alaska/Pacific Northwest (EGOA/PNW).

Overall Trends

Western Alaska stocks comprised 21% of the bycatch, which is much higher than the prior two years (8.0% in 2020 and 8.9% in 2021; Fig. 5) and slightly greater than the its long-term average (2011-2021) of 14.8%. Both SW Alaska and the Upper/Middle Yukon comprised relatively minor portions of the bycatch, 3.6% and 1.9%, respectively. Consistent with prior years, Asia stocks comprised a substantial fraction (43.8%) of the chum salmon bycatch in 2022. The contribution from the NE Asia reporting group (32.9%) was greatly reduced from the 2021 estimate (55.7%) and slightly higher than the EGOA/PNW reporting group (29.6%; Table1 & Fig. 5).

Table 1: Regional stock composition estimates of chum salmon from the 2022 Bering Sea, B-season pollock fishery (PSC = 242,244; n = 3,346). 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	26,369	23,704-29,174	0.109	0.098	0.120	0.00	1.00
NE Asia	79,662	75,551-83,840	0.329	0.312	0.346	0.00	1.00
W Alaska	51,092	47,380-54,865	0.211	0.196	0.226	0.00	1.00
Up/Mid Yukon	4,616	3,257-6,280	0.019	0.013	0.026	0.00	1.00
SW Alaska	8,746	6,639-11,006	0.036	0.027	0.045	0.00	1.00
E GOA/PNW	71,755	67,824-75,744	0.296	0.280	0.313	0.00	1.00

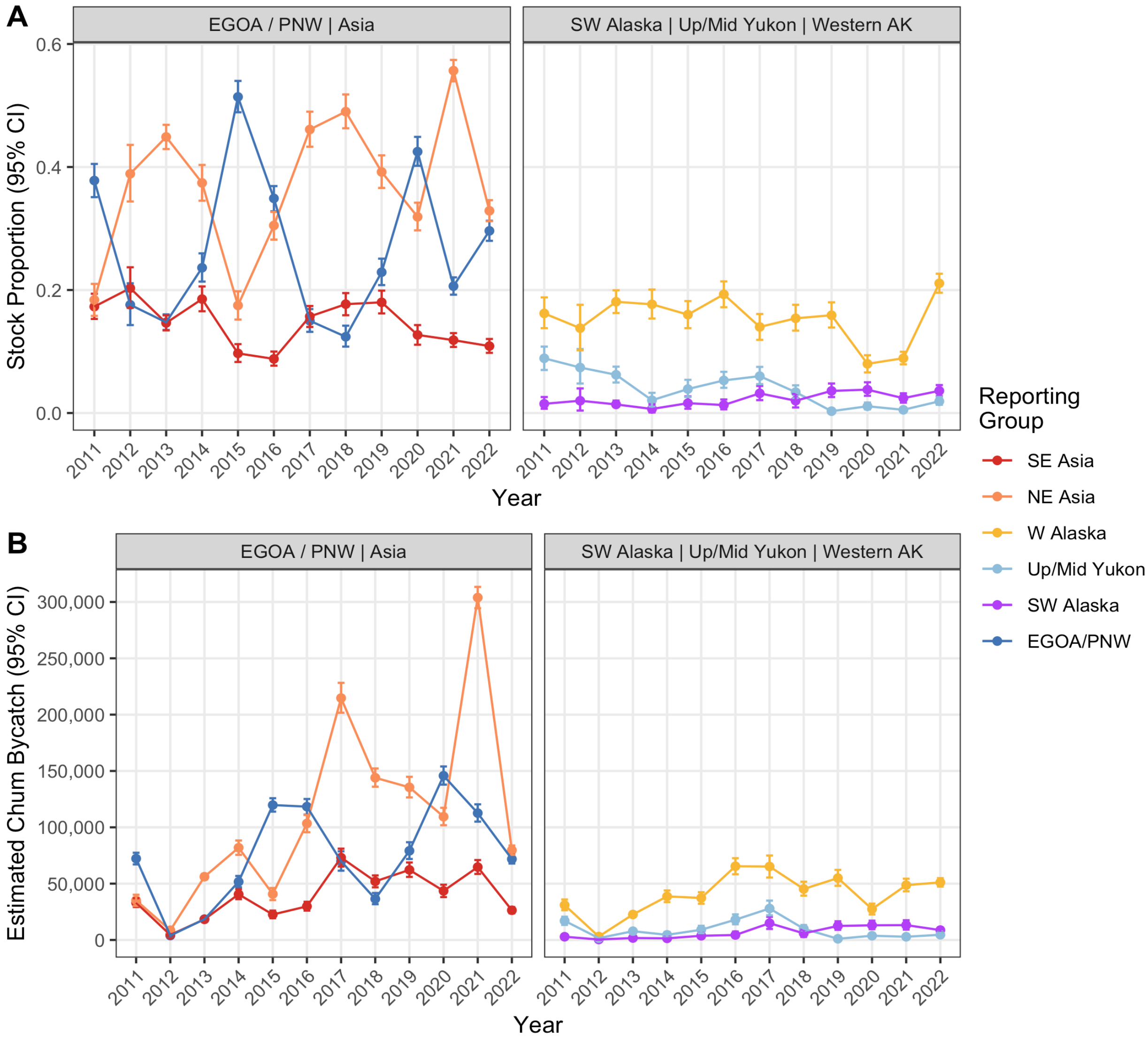

Fig. 5: Annual bycatch estimates of B-season chum salmon PSC from 2011 to 2022. (A) Stock proportions with 95% credible intervals, (B) Estimated number of chum salmon with 95% credible intervals.

There is a clear cyclical pattern of contribution between the NE Asia and EGOA/PNW reporting groups (Fig. 5) with a strong negative correlation ($r = -0.86$). Additionally, the two stocks comprise 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. In 2022, however, the contribution of these two groups combined dropped as a result of the increase in the Western Alaska reporting group.

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.

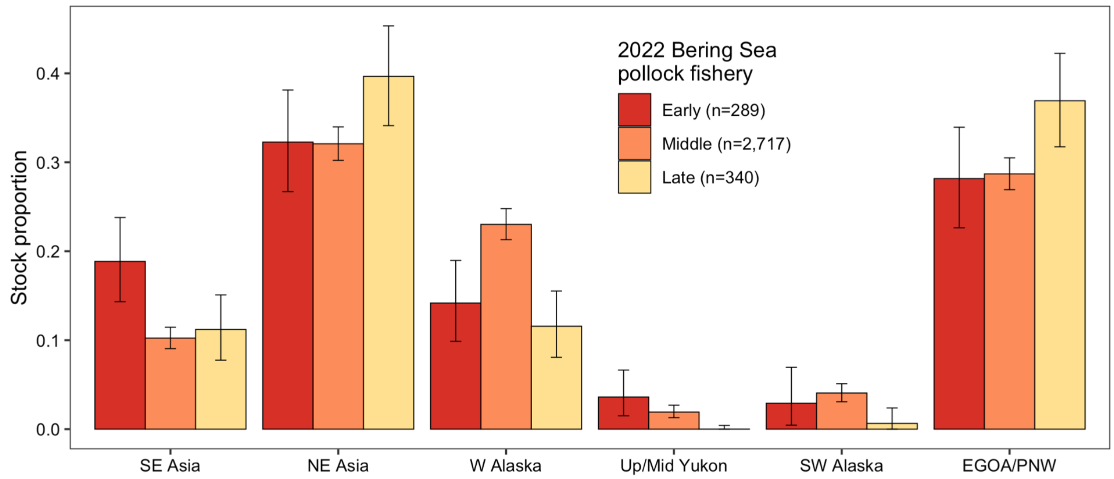

Fig. 6: Stock composition estimates (with 95% CI) for the chum salmon bycatch from the Early, Middle, and Late periods of the 2022 Bering Sea, B-season pollock fishery.

The majority of the bycatch occured in the Middle time period. The smaller sample sizes for the Early and Late analyses resulted in large credible intervals and less pronounced changes in stock composition throughout the season. Nevertheless, the catch composition changed among the time periods for several reporting groups (Fig. 6). The Western Alaska reporting group was highest in the Middle period (23%) while the Upper/Middle Yukon reporting group decreased from the Early and Middle (3.6% and 1.9% respectively) to Late (0%). The SE Asia reporting group decreased in relative contribution to the bycatch from the Early to Middle periods whereas the NE Asia reporting group increased from the Middle to Late period.

Although there is substantial intra-year variability of stock estimates among the three time periods, there are some general trends (Fig. 7). Typically, SE Asia comprises a larger proportion of Early bycatch while NE Asia comprises a larger proportion of Middle and Late 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 Early period typically has the largest proportion of the Upper/Middle Yukon reporting group, while Southwest Alaska displays a minor shift and little variability among time periods. The E GOA/PNW reporting group increases in relative proportion from the Early and Middle periods to the Late period.

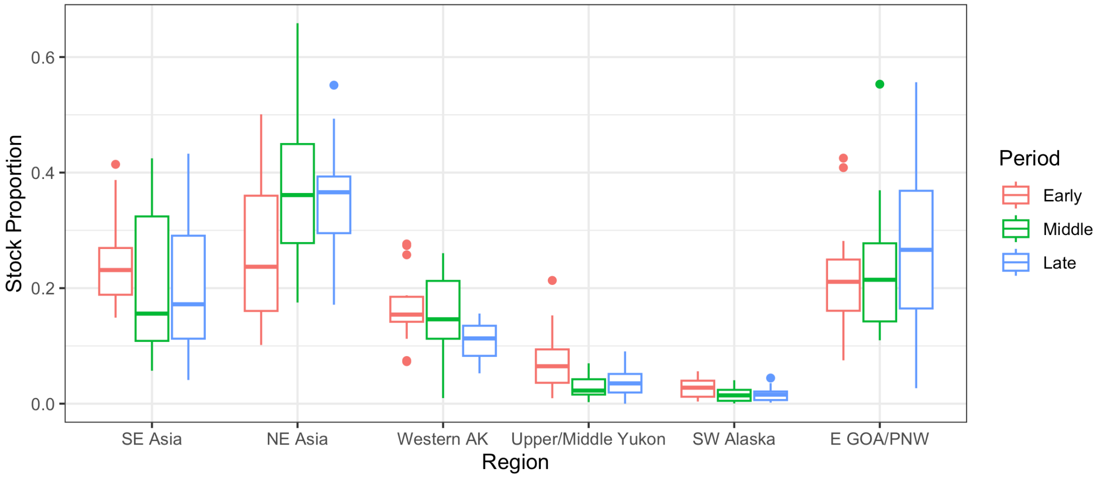

Fig. 7: Boxplot of mean stock composition estimates for the chum salmon bycatch from the Early, Middle, and Late periods from the 2011-2022 Bering Sea, B-season pollock fishery.

It should be noted that the boxplot (Fig. 7) ignores the uncertainty in the point estimates and the credible intervals among time periods within an individual year occasionally overlap. When the Western Alaska reporting group is examined for the three periods from 2011 to 2022, in 7 out of the last 12 years the estimates from the Early or Middle period were greater than the Late period with non-overlapping credible intervals (Fig. 8).

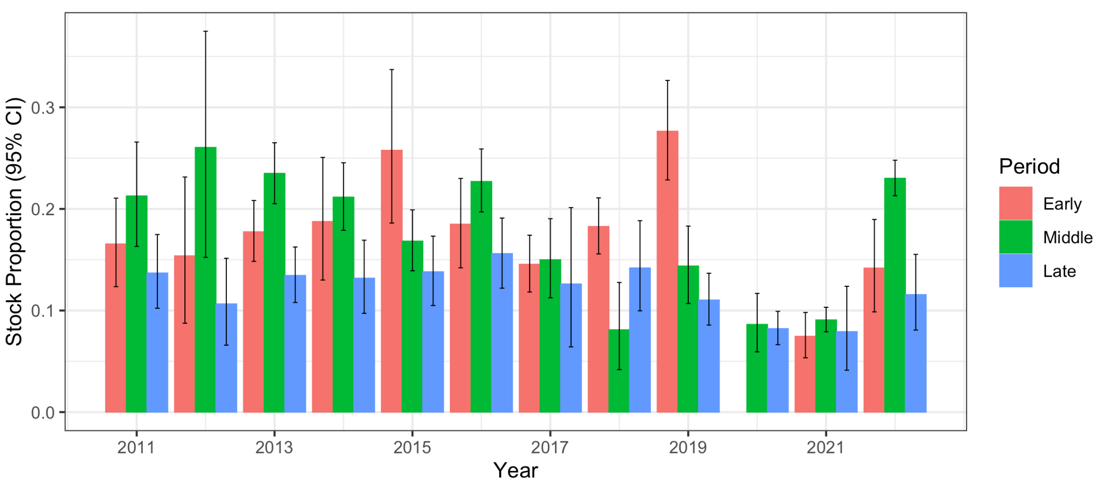

Fig. 8: Mean stock composition estimates of chum salmon bycatch (with 95% CI) for the Western Alaska reportion group from the Early, Middle, and Late periods from the 2011-2022 Bering Sea, B-season pollock fishery.

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, Southwestern Alaska, and EGOA/PNW reporting groups generally are greater closer to the Alaskan Peninsula. In 2022, this was true for the Western Alaska and EGOA/PNW reporting groups while the 95% credible intervals for the Upper/Middle Yukon and Southwestern Alaska overlapped (Fig. 9).

The relative contribution of the Asia reporting groups, alternatively, are greater for mixtures west of 170°W. This was true for both of the Asia reporting groups in 2022: with the SE Asia reporting group; comprising 26.5% of the bycatch west of 170°W and 6.8% of the bycatch east of 170°W; and the NE Asia reporting group comprising 46.5% of the bycatch west of 170°W and 28.6% of the bycatch east of 170°W (Fig. 9).

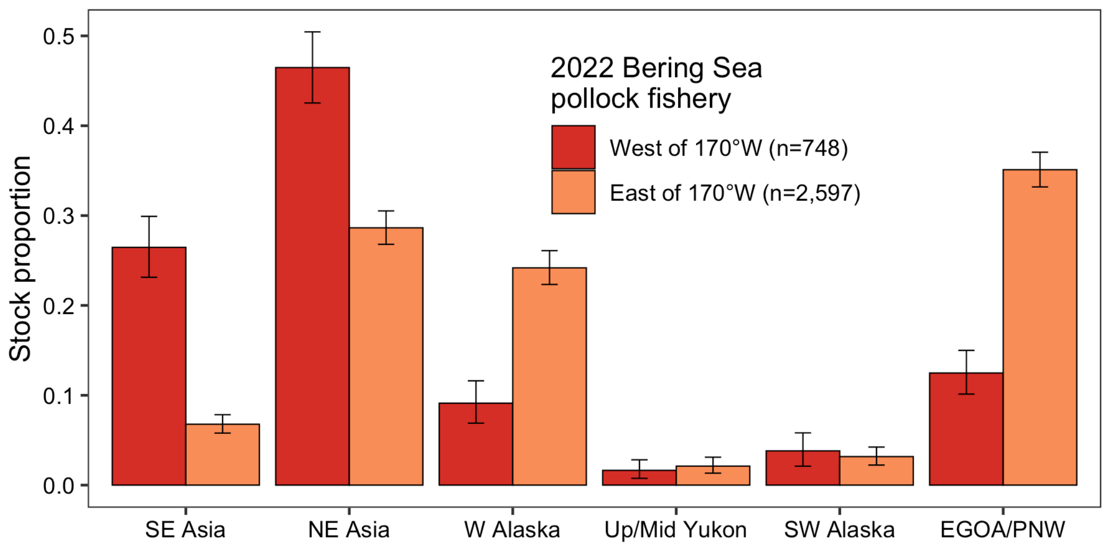

Fig. 9: Stock composition estimates (with 95% CI) for the chum salmon bycatch from the 2022 Bering Sea, B-season pollock fishery from the U.S. waters of the Bering Sea west of 170°*W and the southeastern Bering Sea east of* 170°*W.*

Spatiotemporal Trends

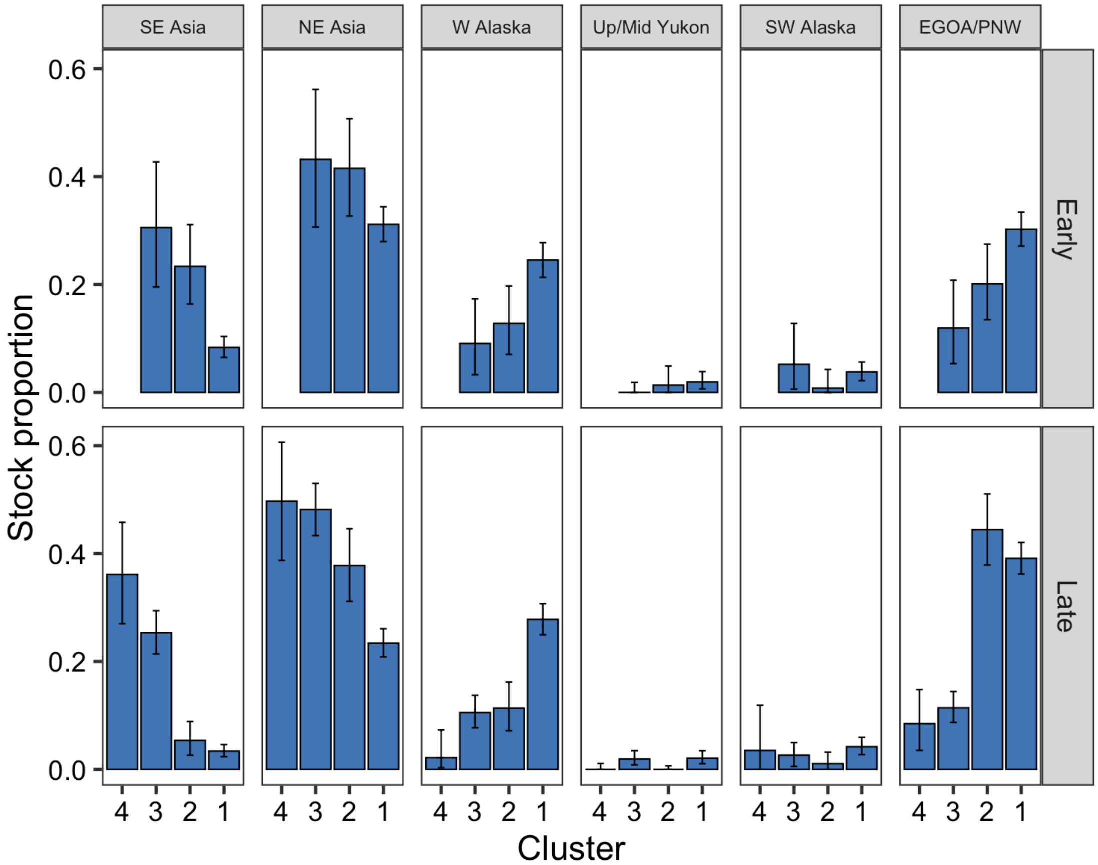

Fig. 10: Stock composition estimates (with 95% CI) for the chum salmon bycatch collected from four spatial clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2022 Bering Sea, B-season pollock fishery. Clusters are ordered from west (cluster 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), and incorporated temporal stratification (Early and Late) to evaluate the spatio-temporal stock specific contributions. There was little fishing effort and too few genetic samples in Cluster 4 during the Early period for analysis (Figs. 3, 10).

Stock composition estimates were mostly consistent with historic trends. The Asian component primarily decreases from west to east and from early to late (Fig. 10 left panels). In the Early period, the Western Alaska contribution increases from an average of 10.9% (2.7% SD) in clusters 2 and 3 to 24.5% in cluster 1. In the Late time period, we see an increase from 2.2% in cluster 4, to an average of 8.2% (4.5% SD) in clusters 2 and 3, to 27.8% in cluster 1. The EGOA/PNW stock group shows an increase from Early to Late in clusters 2 (20% to 44%) and cluster 1 (30% to 39%) and from west to east. In the Early period, the proportion of the EGOA/PNW stock group increases from 13% in cluster 3 to 30% in cluster 1. The 95% credible intervals for cluster 1 and 2 in the early period overlap just slightly. In the Late time period, the break at which the proportions differ is between clusters 3 (11%) and 2 (44%) (Fig. 10 right panel).

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 2022 (Fig. 11). Again, there is some interannual variability in the trend that Western Alaska comprises a larger proportion of the bycatch from Cluster 1; however, in the Early period the estimate for cluster 1 was larger (with non-overlapping credible intervals) than cluster 3 in 46% of the comparisons, but had a larger mean estimate in 91% with only a single year where the point estimate for cluster 3 was larger than cluster 1 (2021). Similarly, the Western Alaska reporting group estimate for cluster 1 exceeded the

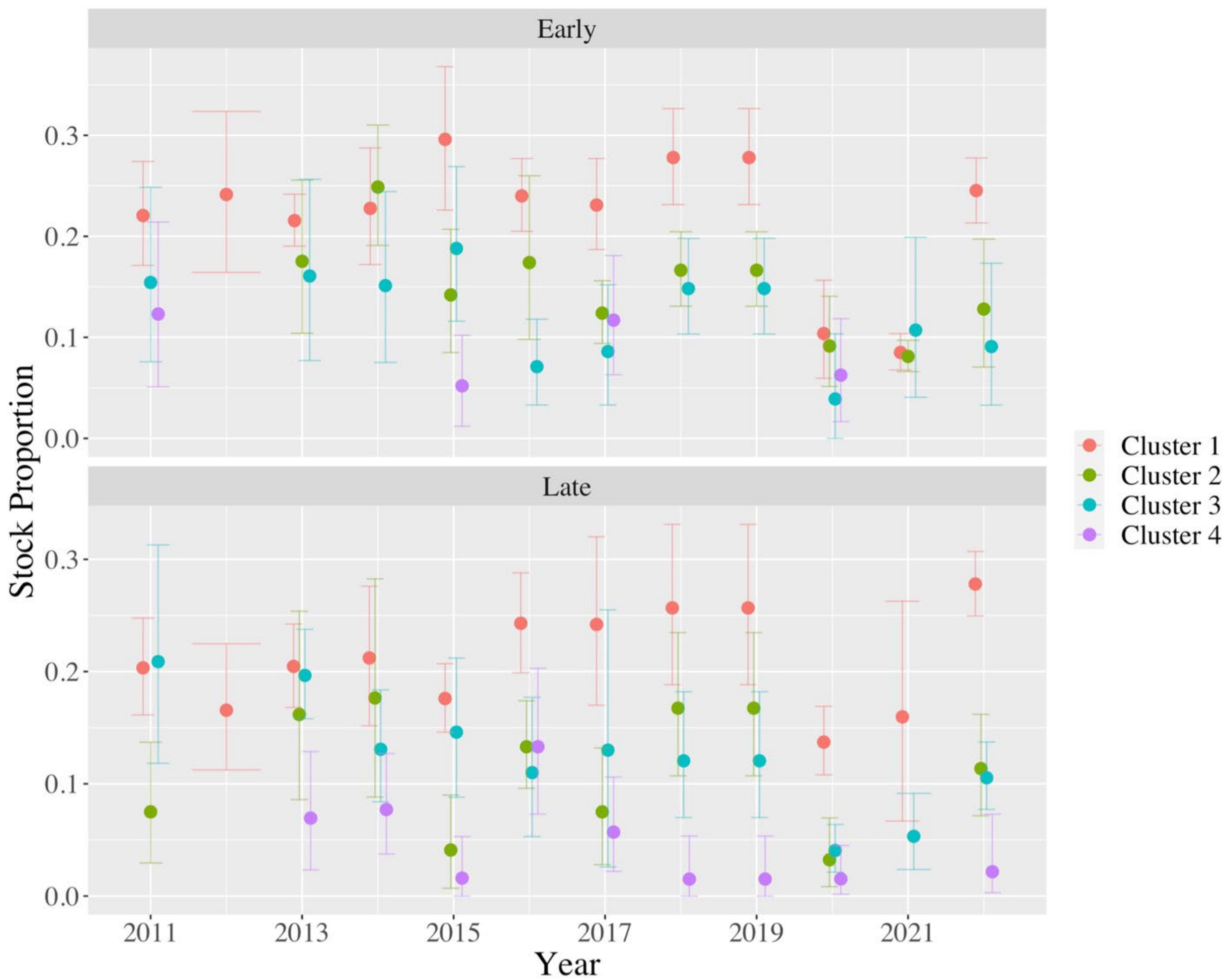

Fig. 11: Western Alaska stock composition estimates (with 95% CI) from four spatial clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2011-2022 Bering Sea, B-season pollock fishery. Clusters are ordered from west (cluster 4) to east (cluster 1).

cluster 3 estimate (with non-overlapping credible intervals) in 46% of comparisons and the point estimate was larger in 91%. It should be noted that decreasing the spatial area (number of ADFG statistical areas aggregated into a cluster) and temporal interval (weekly aggregations into Early and Late) results in smaller collections of genetic samples to analyze and increases the uncertainty (credible intervals) in the estimates.

The total bycatch numbers in cluster 1 vastly exceeds that in cluster 3 and as a result, despite the slight overlap in credible intervals for the proportions, the number of Western Alaska chum salmon estimated to be encountered as bycatch in cluster 1 early exceeds that of cluster 3 early in all years but 2020. In the late period, the estimated number of Western Alaska chum salmon estimated to be encountered as bycatch in cluster 1 exceeds that of cluster 3 in 8 of the 11 years where estimates were possible (Fig 12).

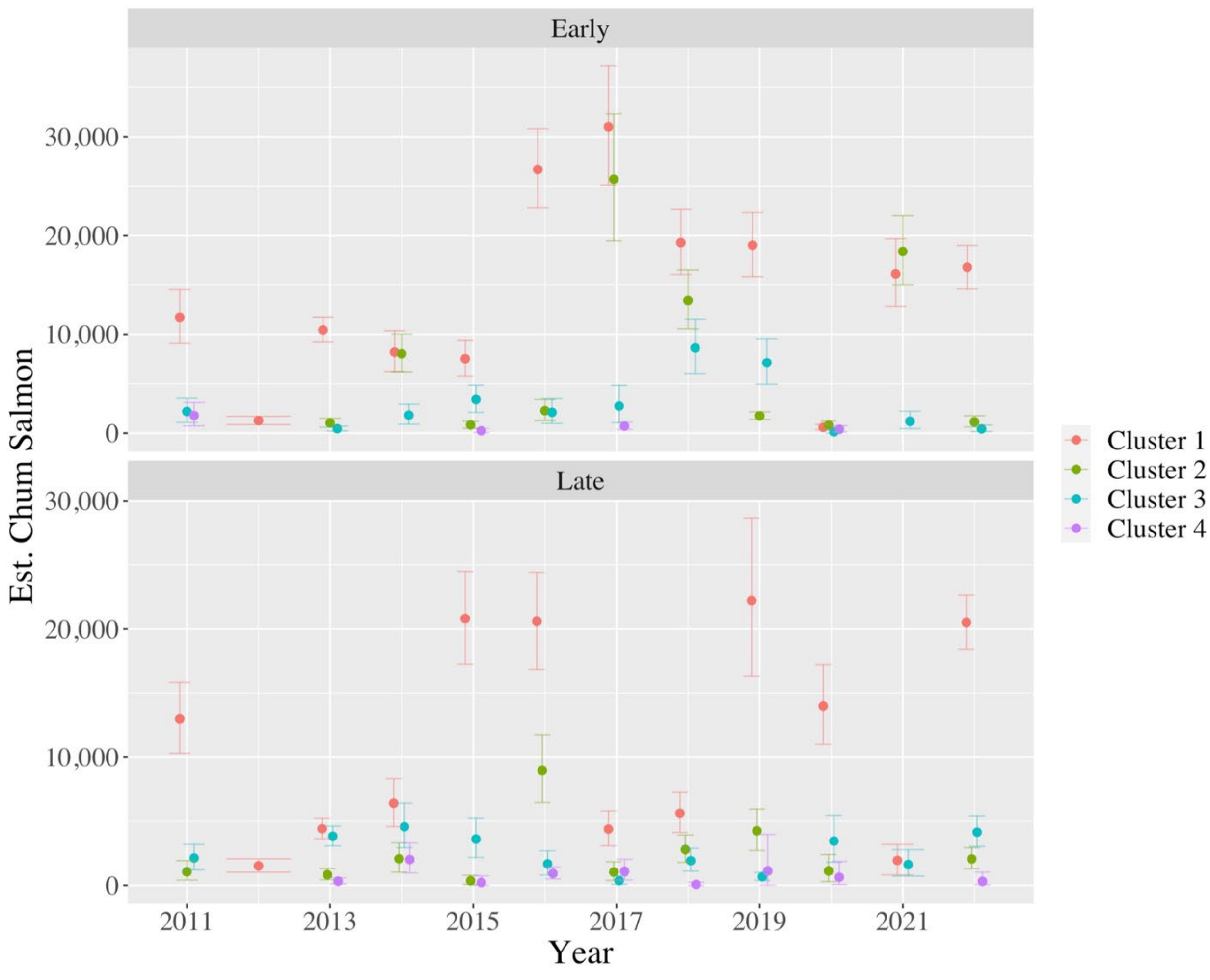

Fig. 12: Estimated number of Western Alaska chum salmon bycatch from four spatial clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2011-2022 Bering Sea, B-season pollock fishery. Clusters are ordered from west (cluster 4) to east (cluster 1).

Age Trends

Total age of individual fish was estimated as the number of freshwater and saltwater annuli formed on the scale plus one to account for the winter spent rearing in fresh water. Aging was performed at the ADF&G Mark, Tag and Age Lab. A total of 1,871 chum salmon were aged. Of those, 1,799 had genotypic information and were included in age specific analyses.

In 2022, Western Alaska stocks comprised a large proportion (27.1%) of age-4 chum salmon (Fig. 13), but only 8.8% of age-3 fish. The Upper/Middle Yukon stocks had relatively similar representation across age classes (1.4%), as did the Southwest Alaska reporting group, which contributed 3.2%, 3.5%, and 3.6% to age-3, age-4 and age-5 classes respectively. SE Asia contributed relatively equal proportions to age-3 and age-4 chum salmon bycatch (~12.5%), but relatively little (1.8%) to age-5 bycatch collections. The EGOA/PNW stocks comprised 48.3% of age-3 fish compared to 24.2% of age-4 and 6.9% of age-5 chum salmon. NE Asia comprised 24.3% of age-3 chum salmon and increased to 32.6% and 71.6% of Age-4 and Age-5 fish, respectively (Fig. 13).

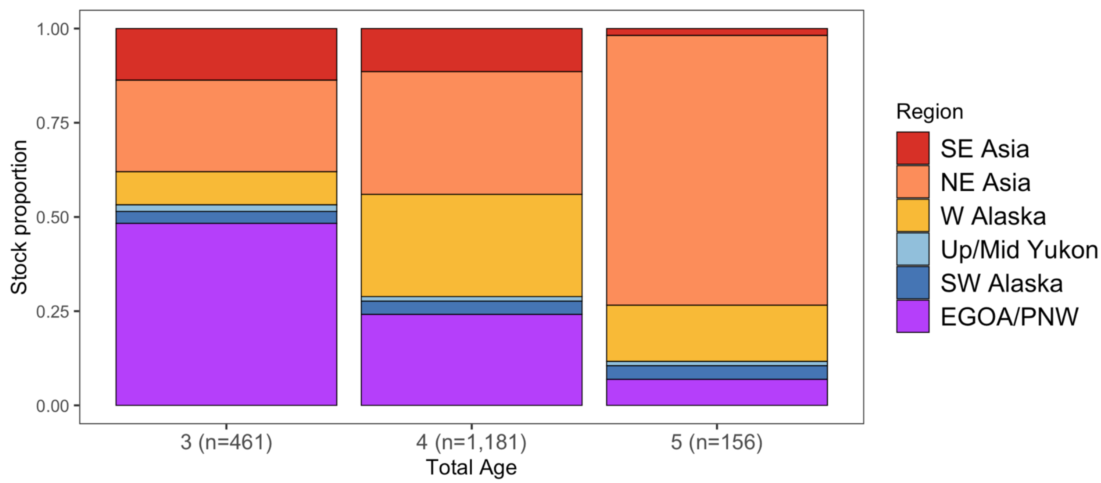

Fig. 13: Stock composition estimates for the three predominate ages of chum salmon bycatch from the 2022 Bering Sea, B-season pollock fishery.

Historically, Age-3 chum salmon in the bycatch are typically dominated by EGOA/PNW stocks while the Age-4 and Age-5 mixtures are overwhelmingly made up of NE Asia stocks (Fig. 14). This may be due to the fact that stocks in the southern range typically mature at an earlier age than northern stocks.

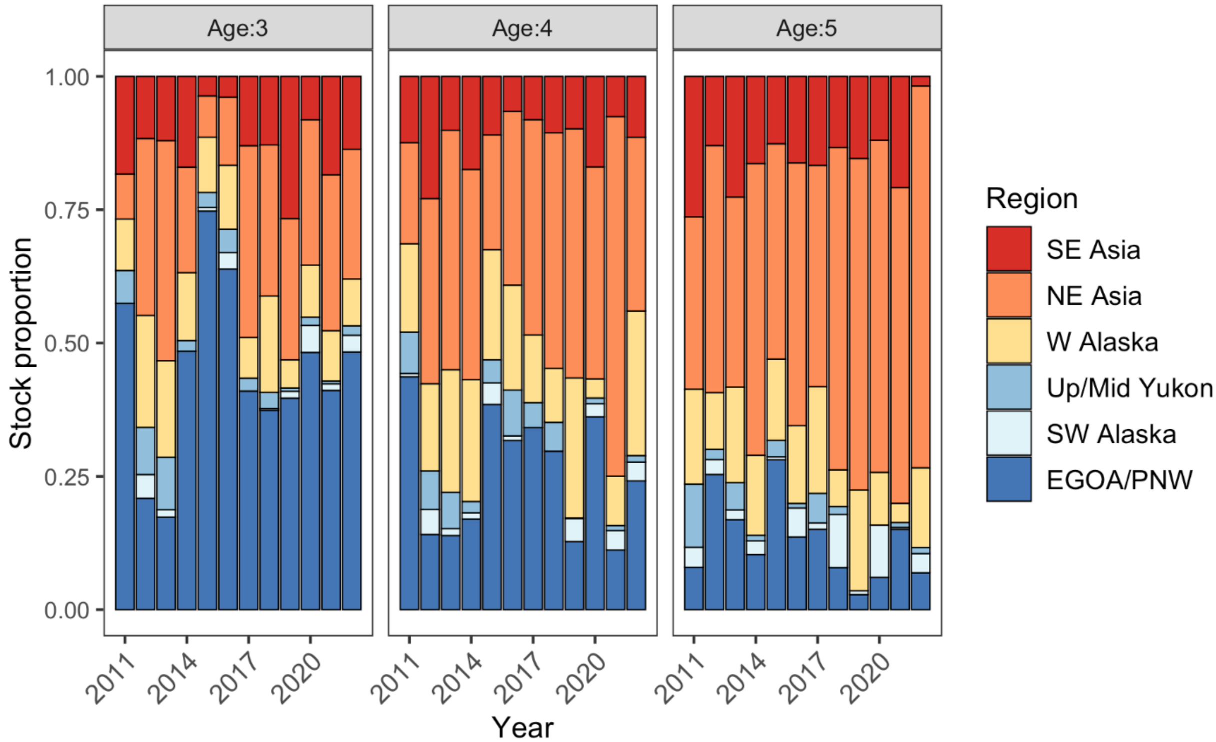

Fig. 14: Stock composition estimates for the three predominate ages of chum salmon bycatch from the 2011-2022 Bering Sea, B-season pollock fishery.

The large proportion of Age-4 fish from Western Alaska stocks in 2022 is similar to estimates observed in 2019 and 2014. The proportion of Age-3 fish from Western Alaska in 2021 was small (9.4%) compared to the long-term average (11.9%) which suggests that predicting age specific proportions for reporting groups is difficult with bycatch data alone. There are weak correlations between the proportion of Western Alaska age-3 and age-4 chum salmon lagged one year ($r = 0.69$) and the proportion of Age-4 fish and Age-5 fish lagged one year ($r = 0.34$).

Sector Trends

Reporting group contributions to the 2022 chum salmon bycatch from each fishing sector were generally consistent with historic patterns. The Western Alaska reporting group comprised a larger proportion of the mothership and shoreside sectors bycatch (25.4% and 23.3%, respectively; Fig. 15) compared to the catcher-processor sector (10.7%). Despite similar proportions of overall bycatch, the shoreside sector has ~4 times more bycatch, resulting in a substantially higher total number of Western Alaska chum salmon caught by the shoreside sector (33,425) than the mothership sector (7,504). The overall proportion of the Upper/Middle Yukon group was similar across sectors (all credible intervals overlapped); however, the estimated number of chum salmon from the Upper/Middle Yukon reporting group from the shoreside sector was on average 2,835 chum salmon more than the catcher-processor and mothership sectors (Fig. 15). Additionally, the SW Alaska reporting group comprised a larger proportion and estimated number of fish of the shoreside sector bycatch than the catcher-processor sector bycatch. As is typical, the catcher-processor sector, which fishes further to the west and encounters most of its chum salmon bycatch in clusters 4, 3, and 2, had a higher proportion of both Asian reporting groups compared to the shoreside sector (Figs. 4, 15).

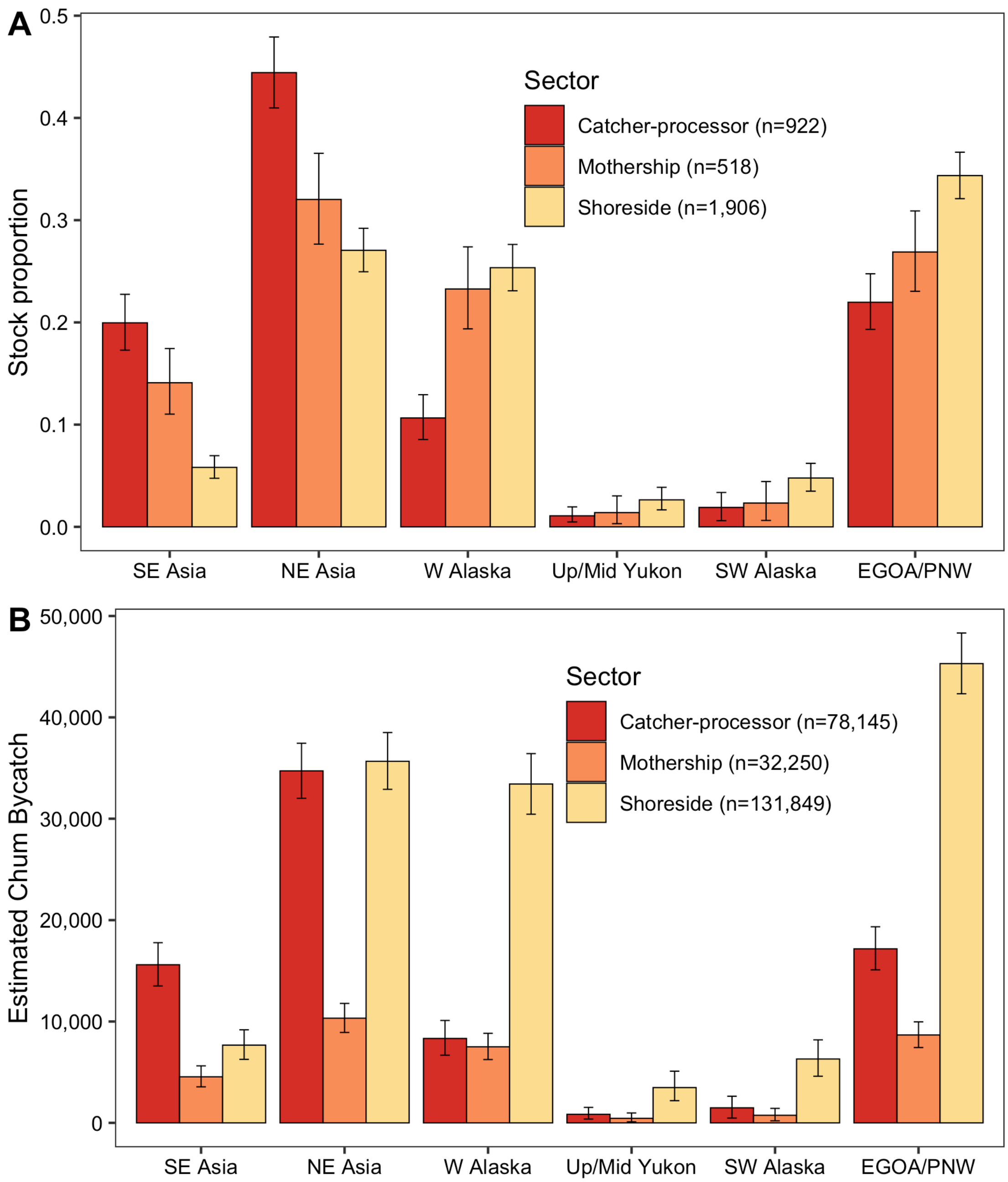

Fig. 15: Stock composition estimates (with 95% CI) for the chum salmon bycatch from the 2022 Bering Sea, B-season pollock fishery from the catcher-processor, shoreside, and mothership fishing sectors. Sample sizes for mixture analysis given in legend. Proportions in top panel; numbers of fish in bottom panel.

Kotzebue Sound

Commercial harvest data suggest that Kotzebue Sound chum salmon populations may be increasing in abundance (https://www.adfg.alaska.gov/static/fishing/PDFs/commercial/norton_kotzebue/2022_kotzebue_salmon_summary.pdf). While the total number of permits is down relative to the high number of permits in the early 1980s, recent harvests have been some of the largest on record (Fig. 16); although harvests in 2020 and 2021 were lower. From the 2022 ADF&G commercial harvest summary, catches after 28 July were well above average, daily catch per unit effort was the highest since 2014, and the harvest of 475,624 chum was the 8^{th} highest on record.

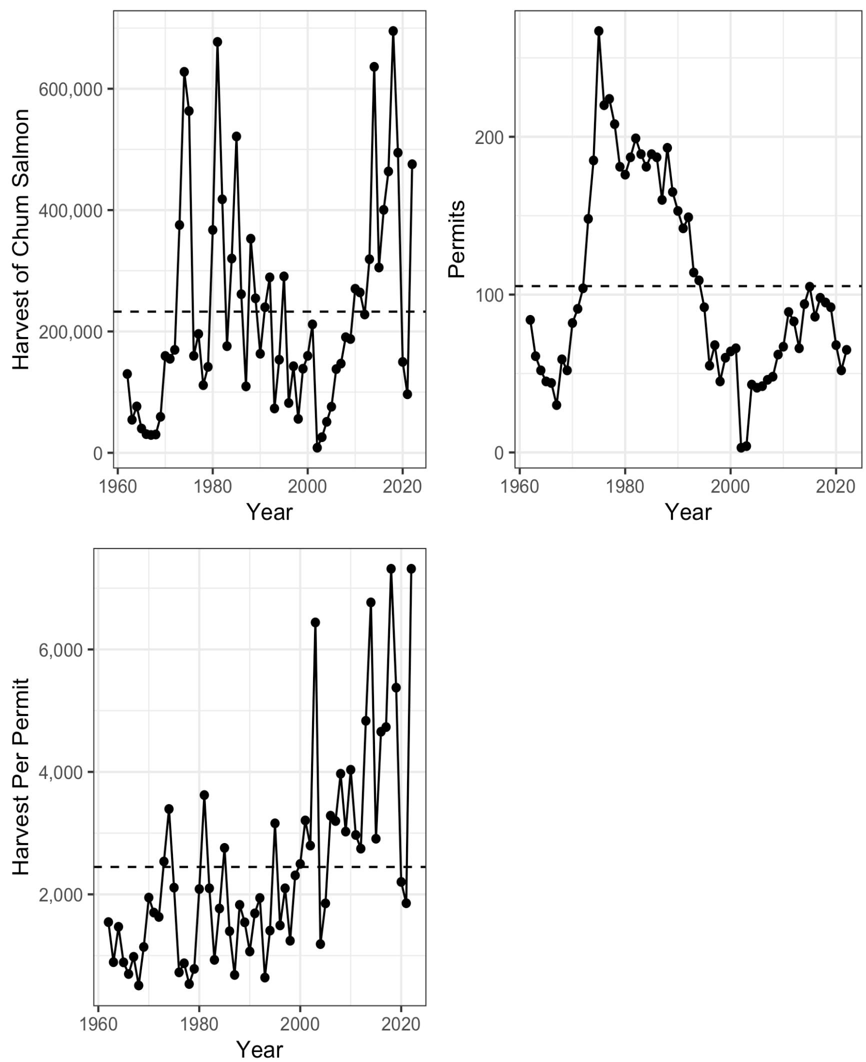

Fig. 16: Kotzebue District chum salmon catch from 1962 - 2022. Long-term means denoted with horizontal dashed line. Source: https://www.adfg.alaska.gov/static/fishing/PDFs/commercial/norton_kotzebue/2022_kotzebue_salmon_summary.pdf

Recently, the ABL switched to a new genetic marker panel and baseline that permitted 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 8 populations: Inmachuk River, Kobuk River (2 collections), Kelly Lake, Noatak River, Selby Slough, Agiapuk River, and American River.

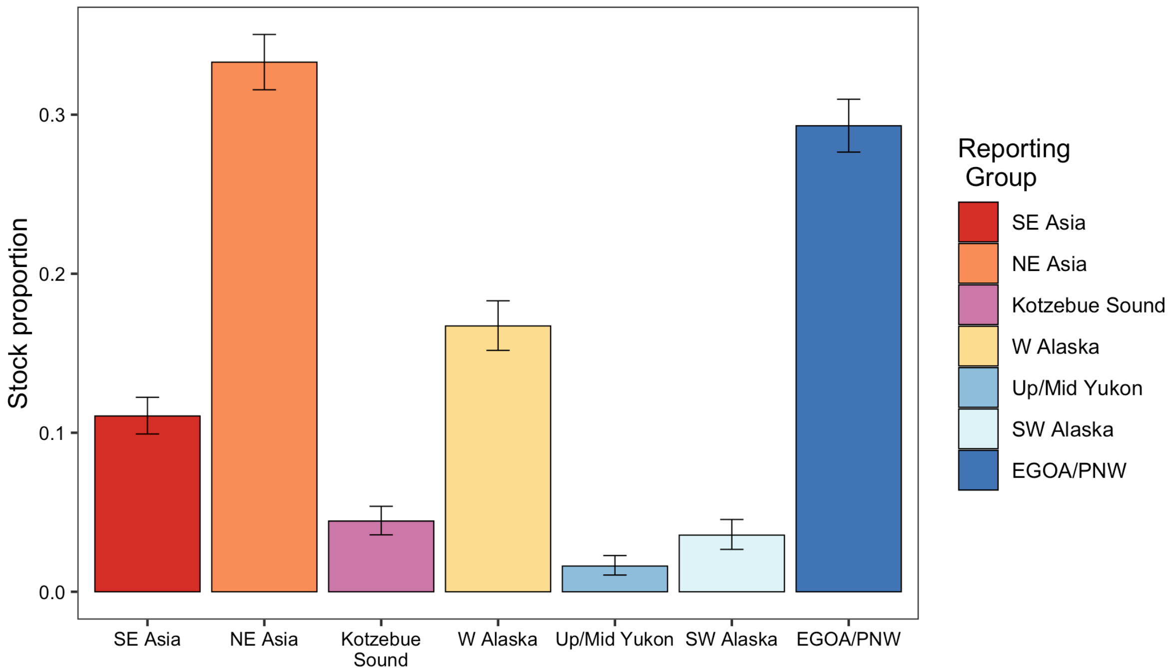

Fig. 17: Stock composition estimates (with 95% CI) for the chum salmon bycatch from the 2022 Bering Sea, B-season pollock fishery with Kotzebue Sound reporting group.

In 2022, Kotzebue Sound represented a non-trivial proportion of the B-season bycatch (Fig. 17). The Kotzebue Sound reporting group comprised 4.5% (3.6 - 5.4%) of the chum salmon bycatch. When multiplied by the total bycatch of 242,244 for the B-season, the number of Kotzebue Sound chum salmon was 10,772 (8,671-13,023 CI) chum salmon. 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 21.1% to 16.7%. When multiplied by the total bycatch for the B-season, the total number of chum salmon from the Western Alaska reporting group decreased from 51,092 (47,380-54,865) to 40,493 (36,768-44,324).

We evaluated the contribution of Kotzebue Sound from 2020 to 2022, the period over which the ABL has used the WASSIP SNP baseline. It appears that there was a substantial increase in the contribution of Kotzebue Sound reporting group between 2020 and 2022 (Fig. 18). In 2020, Kotzebue sound was 2.4% (1.6 - 3.3%) and by 2022 it increased to 4.5% (3.6 - 5.4%).

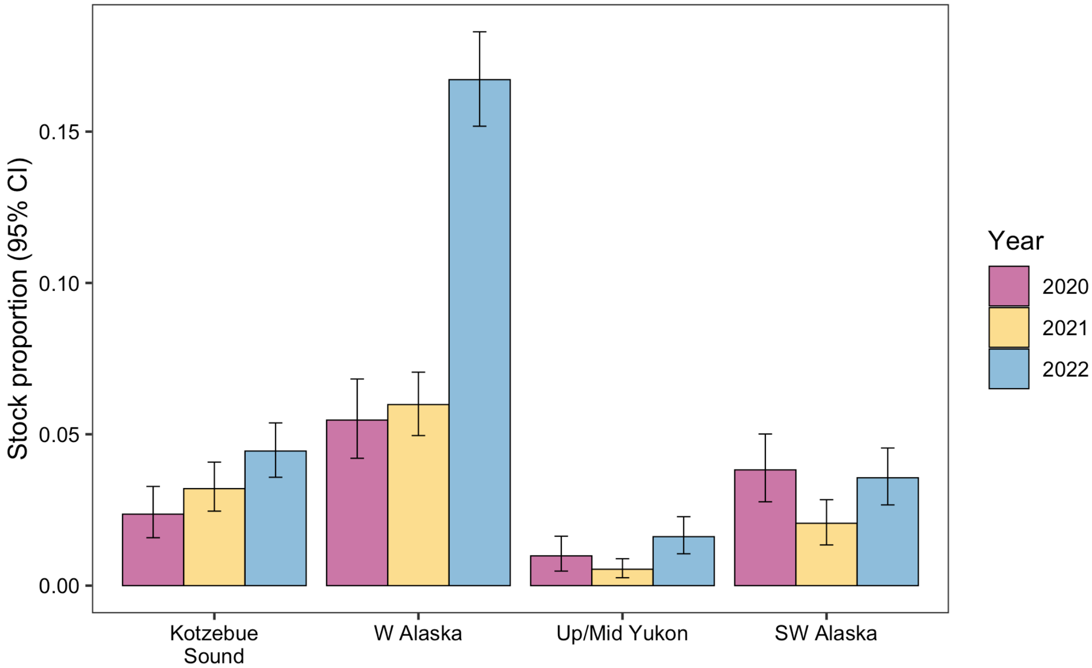

Fig. 18: Stock composition estimates (with 95% CI) for the chum salmon bycatch from the 2020-2022 Bering Sea, B-season pollock fishery with Kotzebue Sound reporting group.

Prior to 2020, the ABL genetics program used a microsatellite baseline produced by Department of Fisheries and Oceans Canada (Beacham et al. 2009) that had slightly less representation in the Kotzebue Sound area. The different marker panel and reduced regional representation requires thorough evaluation before pre-2020 Kotzebue Sound estimates can be made.

Summary of Coastal Western Alaska, Upper Middle Yukon, and Southwest stocks

Despite a large reduction in bycatch between 2021 and 2022, the total number of Western Alaska chum salmon taken as bycatch remained near the long-term average. In 2022, 51,092 (47,380-54,865) Western Alaska chum salmon (including Kotzebue Sound) were caught in the pollock fishery during the B-season. Additionally, 4,616 (3,257-6280) Upper/Middle Yukon and 8,746 (6,639-11,006) Southwest Alaska chum salmon were caught. Combined, these three reporting groups accounted for 26.6% of the 2022 chum salmon bycatch that when multiplied by the total bycatch expands to 64,457 chum salmon.

Historically, the Western Alaska reporting group has accounted for a larger proportion of the bycatch early in the B-season. In 2022, while the Middle time period (weeks 30-34) had the highest proportion of Western Alaska fish, no temporal differences were observed when catch location was accounted for (See Spatiotemporal trends). The Western Alaska reporting group was encountered in its highest proportions East of 170°W, specifically within Cluster 1. Both the Upper/Middle Yukon and Southwest 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. The Western Alaska reporting group comprised a larger proportion of the mothership and shoreside sectors bycatch (25.4% and 23.3%, respectively) compared to the catcher-processor sector (10.7%). The relative proportion of Upper/Middle Yukon and Southwest Alaska were similar across sectors, averaging 1.7% and 3% for each reporting group, respectively. Despite similar proportions the catcher-processor and mothership sector had similar numbers of Coastal Western Alaska chum salmon in their bycatch (mean of 7915), which were substantially fewer than the shoreside sector (33,425).

This was the first 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). Removing Kotzebue Sound from the Coastal Western Alaska reporting group, decreased the estimate for Coastal Western Alaska from 20.9% to 16.7%. Estimates from 2020 and 2021 suggest that Kotzebue Sound may represent an increasing relative proportion of the bycatch, future work will evaluate our ability to distinguish Kotzebue Sound with the previous chum salmon genetic baseline used from 2011-2019.

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Appendix I - GSI Estimates

Regional stock composition estimates of chum salmon samples from the 2022 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 = 242,244; n = 3346)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	26,369	23,704-29,174	0.109	0.098	0.120	0.00	1.00
NE Asia	79,662	75,551-83,840	0.329	0.312	0.346	0.00	1.00
W Alaska	51,092	47,380-54,865	0.211	0.196	0.226	0.00	1.00
Up/Mid Yukon	4,616	3,257-6,280	0.019	0.013	0.026	0.00	1.00
SW Alaska	8,746	6,639-11,006	0.036	0.027	0.045	0.00	1.00
E GOA/PNW	71,755	67,824-75,744	0.296	0.280	0.313	0.00	1.00

East of 170° (PSC = 180,617; n = 2597)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	12,245	10,464-14,158	0.068	0.058	0.078	0.00	1.00
NE Asia	51,724	48,409-55,119	0.286	0.268	0.305	0.00	1.00
W Alaska	43,679	40,337-47,130	0.242	0.223	0.261	0.00	1.00
Up/Mid Yukon	3,823	2,410-5,617	0.021	0.013	0.031	0.00	1.01
SW Alaska	5,737	4,027-7,650	0.032	0.022	0.042	0.00	1.00
E GOA/PNW	63,406	59,945-66,920	0.351	0.332	0.371	0.00	1.00

West of 170° (PSC = 61,627; n = 748)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	16,309	14,256-18,433	0.265	0.231	0.299	0.00	1.00
NE Asia	28,639	26,210-31,086	0.465	0.425	0.504	0.00	1.00
W Alaska	5,621	4,250-7,155	0.091	0.069	0.116	0.00	1.00
Up/Mid Yukon	1,014	466-1,737	0.016	0.008	0.028	0.00	1.00
SW Alaska	2,351	1,299-3,585	0.038	0.021	0.058	0.00	1.00
E GOA/PNW	7,690	6,244-9,241	0.125	0.101	0.150	0.00	1.00

Early (PSC = 22,857; n = 289)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	4,310	3,275-5,437	0.189	0.143	0.238	0.00	1.00
NE Asia	7,375	6,103-8,713	0.323	0.267	0.381	0.00	1.00
W Alaska	3,240	2,255-4,334	0.142	0.099	0.190	0.00	1.00
Up/Mid Yukon	826	345-1,518	0.036	0.015	0.066	0.00	1.00
SW Alaska	666	104-1,589	0.029	0.005	0.070	0.00	1.00
E GOA/PNW	6,438	5,174-7,757	0.282	0.226	0.339	0.00	1.00

Middle (PSC = 187,539; n = 2717)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	19,188	16,982-21,485	0.102	0.091	0.115	0.00	1.00
NE Asia	60,158	56,655-63,715	0.321	0.302	0.340	0.00	1.00
W Alaska	43,157	39,941-46,495	0.230	0.213	0.248	0.00	1.00
Up/Mid Yukon	3,606	2,416-5,051	0.019	0.013	0.027	0.00	1.00
SW Alaska	7,614	5,782-9,586	0.041	0.031	0.051	0.00	1.00
E GOA/PNW	53,812	50,488-57,193	0.287	0.269	0.305	0.00	1.00

Late (PSC = 31,848; n = 340)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	3,570	2,469-4,806	0.112	0.078	0.151	0.00	1.00
NE Asia	12,629	10,866-14,437	0.397	0.341	0.453	0.00	1.00
W Alaska	3,683	2,572-4,945	0.116	0.081	0.155	0.00	1.00
Up/Mid Yukon	2	0-134	0.000	0.000	0.004	0.76	1.00
SW Alaska	204	0-758	0.006	0.000	0.024	0.15	1.00
E GOA/PNW	11,756	10,108-13,454	0.369	0.317	0.422	0.00	1.00

Catcher-processor (PSC = 78,145; n = 922)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	15,596	13,507-17,774	0.200	0.173	0.227	0.00	1.00
NE Asia	34,722	32,021-37,444	0.444	0.410	0.479	0.00	1.00
W Alaska	8,325	6,676-10,102	0.107	0.085	0.129	0.00	1.00
Up/Mid Yukon	845	375-1,528	0.011	0.005	0.020	0.00	1.00
SW Alaska	1,486	473-2,628	0.019	0.006	0.034	0.00	1.00
E GOA/PNW	17,168	15,095-19,344	0.220	0.193	0.248	0.00	1.00

Mothership (PSC = 32,250; n = 518)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	4,545	3,556-5,625	0.141	0.110	0.174	0.00	1.00
NE Asia	10,327	8,919-11,784	0.320	0.277	0.365	0.00	1.00
W Alaska	7,504	6,246-8,833	0.233	0.194	0.274	0.00	1.00
Up/Mid Yukon	450	101-977	0.014	0.003	0.030	0.00	1.00
SW Alaska	750	203-1,430	0.023	0.006	0.044	0.00	1.00
E GOA/PNW	8,671	7,431-9,966	0.269	0.230	0.309	0.00	1.00

Shoreside (PSC = 131,849; n = 1906)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	7,669	6,265-9,181	0.058	0.048	0.070	0.00	1.00
NE Asia	35,665	32,900-38,503	0.271	0.250	0.292	0.00	1.00
W Alaska	33,425	30,445-36,423	0.254	0.231	0.276	0.00	1.00
Up/Mid Yukon	3,483	2,192-5,099	0.026	0.017	0.039	0.00	1.02
SW Alaska	6,301	4,602-8,190	0.048	0.035	0.062	0.00	1.00
E GOA/PNW	45,304	42,330-48,320	0.344	0.321	0.366	0.00	1.00

Age-3 (PSC = 61,888; n = 461)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	8,458	6,551-10,561	0.137	0.106	0.171	0.00	1.00
NE Asia	15,045	12,539-17,704	0.243	0.203	0.286	0.00	1.00
W Alaska	5,453	3,735-7,415	0.088	0.060	0.120	0.00	1.00
Up/Mid Yukon	1,077	213-2,275	0.017	0.003	0.037	0.00	1.00
SW Alaska	1,949	643-3,578	0.032	0.010	0.058	0.00	1.00
E GOA/PNW	29,903	26,935-32,840	0.483	0.435	0.531	0.00	1.00

Age-4 (PSC = 159,122; n = 1181)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	18,162	15,184-21,323	0.114	0.095	0.134	0.00	1.00
NE Asia	51,838	47,288-56,470	0.326	0.297	0.355	0.00	1.00
W Alaska	43,187	38,889-47,569	0.271	0.244	0.299	0.00	1.00
Up/Mid Yukon	1,901	976-3,280	0.012	0.006	0.021	0.00	1.00
SW Alaska	5,597	3,568-7,956	0.035	0.022	0.050	0.00	1.00
E GOA/PNW	38,435	34,346-42,635	0.242	0.216	0.268	0.00	1.00

Age-5 (PSC = 20,974; n = 156)

Region	Est. num.	Est. CI	Mean	2.5%	97.5%	P=0	SF
SE Asia	377	15-992	0.018	0.001	0.047	0.02	1.00
NE Asia	15,018	13,343-16,555	0.716	0.636	0.789	0.00	1.00
W Alaska	3,133	1,913-4,551	0.149	0.091	0.217	0.00	1.00
Up/Mid Yukon	237	19-892	0.011	0.001	0.043	0.00	1.00
SW Alaska	756	124-1,718	0.036	0.006	0.082	0.00	1.00
E GOA/PNW	1,452	695-2,450	0.069	0.033	0.117	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). 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. We re-genotype 3% of all project individuals as quality control measures.

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 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 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.

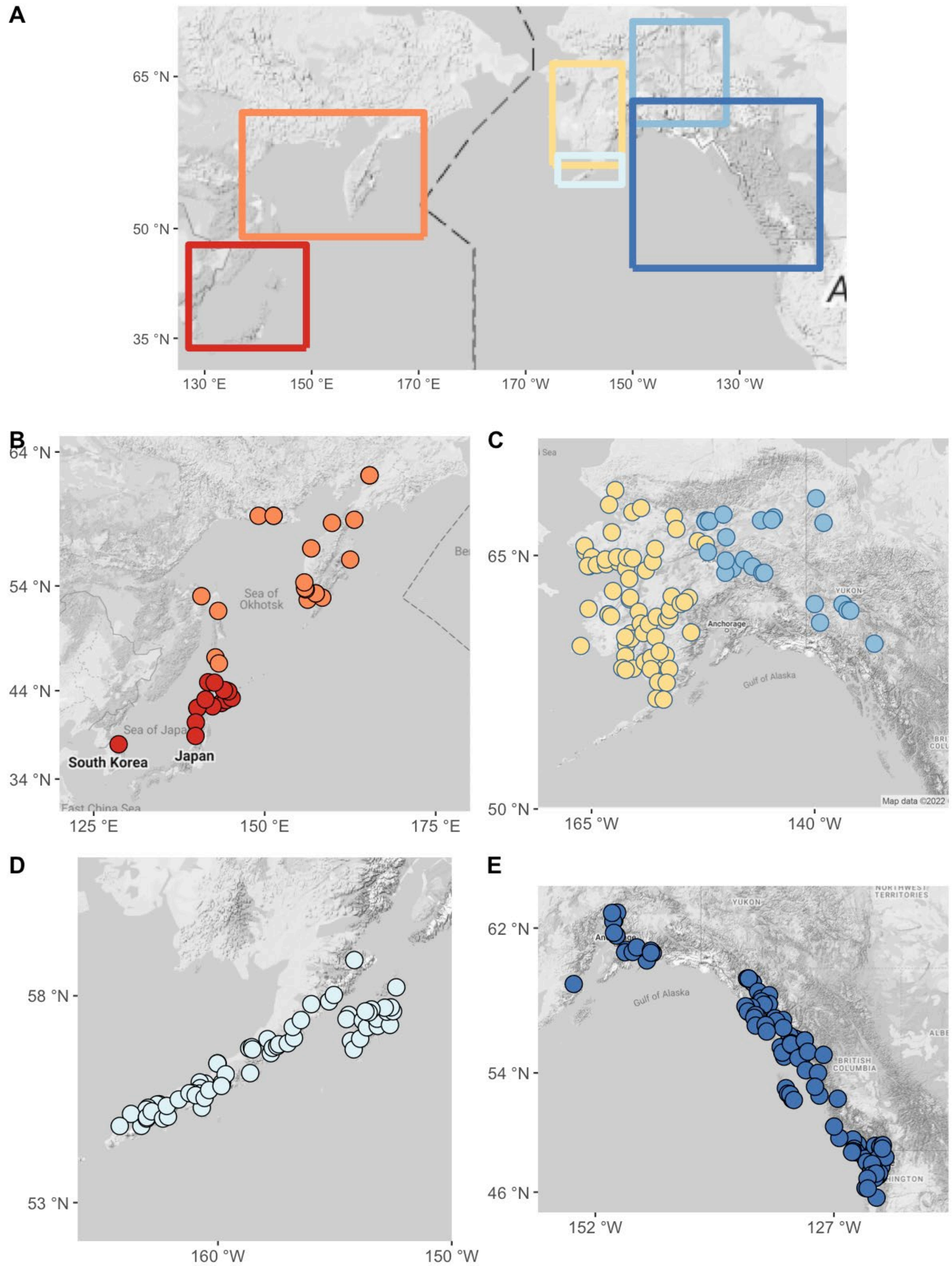

Figure A1: Six reporting groups of baseline chum salmon populations used in this report, circles represent individual populations represented in the baseline. (A) Range wide distribution of the six reporting groups. (B) SE Asia (red) and NE Asia (orange),

(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 A1: Single nucleotide polymorphisms included in the 84-SNP panel used for stock composition analysis for the 2021 Bering Sea, B-season analyses.

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 grouped by six reporting groups used in the analyses of this report.

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Abashiri River	SE Asia	80	Pymta	NE Asia	147
Chitose River - early	SE Asia	80	Tauy	NE Asia	41
Gakko River - early	SE Asia	78	Tym River	NE Asia	53
Kushiro River	SE Asia	79	Udarnitza River	NE Asia	44
Namdae River	SE Asia	90	Vorovskaya	NE Asia	101
Nishibetsu River	SE Asia	79	Agiapuk River	W Alaska	94
Sasanai River	SE Asia	77	Alagnak River	W Alaska	92
Shari River	SE Asia	75	American River	W Alaska	86
Shinzunai River	SE Asia	78	West Fork Andreafsky River	W Alaska	85
Teshio River	SE Asia	80	Andreafsky River - East Fork weir	W Alaska	94
Tokachi River	SE Asia	78	Aniak River	W Alaska	92
Tokoro River	SE Asia	69	Yellow River - Anvik	W Alaska	80
Tokushibetsu River	SE Asia	80	Otter Creek - Anvik	W Alaska	156
Yurappu River - early	SE Asia	80	Big River	W Alaska	94
Yurappu River - late	SE Asia	75	Black River	W Alaska	93
Amur River - summer run	NE Asia	60	Big Creek - Naknek River	W Alaska	69
Bistraya River	NE Asia	66	Chulinak	W Alaska	92
Bolshaya River	NE Asia	93	Clear Creek	W Alaska	94
Hairusova River	NE Asia	85	Eldorado River	W Alaska	89
Kamchatka River	NE Asia	49	Fish River	W Alaska	92
Kanchalan	NE Asia	77	George River	W Alaska	95
Kol River	NE Asia	123	Gisasa River	W Alaska	95
Magadan	NE Asia	77	Goodnews River	W Alaska	137
Naiba	NE Asia	98	Henshaw Creek - early	W Alaska	94
Oklan River	NE Asia	75	Holokuk River	W Alaska	103
Ola River - Hatchery	NE Asia	78	Huslia River, Koyukuk - Set B	W Alaska	95
Ossora	NE Asia	87	Inmachuk River	W Alaska	91
Ozerki Hatchery	NE Asia	93	Iowithla River	W Alaska	95
Palana River	NE Asia	90	Kaltag River	W Alaska	92
Paratunka River	NE Asia	94	Kanektok River weir	W Alaska	94
Penzhina	NE Asia	43	Kasigluk River	W Alaska	55

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Kelly Lake - Noatak River	W Alaska	95	Stony River	W Alaska	150
Kobuk River - at Kiana	W Alaska	95	Stuyahok River	W Alaska	86
Kisaralik River - (Set F)	W Alaska	93	Sunshine Creek	W Alaska	47
Klutuspak Creek	W Alaska	70	Takotna River - 2 mile above Takotna Village	W Alaska	94
Kobuk - Salmon River (Mile 4)	W Alaska	99	Tatlawiksuk River weir	W Alaska	95
Kogrukluk River weir	W Alaska	95	Togiak River	W Alaska	175
Kokwok River	W Alaska	131	Tozitna River	W Alaska	92
Koyuk River	W Alaska	43	Tubutulik River	W Alaska	93
Kwethluk River	W Alaska	143	Tuluksak River Weir	W Alaska	92
Kwiniuk River	W Alaska	94	Unalakleet	W Alaska	188
Mekoryuk River	W Alaska	104	Ungalik River	W Alaska	144
Melozitna River	W Alaska	91	Wandering Creek - tributary of Dog Salmon River	W Alaska	50
Mulchatna River - Upper Nushagak River	W Alaska	91	Whale Mountain Creek, (King Salmon River, Egegik Bay)	W Alaska	189
Necons River	W Alaska	95	Windy Fork Kuskokwim	W Alaska	93
Niukluk River	W Alaska	93	Innoko River (Yukon A)	W Alaska	85
Noatak River - above hatchery	W Alaska	92	American River	SW Alaska	95
Nome River	W Alaska	94	Foster Creek - Balboa Bay	SW Alaska	182
Nulato River	W Alaska	189	Dog Bay	SW Alaska	95
Nunsatuk River - (Set A)	W Alaska	92	Kizhuyak River	SW Alaska	174
Upper Nushagak	W Alaska	97	Peterson Lagoon	SW Alaska	181
Osviak River	W Alaska	88	Uganik River	SW Alaska	175
Pikmiktalik River	W Alaska	95	Alligator Hole	SW Alaska	183
Pilgrim River	W Alaska	75	Main Creek - Amber Bay	SW Alaska	85
Pumice Creek	W Alaska	95	Barling Bay Creek	SW Alaska	92
Salmon River	W Alaska	95	Belkovski River	SW Alaska	87
Selby Slough	W Alaska	90	Big River (Hallo Bay)	SW Alaska	95
South Fork Koyukuk River - Early	W Alaska	90	Big Sukhoi	SW Alaska	189
South Fork Kuskokwim - fall	W Alaska	95	Canoe Bay	SW Alaska	186
Shaktoolik River	W Alaska	94	Chichagof Bay	SW Alaska	180
Snake River	W Alaska	90	Chiginagak Bay River	SW Alaska	159
Solomon River	W Alaska	62	Coal Valley	SW Alaska	94

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Coleman Creek	SW Alaska	95	Russell Creek	SW Alaska	185
Coxcomb Creek	SW Alaska	89	Russian River	SW Alaska	185
Deadman River	SW Alaska	95	Sandy Cove	SW Alaska	186
Deer Valley	SW Alaska	91	Sitkinak Island	SW Alaska	93
Delta Creek (Cold Bay)	SW Alaska	95	Spiridon River - Upper	SW Alaska	89
Dry Bay River	SW Alaska	71	St. Catherine Cove	SW Alaska	171
Eagle Harbor	SW Alaska	94	Big River - Stepovak Bay	SW Alaska	143
Frosty Creek	SW Alaska	190	Stepovak River	SW Alaska	94
Gull Cape Creek	SW Alaska	186	Sturgeon River	SW Alaska	109
Three Hills River	SW Alaska	49	Traders Cove	SW Alaska	76
Ivanof River	SW Alaska	181	Volcano Bay (Cold Bay)	SW Alaska	95
Joshua Green	SW Alaska	92	Bear Bay Creek	SW Alaska	187
Karluk Lagoon	SW Alaska	83	North Fork Creek, Aniakchak River	SW Alaska	94
Kialagvik Creek (Wide Bay)	SW Alaska	177	Alagogshak River	SW Alaska	94
Kitoi Hatchery	SW Alaska	194	Portage Creek	SW Alaska	190
Lawrence Valley Creek	SW Alaska	190	North Fork Creek, Kujulik Bay	SW Alaska	164
Little John Lagoon	SW Alaska	172	Wiggly Creek - Cinder	SW Alaska	177
Meshik River	SW Alaska	78	West Kiliuda Creek	SW Alaska	87
Braided Creek (Meshik River)	SW Alaska	94	Zachary Bay	SW Alaska	76
Moffet Creek	SW Alaska	95	Zachar River	SW Alaska	66
Nakililock River	SW Alaska	95	17 Mile Slough (Nenana) - fall run	Up/Mid Yukon	90
North of Cape Seniavin	SW Alaska	96	Big Creek - Canadian Mainstem (Yukon)	Up/Mid Yukon	100
Northeast Creek	SW Alaska	94	Black River	Up/Mid Yukon	95
Sapsuk River, Nelson Lagoon	SW Alaska	144	Bluff Cabin	Up/Mid Yukon	99
Ocean Bay	SW Alaska	78	Big Salt River	Up/Mid Yukon	69
Pass Creek - Wide Bay	SW Alaska	94	Chandalar River	Up/Mid Yukon	92
Plenty Bear Creek (Meshik River)	SW Alaska	138	Chena River	Up/Mid Yukon	77
NE Portage - Alitak	SW Alaska	94	Delta River - Fairbanks	Up/Mid Yukon	149
Right Hand Moller Bay	SW Alaska	94	Donjek River	Up/Mid Yukon	60
Rough Creek	SW Alaska	77	Fishing Branch	Up/Mid Yukon	90
Ruby's Lagoon (Cold Bay)	SW Alaska	92	Henshaw Creek - late	Up/Mid Yukon	60

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Henshaw Creek - late	Up/Mid Yukon	60	Dosewallips River - summer run	EGOA/PNW	86
Jim River	Up/Mid Yukon	146	Dry Bay Creek	EGOA/PNW	94
Kantishna River	Up/Mid Yukon	94	Ecstall	EGOA/PNW	50
Kluane River	Up/Mid Yukon	114	Elwha River	EGOA/PNW	93
Minto Slough	Up/Mid Yukon	91	Fish Creek - early	EGOA/PNW	131
Old Crow - Porcupine River	Up/Mid Yukon	92	DIPAC Hatchery	EGOA/PNW	281
Pelly River	Up/Mid Yukon	84	Fish Creek - late	EGOA/PNW	49
Salcha River	Up/Mid Yukon	83	Ford Arm Lake - fall	EGOA/PNW	95
South Fork Koyukuk River - Late	Up/Mid Yukon	92	Goldstream River	EGOA/PNW	95
Sheenjek River	Up/Mid Yukon	93	Grays River - fall run	EGOA/PNW	93
Tanana River Mainstem	Up/Mid Yukon	95	Hamma Hamma River - summer	EGOA/PNW	108
Tatchun Creek	Up/Mid Yukon	92	Hamma Hamma River	EGOA/PNW	94
Teslin River	Up/Mid Yukon	92	Harding River	EGOA/PNW	45
Toklat River - Geiger Ck. (Set A) -Mainstream	Up/Mid Yukon	95	Herman Creek - Chilkat River	EGOA/PNW	94
Keta Creek	EGOA/PNW	95	Hidden Falls Hatchery	EGOA/PNW	95
Admiralty Creek	EGOA/PNW	64	Hidden Inlet	EGOA/PNW	82
Aloutte River	EGOA/PNW	95	I-205 Seeps - fall run	EGOA/PNW	72
Bag Harbor	EGOA/PNW	49	Inch Creek	EGOA/PNW	181
Beartrap Creek	EGOA/PNW	582	Jimmy Creek - summer run	EGOA/PNW	92
Big Qualicum River	EGOA/PNW	72	Johns Creek - summer run	EGOA/PNW	92
Big Mission Creek Fall Run	EGOA/PNW	55	Kalama Creek - winter run	EGOA/PNW	54
Carmen Lake	EGOA/PNW	67	Karta River	EGOA/PNW	56
Carroll River	EGOA/PNW	85	Kitasoo Creek	EGOA/PNW	169
Chilkat - mainstem	EGOA/PNW	76	Kitimat River	EGOA/PNW	104
Chunilna River	EGOA/PNW	83	Kitwanga River	EGOA/PNW	74
Constantine Creek	EGOA/PNW	594	Klahini River	EGOA/PNW	50
Conuma River	EGOA/PNW	96	Klehini River - Chilkat River	EGOA/PNW	92
Dewatto River - fall chum	EGOA/PNW	74	Lagoon Creek - fall run	EGOA/PNW	166
Diru Creek - Tribal Hatchery	EGOA/PNW	45	Little Creek - fall run	EGOA/PNW	92
Disappearance Creek - fall run	EGOA/PNW	162	Lilliwaup River - summer run	EGOA/PNW	45
Disappearance Creek	EGOA/PNW	143	Lilliwaup River - fall run	EGOA/PNW	92

Appendix II Table A2 continued

Population	Reporting Group	Samples	Population	Reporting Group	Samples
Long Bay	EGOA/PNW	159	Sarita River	EGOA/PNW	63
Little Qualicum River	EGOA/PNW	98	Satsop River	EGOA/PNW	95
Lower Skagit River - fall run	EGOA/PNW	91	Sawmill Creek - Berners Bay	EGOA/PNW	95
Little Susitna River weir	EGOA/PNW	95	Sedgewick	EGOA/PNW	50
McNeil River Lagoon	EGOA/PNW	108	Sherwood Creek - fall run	EGOA/PNW	87
Medvejie Hatchery	EGOA/PNW	119	Sherwood Creek - summer run	EGOA/PNW	88
Mill Creek - fall run	EGOA/PNW	80	Sisters Lake	EGOA/PNW	86
Nahmint River	EGOA/PNW	95	Siwash Creek	EGOA/PNW	362
Nakat Inlet - summer	EGOA/PNW	95	Skamokawa Creek - fall run	EGOA/PNW	76
Nakwasina River	EGOA/PNW	93	Skykomish River - fall run	EGOA/PNW	87
North Arm Creek	EGOA/PNW	97	Snootli Creek	EGOA/PNW	190
North Creek - fall run	EGOA/PNW	93	Snoqualmie River	EGOA/PNW	84
Neets Bay - fall	EGOA/PNW	95	Sooke River	EGOA/PNW	50
Neets Bay - Summer	EGOA/PNW	145	Spink Creek	EGOA/PNW	44
Nimpkish River	EGOA/PNW	187	Stagoo	EGOA/PNW	49
Nisqually River Hatchery	EGOA/PNW	94	Sugsaw River	EGOA/PNW	60
Nitinat River	EGOA/PNW	113	Surprise	EGOA/PNW	50
Norrish Creek	EGOA/PNW	91	Susitna River (Slough 11)	EGOA/PNW	94
Pallant Creek	EGOA/PNW	209	Swan Cove Creek	EGOA/PNW	88
Prospect Creek	EGOA/PNW	89	Taku River - fall	EGOA/PNW	93
Puntledge River	EGOA/PNW	99	Talkeetna River	EGOA/PNW	50
Olsen Creek (PWS) - Set A	EGOA/PNW	94	Traitors Cove Creek	EGOA/PNW	91
Quilcene - summer run	EGOA/PNW	63	Union River - summer	EGOA/PNW	109
Ralph’s Creek	EGOA/PNW	95	Upper Sauk River - fall run	EGOA/PNW	86
Saginaw Creek	EGOA/PNW	41	West Arm Creek	EGOA/PNW	186
Salmon Creek - summer run	EGOA/PNW	82	West Crawfish	EGOA/PNW	92
Salmon River	EGOA/PNW	47	Weaver Creek	EGOA/PNW	96
Saltery Bay	EGOA/PNW	48	Wells River	EGOA/PNW	597
Sample Creek	EGOA/PNW	74	Wells Bridge	EGOA/PNW	46
Sanborn Creek	EGOA/PNW	94	Wally Noerenberg Hatchery	EGOA/PNW	385
Saook Bay	EGOA/PNW	94	Willow Creek	EGOA/PNW	89