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# Application of Mixed-Stock Analysis for Yukon River Chum Salmon, 2010

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 2010 season, 84% of the chum salmon were from summer run stocks and 16% from fall run stocks. Summer chum salmon comprised the majority of the harvest through July 27. Within the summer run component, apportionments were 77% to the lower river stock group and 23% to the middle river stock group (20% upper Koyukuk and middle mainstem, 3% Tanana). These genetic proportions for lower and middle summer chum salmon were in close agreement to proportions estimated from escapement projects.

Fall chum salmon did not outnumber summer chum salmon until the July 28 to August 10 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 Tanana region (31%). Contributions of fall chum salmon from other regions were: U.S. Border 28%, Canada mainstem 15%, Canada Porcupine 10%, White 16%, and Teslin 0%. 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 contribution 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 2010 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 11 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 10 strata of chum salmon analyzed for stock composition from the Pilot Station sonar test fishery. Strata 1 – 5 were from the summer management season, and strata 6 – 10 were from the fall management season. Strata 5, 8, and 10 were analyzed with sample sizes of 160, 229, and 278 due to low passage and catch. All other strata were analyzed with a sample size of 288 that was proportional to the passage of chum salmon.

For the 2010 season, 84% of the chum salmon were from summer run stocks and 16% from fall run stocks. Summer chum salmon comprised the majority of the harvest through July 27 (Table 1, Figure 2). Within the summer run component, apportionments were 77% to the lower river stock group and 23% to the middle river stock group (20% upper Koyukuk and middle mainstem, 3% Tanana; Table 2). These genetic proportions for lower and middle summer chum salmon were in close agreement to proportions estimated from escapement projects (Table 3). Lower river escapement (Anvik and Gisasa) accounted for 77% of the total, while middle river escapement (Henshaw, Chena, and Salcha) accounted for 23% (18% upper Koyukuk and middle mainstem, 5% Tanana).

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 (≥66%) until the stratum six, July 19 – 27, whereupon their contribution dropped to 27% and the largest contribution then came from the middle river summer stock group (33%). 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 13 – 18), a week prior to the fall management season, and were in the majority by stratum seven (July 28 – August 10; 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 region were the earliest to migrate, followed by fall chum salmon from the Porcupine, mainstem, and White 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). Fall chum salmon from the U.S. border region were sustained throughout the run, with contributions ranging from 12% – 27% for strata 6 – 10 (Table 1), accounting for 28% of the total fall run (Table 4). The Tanana region was the largest contributor at 31%, and overall, U.S. chum salmon accounted for 59% of the fall run (Table 4). The rest of the fall run was comprised of 15% mainstem, 10% Porcupine, and 16% White (Table 4). The contribution by Porcupine was a new high 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 1.6 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 1,026 to 1,396,920 fish (Table 6). Escapement totals from the upriver monitoring projects for fall chum salmon ranged from 22,053 to 121,580 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), though the discrepancy has increased since 2005 (Figure 4; Flannery et al. 2007, 2008, 2009). The Pilot Station sonar abundance estimate during the fall management season, July 19 – September 7, was 340,856 (Table 5, strata 6 – 10), but genetics estimated that only 255,755 of these fish were actually fall chum salmon. The total fall chum salmon passage for the entire season, June 11 – September 7, was estimated by genetics and sonar at 271,036 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. 2010 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 6/11 – 6/21 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.691 | 0.073 | 0.554 | 0.845 |
| UppKoy+Main | 0.302 | 0.074 | 0.141 | 0.440 |
| Tanana Summer | 0.003 | 0.007 | 0.000 | 0.025 |
| Tanana Fall | 0.001 | 0.003 | 0.000 | 0.009 |
| U.S. Border | 0.002 | 0.004 | 0.000 | 0.013 |
| 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 | 0.007 |
| 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 | 0.996 | 0.006 | 0.980 | 1.000 |
| Fall | 0.004 | 0.006 | 0.000 | 0.020 |
| Middle | 0.305 | 0.073 | 0.149 | 0.442 |
| Canada Border | 0.001 | 0.002 | 0.000 | 0.008 |
| Upper Canada | 0.001 | 0.001 | 0.000 | 0.005 |
| Fall U.S. | 0.001 | 0.003 | 0.000 | 0.009 |
| U.S. Border + Canada | 0.003 | 0.005 | 0.000 | 0.017 |
| Mainstem + Upper Canada | 0.003 | 0.005 | 0.000 | 0.017 |

Continued

Table 1. Continued.

| Management Group | Stratum 2 6/22 – 6/28 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.852 | 0.068 | 0.712 | 0.969 |
| UppKoy+Main | 0.125 | 0.072 | 0.000 | 0.273 |
| Tanana Summer | 0.017 | 0.019 | 0.000 | 0.063 |
| Tanana Fall | 0.002 | 0.004 | 0.000 | 0.014 |
| U.S. Border | 0.001 | 0.002 | 0.000 | 0.006 |
| U.S. total | 0.997 | 0.005 | 0.983 | 1.000 |
| | | | | |
| Porcupine | 0.000 | 0.001 | 0.000 | 0.002 |
| Mainstem | 0.002 | 0.004 | 0.000 | 0.016 |
| White | 0.000 | 0.001 | 0.000 | 0.003 |
| Teslin | 0.000 | 0.001 | 0.000 | 0.002 |
| Canada total | 0.003 | 0.005 | 0.000 | 0.017 |
| B. | | | | |
| Summer | 0.995 | 0.006 | 0.977 | 1.000 |
| Fall | 0.005 | 0.006 | 0.000 | 0.023 |
| Middle | 0.142 | 0.068 | 0.025 | 0.285 |
| Canada Border | 0.002 | 0.004 | 0.000 | 0.016 |
| Upper Canada | 0.001 | 0.001 | 0.000 | 0.004 |
| Fall U.S. | 0.002 | 0.004 | 0.000 | 0.016 |
| U.S. Border + Canada | 0.003 | 0.005 | 0.000 | 0.018 |
| Mainstem + Upper Canada | 0.003 | 0.005 | 0.000 | 0.017 |

Continued

Table 1. Continued.

| Management Group | Stratum 3 6/29 – 7/5 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.733 | 0.055 | 0.623 | 0.838 |
| UppKoy+Main | 0.248 | 0.056 | 0.142 | 0.359 |
| Tanana Summer | 0.001 | 0.004 | 0.000 | 0.013 |
| Tanana Fall | 0.001 | 0.003 | 0.000 | 0.009 |
| U.S. Border | 0.014 | 0.012 | 0.000 | 0.043 |
| U.S. total | 0.998 | 0.003 | 0.988 | 1.000 |
| | | | | |
| Porcupine | 0.000 | 0.002 | 0.000 | 0.004 |
| Mainstem | 0.001 | 0.003 | 0.000 | 0.009 |
| 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 | 0.012 |
| B. | | | | |
| Summer | 0.983 | 0.013 | 0.953 | 0.999 |
| Fall | 0.017 | 0.013 | 0.000 | 0.047 |
| Middle | 0.249 | 0.056 | 0.144 | 0.361 |
| Canada Border | 0.002 | 0.003 | 0.000 | 0.011 |
| Upper Canada | 0.001 | 0.002 | 0.000 | 0.005 |
| Fall U.S. | 0.015 | 0.012 | 0.000 | 0.044 |
| U.S. Border + Canada | 0.016 | 0.012 | 0.000 | 0.045 |
| Mainstem + Upper Canada | 0.002 | 0.003 | 0.000 | 0.011 |

Continued

Table 1. Continued.

| Management Group | Stratum 4 7/6 – 7/12 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.895 | 0.035 | 0.814 | 0.948 |
| UppKoy+Main | 0.021 | 0.029 | 0.000 | 0.095 |
| Tanana Summer | 0.079 | 0.021 | 0.041 | 0.124 |
| Tanana Fall | 0.001 | 0.003 | 0.000 | 0.009 |
| U.S. Border | 0.002 | 0.005 | 0.000 | 0.017 |
| U.S. total | 0.998 | 0.004 | 0.987 | 1.000 |
| | | | | |
| Porcupine | 0.000 | 0.001 | 0.000 | 0.003 |
| Mainstem | 0.001 | 0.003 | 0.000 | 0.011 |
| White | 0.000 | 0.001 | 0.000 | 0.004 |
| Teslin | 0.000 | 0.001 | 0.000 | 0.002 |
| Canada total | 0.002 | 0.004 | 0.000 | 0.013 |
| B. | | | | |
| Summer | 0.995 | 0.007 | 0.976 | 1.000 |
| Fall | 0.005 | 0.007 | 0.000 | 0.024 |
| Middle | 0.099 | 0.035 | 0.047 | 0.182 |
| Canada Border | 0.002 | 0.003 | 0.000 | 0.012 |
| Upper Canada | 0.001 | 0.002 | 0.000 | 0.005 |
| Fall U.S. | 0.003 | 0.006 | 0.000 | 0.020 |
| U.S. Border + Canada | 0.004 | 0.006 | 0.000 | 0.021 |
| Mainstem + Upper Canada | 0.002 | 0.003 | 0.000 | 0.012 |

Continued

Table 1. Continued.

| Management Group | Stratum 5 7/13 – 7/18 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.664 | 0.060 | 0.534 | 0.769 |
| UppKoy+Main | 0.116 | 0.067 | 0.000 | 0.263 |
| Tanana Summer | 0.142 | 0.051 | 0.050 | 0.249 |
| Tanana Fall | 0.013 | 0.019 | 0.000 | 0.066 |
| U.S. Border | 0.043 | 0.039 | 0.000 | 0.134 |
| U.S. total | 0.978 | 0.025 | 0.913 | 1.000 |
| | | | | |
| Porcupine | 0.012 | 0.020 | 0.000 | 0.069 |
| Mainstem | 0.008 | 0.016 | 0.000 | 0.058 |
| White | 0.003 | 0.007 | 0.000 | 0.024 |
| Teslin | 0.000 | 0.002 | 0.000 | 0.003 |
| Canada total | 0.022 | 0.025 | 0.000 | 0.086 |
| B. | | | | |
| Summer | 0.922 | 0.038 | 0.837 | 0.984 |
| Fall | 0.078 | 0.038 | 0.015 | 0.163 |
| Middle | 0.258 | 0.064 | 0.144 | 0.394 |
| Canada Border | 0.020 | 0.025 | 0.000 | 0.084 |
| Upper Canada | 0.003 | 0.007 | 0.000 | 0.025 |
| Fall U.S. | 0.056 | 0.041 | 0.000 | 0.149 |
| U.S. Border + Canada | 0.065 | 0.038 | 0.004 | 0.152 |
| Mainstem + Upper Canada | 0.010 | 0.017 | 0.000 | 0.062 |

Continued

Table 1. Continued.

| Management Group | Stratum 6<br>7/19 – 7/27<br>Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.265 | 0.039 | 0.190 | 0.344 |
| UppKoy+Main | 0.215 | 0.061 | 0.094 | 0.337 |
| Tanana Summer | 0.115 | 0.045 | 0.031 | 0.209 |
| Tanana Fall | 0.035 | 0.028 | 0.000 | 0.097 |
| U.S. Border | 0.215 | 0.049 | 0.122 | 0.314 |
| U.S. total | 0.846 | 0.041 | 0.756 | 0.917 |
| | | | | |
| Porcupine | 0.069 | 0.033 | 0.000 | 0.137 |
| Mainstem | 0.028 | 0.031 | 0.000 | 0.105 |
| White | 0.057 | 0.016 | 0.030 | 0.091 |
| Teslin | 0.000 | 0.001 | 0.000 | 0.002 |
| Canada total | 0.154 | 0.041 | 0.082 | 0.244 |
| B. | | | | |
| Summer | 0.595 | 0.043 | 0.507 | 0.679 |
| Fall | 0.405 | 0.043 | 0.321 | 0.493 |
| Middle | 0.330 | 0.052 | 0.231 | 0.434 |
| Canada Border | 0.097 | 0.039 | 0.031 | 0.184 |
| Upper Canada | 0.057 | 0.016 | 0.030 | 0.091 |
| Fall U.S. | 0.250 | 0.054 | 0.146 | 0.358 |
| U.S. Border + Canada | 0.370 | 0.044 | 0.287 | 0.457 |
| Mainstem + Upper Canada | 0.085 | 0.035 | 0.036 | 0.166 |

Continued

Table 1. Continued.

| Management Group | Stratum 7<br>7/28 – 8/10<br>Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.197 | 0.035 | 0.132 | 0.270 |
| UppKoy+Main | 0.078 | 0.047 | 0.000 | 0.175 |
| Tanana Summer | 0.030 | 0.036 | 0.000 | 0.116 |
| Tanana Fall | 0.137 | 0.040 | 0.062 | 0.215 |
| U.S. Border | 0.160 | 0.063 | 0.050 | 0.293 |
| U.S. total | 0.601 | 0.059 | 0.487 | 0.720 |
| | | | | |
| Porcupine | 0.014 | 0.029 | 0.000 | 0.103 |
| Mainstem | 0.225 | 0.057 | 0.112 | 0.336 |
| White | 0.159 | 0.025 | 0.113 | 0.211 |
| Teslin | 0.001 | 0.002 | 0.000 | 0.007 |
| Canada total | 0.399 | 0.059 | 0.280 | 0.513 |
| B. | | | | |
| Summer | 0.305 | 0.044 | 0.222 | 0.392 |
| Fall | 0.695 | 0.044 | 0.608 | 0.778 |
| Middle | 0.107 | 0.047 | 0.019 | 0.205 |
| Canada Border | 0.239 | 0.058 | 0.126 | 0.350 |
| Upper Canada | 0.160 | 0.025 | 0.113 | 0.211 |
| Fall U.S. | 0.296 | 0.070 | 0.167 | 0.437 |
| U.S. Border + Canada | 0.558 | 0.044 | 0.473 | 0.643 |
| Mainstem + Upper Canada | 0.385 | 0.059 | 0.266 | 0.500 |

Continued

Table 1. Continued.

| Management Group | Stratum 8<br>8/11 – 8/17<br>Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.070 | 0.022 | 0.033 | 0.117 |
| UppKoy+Main | 0.006 | 0.013 | 0.000 | 0.047 |
| Tanana Summer | 0.001 | 0.004 | 0.000 | 0.014 |
| Tanana Fall | 0.262 | 0.044 | 0.179 | 0.354 |
| U.S. Border | 0.270 | 0.062 | 0.152 | 0.395 |
| U.S. total | 0.609 | 0.057 | 0.497 | 0.718 |
| | | | | |
| Porcupine | 0.055 | 0.055 | 0.000 | 0.173 |
| Mainstem | 0.139 | 0.048 | 0.051 | 0.239 |
| White | 0.197 | 0.028 | 0.144 | 0.255 |
| Teslin | 0.001 | 0.003 | 0.000 | 0.009 |
| Canada total | 0.391 | 0.057 | 0.282 | 0.503 |
| B. | | | | |
| Summer | 0.077 | 0.025 | 0.037 | 0.132 |
| Fall | 0.923 | 0.025 | 0.868 | 0.963 |
| Middle | 0.007 | 0.014 | 0.000 | 0.049 |
| Canada Border | 0.193 | 0.054 | 0.095 | 0.301 |
| Upper Canada | 0.197 | 0.028 | 0.145 | 0.256 |
| Fall U.S. | 0.532 | 0.059 | 0.415 | 0.646 |
| U.S. Border + Canada | 0.661 | 0.047 | 0.565 | 0.748 |
| Mainstem + Upper Canada | 0.336 | 0.054 | 0.236 | 0.447 |

Continued

Table 1. Continued.

| Management Group | Stratum 9<br>8/18 – 8/22<br>Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.018 | 0.014 | 0.000 | 0.051 |
| UppKoy+Main | 0.048 | 0.033 | 0.000 | 0.119 |
| Tanana Summer | 0.007 | 0.013 | 0.000 | 0.046 |
| Tanana Fall | 0.361 | 0.045 | 0.274 | 0.450 |
| U.S. Border | 0.198 | 0.050 | 0.106 | 0.301 |
| U.S. total | 0.632 | 0.048 | 0.539 | 0.724 |
| | | | | |
| Porcupine | 0.147 | 0.039 | 0.073 | 0.227 |
| Mainstem | 0.083 | 0.041 | 0.004 | 0.170 |
| White | 0.138 | 0.023 | 0.096 | 0.186 |
| Teslin | 0.000 | 0.002 | 0.000 | 0.004 |
| Canada total | 0.368 | 0.048 | 0.276 | 0.461 |
| B. | | | | |
| Summer | 0.073 | 0.032 | 0.019 | 0.143 |
| Fall | 0.927 | 0.032 | 0.857 | 0.981 |
| Middle | 0.055 | 0.033 | 0.001 | 0.127 |
| Canada Border | 0.230 | 0.046 | 0.142 | 0.323 |
| Upper Canada | 0.138 | 0.023 | 0.096 | 0.187 |
| Fall U.S. | 0.559 | 0.051 | 0.458 | 0.660 |
| U.S. Border + Canada | 0.566 | 0.044 | 0.479 | 0.650 |
| Mainstem + Upper Canada | 0.221 | 0.044 | 0.139 | 0.314 |

Continued

Table 1. Continued.

| Management Group | Stratum 10 8/23 – 9/7 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.064 | 0.020 | 0.028 | 0.107 |
| UppKoy+Main | 0.011 | 0.016 | 0.000 | 0.055 |
| Tanana Summer | 0.001 | 0.004 | 0.000 | 0.014 |
| Tanana Fall | 0.475 | 0.041 | 0.395 | 0.554 |
| U.S. Border | 0.119 | 0.037 | 0.053 | 0.195 |
| U.S. total | 0.670 | 0.045 | 0.579 | 0.755 |
| | | | | |
| Porcupine | 0.001 | 0.003 | 0.000 | 0.007 |
| Mainstem | 0.191 | 0.043 | 0.111 | 0.280 |
| White | 0.126 | 0.022 | 0.086 | 0.170 |
| Teslin | 0.012 | 0.014 | 0.000 | 0.048 |
| Canada total | 0.330 | 0.045 | 0.245 | 0.421 |
| B. | | | | |
| Summer | 0.077 | 0.022 | 0.039 | 0.124 |
| Fall | 0.923 | 0.022 | 0.876 | 0.960 |
| Middle | 0.012 | 0.017 | 0.000 | 0.058 |
| Canada Border | 0.192 | 0.043 | 0.112 | 0.280 |
| Upper Canada | 0.138 | 0.026 | 0.092 | 0.193 |
| Fall U.S. | 0.593 | 0.047 | 0.498 | 0.682 |
| U.S. Border + Canada | 0.449 | 0.040 | 0.372 | 0.527 |
| Mainstem + Upper Canada | 0.329 | 0.045 | 0.245 | 0.420 |

Continued

Table 1. Continued.

| Management Group | Overall 6/11 – 9/7 Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 0.647 | 0.026 | 0.596 | 0.697 |
| UppKoy+Main | 0.166 | 0.027 | 0.113 | 0.219 |
| Tanana Summer | 0.025 | 0.006 | 0.012 | 0.037 |
| Tanana Fall | 0.051 | 0.004 | 0.042 | 0.059 |
| U.S. Border | 0.046 | 0.006 | 0.034 | 0.058 |
| U.S. total | 0.934 | 0.005 | 0.924 | 0.944 |
| | | | | |
| Porcupine | 0.016 | 0.004 | 0.009 | 0.024 |
| Mainstem | 0.024 | 0.004 | 0.015 | 0.032 |
| White | 0.026 | 0.002 | 0.022 | 0.030 |
| Teslin | 0.001 | 0.001 | 0.000 | 0.002 |
| Canada total | 0.066 | 0.005 | 0.056 | 0.076 |
| B. | | | | |
| Summer | 0.838 | 0.005 | 0.827 | 0.848 |
| Fall | 0.162 | 0.005 | 0.152 | 0.173 |
| Middle | 0.190 | 0.026 | 0.139 | 0.242 |
| Canada Border | 0.040 | 0.005 | 0.030 | 0.049 |
| Upper Canada | 0.027 | 0.002 | 0.022 | 0.031 |
| Fall U.S. | 0.096 | 0.007 | 0.083 | 0.109 |
| U.S. Border + Canada | 0.112 | 0.006 | 0.101 | 0.123 |
| Mainstem + Upper Canada | 0.050 | 0.005 | 0.041 | 0.059 |

Table 2. Estimates of summer chum salmon stock proportions for 2010. 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 |
| Average | 0.80 | 0.15 | 0.05 |

Table 3. Preliminary summer chum salmon escapement project estimates for 2010.

| Escapement project | Estimate |
|---|---|
| Anvik sonar | 396,173 |
| Gisasa weir | 47,669 |
| Henshaw weir | 105,398 |
| Chena tower | 7,560 |
| Salcha tower | 22,183 |

Table 4. Estimates of fall chum salmon stock proportions for 2010. 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 |
| Average | 0.27 | 0.38 | 0.16 | 0.05 | 0.14 | 0.01 |

Table 5. Preliminary Pilot Station sonar chum salmon passage estimates for 2010.

| Year | Season | Strata | Date | Passage |
|---|---|---|---|---|
| 2010 | Summer | Stratum 1 | 6/11 to 6/21 | 245,314 |
| | Summer | Stratum 2 | 6/22 to 6/28 | 444,768 |
| | Summer | Stratum 3 | 6/29 to 7/5 | 435,826 |
| | Summer | Stratum 4 | 7/6 to 7/12 | 152,578 |
| | Summer | Stratum 5 | 7/13 to 7/18 | 48,614 |
| | Fall | Stratum 6 | 7/19 to 7/27 | 93,237 |
| | Fall | Stratum 7 | 7/28 to 8/10 | 48,234 |
| | Fall | Stratum 8 | 8/11 to 8/17 | 45,870 |
| | Fall | Stratum 9 | 8/18 to 8/22 | 111,319 |
| | Fall | Stratum 10 | 8/23 to 9/7 | 42,196 |
| | | Total | 6/11 to 9/7 | 1,667,956 |

Table 6. Total abundance estimates derived from Pilot Station genetic stock composition and sonar chum salmon passage estimates for 2010. 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, 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 | 2010<br>6/11 – 9/7<br>Estimate | SD | 95% CI | |
|---|---|---|---|---|
| A. | | | | |
| Lower | 1,078,980 | 43,068 | 994,566 | 1,163,394 |
| UppKoy+Main | 276,113 | 45,077 | 187,762 | 364,463 |
| Tanana Summer | 41,005 | 10,835 | 19,768 | 62,242 |
| Tanana Fall | 84,451 | 6,985 | 70,760 | 98,142 |
| U.S. Border | 76,652 | 10,240 | 56,581 | 96,724 |
| U.S. total | 1,557,647 | 8,373 | 1,541,236 | 1,574,058 |
| | | | | |
| Porcupine | 26,955 | 6,254 | 14,698 | 39,211 |
| Mainstem | 39,448 | 7,149 | 25,436 | 53,459 |
| White | 43,324 | 3,659 | 36,152 | 50,496 |
| Teslin | 1,026 | 964 | 0 | 2,914 |
| Canada total | 110,309 | 8,373 | 93,898 | 126,720 |
| B. | | | | |
| Summer | 1,396,920 | 8,990 | 1,379,301 | 1,414,540 |
| Fall | 271,036 | 8,986 | 253,423 | 288,649 |
| Middle | 317,208 | 43,732 | 231,493 | 402,922 |
| Canada Border | 66,286 | 8,031 | 50,546 | 82,026 |
| Upper Canada | 44,241 | 3,774 | 36,844 | 51,638 |
| Fall U.S. | 160,608 | 10,903 | 139,239 | 181,977 |
| U.S. Border + Canada | 186,618 | 9,601 | 167,799 | 205,437 |
| Mainstem + Upper Canada | 83,902 | 7,811 | 68,593 | 99,210 |

Table 7. Preliminary fall chum salmon escapement project estimates for 2010.

| Escapement project | Estimate |
|---|---|
| Chandalar sonar | 157,998 |
| Sheenjek sonar | 22,053 |
| Eagle Sonar Border Passage (Mainstem + Upper) | 121,580 |
| Fishing Branch weir + Old Crow harvest (expanded count) | 28,044 |

Table 8. Subsistence harvest apportionments for 2010. 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 | | | | **157,998** | 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 | **121,580** | | | | 1.0000 | 0.0000 | 0.0000 | 0.0000 | 13,159 | 0 | 0 | 0 |
| Ft. Yukon | 6,908 | 134,739 | **15,773** | **22,053** | | 0.5716 | 0.1416 | 0.1278 | 0.0000 | 5,394 | 631 | 883 | 0 |
| Y5D Below Chandalar | 641 | 140,133 | 16,404 | 22,936 | 159,494 | 0.3222 | 0.0798 | 0.0677 | 0.4705 | 265 | 31 | 43 | 302 |
| Y5C | 1,845 | 140,398 | 16,435 | 22,979 | 159,796 | 0.3222 | 0.0798 | 0.0677 | 0.4705 | 763 | 89 | 125 | 868 |
| Y5B | 20,547 | 141,161 | 16,525 | 23,104 | 160,664 | 0.3222 | 0.0798 | 0.0677 | 0.4705 | 8,494 | 994 | 1,390 | 9,668 |
| Y4 | 6,555 | 149,655 | 17,519 | 24,494 | 170,332 | 0.2215 | 0.0549 | 0.0489 | 0.3398 | 1,957 | 229 | 320 | 2,227 |
| Y3 | 749 | 151,612 | 17,748 | 24,815 | 172,559 | 0.2215 | 0.0549 | 0.0489 | 0.3398 | 224 | 26 | 37 | 254 |
| Y2 (Marshall only) | 503 | 151,835 | 17,774 | 24,851 | 172,813 | 0.2215 | 0.0549 | 0.0489 | 0.3398 | 150 | 18 | 25 | 171 |
| Total | 70,744 | 151,985 | 17,792 | 24,876 | 172,984 | | | | | 30,405 | 2,019 | 2,823 | 14,986 |

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.

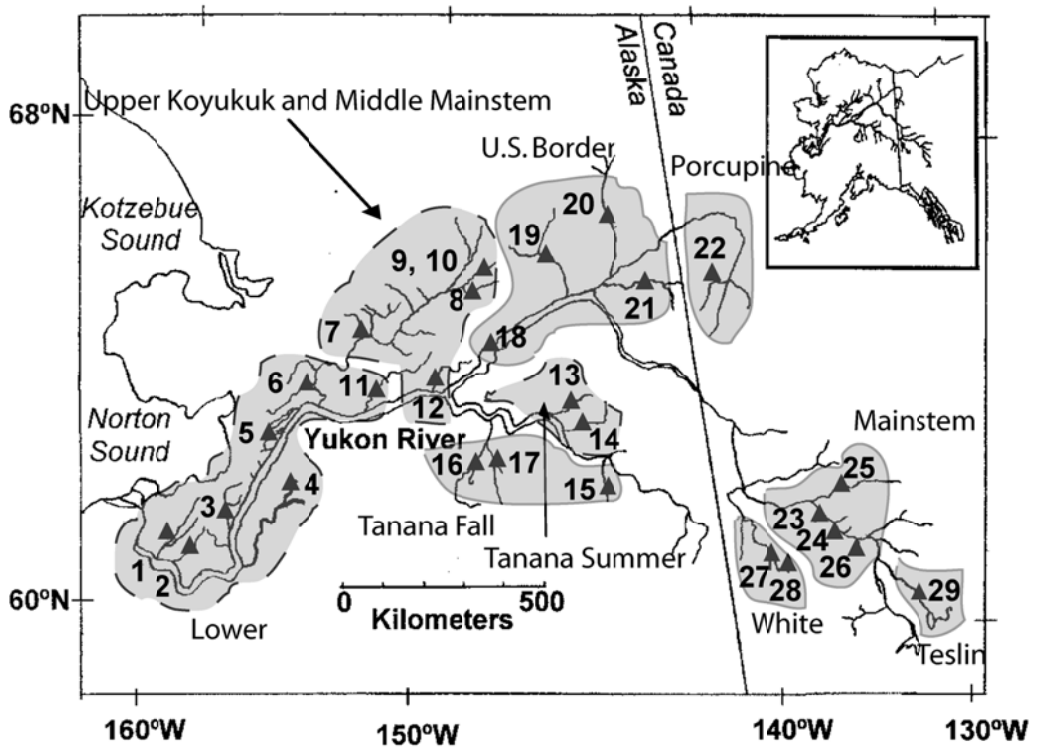


Figure 2. Pilot Station test fishery chum salmon stock composition estimates for 2010. Error bars represent one standard error.

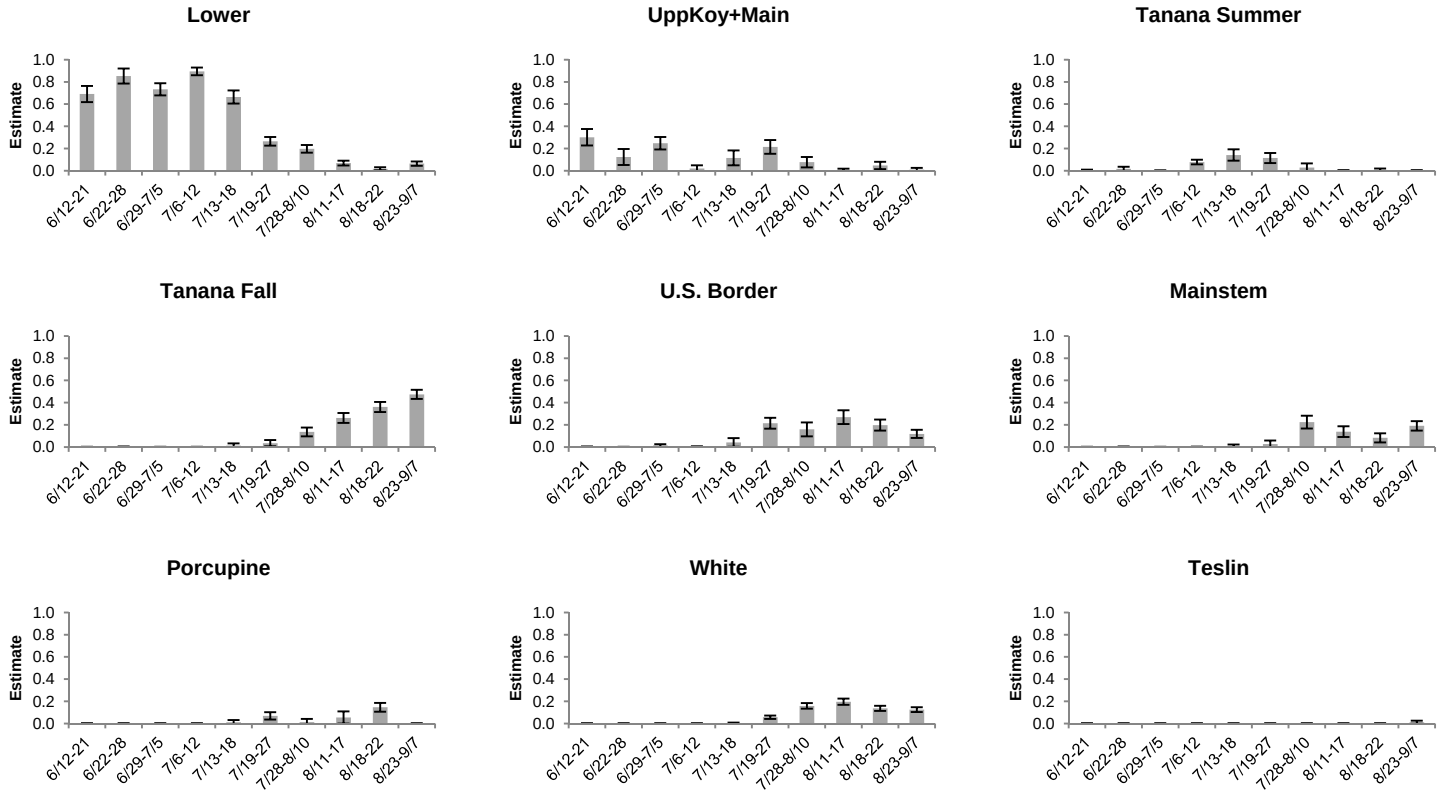


Figure 3. 2010 Pilot Station stock composition estimates for Yukon River chum salmon.

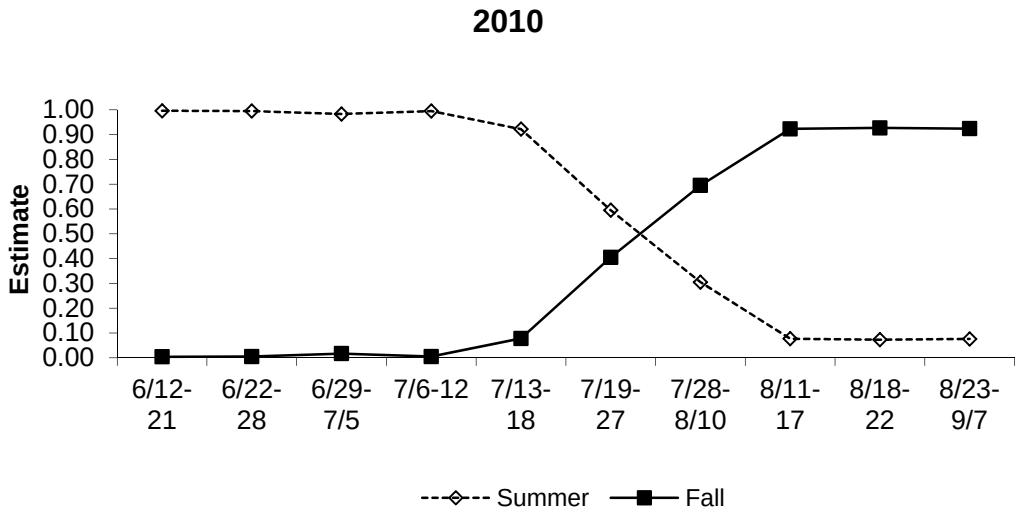
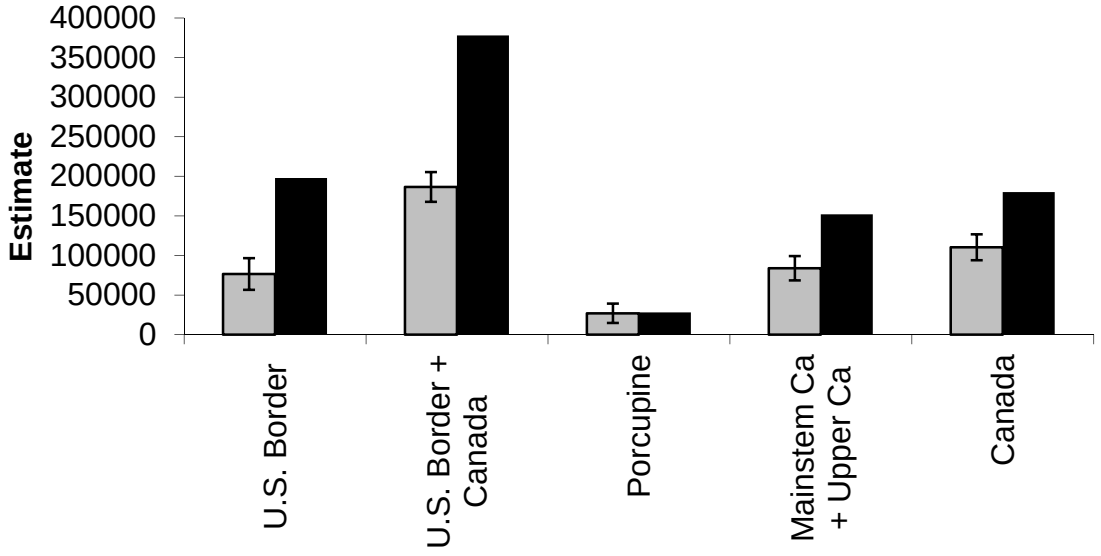



Figure 4. Comparisons of chum salmon stock abundance estimates from genetic/sonar (grey bars) and escapement/harvest (black bars) methods for 2010. The 95% confidence intervals are based on the variances of the genetic estimates only.



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