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Genetic Stock Composition Analysis of Chinook Salmon Bycatch Samples from the 2017 Gulf of Alaska Trawl Fisheries

by
C. M. Guthrie, III, Hv. T. Nguyen, M. Marsh, and J. R. Guyon

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ABSTRACT

A genetic analysis of samples from the Chinook salmon (*Oncorhynchus tshawytscha*) Prohibited Species Catch (bycatch) of the 2017 Gulf of Alaska (GOA) trawl fisheries for walleye pollock (*Gadus chalcogrammus*) and rockfish (*Sebastes* spp.) was undertaken to determine stock composition. Samples were genotyped for 43 single nucleotide polymorphism (SNP) DNA markers and results were estimated using the Alaska Department of Fish and Game's SNP baseline. In 2017, genetic samples were collected from Chinook salmon taken in the bycatch of the GOA pollock trawl fisheries using a simple random sample protocol with trip being the primary unit. This was the fourth year for this sampling protocol and resulted in the second largest available genetic sample set to date with 17% of the estimated salmon bycatch from the pollock fishery successfully genotyped. Based on analysis of 3,571 Chinook salmon samples from a total bycatch of 21,392 fish, British Columbia (43%; 9,096), West Coast US (38%; 8,215), and Coastal Southeast Alaska (13%; 2,762) comprised the largest regional contributions. In 2017, genetic samples from the bycatch of the GOA rockfish catcher vessel fishery were collected by the fishing industry using a census sampling protocol. Based on the genotyping of 280 Chinook salmon bycatch samples collected from this fishery in NMFS Statistical Area 630, West Coast US region had the largest contribution (56%) with smaller contributions from British Columbia (28%), and Coastal Southeast Alaska (11%) regions. The 2017 GOA stock composition estimates for Chinook salmon bycatch continue the trend of past years during which most Chinook salmon encountered originate from three large southern regions between coastal Southeast Alaska and northern California. This pattern also holds for samples collected across finer-scale time and area strata within the GOA.

CONTENTS

INTRODUCTION

The Gulf of Alaska (GOA) is serves as a feeding habitat for multiple brood years of Chinook salmon (*Oncorhynchus tshawytscha*) originating from many different localities in North America and Asia. Determining the geographic origin and stock composition of Pacific salmon caught in federally managed fisheries is essential to understanding whether fisheries management could address potential conservation concerns. This report provides genetic stock identification results for Chinook salmon Prohibited Species Catch (bycatch) samples collected in the GOA from the trawl fisheries for walleye pollock (*Gadus chalcogrammus*) and catcher vessel (CV) trawl fisheries for rockfish (*Sebastes* spp.). The National Marine Fisheries Service (NMFS) and Alaska Department of Fish and Game (ADF&G) geographical statistical areas associated with the groundfish fishery are shown in Figure 1 and are used later in the report to describe the spatial distribution of the Chinook salmon bycatch and genetic samples. All analyses used a single nucleotide polymorphism (SNP) baseline provided by ADF&G (Templin et al. 2011; Appendix 1), the same baseline used to estimate previous stock compositions of samples from the Chinook salmon bycatch of the federally managed GOA trawl fisheries (Guthrie et al. 2013, 2016-18; Guyon et al. 2014, 2015a,b; Larson et al. 2013). For additional information regarding background and methodology refer to the Chinook salmon bycatch report prepared previously for the 2008 Bering Sea trawl fishery (Guyon et al. 2010).

The goal of this report is to present stock composition estimates for samples collected from the bycatch of the 2017 GOA federal trawl fisheries. Stock composition estimates have been applied to bycatch numbers; however, it is important to understand the limitations of each

sample set for applying estimates to the entire bycatch or comparing estimates among sample sets or years.

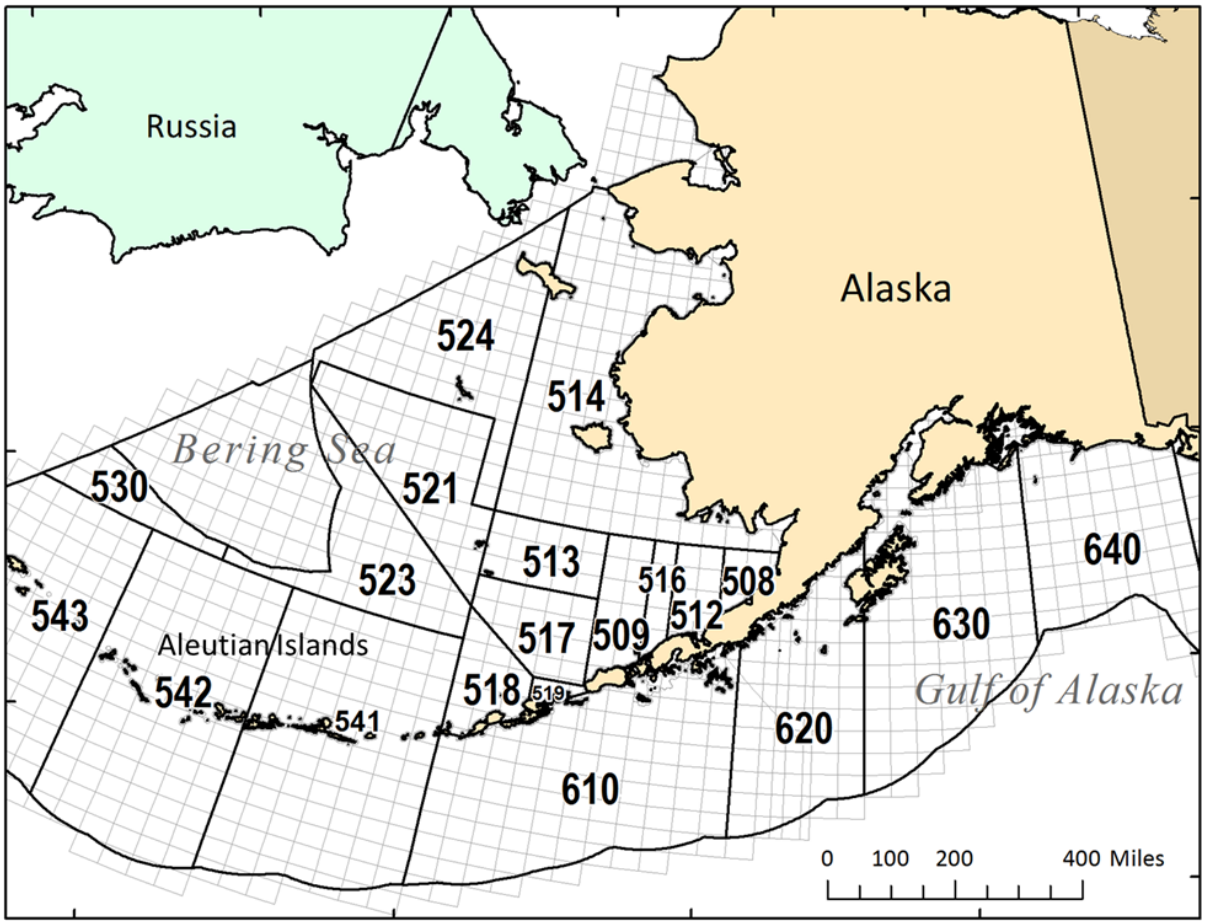


Figure 1. -- NMFS (outlined in black) and ADF&G (outlined in light gray) statistical areas associated with the Bering Sea and Gulf of Alaska (Areas 610-640) groundfish fisheries.

SAMPLE DISTRIBUTION

GOA Pollock Trawl Fishery

Amendment 93 to the GOA groundfish fishery management plan required industry to retain all Chinook salmon caught as bycatch in the GOA pollock trawl fishery. This retention requirement was aimed at providing observers with complete access to the bycatch to support genetic stock composition analyses. However, Amendment 93 did not mandate complete

observer coverage, and not all GOA pollock trips were observed at-sea. Consequently, the North Pacific Groundfish and Halibut Observer Program (Observer Program) lacked the ability to know in advance the delivery times and locations of all GOA pollock deliveries. Recognizing these limitations in the GOA, starting in 2014, the Observer Program implemented a simple random sampling protocol with respect to trip for the collection of genetic samples in the GOA (Faunce et al. 2014). This method randomly samples from trips and censuses the salmon bycatch encountered in each associated delivery to the processor (Faunce 2015). Samples of axillary process tissue for genetic analysis were collected throughout 2017 from the GOA bottom and midwater pollock trawl fishery. Tissues were stored in coin envelopes that were labeled, frozen, and shipped to the AFSC's Auke Bay Laboratories (ABL). Scales were collected as an additional source of tissue for genetic analysis, and for ageing (pending funding).

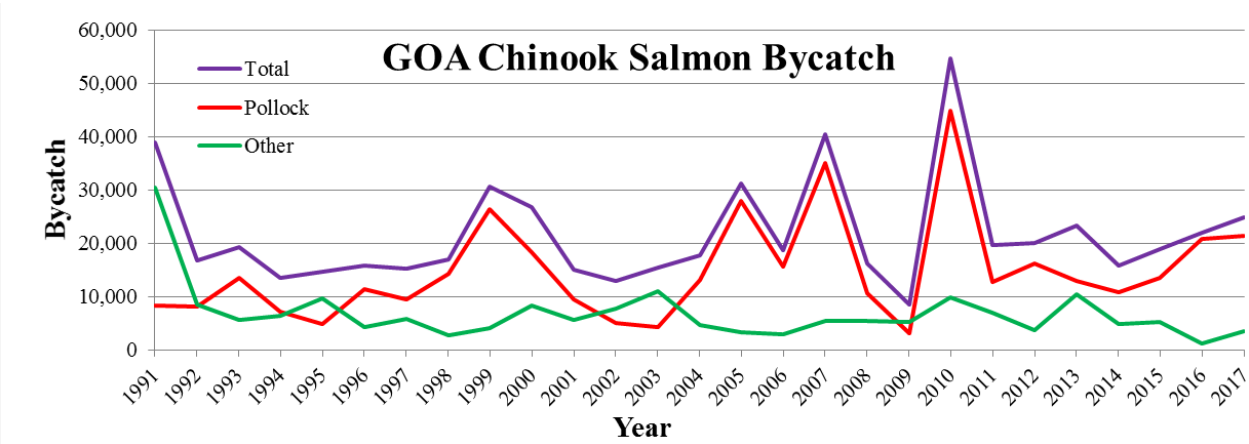


Figure 2. -- Yearly estimated Chinook salmon bycatch in the Gulf of Alaska pollock and non-pollock trawl fisheries (NMFS 2019).

In 2017, an estimated 21,392 Chinook salmon were caught in the GOA pollock trawl fisheries (NMFS 2019), approximately half that of the highest overall Chinook bycatch in 2010 (Fig. 2) when an estimated 44,819 fish were caught. The genotyped (genetic) sample set for the

2017 Chinook salmon bycatch was 3,571 fish, a sampling rate of 16.69% of the estimated catch of the pollock trawl fishery.

Potential spatial and temporal biases associated with the 2017 Chinook salmon GOA bycatch sample sets were evaluated visually by comparing the genetic sample distribution with the estimated overall bycatch distribution. The distributions of the numbers of samples and overall bycatch were similar by week (Fig. 3) and by statistical area and week (Fig. 4). The sampling rate (Fig. 5) was variable, but mostly over 10%, with an average being 20.2% (for all samples 3,959 were collected including those not genotyped). The 281 Chinook salmon caught from NMFS Area 649 (Prince William Sound) were not sampled.

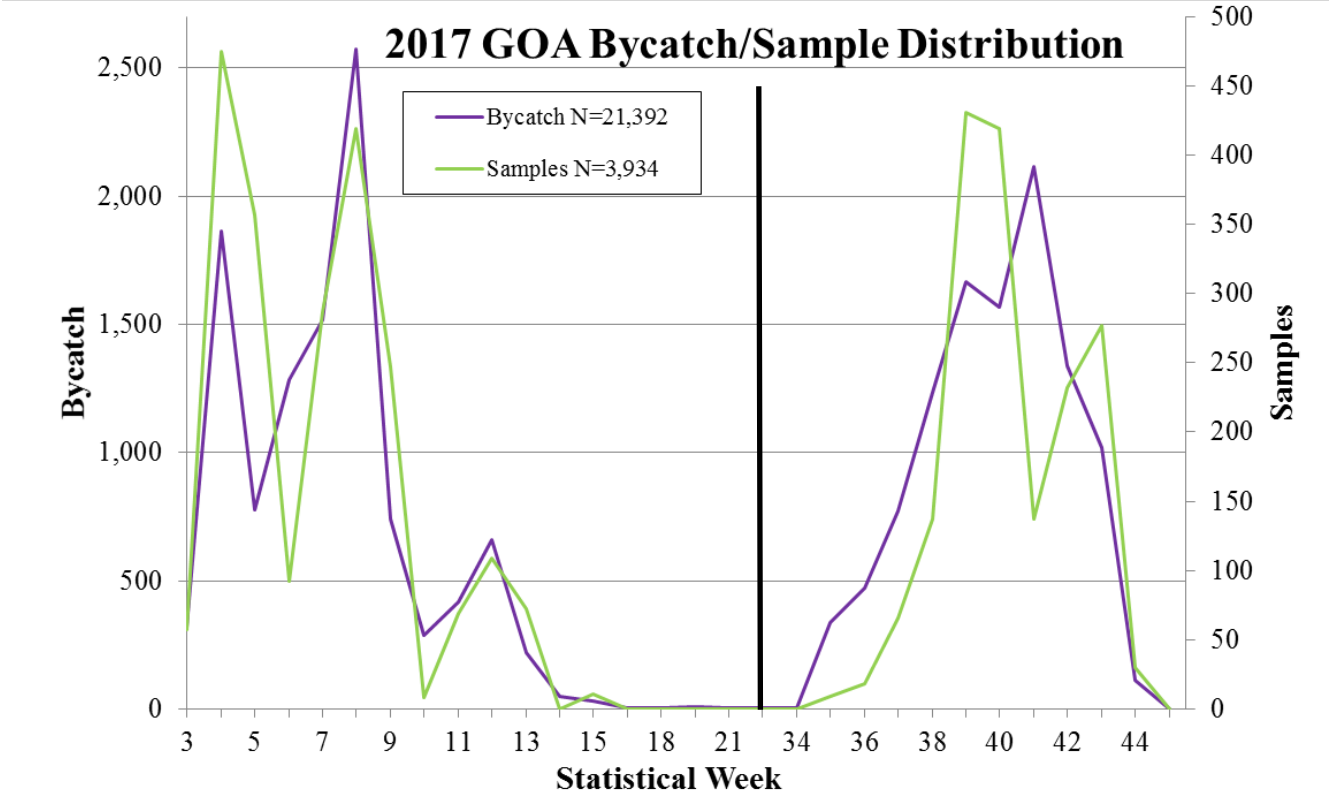
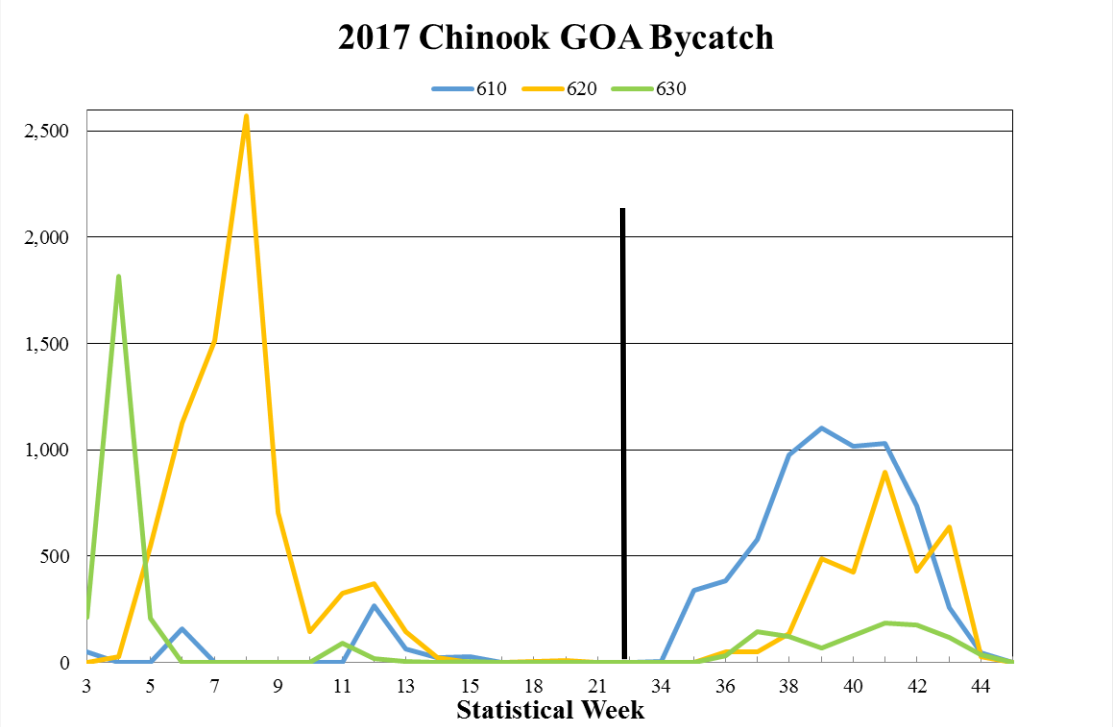


Figure 3. -- Estimated number of Chinook salmon bycatch and genetic samples by statistical week from the 2017 Gulf of Alaska pollock trawl fishery. The vertical line separates weeks 22 to 34 when no fishing occurred.



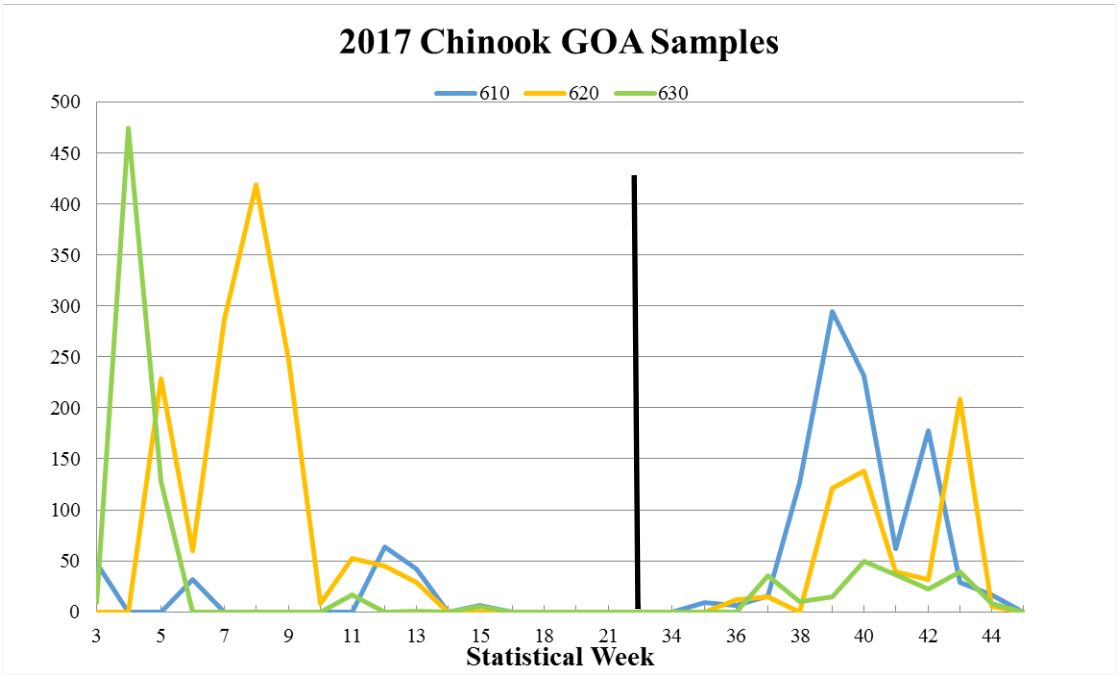


Figure 4. -- Estimated number of Chinook salmon bycatch (top) and available genetic samples (bottom) by statistical week and NMFS area from the 2017 Gulf of Alaska pollock trawl fishery. The vertical line separates weeks 22 to 34 when no fishing occurred.

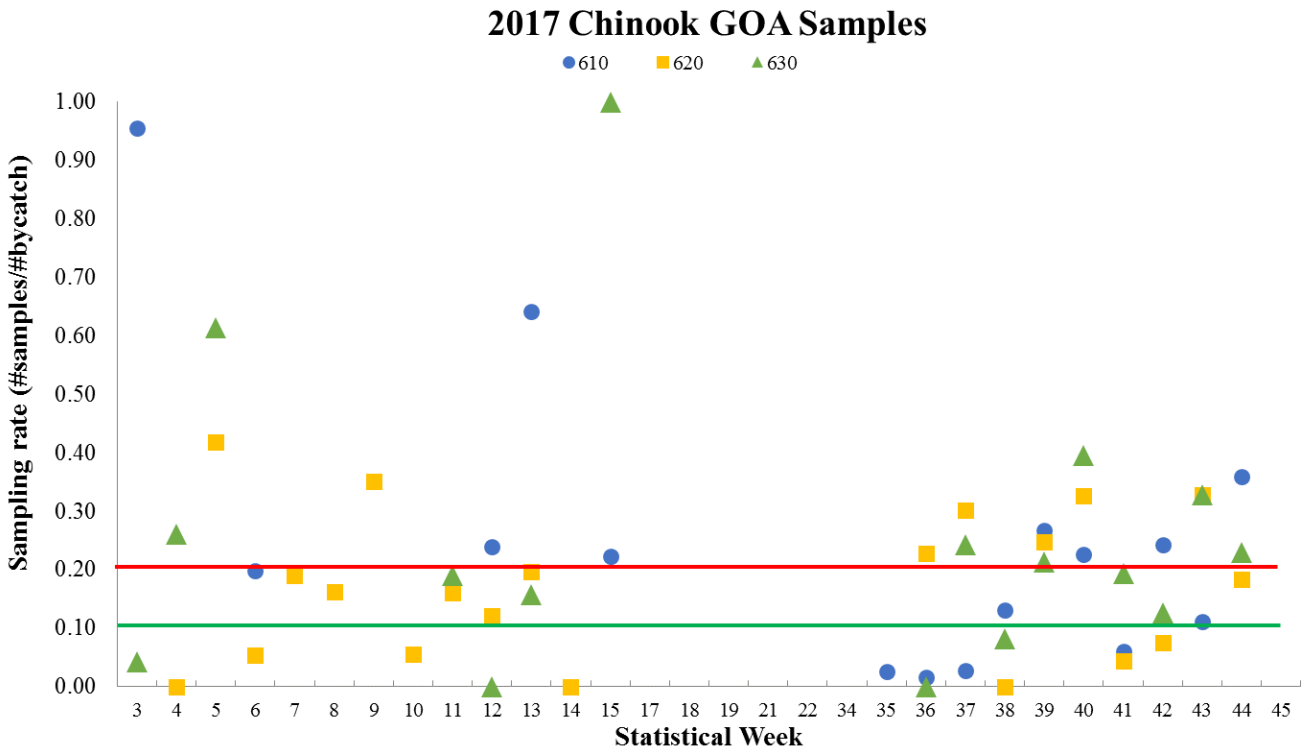


Figure 5. -- Sampling rate of Chinook salmon bycatch by statistical week and NMFS area from the 2017 Gulf of Alaska pollock trawl fishery. The red line shows the average sampling rate (20.2%) across Statistical Areas and Weeks. The green line shows the 10% sampling rate.

GOA Rockfish CV Trawl Fishery

Samples were collected from the Chinook salmon bycatch of the federally managed 2017 GOA CV rockfish trawl fishery by the Alaska Groundfish Data Bank (AGDB) for analysis at the ABL. Although there was no requirement for sample collection, the AGDB implemented a census approach in 2013 (Guyon et al. 2015b), 2014 (Guthrie et al. 2016), 2015 (Guthrie et al. 2017), 2016 (Guthrie et al. 2018), and 2017 whereby genetic samples and biological information were collected from every Chinook salmon encountered in the bycatch. Between 6 May and 15 November 2017 (NMFS statistical week numbers 18-46), genetic samples were collected from 299 Chinook salmon. Because samples were taken from the entire bycatch, the sample

distribution is considered to be the bycatch distribution. The bycatch enumeration by statistical week is shown in Figure 6 and the sample collection area is approximated in Figure 7.

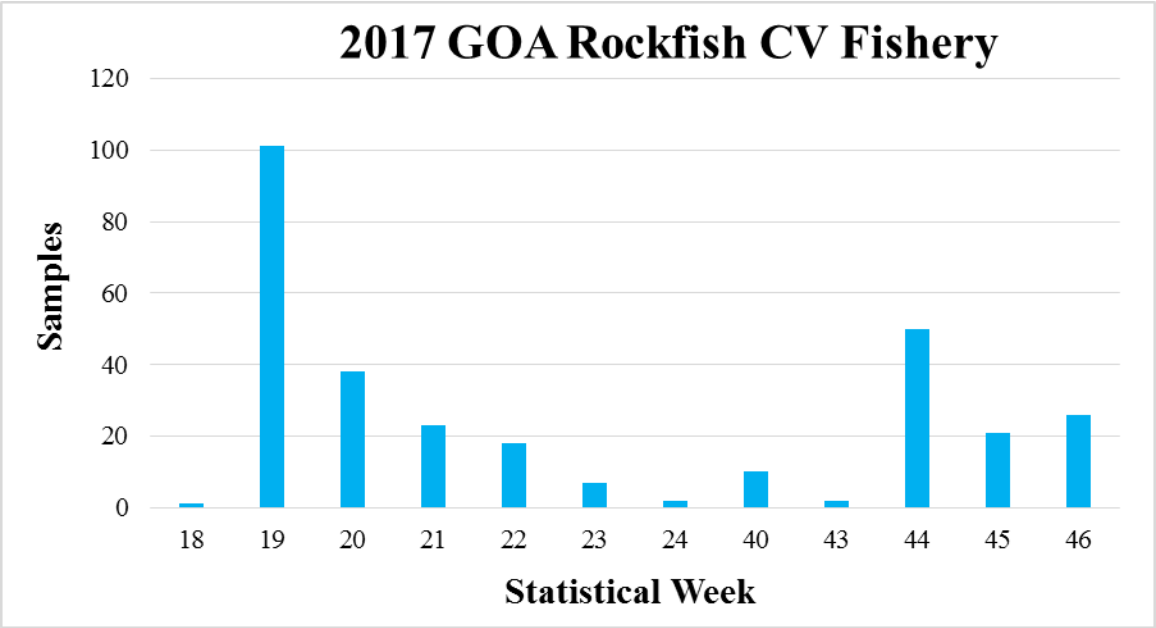


Figure 6. -- Genetic samples collected by Alaska Groundfish Data Bank from the census of the Chinook salmon bycatch in the 2017 Gulf of Alaska rockfish catcher vessel (CV) trawl fishery by statistical week.

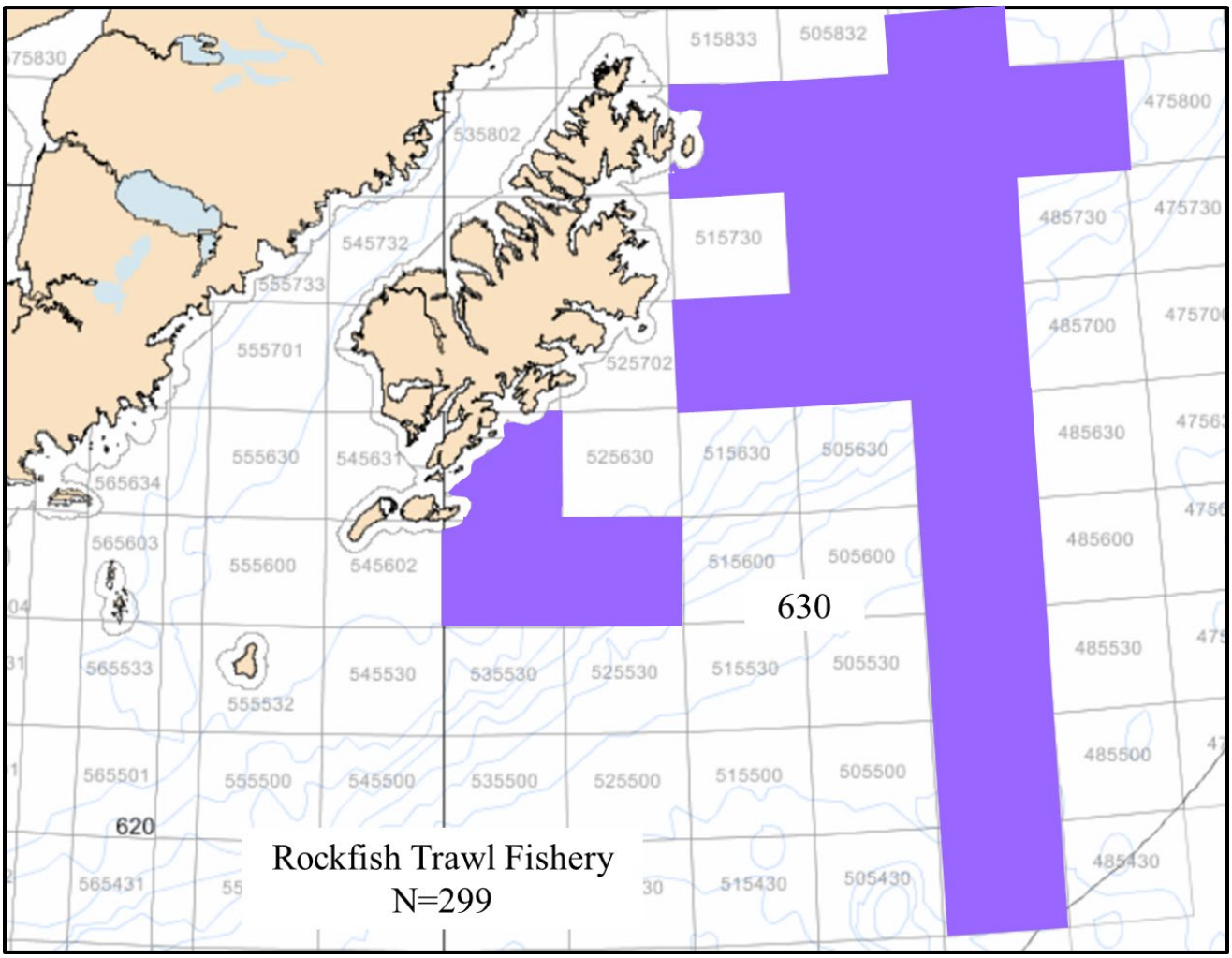


Figure 7. -- Relative location (shaded) of the 299 Chinook salmon bycatch samples collected in NMFS Statistical Area 630 by Alaska Groundfish Data Bank in the 2017 Gulf of Alaska rockfish trawl fishery.

GOA Non-pollock Catcher Processors Trawl Fishery

Samples (N = 56) were collected from the Chinook salmon bycatch of the federally managed 2017 Alaska GOA non-pollock catcher processor trawl fishery by the Alaska Seafood Cooperative for analysis at ABL. The small number of samples precluded accurate stock composition analysis; therefore, these samples were not analyzed.

GENETIC STOCK COMPOSITION - PROCEDURE

DNA was extracted from axillary tissue and genotyping was performed by using Taqman™ chemistries from Applied Biosystems Inc. on a Life Technologies QuantStudio™ or by matrix-assisted laser desorption/ionization - time of flight (MALDI-TOF) (Guyon et al. 2010) on a Sequenom MassARRAY iPLEX platform (Gabriel et al. 2009) for the 43 SNP DNA markers represented in the Chinook salmon baseline (Templin et al. 2011). The SNP baseline contains genetic information for 172 populations of Chinook salmon grouped into 11 geographic regions (also known as stock groups or reporting groups) (Appendix 1). Proof tests performed previously have shown the baseline to be suitable for stock composition analysis (Templin et al. 2011). Replicate samples using 384-well format Taqman™ assays were compared with MALDI-TOF assays, with a concordance rate of 99.99%. In addition to internal MALDI-TOF chip controls, 10 (out of 384 on a chip) previously genotyped samples from ADF&G, which used TaqMan™ chemistries, were included on each chip during the analyses and resulting genotypes were compared. Concordance rates of 99.9% between the two chemistries for the 2017 controls confirmed the utility and compatibility of both genotyping methods.

From the Chinook salmon bycatch from the 2017 GOA pollock trawl fishery, a total of 3,571 of 3,959 samples (91%) were successfully genotyped for 35 or more of the 43 SNP loci. From the Chinook salmon bycatch from the 2017 GOA rockfish CV trawl fishery, 280 of 299 samples received (93.7%) were successfully genotyped for 35 or more of the 43 SNP loci. The successfully genotyped samples had genetic information for an average of 42 of 43 markers.

Stock composition estimates were derived using BAYES software which uses a Bayesian algorithm to produce stock composition estimates and can account for missing alleles in the baseline (Pella and Masuda 2001). For each BAYES analysis, 11 Monte Carlo chains

starting at disparate values of stock proportions were configured such that for each chain 95% of the stocks came from a single designated stock group (region) with weights equally distributed among the stocks of that region. The designated region was unique in each chain. The remaining 5% was equally distributed among remaining stocks from all other regions. For all estimates, a flat prior of 0.005814 (calculated as 1/172) was used for all 172 baseline populations. The analyses were completed for a chain length of 10,000 with the first 5,000 deleted during the burn-in phase when determining overall stock compositions. Convergence of the chains to posterior distributions of stock proportions was determined with Gelman and Rubin shrink statistics (Gelman and Rubin 1992), which were 1.10 or less for all the estimates, conveying strong convergence to a single posterior distribution (Pella and Masuda 2001).

Estimated numbers of fish were calculated from the mean of the posterior distribution of stock composition estimates and the estimated total bycatch of Chinook salmon. Stock composition catch estimates for strata are not additive, this being most apparent for small contributors, for strata with smaller sample sizes, or both. This is because the confidence intervals are bounded by zero resulting in skewed BAYES posterior distributions. For example, the estimated mean number of Chinook salmon originating from the Coastal Western Alaska region in the South of Akutan Island stratum is 208 fish (Appendix 2), whereas in the overall GOA bycatch the contribution from this region is only 96 fish. The 95% confidence interval of the estimated number of fish (79-385 fish) from the Coastal Western Alaska region in the smaller stratum is within the estimated number of fish from the overall GOA bycatch.

GENETIC STOCK COMPOSITION - RESULTS

GOA Pollock Trawl Fishery

The stock composition results indicate that 99.5% of the 3,571 samples from the GOA originated from three southern regions with the British Columbia region contributing the most (43%; 9,096 fish), followed by the West Coast US (38%; 8,215 fish), and Coastal Southeast Alaska (13%; 2,762 fish) regions (Appendix 2). Although care must be taken when comparing estimates across years due to the differences in sampling, the stock composition estimates in 2017 were very similar to estimates from the previous 7 years (Fig. 8).

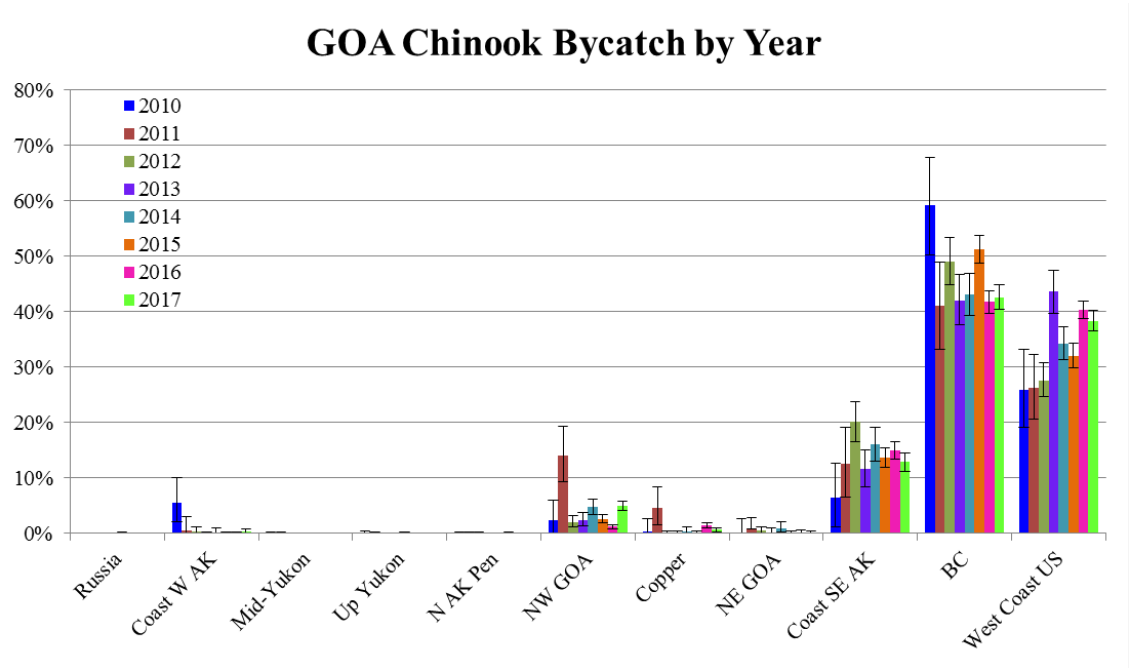


Figure 8. -- Yearly stock composition estimates (2010-2017) with BAYES 95% credible intervals of Chinook salmon bycatch based on available genetic samples from the Gulf of Alaska (GOA) pollock trawl fishery. The same genetic baseline and general regional groupings were used in all analyses.

Using information from the ANSWERS tool provided by AKFIN (NMFS 2018), geographical (ADF&G statistical areas) aggregations were developed to provide stock compositions with greater spatial precision than the existing NMFS statistical areas. We

analyzed 10 additional (other than overall and rockfish) bycatch sample strata (Appendix 2) including South of Akutan Island (Fig. 9); Shumagin Islands Early (statistical weeks 3-15), Late (statistical weeks 36-43), and overall (Fig. 10); Shelikof Strait Early (statistical weeks 4-13), Late (statistical weeks 36-44), and overall (Fig. 11); and Southeast Kodiak Island Early (statistical weeks 3-5), Late (statistical weeks 36-44), and overall (Fig. 12).

The western-most geographical stratum, South of Akutan Island (Fig. 9), had its largest stock composition estimate contribution from the West Coast US (36%) region, followed by the NW GOA (26%), British Columbia (25%), Coastal Western Alaska (6%) and Copper (5%) regions (Appendix 2; Fig. 13). To the east of Akutan Island, the largest stock composition estimates in the Shumagin Islands (Fig. 10) were from British Columbia (64%) and the West Coast US (24%) with a smaller component from Coastal Southeast Alaska (7%) (Appendix 2; Fig 13). Within the Shumagin Island stratum there were temporal differences in stock composition estimates between the Early and Late seasons. For example, the British Columbia region accounted for 47% and 67% of the bycatch in the Early and Late seasons, respectively, and the West Coast US contributed 39% and 19% of the bycatch in the Early and Late seasons, respectively (Appendix 2; Fig. 14). For Shelikof Strait overall (Fig. 11), the West Coast US contributed the most (45%), followed by British Columbia (38%), and Coastal Southeast Alaska (12%) (Appendix 2; Fig. 13). The Early and Late season Shelikof Strait strata exhibited temporal differences in stock estimates. The West Coast US accounted for 50% and 30% of the bycatch in the Early and Late seasons, respectively, while British Columbia contributed 40% and 33% of the bycatch in the Early and Late seasons, respectively (Appendix 2; Fig 15). Contributions from both Coastal Southeast Alaska (10% to 21%) and NW GOA (0% to 14%) increase from Shelikof Strait Early to Late (Appendix 2, Fig. 15). It should be noted that all the fish from Shelikof Strait

Late were from the most southwestern portion (ADF&G Statistical Areas 555600 and 555630) of the stratum (Fig. 11). For the Southeast Kodiak Island overall stratum (Fig. 12), the large stock contribution estimates were from the British Columbia region (48%), followed by the West Coast US (32%) and Coastal Southeast Alaska (18%) regions (Appendix 2; Fig. 13). Although the largest contributor was the British Columbia region in both Early and Late strata (46% and 49%, respectively), there are some temporal differences of stock composition estimates from other regions (Fig.16). From Early to Late strata, the West Coast US contribution decreased (38% to 22%), and Coastal Southeast Alaska contribution increased (15% to 25%).

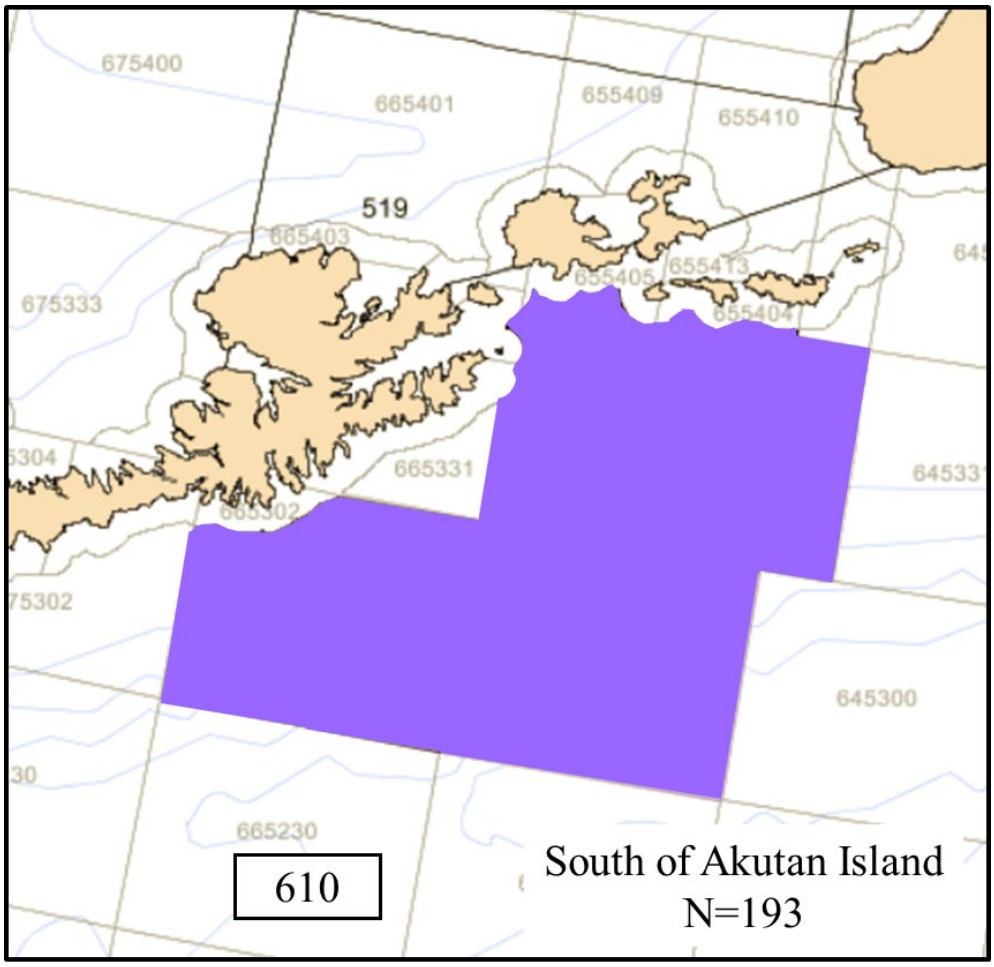


Figure 9. -- Location (shaded) of the South of Akutan Island stratum used in comparative stock composition estimates from the 2017 Gulf of Alaska Chinook salmon bycatch from the pollock trawl fishery (NMFS 2018).

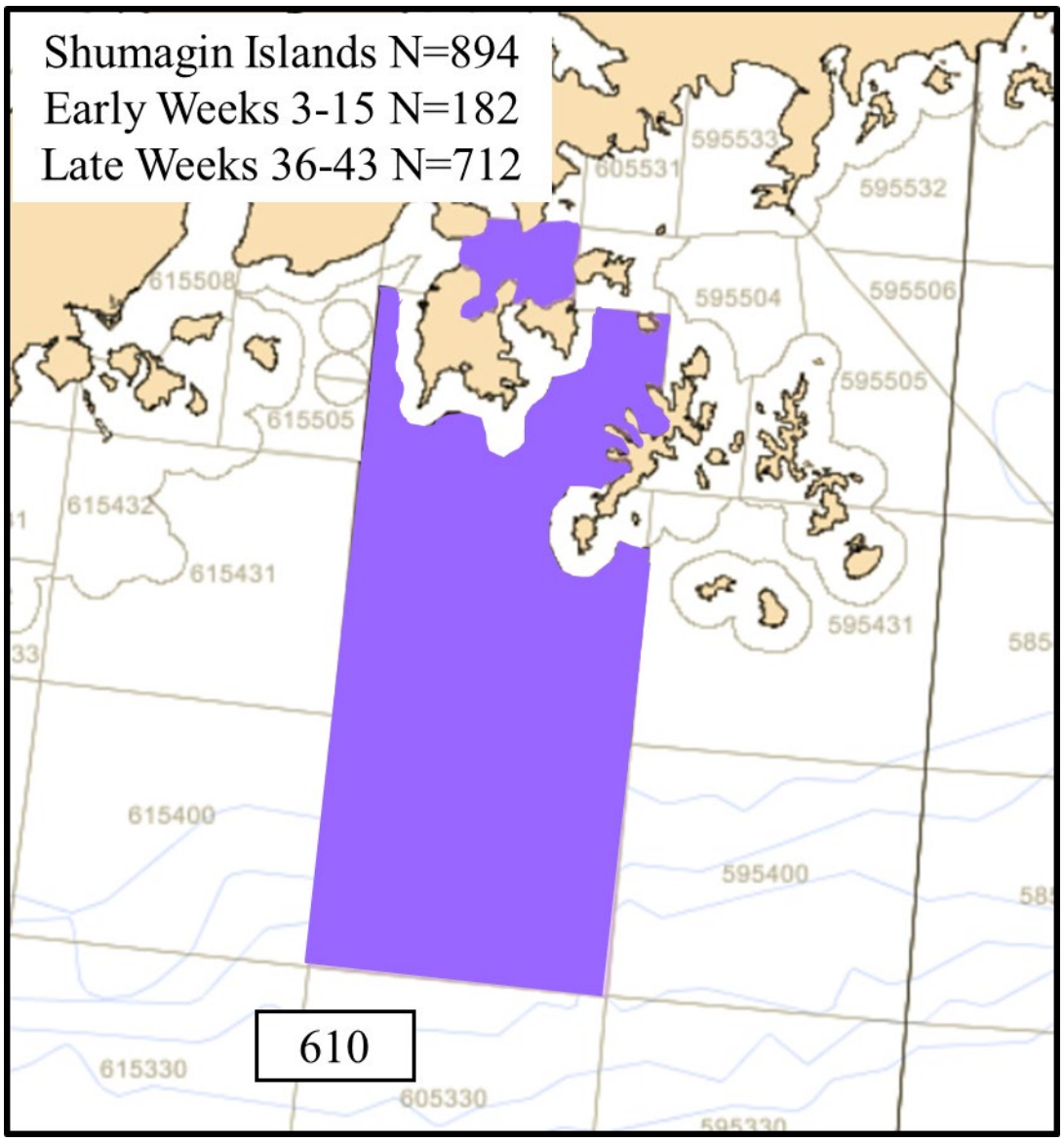


Figure 10. -- Location (shaded) of the Shumagin Islands Early and Late strata used in comparative stock composition estimates from the 2017 Gulf of Alaska Chinook salmon bycatch from the pollock trawl fishery (NMFS 2018).

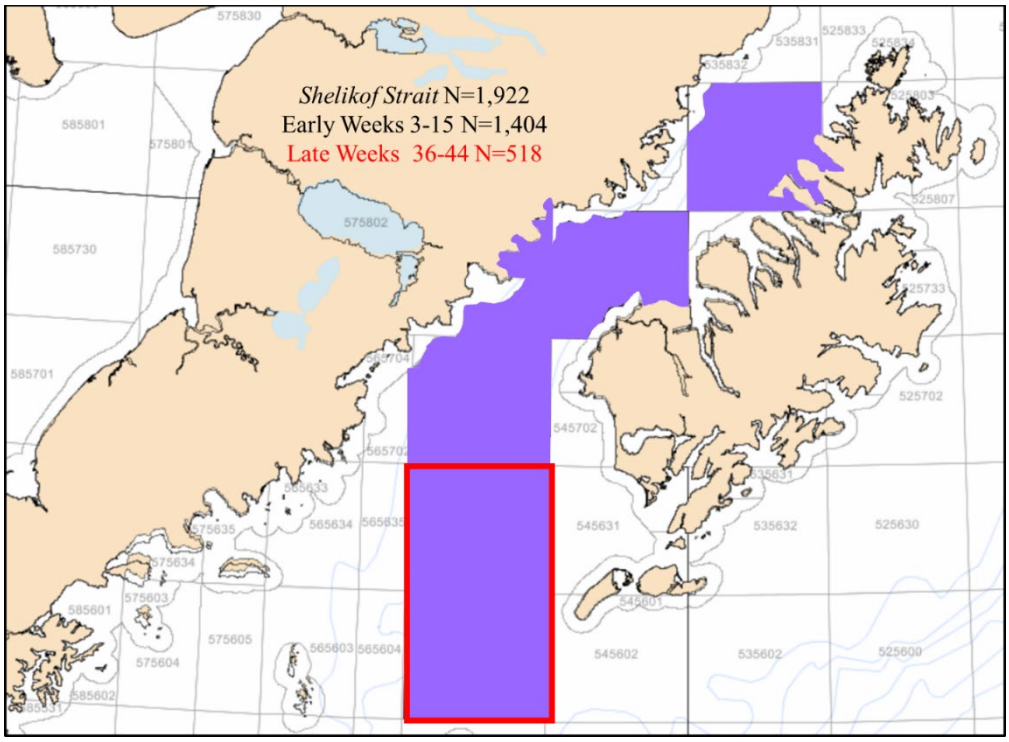


Figure 11. -- Location (shaded) of the Shelikof Strait strata used in comparative stock composition estimates from the 2017 Gulf of Alaska Chinook salmon bycatch from the pollock trawl fishery (NMFS 2018). Location of Late samples is outlined in red.

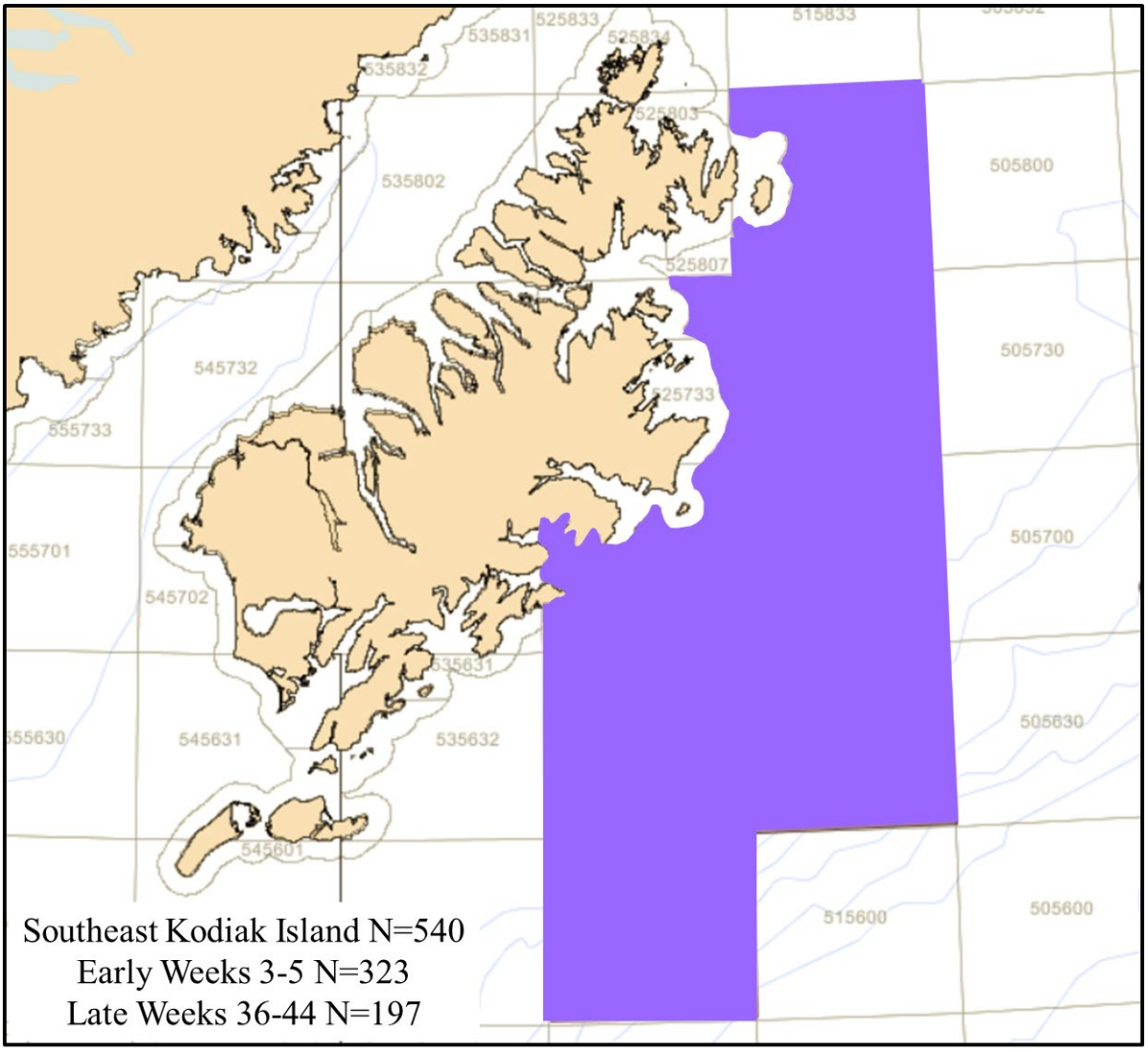


Figure 12. -- Location (shaded) of the Kodiak Island strata used in comparative stock composition estimates from the 2017 Gulf of Alaska Chinook salmon bycatch from the pollock trawl fishery (NMFS 2018).

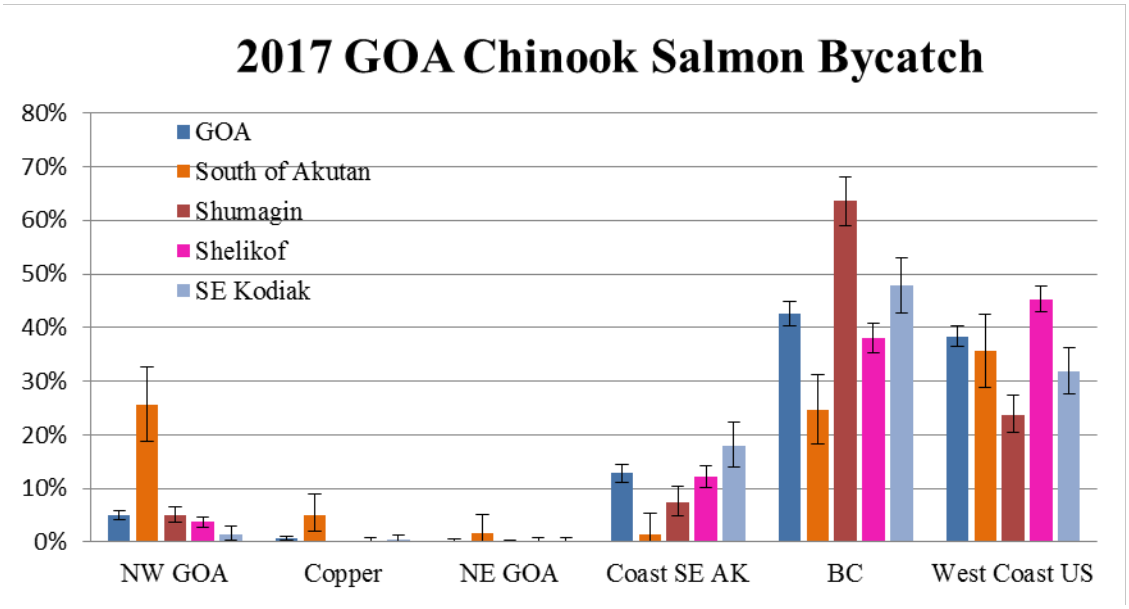


Figure 13. -- Stock composition estimates with BAYES 95% credible intervals of Chinook salmon bycatch samples from five area strata from the 2017 GOA pollock trawl fishery: All GOA (3,571 samples); South of Akutan Island (193, Fig. 9); Shumagin Islands overall (894, Fig. 10); Shelikof Strait overall (1,922, Fig. 11); and Southeast Kodiak Island overall (540, Fig. 12).

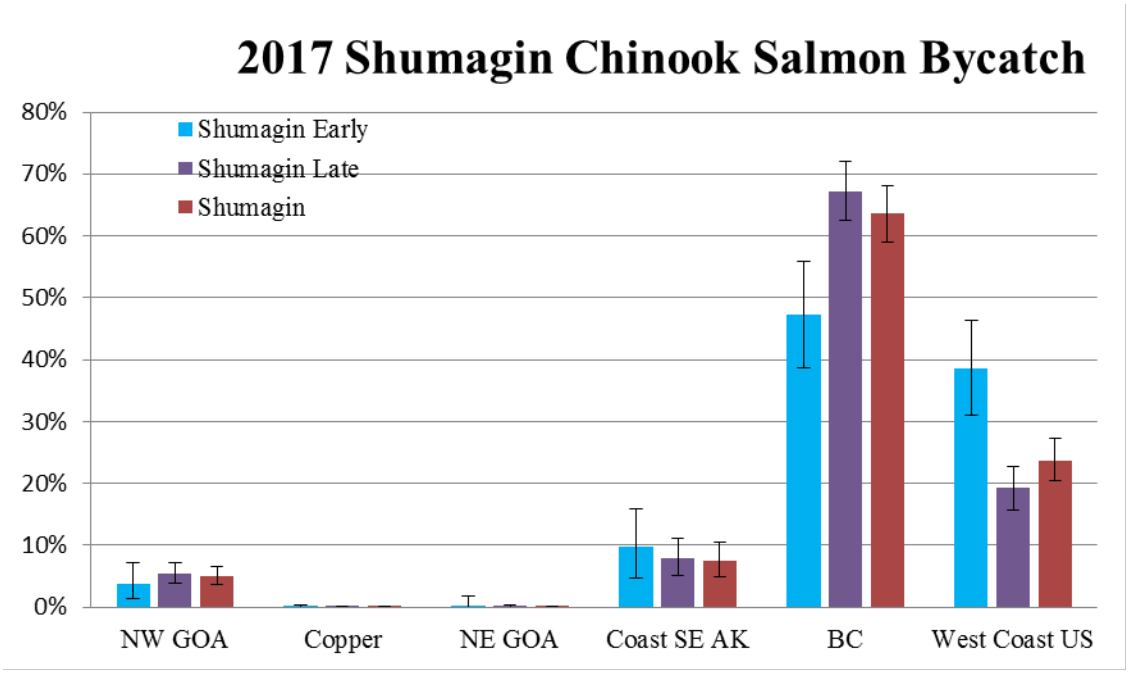


Figure 14. -- Stock composition estimates with BAYES 95% credible intervals of Chinook salmon bycatch samples from Shumagin Islands (Fig. 10) area and time strata from the 2017 GOA) pollock trawl fishery: Early (182), Late (712), and overall (894).

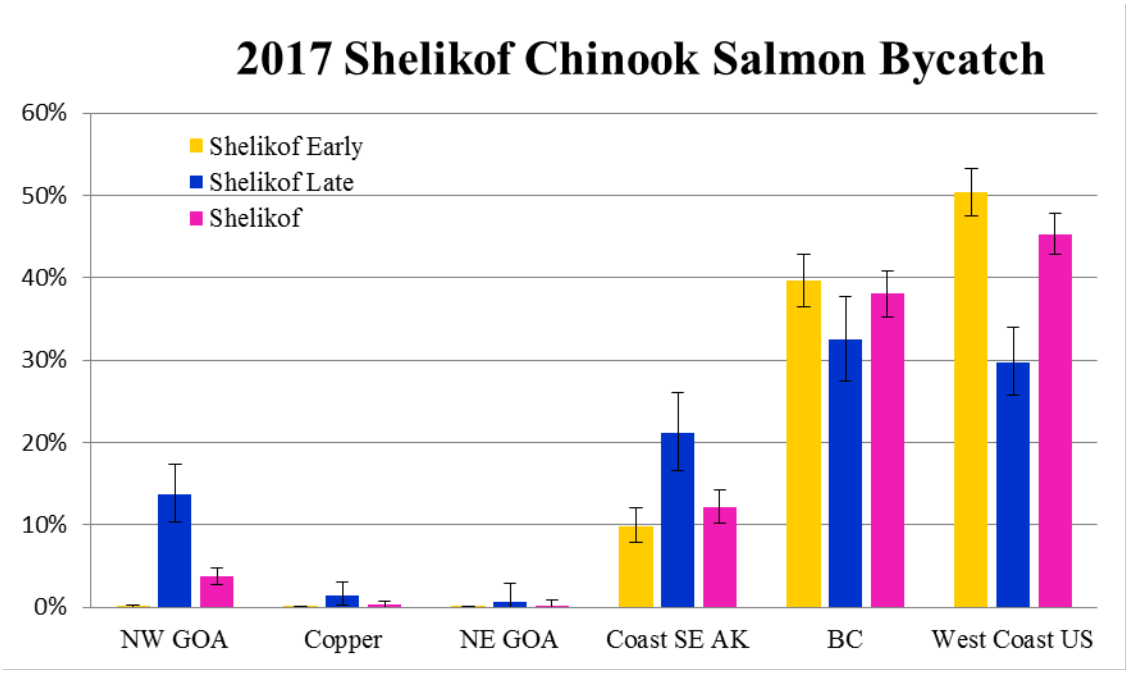


Figure 15. -- Stock composition estimates with BAYES 95% credible intervals of Chinook salmon bycatch samples from Shelikof Strait (Fig. 11) area and time strata from the 2017 Gulf of Alaska pollock trawl fishery: Early (1,404), Late (518) and overall (1,922).

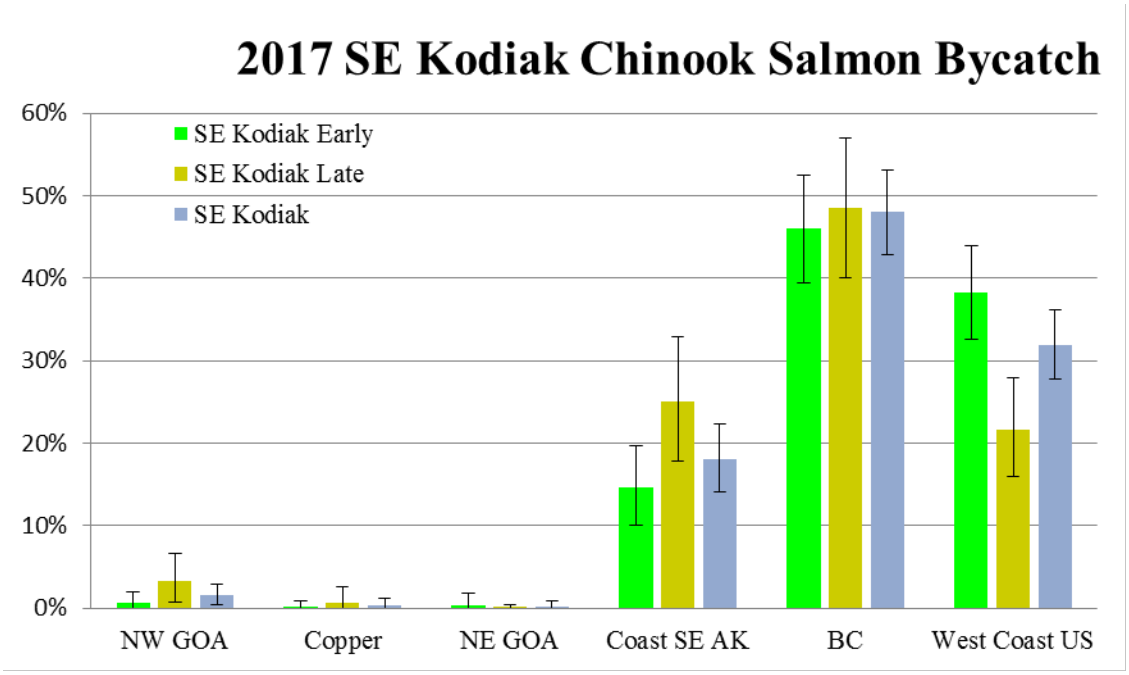


Figure 16. -- Stock composition estimates with BAYES 95% credible intervals of Chinook salmon bycatch samples from Southeast Kodiak Island (Fig. 12) area and time strata from the 2017 Gulf of Alaska pollock trawl fishery: Early (323), Late (197), and overall (540).

Gulf of Alaska Rockfish CV Trawl Fishery

The stock composition results indicate that almost all of the 280 Chinook salmon samples from the bycatch of the 2017 GOA rockfish CV trawl fishery originated from southern regions (99%), primarily from West Coast US (56%), British Columbia (28%), and Coastal Southeast Alaska (11%) regions (Appendix 2). When comparing stock estimates across all years (2013-2017), these same three reporting groups consistently accounted for over 99% of the bycatch (Fig. 17). For the two highest contributing regions, British Columbia and West Coast US, the results in 2017 were most similar to those in 2013 and 2016, and differed slightly from the estimates in 2014 and 2015, which were almost identical.

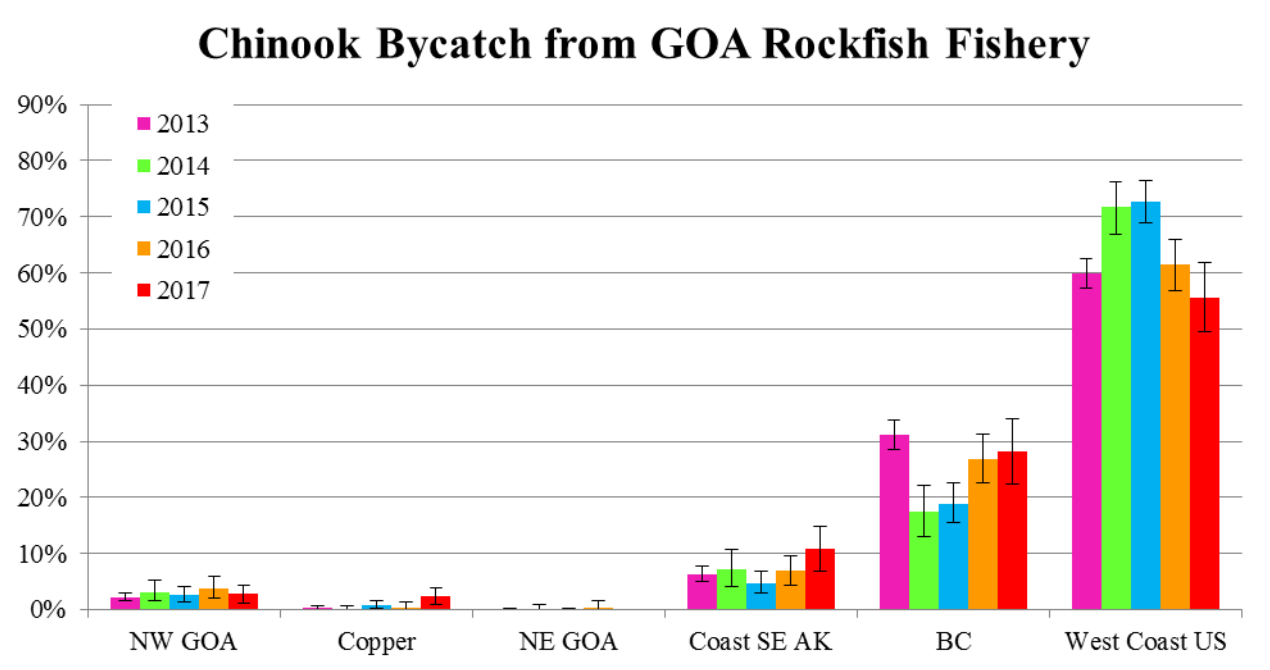


Figure 17. -- Stock composition estimates with 95% BAYES credible intervals of Chinook salmon bycatch from the 2013-2017 Gulf of Alaska rockfish CV trawl fishery.

SUMMARY

The incidental harvest of Chinook salmon from federally managed groundfish fisheries in the GOA averaged 21,521 salmon per year during 1991-2016, with an estimated peak of 54,678 in 2010. In 2017, the largest component of the Chinook salmon bycatch in the GOA was from the pollock trawl fishery with an estimated 21,392 fish. An additional 3,489 fish from other fisheries, including the rockfish and arrowtooth flounder trawl fisheries, bring the GOA 2017 Chinook salmon bycatch total to an estimated 24,881 fish.

Stock composition estimates of the Chinook salmon bycatch help pollock and salmon fishery managers understand the biological effects of the incidental take of salmon in the trawl fishery. However, results should be interpreted judiciously; the limitations of these analyses are summarized below.

Sampling Issues

Due to efforts from the Observer Program and the many observers who collected samples, the number of available samples from the 2017 GOA pollock trawl fishery was almost 17% of the total bycatch. The samples in 2017 were collected in similar proportions to the overall bycatch (Fig. 3), although small differences in spatial and temporal distributions remain (Figs. 4, 5). Because the sample set represents such a large proportion of the total bycatch the overall estimate can be considered the bycatch stock composition from the 2017 GOA pollock trawl fishery.

Similar to the 2013-2016 GOA rockfish CV trawl fisheries, the fishing industry conducted a census approach in 2017 to collect genetic samples from every Chinook salmon encountered. Consequently, the reported stock composition can be considered the overall stock

composition for that fishery with the stipulation that samples were provided outside of the NMFS Observer Program (Appendix 2).

Stock Composition Estimates

The stock composition estimates for Chinook salmon bycatch samples collected from federally managed trawl fisheries in the GOA continue to show that the vast majority of Chinook salmon that are encountered originate from three large southern regions between coastal Southeast Alaska and northern California. This pattern also holds for samples collected across finer-scale area and time strata within the GOA, including bycatch collected during Early and Late time periods from the Shumagin Islands, Shelikof Strait, and Kodiak Island. Bycatch samples collected from the westernmost location, South of Akutan Island, had somewhat different stocks present. Although about half the fish were from the two most southern regions (British Columbia and West Coast US), the remainder was from stocks farther north and west (NW GOA and Coastal Western Alaska).

Application of Estimates

The extent to which any salmon stock is impacted by the bycatch of the GOA trawl fisheries is dependent on many factors including 1) the overall number of fish caught as bycatch, 2) the age of the salmon caught in the bycatch, 3) the age of the returning salmon, and 4) the total run size of the affected stocks taking into account lag time for maturity and returning to the river. As such, a higher contribution of a particular stock in one year does not necessarily imply greater impact than a smaller estimate the next.

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APPENDICES

Appendix 1. -- Chinook salmon populations in the ADF&G SNP baseline with the regional designations used in the analyses of this report. S. = South, R. = River, H. = Hatchery, and L. = Lake.

Population name	Reg Num.	Region	Population name	Reg Num.	Region
Bistraya River	1	Russia	Henshaw Creek	3	Mid Yukon
Bolshaya River	1	Russia	Kantishna River	3	Mid Yukon
Kamchatka River late	1	Russia	Salcha River	3	Mid Yukon
Pakhatcha River	1	Russia	Sheenjek River	3	Mid Yukon
Andreafsky River	2	Coast W AK	S. Fork Koyukuk River	3	Mid Yukon
Aniak River	2	Coast W AK	Big Salmon River	4	Up Yukon
Anvik River	2	Coast W AK	Blind River	4	Up Yukon
Arolik River	2	Coast W AK	Chandindu River	4	Up Yukon
Big Creek	2	Coast W AK	Klondike River	4	Up Yukon
Cheeneetnuk River	2	Coast W AK	Little Salmon River	4	Up Yukon
Eek River	2	Coast W AK	Mayo River	4	Up Yukon
Gagaryah River	2	Coast W AK	Nisutlin River	4	Up Yukon
George River	2	Coast W AK	Nordenskiold River	4	Up Yukon
Gisasa River	2	Coast W AK	Pelly River	4	Up Yukon
Golsovia River	2	Coast W AK	Stewart River	4	Up Yukon
Goodnews River	2	Coast W AK	Takhini River	4	Up Yukon
Kanektok River	2	Coast W AK	Tatchun Creek	4	Up Yukon
Kisaralik River	2	Coast W AK	Whitehorse Hatchery	4	Up Yukon
Kogrukluk River	2	Coast W AK	Black Hills Creek	5	N AK Pen
Kwethluk River	2	Coast W AK	King Salmon River	5	N AK Pen
Mulchatna River	2	Coast W AK	Meshik River	5	N AK Pen
Naknek River	2	Coast W AK	Milky River	5	N AK Pen
Nushagak River	2	Coast W AK	Nelson River	5	N AK Pen
Pilgrim River	2	Coast W AK	Steelhead Creek	5	N AK Pen
Salmon R. -Pitka Fork	2	Coast W AK	Anchor River	6	NW GOA
Stony River	2	Coast W AK	Ayakulik River	6	NW GOA
Stuyahok River	2	Coast W AK	Benjamin Creek	6	NW GOA
Takotna River	2	Coast W AK	Chignik River	6	NW GOA
Tatlawiksuk River	2	Coast W AK	Crescent Creek	6	NW GOA
Togiak River	2	Coast W AK	Crooked Creek	6	NW GOA
Tozitna River	2	Coast W AK	Deception Creek	6	NW GOA
Tuluksak River	2	Coast W AK	Deshka River	6	NW GOA
Unalakleet River	2	Coast W AK	Funny River	6	NW GOA
Beaver Creek	3	Mid Yukon	Juneau Creek	6	NW GOA
Chandalar River	3	Mid Yukon	Karluk River	6	NW GOA
Chena River	3	Mid Yukon	Kasilof River mainstem	6	NW GOA

Appendix 1. -- Cont.

Population name	Reg Num.	Region	Population name	Reg Num.	Region
Kenai River mainstem	6	NW GOA	Kowatua River	9	Coast SE AK
Killey Creek	6	NW GOA	Little Tatsemenie River	9	Coast SE AK
Ninilchik River	6	NW GOA	Macaulay Hatchery	9	Coast SE AK
Prairie Creek	6	NW GOA	Medvejie Hatchery	9	Coast SE AK
Slikok Creek	6	NW GOA	Nakina River	9	Coast SE AK
Talachulitna River	6	NW GOA	Tahltan River	9	Coast SE AK
Willow Creek	6	NW GOA	Unuk R.-Deer Mountain H.	9	Coast SE AK
Bone Creek	7	Copper	Unuk River - LPW	9	Coast SE AK
E. Fork Chistochina River	7	Copper	Upper Nahlin River	9	Coast SE AK
Gulkana River	7	Copper	Big Qualicum River	10	BC
Indian River	7	Copper	Birkenhead River spring	10	BC
Kiana Creek	7	Copper	Bulkley River	10	BC
Manker Creek	7	Copper	Chilko River summer	10	BC
Mendeltna Creek	7	Copper	Clearwater River summer	10	BC
Otter Creek	7	Copper	Conuma River	10	BC
Sinona Creek	7	Copper	Damdochax Creek	10	BC
Tebay River	7	Copper	Ecstall River	10	BC
Tonsina River	7	Copper	Harrison River	10	BC
Big Boulder Creek	8	NE GOA	Kateen River	10	BC
Kelsall River	8	NE GOA	Kincolith Creek	10	BC
King Salmon River	8	NE GOA	Kitimat River	10	BC
Klukshu River	8	NE GOA	Klinaklini River	10	BC
Situk River	8	NE GOA	Kwinageese Creek	10	BC
Tahini River	8	NE GOA	Louis River spring	10	BC
Tahini River - Pullen Creek H.	8	NE GOA	Lower Adams River fall	10	BC
Andrews Creek	9	Coast SE AK	Lower Atnarko River	10	BC
Blossom River	9	Coast SE AK	Lower Kalum River	10	BC
Butler Creek	9	Coast SE AK	Lower Thompson River fall	10	BC
Chickamin River	9	Coast SE AK	Marble Creek	10	BC
Chickamin River-LPW	9	Coast SE AK	Middle Shuswap R. summer	10	BC
Chickamin R.Whitman L. H.	9	Coast SE AK	Morkill River summer	10	BC
Clear Creek	9	Coast SE AK	Nanaimo River	10	BC
Cripple Creek	9	Coast SE AK	Nechako River summer	10	BC
Crystal Lake Hatchery	9	Coast SE AK	Nitinat River	10	BC
Dudidontu River	9	Coast SE AK	Oweegee Creek	10	BC
Genes Creek	9	Coast SE AK	Porteau Cove	10	BC
Hidden Falls Hatchery	9	Coast SE AK	Quesnel River summer	10	BC
Humpy Creek	9	Coast SE AK	Quinsam River	10	BC
Kerr Creek	9	Coast SE AK	Robertson Creek	10	BC
Keta River	9	Coast SE AK	Salmon River summer	10	BC
King Creek	9	Coast SE AK	Sarita River	10	BC

Appendix 1. -- Cont.

Population name	Reg Num.	Region
Stuart River summer	10	BC
Sustut River	10	BC
Torpy River summer	10	BC
Wannock River	10	BC
Alsea River fall	11	West Coast US
Carson Hatchery spring	11	West Coast US
Eel River fall	11	West Coast US
Forks Creek fall	11	West Coast US
Hanford Reach	11	West Coast US
Klamath River	11	West Coast US
Lower Deschutes R. fall	11	West Coast US
Lyons Ferry H. summer/fall	11	West Coast US
Makah National Fish H. fall	11	West Coast US
McKenzie River spring	11	West Coast US
Sacramento River winter	11	West Coast US
Siuslaw River fall	11	West Coast US
Soos Creek Hatchery fall	11	West Coast US
Upper Skagit River summer	11	West Coast US

Appendix 2. -- Regional BAYES stock composition percentage estimates, standard deviations (SD), 95% credible intervals (CI), and estimated numbers of Chinook salmon from the 2017 GOA pollock fishery, different strata of the pollock fishery, and the rockfish trawl fishery. Sample sizes are adjacent to stratum designation. Total catch is the estimated catch from AKFIN reports (NMFS 2018). GOA, pollock (upper, left) encompasses other strata except the rockfish trawl fishery. Stock composition estimates may not sum to 100% and stock-specific catch estimates may not sum to the total catch due to rounding error. Note: for smaller sample sets, the estimated numbers of fish from small contributors may be higher than for the overall GOA.

	Gulf of Alaska, pollock (N=3,571)				Shelikof Strait Early (N=1,404)				Shelikof Strait Late (N=518)				Shelikof Strait (N=1,922)			
Region	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI
Russia	6	0.0	0.03	(0.0,0.1)	0	0.0	0.01	(0.0,0.0)	0	0.0	0.03	(0.0,0.1)	0	0.0	0.01	(0.0,0.0)
Coast W AK	96	0.5	0.18	(0.2,0.9)	2	0.0	0.05	(0.0,0.2)	23	0.8	0.89	(0.0,3.0)	22	0.2	0.25	(0.0,0.9)
Mid Yukon	0	0.0	0.01	(0.0,0.0)	0	0.0	0.02	(0.0,0.0)	0	0.0	0.05	(0.0,0.1)	0	0.0	0.01	(0.0,0.0)
Up Yukon	0	0.0	0.01	(0.0,0.0)	1	0.0	0.02	(0.0,0.1)	1	0.0	0.06	(0.0,0.2)	0	0.0	0.02	(0.0,0.0)
N AK Pen	0	0.0	0.02	(0.0,0.1)	0	0.0	0.02	(0.0,0.0)	0	0.0	0.07	(0.0,0.2)	1	0.0	0.03	(0.0,0.1)
NW GOA	1,065	5.0	0.41	(4.2,5.8)	6	0.1	0.09	(0.0,0.3)	387	13.7	1.78	(10.4,17.3)	415	3.7	0.50	(2.8,4.8)
Copper	137	0.6	0.18	(0.3,1.0)	1	0.0	0.02	(0.0,0.1)	39	1.4	0.73	(0.2,3.0)	35	0.3	0.21	(0.0,0.8)
NE GOA	13	0.1	0.13	(0.0,0.5)	1	0.0	0.04	(0.0,0.1)	16	0.6	0.90	(0.0,2.9)	23	0.2	0.29	(0.0,0.9)
Coast SE AK	2,762	12.9	0.86	(11.2,14.6)	819	9.9	1.09	(7.8,12.1)	599	21.2	2.41	(16.6,26.1)	1,359	12.2	1.04	(10.2,14.3)
BC	9,096	42.5	1.14	(40.4,44.9)	3,292	39.6	1.63	(36.5,42.9)	916	32.5	2.61	(27.5,37.7)	4,234	38.0	1.41	(35.3,40.8)
West Coast US	8,215	38.4	0.92	(36.6,40.2)	4,188	50.4	1.45	(47.6,53.2)	839	29.8	2.10	(25.7,33.9)	5,041	45.3	1.24	(42.9,47.7)
Total Catch	21,392				8,309				2,821				11,130			

	South of Akutan Island (N=193)				Shumagin Islands Early (N=182)				Shumagin Islands Late (N=712)				Shumagin Islands (N=894)			
Region	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI
Russia	20	0.5	0.52	(0.0,1.9)	0	0.0	0.09	(0.0,0.1)	0	0.0	0.02	(0.0,0.0)	0	0.0	0.02	(0.0,0.0)
Coast W AK	208	5.6	2.11	(2.1,10.4)	1	0.2	0.43	(0.0,1.5)	3	0.1	0.16	(0.0,0.6)	2	0.1	0.11	(0.0,0.4)
Mid Yukon	1	0.0	0.12	(0.0,0.3)	0	0.0	0.17	(0.0,0.5)	0	0.0	0.03	(0.0,0.1)	0	0.0	0.03	(0.0,0.1)
Up Yukon	1	0.0	0.16	(0.0,0.5)	0	0.0	0.15	(0.0,0.4)	0	0.0	0.05	(0.0,0.2)	0	0.0	0.04	(0.0,0.1)
N AK Pen	4	0.1	0.46	(0.0,1.5)	0	0.0	0.18	(0.0,0.4)	0	0.0	0.07	(0.0,0.2)	0	0.0	0.06	(0.0,0.1)
NW GOA	949	25.5	3.56	(18.7,32.7)	22	3.9	1.50	(1.5,7.3)	137	5.4	0.88	(3.8,7.2)	156	5.0	0.76	(3.6,6.6)
Copper	186	5.0	1.75	(2.1,8.9)	0	0.0	0.14	(0.0,0.4)	1	0.0	0.06	(0.0,0.2)	0	0.0	0.05	(0.0,0.1)
NE GOA	65	1.8	1.38	(0.0,5.0)	1	0.2	0.52	(0.0,1.8)	1	0.0	0.10	(0.0,0.3)	1	0.0	0.08	(0.0,0.2)
Coast SE AK	49	1.3	1.57	(0.0,5.5)	56	9.8	2.92	(4.6,16.0)	202	8.0	1.51	(5.2,11.1)	230	7.4	1.44	(4.9,10.4)
BC	913	24.6	3.30	(18.4,31.3)	273	47.2	4.44	(38.6,55.9)	1,700	67.2	2.42	(62.4,71.9)	1,979	63.7	2.33	(59.1,68.1)
West Coast US	1,321	35.5	3.52	(28.7,42.6)	223	38.6	3.94	(31.1,46.4)	486	19.2	1.80	(15.8,22.8)	737	23.7	1.75	(20.4,27.3)
Total Catch	3,717				578				2,529				3,106			

	SE Kodiak I. Early (N=323)				Southeast Kodiak I. Late (N=197)				Southeast Kodiak Island (N=540)				Rockfish Trawl Fishey (N=280)			
Region	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI	Est. #	Mean	SD	95% CI
Russia	0	0.0	0.05	(0.0,0.1)	0	0.0	0.08	(0.0,0.1)	0	0.0	0.03	(0.0,0.0)	0	0.0	0.07	(0.0,0.1)
Coast W AK	1	0.1	0.17	(0.0,0.6)	6	0.6	1.01	(0.0,3.5)	3	0.1	0.24	(0.0,0.9)	0	0.1	0.21	(0.0,0.7)
Mid Yukon	0	0.0	0.07	(0.0,0.2)	0	0.0	0.11	(0.0,0.3)	0	0.0	0.04	(0.0,0.1)	0	0.0	0.08	(0.0,0.2)
Up Yukon	0	0.0	0.08	(0.0,0.3)	0	0.0	0.15	(0.0,0.4)	0	0.0	0.05	(0.0,0.2)	0	0.0	0.10	(0.0,0.3)
N AK Pen	0	0.0	0.13	(0.0,0.3)	0	0.1	0.26	(0.0,0.6)	1	0.1	0.20	(0.0,0.7)	0	0.0	0.15	(0.0,0.4)
NW GOA	9	0.7	0.57	(0.0,2.1)	31	3.3	1.51	(0.8,6.7)	37	1.5	0.64	(0.5,3.0)	8	2.7	1.03	(1.1,5.1)
Copper	1	0.1	0.25	(0.0,0.9)	7	0.7	0.72	(0.0,2.6)	9	0.4	0.35	(0.0,1.2)	7	2.4	0.95	(0.8,4.6)
NE GOA	5	0.3	0.54	(0.0,1.9)	0	0.0	0.17	(0.0,0.4)	2	0.1	0.24	(0.0,0.9)	0	0.0	0.22	(0.0,0.5)
Coast SE AK	207	14.6	2.50	(10.0,19.7)	236	25.1	3.81	(17.9,32.8)	440	18.0	2.12	(14.0,22.4)	33	10.9	2.21	(6.9,15.5)
BC	650	46.0	3.30	(39.5,52.4)	455	48.5	4.33	(40.0,57.0)	1,172	48.0	2.61	(42.8,53.0)	84	28.1	3.07	(22.3,34.3)
West Coast US	540	38.2	2.88	(32.6,43.9)	203	21.6	3.06	(15.9,27.9)	779	31.9	2.14	(27.8,36.1)	166	55.6	3.11	(49.4,61.6)
Total Catch	1,414				939				2,443				299			

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