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Application of Mixed-Stock Analysis for Yukon River Chum Salmon, 2011

Annual Report for Study 10-205

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Abstract

Here we report interim results for genetic mixed-stock analysis (MSA) of Yukon River chum salmon harvested from the Pilot Station sonar test fishery; this is a continuation of previous work by Flannery et al. (2007). For the 2011 season, 74% of the chum salmon were from summer run stocks and 26% from fall run stocks. Summer chum salmon comprised the majority of the harvest through July 25. Within the summer run component, apportionments were 84% to the lower river stock group and 16% to the middle river stock group (12% upper Koyukuk and middle mainstem, 4% Tanana). These genetic proportions for lower and middle summer chum salmon were within 10% of proportions estimated by escapement projects.

Fall chum salmon did not outnumber summer chum salmon until the July 26 to August 5 time period, well after the start of the fall management season. Within the fall run component, the largest contribution of fall chum salmon came from the U.S. Border region (44%). Contributions of fall chum salmon from other regions were: Tanana 16%, Canada mainstem 14%, Canada Porcupine 8%, White 16%, and Teslin 2%. The abundance estimates for fall chum salmon derived from the genetic and sonar method continued to be less than those from the escapement and harvest method. The level of agreement between the methods appears to be related to the run timing in a given year, with better agreement when the fall run is not late.

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

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Introduction

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 through the use of genetic mixed-stock analysis (MSA; Cadrin et al. 2005). Here we provide an interim report documenting the 2011 results of an ongoing MSA study of Yukon River chum salmon harvested from the Pilot Station sonar test fishery where regional stock composition estimates are distributed in-season to assist in management decisions. This work represents a continuation of a study initiated in 2004 under the U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, project 04-228. The final report for that study (Flannery et al. 2007) should be referenced for additional details.

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. Furthermore, 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).

Methods

Sample collection and laboratory analysis—Tissue samples (axillary process) were collected from every chum salmon caught in the Pilot Station sonar test fishery, located 197 km upriver of the Yukon River mouth, 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); 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 Pilot Station 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 Pilot Station genetic stock composition estimates.

A post season analysis was conducted to compare the fall stock specific abundance estimates from the genetic/sonar method against estimates from the escapement/harvest method. No comparison was possible for fall chum salmon from the Tanana River due to

the discontinuation of the Tanana River mark and recapture project. No absolute comparisons were possible for summer chum salmon because escapements are only partially monitored; however, the relative proportions of the summer stock groups estimated from genetics and the index tributaries monitored for escapement were compared. Escapements from the following projects were compiled: Anvik River sonar (JTC 2012), Gisasa River weir (JTC 2012), Henshaw Creek weir (JTC 2012), Chena River counting tower (JTC 2012), Salcha River counting tower (JTC 2012), Chandalar River sonar (JTC 2012), Sheenjek River sonar (JTC 2012), Canada border sonar (JTC 2012), and Fishing Branch weir with Old Crow harvest (JTC 2012). The latest five year average harvest estimates (upriver of Pilot Station) by river location were obtained from a post season survey of subsistence fishers conducted by the Alaska Department of Fish and Game (ADFG; Busher et al. 2009). 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 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

Sampling occurred from June 6 through September 7 at Pilot Station, with July 19 designated by the Alaska Department of Fish and Game as the transition date between summer and fall management seasons. There were 12 strata of chum salmon analyzed for stock composition from the Pilot Station sonar test fishery. Strata 1 – 6 were from the summer management season, and strata 7 – 12 were from the fall management season. All strata were analyzed with a sample size of 288 that was proportional to the passage of chum salmon.

For the 2011 season, 74% of the chum salmon were from summer run stocks and 26% from fall run stocks. Summer chum salmon comprised the majority of the harvest through July 25 (Table 1, Figure 2). Within the summer run component, apportionments were 84% to the lower river stock group and 16% to the middle river stock group (12% upper Koyukuk and middle mainstem, 4% Tanana; Table 2). These genetic proportions for lower and middle summer chum salmon were within 10% of proportions estimated by escapement projects (Table 3). Lower river escapement (Anvik and Gisasa) accounted for 75% of the total, while middle river escapement (Henshaw) accounted for 25%.

Run timing differences among the summer stock groups were apparent. Lower river chum salmon were present throughout the run and were the largest contributing stock (≥47%) until stratum eight, July 26 – August 5, whereupon their contribution dropped to 7%, and the largest contribution then came from the U.S. Border fall stock group (53%). Tanana River summer chum salmon, like their fall counterpart, had late migration timing.

Fall chum salmon were first detected with a significant contribution in stratum five (July 6 – 11), a week prior to the fall management season, and were in the majority by stratum eight (July 26 – August 5; Table 1, Figure 3). 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). 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 accounted for by fishery managers in order to sustain overall production and biodiversity.

Fall chum salmon from the U.S. border and White regions were the earliest to migrate, followed by fall chum salmon from the Porcupine and mainstem regions (Figure 2). Teslin fall chum salmon were not appreciable contributors, and Tanana fall chum salmon continued to migrate last, slowly building until they comprised the majority of the final strata (Figure 2). Overall, U.S. chum salmon accounted for 60% of the fall run (Table 4). Fall chum salmon from the U.S. border region were sustained throughout the run, with contributions ranging from 11% – 53% for strata 7 – 12 (Table 1), accounting for 44% of the total fall run (Table 4). The contributions from the other fall stocks were 16% Tanana, 14% mainstem, 8% Porcupine, 14% White, and 2% Teslin (Table 4). The contribution by Tanana fall chum salmon was a new low for this region. All of the other contributions were within reported ranges (Table 4). Canada border fall fish, which includes the Porcupine and mainstem regions, continued to return in greater numbers than upper Canada fall fish, which includes the White and Teslin regions. The contribution of Canada border fall fish was 1.3 times larger than upper Canada (Table 4).

Stock abundance estimates, the products of estimates of Pilot Station genetic stock composition (Table 1) and Pilot Station sonar passage (Table 5), ranged from 8,720 to 2,218,536 fish (Table 6). Escapement totals from the upriver monitoring projects for fall chum salmon ranged from 24,807 to 295,335 fish (Table 7). Subsistence harvests of fall chum salmon from the fishing districts, upriver of Pilot Station, were added to the fall escapement totals (Table 8). The genetic/sonar estimates of fall chum salmon continued to be less than the escapement/harvest estimates, as expected (Pfisterer and Maxwell 2000), with the exception of the estimate for Porcupine. This is likely the result of the Fishing Branch weir being flooded out for a long period and the migration of chum salmon to other spawning areas in the Porcupine, which is suggested by the bimodal run timing (Figure 2). The Pilot Station sonar abundance estimate during the fall management season, July 19 – September 7, was 695,263 (Table 5, strata 6 – 10), but genetics estimated that only 598,621 of these fish were actually fall chum salmon. The total fall chum salmon passage for the entire season, June 6 – September 7, was estimated by genetics and sonar at 632,331 fish (Table 6).

The level of agreement between the genetic/sonar and escapement/harvest methods for fall chum salmon appears to be related, in part, to the run timing. There was better agreement in 2004 and 2005 (Flannery et al. 2007). In those years, fall chum salmon comprised the majority of the run after the transition date. Less agreement has been observed since 2006 as a result of later fall run timing. These results are consistent with the hypothesis that a significant number of late returning fish are missed after the sonar shuts down, and that some escapement projects are counting summer chum as fall chum salmon during the overlap between runs. Additional experimental error (e.g. incomplete sonar coverage) by all of the monitoring projects will also affect the level of agreement.

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Table 1. 2011 Pilot Station test fishery chum salmon stock composition estimates with associated standard deviations and 95% confidence intervals by stratum and management group. A. see Figure 1 for management groups. B. contains allocations to various combinations of management groups; Summer represents allocations to Lower, Upp Koy+Main, and Tanana Summer; Fall represents allocations to U.S. Border, Porcupine, Mainstem, White, and Teslin; Middle represents allocations to UppKoy+Main and Tanana Summer; Canada Border represents allocations to Porcupine and Mainstem; Upper Canada represents allocations to White and Teslin; Fall U.S. represents allocations to the Tanana Fall and U.S. Border; U.S. Border + Canada represents allocations to the U.S. Border, Porcupine, Mainstem, White, and Teslin; Mainstem + Upper Canada represents allocations to the Mainstem, White, and Teslin.

Management Group	Stratum 1 6/6 – 6/13 Estimate	SD	95% CI	
A.				
Lower	0.817	0.056	0.692	0.916
UppKoy+Main	0.176	0.056	0.078	0.303
Tanana Summer	0.001	0.004	0.000	0.013
Tanana Fall	0.001	0.003	0.000	0.009
U.S. Border	0.002	0.004	0.000	0.014
U.S. total	0.998	0.003	0.989	1.000
Porcupine	0.000	0.001	0.000	0.003
Mainstem	0.001	0.002	0.000	0.007
White	0.001	0.001	0.000	0.004
Teslin	0.000	0.001	0.000	0.003
Canada total	0.002	0.003	0.000	0.011
B.				
Summer	0.996	0.006	0.979	1.000
Fall	0.004	0.006	0.000	0.021
Middle	0.177	0.056	0.080	0.304
Canada Border	0.001	0.003	0.000	0.009
Upper Canada	0.001	0.002	0.000	0.006
Fall U.S.	0.003	0.005	0.000	0.017
U.S. Border + Canada	0.004	0.005	0.000	0.018
Mainstem + Upper Canada	0.002	0.003	0.000	0.010

Continued

Table 1. Continued.

Management Group	Stratum 2 6/14 – 6/19 Estimate	SD	95% CI	
A.				
Lower	0.877	0.066	0.754	0.985
UppKoy+Main	0.109	0.068	0.001	0.238
Tanana Summer	0.002	0.005	0.000	0.019
Tanana Fall	0.008	0.011	0.000	0.037
U.S. Border	0.001	0.002	0.000	0.006
U.S. total	0.997	0.005	0.984	1.000
Porcupine	0.000	0.001	0.000	0.002
Mainstem	0.002	0.003	0.000	0.012
White	0.000	0.001	0.000	0.003
Teslin	0.001	0.002	0.000	0.009
Canada total	0.003	0.005	0.000	0.016
B.				
Summer	0.989	0.012	0.958	1.000
Fall	0.012	0.012	0.000	0.042
Middle	0.111	0.068	0.001	0.239
Canada Border	0.002	0.004	0.000	0.012
Upper Canada	0.001	0.003	0.000	0.010
Fall U.S.	0.009	0.011	0.000	0.038
U.S. Border + Canada	0.003	0.005	0.000	0.017
Mainstem + Upper Canada	0.003	0.004	0.000	0.015

Continued

Table 1. Continued.

Management Group	Stratum 3 6/20 – 6/27 Estimate	SD	95% CI	
A.				
Lower	0.910	0.053	0.796	0.992
UppKoy+Main	0.077	0.054	0.000	0.196
Tanana Summer	0.004	0.009	0.000	0.034
Tanana Fall	0.005	0.009	0.000	0.031
U.S. Border	0.002	0.004	0.000	0.014
U.S. total	0.998	0.003	0.989	1.000
Porcupine	0.000	0.001	0.000	0.003
Mainstem	0.001	0.002	0.000	0.008
White	0.000	0.001	0.000	0.004
Teslin	0.000	0.001	0.000	0.002
Canada total	0.002	0.003	0.000	0.010
B.				
Summer	0.991	0.010	0.963	1.000
Fall	0.009	0.010	0.000	0.037
Middle	0.081	0.054	0.001	0.198
Canada Border	0.001	0.003	0.000	0.009
Upper Canada	0.001	0.001	0.000	0.005
Fall U.S.	0.007	0.010	0.000	0.035
U.S. Border + Canada	0.003	0.005	0.000	0.018
Mainstem + Upper Canada	0.002	0.003	0.000	0.010

Continued

Table 1. Continued.

Management Group	Stratum 4 6/28 – 7/5 Estimate	SD	95% CI	
A.				
Lower	0.840	0.050	0.733	0.928
UppKoy+Main	0.117	0.053	0.025	0.230
Tanana Summer	0.034	0.028	0.000	0.092
Tanana Fall	0.004	0.008	0.000	0.031
U.S. Border	0.003	0.005	0.000	0.018
U.S. total	0.998	0.003	0.990	1.000
Porcupine	0.000	0.001	0.000	0.003
Mainstem	0.001	0.002	0.000	0.008
White	0.000	0.001	0.000	0.003
Teslin	0.000	0.001	0.000	0.002
Canada total	0.002	0.003	0.000	0.010
B.				
Summer	0.992	0.010	0.963	1.000
Fall	0.008	0.010	0.000	0.037
Middle	0.151	0.051	0.064	0.260
Canada Border	0.001	0.003	0.000	0.009
Upper Canada	0.001	0.002	0.000	0.005
Fall U.S.	0.007	0.010	0.000	0.035
U.S. Border + Canada	0.004	0.006	0.000	0.021
Mainstem + Upper Canada	0.001	0.003	0.000	0.009

Continued

Table 1. Continued.

Management Group	Stratum 5 7/6 – 7/11 Estimate	SD	95% CI	
A.				
Lower	0.685	0.060	0.569	0.804
UppKoy+Main	0.193	0.071	0.063	0.337
Tanana Summer	0.074	0.040	0.000	0.153
Tanana Fall	0.015	0.022	0.000	0.075
U.S. Border	0.024	0.021	0.000	0.071
U.S. total	0.991	0.010	0.964	1.000
Porcupine	0.001	0.005	0.000	0.017
Mainstem	0.004	0.007	0.000	0.026
White	0.003	0.005	0.000	0.016
Teslin	0.000	0.002	0.000	0.004
Canada total	0.009	0.010	0.000	0.036
B.				
Summer	0.953	0.030	0.884	0.997
Fall	0.047	0.030	0.003	0.116
Middle	0.267	0.064	0.146	0.393
Canada Border	0.005	0.009	0.000	0.031
Upper Canada	0.004	0.005	0.000	0.017
Fall U.S.	0.039	0.029	0.000	0.107
U.S. Border + Canada	0.033	0.021	0.002	0.080
Mainstem + Upper Canada	0.007	0.009	0.000	0.031

Continued

Table 1. Continued.

Management Group	Stratum 6 7/12 – 7/18 Estimate	SD	95% CI	
A.				
Lower	0.653	0.060	0.531	0.766
UppKoy+Main	0.133	0.067	0.002	0.274
Tanana Summer	0.098	0.036	0.021	0.169
Tanana Fall	0.008	0.013	0.000	0.047
U.S. Border	0.035	0.030	0.000	0.103
U.S. total	0.927	0.028	0.868	0.976
Porcupine	0.010	0.016	0.000	0.054
Mainstem	0.051	0.027	0.002	0.108
White	0.012	0.010	0.000	0.035
Teslin	0.000	0.001	0.000	0.002
Canada total	0.073	0.028	0.024	0.131
B.				
Summer	0.884	0.029	0.825	0.937
Fall	0.116	0.029	0.063	0.175
Middle	0.231	0.063	0.116	0.358
Canada Border	0.061	0.028	0.012	0.121
Upper Canada	0.012	0.010	0.000	0.036
Fall U.S.	0.043	0.031	0.000	0.113
U.S. Border + Canada	0.108	0.029	0.056	0.167
Mainstem + Upper Canada	0.063	0.026	0.015	0.119

Continued

Table 1. Continued.

Management Group	Stratum 7 7/19 – 7/25 Estimate	SD	95% CI	
A.				
Lower	0.475	0.055	0.365	0.578
UppKoy+Main	0.292	0.066	0.163	0.423
Tanana Summer	0.012	0.023	0.000	0.082
Tanana Fall	0.002	0.006	0.000	0.021
U.S. Border	0.153	0.041	0.077	0.239
U.S. total	0.936	0.030	0.873	0.985
Porcupine	0.002	0.007	0.000	0.025
Mainstem	0.037	0.027	0.000	0.096
White	0.024	0.011	0.008	0.050
Teslin	0.000	0.001	0.000	0.003
Canada total	0.064	0.030	0.015	0.127
B.				
Summer	0.780	0.038	0.702	0.848
Fall	0.220	0.038	0.152	0.298
Middle	0.304	0.062	0.186	0.427
Canada Border	0.039	0.028	0.000	0.099
Upper Canada	0.025	0.011	0.008	0.050
Fall U.S.	0.156	0.041	0.079	0.242
U.S. Border + Canada	0.218	0.037	0.151	0.295
Mainstem + Upper Canada	0.062	0.030	0.014	0.124

Continued

Table 1. Continued.

Management Group	Stratum 8 7/26 – 8/5 Estimate	SD	95% CI	
A.				
Lower	0.074	0.023	0.033	0.122
UppKoy+Main	0.013	0.018	0.000	0.059
Tanana Summer	0.058	0.025	0.016	0.113
Tanana Fall	0.035	0.027	0.000	0.092
U.S. Border	0.533	0.064	0.409	0.657
U.S. total	0.713	0.057	0.600	0.821
Porcupine	0.114	0.046	0.001	0.204
Mainstem	0.033	0.036	0.000	0.121
White	0.139	0.023	0.098	0.186
Teslin	0.001	0.002	0.000	0.006
Canada total	0.287	0.057	0.180	0.400
B.				
Summer	0.146	0.029	0.093	0.208
Fall	0.854	0.029	0.792	0.907
Middle	0.071	0.027	0.025	0.130
Canada Border	0.147	0.054	0.043	0.259
Upper Canada	0.140	0.023	0.098	0.187
Fall U.S.	0.567	0.061	0.451	0.689
U.S. Border + Canada	0.820	0.035	0.748	0.885
Mainstem + Upper Canada	0.173	0.041	0.109	0.267

Continued

Table 1. Continued.

Management Group	Stratum 9 8/6 – 8/11 Estimate	SD	95% CI	
A.				
Lower	0.004	0.006	0.000	0.022
UppKoy+Main	0.021	0.017	0.000	0.062
Tanana Summer	0.018	0.024	0.000	0.079
Tanana Fall	0.127	0.037	0.059	0.201
U.S. Border	0.431	0.061	0.310	0.549
U.S. total	0.601	0.055	0.488	0.706
Porcupine	0.026	0.037	0.000	0.121
Mainstem	0.206	0.054	0.101	0.315
White	0.163	0.024	0.119	0.212
Teslin	0.004	0.008	0.000	0.026
Canada total	0.399	0.055	0.294	0.512
B.				
Summer	0.043	0.026	0.005	0.103
Fall	0.957	0.026	0.897	0.995
Middle	0.039	0.027	0.000	0.099
Canada Border	0.232	0.054	0.130	0.343
Upper Canada	0.167	0.025	0.121	0.218
Fall U.S.	0.558	0.059	0.441	0.671
U.S. Border + Canada	0.830	0.036	0.755	0.897
Mainstem + Upper Canada	0.373	0.056	0.266	0.484

Continued

Table 1. Continued.

Management Group	Stratum 10 8/12 – 8/21 Estimate	SD	95% CI	
A.				
Lower	0.002	0.004	0.000	0.014
UppKoy+Main	0.019	0.027	0.000	0.091
Tanana Summer	0.002	0.005	0.000	0.015
Tanana Fall	0.140	0.035	0.076	0.211
U.S. Border	0.408	0.062	0.288	0.532
U.S. total	0.570	0.055	0.463	0.676
Porcupine	0.001	0.004	0.000	0.012
Mainstem	0.230	0.050	0.134	0.329
White	0.173	0.029	0.118	0.232
Teslin	0.026	0.013	0.005	0.054
Canada total	0.430	0.055	0.324	0.537
B.				
Summer	0.022	0.027	0.000	0.094
Fall	0.978	0.027	0.905	1.000
Middle	0.020	0.027	0.000	0.092
Canada Border	0.231	0.050	0.135	0.330
Upper Canada	0.199	0.032	0.139	0.263
Fall U.S.	0.548	0.060	0.430	0.662
U.S. Border + Canada	0.838	0.040	0.752	0.910
Mainstem + Upper Canada	0.429	0.055	0.322	0.537

Continued

Table 1. Continued.

Management Group	Stratum 11 8/22 – 8/26 Estimate	SD	95% CI	
A.				
Lower	0.030	0.014	0.008	0.062
UppKoy+Main	0.005	0.009	0.000	0.033
Tanana Summer	0.002	0.005	0.000	0.017
Tanana Fall	0.230	0.037	0.162	0.306
U.S. Border	0.240	0.054	0.135	0.344
U.S. total	0.506	0.055	0.395	0.610
Porcupine	0.124	0.040	0.052	0.206
Mainstem	0.161	0.046	0.079	0.255
White	0.188	0.026	0.140	0.241
Teslin	0.021	0.015	0.000	0.057
Canada total	0.494	0.055	0.390	0.605
B.				
Summer	0.036	0.016	0.011	0.074
Fall	0.964	0.016	0.926	0.989
Middle	0.006	0.010	0.000	0.036
Canada Border	0.285	0.053	0.188	0.395
Upper Canada	0.209	0.029	0.155	0.270
Fall U.S.	0.470	0.056	0.355	0.578
U.S. Border + Canada	0.734	0.039	0.654	0.807
Mainstem + Upper Canada	0.371	0.049	0.277	0.470

Continued

Table 1. Continued.

Management Group	Stratum 12 8/27 – 9/7 Estimate	SD	95% CI	
A.				
Lower	0.009	0.012	0.000	0.042
UppKoy+Main	0.033	0.018	0.000	0.071
Tanana Summer	0.001	0.004	0.000	0.012
Tanana Fall	0.539	0.049	0.444	0.637
U.S. Border	0.105	0.051	0.032	0.239
U.S. total	0.688	0.062	0.574	0.824
Porcupine	0.002	0.006	0.000	0.020
Mainstem	0.158	0.060	0.003	0.262
White	0.106	0.033	0.047	0.174
Teslin	0.045	0.020	0.008	0.089
Canada total	0.312	0.062	0.176	0.425
B.				
Summer	0.044	0.016	0.017	0.081
Fall	0.956	0.016	0.919	0.983
Middle	0.034	0.018	0.001	0.074
Canada Border	0.160	0.060	0.004	0.263
Upper Canada	0.152	0.038	0.083	0.231
Fall U.S.	0.644	0.064	0.528	0.783
U.S. Border + Canada	0.417	0.048	0.323	0.512
Mainstem + Upper Canada	0.310	0.063	0.175	0.424

Table 1. Continued.

Management Group	Overall 6/6 – 9/7 Estimate	SD	95% CI	
A.				
Lower	0.625	0.020	0.586	0.664
UppKoy+Main	0.092	0.021	0.051	0.133
Tanana Summer	0.026	0.008	0.010	0.042
Tanana Fall	0.042	0.006	0.031	0.053
U.S. Border	0.113	0.009	0.096	0.130
U.S. total	0.899	0.008	0.884	0.914
Porcupine	0.020	0.006	0.009	0.031
Mainstem	0.037	0.006	0.025	0.048
White	0.042	0.003	0.035	0.048
Teslin	0.004	0.001	0.001	0.006
Canada total	0.101	0.008	0.086	0.116
B.				
Summer	0.744	0.006	0.732	0.755
Fall	0.256	0.006	0.245	0.268
Middle	0.118	0.020	0.078	0.158
Canada Border	0.056	0.007	0.042	0.071
Upper Canada	0.045	0.003	0.038	0.052
Fall U.S.	0.155	0.009	0.137	0.173
U.S. Border + Canada	0.214	0.006	0.203	0.225
Mainstem + Upper Canada	0.082	0.006	0.069	0.094

Table 2. Estimates of summer chum salmon stock proportions for 2011. Proportions were calculated by dividing the region proportion by the total summer contribution in Table 1.

Year	Lower	UppKoy+Main	Tanana
2008	0.75	0.19	0.06
2009	0.86	0.06	0.07
2010	0.77	0.20	0.03
2011	0.84	0.12	0.04
Average	0.81	0.14	0.05

Table 3. Preliminary summer chum salmon escapement project estimates for 2011.

Escapement project	Estimate
Anvik sonar	642,527
Gisasa weir	95,796
Henshaw weir	248,247
Chena tower	No est.
Salcha tower	No est.

Table 4. Estimates of fall chum salmon stock proportions for 2011. 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	0.37	0.31	0.12	0.08	0.12	0.00
2005	0.21	0.49	0.12	0.05	0.11	0.02
2006	0.21	0.44	0.19	0.03	0.13	0.01
2007	0.28	0.33	0.18	0.03	0.17	0.00
2008	0.25	0.39	0.14	0.04	0.16	0.01
2009	0.26	0.38	0.20	0.04	0.11	0.01
2010	0.31	0.28	0.15	0.10	0.16	0.00
2011	0.16	0.44	0.14	0.08	0.16	0.02
Average	0.26	0.38	0.16	0.06	0.14	0.01

Table 5. Preliminary Pilot Station sonar chum salmon passage estimates for 2011.

Year	Season	Strata	Date	Passage
2011	Summer	Stratum 1	6/6 to 6/13	48,882
	Summer	Stratum 2	6/14 to 6/19	209,852
	Summer	Stratum 3	6/20 to 6/27	654,991
	Summer	Stratum 4	6/28 to 7/5	558,001
	Summer	Stratum 5	7/6 to 7/11	206,495
	Summer	Stratum 6	7/12 to 7/18	95,413
	Fall	Stratum 7	7/19 to 7/25	58,423
	Fall	Stratum 8	7/26 to 8/5	259,160
	Fall	Stratum 9	8/6 to 8/11	107,800
	Fall	Stratum 10	8/12 to 8/21	99,254
	Fall	Stratum 11	8/22 to 8/26	119,073
	Fall	Stratum 12	8/27 to 9/7	51,553
		Total	6/6 to 9/7	2,468,897

Table 6. Total abundance estimates derived from Pilot Station genetic stock composition and sonar chum salmon passage estimates for 2011. The standard deviations and 95% confidence intervals are based on the variances of the genetic estimates only. A. see Figure 1 for management groups. B. contains allocations to various combinations of management groups; Summer represents allocations to Lower, UppKoy+Main, and Tanana Summer; Fall represents allocations to U.S. Border, Porcupine, Mainstem, White, and Teslin; Middle represents allocations to UppKoy+Main and Tanana Summer; Canada Border represents allocations to Porcupine and Mainstem; Upper Canada represents allocations to White and Teslin; Fall U.S. represents allocations to the Tanana Fall and U.S. Border; U.S. Border + Canada represents allocations to the U.S. Border, Porcupine, Mainstem, White, and Teslin; Mainstem + Upper Canada represents allocations to the Mainstem, White, and Teslin.

Management Group	6/6 – 9/7 Estimate	SD	95% CI	
A.				
Lower	1,544,135	49,132	1,447,836	1,640,433
UppKoy+Main	227,106	51,414	126,334	327,878
Tanana Summer	64,404	20,324	24,569	104,239
Tanana Fall	103,245	13,605	76,578	129,912
U.S. Border	279,117	21,306	237,357	320,878
U.S. total	2,218,536	18,843	2,181,603	2,255,469
Porcupine	49,085	13,685	22,264	75,907
Mainstem	90,485	14,140	62,770	118,200
White	102,604	8,074	86,779	118,428
Teslin	8,720	2,806	3,221	14,220
Canada total	250,361	18,843	213,428	287,294
B.				
Summer	1,836,566	14,545	1,808,058	1,865,073
Fall	632,331	14,542	603,829	660,833
Middle	291,536	50,463	192,629	390,444
Canada Border	139,415	18,064	104,009	174,821
Upper Canada	111,195	8,472	94,589	127,801
Fall U.S.	382,106	22,615	337,780	426,431
U.S. Border + Canada	529,241	14,019	501,764	556,719
Mainstem + Upper Canada	201,426	15,648	170,756	232,097

Table 7. Preliminary fall chum salmon escapement project estimates for 2011.

Escapement project	Estimate
Chandalar sonar	295,335
Sheenjek sonar	97,976
Eagle Sonar Border Passage (Mainstem + Upper)	211,929
Fishing Branch weir + Old Crow harvest (expanded count)	24,807

Table 8. Subsistence harvest apportionments for 2011. Bold numbers indicate escapements estimated by the monitoring projects. Harvest estimates are averages from 2003–2007 (Busher et al. 2009). 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				**Proportion**				**Apportionment**			
Location	**Harvest**	M.S. CA	Porcupine	Sheenjek	Chandalar	M.S. CA	Porcupine	Sheenjek	Chandalar	M.S. CA	Porcupine	Sheenjek	Chandalar
Chandalar (w/ Black)	1,496				**295,335**	0.0000	0.0000	0.0000	1.0000	0	0	0	1,496
Y6	18,341					0.0000	0.0000	0.0000	0.0000	0	0	0	0
Y5D Above Porcupine	13,159	**211,929**				1.0000	0.0000	0.0000	0.0000	13,159	0	0	0
Ft. Yukon	6,908	225,088	**24,807**	**97,976**		0.6470	0.0713	0.2816	0.0000	4,470	493	1,946	0
Y5D Below Chandalar	641	229,558	25,300	99,922	296,831	0.3523	0.0388	0.1533	0.4555	226	25	98	292
Y5C	1,845	229,784	25,325	100,020	297,123	0.3523	0.0388	0.1533	0.4555	650	72	283	840
Y5B	20,547	230,434	25,396	100,303	297,963	0.3523	0.0388	0.1533	0.4555	7,239	798	3,151	9,360
Y4	6,555	237,672	26,194	103,454	307,323	0.2466	0.0272	0.1073	0.3189	1,616	178	704	2,090
Y3	749	239,289	26,372	104,157	309,413	0.2466	0.0272	0.1073	0.3189	185	20	80	239
Y2 (Marshall only)	503	239,473	26,392	104,238	309,652	0.2466	0.0272	0.1073	0.3189	124	14	54	160
Total	70,744	239,597	26,406	104,292	309,813					27,668	1,599	6,316	14,478

Figure 1. Baseline sampling locations, 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 fishery management regions, with summer regions outlined by dashed lines and fall regions by solid lines. 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.

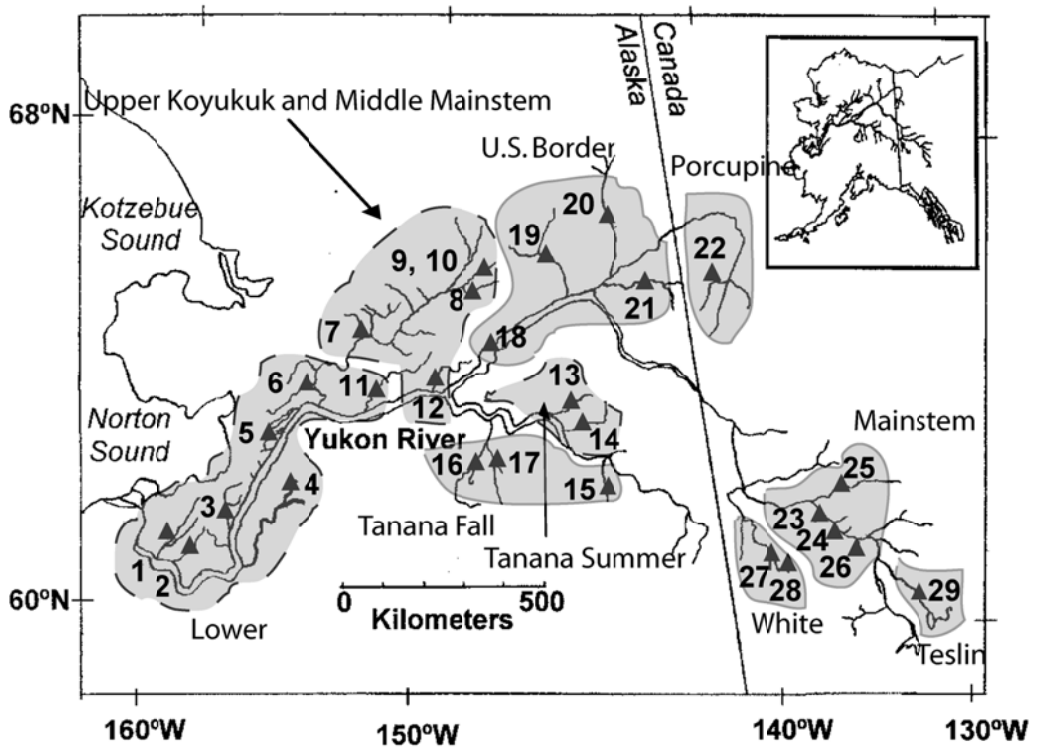


Figure 2. Pilot Station test fishery chum salmon stock composition estimates for 2011. Error bars represent one standard error.

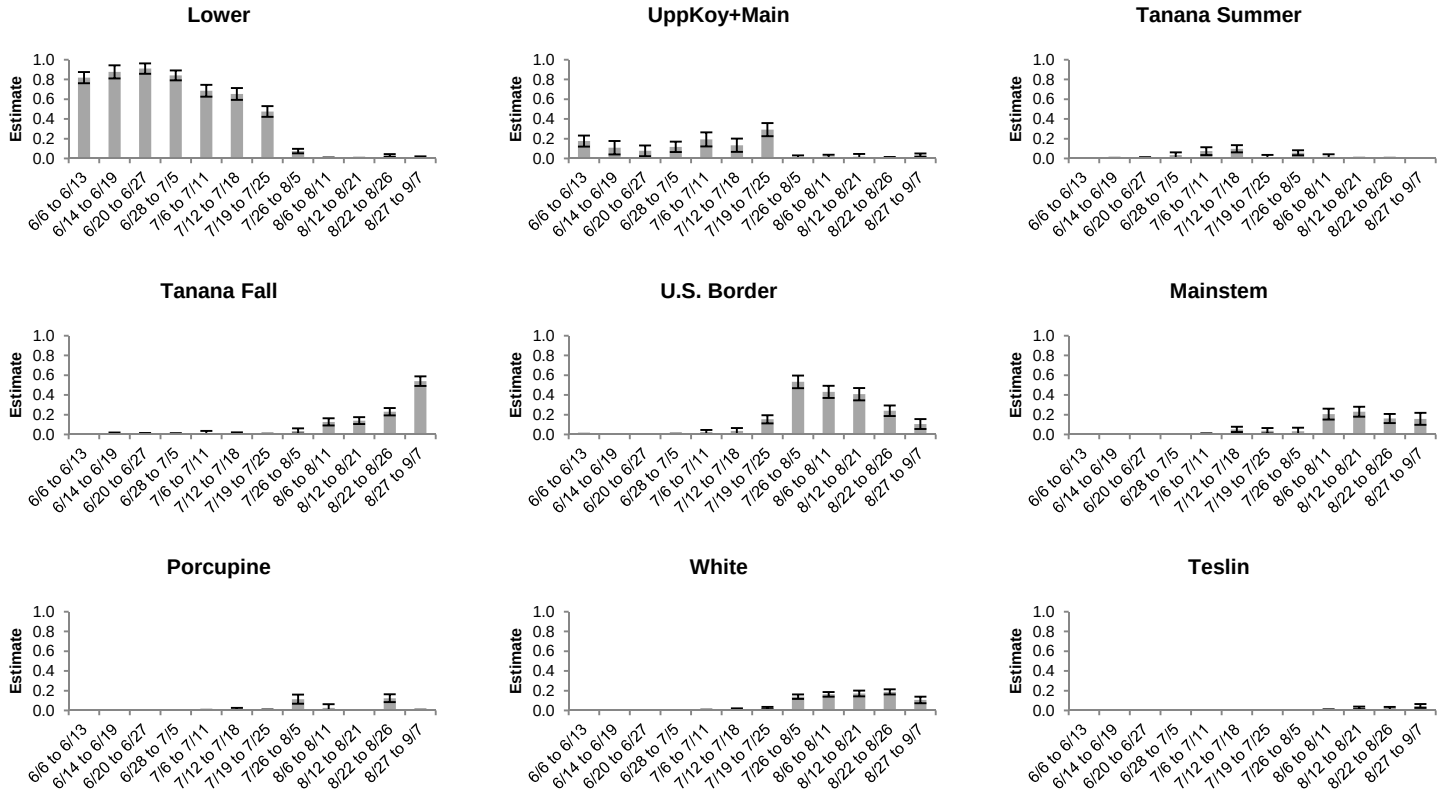


Figure 3. 2011 Pilot Station stock composition estimates for Yukon River chum salmon.

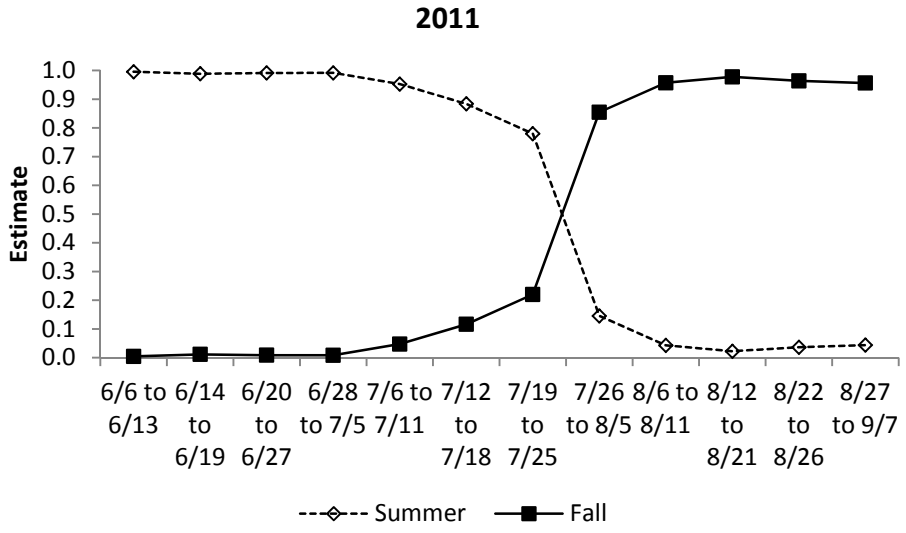
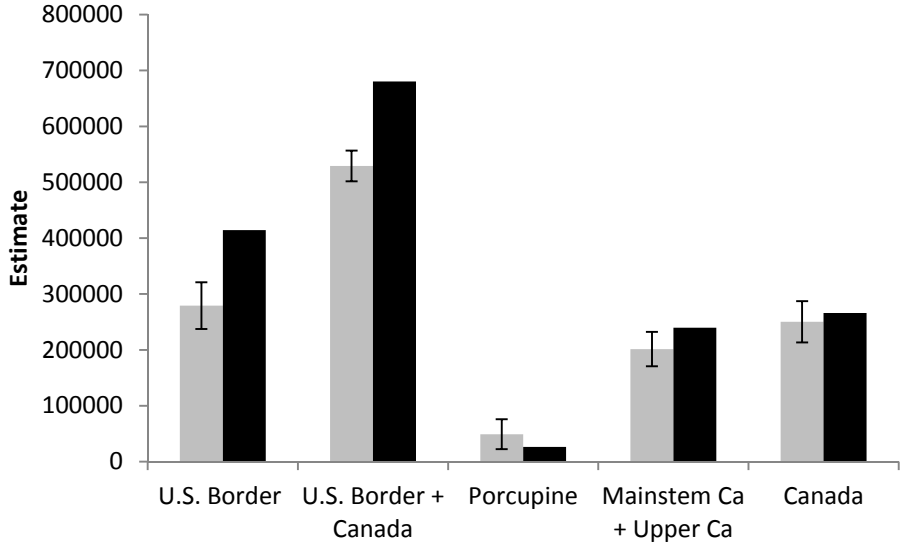


Figure 4. Comparisons of chum salmon stock abundance estimates from genetic/sonar (grey bars) and escapement/harvest (black bars) methods for 2011. The 95% confidence intervals are based on the variances of the genetic estimates only.



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