Yukon River Panel
Restoration and Enhancement Fund

Application of Mixed-Stock Analysis for Yukon River Chum Salmon, 2019

Final Report for Project URE-164-19N

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Abstract

Here we report interim results for genetic mixed-stock analysis (MSA) of Yukon River chum salmon harvested from the sonar test fishery operated near Pilot Station; this is a continuation of previous work by Flannery et al. (2007). For the 2019 season, 75% of the chum salmon were from summer run stocks and 25% from fall run stocks. Summer chum salmon comprised most of the harvest through July 26. Within the summer run component, apportionments were 74% to the lower river stock group and 26% to the middle river stock group (18% upper Koyukuk and middle mainstem, 8% Tanana).

Fall chum salmon outnumbered summer chum salmon during the July 27 to August 9 stratum, a slightly delayed summer to fall run transition based on the July 19 start date of the fall season management at Pilot Station. Within the fall run component, the largest contribution of fall chum salmon came from the Tanana River (37%). Contributions of fall chum salmon from other regions were U.S. Border 30%, Canada mainstem 10%, Canada Porcupine 6%, and White 15%. Abundance estimates for Canada stocks from genetic and sonar data were concordant with those from escapement and harvest data.

Key Words: chum salmon, Yukon River, mixed-stock analysis, microsatellites.

Introduction

The Yukon River flows 3,200 km through Alaska and Canada, and chum salmon are an important resource for subsistence users in both countries. Two seasonal races of chum salmon, termed "summer" and "fall", return to spawn in the Yukon River. Summer chum salmon spawn only in the Alaska portion of the Yukon River, whereas fall chum salmon spawn in both Alaska and Canada. Both runs are managed to meet escapement goals and provide maximum harvest opportunities. Fishery managers have additional obligations to conserve and equitably share fall chum salmon with Canada, per the Yukon River Salmon Agreement, an annex of the 1985 U.S.–Canada Pacific Salmon Treaty (PST).

Determining stock structure and the relative contributions of stocks to harvests are essential for effective management (Larkin 1981). This is a difficult task, greatly simplified using genetic mixed-stock analysis (MSA; Cadrin et al. 2005). Since 2004, MSA has been conducted on Yukon River chum salmon harvested from the sonar test fishery operated near Pilot Station (Flannery et al. 2007). Here we document the 2019 results and compare estimates over the course of the project.

Methods

Sample collection and laboratory analysis—Tissue samples (axillary process) were collected from every chum salmon caught in the sonar test fishery, located 197 km upriver of the Yukon River mouth near Pilot Station, from the start of the run until the end of test fishing. Samples were stratified by pulse of fish or time period, and 288 samples were selected for each stratum, with the daily sample size proportional to the daily sonar passage estimate. Samples were genotyped as in Flannery et al. (2007) for the following loci: *Oki1, Oki2* (Smith et al. 1998); *Oki100* (Miller unpublished); *Omy1011* (Spies et al. 2005); *One102, One103, One104, One114* (Olsen et al. 2000); *Ots103* (Beacham et al. 1998); *OtsG68* (Williamson et al. 2002); *Oke3* (Buchholz et al. 2001); and *Ssa419* (Cairney et al. 2000).

Data analysis—The stock compositions of the mixtures were estimated using Bayesian mixture modeling (Pella and Masuda 2001) with the baseline data (Figure 1) described in Flannery et al. (2007). The estimates were summed by seasonal race, region, and country (Figure 1) and then distributed to fishery managers within 24 – 48 hours after the samples were received in the laboratory. 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 sonar passage estimates (Seeb et al. 1997). Stock specific abundance estimates were derived by combining the mainstem sonar passage estimates with the genetic stock composition estimates.

A post season analysis was conducted to compare Canada stocks abundance estimates from the genetic/sonar method against estimates from the escapement/harvest method. Escapements from the following projects were compiled: Tanana River regression (ADFG 2019), Chandalar River sonar (ADFG 2019), Sheenjek River regression (ADFG 2019), Canada border (Eagle) sonar (ADFG 2019), and Porcupine sonar (ADFG 2019). Average subsistence harvest estimates from 2010 – 2014 (upriver of Pilot Station) by river location were compiled (Jallen et al. 2017). Subsistence harvest was apportioned to U.S. and Canada fall stocks in a stepwise downstream fashion by using escapements to estimate relative proportions of these stocks available at various locations and multiplying these proportions by the harvest at each location. These stock specific harvest estimates were then added to the appropriate escapements in order to allow a direct comparison between data sources.

Results and Discussion

2019

Sampling occurred from June 4 through August 31 at Pilot Station, with July 19 designated by ADFG as the transition date between summer and fall management seasons. There were seven strata of chum salmon analyzed for stock composition from the mainstem sonar test fishery. Strata 1 – 3 were from the summer management season, and strata 4 – 7 were from the fall management season. Stratum one was analyzed with a sample size of 263 due to low passage and harvest. All other strata were analyzed with a sample size of 288 that was proportional to the passage of chum salmon.

For the 2019 season, 75% of the chum salmon were from summer run stocks and 25% from fall run stocks (Table 1). Summer chum salmon comprised most of the harvest through July 26 and were detected with a 7% or greater contribution until August 20 (Table 1). Within the summer run component, apportionments were 74% to the lower river stock group and 26% to the middle river stock group (18% upper Koyukuk and middle mainstem, 8% Tanana; Table 2). Fall chum salmon were first detected with a significant contribution in stratum four (12%, July 19 – 26), the start of the fall management season, and were in the majority by stratum five (63%, July 27 – August 9; Table 1, Figure 2). This represents a slightly delayed summer to fall run transition based on the July 19 start date of fall season management at Pilot Station. The presence of both summer and fall chum salmon before and after the switch in management seasons is consistent with data from previous studies (Wilmot et al. 1992; ADFG 2003; Flannery et al. 2007).

Stock compositions and timing vary significantly from year to year. Nevertheless, there are some apparent consistencies. Fall chum salmon from the U.S. border and Porcupine regions have the earliest run timing, followed by fall chum salmon from the mainstem, White, and Teslin regions (Figure 3). Tanana fall chum salmon continue to migrate last, slowly building until they comprise most of the final strata (Figure 3). Fall chum salmon from the U.S. border region were again sustained throughout the run, with contributions ranging from 7.1 – 36.6% for strata 4 – 7 (Table 1), accounting for 30.5% of the total fall run (Table 3). The Tanana region was the largest contributor at 37.4%, and overall, U.S. chum salmon accounted for 67.8% of the fall run (Table 3). The rest of the fall run was comprised of 9.8% mainstem, 6.2% Porcupine, 14.9% White, and 1.4% Teslin (Table 3). All contributions are within reported ranges (Table 3). For the third consecutive season, upper Canada fall fish, which includes the White and Teslin regions, returned in greater numbers than Canada border fall fish, which includes the Porcupine and mainstem regions (Table 3).

The sonar abundance estimate during the fall management season, July 19 – August 31, was 843,865 (Table 4, strata 4 – 7), but genetics estimated that only 550,213 of these fish were fall chum salmon. This discrepancy is due to significant numbers of summer chum salmon migrating past Pilot Station after July 19. The total fall chum salmon passage for the entire season, June 4 – August 31, was estimated by genetics and sonar at 563,604 fish (Table 5).

The post season comparison with escapement and harvest data was performed using the stock composition estimates (Table 1) and the sonar passage estimates (Table 4). Overall, stock abundance based on the products of estimates of genetic stock composition and sonar passage ranged from 7,822 to 2,059,422 fish (Table 5). Escapement totals from the upriver monitoring projects ranged from 27,805 to 189,994 fish (Table 6). Harvests from the fishing districts, upriver of Pilot Station, were added to the escapement totals (Table 7). The abundance estimates for Canada stocks from genetic and sonar data were concordant with those from escapement and harvest data (Figure 4).

2004 – 2019

Initially the project was focused on stock composition estimation of fall chum salmon owing to Pacific Salmon Treaty obligations. Sampling began in 2004 at the mainstem sonar site, near Pilot Station, on July 19, coinciding with the start of the fall management season. However, in 2005 – 2007 sampling began on July 1 to account for early fall chum salmon. Interest in the stock composition of summer chum salmon developed, and, since 2008, stock composition estimation has included the summer run. Sampling now begins at the start of operations (5/30) at the mainstem sonar and concludes at the end of operations (8/31 or 9/7). The first day summer chum salmon have arrived has ranged from May 30 in 2016 to June 13 in 2013.

The composition of the total chum salmon migration by seasonal race has ranged from 66% – 87% for summer chum salmon and 13% – 34% for fall chum salmon. Within the summer run, the largest contributing stock is from the lower river. Chum salmon from the lower river have comprised 64% – 87% of the summer run whereas chum salmon from the upper Koyukuk/middle mainstem and Tanana have comprised 6% – 27% and 2% – 9%, respectively (Table 2). The contribution of U.S. origin chum salmon to the fall run has ranged from 59% – 74% whereas Canada has contributed 26% – 41%. The U.S. border and Tanana stocks are the largest contributors to the fall run (Table 3). The U.S. border has ranged in contributions from 28% – 49% of the fall run, and Tanana has ranged from 16% – 42%. For Canada, the major contributing stocks are mainstem and White, which have contributed 7% – 20% and 8% – 19% of the fall run (Table 3). Porcupine and Teslin are minor contributing stocks in Canada. The Porcupine stock has contributed 1% – 10% of fall chum salmon and Teslin 0.2% – 2%.

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Table 1. Chum salmon stock composition estimates from the test fishery operated near Pilot Station, 2019, with associated standard deviations and 95% credible intervals by stratum and management group. See figure 1 for management groups. Summer represents apportionments to Lower, UppKoy+Main, and Tanana Summer; Fall represents apportionments to U.S. Border, Porcupine, Mainstem, White, and Teslin; Middle represents apportionments to UppKoy+Main and Tanana Summer; Canada Border represents apportionments to Porcupine and Mainstem; Upper Canada represents apportionments to White and Teslin; Fall U.S. represents apportionments to the Tanana Fall and U.S. Border; U.S. Border + Canada represents apportionments to the U.S. Border, Porcupine, Mainstem, White, and Teslin; Mainstem + Upper Canada represents apportionments to the Mainstem, White, and Teslin.

Management Group	Stratum 1 6/4 – 6/24			
	Estimate	SD	95% CI	
Summer	0.996	0.006	0.978	1.000
Lower	0.804	0.080	0.652	0.963
Middle	0.192	0.081	0.031	0.344
UppKoy+Main	0.183	0.085	0.008	0.341
Tanana	0.009	0.017	0.000	0.060
Fall	0.004	0.006	0.000	0.022
Tanana	0.001	0.003	0.000	0.010
BorderUS	0.001	0.004	0.000	0.012
BorderCanada	0.001	0.003	0.000	0.011
Porcupine	0.001	0.002	0.000	0.008
Mainstem	0.001	0.002	0.000	0.007
UpperCanada	0.001	0.001	0.000	0.004
White	0.000	0.001	0.000	0.003
Teslin	0.000	0.001	0.000	0.001
FallUS	0.003	0.005	0.000	0.016
Mainstem+UpperCanada	0.001	0.002	0.000	0.008
BorderUS+Canada	0.003	0.005	0.000	0.018
US	0.998	0.003	0.988	1.000
Canada	0.002	0.003	0.000	0.012

Continued

Table 1. Continued.

Management Group	Stratum 2 6/25 – 7/7 Estimate	SD	95% CI	
Summer	0.991	0.010	0.964	1.000
Lower	0.711	0.072	0.573	0.856
Middle	0.280	0.073	0.133	0.419
UppKoy+Main	0.204	0.079	0.039	0.354
Tanana	0.076	0.027	0.027	0.132
Fall	0.009	0.010	0.000	0.036
Tanana	0.004	0.007	0.000	0.025
BorderUS	0.003	0.007	0.000	0.025
BorderCanada	0.002	0.004	0.000	0.014
Porcupine	0.001	0.003	0.000	0.010
Mainstem	0.001	0.002	0.000	0.008
UpperCanada	0.000	0.001	0.000	0.003
White	0.000	0.001	0.000	0.002
Teslin	0.000	0.001	0.000	0.001
FallUS	0.007	0.009	0.000	0.033
Mainstem+UpperCanada	0.001	0.003	0.000	0.009
BorderUS+Canada	0.005	0.008	0.000	0.028
US	0.998	0.004	0.985	1.000
Canada	0.002	0.004	0.000	0.014

Continued

Table 1. Continued.

Management Group	Stratum 3 7/8 – 7/18 Estimate	SD	95% CI	
Summer	0.987	0.012	0.956	1.000
Lower	0.877	0.060	0.753	0.968
Middle	0.109	0.061	0.018	0.236
UppKoy+Main	0.076	0.066	0.000	0.213
Tanana	0.032	0.020	0.000	0.076
Fall	0.013	0.012	0.000	0.044
Tanana	0.003	0.005	0.000	0.018
BorderUS	0.004	0.009	0.000	0.031
BorderCanada	0.006	0.009	0.000	0.033
Porcupine	0.003	0.008	0.000	0.029
Mainstem	0.003	0.006	0.000	0.021
UpperCanada	0.001	0.002	0.000	0.006
White	0.001	0.002	0.000	0.005
Teslin	0.000	0.001	0.000	0.002
FallUS	0.007	0.010	0.000	0.033
Mainstem+UpperCanada	0.004	0.006	0.000	0.022
BorderUS+Canada	0.011	0.012	0.000	0.041
US	0.993	0.010	0.967	1.000
Canada	0.007	0.010	0.000	0.033

Continued

Table 1. Continued.

Management Group	Stratum 4 7/19 – 7/26 Estimate	SD	95% CI	
Summer	0.883	0.026	0.828	0.929
Lower	0.639	0.058	0.523	0.749
Middle	0.243	0.061	0.128	0.364
UppKoy+Main	0.112	0.065	0.001	0.244
Tanana	0.131	0.034	0.064	0.200
Fall	0.117	0.026	0.070	0.171
Tanana	0.005	0.008	0.000	0.028
BorderUS	0.071	0.033	0.002	0.136
BorderCanada	0.029	0.026	0.000	0.085
Porcupine	0.027	0.026	0.000	0.083
Mainstem	0.002	0.005	0.000	0.019
UpperCanada	0.012	0.008	0.002	0.031
White	0.012	0.008	0.001	0.030
Teslin	0.000	0.001	0.000	0.001
FallUS	0.076	0.034	0.008	0.143
Mainstem+UpperCanada	0.014	0.009	0.002	0.036
BorderUS+Canada	0.113	0.025	0.067	0.164
US	0.959	0.027	0.901	0.996
Canada	0.041	0.027	0.004	0.098

Continued

Table 1. Continued.

Management Group	Stratum 5 7/27 – 8/9 Estimate	SD	95% CI	
Summer	0.365	0.037	0.295	0.438
Lower	0.233	0.047	0.144	0.321
Middle	0.133	0.050	0.043	0.231
UppKoy+Main	0.086	0.056	0.000	0.201
Tanana	0.047	0.032	0.000	0.112
Fall	0.635	0.037	0.561	0.705
Tanana	0.107	0.029	0.054	0.165
BorderUS	0.191	0.049	0.098	0.290
BorderCanada	0.218	0.048	0.129	0.316
Porcupine	0.059	0.041	0.000	0.140
Mainstem	0.160	0.040	0.085	0.243
UpperCanada	0.119	0.021	0.081	0.162
White	0.118	0.021	0.081	0.161
Teslin	0.001	0.003	0.000	0.007
FallUS	0.297	0.053	0.194	0.402
Mainstem+UpperCanada	0.279	0.043	0.196	0.364
BorderUS+Canada	0.528	0.037	0.454	0.598
US	0.663	0.049	0.566	0.758
Canada	0.337	0.049	0.242	0.434

Continued

Table 1. Continued.

Management Group	Stratum 6 8/10 – 8/20 Estimate	SD	95% CI	
Summer	0.106	0.025	0.063	0.161
Lower	0.076	0.023	0.029	0.122
Middle	0.030	0.027	0.000	0.093
UppKoy+Main	0.030	0.027	0.000	0.091
Tanana	0.001	0.002	0.000	0.007
Fall	0.894	0.025	0.839	0.937
Tanana	0.311	0.037	0.241	0.384
BorderUS	0.366	0.055	0.252	0.464
BorderCanada	0.036	0.043	0.000	0.135
Porcupine	0.033	0.043	0.000	0.134
Mainstem	0.002	0.007	0.000	0.023
UpperCanada	0.181	0.025	0.134	0.233
White	0.180	0.025	0.133	0.231
Teslin	0.001	0.003	0.000	0.011
FallUS	0.677	0.054	0.559	0.763
Mainstem+UpperCanada	0.184	0.026	0.136	0.239
BorderUS+Canada	0.583	0.038	0.507	0.657
US	0.783	0.048	0.675	0.856
Canada	0.217	0.048	0.143	0.325

Continued

Table 1. Continued.

Management Group	Stratum 7 8/21 – 8/31 Estimate	SD	95% CI	
Summer	0.011	0.009	0.001	0.033
Lower	0.007	0.006	0.000	0.023
Middle	0.004	0.006	0.000	0.022
UppKoy+Main	0.002	0.004	0.000	0.015
Tanana	0.002	0.005	0.000	0.017
Fall	0.989	0.009	0.966	0.999
Tanana	0.579	0.038	0.505	0.651
BorderUS	0.183	0.049	0.095	0.284
BorderCanada	0.101	0.043	0.022	0.190
Porcupine	0.035	0.036	0.000	0.111
Mainstem	0.066	0.040	0.000	0.149
UpperCanada	0.125	0.026	0.079	0.179
White	0.091	0.020	0.055	0.133
Teslin	0.034	0.017	0.005	0.071
FallUS	0.763	0.047	0.667	0.852
Mainstem+UpperCanada	0.191	0.043	0.111	0.278
BorderUS+Canada	0.410	0.038	0.337	0.484
US	0.774	0.046	0.678	0.862
Canada	0.226	0.046	0.138	0.322

Continued

Table 1. Continued.

Management Group	Overall 6/4 – 8/31 Estimate	SD	95% CI	
Summer	0.748	0.007	0.734	0.763
Lower	0.556	0.036	0.485	0.626
Middle	0.193	0.036	0.122	0.264
UppKoy+Main	0.135	0.040	0.057	0.213
Tanana	0.058	0.014	0.030	0.085
Fall	0.252	0.007	0.237	0.266
Tanana	0.094	0.007	0.081	0.107
BorderUS	0.077	0.009	0.058	0.095
BorderCanada	0.040	0.008	0.024	0.056
Porcupine	0.016	0.007	0.002	0.030
Mainstem	0.025	0.006	0.013	0.036
UpperCanada	0.041	0.004	0.033	0.049
White	0.037	0.004	0.030	0.045
Teslin	0.003	0.002	0.000	0.007
FallUS	0.171	0.010	0.151	0.190
Mainstem+UpperCanada	0.065	0.007	0.052	0.079
BorderUS+Canada	0.158	0.008	0.143	0.172
US	0.919	0.009	0.902	0.936
Canada	0.081	0.009	0.064	0.098

Table 2. Estimates of summer chum salmon stock proportions for 2019. Proportions were calculated by dividing the region proportion by the total summer contribution in Table 1.

Year	Lower	UppKoy+Main	Tanana
2008	0.749	0.194	0.056
2009	0.864	0.060	0.075
2010	0.772	0.198	0.029
2011	0.841	0.124	0.035
2012	0.867	0.108	0.024
2013	0.798	0.160	0.041
2014	0.745	0.193	0.061
2015	0.730	0.245	0.025
2016	0.727	0.189	0.084
2017	0.771	0.165	0.063
2018	0.639	0.268	0.092
2019	0.742	0.180	0.077
Average	0.771	0.174	0.055

Table 3. Estimates of fall chum salmon stock proportions for 2019. Proportions were calculated by dividing the region proportion by the total fall contribution in Table 1.

Year	Tanana	U.S. Border	Mainstem	Porcupine	White	Teslin
2004	0.370	0.312	0.116	0.079	0.118	0.004
2005	0.209	0.494	0.117	0.048	0.108	0.024
2006	0.206	0.438	0.189	0.033	0.127	0.007
2007	0.283	0.330	0.184	0.030	0.171	0.002
2008	0.255	0.385	0.144	0.044	0.164	0.008
2009	0.257	0.385	0.202	0.039	0.111	0.010
2010	0.312	0.283	0.146	0.099	0.160	0.004
2011	0.163	0.441	0.143	0.078	0.162	0.014
2012	0.321	0.397	0.145	0.010	0.120	0.008
2013	0.364	0.278	0.161	0.045	0.146	0.006
2014	0.305	0.365	0.132	0.007	0.183	0.010
2015	0.298	0.377	0.154	0.028	0.136	0.009
2016	0.288	0.378	0.205	0.042	0.083	0.005
2017	0.363	0.380	0.069	0.048	0.138	0.003
2018	0.424	0.276	0.087	0.020	0.189	0.005
2019	0.374	0.305	0.098	0.062	0.149	0.014
Average	0.300	0.364	0.143	0.044	0.142	0.008

Table 4. Preliminary mainstem sonar chum salmon passage estimates near Pilot Station for 2019.

Year	Season	Strata	Date	Passage
2019	Summer	Stratum 1	6/4–6/24	89,008
	Summer	Stratum 2	6/25–7/7	1,071,582
	Summer	Stratum 3	7/8–7/18	236,452
	Fall	Stratum 4	7/19–7/26	207,757
	Fall	Stratum 5	7/27–8/9	241,013
	Fall	Stratum 6	8/10–8/20	187,271
	Fall	Stratum 7	8/21–8/31	207,824
		Total	6/4–8/31	2,240,907

Table 5. Total abundance estimates derived from genetic stock composition and sonar chum salmon passage estimates collected near Pilot Station in 2019. The standard deviations and 95% credible intervals are based on the variances of the genetic estimates only. See figure 1 for management groups. Summer represents apportionments to Lower, UppKoy+Main, and Tanana Summer; Fall represents apportionments to U.S. Border, Porcupine, Mainstem, White, and Teslin; Middle represents apportionments to UppKoy+Main and Tanana Summer; Canada Border represents apportionments to Porcupine and Mainstem; Upper Canada represents apportionments to White and Teslin; Fall U.S. represents apportionments to the Tanana Fall and U.S. Border; U.S. Border + Canada represents apportionments to the U.S. Border, Porcupine, Mainstem, White, and Teslin; Mainstem + Upper Canada represents apportionments to the Mainstem, White, and Teslin.

Management Group	6/4–8/31 Estimate	SD	95% CI	
Summer	1,677,303	16,078	1,645,791	1,708,816
Lower	1,244,881	80,672	1,086,764	1,402,999
Middle	431,910	81,440	272,288	591,533
UppKoy+Main	302,647	88,828	128,543	476,750
Tanana	129,047	31,018	68,252	189,842
Fall	563,604	16,085	532,077	595,130
Tanana	210,811	14,649	182,099	239,522
BorderUS	171,659	21,252	130,004	213,313
BorderCanada	89,905	18,137	54,356	125,454
Porcupine	35,043	16,124	3,441	66,646
Mainstem	54,981	13,215	29,080	80,881
UpperCanada	91,747	8,949	74,206	109,288
White	83,997	8,219	67,888	100,106
Teslin	7,822	3,715	541	15,103
FallUS	382,237	22,751	337,645	426,829
Mainstem+UpperCanada	146,517	15,070	116,980	176,053
BorderUS+Canada	352,971	17,084	319,486	386,455
US	2,059,422	19,222	2,021,747	2,097,097
Canada	181,485	19,229	143,796	219,175

Table 6. Preliminary fall chum salmon escapement project estimates for 2019.

Escapement project (Genetic Equivalent)	Estimate
Chandalar sonar (U.S. Border)	116,323
Sheenjek regression (U.S. Border)	91,000
Eagle sonar border passage (Mainstem + Upper)	113,226
Porcupine sonar (Porcupine CA)	27,805
Tanana regression (Tanana Fall)	189,994

Table 7. Preliminary harvest apportionments for 2019. Bold numbers indicate escapements estimated by the monitoring projects. Average subsistence harvest estimates from 2010–2014 (Jallen et al. 2017) were summed. Harvest was apportioned to the U.S. and Canada fall stocks in a stepwise downstream fashion by using the escapements to estimate the relative proportions of these stocks available at the river locations and multiplying these proportions by the harvest at the river locations.

		Abundance of Contributing Stocks				
Location	**Harvest**	M.S. CA	Porcupine	Sheenjek	Chandalar	Tanana
Chandalar (w/ Black)	2,527				**116,323**	
Y6	13,100					**189,994**
Y5D Above Porcupine	18,315	**113,226**				
Ft. Yukon	10,066	131,541	**27,805**	**91,000**		
Y5D Below Chandalar	2,422	136,830	28,923	94,659	118,850	
Y5C	1,448	137,704	29,108	95,263	119,609	
Y5B	20,571	138,226	29,218	95,625	120,063	
Y5A						203,094
Y4	11,223	145,648	30,787	100,759	126,509	203,094
Y3	1,307	148,342	31,356	102,623	128,849	206,850
Y2 (Marshall only)	551	148,655	31,423	102,840	129,121	207,288
Total	81,530	148,788	31,451	102,931	129,236	207,472

Continued

Table 7. Continued.

	Proportion of Contributing Stocks				
Location	M.S. CA	Porcupine	Sheenjek	Chandalar	Tanana
Chandalar (w/ Black)	0.0000	0.0000	0.0000	1.0000	0.0000
Y6	0.0000	0.0000	0.0000	0.0000	1.0000
Y5Dbove Porcupine	1.0000	0.0000	0.0000	0.0000	0.0000
Ft. Yukon	0.5254	0.1111	0.3635	0.0000	0.0000
Y5D Below Chandalar	0.3608	0.0763	0.2496	0.3134	0.0000
Y5C	0.3608	0.0763	0.2496	0.3134	0.0000
Y5B	0.3608	0.0763	0.2496	0.3134	0.0000
Y5A	0.0000	0.0000	0.0000	0.0000	1.0000
Y4	0.2400	0.0507	0.1661	0.2085	0.3347
Y3	0.2400	0.0507	0.1661	0.2085	0.3347
Y2 (Marshall only)	0.2400	0.0507	0.1661	0.2085	0.3347

	Harvest Apportionment				
Location	M.S. CA	Porcupine	Sheenjek	Chandalar	Tanana
Chandalar (w/ Black)	0	0	0	2,527	0
Y6	0	0	0	0	13,100
Y5D Above Porcupine	18,315	0	0	0	0
Ft. Yukon	5,289	1,118	3,659	0	0
Y5D Below Chandalar	874	185	605	759	0
Y5C	522	110	361	454	0
Y5B	7,422	1,569	5,134	6,446	0
Y5A	0	0	0	0	0
Y4	2,694	569	1,864	2,340	3,756
Y3	314	66	217	272	437
Y2 (Marshall only)	132	28	91	115	184
Total	35,562	3,646	11,931	12,913	17,478

Figure 1. Baseline sampling locations, 1 = Andreafsky, 2 = Chulinak, 3 = Anvik, 4 = California, 5 = Tolstoi, 6 = Rodo, 7 = Kaltag, 8 = Nulato, 9 = Gisasa, 10 = Dakli, 11 = Clear, 12 = Henshaw, 13 = Jim, 14 = South Fork Koyukuk Early, 15 = South Fork Koyukuk Late, 16 = Melozitna, 17 = Tozitna, 18 = Chena, 19 = Salcha, 20 = Bluff Cabin, 21 = Tanana Mainstem, 22 = Delta, 23 = Nenana, 24 = Toklat, 25 = Kantishna, 26 = Big Salt, 27 = Chandalar, 28 = Sheenjek, 29 = Black, 30 = Fishing Branch, 31 = Big Creek, 32 = Minto, 33 = Pelly, 34 = Tatchun, 35 = Donjek, 36 = Kluane, and 37 = Teslin. Pilot Station is located on the Yukon River mainstem near sample location 2. The middle region encompasses the upper Koyukuk and middle mainstem and Tanana summer regions. The Canada border encompasses the Porcupine and mainstem regions, and upper Canada encompasses the White and Teslin regions.

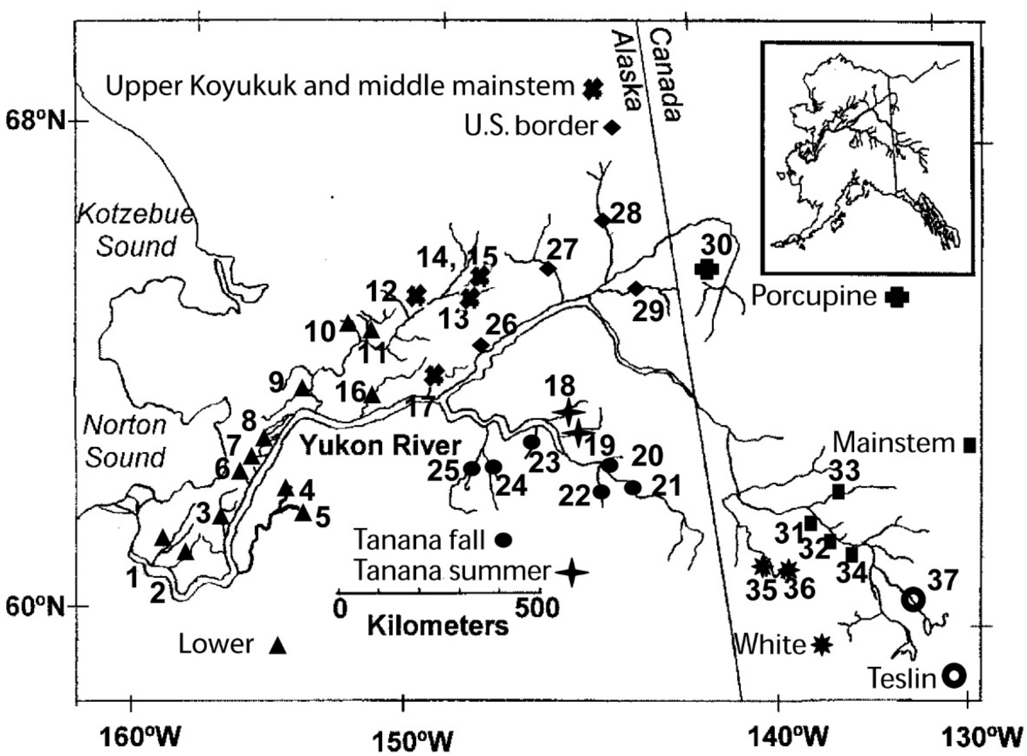

Figure 2. Stock composition estimates for Yukon River chum salmon from the test fishery near Pilot Station for 2019.

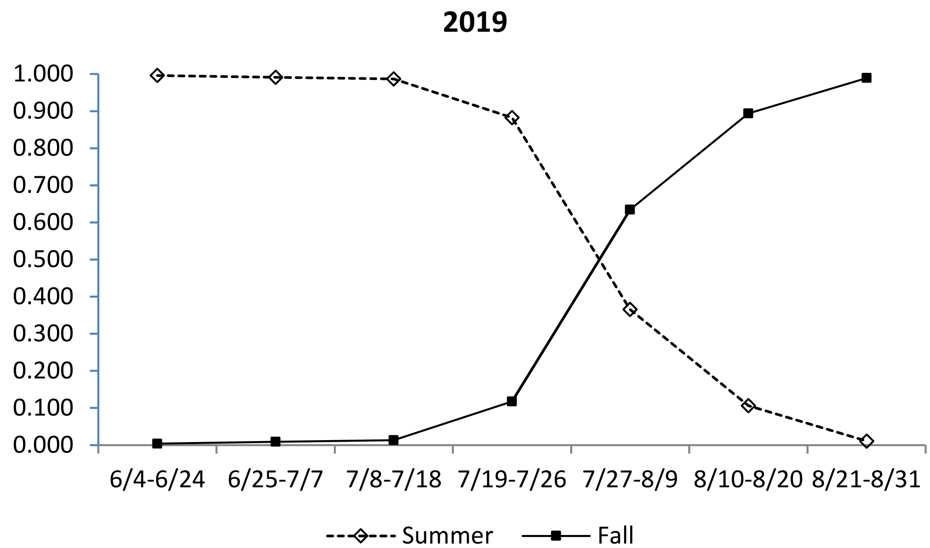

Figure 3. Chum salmon stock composition estimates from the test fishery near Pilot Station for 2019. Error bars represent one standard error.

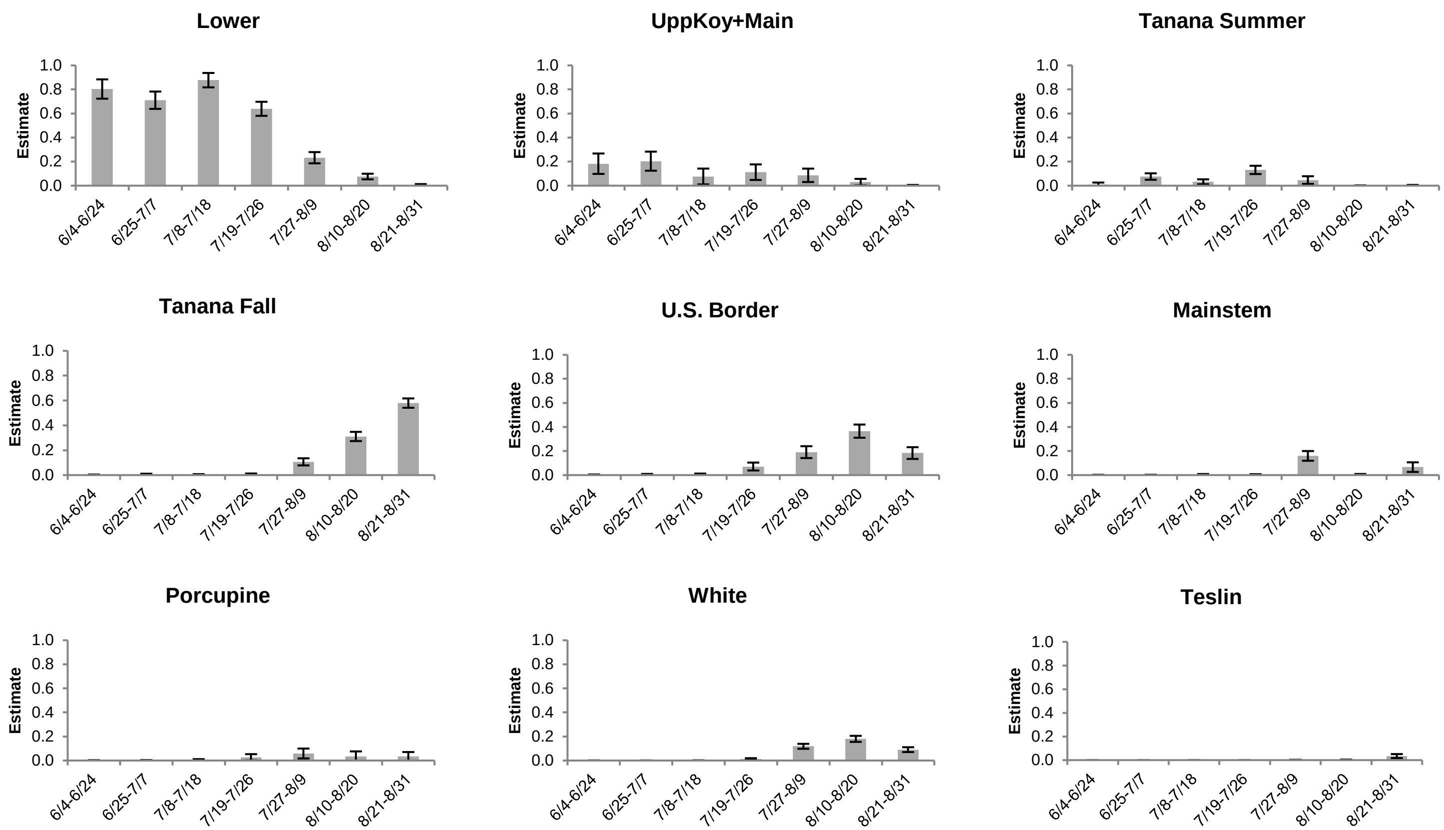

Figure 4. Comparisons of chum salmon stock abundance estimates from genetic/sonar (grey bars) and escapement/harvest (black bars) methods for 2019. The 95% credible intervals are based on the variances of the genetic estimates only.