NOAA Technical Memorandum NMFS-AFSC-454

Genetic Stock Composition Analysis of Chum Salmon from the Prohibited Species Catch of the 2021 Bering Sea Walleye Pollock Trawl Fishery

P. D. Barry, C. M. Kondzela, J. A. Whittle, J. T. Watson, K. Karpan, K. D'Amelio, and W. A. Larson

November 2022

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

The National Marine Fisheries Service's Alaska Fisheries Science Center uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

The NMFS-AFSC Technical Memorandum series of the Alaska Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest Fisheries Center. The NMFS-NWFSC series is currently used by the Northwest Fisheries Science Center.

This document should be cited as follows:

Barry, P. D., C. M. Kondzela, J. A. Whittle, J. T. Watson, K. Karpan, K. D'Amelio, and W. A. Larson. 2022. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2021 Bering Sea walleye pollock trawl fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-454, 50 p.

This document is available online at:

Document available: https://repository.library.noaa.gov

Genetic Stock Composition Analysis of Chum Salmon from the Prohibited Species Catch of the 2021 Bering Sea Walleye Pollock Trawl Fishery

P. D. Barry, C. M. Kondzela, J. A. Whittle, J. T. Watson, K. Karpan, K. D'Amelio, and W. A. Larson

Auke Bay Laboratories
Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
17109 Lena Point Loop Road
Juneau, AK 99801

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center

NOAA Technical Memorandum NOAA-TM-AFSC-454

November 2022

ABSTRACT

We analyzed genetic stock compositions of chum salmon (*Oncorhynchus keta*) prohibited species catch (PSC), referred to as "bycatch", samples collected from the 2021 walleye pollock (*Gadus chalcogrammus*) trawl 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 was 546,043 fish, the second highest bycatch number since 1991 and considerably higher than the 10-year average of 257,023. Despite the large incidence of chum salmon bycatch early in the year and relatively close to the Alaska Peninsula where higher proportions of coastal western Alaska fish are expected, the combined proportion of Western Alaska and Upper/Middle Yukon fish was 9.4%, which was similar to the proportion in 2020, but substantially less than the recent (10-year) long-term average of 20%. The total number of Western Alaska and Upper/Middle Yukon chum salmon caught as PSC in the Bering Sea B-season in 2021 was estimated to be 51,510 fish. Despite the large total PSC in 2021, the number of Western Alaska fish caught is similar to the long-term average of 49,290 from 2011 to 2020. We hypothesize that the relatively low proportion of Western Alaska fish reflects their recent low run sizes but cannot rule out other factors such as fleet behavior or differences in chum salmon distribution. Fish from Asia were by far the most numerous stocks in our bycatch samples (68%), with Northeast Asia contributing 55.7% and Southeast Asia contributing 11.9%. The Eastern Gulf of Alaska/Pacific Northwest (EGOA/PNW) stock contribution (20%) was down substantially from the high proportion observed in 2020 (42.5%). Over the last 11 years the relative contributions of Northeast Asia and EGOA/PNW stocks were negatively correlated (r = -0.86) with large proportions from Asia coinciding with small proportions from the EGOA/PNW and vice versa. Stock estimates on finer-scale spatial and temporal strata were generally consistent with prior observations.

CONTENTS

INTRODUCTION

Pacific salmon (*Oncorhynchus* spp.) are prohibited species in the federally managed Bering Sea and Gulf of Alaska (GOA) groundfish fisheries, which are subject to complex management rules (NPFMC 2020a, b) that are in part designed to reduce prohibited species catch (PSC). It is important to understand the stock composition of Pacific salmon caught in these fisheries, which take place in areas that are known feeding habitat for multiple brood years of chum salmon (*O. keta*) from many different localities in North America and Asia (Myers et al. 2007, Davis et al. 2009, Urawa et al. 2009). Determining the geographic origin of salmon caught in federally managed fisheries is essential for understanding the effects that fishing has on chum salmon stocks, especially those with conservation concerns (NPFMC 2012).

We present the genetic stock composition estimates for the samples of chum salmon PSC collected during 2021 from the U.S. Bering Sea walleye pollock (*Gadus chalcogrammus*) trawl fishery. In 2021, the Bering Sea pollock fishery accounted for 99% of the total chum salmon taken in the groundfish fisheries (NMFS 2022a). The samples collected from the 2021 GOA groundfish fisheries were not analyzed due to restricted access to the laboratory during the COVID-19 pandemic.

For additional background and methods, this report is intended to be supplemented with the chum salmon reports prepared previously for the 2005-2020 Bering Sea trawl fisheries (Barry et al. 2022; Gray et al. 2010, 2011a, b; Guyon et al. 2010; Kondzela et al. 2012, 2013, 2016, 2017, 2021; Marvin et al. 2011; Vulstek et al. 2014; Whittle et al. 2015, 2018, 2021a, b). The chum salmon PSC is designated as non-Chinook (*O. tshawytscha*) in the NMFS database and comprises over 95% of the non-Chinook category in the Bering Sea (NPFMC 2007).

METHODS

Bycatch Sampling and Genotyping

Data from the Alaska Fisheries Science Center (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 (NMFS 2022b). The Auke Bay Laboratories (ABL) Genetics Program received 16,371 genetic samples from the Bering Sea and 244 samples from the Gulf of Alaska (GOA) that were collected by the Observer Program in 2021. 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 Eastern Gulf of Alaska/Pacific Northwest (EGOA/PNW) stocks.

Biases and errors associated with non-systematic collections of genetic samples from the salmon bycatch have the potential to affect stock composition estimates (NMFS 2009, Pella and Geiger 2009). Since 2011, the bycatch in the Bering Sea has been sampled with a systematic sampling protocol (Pella and Geiger 2009) to reduce sampling error and bias. We evaluated the sampling proportions by plotting the bycatch by statistical week and NMFS statistical area and using a Chi-square test where statistical weeks were pooled if the expected number of genetic samples was fewer than five.

After inventorying the genetic samples received, a 1-in-5 subsample was conducted for genotyping. DNA from 4,069 genetic samples, 25.0% 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 A Table A-1). The subsample exceeded the target of 20% (1-in-5 subsample) in order to obtain adequate sample sizes for smaller spatiotemporal strata (e.g., Cluster 4 Late). Samples that were not genotyped for greater than 80% of the GT-Seq panel (minimum of 68 loci) were omitted from analyses. Of the 4,069 samples amplified, 3,534 (86.3%) were of adequate quality to include for stock composition analyses (21.6% of the total sample collection).

We re-amplified and genotyped 3% of the subset samples for quality control. The allele calls of these quality control samples were compared with the allele calls 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 (98%), indicating high genotyping accuracy and correct sample organization.

Mixed Stock Analysis

Sequencing libraries were prepared using the Genotyping-in-Thousands by Sequencing (GT-seq) protocol (Campbell et al. 2015). Polymerase chain reaction (PCR) was performed on extracted DNA with primers that amplify 84 SNP loci in the WASSIP chum panel (DeCovich et al. 2012; Appendix A Table A-1). The PCR products were then indexed in a barcoding PCR, normalized with SequalPrep™ plates and each 96-well plate subsequently pooled. Next, a double-sided bead size selection was performed using AMPure XP beads (Beckman Coulter) in ratios of 0.5× beads-to-library to remove larger non-target fragments and then 1.2× to retain the desired amplicon. Libraries were sequenced on a MiSeq™ System (Illumina) using a single 150-cycle lane run with 2 × 75 bp paired-end chemistry. Paired-end reads for each individual were joined with FLASH2 (Magoč and Salzberg 2011; https://github.com/dstreett/FLASH2). Merged reads were genotyped with the R package GTscore (McKinney; https://github.com/gjmckinney/GTscore). Individuals with low quality multi-locus genotypes (< 80% of loci scored) were discarded.

Mixtures of genotypes were created by separating sampled fish into spatial and temporal strata from Observer Program data in the AKFIN database. Genetic stock identification was performed with the conditional genetic stock identification model in the R package rubias (Moran and Anderson 2019). Mixture genotypes were compared to the WASSIP baseline (DeCovich et al. 2012; Fig. 1, Appendix B Table B-1) in which populations were grouped into regions that were consistent with prior analyses based on the Fisheries and Oceans Canada chum salmon microsatellite baseline (Beacham et al. 2009a, b). As described previously (Gray et al. 2010) and 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 Gulf of Alaska/Pacific Northwest (EGOA/PNW; Fig. 1; Appendix B Table B-1). 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. Each chain was started at disparate values of stock proportions and configured such that for each chain 95% of the stocks came from a single region (with probability equally distributed among the populations within that region) and the remaining 5% equally distributed among remaining stocks from all other regions. The convergence of chains for each region was assessed with the Gelman-Rubin statistic (Gelman and Rubin 1992) estimated with the gelman.diag function in the coda library (Plummer et al. 2006) within R. Once chain convergence was confirmed, inference was conducted with the conditional genetic stock identification model with bootstrapping over regions (MCMC chains of 100,000 iterations, burn-in of 50,000, 100 bootstrap iterations).

The stock composition estimates were summarized by the mean, 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.

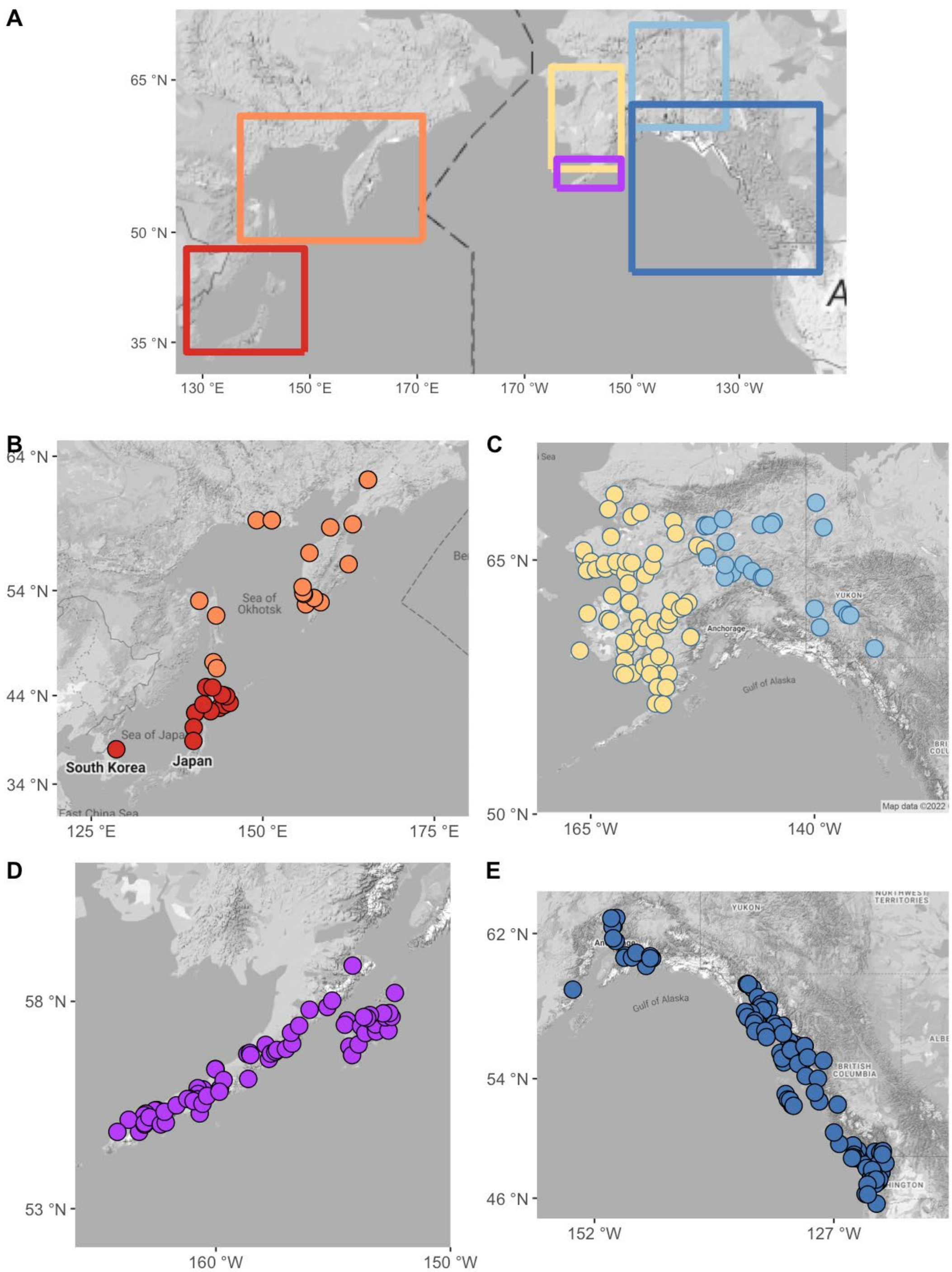

Figure 1. -- Six regional groups of baseline chum salmon populations used in this report, circles represent individual populations in the baseline. (A) Range wide distribution of the six regions, (B) SE Asia (red) and NE Asia (orange), (C) W Alaska (yellow) and Up/Mid Yukon (medium blue), (D) SW Alaska (purple), and (E) EGOA/PNW (dark blue). For a complete list of populations within each region see Appendix B Table B-1.

SAMPLING DISTRIBUTION

Genetic sampling among statistical weeks and NMFS statistical areas was representative of the overall bycatch (χ^2 = 728, df = 676, p = 0.08), yet there was some evidence of under-sampling. In NMFS area 509 during week 29 the sampling proportion (0.21) deviated from the goal of 1-in-30 (Fig. 2). Of the 43 observers that sampled hauls/offloads from NMFS area 509 during week 29, 3 observers accounted for all hauls, 21 in total, where the discrepancy between the observed and expected number of genetic samples differed by more than 10 fish. In all but one case the number of genetic samples collected was 0. Examination of the sampling rate of each of these three observers for weeks prior, suggests that an exhaustion of sampling supplies may explain under-sampling issues. When evaluated on a per vessel basis, the correlation between the number of genetic samples collected followed the 1-in-30 Observer Program sampling protocol (*r* = 0.97; AFSC 2020); however, the bycatch from nine vessels were underrepresented by greater than 100 genetic samples. The bias introduced from under-sampling in space and time appears to be minimal suggesting that the genetic samples taken were representative of the overall bycatch.

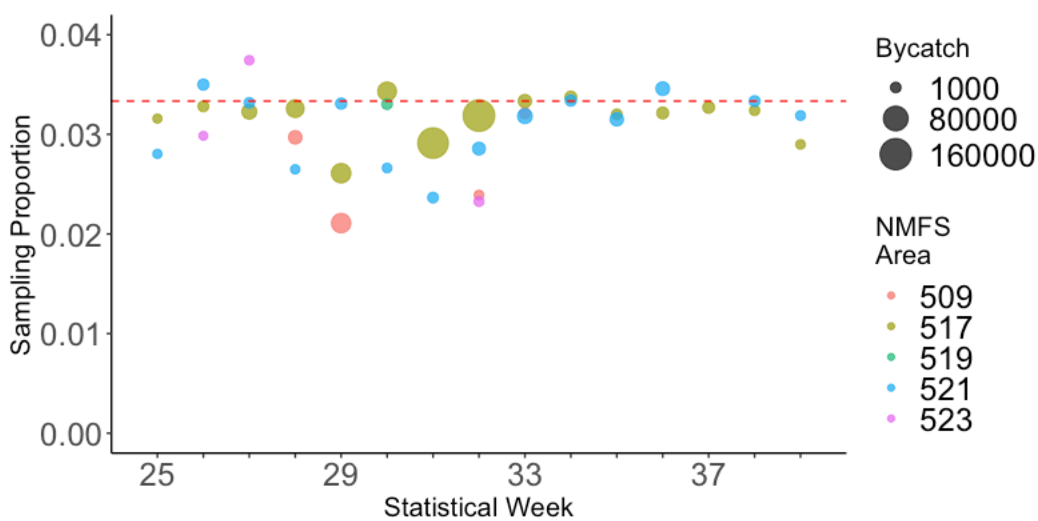

Figure 2. -- Sampling proportion of chum salmon prohibited species catch for the B-season from the 2021 Bering Sea pollock trawl fishery by statistical week and NMFS areas. The mean sampling proportion (0.031) is slightly less than the 1-in-30 sampling protocol (dashed red horizontal line).

BYCATCH 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 546,043 fish in 2021, with 545,883 from the B-season (NMFS 2022a; Fig. 3). This was 273,603 fish more than the 10-year average of 257,023 (SD 126,526). As is typical, over 99% of the bycatch of chum salmon occurred in the B-season (between June and October).

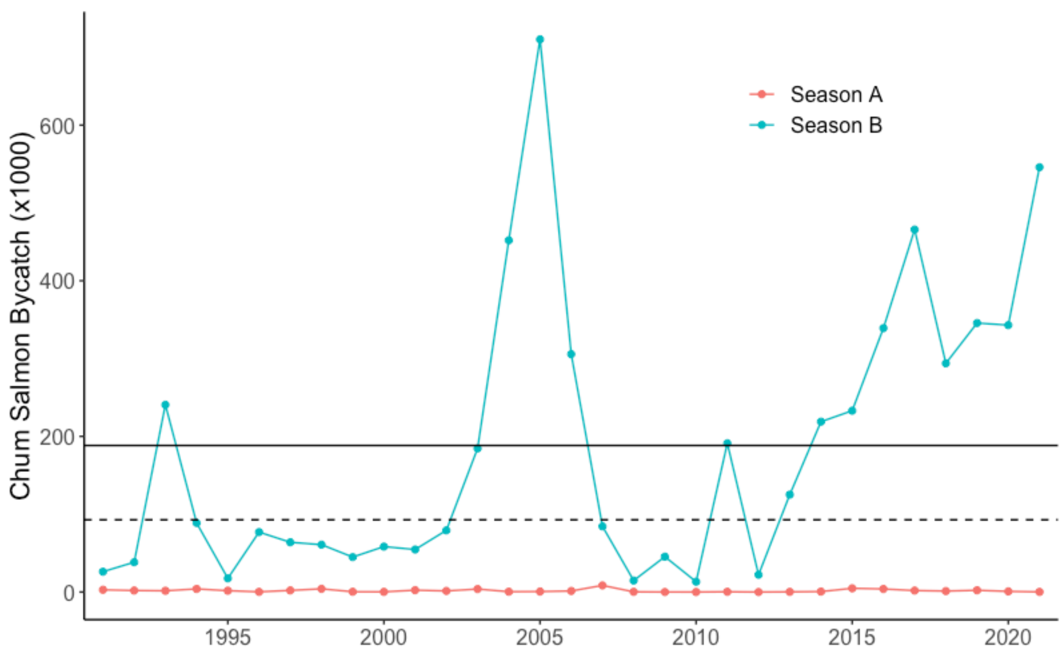

Figure 3. -- Chum salmon prohibited species catch (PSC) for the A- and B-seasons from the Bering Sea pollock trawl fishery. The solid horizontal line represents the mean PSC and the dashed line represents the median PSC from 1991 to 2020.

Within the B-season, the chum salmon bycatch was bimodally distributed with peaks occurring in weeks 29 and 32 (Fig. 4, top panel). Overall, the timing of the bycatch fell between the early catches in 2017 and 2018 and the later catch in 2020 (Fig. 4, bottom panel).

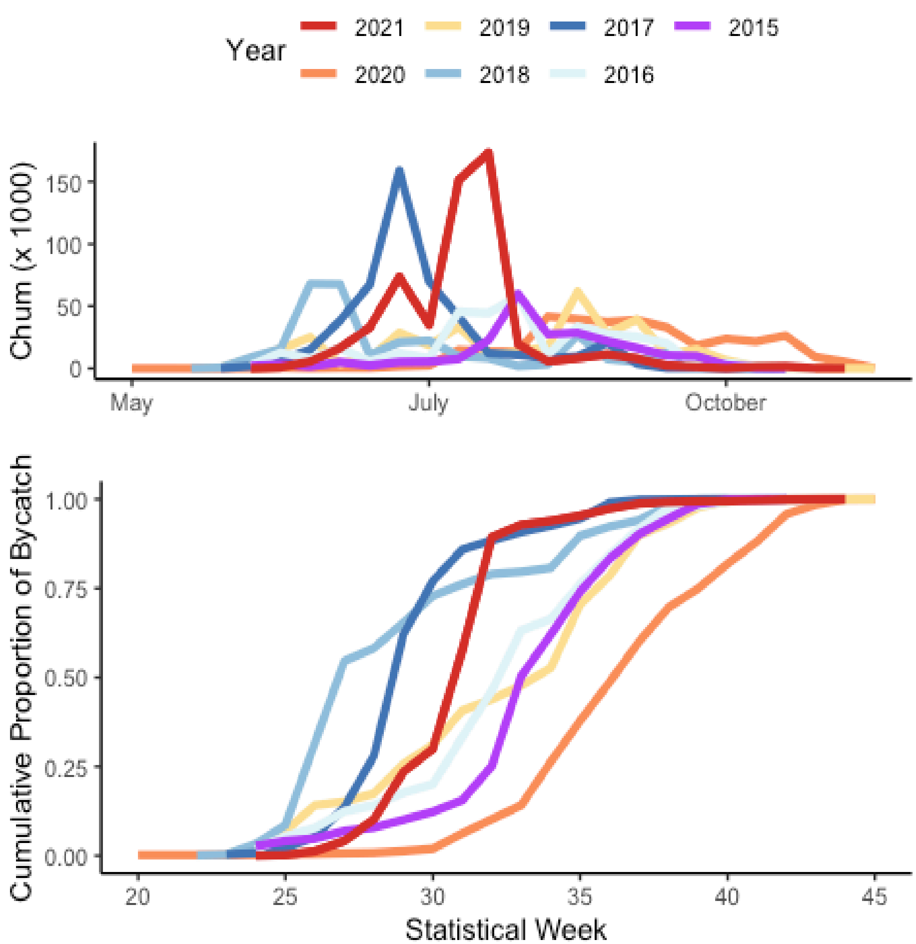

Figure 4. -- Number of chum salmon caught during the B-season (top) and cumulative proportion of chum salmon catch (bottom) from the Bering Sea pollock trawl fishery by statistical week for years 2016 to 2021.

Spatial Trends

The geographical distribution of the chum salmon bycatch was concentrated closer to the Alaska Peninsula in 2021 relative to prior years (Fig. 5). Of the spatial clusters previously defined by the AFSC-ABL Genetics Program (Appendix C Table C-1), most of the bycatch occurred in clusters 1 and 2, with the highest bycatch from Alaska Department of Fish and Game (ADF&G) groundfish statistical area 685530.

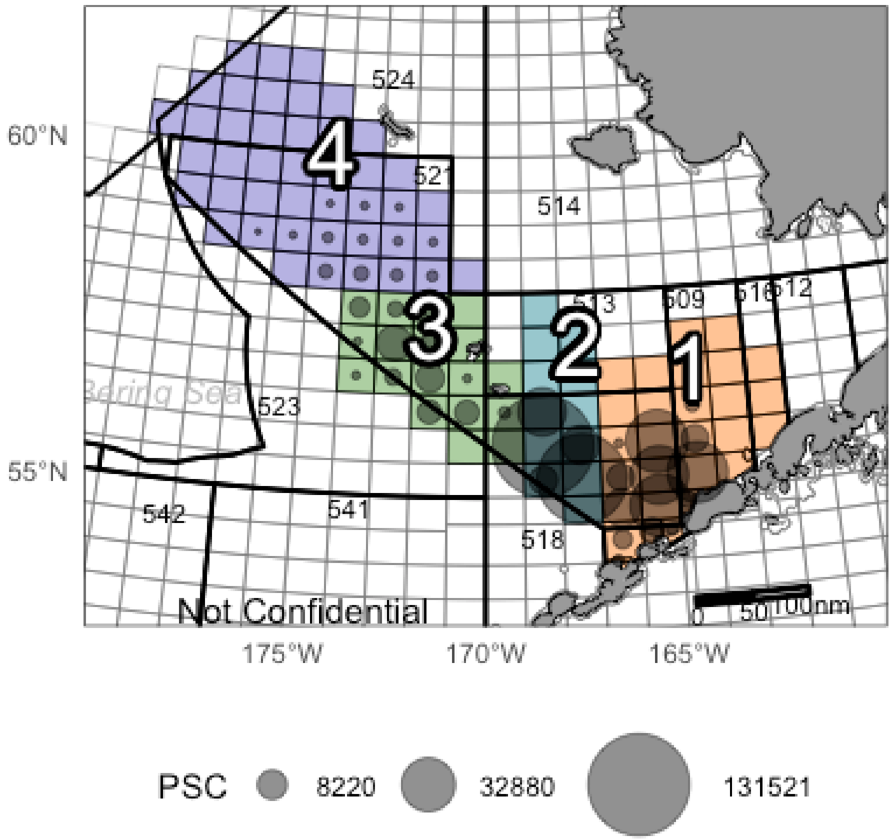

Figure 5. -- Spatial distribution of chum salmon bycatch caught in the 2021 Bering Sea B-season pollock fishery. ADF&G groundfish statistical areas are highlighted based on the four geographic strata assigned in prior genetic analyses. For a complete list of ADF&G statistical areas included in each cluster see Appendix C Table C-1.

To evaluate shifts in the distribution of the chum salmon bycatch, the centroid (center of the bycatch) was calculated for each year by fishing sector: catcher-processor (CP), mothership (M), and shoreside (S). The spatial arrangement of the centroid was investigated for associations with sea surface temperature (not shown) and sea ice extent anomaly. The centroid of the 2021 chum salmon bycatch for the catcher-processor sector was the most eastern of the time series (2011-2021; Fig. 6, CP). It also appears that in years with more sea ice (less negative sea ice extent anomalies), the centroid of the catcher-processor sector is farther west than in years with less sea ice (more negative sea ice extent anomalies). Similar to the catcher-processor sector, the 2021 centroid for the mothership sector was closer to the Alaska Peninsula than typical (Fig. 6, M) and was similar to years 2016 and 2017. The distribution of the shoreside sector centroids is much more concentrated than the catcher-processor and mothership sectors and may be influenced less by sea ice extent and sea surface temperature than the more mobile fishing sectors.

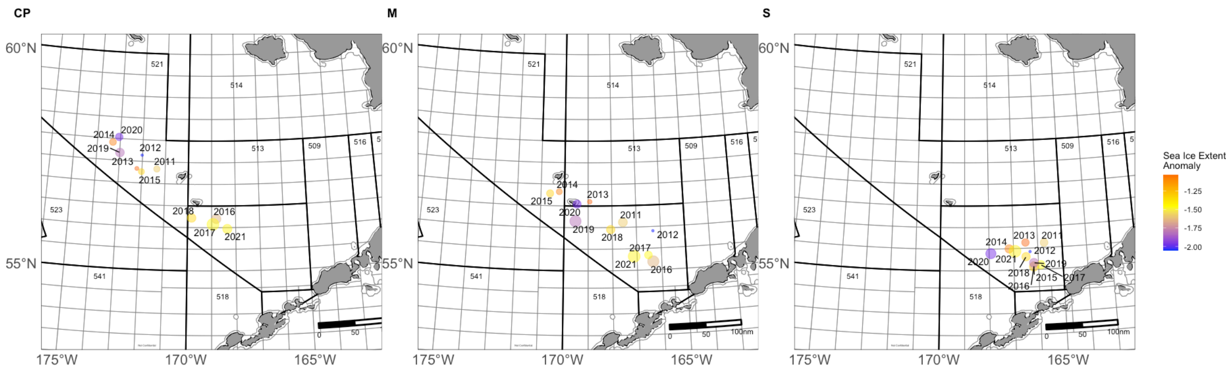

Figure 6. -- Change in the spatial distribution of chum salmon bycatch as measured by the centroid of the bycatch by sector; catcher-processor (CP), mothership (M), and shoreside (S). Point sizes reflect the relative size of the bycatch and point colors reflect the sea ice extent anomaly between June and September.

GENETIC STOCK COMPOSITION

Overall Trends

Western Alaska stocks comprised 8.9% of the bycatch which is similar to the contribution in 2020 and less than the long-term average from 2011 to 2020 of 15.7% (Table 1, Fig. 7). SW Alaska and the Up/Mid Yukon stocks also comprised relatively minor portions of the bycatch, 2.4% and 0.5%, respectively. Consistent with prior years, Asian stocks comprised a substantial fraction (67.5%) of the chum salmon bycatch in 2021. Of the chum salmon bycatch in the B-season, the contribution from the NE Asia stocks (55.7%) was the highest since systematic sampling of the bycatch was undertaken in 2011 (Fig. 7). The EGOA/PNW stocks accounted for (20.6%) of the bycatch, which is substantially less than the composition in 2020 (43%) and slightly less than the long-term average of 27.5% (Fig. 7).

There is a cyclical pattern of contribution between the NE Asia and EGOA/PNW stocks (Fig. 7) with a negative correlation (Fig. 8; $r = -0.86$, $p < 0.001$). Additionally, these 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. The recent, large declines in run size of western Alaska chum salmon (JTC 2022) may have led in part to a relative increase in the proportion of the NE Asia and EGOA/PNW stocks; however, there is also some evidence that the NE Asia run sizes are increasing (Ruggerone and Irvine 2018).

Table 1. -- Regional stock composition estimates of chum salmon from the 2021 Bering Sea B-season pollock fishery (PSC = 545,883; n = 3,534 samples). The estimated number of chum salmon bycatch and credible interval, and mean proportion are provided with 95% credible intervals, median estimate, *P* = 0 statistic, and the Gelman-Rubin shrink factor (SF).

B-season (PSC = 545,883; n = 3,534)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	64,692	58,644-70,934	0.119	0.107	0.118	0.130	0.00	1.00
NE Asia	303,892	294,418-313,399	0.557	0.539	0.557	0.574	0.00	1.00
W Alaska	48,656	43,208-54,367	0.089	0.079	0.089	0.100	0.00	1.00
Up/Mid Yukon	2,854	1,324-4,778	0.005	0.002	0.005	0.009	0.00	1.00
SW Alaska	13,175	9,225-17,521	0.024	0.017	0.024	0.032	0.00	1.00
E GOA/PNW	112,611	105,032-120,388	0.206	0.192	0.206	0.221	0.00	1.00

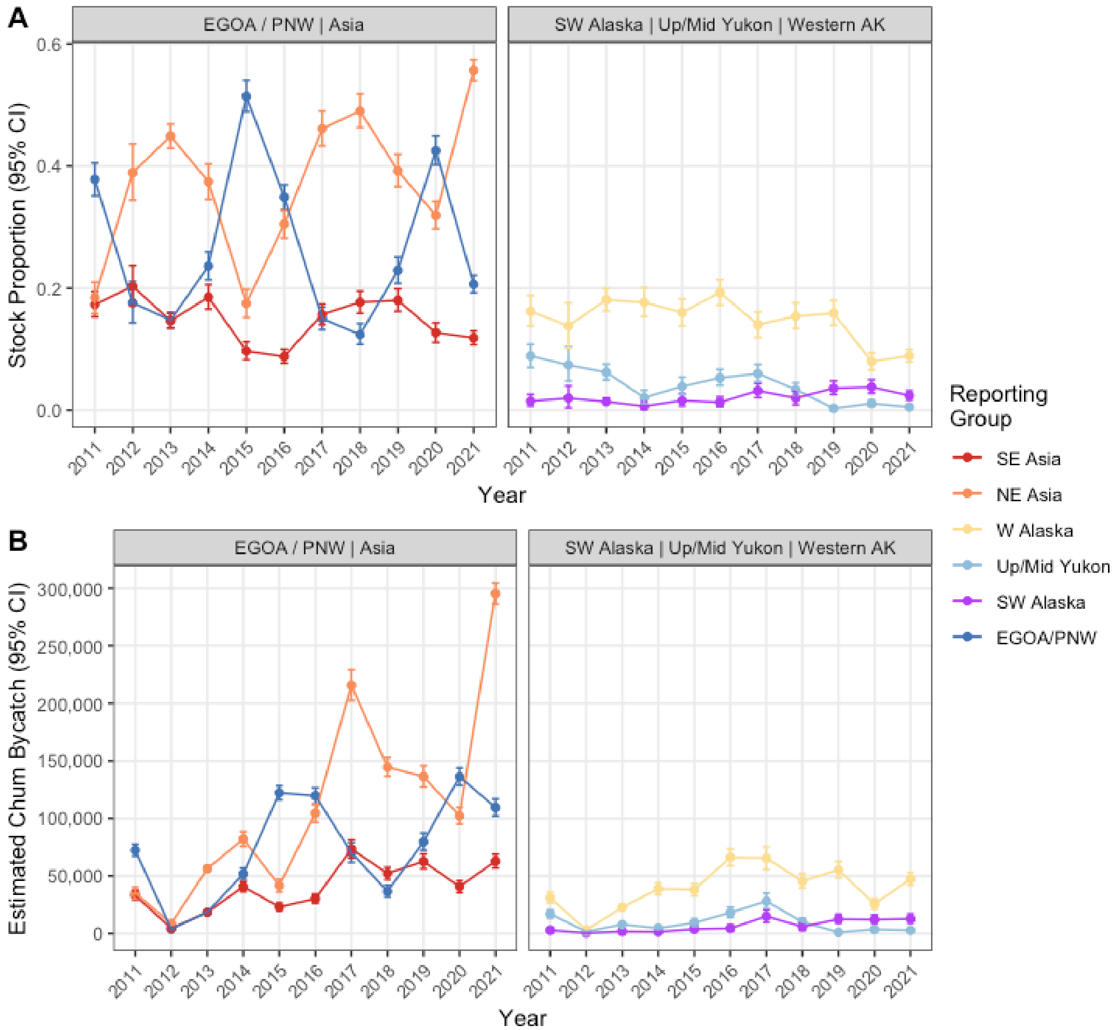

Figure 7. -- Annual bycatch estimates of B-season chum salmon bycatch from 2011 to 2021; (A) stock proportions with 95% credible intervals and (B) estimated number of chum salmon with 95% credible intervals.

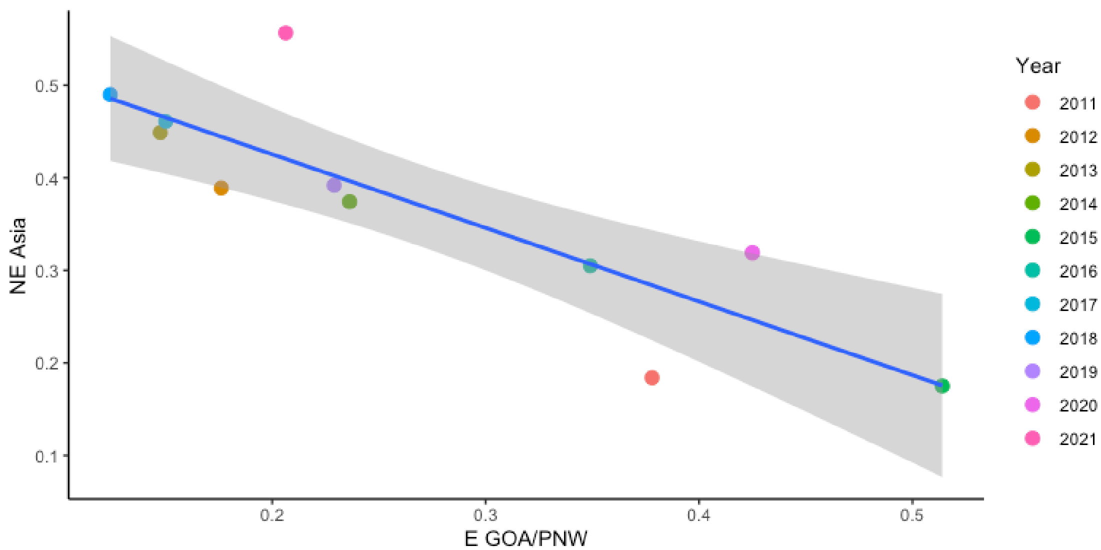

Figure 8. -- Correlation between NE Asia and EGOA/PNW stock proportions of chum salmon bycatch from the Bering Sea B-season pollock trawl fishery from 2011 to 2021 (r = - 0.86).

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 stock contributions changed through the season. The catch composition changed among the time periods for some stocks (Fig. 9). The EGOA/PNW stocks increased from 21.0% and 19.4% in the Early and Middle time periods, respectively, to 29.6% in the Late time period. Since 2011, the average contribution of GOA/PNW stocks has increased from 16.1% in the Early period to 24.7% and 34.8% in the Middle and Late periods, respectively. The contribution of the NE Asia stocks peaked in the Middle time period, increasing from 50.1% in the Early time period to 58.4% in the Middle time period, and declined to 43.7% in the Late time period. The Western Alaska stocks had no significant temporal pattern; however, historically Western Alaska stocks have contributed more to early catches. Since 2011, the average contribution of the Western Alaska stocks decreased from 19.2% to 17.8% and 12.6% in the Early, Middle, and Late time periods, respectively. The Up/Mid Yukon increased from 1.5% to 3.2% between the Early and Late time periods, however the credible intervals overlap. This was in contrast to the long-term historic pattern in which the Up/Mid Yukon stocks have, on average, contributed more to early catches. Between 2011 and 2020, the average contribution of the Up/Mid Yukon stocks decreased from 6.0% to 3.0% and

3.7% in the Early, Middle, and Late time periods, respectively. Contributions from SW Alaska stocks generally decrease over the season, and this was consistent in 2021. The SW Alaska stocks contributed 5.1% in the Early time period and decreased to 0.5% in the Late time period. From 2011 to 2020 the long-term average for the Early period was 2.5% and the Late time period was 1.8%.

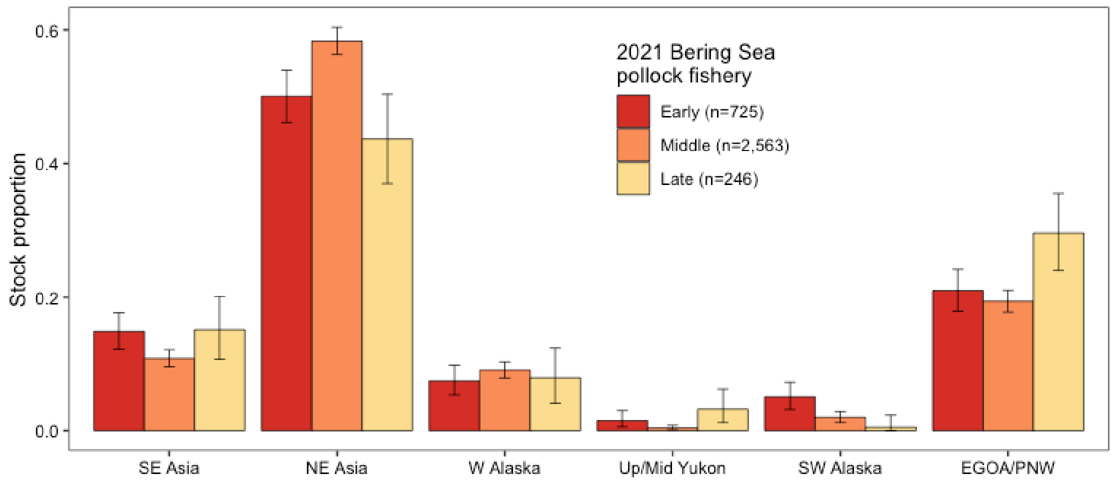

Figure 9. -- Stock composition estimates and 95% credible intervals for the chum salmon bycatch from the Early, Middle, and Late time periods of the 2021 Bering Sea B-season pollock fishery.

Spatial Trends

Analyses in which the bycatch has been divided into mixtures based on longitude, with 170°Was the dividing line, have historically shown that the relative contributions of the Western Alaska, Up/Mid Yukon, SW Alaska, and EGOA/PNW stocks generally increase in the southeastern portion of the Bering Sea, closer to the Alaska Peninsula. In 2021, this was true for the point estimates of the Western Alaska, SW Alaska, and EGOA/PNW stocks, although the 95% credible intervals overlapped substantially (Fig. 10). Uncharacteristically, the contribution of Up/Mid Yukon stocks was higher from bycatch west of 170°W (2.6%) than east of 170°W (0.3%), a pattern also observed in 2013 (9.2% west and 4.8% east of 170°W). The relative contribution of the Asian stocks, alternatively, are generally larger for mixtures west of 170°W. This was true for the SE Asia stocks, which comprised 20% of the bycatch west of 170°W and

11.1% of the bycatch east of 170°W. The NE Asia stocks contributed slightly more to catches east of 170°W (Fig. 10), although due to the small sample size, the credible interval around the west of 170°W mean estimate was large.

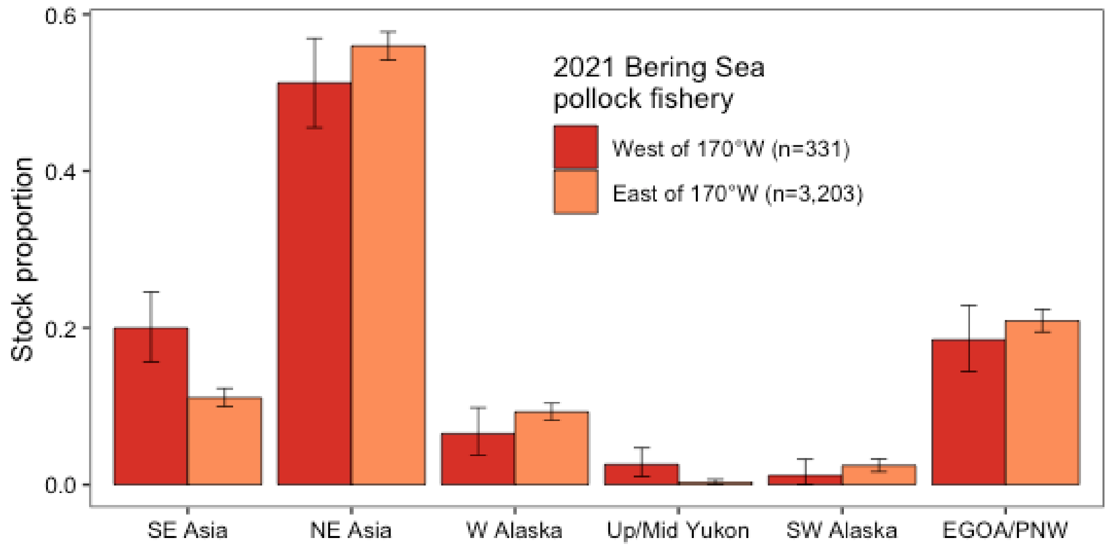

Figure 10. -- Stock composition estimates and 95% credible intervals for the chum salmon bycatch from the 2021 Bering Sea B-season pollock fishery from the U.S. waters of the Bering Sea west of 170°W and the southeastern Bering Sea east of 170°W.

Spatiotemporal Trends

The ABL Genetics Program previously separated the Bering Sea into finer-scale spatial strata (4 clusters of ADF&G statistical areas; Appendix C Table C-1; Fig. 5) and temporal strata (Early and Late time periods) to evaluate spatiotemporal stock contributions. Because the bycatch distribution was geographically contracted in 2021, too few samples were available from cluster 4 (Fig. 11) for analyses. Additionally, an insufficient number of samples were available to analyze the Late time period for cluster 2.

Stock composition estimates of chum salmon bycatch from the 2021 spatiotemporal strata were mostly consistent with historic trends. The Asian component primarily decreased from west to east and from Early to Late (Fig. 11, left panels). The Western Alaska contribution was similar across spatial clusters in the Early time period, but had a higher mean estimated proportion in cluster 1 than cluster 3 in the Late time period, albeit with overlapping credible intervals. The EGOA/PNW stock increased from Early to Late and west to east with the largest contribution in cluster 1, which is nearest to the Alaska Peninsula (Fig. 11, right panel).

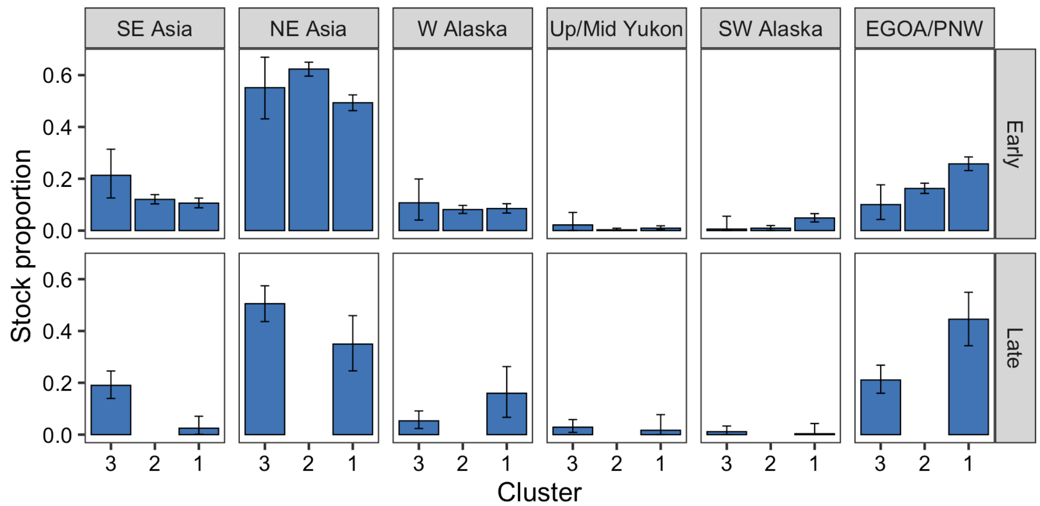

Figure 11. -- Stock composition estimates for the chum salmon collected from four spatial clusters along the continental shelf edge during Early (Weeks 24-32) and Late (Weeks 33-43) time periods of the 2021 Bering Sea B-season pollock fishery. Clusters are ordered from west (cluster 3) to east (cluster 1); see map in Fig. 5 and Appendix C.

Age Trends

The 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. A total of 3,459 chum salmon were aged. Of those, 3,028 had genotypic information and were included in stock composition analyses.

Historically, age-3 chum salmon are dominated by EGOA/PNW stocks, and the age-4 and age-5 chum salmon have been overwhelmingly from NE Asian stocks, a pattern supported by maturation at an earlier age in southern stocks and at a later age in northern stocks (Salo 1991). In 2021, Western Alaska stocks comprised an average of 9.4% of age-3 and age-4 fish, but only 3.6% of age-5 fish. The Up/Mid Yukon stocks had relatively similar representation across age classes (0.8%). The most common age for fish from SW Alaska stocks was age-4, with much less representation in other age classes. SE Asia stocks contributed an equal proportion to age-3 and age-5 fish (19.7%). The EGOA/PNW stocks comprised 41.1% of age-3 fish compared to 11.2% of age-4 fish and 15.1% of age-5 fish. NE Asia stocks comprised 29.2% of age-3 fish, and 67.4% and 59.2% of age-4 and age-5 fish, respectively (Fig. 12). Additional stock estimates for many combinations of age, time, and spatial strata are available in Appendix D.

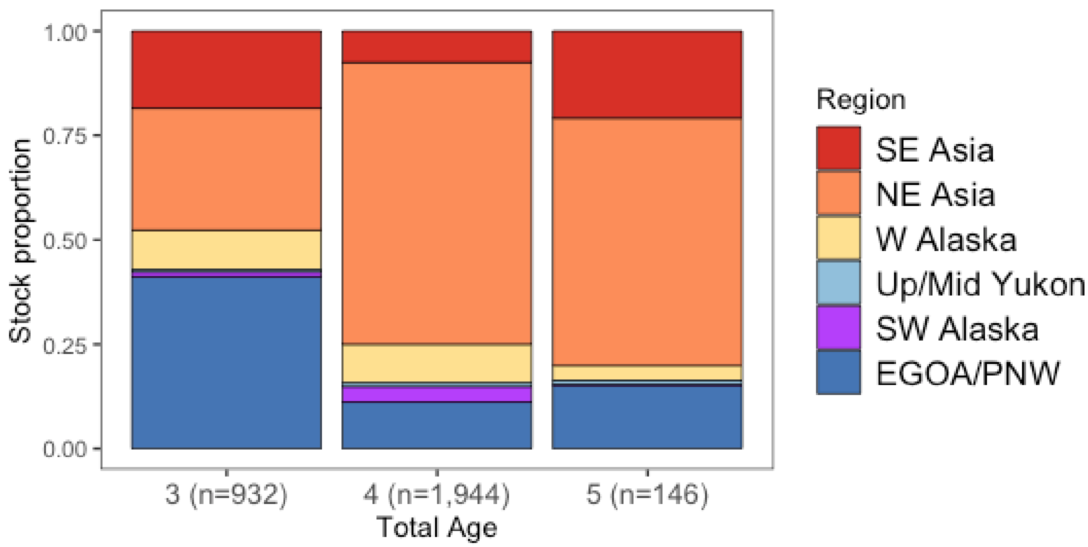

Figure 12. -- Stock composition estimates for the three predominate ages of chum salmon bycatch from the 2021 Bering Sea B-season pollock fishery.

Sector Trends

Stock contributions to the 2021 chum salmon bycatch from each fishing sector were generally consistent with historic patterns. The Alaska stock contributions were low, and within each region, similar by fishing sector (Fig. 13). The NE Asia stocks comprised the majority of the chum salmon bycatch (> 50%) from all three fishing sectors. The three fishing sectors had similar (< 14%) stock contributions from SE Asia stocks because so much of the fishing was centered closer to the Alaska Peninsula for all three sectors in 2021 (compared to 2020). The catcher-processor sector had a lower contribution of EGOA/PNW stocks than the shoreside and mothership sectors.

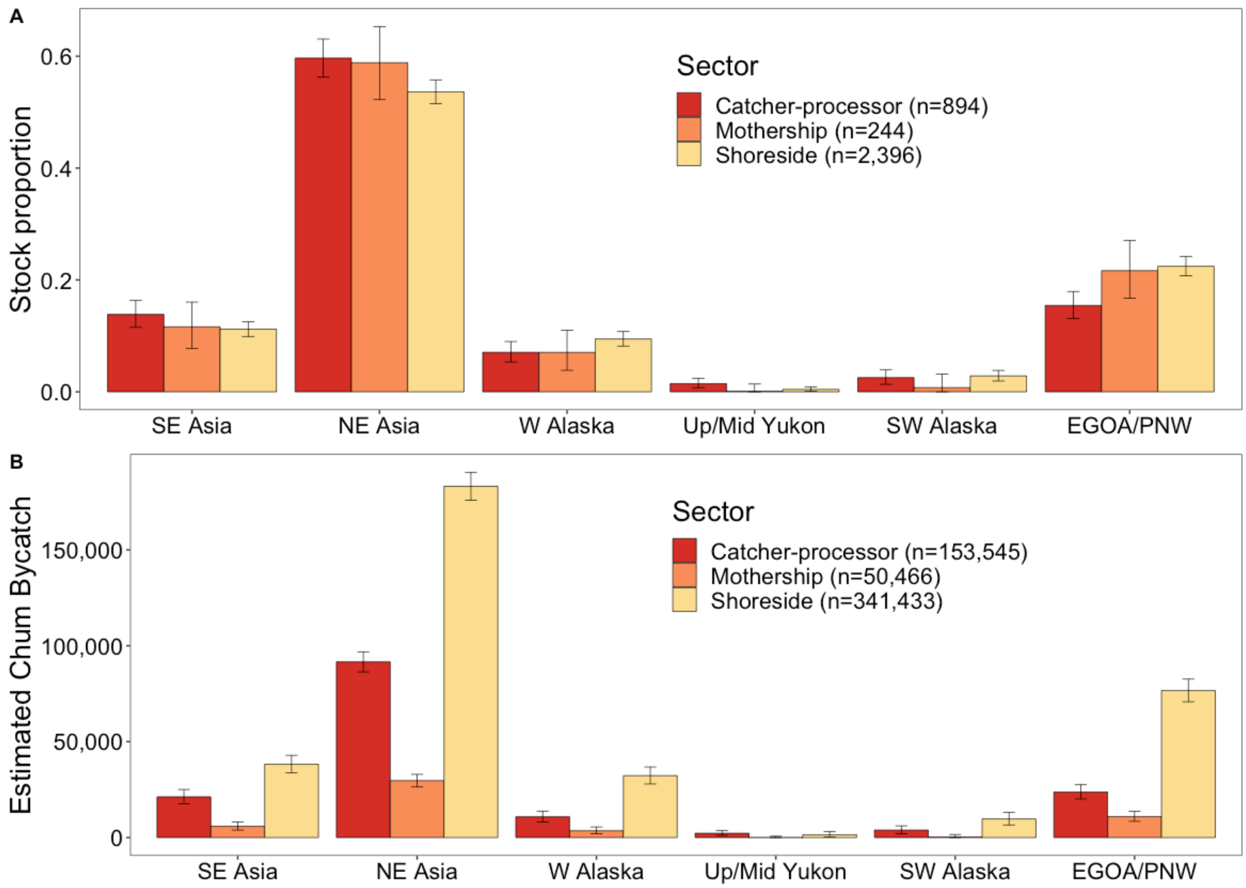

Figure 13. -- Stock composition estimates for chum salmon bycatch from the 2021 Bering Sea B-season pollock fishery from the catcher-processor, shoreside, and mothership fishing sectors. (A) Stock proportions with sample sizes for mixture analysis in the legend. (B) Estimated number of chum salmon with total bycatch for each fishing sector in the legend.

Excluder Device Experimental Trawls

In July of 2021, three experimental trips were conducted with a trawl equipped with a salmon excluder device. Seven hauls were made and 499 chum salmon genetic samples were collected. We conducted mixed stock analysis of samples from each trip, combining all hauls within a trip, as well as from individual hauls with at least 70 genetic samples. These analyses provide insight on whether individual hauls are typically comprised of a single stock group or are mixtures of multiple stocks and more reflective of the bycatch stock composition in a given area and time period. Of the 499 genetic samples collected, 445 were successfully genotyped (89.2%). We analyzed each of the three trips (Cruises 1, 3, and 4), with a single haul in Cruise 1, three hauls in Cruise 3, and three hauls in Cruise 4. The sample sizes from each of the three hauls in Cruise 3 were too small to analyze individually; however, the three hauls in Cruise 4 were large enough to be analyzed individually. The stock composition estimates from these Cruises and individual hauls were compared with the most similar spatial and temporal strata available from analysis of observer collected bycatch samples. Cruise 1 and Cruise 3 hauls were compared with Cluster 1 Early, and Cruise 4 hauls were compared with Cluster 2 Early (Fig. 14).

Stock estimates of chum salmon caught in the 2021 experimental salmon excluder device cruises and individual hauls were generally reflective of the stock estimates of bycatch from larger aggregations of fishery hauls over similar spatial and temporal strata (Appendix D). Cruise 1 and Cruise 3 occurred 5 days apart near the Alaska Peninsula in Cluster 1. Mean stock estimates from Cruise 1 and Cruise 3 and bycatch from Cluster 1 Early were similar with nearly all 95% credible intervals overlapping within each region (Fig. 14, top panel). Cruise 4 occurred farther west than Cruises 1 and 3, within Cluster 2 (see map in Fig. 5). While there was some variation in the mean estimate for each region across hauls, nearly all 95% credible intervals overlapped.

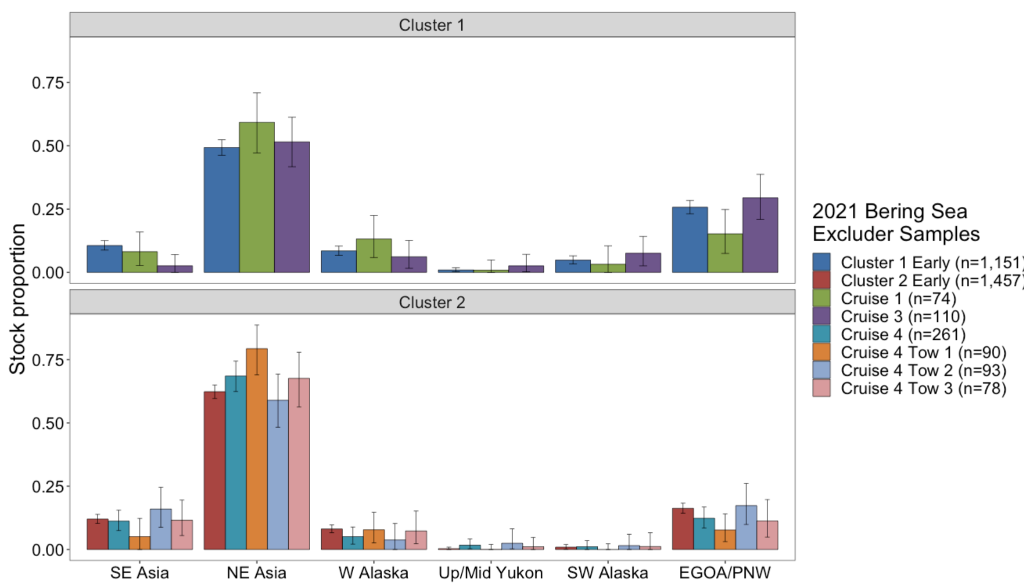

Figure 14. -- Stock composition estimates for chum salmon caught in experimental salmon excluder device cruises from the Bering Sea in 2021. Sample sizes for mixture analysis are given in the legend. Stock composition estimates were compared with results from the most similar bycatch spatial and temporal strata (Cluster 1 and Cluster 2, see map in Fig. 5).

The 2021 results are consistent with analyses of excluder device samples from 2015 in which each haul was a mix of stocks and generally more similar to the overall bycatch samples pooled across larger areas and time periods (Kondzela et al. 2017). The consistency in these patterns both among hauls within a year and between years suggests that stock-specific bycatch avoidance measures likely would not benefit from trying to optimize stock-specific catch rates at the individual haul level.

Summary for Western Alaska, Upper/Middle Yukon, and Southwest Alaska stocks

The 2021 chum salmon bycatch from the Bering Sea was the second highest since 1991, occurred in two pulses during statistical weeks 29 and 32, and was caught predominately in the southeastern portion of the pollock fishing grounds. Despite the pollock fishery proximity to the Alaska Peninsula in 2021, the relative contribution of the Western Alaska, Up/Mid Yukon, and SW Alaska stocks was relatively low, with a combined contribution of 11.9%, which when multiplied by the total bycatch expands to 64,685 fish. Thus, while the amount of chum salmon bycatch in 2021 was high, the number of fish caught from Western Alaska, Up/Mid Yukon, and SW Alaska stocks was average or below average.

ACKNOWLEDGMENTS

We are grateful for the help from the AFSC's Fisheries Monitoring and Analysis Division, and the many participating observers who provided genetic samples. Thanks to Rob Ames, Camille Kohler, Matt Callahan, and Bob Ryznar for developing AKFIN Answer reports that helped us develop new strata for genetic analyses and tabulate strata specific PSC numbers. Particular thanks go to Noelle Yochum and the RACE division for collecting excluder device samples to evaluate individual haul bycatch collections. We also appreciate the work of Bev Agler, Jodi Neil, and the rest of the ADF&G Mark, Tag, and Age Laboratory staff for conducting age analysis accurately and efficiently, and Dave Nicolls at ABL for mounting and pressing the scales. We are grateful to Katie Howard, Dani Evenson, and Tyler Dann of ADF&G for their thoughtful reviews of this report. Special thanks to AFSC Communications Program staff, especially James Lee, for their rapid and thorough editorial review of this document.

CITATIONS

AFSC (Alaska Fisheries Science Center). 2020. 2021 Observer sampling manual. Fisheries Monitoring and Analysis Division, North Pacific Groundfish Observer Program. AFSC, 7600 Sand Point Way N.E., Seattle, Washington, 98115.

Barry, P. D., C. M. Kondzela, J. A. Whittle, J. T. Watson, K. Karpan, K. D'Amelio, and W. A. Larson. 2022. Genetic stock composition analysis of chum salmon from the prohibited species catch for the 2020 Bering Sea walleye pollock trawl fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-453, 50 p.

Beacham, T. D., J. R. Candy, K. D. Le, and M. Wetklo. 2009a. Population structure of chum salmon (*Oncorhynchus keta*) across the Pacific Rim, determined from microsatellite analysis. Fish. Bull., U.S. 107:244-260.

Beacham, T. D., J. R. Candy, C. Wallace, S. Urawa, S. Sato, N. V. Varnavskaya, K. D. Le, and M. Wetklo. 2009b. Microsatellite stock identification of chum salmon on a Pacific Rim basis. N. Am. J. Fish. Manage. 29:1757-1776.

Campbell, N. R., S. A. Harmon, and S. R. Narum. 2015. Genotyping-in-Thousands by Sequencing (GT-Seq): A cost effective SNP genotyping method based on custom amplicon sequencing. Mol. Ecol. Res. 15(4):855–867. https://doi.org/10.1111/1755-0998.12357

Davis, N. D., A. V. Volkov, A. Y. Efimkin, N. A. Kuznetsova, J. L. Armstrong, and O. Sakai. 2009. Review of BASIS salmon food habits studies. N. Pac. Anadr. Fish. Comm. Bull. 5:197-208.

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. Alaska Department of Fish and Game Special Publication 12-26.

Gelman, A. and D. B. Rubin. 1992. Inference from iterative simulation using multiple sequences. Stat. Sci. 7:457-511.

Gray, A., T. McCraney, C. Kondzela, C. Marvin, and J. R. Guyon. 2011a. Genetic stock composition analysis of chum salmon bycatch samples from the 2007 Bering Sea trawl fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-220, 28 p. https://repository.library.noaa.gov/view/noaa/3823

Gray, A. K., W. T. McCraney, C. T. Marvin, C. M. Kondzela, H. T. Nguyen, and J. R. Guyon. 2011b. Genetic stock composition analysis of chum salmon bycatch samples from the 2008 Bering Sea groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-222, 29 p. https://repository.library.noaa.gov/view/noaa/3824

Gray, A., C. Marvin, C. Kondzela, 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, 23 p.

Guyon, J. R., C. Kondzela, T. McCraney, C. Marvin, and E. Martinson. 2010. Genetic stock composition analysis of chum salmon bycatch samples from the 2005 Bering Sea groundfish fishery. Report to the North Pacific Fishery Management Council, 605 W. 4th Ave., Anchorage, Alaska, 99510, 31 p.

JTC (Joint Technical Committee of the Yukon River U.S./Canada Panel). 2022. Yukon River salmon 2021 season summary and 2022 season outlook. Alaska Department of Fish; Game, Division of Commercial Fisheries, Regional Information Report No. 3A22-01, Anchorage. https://www.yukonriverpanel.com/publications/yukon-river-joint-technical-committee-reports/

Kondzela, C. M., J. A. Whittle, P. D. Barry, Hv. T. Nguyen, E. M. Yasumiishi, D. W. Nicolls, J. T. Watson, and W. A. Larson. 2021. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2019 Bering Sea walleye pollock trawl fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-422, 69 p. https://repository.library.noaa.gov/view/noaa/31530

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. https://repository.library.noaa.gov/view/noaa/13521

Kondzela, C. M., J. A. Whittle, D. Yates, S. C. Vulstek, H. T. Nguyen, and J. R. Guyon. 2016. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2014 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-314, 49 p. https://repository.library.noaa.gov/view/noaa/8688

Kondzela, C. M., C. T. Marvin, S. C. Vulstek, H. T. Nguyen, and J. R. Guyon. 2013. Genetic stock composition analysis of chum salmon bycatch samples from the 2011 Bering Sea walleye pollock trawl fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC243, 39 p. https://repository.library.noaa.gov/view/noaa/4367

Kondzela, C. M., W. T. McCraney, H. T. Nguyen, and J. R. Guyon. 2012. Genetic stock composition analysis of chum salmon bycatch samples from the 2010 Bering Sea groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-233, 29 p. https://repository.library.noaa.gov/view/noaa/4052

Marvin, C. T, S. L. Wildes, C. M. Kondzela, H. T. Nguyen, and J. R. Guyon. 2011. Genetic stock composition analysis of chum salmon bycatch samples from the 2006 Bering Sea groundfish fisheries. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-220, 29 p. https://repository.library.noaa.gov/view/noaa/3822

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. Can. J. Fish. Aquat. Sci. 76:551-560.

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.

Myers, K. W., N. V. Klovach, O. F. Gritsenko, S. Urawa, and T. C. Royer. 2007. Stock-specific distributions of Asian and North American salmon in the open ocean, interannual changes, and oceanographic conditions. N. Pac. Anadr. Fish. Comm. Bull. 4:159-177.

NMFS (National Marine Fisheries Service). 2022a. BSAI non-Chinook salmon mortality estimates, 1991-present, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Regional Office, Juneau, Alaska. Retrieved on May 26, 2022 from https://www.fisheries.noaa.gov/sites/default/files/akro/chum_salmon_mortality2022.html

NMFS (National Marine Fisheries Service). 2022b. Catch Accounting System data. NMFS Alaska Regional Office. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Juneau. [URL not publicly available as some information is confidential.]

NMFS (National Marine Fisheries Service). 2009. Bering Sea Chinook salmon bycatch management, Volume I. Final Environmental Impact Statement, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Regional Office, Juneau, Alaska.

NPFMC (North Pacific Fishery Management Council). 2020a. Fishery management plan for groundfish of the Bering Sea and Aleutian Islands management area. North Pacific Fishery Management Council, 605 W. 4th Ave., Anchorage, Alaska, 99501. https://www.npfmc.org/wp-content/PDFdocuments/fmp/BSAI/BSAIfmp.pdf

NPFMC (North Pacific Fishery Management Council). 2020b. Fishery management plan for groundfish of the Gulf of Alaska. North Pacific Fishery Management Council, 605 W. 4th Ave., Anchorage, Alaska, 99501. https://www.npfmc.org/wp-content/PDFdocuments/fmp/GOA/GOAfmp.pdf

NPFMC (North Pacific Fishery Management Council). 2012. Bering Sea non-Chinook salmon PSC management measures, initial review draft environmental assessment. North Pacific Fishery Management Council, 605 W. 4th Ave., Anchorage, Alaska, 99501.

NPFMC (North Pacific Fishery Management Council). 2007. Environmental assessment/regulatory impact review/final regulatory flexibility analysis for modifying existing Chinook and chum salmon savings areas: Amendment 84 to the fishery management plan for groundfish of the Bering Sea and Aleutian Islands management area. North Pacific Fishery Management Council, 605 W. 4th Ave., Anchorage, Alaska, 99501.

Pella, J. and H. J. Geiger. 2009. Sampling considerations for estimating geographic origins of Chinook salmon bycatch in the Bering Sea pollock fishery. Alaska Dep. Fish Game Spec. Publ. No. SP 09-08.

Plummer, M., N. Best, K. Cowles, and K. Vines. 2006 CODA: Convergence Diagnosis and Output Analysis for MCMC. R News 6:7-11.

Ruggerone, G. T. and J. R. Irvine. 2018. Numbers and biomass of natural- and hatchery-origin pink salmon, chum salmon, and sockeye salmon in the North Pacific Ocean, 1925–2015. Marine and Coastal Fisheries 10(2):152–68. https://doi.org/10.1002/mcf2.10023

Salo, E. O. 1991. Life history of chum salmon (*Oncorhynchus keta*), p. 231-309. *In*: Groot, C. and L. Margolis (editors), Pacific Salmon Life Histories. UBC Press, Vancouver.

Urawa, S., S. Sato, P. A. Crane, B. Agler, R. Josephson, and T. Azumaya. 2009. Stock-specific ocean distribution and migration of chum salmon in the Bering Sea and North Pacific Ocean. N. Pac. Anadr. Fish Comm. Bull. 5:131-146.

Vulstek, S. C., C. M. Kondzela, C. T. Marvin, J. Whittle, and J. R. Guyon. 2014. Genetic stock composition analysis of chum salmon bycatch and excluder device samples from the 2012 Bering Sea walleye pollock trawl fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-271, 35 p. https://repository.library.noaa.gov/view/noaa/4659

Whittle, J. A., S. C. Vulstek, C. M. Kondzela, and J. R. Guyon. 2015. Genetic stock composition analysis of chum salmon bycatch from the 2013 Bering Sea walleye pollock trawl fishery. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-292, 50 p. https://repository.library.noaa.gov/view/noaa/4852

Whittle, J. A., C. M. Kondzela, Hv. T. Nguyen, K. Hauch, D. Cuadra, and J. R. Guyon. 2018. Genetic stock composition analysis of chum salmon bycatch from the 2016 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-366, 58 p. https://repository.library.noaa.gov/view/noaa/17119

Whittle, J. A., C. M. Kondzela, J. T. Watson, P. D. Barry, Hv. T. Nguyen, E. M. Yasumiishi, D. Nicolls, and W. A. Larson. 2021a. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2017 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-419, 73 p. https://repository.library.noaa.gov/view/noaa/30602

Whittle, J. A., C. M. Kondzela, J. T. Watson, P. D. Barry, Hv. T. Nguyen, E. M. Yasumiishi, D. Nicolls, and W. A. Larson. 2021b. Genetic stock composition analysis of chum salmon from the prohibited species catch of the 2018 Bering Sea walleye pollock trawl fishery and Gulf of Alaska groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-420, 81 p. https://repository.library.noaa.gov/view/noaa/30603

APPENDIX A – GENETIC MARKERS

Appendix Table A-1 -- Single nucleotide polymorphisms included in the 84-SNP panel used for stock composition analysis of chum salmon bycatch samples from the 2021 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 Table A-1 -- 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 B – GENETIC BASELINE

Appendix Table B-1 -- Chum salmon populations in the Alaska Department of Fish and Game single nucleotide polymorphism baseline grouped by six regional 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 Table B-1 -- 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 Table B-1 -- 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 Table B-1 -- 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 Table B-1 -- 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

APPENDIX C – SPATIAL CLUSTERS OF ADF&G STATISTICAL AREAS

Appendix Table C-1 -- Four spatial clusters of ADF&G groundfish statistical areas[1] of chum salmon prohibited species catch sampled from 2013 to 2021 during the B-season of the Bering Sea pollock trawl fishery and analyzed for genetic stock composition.

Cluster 1: 625504, 625531, 625600, 625630, 625700, 625730, 635501, 635504, 635530, 635600, 635630, 635700, 635730, 645434, 645501, 645502, 645530, 645600, 645630, 645700, 645730, 655407, 655409, 655410, 655430, 655500, 655530, 655600, 655630, 655700, 655730, 665335, 665336, 665401, 665403, 665404, 665430, 665500, 665530, 665600, 665630, 665700, 665730

Cluster 2: 675430, 675500, 675530, 675600, 675630, 675700, 675730, 685500, 685530, 685600, 685630, 685700, 685730

Cluster 3: 695530, 695600, 695631, 695632, 705530, 705600, 705630, 705701, 705730, 715600, 715630, 715700, 715730, 725630, 725700, 725730, 735630, 735700, 735730, 745730

Cluster 4: 705800, 705830, 715800, 715830, 725800, 725830, 725900, 735800, 735830, 735900, 735930, 745800, 745830, 745900, 745930, 746000, 755800, 755830, 755900, 755930, 756000, 765830, 765900, 765930, 766000, 766030, 775830, 775900, 775930, 776000, 776030, 785900, 785930, 786000, 786030

[1] http://www.adfg.alaska.gov/index.cfm?adfg=fishingCommercialByFishery.statmaps

APPENDIX D – GSI ESTIMATES

Regional stock composition estimates of chum salmon samples from the 2021 Bering Sea B-season pollock trawl fishery and test excluder device hauls. Note that total PSC was tabulated from the AKFIN database with observer records and slightly exceeds the NMFS Alaska Regional Office mortality estimate.

West of 170° (PSC = 45,508; n = 331)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	9,100	7,148-11,207	0.200	0.157	0.199	0.246	0.00	1.00
NE Asia	23,319	20,736-25,920	0.512	0.456	0.512	0.570	0.00	1.00
W Alaska	2,970	1,724-4,467	0.065	0.038	0.064	0.098	0.00	1.00
Up/Mid Yukon	1,172	477-2,135	0.026	0.010	0.025	0.047	0.00	1.00
SW Alaska	533	0-1,462	0.012	0.000	0.010	0.032	0.05	1.00
E GOA/PNW	8,411	6,570-10,423	0.185	0.144	0.184	0.229	0.00	1.00

East of 170° (PSC = 502,053; n = 3,203)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	55,715	50,029-61,612	0.111	0.100	0.111	0.123	0.00	1.00
NE Asia	280,909	271,685-290,006	0.560	0.541	0.560	0.578	0.00	1.00
W Alaska	46,590	41,222-52,221	0.093	0.082	0.093	0.104	0.00	1.00
Up/Mid Yukon	1,548	259-3,314	0.003	0.001	0.003	0.007	0.01	1.00
SW Alaska	12,283	8,392-16,455	0.024	0.017	0.024	0.033	0.00	1.00
E GOA/PNW	105,006	97,683-112,495	0.209	0.195	0.209	0.224	0.00	1.00

Early (PSC = 128,904; n = 725)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	19,192	15,804-22,801	0.149	0.123	0.149	0.177	0.00	1.00
NE Asia	64,560	59,490-69,605	0.501	0.462	0.501	0.540	0.00	1.00
W Alaska	9,620	6,889-12,642	0.075	0.053	0.074	0.098	0.00	1.00
Up/Mid Yukon	1,971	707-3,844	0.015	0.005	0.014	0.030	0.00	1.00
SW Alaska	6,537	4,068-9,376	0.051	0.032	0.050	0.073	0.00	1.00
E GOA/PNW	27,021	23,101-31,139	0.210	0.179	0.209	0.242	0.00	1.00

Middle (PSC = 384,865; n = 2,563)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	41,605	36,839-46,654	0.108	0.096	0.108	0.121	0.00	1.00
NE Asia	224,571	216,738-232,407	0.584	0.563	0.584	0.604	0.00	1.00
W Alaska	34,917	30,425-39,703	0.091	0.079	0.091	0.103	0.00	1.00
Up/Mid Yukon	1,496	454-2,983	0.004	0.001	0.004	0.008	0.00	1.00
SW Alaska	7,722	4,733-11,055	0.020	0.012	0.020	0.029	0.00	1.01
E GOA/PNW	74,552	68,435-80,916	0.194	0.178	0.194	0.210	0.00	1.00

Late (PSC = 33,792; n = 246)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	5,117	3,605-6,796	0.151	0.107	0.151	0.201	0.00	1.00
NE Asia	14,753	12,510-17,028	0.437	0.370	0.436	0.504	0.00	1.00
W Alaska	2,676	1,394-4,185	0.079	0.041	0.078	0.124	0.00	1.00
Up/Mid Yukon	1,083	413-2,096	0.032	0.012	0.030	0.062	0.00	1.00
SW Alaska	166	0-786	0.005	0.000	0.003	0.023	0.28	1.00
E GOA/PNW	9,995	8,102-11,997	0.296	0.240	0.295	0.355	0.00	1.00

Catcher-processor (PSC = 153,545; n = 894)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	21,250	17,693-25,061	0.138	0.115	0.138	0.163	0.00	1.00
NE Asia	91,618	86,372-96,856	0.597	0.563	0.597	0.631	0.00	1.00
W Alaska	10,836	8,191-13,799	0.071	0.053	0.070	0.090	0.00	1.00
Up/Mid Yukon	2,238	1,132-3,715	0.015	0.007	0.014	0.024	0.00	1.00
SW Alaska	3,894	2,046-6,106	0.025	0.013	0.025	0.040	0.00	1.00
E GOA/PNW	23,705	20,111-27,541	0.154	0.131	0.154	0.179	0.00	1.00

Mothership (PSC = 50,466; n = 244)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	5,860	3,912-8,099	0.116	0.078	0.115	0.160	0.00	1.00
NE Asia	29,694	26,365-32,955	0.588	0.522	0.589	0.653	0.00	1.00
W Alaska	3,555	1,937-5,545	0.070	0.038	0.069	0.110	0.00	1.00
Up/Mid Yukon	48	0-704	0.001	0.000	0.000	0.014	0.68	1.00
SW Alaska	378	0-1,601	0.008	0.000	0.006	0.032	0.26	1.00
E GOA/PNW	10,928	8,446-13,664	0.217	0.167	0.216	0.271	0.00	1.00

Shoreside (PSC = 341,433; n = 2,396)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	38,246	33,783-42,876	0.112	0.099	0.112	0.126	0.00	1.00
NE Asia	183,120	175,869-190,427	0.536	0.515	0.536	0.558	0.00	1.00
W Alaska	32,256	27,940-36,792	0.094	0.082	0.094	0.108	0.00	1.00
Up/Mid Yukon	1,478	300-3,096	0.004	0.001	0.004	0.009	0.01	1.00
SW Alaska	9,699	6,591-13,056	0.028	0.019	0.028	0.038	0.00	1.00
E GOA/PNW	76,631	70,795-82,625	0.224	0.207	0.224	0.242	0.00	1.00

Age-3 (PSC = 171,647; n = 932)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	31,685	27,336-36,265	0.185	0.159	0.184	0.211	0.00	1.00
NE Asia	50,176	44,916-55,604	0.292	0.262	0.292	0.324	0.00	1.00
W Alaska	16,202	12,928-19,805	0.094	0.075	0.094	0.115	0.00	1.00
Up/Mid Yukon	875	210-2,015	0.005	0.001	0.005	0.012	0.00	1.00
SW Alaska	2,114	667-4,013	0.012	0.004	0.012	0.023	0.00	1.00
E GOA/PNW	70,592	65,087-76,114	0.411	0.379	0.411	0.443	0.00	1.00

Age-4 (PSC = 348,836; n = 1,944)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	26,358	22,176-30,837	0.076	0.064	0.075	0.088	0.00	1.00
NE Asia	235,135	227,169-242,925	0.674	0.651	0.674	0.696	0.00	1.00
W Alaska	32,370	27,466-37,621	0.093	0.079	0.093	0.108	0.00	1.00
Up/Mid Yukon	3,250	1,572-5,492	0.009	0.005	0.009	0.016	0.00	1.00
SW Alaska	12,691	9,007-16,823	0.036	0.026	0.036	0.048	0.00	1.00
E GOA/PNW	39,029	33,961-44,302	0.112	0.097	0.112	0.127	0.00	1.00

Age-5 (PSC = 26,127; n = 146)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	5,448	3,774-7,325	0.209	0.144	0.207	0.280	0.00	1.00
NE Asia	15,471	13,249-17,620	0.592	0.507	0.593	0.674	0.00	1.00
W Alaska	941	153-2,100	0.036	0.006	0.034	0.080	0.00	1.00
Up/Mid Yukon	232	12-933	0.009	0.000	0.005	0.036	0.00	1.00
SW Alaska	96	0-767	0.004	0.000	0.000	0.029	0.49	1.00
E GOA/PNW	3,937	2,547-5,565	0.151	0.097	0.149	0.213	0.00	1.00

Cluster 1 Early (PSC = 189,688; n = 1,151)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	20,120	16,694-23,775	0.106	0.088	0.106	0.125	0.00	1.00
NE Asia	93,568	87,801-99,341	0.493	0.463	0.493	0.524	0.00	1.00
W Alaska	16,129	12,840-19,672	0.085	0.068	0.085	0.104	0.00	1.00
Up/Mid Yukon	1,789	619-3,522	0.009	0.003	0.009	0.019	0.00	1.00
SW Alaska	9,226	6,322-12,413	0.049	0.033	0.048	0.065	0.00	1.00
E GOA/PNW	48,853	43,938-53,924	0.258	0.232	0.257	0.284	0.00	1.00

Cluster 1 Late (PSC = 12,145; n = 92)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	302	15-861	0.025	0.001	0.021	0.071	0.01	1.00
NE Asia	4,244	2,989-5,577	0.349	0.246	0.348	0.459	0.00	1.00
W Alaska	1,939	812-3,190	0.160	0.067	0.158	0.263	0.00	1.00
Up/Mid Yukon	205	0-938	0.017	0.000	0.007	0.077	0.00	1.00
SW Alaska	42	0-521	0.004	0.000	0.000	0.043	0.59	1.00
E GOA/PNW	5,409	4,167-6,671	0.445	0.343	0.445	0.549	0.00	1.00

Cluster 2 Early (PSC = 226,750; n = 1,457)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	27,308	23,325-31,479	0.120	0.103	0.120	0.139	0.00	1.00
NE Asia	141,358	135,178-147,351	0.623	0.596	0.623	0.650	0.00	1.00
W Alaska	18,391	14,986-22,023	0.081	0.066	0.081	0.097	0.00	1.00
Up/Mid Yukon	710	27-2,087	0.003	0.000	0.003	0.009	0.01	1.00
SW Alaska	2,108	160-4,410	0.009	0.001	0.009	0.019	0.01	1.00
E GOA/PNW	36,871	32,499-41,477	0.163	0.143	0.162	0.183	0.00	1.00

Cluster 3 Early (PSC = 11,158; n = 77)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	2,380	1,405-3,503	0.213	0.126	0.211	0.314	0.00	1.00
NE Asia	6,154	4,810-7,465	0.552	0.431	0.552	0.669	0.00	1.00
W Alaska	1,195	453-2,222	0.107	0.041	0.103	0.199	0.00	1.00
Up/Mid Yukon	242	1-781	0.022	0.000	0.017	0.070	0.02	1.00
SW Alaska	65	0-618	0.006	0.000	0.000	0.055	0.54	1.00
E GOA/PNW	1,120	479-1,971	0.100	0.043	0.097	0.177	0.00	1.00

Cluster 3 Late (PSC = 30,400; n = 225)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	5,785	4,243-7,464	0.190	0.140	0.189	0.246	0.00	1.00
NE Asia	15,362	13,263-17,460	0.505	0.436	0.505	0.574	0.00	1.00
W Alaska	1,617	719-2,781	0.053	0.024	0.052	0.091	0.00	1.00
Up/Mid Yukon	872	260-1,765	0.029	0.009	0.027	0.058	0.00	1.00
SW Alaska	349	0-1,008	0.012	0.000	0.010	0.033	0.05	1.00
E GOA/PNW	6,412	4,855-8,148	0.211	0.160	0.210	0.268	0.00	1.00

Age-3 Cluster 1 (PSC = 63,251; n = 273)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	10,219	7,537-13,219	0.162	0.119	0.161	0.209	0.00	1.00
NE Asia	15,296	12,064-18,782	0.242	0.191	0.241	0.297	0.00	1.00
W Alaska	5,190	3,264-7,510	0.082	0.052	0.081	0.119	0.00	1.00
Up/Mid Yukon	38	0-570	0.001	0.000	0.000	0.009	0.70	1.00
SW Alaska	1,475	117-3,309	0.023	0.002	0.022	0.052	0.02	1.00
E GOA/PNW	31,030	27,126-34,881	0.491	0.429	0.491	0.551	0.00	1.00

Age-3 Cluster 1 Early (PSC = 59,445; n = 240)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	9,827	7,109-12,856	0.165	0.120	0.164	0.216	0.00	1.00
NE Asia	13,751	10,602-17,160	0.231	0.178	0.231	0.289	0.00	1.00
W Alaska	4,251	2,440-6,508	0.072	0.041	0.070	0.109	0.00	1.00
Up/Mid Yukon	15	0-482	0.000	0.000	0.000	0.008	0.75	1.00
SW Alaska	1,937	379-4,026	0.033	0.006	0.031	0.068	0.00	1.00
E GOA/PNW	29,661	25,719-33,600	0.499	0.433	0.499	0.565	0.00	1.00

Age-3 Cluster 2 (PSC = 73,345; n = 444)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	14,868	12,047-17,850	0.203	0.164	0.202	0.243	0.00	1.00
NE Asia	24,188	20,795-27,683	0.330	0.284	0.330	0.377	0.00	1.00
W Alaska	7,310	5,260-9,650	0.100	0.072	0.099	0.132	0.00	1.00
Up/Mid Yukon	6	0-333	0.000	0.000	0.000	0.005	0.76	1.00
SW Alaska	119	0-1,358	0.002	0.000	0.000	0.019	0.63	1.00
E GOA/PNW	26,850	23,522-30,224	0.366	0.321	0.366	0.412	0.00	1.00

Age-3 Cluster 2 Early (PSC = 71,060; n = 423)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	14,802	11,983-17,810	0.208	0.169	0.208	0.251	0.00	1.00
NE Asia	23,022	19,731-26,476	0.324	0.278	0.324	0.373	0.00	1.00
W Alaska	6,857	4,881-9,132	0.097	0.069	0.096	0.129	0.00	1.00
Up/Mid Yukon	35	0-372	0.000	0.000	0.000	0.005	0.64	1.00
SW Alaska	112	0-1,328	0.002	0.000	0.000	0.019	0.63	1.00
E GOA/PNW	26,229	22,933-29,578	0.369	0.323	0.369	0.416	0.00	1.00

Age-3 Cluster 3 (PSC = 13,023; n = 79)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	3,247	2,097-4,552	0.249	0.161	0.247	0.349	0.00	1.00
NE Asia	3,016	1,786-4,400	0.232	0.137	0.230	0.338	0.00	1.00
W Alaska	933	256-1,932	0.072	0.020	0.067	0.148	0.00	1.00
Up/Mid Yukon	511	60-1,303	0.039	0.005	0.035	0.100	0.00	1.00
SW Alaska	0	0-214	0.000	0.000	0.000	0.016	0.78	1.00
E GOA/PNW	5,313	3,947-6,754	0.408	0.303	0.407	0.519	0.00	1.00

Age-3 Cluster 3 Late (PSC = 9,526; n = 74)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	2,174	1,331-3,156	0.228	0.140	0.226	0.331	0.00	1.00
NE Asia	2,170	1,277-3,193	0.228	0.134	0.226	0.335	0.00	1.00
W Alaska	663	140-1,419	0.070	0.015	0.065	0.149	0.00	1.00
Up/Mid Yukon	392	49-996	0.041	0.005	0.036	0.105	0.00	1.00
SW Alaska	0	0-162	0.000	0.000	0.000	0.017	0.78	1.00
E GOA/PNW	4,124	3,060-5,222	0.433	0.321	0.432	0.548	0.00	1.00

Age-3 Early (PSC = 153,156; n = 791)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	27,702	23,511-32,162	0.181	0.154	0.181	0.210	0.00	1.00
NE Asia	46,463	41,310-51,727	0.303	0.270	0.303	0.338	0.00	1.00
W Alaska	14,287	11,172-17,694	0.093	0.073	0.093	0.116	0.00	1.00
Up/Mid Yukon	88	0-763	0.001	0.000	0.000	0.005	0.56	1.00
SW Alaska	1,999	462-3,949	0.013	0.003	0.013	0.026	0.01	1.00
E GOA/PNW	62,614	57,300-68,036	0.409	0.374	0.409	0.444	0.00	1.00

Age-3 Late (PSC = 18,441; n = 141)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	3,645	2,472-4,965	0.198	0.134	0.196	0.269	0.00	1.00
NE Asia	4,706	3,345-6,215	0.255	0.181	0.254	0.337	0.00	1.00
W Alaska	1,853	937-2,978	0.100	0.051	0.099	0.161	0.00	1.00
Up/Mid Yukon	379	30-1,075	0.021	0.002	0.018	0.058	0.00	1.00
SW Alaska	83	0-556	0.005	0.000	0.001	0.030	0.44	1.00
E GOA/PNW	7,772	6,278-9,307	0.421	0.340	0.421	0.505	0.00	1.00

Age-4 Cluster 1 (PSC = 128,603; n = 693)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	9,639	7,181-12,423	0.075	0.056	0.074	0.097	0.00	1.00
NE Asia	72,603	67,536-77,607	0.565	0.525	0.565	0.603	0.00	1.00
W Alaska	12,843	9,647-16,250	0.100	0.075	0.100	0.126	0.00	1.00
Up/Mid Yukon	1,961	732-3,742	0.015	0.006	0.015	0.029	0.00	1.00
SW Alaska	8,411	5,570-11,710	0.065	0.043	0.065	0.091	0.00	1.00
E GOA/PNW	23,142	19,378-27,154	0.180	0.151	0.180	0.211	0.00	1.00

Age-4 Cluster 1 Early (PSC = 120,865; n = 647)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	9,603	7,091-12,409	0.079	0.059	0.079	0.103	0.00	1.00
NE Asia	70,121	65,192-74,963	0.580	0.539	0.580	0.620	0.00	1.00
W Alaska	10,485	7,632-13,684	0.087	0.063	0.086	0.113	0.00	1.00
Up/Mid Yukon	2,193	892-4,005	0.018	0.007	0.017	0.033	0.00	1.00
SW Alaska	7,736	5,037-10,831	0.064	0.042	0.063	0.090	0.00	1.00
E GOA/PNW	20,723	17,159-24,508	0.171	0.142	0.171	0.203	0.00	1.00

Age-4 Cluster 2 (PSC = 149,125; n = 839)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	10,426	7,783-13,361	0.070	0.052	0.070	0.090	0.00	1.00
NE Asia	113,551	108,783-118,134	0.761	0.729	0.762	0.792	0.00	1.00
W Alaska	11,773	8,616-15,141	0.079	0.058	0.079	0.102	0.00	1.00
Up/Mid Yukon	1,438	283-3,514	0.010	0.002	0.008	0.024	0.00	1.00
SW Alaska	1,353	0-3,229	0.009	0.000	0.009	0.022	0.03	1.00
E GOA/PNW	10,582	7,984-13,492	0.071	0.054	0.071	0.090	0.00	1.00

Age-4 Cluster 2 Early (PSC = 144,480; n = 808)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	10,257	7,673-13,110	0.071	0.053	0.071	0.091	0.00	1.00
NE Asia	110,371	105,704-114,845	0.764	0.732	0.764	0.795	0.00	1.00
W Alaska	11,067	8,105-14,282	0.077	0.056	0.076	0.099	0.00	1.00
Up/Mid Yukon	1,262	271-3,132	0.009	0.002	0.008	0.022	0.00	1.00
SW Alaska	1,352	0-3,286	0.009	0.000	0.009	0.023	0.04	1.00
E GOA/PNW	10,168	7,611-13,049	0.070	0.053	0.070	0.090	0.00	1.00

Age-4 Cluster 3 (PSC = 26,479; n = 168)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	3,557	2,240-5,088	0.134	0.085	0.133	0.192	0.00	1.00
NE Asia	16,604	14,481-18,643	0.627	0.547	0.628	0.704	0.00	1.00
W Alaska	2,099	1,000-3,478	0.079	0.038	0.077	0.131	0.00	1.00
Up/Mid Yukon	730	138-1,661	0.028	0.005	0.025	0.063	0.00	1.00
SW Alaska	851	92-2,048	0.032	0.003	0.029	0.077	0.01	1.00
E GOA/PNW	2,636	1,452-4,072	0.100	0.055	0.098	0.154	0.00	1.00

Age-4 Cluster 3 Late (PSC = 19,370; n = 115)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	2,436	1,341-3,764	0.126	0.069	0.124	0.194	0.00	1.00
NE Asia	12,799	10,972-14,516	0.661	0.566	0.662	0.749	0.00	1.00
W Alaska	1,154	372-2,243	0.060	0.019	0.057	0.116	0.00	1.00
Up/Mid Yukon	452	0-1,286	0.023	0.000	0.020	0.066	0.03	1.00
SW Alaska	876	158-1,925	0.045	0.008	0.042	0.099	0.00	1.00
E GOA/PNW	1,650	741-2,892	0.085	0.038	0.082	0.149	0.00	1.00

Age-4 Early (PSC = 311,398; n = 1,733)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	22,504	18,575-26,713	0.072	0.060	0.072	0.086	0.00	1.00
NE Asia	213,902	206,567-221,135	0.687	0.663	0.687	0.710	0.00	1.00
W Alaska	27,224	22,654-32,026	0.087	0.073	0.087	0.103	0.00	1.00
Up/Mid Yukon	2,865	1,273-5,106	0.009	0.004	0.009	0.016	0.00	1.00
SW Alaska	10,848	7,362-14,728	0.035	0.024	0.035	0.047	0.00	1.00
E GOA/PNW	34,053	29,390-39,027	0.109	0.094	0.109	0.125	0.00	1.00

Age-4 Late (PSC = 37,495; n = 211)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	3,655	2,213-5,354	0.097	0.059	0.096	0.143	0.00	1.00
NE Asia	21,464	18,796-24,090	0.572	0.501	0.573	0.642	0.00	1.00
W Alaska	4,570	2,816-6,566	0.122	0.075	0.121	0.175	0.00	1.00
Up/Mid Yukon	725	79-1,826	0.019	0.002	0.017	0.049	0.00	1.00
SW Alaska	1,199	279-2,594	0.032	0.007	0.030	0.069	0.00	1.00
E GOA/PNW	5,880	4,015-7,929	0.157	0.107	0.156	0.211	0.00	1.00

Salmon Excluder Device: Cruise 1 (n = 74)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	6	2 - 12	0.082	0.027	0.078	0.159	0.00	1.00
NE Asia	43	35 - 52	0.593	0.471	0.593	0.709	0.00	1.00
W Alaska	9	4 - 17	0.132	0.059	0.128	0.225	0.00	1.00
Up/Mid Yukon	0	0 - 4	0.009	0.000	0.004	0.049	0.35	1.00
SW Alaska	2	0 - 8	0.032	0.000	0.026	0.105	0.11	1.00
E GOA/PNW	11	6 - 18	0.152	0.075	0.149	0.248	0.00	1.00

Salmon Excluder Device: Cruise 3 (n = 110)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	2	0 - 8	0.026	0.000	0.023	0.071	0.03	1.00
NE Asia	56	46 - 67	0.516	0.417	0.516	0.613	0.00	1.00
W Alaska	6	2 - 14	0.062	0.016	0.058	0.126	0.00	1.00
Up/Mid Yukon	2	0 - 8	0.026	0.002	0.023	0.071	0.00	1.00
SW Alaska	8	3 - 16	0.076	0.026	0.073	0.142	0.00	1.00
E GOA/PNW	32	23 - 43	0.295	0.209	0.294	0.387	0.00	1.00

Salmon Excluder Device: Cruise 4 (n = 261)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	29	19 - 40	0.112	0.075	0.111	0.155	0.00	1.00
NE Asia	178	163 - 194	0.685	0.624	0.686	0.744	0.00	1.00
W Alaska	13	6 - 23	0.051	0.021	0.049	0.089	0.00	1.00
Up/Mid Yukon	4	1 - 11	0.017	0.003	0.016	0.041	0.00	1.00
SW Alaska	2	0 - 9	0.011	0.000	0.009	0.035	0.08	1.00
E GOA/PNW	32	22 - 44	0.123	0.085	0.122	0.168	0.00	1.00

Salmon Excluder Device: Cruise 4, Haul 1 (n = 90)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	4	0 - 11	0.051	0.000	0.048	0.123	0.03	1.00
NE Asia	71	62 - 80	0.793	0.690	0.795	0.886	0.00	1.00
W Alaska	7	2 - 13	0.078	0.026	0.075	0.147	0.00	1.00
Up/Mid Yukon	0	0 - 2	0.000	0.000	0.000	0.020	0.76	1.00
SW Alaska	0	0 - 2	0.000	0.000	0.000	0.022	0.78	1.00
E GOA/PNW	6	3 - 13	0.077	0.031	0.074	0.141	0.00	1.00

Salmon Excluder Device: Cruise 4, Haul 2 (n = 93)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	14	8 - 23	0.160	0.088	0.157	0.246	0.00	1.00
NE Asia	54	45 - 64	0.589	0.483	0.590	0.693	0.00	1.00
W Alaska	3	0 - 10	0.038	0.000	0.033	0.103	0.02	1.00
Up/Mid Yukon	2	0 - 8	0.025	0.003	0.018	0.081	0.00	1.00
SW Alaska	1	0 - 6	0.015	0.000	0.010	0.060	0.14	1.00
E GOA/PNW	16	9 - 24	0.173	0.099	0.171	0.261	0.00	1.00

Salmon Excluder Device: Cruise 4, Haul 3 (n = 78)

Region	Est. num.	Est. CI	Mean	2.5%	Median	97.5%	P=0	SF
SE Asia	9	4 - 15	0.116	0.055	0.112	0.195	0.00	1.00
NE Asia	52	44 - 61	0.676	0.562	0.678	0.779	0.00	1.00
W Alaska	5	2 - 12	0.073	0.023	0.068	0.152	0.00	1.00
Up/Mid Yukon	0	0 - 4	0.011	0.000	0.007	0.047	0.20	1.00
SW Alaska	0	0 - 5	0.012	0.000	0.005	0.066	0.38	1.00
E GOA/PNW	8	4 - 15	0.113	0.049	0.109	0.197	0.00	1.00

U.S. Secretary of Commerce
Gina M. Raimondo

Under Secretary of Commerce for
Oceans and Atmosphere
Dr. Richard W. Spinrad

Assistant Administrator, National Marine
Fisheries Service. Also serving as
Acting Assistant
Secretary of Commerce for Oceans
and Atmosphere, and Deputy NOAA
Administrator
Janet Coit

November 2022

www.nmfs.noaa.gov

OFFICIAL BUSINESS

National Marine
Fisheries Service
Alaska Fisheries Science Center
7600 Sand Point Way N.E.
Seattle, WA 98115-6349