2008 YUKON RIVER PANEL RESEARCH AND MANAGEMENT FUND
FINAL REPORT

Project Number: RM-14-08

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Project Title: Yukon River summer chum salmon mixed-stock analysis, 2008

Project Location: Pilot Station, Yukon River

Objectives Summary: Estimate regional stock contributions and run timing of Yukon River summer chum salmon from Pilot Station sonar test fishery harvests.

Project Summary: Information on stock composition of Yukon River summer chum salmon, during the spawning run, has been limited. The disparate strength of individual chum salmon stocks within and among years, combined with overlapping multi-species spawning runs, the immense size of the drainage, and the inability to determine stock specific abundance and timing makes fishery management difficult. Knowledge of the origin of chum salmon as they enter the river would assist in managing fisheries to achieve adequate escapement and may allow for increased fishing opportunities by identifying harvestable surpluses, particularly with respect to the independent Tanana River terminal fisheries. A similar mixed-stock analysis project, funded by the U.S. Fish and Wildlife Service, Office of Subsistence Management (OSM #06-205) and Conservation Genetics Laboratory, has been conducted for fall chum salmon since 2004.

Here, estimates of stock compositions for major Yukon River summer chum salmon stock groups were provided during the spawning run to facilitate management. From the beginning of the spawning run, genetic samples were collected from the Pilot Station test fishery and analyzed on a weekly basis using Bayesian mixture modeling as implemented in the computer program BAYES (Pella and Masuda 2001).

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YUKON RIVER SUMMER CHUM SALMON MIXED-STOCK ANALYSIS, 2008

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April 2009

Abstract

Genetic mixed-stock analysis (MSA) is used to derive stock composition estimates for Yukon River summer chum salmon with samples collected in the Pilot Station sonar test fishery. For the 2008 season, 78% of the chum salmon are from summer run stocks and 22% from fall run stocks. Within the summer run component, allocations are 75% to the lower river stock group and 25% to the middle river stock group (19% upper Koyukuk and middle mainstem, 6% Tanana River). Lower river chum salmon are present throughout the run and are the largest contributing stock (>64%) until the week of July 19 – 27, whereupon their contribution drops to 33% and the largest contribution then comes from the middle river summer stock group (40%). The fall chum salmon contribution is less than 30% until the week of July 28 to August 5, when it jumps to 85%. Based on the fall season management start date of July 19 at Pilot Station, this represents a delayed run transition, which, along with the presence of summer chum salmon well into August, should be addressed by fishery managers in order to sustain overall production and biodiversity.

Introduction

Management of the Yukon salmon fishery is complex because of the disparate strength of individual chum salmon stocks within and among years, combined with overlapping multi-species spawning runs, the immense size of the drainage, and the inability to determine stock specific abundance and timing. Salmon fisheries within the Yukon River may harvest stocks that are up to several weeks and hundreds of miles from their spawning grounds. Because the Yukon River fisheries are largely mixed-stock fisheries, some tributary stocks may be under- or over-exploited.

The stock composition of Yukon River summer chum runs has been in flux for more than a decade. The Anvik River contribution to the overall Yukon River stock production above Pilot Station sonar has decreased from approximately 46% during the period from 1995 – 2002 to an average of 24% post 2002. This reduction corresponds with increased production in other chum salmon spawning streams. Chum salmon in the Tanana River drainage also exhibit large fluctuations in abundance, with record escapements of over 100,000 summer chum salmon observed in Salcha River in 2005 and 2006, and less than 15,000 in 2007. Fluctuations have been observed elsewhere in the Yukon River drainage. The disparate strength of individual stocks within and among years makes it clear that in-season stock return data would facilitate fishery management. Knowledge of the origin of chum salmon as they enter the river would assist in managing fisheries to achieve adequate escapement and may allow for increased fishing opportunities by identifying harvestable surpluses, particularly with respect to the independent Tanana River terminal fisheries.

Based on the genetic and geographic stock relationships, two stock groups of summer chum salmon have been identified: lower river and middle river (Tanana). Mixed-stock analysis (MSA) simulations reveal that apportionment accuracies exceed 90% for these groups (Flannery et al. 2007), indicating that they are highly identifiable in actual fishery mixtures (Seeb and Crane 1999). A similar MSA project, funded by the U.S. Fish and Wildlife Service, Office of Subsistence Management (OSM #06-205) and the Conservation Genetics Laboratory (CGL), has been conducted for fall chum salmon MSA since 2004. Partial results from the fall chum salmon analysis are provided below; complete results will be presented in the OSM annual report. Here, we provide results for estimates of stock composition for major summer chum salmon stock groups determined in-season during the spawning run to facilitate their management.

Methods

Sample Collection

Genetic samples were collected from every chum salmon caught in the Pilot Station sonar test fishery from the start of the run until the end of test fishing, and sent to the CGL every week (Note: sampling from July on continued under the OSM fall chum salmon MSA project 06-205; partial results of fall chum salmon stock composition are presented below). Samples were stored in individual vials with the following associated catch data recorded for each sample: river bank, date, time of day, gill net mesh size, drift time, and fish length. Samples were stratified by week; a subsample of 200 was analyzed for each stratum, with the daily sample size proportional to the daily sonar passage estimate within a stratum. Sample size was determined by MSA simulations using SPAM 3.7 (Debevec et al. 2000), so that 90% interval estimates of 10% contributions of the major stock groups excluded zero. An estimate with a 90% confidence interval that does not include zero provides evidence that the stock is actually present in the mixture at the 5% level of significance (Weir 1996).

Genetic Analysis

Total genomic DNA was extracted from fin tissue (~25mg) using proteinase K with the Dneasy™ DNA isolation kit (Quiagen Inc. Valencia, CA), quantified with fluorometry and diluted to a standard concentration. The following micosatellite loci were assayed for genetic variation: *Oki1*, *Oki2* (Smith et al. 1998); *Oki100* (Miller unpublished); *Omy1011* (Spies et al. 2005); *One102, One103, One104,* and *One114* (Olsen et al. 2000); *Ssa419* (Cairney et al. 2000); *OtsG68* (Williamson et al. 2002); *Ots103* (Beacham et al. 1998). An MJResearch DNA Engine® thermal cycler was used to perform polymerase chain reactions (PCR) in 10 µl volumes; general conditions were: 2.5 mM $MgCl_2$, 1X PCR buffer (20 mM Tris-HCl pH 8.0, 50 mM KCl), 200 µM of each dNTP, 0.40µM fluorescently labeled forward primer, 0.40 µM unlabeled reverse primer, 0.008 units *Taq* polymerase, and 1 µl of DNA (30ng/µl). Standard thermal cycling conditions were: initial denaturation cycle of 94°C for 3 min, followed by 94°C for 1 min, 50-62°C for 1 min (locus-specific annealing temperature), 72°C for 1 min, with a final single cycle of 72°C for 10 min. One µl of PCR product was electrophoresed and visualized with the Applied Biosystems 3730 Genetic Analyzer utilizing a polymer denaturing capillary system. The sizes of bands were estimated and scored by the computer program GeneMapper® version 4.0. Applied Biosystems GeneScan™-600 LIZ® size standards, 20-600 bases, were loaded in all lanes as an internal lane standard. All scores were verified manually. Alleles were scored by two independent researchers, with any discrepancies being resolved by replicating the analysis for the samples in question and repeating the double scoring process until scores matched (unresolved scores were excluded from further analysis).

Statistical Analysis

The mixture data were compared to the genetic baseline (Figure 1) to estimate the relative stock compositions using the Bayesian mixture modeling method as implemented in the program BAYES (Pella and Masuda 2001). Stock composition estimates were reported to fishery managers as soon as possible after receiving the samples (typically 24-48 hours) for the following three tiered hierarchical stock grouping (Figure 1):

1a) Summer
- 2a) Lower
- 2b) Middle
  - 3a) Upper Koyukuk and middle mainstem
  - 3b) Tanana

1b) Fall

The stock composition for the entire sampling period was calculated by taking a weighted average of each stratum's estimate of stock composition based on the stratum's relative abundance for the entire period as determined from Pilot Station sonar passage estimates (Seeb et al. 1997). Stock specific abundance estimates were derived by combining the Pilot Station sonar passage estimates with the stock composition estimates.

Results and Discussion

Sampling occurred from June 9 through September 7 at Pilot Station, with July 19 designated by the Alaska Department of Fish and Game (ADF&G) as the transition date between summer and fall management seasons. There are 12 sampling periods analyzed for stock composition (Table 1). These periods are equally divided between the two management seasons. For the 2008 season, 78% of the chum salmon are from summer run stocks and 22% from fall run stocks. Within the summer run component, allocations are 75% to the lower river stock group and 25% to the middle river stock group (19% upper Koyukuk and middle mainstem, 6% Tanana). Stock abundance estimates, derived from the products of estimates of the stock composition (Table 1) and Pilot Station sonar passage (Table 2), range from 108,390 – 1,926,120 (Table 3). These proportions and the presence of summer chum salmon after the switch to fall management are consistent with data from previous studies (Wilmot et al. 1992; ADF&G 2003; Flannery et al. 2007, 2008).

Run timing differences among the summer stock groups are apparent. Lower river chum salmon are present throughout the run and are the largest contributing stock (>64%) until the week of July 19 – 27, whereupon their contribution drops to 33% and the largest contribution then comes from the middle river summer stock group (40%). This pulse of middle river fish is largely the result of late summer chum salmon returning to the Tanana River (Table 1, Figure 2) and probably the upper Koyukuk as well due to late spawning documentation (Troyer 1993; Wiswar 1997).

The fall chum salmon contribution is less than 30% until the week of July 28 to August 5, when it jumps to 85% (Table 1, Figure 3). Based on the fall season management start date of July 19 at Pilot Station, this represents a delayed summer to fall run transition and continues a trend observed since 2006 (Flannery et al. 2008). This may be caused by delayed fall run timing or by a production shift increasing late summer chum salmon returns. The delayed run transition and presence of summer chum salmon well into August are issues that should be addressed by fishery managers in order to sustain overall production and biodiversity.

Acknowledgements

Funding for the project was provided by the Yukon River Panel Research and Management Fund, the U.S. Fish and Wildlife Service (USFWS), and the Alaska Department of Fish and Game (ADF&G). We thank Eric Kretschmer, Ora Schlei, Cara Lewis and Matt Siegle of the USFWS for laboratory analyses. We thank Holly Carroll of the ADF&G and her staff at Pilot Station sonar for collecting the samples. We thank Tom Doolittle, Robert Sundown, George Walters, and Hollis Twitchell of the Yukon Delta National Wildlife Refuge for transporting the samples.

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Table 1. 2008 Pilot Station test fishery chum salmon stock composition estimates with associated standard deviations and 95% confidence intervals by stratum and stock group.

	Summer Stratum 1 6/9 – 6/15 Estimate	SD	95% CI		Summer Stratum 2 6/16 – 6/22 Estimate	SD	95% CI	
Summer	0.992	0.009	0.967	1.000	0.996	0.006	0.980	1.000
Lower	0.766	0.070	0.624	0.893	0.716	0.068	0.576	0.843
Middle	0.226	0.070	0.098	0.369	0.280	0.068	0.153	0.420
UppKoy+Main	0.224	0.070	0.095	0.367	0.231	0.068	0.106	0.372
Tanana	0.002	0.007	0.000	0.023	0.048	0.030	0.000	0.110
Fall	0.008	0.009	0.000	0.033	0.004	0.006	0.000	0.020

	Summer Stratum 3 6/23 – 6/29 Estimate	SD	95% CI		Summer Stratum 4 6/30 – 7/6 Estimate	SD	95% CI	
Summer	0.992	0.010	0.963	1.000	0.992	0.009	0.966	1.000
Lower	0.684	0.076	0.535	0.830	0.912	0.058	0.771	0.992
Middle	0.308	0.077	0.162	0.457	0.080	0.058	0.000	0.224
UppKoy+Main	0.298	0.079	0.146	0.452	0.060	0.059	0.000	0.204
Tanana	0.010	0.019	0.000	0.066	0.021	0.023	0.000	0.074
Fall	0.008	0.010	0.000	0.037	0.008	0.009	0.000	0.034

	Summer Stratum 5 7/7 – 7/13 Estimate	SD	95% CI		Summer Stratum 6 7/14 – 7/18 Estimate	SD	95% CI	
Summer	0.959	0.031	0.888	1.000	0.837	0.042	0.749	0.914
Lower	0.643	0.070	0.498	0.772	0.644	0.071	0.500	0.771
Middle	0.316	0.074	0.177	0.472	0.193	0.073	0.068	0.347
UppKoy+Main	0.215	0.077	0.079	0.380	0.078	0.067	0.000	0.227
Tanana	0.101	0.043	0.017	0.189	0.115	0.043	0.041	0.207
Fall	0.041	0.031	0.000	0.112	0.163	0.042	0.086	0.251

Continued

Table 1. Continued

	Fall Stratum 1 7/19 – 7/27 Estimate	SD	95% CI		Fall Stratum 2 7/28 – 8/5 Estimate	SD	95% CI	
Summer	0.730	0.042	0.646	0.811	0.154	0.049	0.063	0.253
Lower	0.334	0.061	0.220	0.459	0.053	0.028	0.001	0.112
Middle	0.396	0.067	0.266	0.526	0.101	0.053	0.000	0.209
UppKoy+Main	0.125	0.066	0.000	0.257	0.094	0.056	0.000	0.205
Tanana	0.271	0.047	0.182	0.367	0.006	0.016	0.000	0.058
Fall	0.270	0.042	0.189	0.354	0.846	0.049	0.747	0.937

	Fall Stratum 3 8/6 – 8/14 Estimate	SD	95% CI		Fall Stratum 4 8/15 – 8/18 Estimate	SD	95% CI	
Summer	0.136	0.037	0.073	0.215	0.047	0.025	0.008	0.106
Lower	0.087	0.030	0.032	0.148	0.014	0.017	0.000	0.057
Middle	0.049	0.036	0.000	0.131	0.033	0.027	0.000	0.094
UppKoy+Main	0.017	0.023	0.000	0.080	0.030	0.026	0.000	0.090
Tanana	0.033	0.034	0.000	0.112	0.003	0.009	0.000	0.030
Fall	0.864	0.037	0.785	0.927	0.953	0.025	0.894	0.992

	Fall Stratum 5 8/19 – 8/26 Estimate	SD	95% CI		Fall Stratum 6 8/27 – 9/7 Estimate	SD	95% CI	
Summer	0.041	0.019	0.013	0.088	0.081	0.031	0.028	0.148
Lower	0.033	0.015	0.010	0.067	0.023	0.017	0.000	0.062
Middle	0.008	0.013	0.000	0.048	0.059	0.029	0.008	0.124
UppKoy+Main	0.004	0.010	0.000	0.035	0.010	0.019	0.000	0.067
Tanana	0.004	0.009	0.000	0.034	0.048	0.028	0.000	0.107
Fall	0.959	0.019	0.912	0.987	0.919	0.031	0.852	0.972

Continued

Table 1. Continued

	Total (6/9 – 9/7) Estimate	SD	95% CI	
Summer	0.776	0.008	0.762	0.791
Lower	0.582	0.025	0.532	0.632
Middle	0.195	0.026	0.143	0.246
UppKoy+Main	0.151	0.027	0.099	0.203
Tanana	0.044	0.011	0.023	0.065
Fall	0.224	0.008	0.209	0.238

Table 2. Pilot Station sonar passage estimates for 2008.

Season	Period	Date	Passage
Summer	Stratum1	6/9 to 6/15	26,026
Summer	Stratum2	6/16 to 6/22	215,492
Summer	Stratum3	6/23 to 6/29	514,303
Summer	Stratum4	6/30 to 7/6	605,137
Summer	Stratum5	7/7 to 7/13	426,182
Summer	Stratum6	7/14 to 7/18	70,970
Fall	Stratum1	7/19 to 7/27	72,686
Fall	Stratum2	7/28 to 8/5	174,262
Fall	Stratum3	8/6 to 8/14	66,506
Fall	Stratum4	8/15 to 8/18	109,131
Fall	Stratum5	8/19 to 8/26	79,917
Fall	Stratum6	8/27 to 9/7	119,956
Total		6/9 to 9/7	2,480,568

Table 3. Stock abundance estimates derived from the products of the genetic stock composition estimates and Pilot Station sonar passage estimates for 2008. The standard deviations and 95% confidence intervals are based on the variances of the genetic estimates only.

	2008 6/9 – 9/7 Estimate	SD	95% CI	
Summer	1,926,120	18,870	1,889,134	1,963,106
Lower	1,443,579	62,772	1,320,545	1,566,612
Middle	482,534	64,824	355,480	609,588
UppKoy+Main	374,162	66,116	244,576	503,749
Tanana	108,390	26,586	56,281	160,498
Fall	554,448	18,870	517,462	591,434

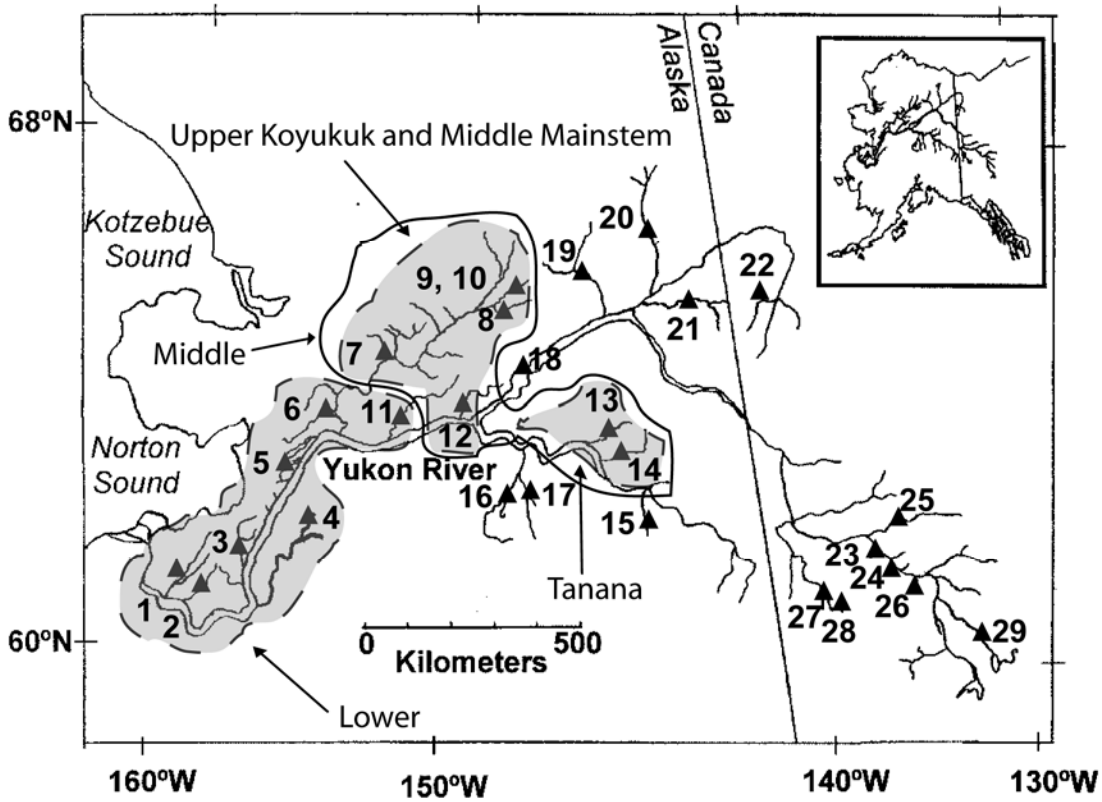

Figure 1. Baseline sampling locations: summer stocks are 1 – 14, and fall stocks are 15 – 29. 1 = Andreafsky, 2 = Chulinak, 3 = Anvik, 4 = California, 5 = Nulato, 6 = Gisasa, 7 =Henshaw, 8 = Jim, 9 = South Fork Koyukuk Early, 10 = South Fork Koyukuk Late, 11 = Melozitna, 12 = Tozitna, 13 = Chena, 14 = Salcha, 15 = Delta, 16 = Kantishna, 17 = Toklat, 18 = Big Salt, 19 = Chandalar, 20 = Sheenjek, 21 = Black, 22 = Fishing Branch, 23 = Big Creek, 24 = Minto, 25 = Pelly, 26 = Tatchun, 27 = Donjek, 28 = Kluane, and 29 = Teslin. Pilot Station is located on the Yukon River mainstem near sample location 2. The grey shaded areas delineate summer stock groups. The middle river summer stock group is comprised of the Tanana and upper Koyukuk and middle mainstem and is circled by a solid black line. Fall chum salmon stocks (15 – 29) are not shaded.

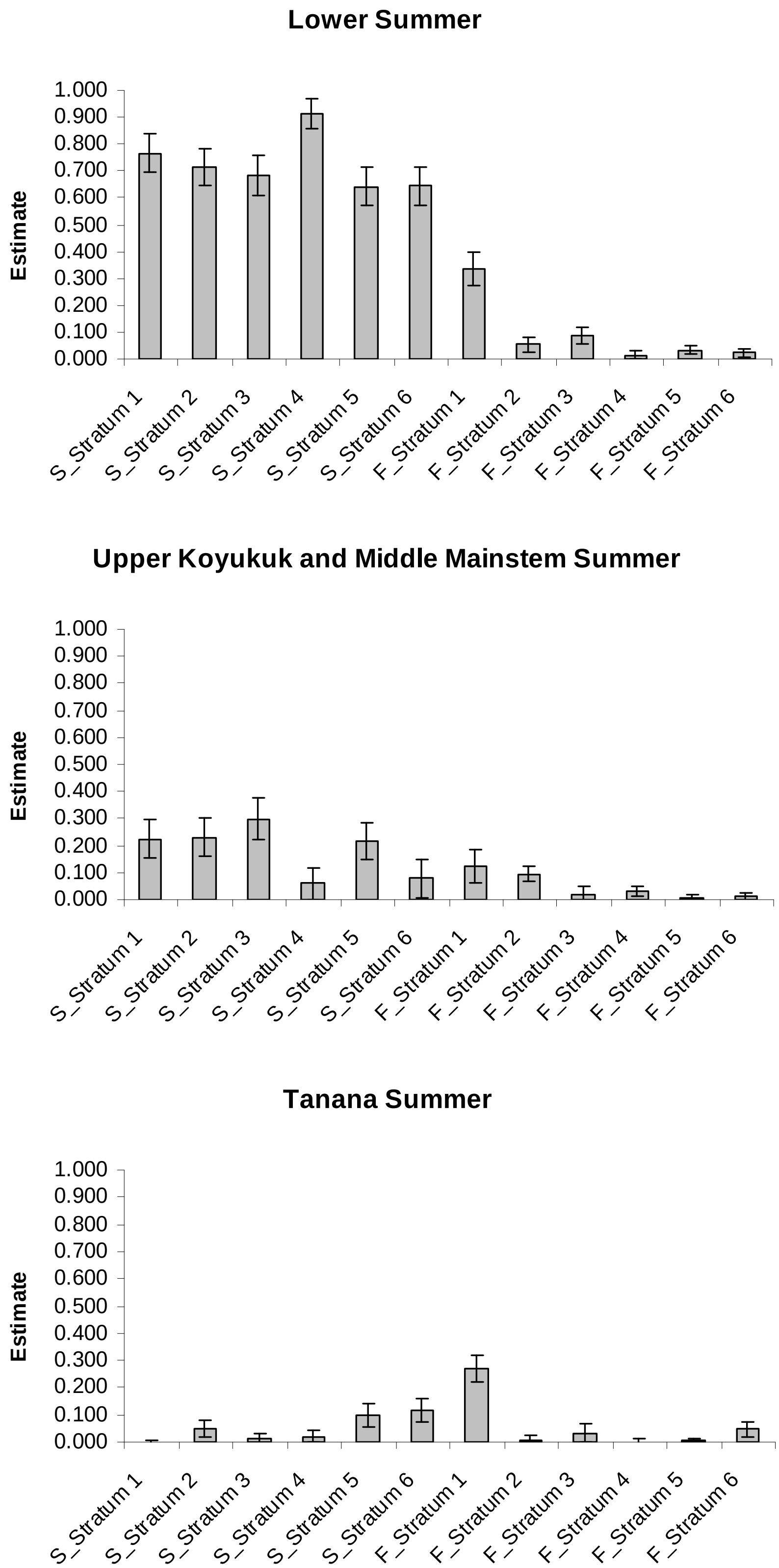

Figure 2. Pilot Station test fishery summer chum salmon stock composition estimates for 2008. Error bars represent one standard error.

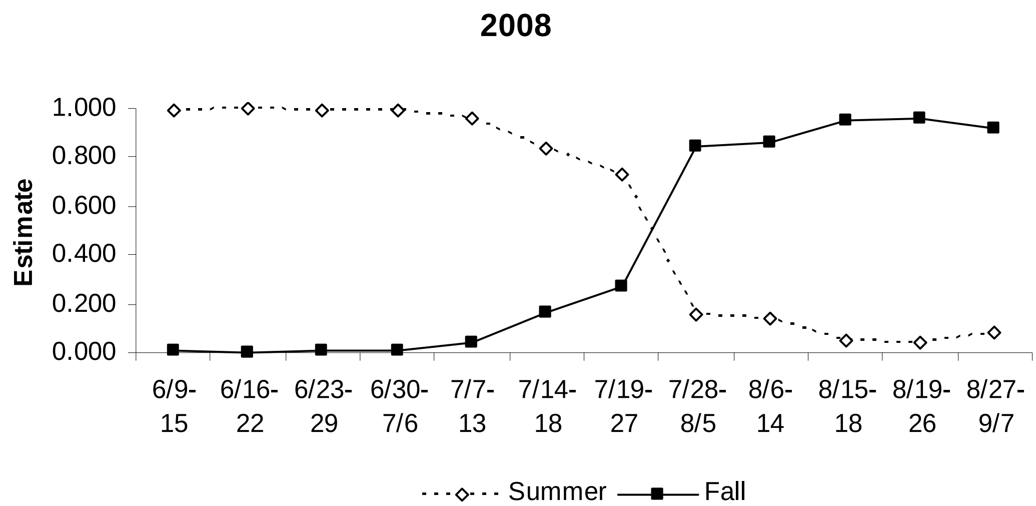

Figure 3. Stock composition estimates for Yukon River summer and fall chum salmon throughout the run.