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Application of Mixed-Stock Analysis for Yukon River Chum Salmon, 2012

Annual Report for Study 10-205

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Table of Contents

List of Tables iii

List of Figures iv

Abstract 1

Introduction 2

Methods 2

Results and Discussion 3

Acknowledgements 5

References 5

Non-discrimination statement 27

List of Tables

Table 1. Chum salmon stock composition estimates from the test fishery near Pilot Station with associated standard deviations and 95% credible intervals by stratum and management group for 2012. 7

Table 2. Estimates of summer chum salmon stock proportions for 2012. 18

Table 3. Estimates of fall chum salmon stock proportions for 2012. 18

Table 4. Preliminary mainstem sonar chum salmon passage estimates for 2012. 19

Table 5. Total abundance estimates derived from genetic stock composition and sonar chum salmon passage estimates for 2012. 20

Table 6. Preliminary fall chum salmon escapement project estimates for 2012. 21

Table 7. Average subsistence harvest apportionments for 2012. 22

List of Figures

Figure 1. Baseline sampling locations. 24

Figure 2. Chum salmon stock composition estimates from the test fishery near Pilot Station for 2012. Error bars represent one standard error. 25

Figure 3. Stock composition estimates for Yukon River summer and fall chum salmon from the test fishery near Pilot Station for 2012. 26

Figure 4. Comparisons of chum salmon stock abundance estimates from genetic/sonar (grey bars) and escapement/harvest (black bars) methods for 2012. The 95% credible intervals are based on the variances of the genetic estimates only. 26

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 2012 season, 80% of the chum salmon were from summer run stocks and 20% from fall run stocks. Summer chum salmon comprised the majority of the harvest through July 24. Within the summer run component, apportionments were 87% to the lower river stock group and 13% to the middle river stock group (11% upper Koyukuk and middle mainstem, 2% Tanana).

Fall chum salmon did not outnumber summer chum salmon until the July 25 to August 2 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 (40%). Contributions of fall chum salmon from other regions were: Tanana 32%, Canada mainstem 15%, Canada Porcupine 1%, White 12%, and Teslin 1%. 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 2012 results of an ongoing MSA study of Yukon River chum salmon harvested from the sonar test fishery operated near Pilot Station 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 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 the fall stock specific abundance estimates from the genetic/sonar method against estimates from the escapement/harvest

method. The escapement for Tanana River fall chum salmon was estimated from the Delta River escapement using a regression relationship between historical Delta River escapement and Tanana River mark and recapture abundance estimates (JTC 2013). Comparisons were not possible for summer chum salmon because escapements are only partially monitored. Escapements from the following projects were compiled: Tanana River regression (JTC 2013), Chandalar River sonar (JTC 2013), Sheenjek River sonar (JTC 2013), Canada border sonar (JTC 2013), and Fishing Branch weir (JTC 2013). 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; Jallen et al. 2012). 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 12 through September 7 at Pilot Station, with July 19 designated by the ADFG as the transition date between summer and fall management seasons. There were 10 strata of chum salmon analyzed for stock composition from the mainstem sonar test fishery. Strata 1 – 5 were from the summer management season, and strata 6 – 10 were from the fall management season. Stratum 10 was analyzed with a sample size of 203 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 2012 season, 80% of the chum salmon were from summer run stocks and 20% from fall run stocks. Summer chum salmon comprised the majority of the harvest through July 24 (Table 1). Within the summer run component, apportionments were 87% to the lower river stock group and 13% to the middle river stock group (11% upper Koyukuk and middle mainstem, 2% Tanana; Table 2).

Run timing differences among the summer stock groups were apparent (Figure 2). Lower river chum salmon were present throughout the run and were the largest contributing stock (≥36%) until stratum seven, July 25 – August 2, whereupon their contribution dropped to 10%, and the largest contribution then came from the U.S. Border fall stock group (50%). 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 10 – 18), a week prior to the fall management season, and were in the majority by stratum seven (July 25 – August 2; 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 are accounted for by fishery managers using this data inseason 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 72% of the fall run (Table 3). Fall chum salmon from the U.S. border region were sustained throughout the run, with contributions ranging from 12% – 50% for strata 6 – 10 (Table 1), accounting for 40% of the total fall run (Table 3). The contributions from the other fall stocks were 32% Tanana, 15% mainstem, 1% Porcupine, 12% White, and 1% Teslin (Table 3). The contribution by Porcupine fall chum salmon was a new low for this region. All of the other contributions were within reported ranges (Table 3). 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 1.2 times larger than upper Canada (Table 3).

Stock abundance estimates, the products of estimates of genetic stock composition (Table 1) and mainstem sonar passage near Pilot Station (Table 4), ranged from 4,856 to 2,649,287 fish (Table 5). Escapement totals from the upriver monitoring projects for fall chum salmon ranged from 22,399 to 205,404 fish (Table 6). Subsistence harvests of fall chum salmon from the fishing districts, upriver of Pilot Station, were added to the fall escapement totals (Table 7). The genetic/sonar estimates of fall chum salmon continued to be less than the escapement/harvest estimates (Figure 4), as expected (Pfisterer and Maxwell 2000), with the exception of the estimate for Tanana Fall. This is likely the result of error in extrapolating Delta River escapement. The sonar abundance estimate during the fall management season, July 19 – September 7, was 682,510 (Table 4, strata 6 – 10), but genetics estimated that only 547,857 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 573,948 fish (Table 5).

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. Chum salmon stock composition estimates from the test fishery operated near Pilot Station, 2012, with associated standard deviations and 95% credible intervals by stratum and management group. A. see Figure 1 for management groups. B. contains apportionments to various combinations of management groups; Summer represents apportionments to Lower, Upp Koy+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 6/12 – 6/18			
	Estimate	SD	95% CI	
A.				
Lower	0.987	0.019	0.931	1.000
UppKoy+Main	0.007	0.018	0.000	0.062
Tanana Summer	0.003	0.008	0.000	0.030
Tanana Fall	0.001	0.002	0.000	0.007
U.S. Border	0.001	0.002	0.000	0.006
U.S. total	0.999	0.002	0.992	1.000
Porcupine	0.000	0.001	0.000	0.001
Mainstem	0.001	0.001	0.000	0.004
White	0.000	0.001	0.000	0.002
Teslin	0.000	0.002	0.000	0.005
Canada total	0.001	0.002	0.000	0.008
B.				
Summer	0.997	0.004	0.987	1.000
Fall	0.003	0.004	0.000	0.013
Middle	0.010	0.019	0.000	0.067
Canada Border	0.001	0.002	0.000	0.005
Upper Canada	0.001	0.002	0.000	0.005
Fall U.S.	0.002	0.003	0.000	0.010
U.S. Border + Canada	0.002	0.003	0.000	0.010
Mainstem + Upper Canada	0.001	0.002	0.000	0.007

Continued

Table 1. Continued.

Management Group	Stratum 2 6/19 – 6/25 Estimate	SD	95% CI	
A.				
Lower	0.909	0.061	0.768	0.984
UppKoy+Main	0.062	0.067	0.000	0.218
Tanana Summer	0.023	0.018	0.000	0.064
Tanana Fall	0.001	0.003	0.000	0.010
U.S. Border	0.001	0.003	0.000	0.011
U.S. total	0.997	0.005	0.981	1.000
Porcupine	0.000	0.001	0.000	0.002
Mainstem	0.002	0.005	0.000	0.017
White	0.000	0.001	0.000	0.002
Teslin	0.000	0.001	0.000	0.004
Canada total	0.003	0.005	0.000	0.019
B.				
Summer	0.995	0.007	0.975	1.000
Fall	0.005	0.007	0.000	0.025
Middle	0.085	0.061	0.011	0.227
Canada Border	0.002	0.005	0.000	0.018
Upper Canada	0.001	0.002	0.000	0.005
Fall U.S.	0.002	0.004	0.000	0.015
U.S. Border + Canada	0.004	0.006	0.000	0.021
Mainstem + Upper Canada	0.003	0.005	0.000	0.018

Continued

Table 1. Continued.

Management Group	Stratum 3 6/26 – 7/2 Estimate	SD	95% CI	
A.				
Lower	0.969	0.025	0.898	0.997
UppKoy+Main	0.012	0.023	0.000	0.086
Tanana Summer	0.006	0.010	0.000	0.036
Tanana Fall	0.002	0.004	0.000	0.015
U.S. Border	0.004	0.008	0.000	0.031
U.S. total	0.993	0.007	0.975	1.000
Porcupine	0.000	0.002	0.000	0.005
Mainstem	0.002	0.004	0.000	0.015
White	0.004	0.006	0.000	0.021
Teslin	0.000	0.001	0.000	0.001
Canada total	0.007	0.007	0.000	0.025
B.				
Summer	0.987	0.011	0.959	1.000
Fall	0.013	0.011	0.000	0.041
Middle	0.018	0.024	0.000	0.092
Canada Border	0.003	0.005	0.000	0.017
Upper Canada	0.005	0.006	0.000	0.021
Fall U.S.	0.006	0.009	0.000	0.034
U.S. Border + Canada	0.011	0.010	0.000	0.038
Mainstem + Upper Canada	0.006	0.007	0.000	0.024

Continued

Table 1. Continued.

Management Group	Stratum 4 7/3 – 7/9 Estimate	SD	95% CI	
A.				
Lower	0.822	0.059	0.687	0.914
UppKoy+Main	0.161	0.064	0.059	0.304
Tanana Summer	0.012	0.020	0.000	0.068
Tanana Fall	0.002	0.003	0.000	0.012
U.S. Border	0.002	0.004	0.000	0.013
U.S. total	0.999	0.003	0.990	1.000
Porcupine	0.000	0.001	0.000	0.003
Mainstem	0.001	0.002	0.000	0.007
White	0.000	0.001	0.000	0.002
Teslin	0.000	0.001	0.000	0.002
Canada total	0.001	0.003	0.000	0.010
B.				
Summer	0.996	0.006	0.978	1.000
Fall	0.004	0.006	0.000	0.021
Middle	0.174	0.059	0.082	0.311
Canada Border	0.001	0.003	0.000	0.009
Upper Canada	0.001	0.001	0.000	0.004
Fall U.S.	0.003	0.005	0.000	0.019
U.S. Border + Canada	0.003	0.005	0.000	0.017
Mainstem + Upper Canada	0.001	0.003	0.000	0.009

Continued

Table 1. Continued.

Management Group	Stratum 5 7/10 – 7/18 Estimate	SD	95% CI	
A.				
Lower	0.597	0.068	0.466	0.730
UppKoy+Main	0.327	0.078	0.171	0.478
Tanana Summer	0.026	0.029	0.000	0.095
Tanana Fall	0.010	0.013	0.000	0.044
U.S. Border	0.022	0.023	0.000	0.076
U.S. total	0.983	0.017	0.943	1.000
Porcupine	0.003	0.008	0.000	0.030
Mainstem	0.014	0.016	0.000	0.053
White	0.000	0.001	0.000	0.003
Teslin	0.000	0.001	0.000	0.002
Canada total	0.017	0.017	0.000	0.057
B.				
Summer	0.951	0.025	0.895	0.991
Fall	0.049	0.025	0.008	0.104
Middle	0.354	0.073	0.213	0.493
Canada Border	0.017	0.017	0.000	0.056
Upper Canada	0.001	0.002	0.000	0.005
Fall U.S.	0.032	0.027	0.000	0.094
U.S. Border + Canada	0.039	0.021	0.006	0.087
Mainstem + Upper Canada	0.015	0.016	0.000	0.053

Continued

Table 1. Continued.

Management Group	Stratum 6 7/19 – 7/24 Estimate	SD	95% CI	
A.				
Lower	0.361	0.055	0.257	0.476
UppKoy+Main	0.222	0.067	0.094	0.356
Tanana Summer	0.149	0.034	0.084	0.220
Tanana Fall	0.025	0.025	0.000	0.084
U.S. Border	0.221	0.040	0.142	0.301
U.S. total	0.978	0.019	0.928	0.998
Porcupine	0.002	0.008	0.000	0.029
Mainstem	0.010	0.016	0.000	0.054
White	0.010	0.007	0.001	0.027
Teslin	0.000	0.002	0.000	0.003
Canada total	0.022	0.019	0.002	0.071
B.				
Summer	0.732	0.040	0.653	0.807
Fall	0.268	0.040	0.193	0.347
Middle	0.371	0.066	0.242	0.497
Canada Border	0.012	0.017	0.000	0.060
Upper Canada	0.010	0.007	0.001	0.028
Fall U.S.	0.246	0.042	0.166	0.329
U.S. Border + Canada	0.243	0.039	0.169	0.321
Mainstem + Upper Canada	0.020	0.018	0.002	0.069

Continued

Table 1. Continued.

Management Group	Stratum 7 7/25 – 8/2 Estimate	SD	95% CI	
A.				
Lower	0.101	0.037	0.024	0.167
UppKoy+Main	0.079	0.066	0.000	0.223
Tanana Summer	0.033	0.038	0.000	0.116
Tanana Fall	0.050	0.029	0.001	0.114
U.S. Border	0.497	0.062	0.374	0.617
U.S. total	0.760	0.056	0.645	0.863
Porcupine	0.002	0.009	0.000	0.028
Mainstem	0.155	0.054	0.058	0.268
White	0.082	0.018	0.051	0.119
Teslin	0.001	0.002	0.000	0.007
Canada total	0.240	0.056	0.137	0.355
B.				
Summer	0.213	0.039	0.141	0.293
Fall	0.787	0.039	0.707	0.859
Middle	0.113	0.050	0.032	0.225
Canada Border	0.157	0.055	0.058	0.271
Upper Canada	0.083	0.018	0.051	0.120
Fall U.S.	0.546	0.066	0.418	0.674
U.S. Border + Canada	0.737	0.039	0.659	0.810
Mainstem + Upper Canada	0.238	0.056	0.135	0.353

Continued

Table 1. Continued.

Management Group	Stratum 8 8/3 – 8/10 Estimate	SD	95% CI	
A.				
Lower	0.063	0.023	0.020	0.109
UppKoy+Main	0.043	0.033	0.000	0.118
Tanana Summer	0.004	0.010	0.000	0.036
Tanana Fall	0.161	0.033	0.100	0.227
U.S. Border	0.307	0.060	0.197	0.429
U.S. total	0.579	0.058	0.464	0.692
Porcupine	0.040	0.047	0.000	0.147
Mainstem	0.191	0.059	0.082	0.313
White	0.190	0.026	0.142	0.242
Teslin	0.000	0.001	0.000	0.002
Canada total	0.421	0.058	0.309	0.536
B.				
Summer	0.111	0.031	0.058	0.177
Fall	0.889	0.031	0.823	0.942
Middle	0.047	0.033	0.000	0.120
Canada Border	0.231	0.057	0.123	0.345
Upper Canada	0.190	0.026	0.142	0.242
Fall U.S.	0.468	0.063	0.346	0.593
U.S. Border + Canada	0.728	0.039	0.649	0.800
Mainstem + Upper Canada	0.381	0.062	0.268	0.506

Continued

Table 1. Continued.

Management Group	Stratum 9 8/11 – 8/22 Estimate	SD	95% CI	
A.				
Lower	0.011	0.008	0.001	0.031
UppKoy+Main	0.005	0.010	0.000	0.036
Tanana Summer	0.002	0.006	0.000	0.022
Tanana Fall	0.415	0.040	0.336	0.495
U.S. Border	0.316	0.045	0.230	0.406
U.S. total	0.750	0.040	0.670	0.823
Porcupine	0.003	0.011	0.000	0.037
Mainstem	0.122	0.036	0.057	0.198
White	0.114	0.021	0.076	0.158
Teslin	0.011	0.010	0.000	0.035
Canada total	0.250	0.040	0.177	0.330
B.				
Summer	0.018	0.014	0.002	0.055
Fall	0.982	0.014	0.945	0.998
Middle	0.007	0.011	0.000	0.042
Canada Border	0.125	0.037	0.058	0.201
Upper Canada	0.125	0.023	0.083	0.172
Fall U.S.	0.732	0.041	0.649	0.807
U.S. Border + Canada	0.566	0.041	0.485	0.644
Mainstem + Upper Canada	0.247	0.039	0.175	0.327

Continued

Table 1. Continued.

Management Group	Stratum 10 8/23 – 9/7 Estimate	SD	95% CI	
A.				
Lower	0.027	0.016	0.003	0.066
UppKoy+Main	0.062	0.045	0.000	0.152
Tanana Summer	0.002	0.006	0.000	0.018
Tanana Fall	0.643	0.047	0.548	0.731
U.S. Border	0.116	0.046	0.043	0.222
U.S. total	0.849	0.044	0.755	0.925
Porcupine	0.001	0.007	0.000	0.018
Mainstem	0.056	0.040	0.000	0.144
White	0.075	0.020	0.041	0.119
Teslin	0.018	0.012	0.002	0.048
Canada total	0.151	0.044	0.075	0.244
B.				
Summer	0.091	0.041	0.022	0.177
Fall	0.909	0.041	0.823	0.978
Middle	0.064	0.045	0.000	0.153
Canada Border	0.057	0.040	0.000	0.145
Upper Canada	0.093	0.024	0.053	0.143
Fall U.S.	0.759	0.057	0.647	0.869
U.S. Border + Canada	0.267	0.048	0.178	0.364
Mainstem + Upper Canada	0.149	0.044	0.074	0.243

Continued

Table 1. Continued.

Management Group	Overall 6/12 – 9/7 Estimate	SD	95% CI	
A.				
Lower	0.690	0.018	0.654	0.726
UppKoy+Main	0.086	0.020	0.047	0.126
Tanana Summer	0.019	0.007	0.006	0.032
Tanana Fall	0.066	0.005	0.056	0.075
U.S. Border	0.081	0.007	0.068	0.094
U.S. total	0.942	0.006	0.931	0.954
Porcupine	0.002	0.002	0.000	0.006
Mainstem	0.030	0.005	0.019	0.040
White	0.024	0.003	0.019	0.030
Teslin	0.002	0.001	0.000	0.004
Canada total	0.058	0.006	0.046	0.069
B.				
Summer	0.796	0.005	0.786	0.806
Fall	0.204	0.005	0.194	0.214
Middle	0.105	0.019	0.069	0.142
Canada Border	0.032	0.005	0.021	0.042
Upper Canada	0.026	0.003	0.020	0.032
Fall U.S.	0.146	0.007	0.133	0.160
U.S. Border + Canada	0.139	0.006	0.127	0.151
Mainstem + Upper Canada	0.056	0.006	0.044	0.067

Table 2. Estimates of summer chum salmon stock proportions for 2012. 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
2012	0.87	0.11	0.02
Average	0.82	0.14	0.04

Table 3. Estimates of fall chum salmon stock proportions for 2012. 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	0.01
2012	0.32	0.40	0.15	0.01	0.12	0.01
Average	0.26	0.39	0.15	0.05	0.14	0.01

Table 4. Preliminary mainstem sonar chum salmon passage estimates near Pilot Station for 2012.

Year	Season	Strata	Date	Passage
2012	Summer	Stratum 1	6/12 to 6/18	104,027
	Summer	Stratum 2	6/19 to 6/25	584,553
	Summer	Stratum 3	6/26 to 7/2	745,205
	Summer	Stratum 4	7/3 to 7/9	461,098
	Summer	Stratum 5	7/10 to 7/18	234,376
	Fall	Stratum 6	7/19 to 7/24	114,553
	Fall	Stratum 7	7/25 to 8/2	146,778
	Fall	Stratum 8	8/3 to 8/10	81,515
	Fall	Stratum 9	8/11 to 8/22	278,130
	Fall	Stratum 10	8/23 to 9/7	62,534
		Total	6/12 to 9/7	2,812,914

Table 5. Total abundance estimates derived from genetic stock composition and sonar chum salmon passage estimates collected near Pilot Station in 2012. The standard deviations and 95% credible intervals are based on the variances of the genetic estimates only. A. see Figure 1 for management groups. B. contains apportionments to various combinations of 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	6/12 – 9/7 Estimate	SD	95% CI	
A.				
Lower	1,940,814	51,729	1,839,425	2,042,203
UppKoy+Main	242,395	56,459	131,735	353,055
Tanana Summer	53,535	18,835	16,618	90,452
Tanana Fall	184,440	13,840	157,313	211,566
U.S. Border	227,577	19,205	189,935	265,219
U.S. total	2,649,287	16,651	2,616,651	2,681,923
Porcupine	5,921	5,684	0	17,063
Mainstem	83,496	15,187	53,730	113,262
White	68,745	8,262	52,552	84,937
Teslin	4,856	3,189	0	11,107
Canada total	162,490	16,661	129,836	195,145
B.				
Summer	2,237,829	14,344	2,209,715	2,265,943
Fall	573,948	14,342	545,837	602,058
Middle	295,902	52,652	192,705	399,099
Canada Border	89,244	15,347	59,165	119,324
Upper Canada	73,493	8,810	56,225	90,762
Fall U.S.	411,659	19,484	373,471	449,847
U.S. Border + Canada	389,763	17,290	355,875	423,650
Mainstem + Upper Canada	156,747	16,541	124,327	189,167

Table 6. Preliminary fall chum salmon escapement project estimates for 2012.

Escapement project (Genetic Equivalent)	Estimate
Chandalar sonar (U.S. Border)	205,404
Sheenjek sonar (U.S. Border)	104,701
Eagle Sonar Border Passage (Mainstem + Upper)	137,662
Fishing Branch weir (Porcupine CA)	22,399
Tanana regression (Tanana Fall)	102,096

Table 7. Subsistence harvest apportionments for 2012. Bold numbers indicate escapements estimated by the monitoring projects. Harvest estimates are averages from 2006–2010 (Jallen et al. 2012). 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)	1,728				**205,404**	
Y6	18,085					**102,096**
Y5D Above Porcupine	16,576	**137,662**				
Ft. Yukon	7,306	154,238	**22,399**	**104,701**		
Y5D Below Chandalar	979	158,243	22,981	107,420	207,132	
Y5C	2,468	158,556	23,026	107,632	207,541	
Y5B	19,364	159,344	23,140	108,167	208,572	
Y5A						120,181
Y4	6,185	165,524	24,038	112,362	216,662	120,181
Y3	1,098	167,127	24,271	113,450	218,760	121,345
Y2 (Marshall only)	439	167,412	24,312	113,644	219,133	121,551
Total	74,228	167,525	24,329	113,721	219,281	121,634

Continued

Table 7. Continued.

	Proportion of Contributing Stocks				
Location	M.S. CA	Porcupine	Sheenjek	Chandalar	Tanana
Chandalar (w/ Black)	0.000	0.000	0.000	1.000	0.000
Y6	0.000	0.000	0.000	0.000	1.000
Y5D Above Porcupine	1.000	0.000	0.000	0.000	0.000
Ft. Yukon	0.548	0.080	0.372	0.000	0.000
Y5D Below Chandalar	0.319	0.046	0.217	0.418	0.000
Y5C	0.319	0.046	0.217	0.418	0.000
Y5B	0.319	0.046	0.217	0.418	0.000
Y5A	0.000	0.000	0.000	0.000	1.000
Y4	0.259	0.038	0.176	0.339	0.188
Y3	0.259	0.038	0.176	0.339	0.188
Y2 (Marshall only)	0.259	0.038	0.176	0.339	0.188

	Harvest Apportionment				
Location	M.S. CA	Porcupine	Sheenjek	Chandalar	Tanana
Chandalar (w/ Black)	0	0	0	1,728	0
Y6	0	0	0	0	18,085
Y5D Above Porcupine	16,576	0	0	0	0
Ft. Yukon	4,005	582	2,719	0	0
Y5D Below Chandalar	312	45	212	409	0
Y5C	788	114	535	1,031	0
Y5B	6,181	898	4,196	8,090	0
Y5A	0	0	0	0	0
Y4	1,603	233	1,088	2,098	1,164
Y3	285	41	193	372	207
Y2 (Marshall only)	114	17	77	149	83
Total	29,863	1,930	9,020	13,877	19,538

Figure 1. Baseline sampling locations, 1 = Andreafsky, 2 = Chulinak, 3 = Anvik, 4 = California, 5 = Tostoi, 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.

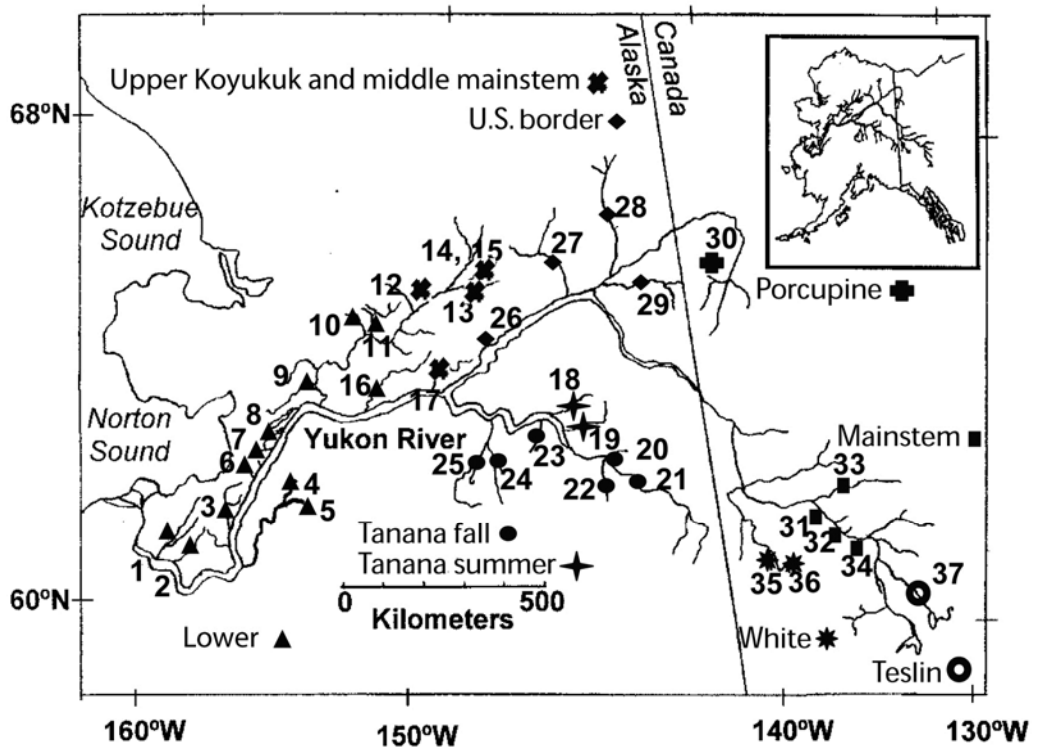


Figure 2. Chum salmon stock composition estimates from the test fishery near Pilot Station for 2012. Error bars represent one standard error.

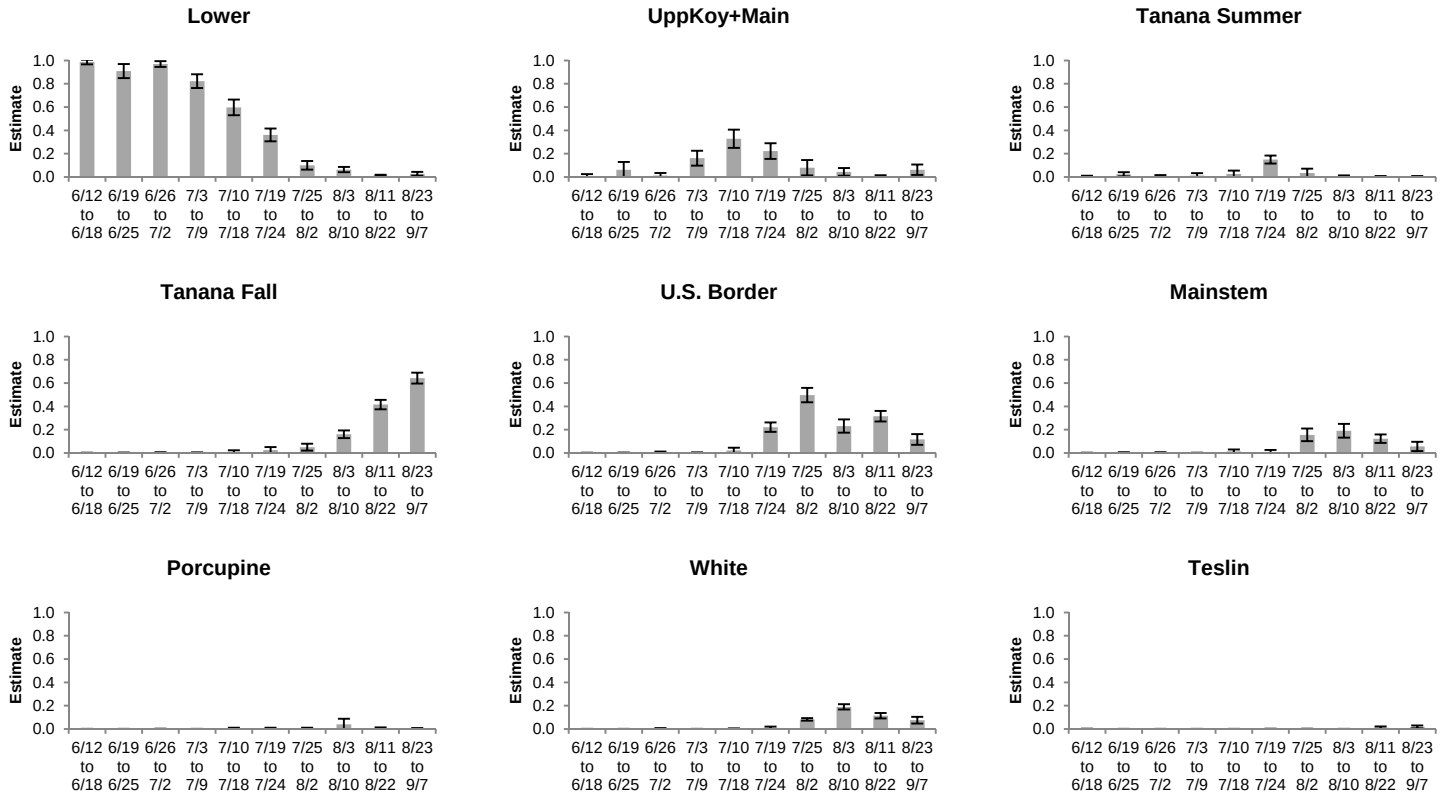


Figure 3. Stock composition estimates for Yukon River chum salmon from the test fishery near Pilot Station for 2012.

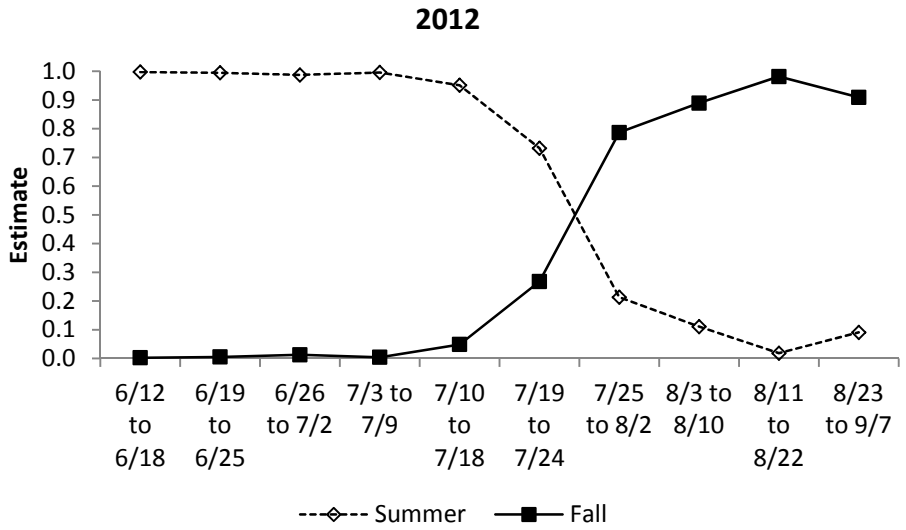
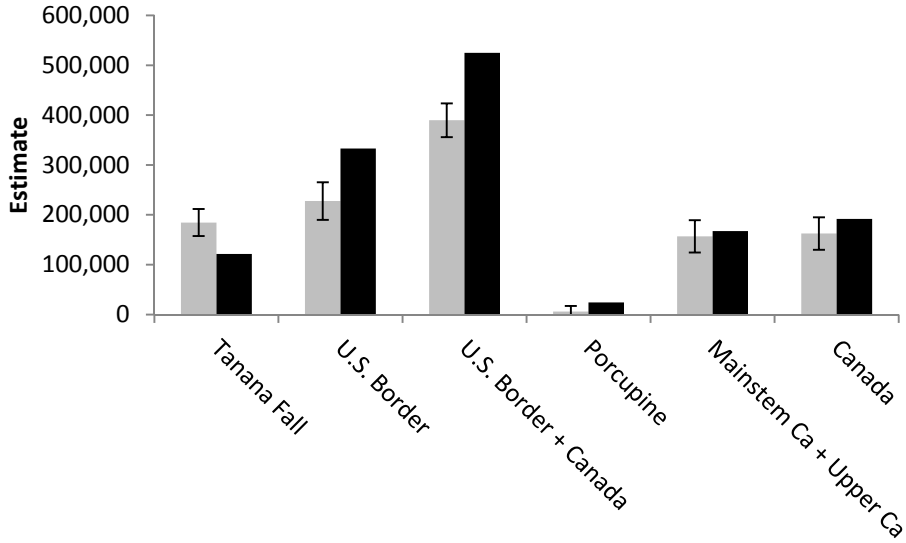


Figure 4. Comparisons of chum salmon stock abundance estimates from genetic/sonar (grey bars) and escapement/harvest (black bars) methods for 2012. The 95% credible intervals are based on the variances of the genetic estimates only.



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