Genetic Stock Identification of Yukon River Chinook and Fall Chum Salmon using Microsatellites, 2015

Report to Yukon River Panel: Project CRE 79-15

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March 15, 2016

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Abstract

Stock identification of chum and Chinook salmon migrating past the Eagle, Alaska sonar site near the Yukon-Alaska border was conducted in 2015 through analysis of microsatellite variation. Variation at 14 microsatellites was surveyed for 475 chum salmon and variation at 15 microsatellites was surveyed for 1026 Chinook salmon collected from the sonar site.

Chum salmon from the Yukon River mainstem stocks were estimated to comprise 61.9% of the samples collected through the season at the Eagle sonar site, while 37.2% of the samples were estimated to be from chum salmon from the White River drainage. Chinook salmon samples collected at the Eagle sonar site indicated that the major regional stocks contributing to the run were the Teslin River (25.4%), Mainstem Yukon River (25.4%), Pelly River (18.2%), Carmacks area tributaries (17.5%), Stewart River (8.2%), upper Yukon tributaries (4.6%), White River (5.6%), and lower Yukon tributaries (4.4%).

Acknowledgments

Genetic analysis was conducted by staff at the DFO Pacific Biological Station Molecular Genetics Laboratory. Financial support for the project was provided by the Yukon River Panel's Yukon River Restoration and Enhancement Fund as well as DFO.

Contents

List of Tables

List of Figures

Introduction

Background

Chum salmon (*Oncorhynchus keta)* and Chinook salmon (*O. tshawytscha*) are widely distributed throughout the Yukon River drainage, spawning in tributaries ranging from the extreme headwaters (e.g. Teslin River, British Columbia) to near the mouth of the river (e.g. Andreafsky River, Alaska). Management for conservation of biodiversity within the drainage requires knowledge of genetic variation among populations as well as population-specific information from fisheries. Effective management of fisheries in major drainages like the Yukon River requires information on the harvest and timing of specific populations to enable managers to change exploitation rates on specific populations for conservation purposes, and to understand how management measures affect specific stocks. It is important to accurately the status of these stocks so that management decisions can ensure that treaty obligation and conservation objectives are achieved. Accurate post-season run reconstructions are essential in evaluating whether management actions were consistent with meeting overall objectives and Treaty obligations. Run reconstructions are necessary for Post season run reconstructions are important for monitoring the achievement of treaty objective, for developing pre-season forecasts, and for assessing the adequacy of current escapement targets. Assessment of individual stock status provides critical information for assessing the factors influencing stock productivity levels, which appear to have fluctuated widely in recent years. Genetic stock identification is a key tool for achieving all of these management objectives.

Stock identification of chum and Chinook salmon migrating through the mainstem Yukon River through analysis of variation in microsatellite loci has been has been used for population-specific estimates of stock composition of Yukon River Chinook salmon since 2005 (Beacham et al. 2008a). Microsatellite analysis has been used to identify the stock composition of Chinook salmon sampled in test netting associated with the Eagle sonar project since 2008, and was also used to identify stock composition of Chinook salmon captured in the DFO fishwheels between 2004 and 2008 (JTC, 2016). Microsatellites have also been used to estimate the stock composition of chum salmon samples collected at the Eagle sonar site since 2009, and of samples collected at the DFO fishwheels between 2005 and 2008.

Project overview

The intent of this project was to determine stock compositions of chum and Chinook salmon run into Canada through genetic analysis of tissue samples from the Eagle Sonar project test fishing operation. In 2015, the DFO MGL surveyed variation at 15 microsatellite loci for 1026 Chinook salmon and 475 chum salmon live-captured in the test fishery associated with the sonar program near Eagle, Alaska between July 2 and Oct 2, 2015. Microsatellite variation was used to estimate stock composition in the samples collected.

Materials and Methods

Collection of DNA Samples

Tissue samples were collected from adult Chinook and chum salmon captured in the test fishery associated with the Eagle sonar salmon enumeration project between July 2, 2015 and August 15, 2015. Salmon were captured in drift gill nets operated following a study design to reflect the age, sex and length composition of the Chinook salmon escapement to Canada, and to identify the date at which the portion of chum salmon exceeded the returns for Chinook salmon. Gill net mesh sizes were 5.25”, 6.5”, 7.5” and 8.5 (Lozori & Borden, 2015). All salmon caught during this period were sampled. Axial processes were taken from all Chinook salmon and placed individual vials containing anhydrous ethanol; vials were labelled with a unique number recorded alongside the age, sex and length data from the corresponding sampled fish. Axial processes taken from chum salmon were placed in bulk sample vials rather than

individual sample vials; three bulk sample vials were collected over the course of the season. Samples were shipped to the ADF&G genetics lab in Anchorage at the end of the season, where technicians catalogued the samples and prepared them for shipping.

Laboratory Analysis

DNA was extracted, samples were processed and laboratory analysis was conducted following the same procedures used in analysis of the 2013 Eagle test fishery samples, and as described in the report to the Panel (Beacham &Candy, 2014). (Further information on laboratory equipment and techniques is available at the Molecular Genetics Laboratory website at http://www.pac.dfo-mpo.gc.ca/science/facilities- installations/pbs-sbp/mgl-lgm.)

Variation at 14 microsatellites was surveyed for 475 (from a total sample of 782) chum salmon tissue samples collected between August 1 and Oct 2, 2015 in the Eagle sonar test fishery. Variation of 15 microsatellite loci was surveyed from 1,026 Chinook salmon sampled between July 2 and August 20, 2015.

Baseline Populations

The baseline survey consisted of microsatellite analysis of chum salmon from 9 locations within the Canadian portion of the drainage (Table 1), and microsatellite analysis of Chinook salmon from 27 locations within the Canadian portion of the drainage (Table 2). All annual samples available for a specific sample location were combined to estimate population allele frequencies, as was recommended by Waples (1990). While the chum salmon baseline is as described in Beacham &Candy (2014), McQuesten River and Ross River have been added to the Chinook salmon baseline since the 2013 analysis.

Chum salmon

Chum salmon stock contribution estimates were based on 4 regional reporting groups (stock aggregates; Table 1) and estimated by period and for the entire season (Figure 1; Appendix 1).

Table 1. Baseline comprised of 9 stocks used to estimate stock compositions of fall chum salmon collected from the test gillnetting program at the mainstem Yukon River sonar project at Eagle in 2015.

Stock Aggregate Name	Population in Baseline
Yukon Early	Chandindu River
White River	Kluane River, Kluane Lake, Donjek River
Mainstem Yukon River	Mainstem Yukon River at Pelly River, Tatchun Creek, Big Creek, and Minto
Teslin River	Teslin River

Chinook salmon

Chinook salmon stock contribution estimates were based on 8 regional reporting groups (stock aggregates; Table 2) and estimated by period and for the entire season (Figure 3; Appendix 2).

Table 2. Baseline comprised of 27 stocks used to estimate stock compositions of Chinook salmon collected at the mainstem Yukon River sonar at Eagle test drift gillnet program, Yukon River, 2015.

Stock aggregate name	Populations in baseline
Yukon Lower	Chandindu and Klondike rivers
White River	Tincup Creek, Nisling River
Stewart River	Mayo, McQuesten, and Stewart rivers
Pelly River	Little and Big Kalzas, Earn, Glenlyon, Ross and Pelly rivers, Blind Creek
Mid-mainstem Tributaries	Mainstem Yukon and Nordenskiold rivers
Carmacks Area Tributaries	Little Salmon, Big Salmon, and North Big Salmon rivers, Tatchun Creek
Teslin River	Teslin Lake, Nisutlin, Morley, Jennings, and Teslin rivers
Upper Yukon Tributaries	Whitehorse Hatchery and Takhini River

Estimation of Stock Composition:

Analysis of fishery samples was conducted with a Bayesian procedure (BAYES) as outlined by Pella and Masuda (2001), and as described in the 2014 report for the project (Beachan &Canady, 2014).

Passage estimates by stock aggregate for the 2015 Chinook and chum salmon migration bound for Canada were estimated using the stock aggregate proportions of genetic samples collected from the Eagle sonar test fishery samples and the Eagle sonar passage estimates. The Eagle Sonar salmon passage estimate for each sampling period (Jody Lozori, personal communication) was multiplied by the stock proportion estimate of the samples analyzed from that period to estimate the salmon stock aggregate abundance for each sampling period, and for the season sampling period as a whole (Figure 2). The sample proportion was not applied to the chum salmon that migrated past the Eagle sonar period after sampling had ceased.

Results and Discussion

Chum Salmon

Proportions

In the 2015 season, chum salmon spawning populations from the Mainstem spawning Yukon River populations, represented by Big Creek, Minto, Pelly and Tatchun populations accounted for 61.9 % of the samples collected from the Eagle sonar test fishery; the White River drainage, represented by Donjek River, Kluane River and Kluane Lake chum salmon populations was estimated to comprise 37.2% of the samples (Appendix 1; Figure 1). The Mainstem spawning population group formed the majority of each of the samples, and formed the highest proportion (70.6%) of the sample collected in the last period. The White River proportion was highest (44.1%) in the Sept 7 to Sept 22 (middle period) sample. Yukon Summer chum salmon were estimated to form 5.1 % of the sample in the first period, but were estimated to comprise a negligible proportion of the sample in later samples, and formed an estimated 0.8% of the pooled season samples. Teslin chum salmon were estimated to form a tiny proportion (0% to 0.6%) of each sample group, and 0.3% of the pooled season samples (Appendix 1; Figure 1).

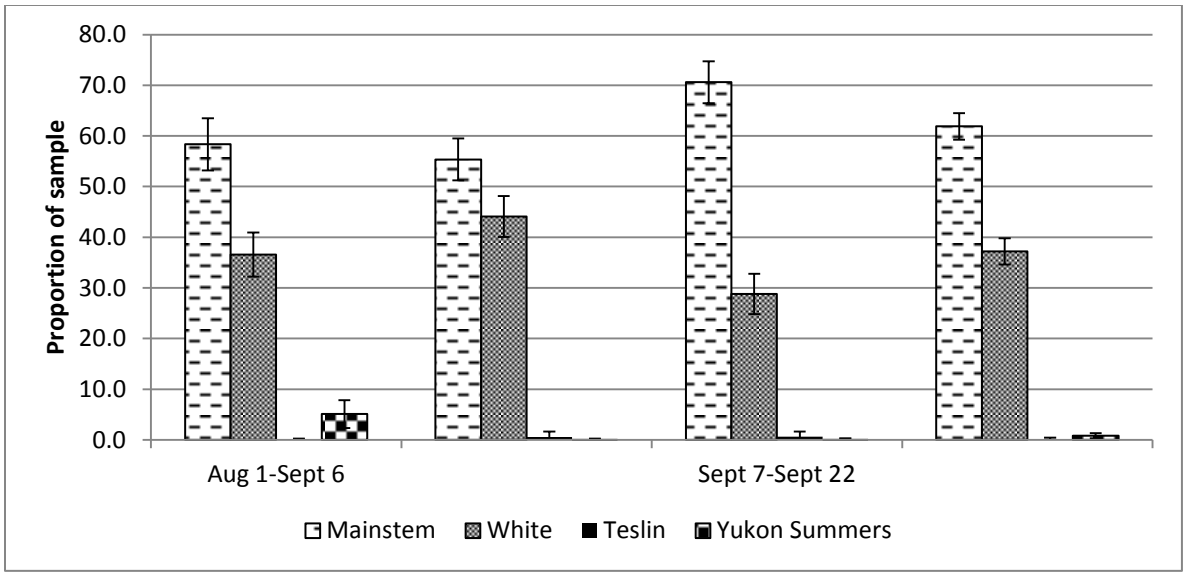

Figure 1. Estimated aggregate stock composition of samples collected from chum salmon migrating past the Eagle sonar site, 2015, with bars showing standard error.

Passage Estimates

The estimate for passage at the sonar site for the Mainstem chum salmon stock aggregate was 57,373 chum salmon for this period, while the estimate for the White River stock aggregate was 34,472. A passage estimate of zero was within the standard error range for both the Teslin and Yukon summers stocks (Figure 2). The stock passage estimates are calculated using 92,722 for the Eagle sonar passage estimate during the period of sampling; it does not include a stock passage estimate for 19,414 chum salmon that were estimated to pass by the sonar site after sampling ceased for the season (Lozori, ADF&G, personal communication).

Stock proportion estimates for the individual stocks comprising the aggregate groups (Appendix 1) have high levels of uncertainty, and were not used for passage estimation.

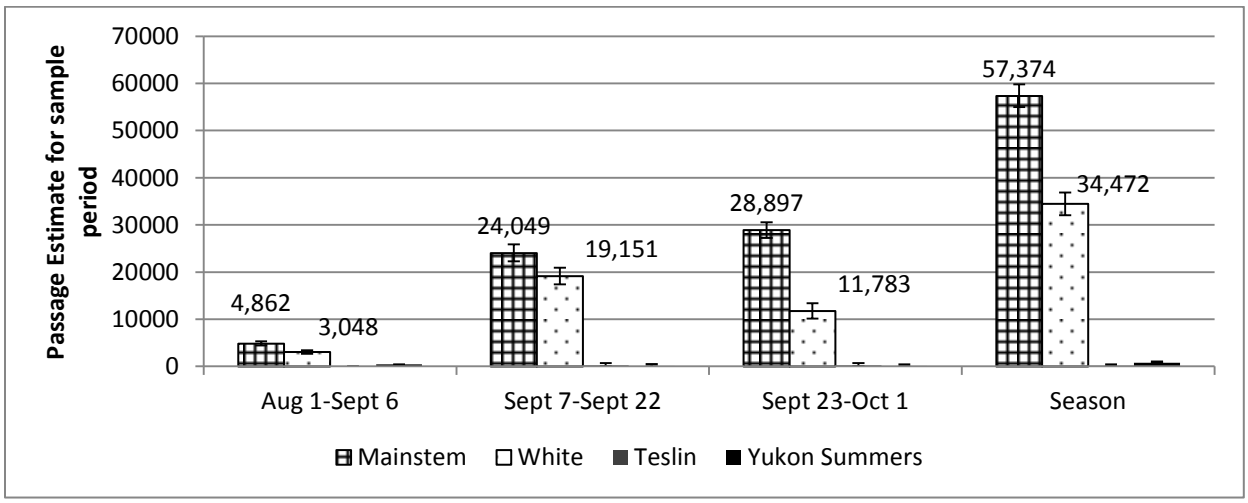

Figure 2. Estimated aggregate stock abundance of chum salmon migrating past the Eagle sonar site between Aug 15 and Oct 2, 2015, with bars showing standard error of the genetic estimate.

Chinook Salmon

Proportions

The contributions of the Chinook salmon stock aggregates to the total 2015 Eagle sonar test fishery samples were estimated by period and for the total season sample. The Chinook salmon stock composition of the total season sample was: Upper Yukon River Tributaries (4.6%); Teslin River (25.4%); Carmacks Area Tributaries (17.5%); Mid-mainstem Tributaries (16.0%); Pelly River (18.2%); Stewart River (8.2%); North Yukon Tributaries (4.4%); White River (5.6%); and Upper Yukon River Tributaries (4.6%; Appendix 2; Figure 3).

The Yukon Teslin, Yukon Mainstem stock, and Yukon Upper Yukon stock aggregate proportions increased with successive sampling periods through the run, whereas the Yukon Pelly, Yukon White and Yukon Lower aggregates estimated proportions decreased as the run progressed. The Yukon Carmacks aggregate portion was greatest in the middle of the run throughout the run (Figure 3).

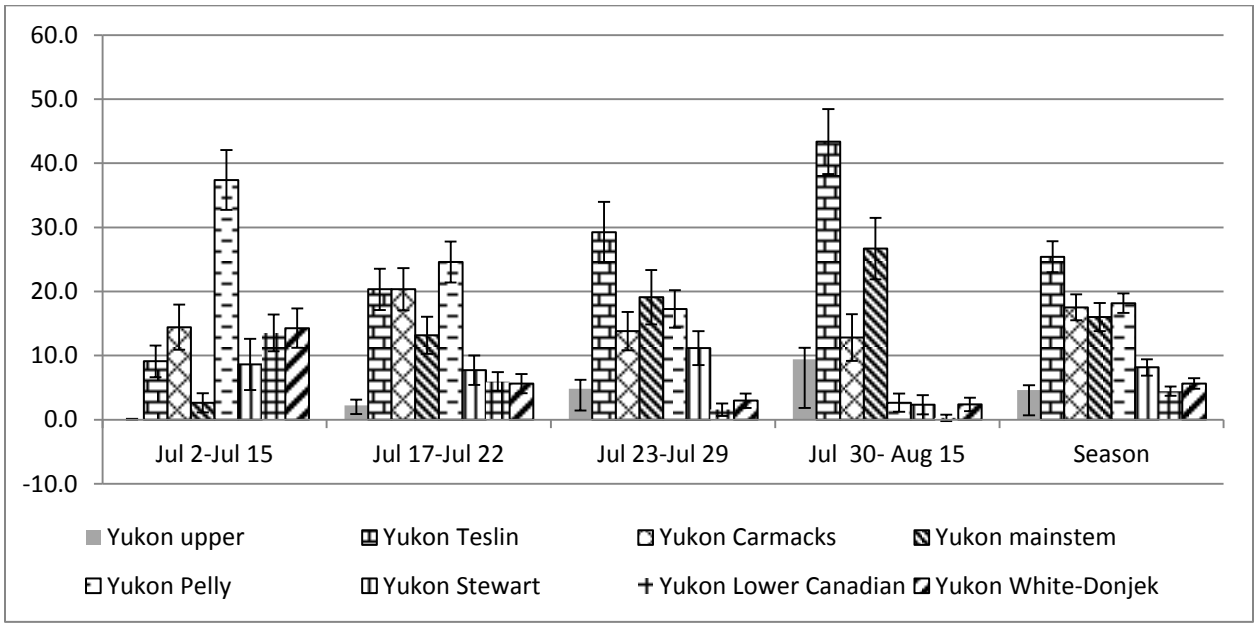

Figure 3. Estimated aggregate stock composition of samples collected from Chinook salmon migrating past the Eagle sonar site, 2015, with bars showing standard error

Passage Estimates

The Eagle Sonar Chinook salmon passage estimate for each sampling period (Jody Lozori, ADF&G, personal communication) multiplied by the stock proportion estimate of the samples analyzed from that period provides an estimate of Chinook salmon stock aggregate abundance for each sampling period, and for the season sampling period as a whole (Appendix 2; Figure 4). A passage estimate of zero was within the standard error range for both the Upper Yukon stock

aggregate in the first sampling period, and the Canada Lower Yukon stock aggregate in the last sampling period.

Stock proportion estimates for the individual stocks comprising the aggregate groups (Appendix 2) have higher levels of uncertainty, and were not used for passage estimation.

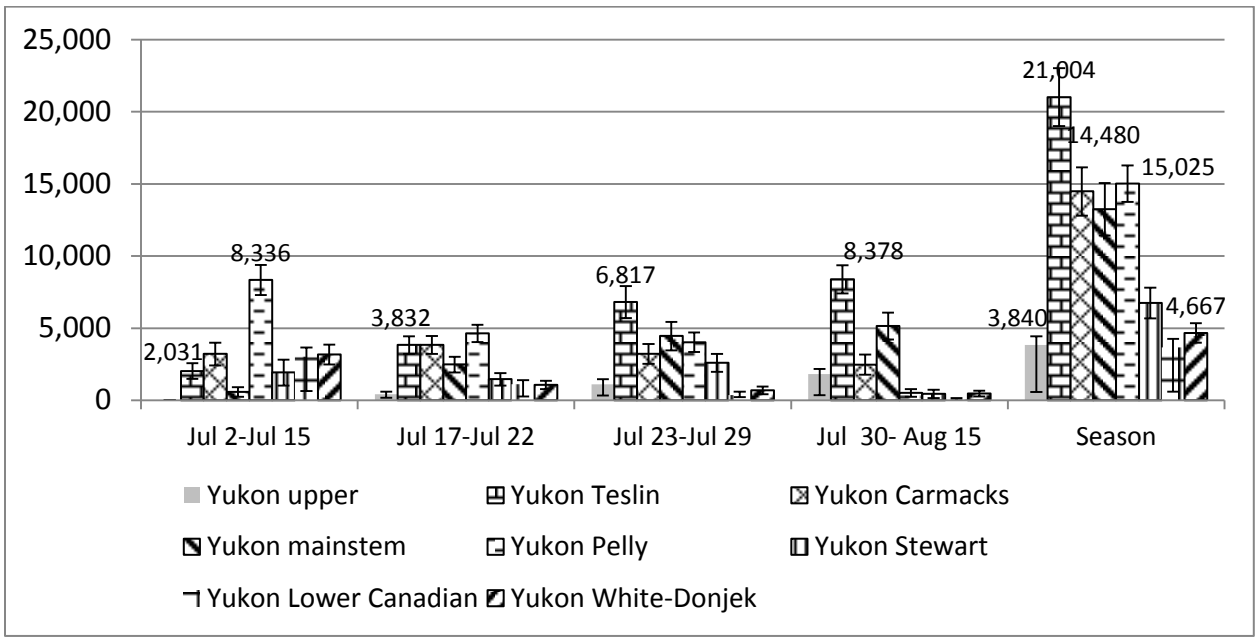

Figure 4. Estimated aggregate stock abundance of Chinook salmon migrating past the Eagle sonar site between July 2 and Aug 15, 2015, with bars showing standard error of the genetic estimate.

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Appendices

Appendix 1: Eagle Sonar Test Fishery Samples Chum Salmon Estimates

Eagle Sonar Test Fishery Samples Chum Salmon Aggregate Stocks (Regional) Proportion Estimates

Samples Analyzed	150		163		162		475	
Sample Period	Aug 1-Sept 6		Sept 7-Sept 22		Sept 23-Oct 1		Season	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Canadian mainstem	58.3	(5.1)	55.3	(4.1)	70.6	(4.1)	61.9	(2.6)
White	36.6	(4.3)	44.1	(4.1)	28.8	(4.0)	37.2	(2.6)
Teslin	0.0	(0.2)	0.6	(1.1)	0.6	(1.0)	0.1	(0.3)
Yukon Summers	5.1	(2.7)	0.0	(0.2)	0.0	(0.3)	0.8	(0.5)

Eagle Sonar Test Fishery Samples Chum Salmon Stock Proportion Estimates

Samples Analyzed	150		163		162		475	
Sample Period	Aug 1-Sept 6		Sept 7-Sept 22		Sept 23-Oct 1		Season	
	Estimat	SD	Estimate	SD	Estimate	SD	Estimate	SD
Big_Cr	38.0	(26.4)	54.7	(4.3)	32.7	(7.7)	27.4	(30.3)
Minto	0.1	(0.5)	0.4	(1.0)	0.1	(0.4)	6.8	(19.1)
Pelly	20.2	(28.4)	0.2	(0.7)	37.7	(8.0)	27.7	(30.9)
Tatchun	0.0	(0.3)	0.0	(0.3)	0.1	(0.4)	0.0	(0.1)
Donjek	8.4	(15.2)	24.3	(21.7)	25.3	(9.4)	28.8	(15.5)
Kluane	0.2	(0.5)	0.0	(0.3)	0.2	(0.6)	0.0	(0.1)
Kluane_Lake	28.0	(15.3)	19.8	(22.1)	3.3	(9.3)	8.4	(15.7)
Teslin	0.0	(0.2)	0.6	(1.1)	0.6	(1.0)	0.1	(0.3)
Chandindu	5.1	(2.7)	0.0	(0.2)	0.0	(0.3)	0.8	(0.5)

Appendix 2: Eagle Sonar Test Fishery Samples Chinook Salmon Estimates

Eagle Sonar Test Fishery Samples Chinook Salmon Aggregate Stocks (Regional) Proportion Estimates

Samples Analyzed	168		302		252		304		1026	
Sample Period	Jul 2-Jul 15		Jul 17-Jul 22		Jul 23-Jul 29		Jul 30- Aug 15		Season	
	Estima	SD	Estima	SD	Estima	SD	Estima	SD	Estima	SD
Yukon upper	0.0	(0.2)	2.2	(0.9)	4.8	(1.4)	9.4	(1.8)	4.6	(0.7)
Yukon Teslin	9.1	(2.5)	20.3	(3.2)	29.2	(4.7)	43.4	(5.1)	25.4	(2.4)
Yukon Carmacks	14.4	(3.5)	20.3	(3.3)	13.8	(3.0)	12.8	(3.7)	17.5	(2.0)
Yukon mainstem	2.6	(1.5)	13.2	(2.9)	19.1	(4.2)	26.7	(4.8)	16.0	(2.2)
Yukon Pelly	37.4	(4.7)	24.6	(3.2)	17.3	(2.9)	2.7	(1.4)	18.2	(1.5)
Yukon Stewart	8.6	(4.0)	7.7	(2.3)	11.2	(2.7)	2.3	(1.5)	8.2	(1.3)
Yukon Lower Canadian	13.5	(2.9)	6.0	(1.5)	1.6	(1.0)	0.3	(0.5)	4.4	(0.7)
Yukon White-Donjek	14.3	(3.1)	5.6	(1.5)	3.0	(1.1)	2.4	(1.0)	5.6	(0.8)

Eagle Sonar Test Fishery Samples Chinook Salmon Stock Proportion Estimates

Samples Analyzed	168		302		252		304		1026	
Sample Period	Jul 2-Jul 15		Jul 17-Jul 22		Jul 23-Jul 29		Jul 30- Aug 15		Season	
	Est.	SD	Est.	SD	Est.	SD	Est.	SD	Est.	SD
Takhini	0.0	(0.1)	0.6	(0.5)	0.1	(0.4)	3.1	(1.1)	1.2	(0.4)
Whitehorse	0.0	(0.1)	1.6	(0.7)	4.7	(1.4)	6.3	(1.5)	3.4	(0.6)
Wolf_R	0.3	(0.7)	0.9	(1.2)	0.1	(0.3)	0.0	(0.1)	0.2	(0.3)
100_Mile_R	0.0	(0.2)	0.0	(0.2)	0.0	(0.2)	0.1	(0.4)	0.0	(0.1)
Morley	0.1	(0.5)	2.6	(2.9)	0.2	(0.6)	0.1	(0.2)	0.0	(0.1)
Nisutlin	0.9	(1.3)	2.6	(2.9)	10.0	(2.2)	0.3	(0.5)	4.7	(1.1)
Teslin	0.1	(0.4)	7.9	(2.6)	18.8	(4.6)	42.3	(5.1)	17.1	(2.4)
Teslin_Lake	7.7	(2.4)	6.3	(2.4)	0.2	(0.8)	0.6	(0.7)	3.4	(1.1)
Big_Salmon	1.0	(2.2)	16.5	(3.4)	13.2	(2.9)	5.0	(2.4)	9.1	(1.7)
L_Salmon	9.8	(3.6)	1.1	(2.1)	0.3	(1.1)	2.2	(2.9)	5.8	(2.1)
N_Big_Salmon	3.7	(2.6)	2.4	(2.1)	0.1	(0.4)	0.0	(0.2)	0.6	(0.8)
Tatchun	0.0	(0.3)	0.4	(0.6)	0.2	(0.5)	5.6	(2.1)	2.0	(0.7)
Nordenskiold	2.6	(1.5)	3.9	(1.3)	0.9	(0.7)	0.0	(0.1)	1.8	(0.5)
Yukon_main	0.0	(0.3)	9.3	(2.6)	18.2	(4.2)	26.7	(4.8)	14.3	(2.2)
Blind_Cr	1.4	(2.4)	3.0	(1.7)	1.0	(1.3)	0.0	(0.2)	2.1	(0.8)
Earn	0.1	(0.3)	2.2	(2.1)	0.1	(0.4)	0.2	(0.4)	0.4	(0.6)
Glenlyon	0.0	(0.3)	0.0	(0.2)	0.0	(0.1)	0.0	(0.1)	0.0	(0.1)
Hoole	0.3	(0.9)	1.0	(1.6)	0.0	(0.1)	0.0	(0.2)	0.2	(0.4)
Kalzas	0.2	(0.6)	0.0	(0.2)	0.5	(0.9)	0.1	(0.2)	0.0	(0.1)
L_andB_Kalzas	2.0	(1.8)	2.6	(1.1)	1.4	(1.1)	1.6	(0.9)	2.1	(0.6)
Pelly	26.0	(5.0)	11.1	(3.3)	5.0	(2.9)	0.6	(1.1)	8.2	(1.6)
Ross_YT	7.4	(3.0)	4.6	(1.6)	9.3	(2.4)	0.1	(0.3)	5.1	(1.1)
Mayo	0.9	(1.7)	0.3	(0.9)	0.1	(0.5)	0.8	(1.1)	0.2	(0.5)
McQuesten	4.2	(2.1)	0.2	(0.5)	0.4	(0.8)	1.2	(1.2)	1.8	(0.6)
Stewart	3.6	(4.0)	7.3	(2.2)	10.6	(2.6)	0.3	(0.8)	6.2	(1.2)
Chandindu	9.0	(3.3)	2.2	(1.6)	0.7	(0.9)	0.1	(0.4)	2.3	(0.7)
Klondike	4.5	(3.1)	3.8	(1.7)	0.9	(1.1)	0.2	(0.4)	2.1	(0.7)
Kluane	0.0	(0.1)	1.3	(0.7)	3.0	(1.1)	0.3	(0.3)	1.2	(0.4)
Nisling	14.3	(3.1)	4.3	(1.4)	0.0	(0.2)	2.1	(1.0)	4.4	(0.7)