2013 Teslin River Chinook Sonar Project

CRE-01N-13

Prepared For: The Yukon River Panel
Restoration and Enhancement Fund

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March, 2014

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ABSTRACT

Multiple beam high resolution sonars were used to enumerate the 2013 Chinook salmon (*Onchorynchus tshawytscha)* escapement to the Teslin River system. This was the second year the project was conducted at this site. The sonars were operated on the mainstem Teslin River at the site identified during the 2011 feasibility study; approximately 12 km upstream of the confluence of the Teslin and Yukon Rivers at Hootalinqua. Sonar operation began on July 17 and operated continuously through to September 3. A total of 9,916 targets identified as Chinook salmon was counted during the period of operation. Of this total, the north bank sonar counted 6,215 (63%) and the south bank 3,701 (37%) of the passing Chinook. Daily 24 hour counts ranged from 0 to 547 with a mean of 230. The peak daily count of 547 occurred on August 11 at which time 50% of the run had passed the sonar station. 2013 genetic stock identification (GSI) sampling indicated the Teslin stock group comprised 25.6% (SD = 5.2%) of upper Yukon River Chinook escapement.

A carcass pitch was conducted over approximately 120 km of the mainstem Teslin River from August 31 through September 9. This yielded 220 Chinook sampled for age, length and sex. Of these, 108(49%) were female and 112 (51%) were male. The mean fork length of females and males sampled was 849 mm and 736 mm, respectively. The DFO scale lab determined ages from 195 Chinook sampled. Age 1.3 (46%) was the dominant age class, followed by age 1.4 fish (43%). Age 1.2 and 1.5 fish each represented 2% of the sample. A total of 166 tissue samples was collected for GSI analysis.

TABLE OF CONTENTS

ABSTRACT i

1. INTRODUCTION 1

Background 1
Multiple Beam Sonar 2
Teslin River System and Study Area 2

2. OBJECTIVES 5

3. METHODS 5

Site Selection 5
Regulatory Submissions and Permits 5
Mobilization and Personnel 5
Sonar Deployment and Operation 6
Target Identification 10
Precision of Counts 10
Carcass Pitch 11
Hydrometric Data and Weather 12
Communication 12

4. RESULTS 12

Chinook Counts 12
Above Border Chinook Spawning Escapement Estimates 17

5. DISCUSSION AND RECOMMENDATIONS 17

6. REFERENCES 20

7. ACKNOWLEDGEMENTS 22

LIST OF TABLES

Table 1. 2013 Daily counts of Teslin River Chinook salmon..... 13
Table 2. Double reviewed files and calculated difference between counts. 15

LIST OF FIGURES

Figure 1. Mainstem Teslin River and sonar site. 3
Figure 2. Daily minimum, maximum and mean discharge rates for mainstem Teslin River at station 09AF001 from December 1955 through January 1973. 4
Figure 3. Aerial view of sonar site depicting the camp, sonar locations and schematic representation of ensonified portions of the river. 7
Figure 4. SB sonar unit mounted on stand. 8
Figure 5. NB sonar unit mounted on tripod stand with diversion weir downstream of the sonar. 8
Figure 6. NB diversion weir in place. 9
Figure 7. Daily Counts of Chinook at Teslin River sonar station 2011 - 2013. 14
Figure 8. Cross sectional distribution of migrating Chinook at the Teslin sonar site, 2011, 2012 and 2013. 14
Figure 9. 2013 daily counts of NB and SB sonars. 15
Figure 10. Linear regression between double reviewed file data that has been analysed by 2 different readers. 15
Figure 11. Length Frequency histogram of sampled Teslin River Chinook, 2013..... 16

LIST OF APPENDICES

Appendix 1. Location of radio tagged Chinook during peak spawning in the Teslin River drainage in 2003. 23
Appendix 2. 2013 Mainstem Teslin River carcass pitch data. 24
Appendix 3. Daily count of radio tagged Chinook (n=86) passing the Teslin telemetry station in 2003. 29
Appendix 4. Hydrometric data and weather observations, Teslin sonar site 2013. 30
Appendix 5. Referenced water levels at Teslin sonar site 212 and 2013. 31
Appendix 6. Age, sex, and length summary of sampled and aged 2013 mainstem Teslin Chinook. 31
Appendix 7. Estimated proportions of Big Salmon River and Teslin River Chinook in upper Yukon River Chinook escapements, 2002 through 2012. 32
Appendix 8(a). 2013 above border escapement estimates based on Eagle sonar counts, and expansion of sonar counts based GSI based stock proportions. 33
Appendix 8(b). Table of stratified GSI stock proportions and expanded escapement estimate based on aggregate Teslin/Big Salmon. 33
sonar counts. 33

1. INTRODUCTION

Background

The Yukon River system encompasses a drainage area of approximately 854,000 km^2 and contributes to important aboriginal, subsistence and commercial fisheries in the U.S. and Canada. Of the five species of salmon entering the Yukon River, adult Chinook salmon travel the farthest upstream and have been documented at the furthest headwaters of the Teslin system in the McNeil River, 3,300 km from the river mouth (Mercer & Eiler 2004). Approximately 50% of Chinook salmon entering the Yukon River from the Bering Sea is typically destined for spawning grounds in Canada (Eiler et al. 2004, 2006). Canadian origin fish contribute approximately 47% to 67% of the total U.S. commercial and subsistence fisheries (Templin et al. 2005; cited in Daum and Flannery 2009).

Canadian and U.S. fishery managers of the Yukon River Joint Technical Committee (JTC) as well as members of the Yukon River Panel (YRP) recognize that obtaining accurate estimates of abundance is required for the management of Yukon River Chinook stocks. Quantified Chinook escapements and biological information is important for post-season run reconstruction, pre-season run forecasts and the establishment of biologically based escapement goals. The accurate enumeration of genetically distinct stocks, coupled with a representative genetic stock identification (GSI) sampling program can also be used to obtain independent above border as well as stock specific Chinook escapement estimates[1].

The Teslin River system has been identified as a potential discrete Conservation Unit under the Fisheries and Oceans Canada (DFO) Wild Salmon Policy (DFO 2007). One of the long term goals of the Wild Salmon Policy is the establishment of biologically based escapement goals for all species of salmon within designated conservation units. A sufficiently long time series data set of salmon escapements coupled with stock recruitment modelling is the primary recognized method for the establishment of biologically based escapement goals. Currently, there is no other in-season monitoring specific to Teslin River Chinook. Based on current evidence the Teslin system is the largest single tributary contributor to upper Yukon River Chinook production

Teslin River origin Chinook are an important contributor to aboriginal fisheries in the upper Yukon watershed and are of particular importance to the Teslin Tlingit First Nation. Monitoring of Teslin River Chinook will assist in achieving long term management and escapement objectives for the Teslin Tlingit Council (TTC).

[1] For the purposes of this report border escapement is defined as the number of Chinook salmon estimated to have crossed the Canada/U.S. border into the Upper Yukon River drainage minus the total Canadian harvest. Representative GSI sampling of upper Yukon River Chinook stocks occurs at the Eagle sonar site near the Canada/U.S. border in Alaska.

Multiple Beam Sonar

Fixed-location, side-view sonar techniques are presently the primary means of obtaining abundance estimates for anadromous fish stocks migrating in rivers that are either: a) too wide for conventional weir structures; b) too turbid for visual observations or; c) where weir emplacements would be a navigational impediment. Since 2002 high resolution sonar has been used for enumeration of several species of salmon in a broad range of environments (Galbreath and Barber 2005, Holmes et al. 2006, Maxwell et al. 2004, Enzenhofer et al., 2010). Sound Metrics Corporation manufactures the DIDSON® and ARIS® sonar units used on the Teslin sonar project. They are currently the sole manufacturers of multi-beam sonars employed for enumerating migrating salmon in riverine environments. In general, these sonar units have been found to be reliable, do not require extensive operator training and provide accurate counts of migrating salmon. Detecting and counting migrating salmon using a properly positioned imaging sonar is as accurate as visual counts of fish migrating through an enumeration fence in a clear water river (Holmes et al., 2006). In the upper Yukon drainage DIDSON sonar has been used on the Big Salmon River (Mercer & Wilson, 2005-2012) and the Klondike River (Mercer, 2009-2011) to enumerate annual Chinook salmon escapements into these systems. The 2013 Teslin sonar project deployed a standard DIDSON sonar as well as a second generation multiple beam ARIS (Adaptive Resolution Imaging Sonar) model.

The deployment configuration of the sonar is dependent on the characteristics of the particular site, species involved, and project objectives. Both sonar models produce an ensonified field 29° wide in the horizontal plane and, depending on the transducer lens configuration, from 1° to 12° deep in the vertical plane. The maximum ensonified distance the sonars (with an 8° lens) can detect migrating Chinook is approximately 40 m. With a horizontally aligned 8° transducer lens the maximum ensonifiable depth at 40 m is 5.6 m. For the accurate enumeration of fish it is essential that the sonar is aimed so the beams completely ensonify the area through which fish are migrating. In addition, the bathymetric profile must preclude the presence of acoustic shadows or turbulence (air entrained water) that could mask fish targets. Species identification and/or apportionment should also be unambiguous.

Unlike split beam sonar the multiple beam sonar produces a real time image of the target. This imaging capability can allow for the identification of the species based on size, form and swimming characteristics. When mounted in a horizontal configuration the sonar provides information on the distance the target is from the sonar but not the depth of the target within the water column.

Teslin River System and Study Area

The Teslin River system has a drainage area of 36,500 km^2 that over laps the Yukon and B.C. border (Figure 1, Appendix 1). Teslin Lake is the largest water body in the system with a surface area of approximately 354 km^2. Teslin Lake is fed by several drainages in the upper system and discharges at its outlet into the mainstem Teslin River. The lower

mainstem Teslin River has a mean annual discharge volume of 869 m^3/sec (range 1080 – 643 m^3/sec; Water survey of Canada, Station 09AF001; Figure 2).

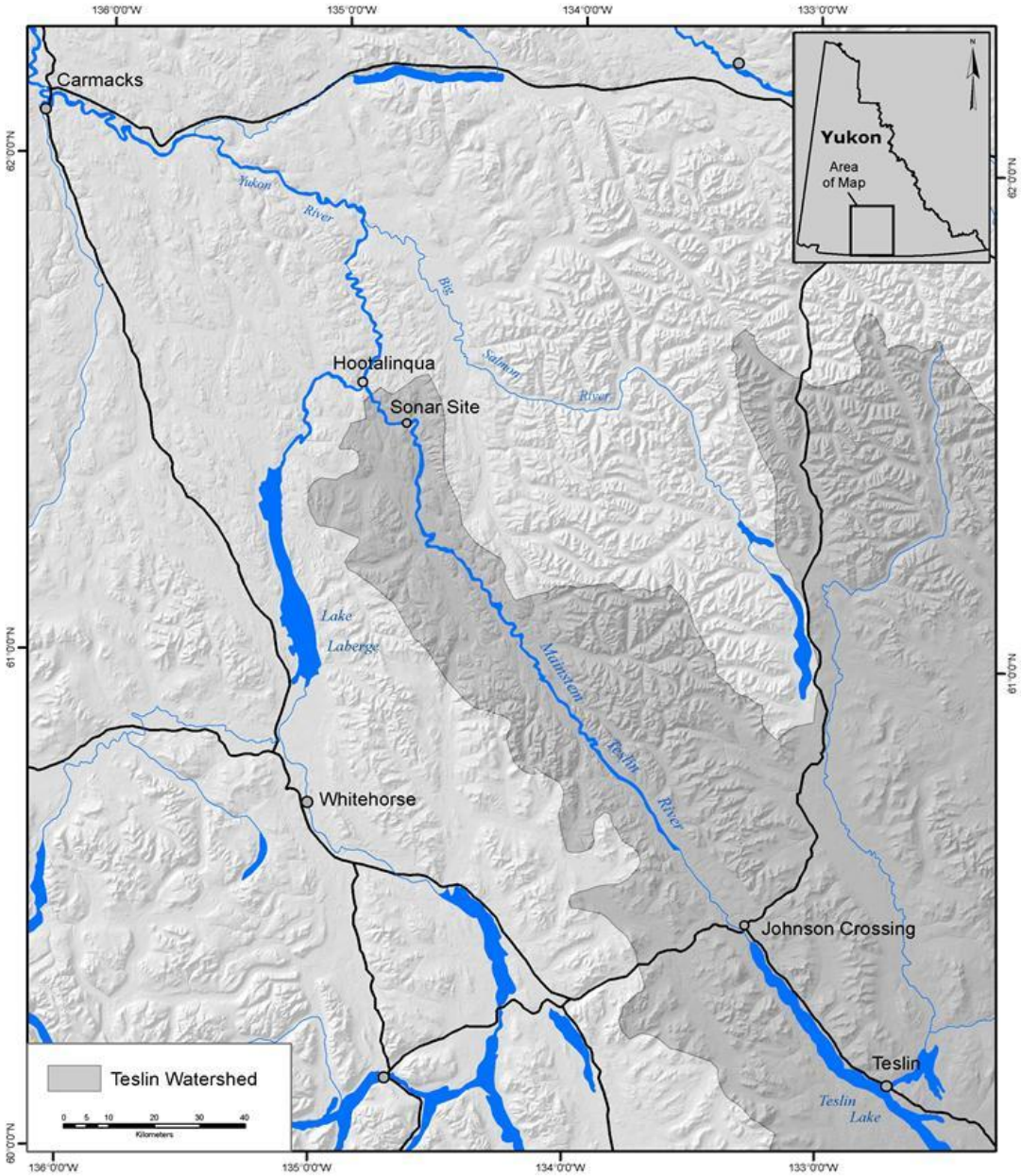

Figure 1. Mainstem Teslin River and sonar site.
Digital map data source: Yukon Government spatial data collection. www.geomaticsyukon.ca.

The lower mainstem Teslin River area is remote with no road access. Access to the area is by riverboat from Lake Laberge or Johnson's Crossing (approximately 100 and 145

river km respectively) or by floatplane with a direct distance of approximately 95 km from Whitehorse, Yukon.

Fish species documented in the mainstem Teslin River system include, but are likely not limited to, Chinook and Chum salmon (*Oncorhynchus tshawytscha* and *O. keta)*, Grayling (*Thymallus thymallus)*, Burbot (*Lota lota*), Inconnu (*Stenodus leucichthys)*, Round Whitefish (*Prosopium cylindraceum*), slimy sculpin (*Cottus cognatus*) and longnose sucker (*Catostomus catostomus*) (DFO FISS database).

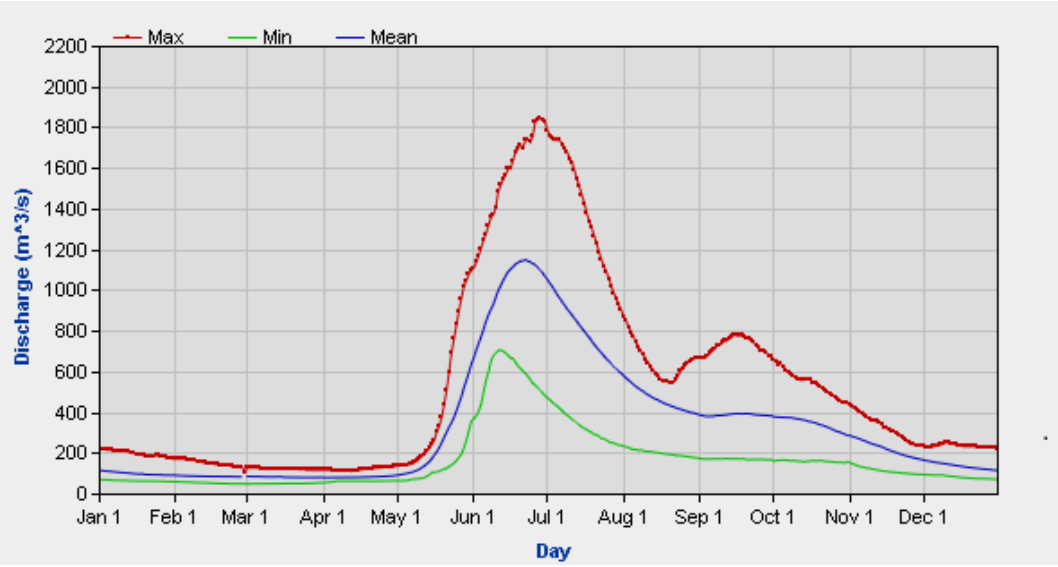

Figure 2. Daily minimum, maximum and mean discharge rates for mainstem Teslin River at station 09AF001[2] from December 1955 through January 1973.
Source: Water Survey Board of Canada.

A three year radio telemetry study conducted on Yukon River Chinook from 2002 through 2004 indicated that the Teslin River system received on average 19.6% (range 18.1% - 20.8%) of the total Canadian origin Chinook in the Yukon River watershed (Mercer et al. 2004, 2005; Osborne et al. 2003). Based on this radio telemetry data, approximately 70% of the radio tagged Chinook entering the Teslin River watershed were located in the mainstem Teslin River (Appendix 1). The remaining 30% were located throughout several headwater systems draining into Teslin Lake. This proportional distribution within the Teslin system was consistent over the three years of the study (mean 70%, SD = 2). The Chinook stock proportions in other upper Yukon River basin as indicated by the telemetry results have been corroborated by subsequent sonar enumeration projects on the Klondike and Big Salmon rivers (Mercer and Wilson 2005-2011). Genetic stock identification (GSI) data collected at the Eagle sonar site from 2008 through 2013 is also congruent with the stock proportions observed in the three years of telemetry (Unpublished data, DFO Whitehorse). Telemetry, GSI and the 2012

[2] This station, decommissioned in 1973, was located 300 m downstream of the sonar site.

Teslin sonar data indicate the Teslin system is the largest single tributary contributor to upper Yukon River Chinook production.

2. OBJECTIVES

The objectives of the 2013 Teslin River sonar project were to:

1. Enumerate the Teslin River Chinook salmon escapement and obtain information on run timing and diel migration patterns.

2. Conduct spawning ground sampling for age-sex-length data and genetic tissue samples from post-spawn fish.

3. METHODS

Site Selection

The sonar site used in 2013 and 2012 was the site selected during the 2011 feasibility study (Mercer 2012, 2013). This site, located approximately 12 km upstream from the confluence with the Yukon River (Figure 1), was initially selected for the following reasons:

- It is a sufficient distance upstream of the mouth to avoid straying or milling Chinook salmon destined for other headwater spawning sites.
- The site is in a relatively straight section of the river and far enough downstream from any bends in the river so that recreational boaters using the river have a clear view of the in-stream structures.
- The river flow is laminar and swift enough to preclude milling or 'holding' behaviour by migrating fish.
- The stream bottom profile and river width allows for complete ensonification of the water column by two sonars.
- The site is accessible by boat and floatplane.

Regulatory Submissions and Permits

A three year land use permit was granted by the Yukon Territorial Government (YTG) Lands Branch for the sonar camp on the mainstem Teslin River. Approval was granted from Transport Canada (Marine Branch), Navigable Waters Protection to install partial fish diversion fences in a navigable waterway for the 2013 project.

Mobilization and Personnel

Construction of the camp infrastructure began on July 12 with the transport of materials, construction personnel and project manager to the site via river boat and aircraft. Some

of the project equipment was stored at the Big Salmon sonar site and was transported by aircraft to the project.

The project supervisor was on site continually for the duration of the project, including the carcass pitch. Two BMA technicians were employed on the project on a rotational basis. The project manager was on-site for 10 days during the construction and start-up phase and again at three separate periods over the course of the project.

Sonar Deployment and Operation

The 2013 operational plan was to place a sonar unit on each side of the river. The sonar units were configured to aim across the river enabling ensonification of the migration corridor (Figure 3). An ARIS sonar unit was deployed from the north bank (NB) of the river for the full duration of the project. A DIDSON sonar was deployed on the south bank (SB). Initially the operational plan was to operate the SB sonar for only 2 weeks as previous results at this site indicated almost all the migrating Chinook were oriented to the north side of the river (Mercer 2012, 2013). However, due to the large number of fish detected by the SB sonar in 2013 (discussed below), a DIDSON sonar was deployed on the SB for the entire project.

Power for the sonar units, computer apparatus, and wireless transceivers was obtained from 12 volt battery banks located on each side of the river. The 12 volt battery current was converted to 120 volt AC using 1000 watt inverters. The north bank batteries were charged using 4 solar panels as well as a commercial grade battery charger powered by a 2000 watt Honda® generator. The south bank sonar location was in perpetual shade precluding the use of solar panels. These batteries were charged using an Ampair® model UW100 in-stream water turbine, as well as a second Honda® generator and battery charger.

For the SB sonar, the sonar stand used during the 2012 project was again used in 2013 (Figure 4). This apparatus is described in a previous report (Mercer 2013). A new stand was fabricated for mounting the NB sonar for the 2013 project. This stand consisted of a 2 m high metal tripod with 5 cm O.D. aluminum pipes attached. The pipes were connected using Klee Klamps allowing roll and tilt adjustments of the sonar unit to be made in a full 360 axis range. The metal tripod and pipe configuration created a stable in-river sonar platform that could be re-positioned with changing water levels and be deployed in deep fast flowing water (Figure 5).

The sonar transducer lenses were positioned to a depth of approximately 12 cm below the surface of the river and angled downward approximately 3º from horizontal. This resulted in the upper edge of the ensonified field of view remaining parallel to the surface of the river. The sonars have a compass and inclinometer that shows the tilt and azimuth of the sonar beams on the computer display.

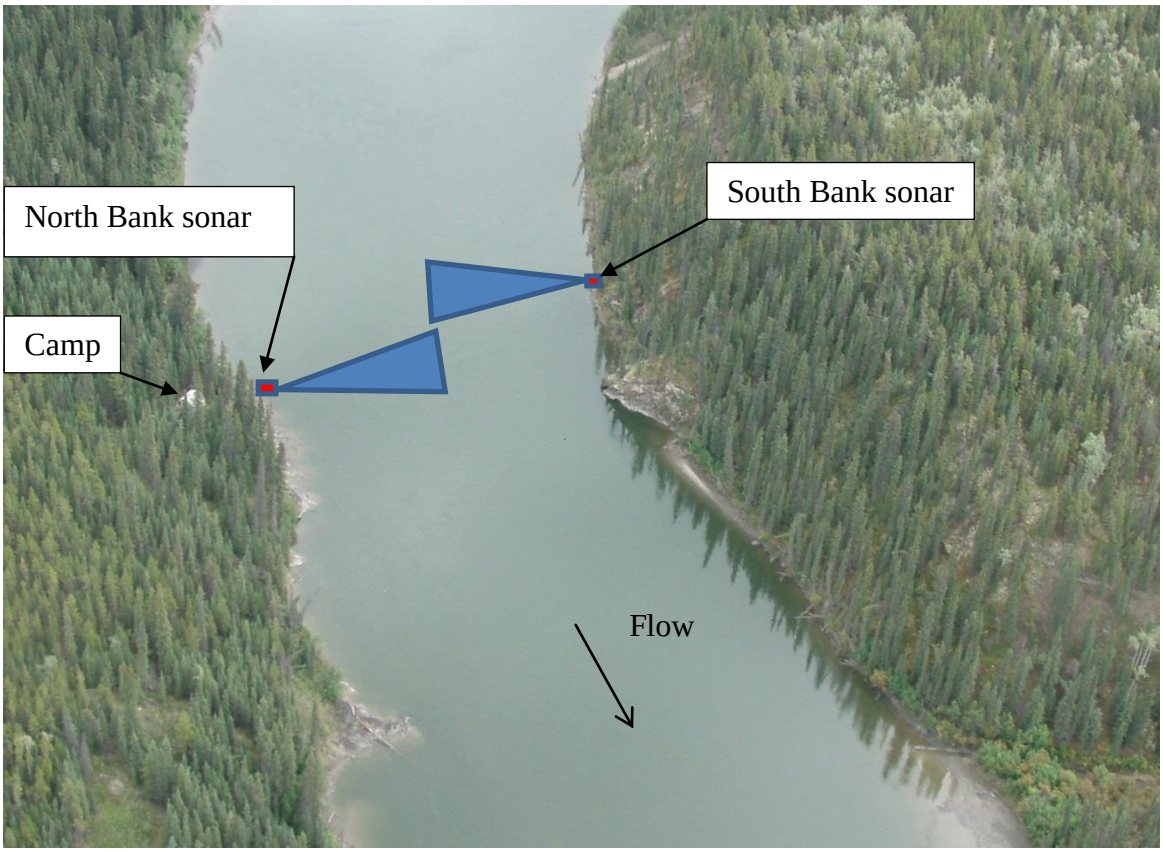

Figure 3. Aerial view of sonar site depicting the camp, sonar locations and schematic representation of ensonified portions of the river (2012 photo).

After placement of the sonars a diversion fence was positioned 3 m downstream of each sonar unit to deflect migrating Chinook into the ensonified area of the river. The NB weir was constructed of metal tripods with horizontally connected wooden "stringers". Prefabricated panels of electrical conduit were placed on the tripod structures to create the diversion fence (Figures 5 and 6). The fence for the SB sonar consisted of a log boom extending approximately 6 meters out from the shore perpendicular to the current,. A 6 m x 2m length of page wire fencing was attached to the length of the boom. The bottom margin of the fencing was weighted with rocks so the wire would hang perpendicular to the surface.

For the DIDSON sonar the receiver gain was set at –40 dB, the window start at 5.0 m, and window length at 40 m. The DIDSON default frequency is 1.1 Mhz. with these settings. The ARIS start and end ranges were 5.0 m and 41.5m. The ARIS sonar settings were the default frequency of 1.1 Mhz. and receiver gain of 23 dB. The recording frame rate of both sonars was set at 4 frames per second.

Figure 4. SB sonar unit mounted on stand.

Figure 5. NB sonar unit mounted on tripod stand with diversion weir downstream of the sonar.

Data Collection and Chinook Enumeration

The sonar data was collected continuously and stored automatically in pre-programmed, 20 minute date stamped files. This resulted in an accumulation of 72 files over a 24 hour period for each unit. These files were subsequently reviewed the following day and backed up on an external hard drive.

Figure 6. NB diversion weir in place.
Note: Photo taken in late August at lower water levels than photo in Figure 4.

The sonars were operated over the course of the project with minor planned and unplanned stoppages varying in duration from 2 minutes to 9 hours and 18 minutes. All stoppages were recorded and potentially missed fish were added to the counts by extrapolation based on the mean number of fish per hour counted 12 hours before and after the outage. When complete files were missed the Chinook passage was estimated by interpolation of the average file count over the 12 hour period before and after the missing sample event as follows:

$$P_m = \frac{X_a + X_b}{2}$$

Where m is mth missing value, X_a is the mean file count prior to the missing sample event and X_b is the mean file count of the sample after the missing file(s).

The recorded files were reviewed using either the sonar view platform or echograms of each file. The DIDSON files were typically reviewed using the sonar view platform. Review of the ARIS files typically used the echogram feature of the ARISfish® software. However, if a reviewer was uncertain about a particular target both views could be used for positive identification. To optimize target detection in sonar view, the background subtraction feature was used to remove the static images such as the river bottom and weir structures. The playback speed depended on the preference and experience of the observer, but was generally set between 40 and 50 frames per second, approximately 10 - 12 times the recording rate. When necessary, the file review was stopped when a target was observed and replayed at a slower rate to aid in identifying passing fish.

All targets identified as Chinook were visually counted and entered into an excel spreadsheet. The position of each Chinook observed within the cross section profile of

the river was recorded within 5m increments. This provided information on the spatial pattern of migrating Chinook within the ensonified area of the river. A record was maintained of each 20 minute file count as well as hourly, daily and cumulative counts. The count data from each sonar was combined and entered daily into a master spreadsheet.

Target Identification

Fish identification was based on the size, form and swimming behaviour of detected sonar targets. The target measurement feature of the sonar software was used to estimate the size of the observed fish when required. The minimum size used to classify Chinook salmon for the project was 50 cm. It has been demonstrated that with adequate training the sonar operators are able to differentiate, with a high degree of accuracy, between resident fish species and migrating salmon (Enzenhofer et al. 2010). Blind trials comparing both visual and DIDSON sonar counts of Chinook on the Klondike River demonstrated that trained sonar operators detected and correctly identified 100% of the visually observed (n=106) Chinook passing the Station (Mercer 2010).

It is possible that co-migrating Chum salmon could be incorrectly identified as migrating Chinook due to similar form, swimming behaviour and overlapping of size. Fall Chum salmon are documented spawning in the mainstem Teslin River (DFO FISS database). However, it is unlikely a temporal overlap of migrating fall Chum and Chinook occurs in the Teslin system. Test fishing at the Eagle sonar station from 2007 through 2009 captured the first fall Chum Salmon on August 8, 9, and 19 respectively (Crane and Dunbar, 2009 and 2011). The first Chum salmon counted in 2013 at the Eagle sonar sites was on August 19 (http://www.adfg.alaska. gov/sf/FishCounts/index.cfm?). The river distance from Eagle Alaska to the Teslin sonar site is approximately 780 km. Mean migration rates for upper Yukon River fall Chum have been documented at approximately 40 km/day (Boyce 1999). This suggests the Teslin Chinook migration would have been complete before the arrival of fall Chum in the system.

Precision of Counts

Many salmon enumeration sonar projects review a sub-set of recorded data and apply an expansion factor to obtain a total estimate of fish passage. The variance associated with this expansion method can be is quantified and incorporated into the total fish passage estimate (Enzenhofer et al., 2010, Crane and Dunbar (2007, 2010). All recorded files for the Teslin sonar project were reviewed in their entirety so there was no variance associated with the expansion of a sub-set of a file data.

The precision of the file counts was measured by double reviewing a sub-set of all the files recorded. Precision refers to the repeatability of a count between different individuals for the same data file. Approximately 10% of the 144 files recorded were double checked each day by a second reader. The re-count from each file was recorded for comparison with the original.

Some sonar projects, particularly those with high fish passage rates, use the the average percent error (APE) method to quantify the repeatability (precision) of counts (Enzenhofer *et. al*, 2010). This formula is expressed as:

$$APE = \frac{1}{N}\sum_{j=1}^{N}\left[\frac{1}{R}\sum_{i=1}^{R}\frac{\left|X_{ij} - \overline{X}_j\right|}{\overline{X}_j}\right] \times 100$$

However, because of the relatively low number of fish per hour in most of the Teslin sonar files the percent error could be over-estimated. For example, if the first counter observed 2 upstream fish and the second counter missed one, the APE would be as high as 33 %. This is because of the leverage that small numerical differences in low counts have on the overall calculation of APE. It should be noted that the magnitude of this error is high when individual file counts are low but because these numbers are also relatively low it has little influence on the overall estimate of escapement. Because of this the average percent error for this project was calculated using files with fish counts ≥ 5 fish/ file.

As well as calculating APE a sample variance estimator based on the absolute difference between readers was used to quantify the precision of the counts and the net variability between readers.

Carcass Pitch

The carcass pitch on the upper mainstem Teslin River was conducted by a crew of two technicians. Access to Chinook spawning areas was by a river boat powered by a 60 hp outboard jet. The crew made two trips during the periods August 31 – September 2 and September 7 – 10. On the first trip the crew accessed the river from the sonar site to a point approximately 100 km upstream on the first trip. For the second trip the river was accessed at the Johnson's Crossing boat ramp, located approximately 4 km downstream from the outlet of Teslin Lake (Figure 1). Carcass pitch efforts extended downstream approximately 110 km from Johnson's Crossing. Only dead or moribund fish were collected. Collection was by hand or by using an extendable spear.

Tissue samples for DNA analysis were collected from fresh (gills still red) carcasses only. A portion of both the left and right axillary appendages was removed using guillotine clippers and placed in paired vials containing 95% ethyl alcohol[3]. Sampling for age, sex and length data was conducted on all moribund and dead Chinook collected. Five scales for aging were obtained from each recovered fish. The sex and mid-eye-fork and post-orbital hypural lengths (to the nearest 5 mm) were also recorded. Tissue samples, scale cards and an electronic copy of the ASL data were submitted to DFO Whitehorse on completion of the project.

[3] One of each pair of samples is sent to both the Pacific Biological Station in Canada and the Alaska Department of Fish & Game (ADF&G) Gene Conservation Laboratory for analysis.

Hydrometric Data and Weather

Air and water temperatures and water levels were recorded daily at the sonar site. A referenced water gauge was established so that relative water levels can be recorded in subsequent years. Anecdotal weather observations were also recorded.

Communication

For safety purposes a satellite phone was present in the camp at all times as well as carried during extended boat trips. In addition, a satellite internet system was installed at the site. The satellite internet system facilitated communications between the field personnel, project manager and technical support team from Sound Metrics. Bi-weekly sonar counts were passed on by email to DFO Whitehorse, the TTC Department of Lands and Resources and other interested parties. The satellite internet allowed direct real time communication and file sharing with technical staff at Sound Metrics.

4. RESULTS

Chinook Counts

A total of 9,894 targets identified as Chinook salmon was counted during the period of operation. The first Chinook salmon was observed by the NB sonar on July 22 and on July 26 by the SB sonar. A peak daily count of 547 fish occurred on August 11, at which time 51% of the run had passed the sonar station; 90% of the run had passed the station on August 19. Daily and cumulative counts are presented in Table 1 and illustrated in Figure 7.

Due to planned and unplanned stoppages in the sonar, a total of 14.5 hours of sonar data collection was missed by the NB sonar; resulting in an additional 19 interpolated Chinook. The SB sonar was inoperative for a total 8.9 hours resulting in 21 interpolated fish. The total interpolated count was 40 Chinook. These counts were added to the daily counts during the course of the project.

The cross sectional distribution pattern of the migrating Chinook is presented in Figure 8. In 2011 and 2012 the distribution of Chinook passing the station was skewed to the north side of the river with few Chinook (3% and 0% respectively) detected by the SB sonar (Mercer 2012, 2013). However, in 2013 a significant proportion the run (37%) was detected by the SB sonar (Figures 8 and 9). It should be noted in respect to Figure 8 that the deflection fences were absent during the 2011 feasibility study and therefore fish within the near field of the sonar (<5m) would have been missed.

Table 1. 2013 Daily counts of Teslin River Chinook salmon.

Date	North Bank Sonar	South Bank Sonar	Daily Total	Cumulative
21-Jul	0	0	0	0
22-Jul	4	0	4	4
23-Jul	5	0	5	9
24-Jul	5	0	5	14
25-Jul	9	0	9	23
26-Jul	10	1	11	34
27-Jul	23	0	23	57
28-Jul	69	1	70	127
29-Jul	61	1	62	189
30-Jul	71	0	71	260
31-Jul	146	12	158	418
01-Aug	165	26	191	609
02-Aug	216	50	266	875
03-Aug	240	55	295	1170
04-Aug	357	96	453	1623
05-Aug	260	128	388	2011
06-Aug	296	191	487	2498
07-Aug	279	205	484	2982
08-Aug	305	202	507	3489
09-Aug	291	207	498	3987
10-Aug	259	208	467	4454
11-Aug	277	270	547	5001
12-Aug	333	205	538	5539
13-Aug	258	187	445	5984
14-Aug	281	248	529	6513
15-Aug	213	199	412	6925
16-Aug	268	148	416	7341
17-Aug	229	168	397	7738
18-Aug	221	142	363	8101
19-Aug	194	133	327	8428
20-Aug	141	114	255	8683
21-Aug	122	82	204	8887
22-Aug	135	81	216	9103
23-Aug	90	58	148	9251
24-Aug	101	72	173	9424
25-Aug	79	41	120	9544
26-Aug	58	49	107	9651
27-Aug	42	37	79	9730
28-Aug	35	28	63	9793
29-Aug	26	27	53	9846
30-Aug	15	6	21	9867
31-Aug	12	0	12	9879
01-Sep	14	0	14	9893
02-Sep	1	0	1	9894
03-Sep	0	0	0	9894

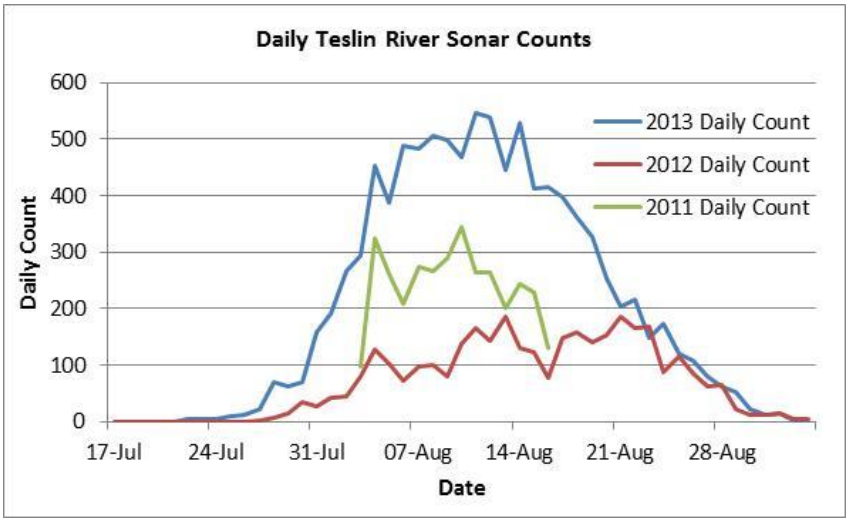

Figure 7. Daily Counts of Chinook at Teslin River sonar station 2011 - 2013.
Note: 2011 counts from feasibility study with only 12 full days of sonar operation, Aug. 3-15.

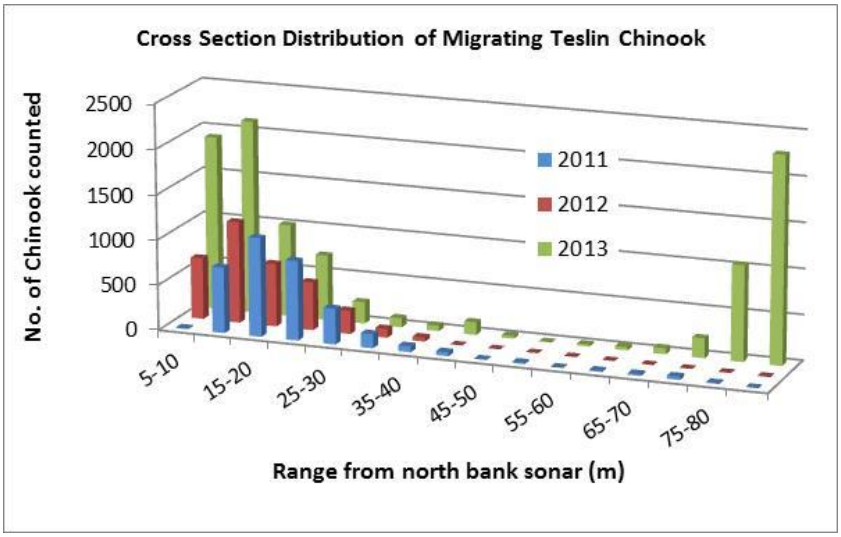

Figure 8. Cross sectional distribution of migrating Chinook at the Teslin sonar site, 2011, 2012 and 2013.

Precision of Counts

Figure 10 illustrates the relationship between counts of 2 different file readers using daily pooled original and double reviewed files. Linear regression between readers showed variation between counts but overall the correlation is high (R^2= 0.99).

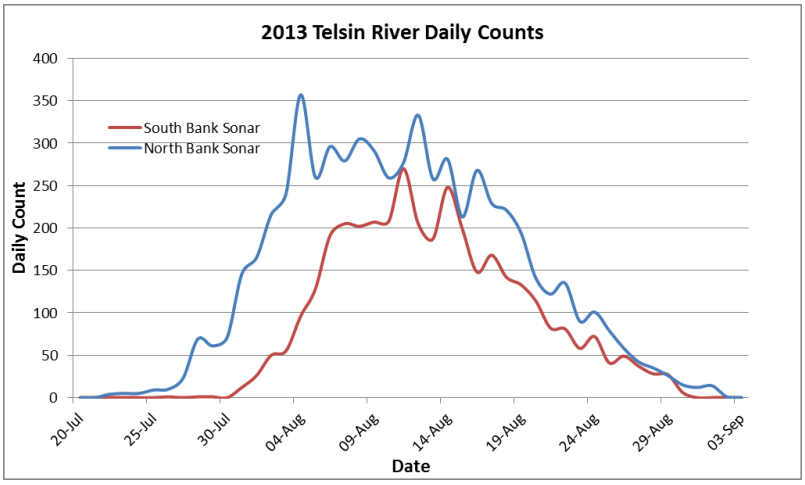

Figure 9. 2013 daily counts of NB and SB sonars.

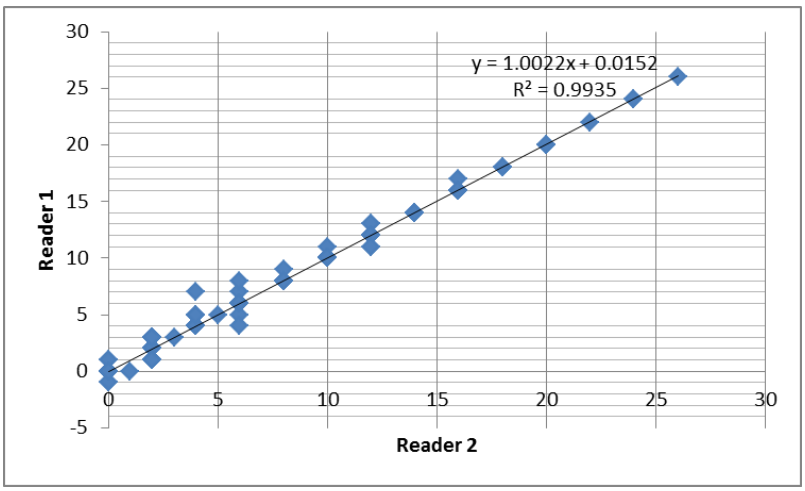

Figure 10. Linear regression between double reviewed file data that has been analysed by 2 different readers.
Note: Data points are NB sonar counts for the month of August representing daily pooled original and double reviewed file data.

A total of 694 files (11.2%) from the overall project total of 6,192 was reviewed twice (Table 2). Of the double checked files a total of 78 (11.2%) resulted in dissimilar counts. A positive difference was recorded in 52 (7.5%) of the double checked files and a negative difference in 26 (3.7%) of the files. The total number of fish counted in the original file set was 1,260. The total number of fish counted in the reviewed file set was 1,280. The covariance for the 2 file sets was 25.4. The net difference between the sums of the original and double reviewed files was +20 fish; 1.6% of the total fish counted.

The average percent error (APE) was calculated for the 127 double reviewed files that had fish counts ≥ 5 fish/file. The APE for this subset was 1.3%.

Table 2. Double reviewed files and calculated difference between counts.

	Count	%
Total files recorded during project	6192	
Total files double reviewed	694	11.2%
Total fish counted in double reviewed files	1280	
Total files with + variance	52	7.5%
Total files with - variance	26	3.7%
Total Files with variance	78	11.2%
Total plus fish	63	+4.3%
Total minus fish	43	-3.3%
Difference	+20	+1.6%

Carcass Pitch

A total of 220 dead or moribund Chinook was recovered during the carcass pitches. All except one of the fish were recovered during the second carcass pitch trip on Sept 6 -9. Of the fish collected, 108 (49%) were female and 112 (51%) were male. A length frequency histogram of all sampled Teslin Chinook is illustrated in Figure 11. The mean mid-eye fork length of females and males sampled was 848 mm and 732 mm, respectively.

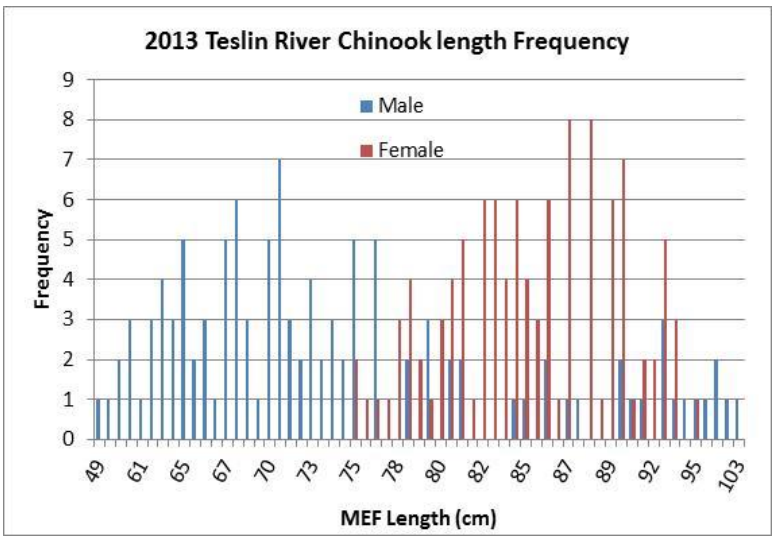

Figure 11. Length Frequency histogram of sampled Teslin River Chinook, 2013.

Complete age data[4] was determined from 195 of the Chinook sampled; the remaining 25 samples yielded partial ages or no ages due to regenerate scales. Complete age, length and sex data are presented in Appendix 2. Age 1.3 (46%) was the dominant age class,

[4] Scale age analysis was conducted for DFO Whitehorse by the Pacific Biological Station, fish ageing lab in Nanaimo, British Columbia.

followed by age 1.4 fish (43%). Age 1.2 and 1.5 fish each represented 2% of the sample. A total of 166 tissue samples was collected for GSI analysis. ASL data for each age class and sex are presented in Appendix 6.

Above Border Chinook Spawning Escapement Estimates

The 2013 Eagle sonar project on the Yukon River downstream of the Canada/U.S. border yielded a Chinook passage estimate of 30,725 and a spawning escapement[5] estimate of 28,669 Chinook salmon (DFO Whitehorse unpublished data 2013). Genetic stock identification (GSI) samples were also obtained at the Eagle sonar site using drift nets. The GSI data provides information on the proportional contribution of identified stocks to the total above border Chinook escapement. The 2013 proportional contribution of the regional Teslin River stock to the Chinook border escapement based on un-weighted analysis of the GSI samples was 25.6% (SD 5.2), (DFO Whitehorse unpublished data). Expansion of the 2013 Teslin sonar count (9,894) using the proportion of Teslin origin stock derived from the Eagle GSI sampling resulted in an expanded 2013 Chinook border escapement estimate of 38,648 (95% CI, 27,636 – 64,246).

Using this technique it is possible to obtain a more precise Chinook border escapement by using the sum of the sonar counts from the Big Salmon and Teslin and the aggregate of the GSI proportions from these two stocks: this can be achieved using either:

1. Total un-weighted stock proportion or;
2. Weighted stock proportions using temporal stratification of the Eagle GSI sampling results.

The combined 2013 Teslin and Big Salmon sonar counts totalled 13,136 Chinook. The un-weighted aggregate Big Salmon and Teslin GSI stock proportion based on the 2013 Eagle sampling is 32.5% (SD = 5.4) (Unpublished data, DFO – PBS Nanaimo genetics lab). Using the aggregate GSI stock proportions and the total of the two sonar counts would result in an expanded 2013 Chinook border escapement estimate of 40,486 (95% CI = 30,540 – 60,038).

Using weighted stock proportions based on temporally stratified GSI sampling results from Eagle (Appendix 8b), yields an above border escapement point estimate of 41,997 (95% CI = 33,141 – 50,853). Appendix 8(a) lists the above border escapement estimates detailed above.

5. DISCUSSION AND RECOMMENDATIONS

The 2013 Teslin River sonar project was conducted successfully and as planned throughout the course of the Chinook run. The contractor is confident the sonar count accurately reflects the Chinook escapement into the Teslin system. In general the sonars and related equipment functioned well with minimal down time. In a project of this nature it is to be expected there may

[5] Spawning escapement is the Eagle sonar count minus the catches in the U.S. above the sonar station and in the Canadian fisheries.

be brief periods of down time due to equipment adjustments, maintenance and unplanned technical difficulties.

The average percent error between readers calculated for the 127 double reviewed files with ≥ 5 fish/file was 1.3%. The 694 files reviewed twice resulted in a net difference between the sums of the original and double reviewed files of +20 fish; 1.6% of the total 1260 fish counted. This indicates the precision of the Teslin sonar counts was relatively high. The variability between double reviewed files is likely due to missed fish rather than mis-identified fish. This statement is based on the knowledge that only one species of salmon is being counted and the migrating Chinook are readily distinguishable from resident fish and other non-fish targets. Based on this evidence the 2013 Teslin sonar count could be biased low by approximately 1.5% of the final abundance estimate. No adjustments were made to the final count to compensate for this possible bias.

The time of arrival and peak migration of the 2013 Teslin River Chinook run occurred 7 - 10 days earlier than was observed in 2012. The first Chinook was observed passing the Teslin sonar site in 2013 on July 20. This is similar to the timing of the first radio tagged fish that was recorded entering the system in 2003 (Appendix 3).

The significantly higher proportion of Chinook observed migrating on the south side of the river in 2013 compared to the two previous years may be due to the lower water levels. It is worth noting that significant numbers of Chinook were not observed by the SB sonar until 10 days after Chinook were first recorded by the NB sonar (Figure 9). This lag may be a function of continued orientation of migrating fish to the NB until water levels receded to the point when swimming energetics were conducive to migration along the south side of the river.

The Teslin sonar project is challenging due to the size of the river and the strong bank orientation of the migrating Chinook, particularly along the north bank. It is apparent based on the 2013 results that 2 sonar units would need to be deployed throughout the run in order to obtain an accurate escapement estimate. It is also important that the diversion fences are able to deflect all passing Chinook into the ensonified areas of the river. High water conditions and associated strong currents could prevent the installation and maintenance of fish tight deflection fences. If the project continues in 2014 it is recommended an additional two larger tripods and requisite panels be constructed and deployed on the north bank.

The 2013 above border escapement estimates based on expansion of sonar counts and GSI stock proportions were approximately 30% higher than the escapement estimate based on the Eagle sonar counts. It is outside the scope of the Teslin sonar project and this report to analyze in detail and comment on the upper Yukon River Chinook GSI stock compositions, related sonar counts and the precision of the resultant escapement estimates. However, examination of this data does highlight the value of obtaining independent[6] escapement estimates of upper Yukon Chinook. The value of accurate escapement data is increased if it can be correlated with accurate stock composition information. An accurate count of a Chinook stock or aggregate stocks coupled with accurate GSI stock proportions has the capability of generating independent upper Yukon Chinook escapement estimates that are within defined statistical parameters.

[6] Using data separate from the Eagle or Pilot Station sonar projects.

The carcass pitch conducted in 2013 demonstrated there are areas of relatively high densities of spawning Chinook in the mainstem Teslin. The first run of the carcass pitch was conducted too early to coincide with the start of the die off from un-spawned fish. This, combined with the relatively low total Chinook return to the upper Yukon system in 2013 resulted in fewer samples collected than expected. It was proposed to expand the sample collection effort on the mainstem Teslin River in 2014.

6. REFERENCES

Boyce, Ian. 1999. Upper Yukon Radio Telemetry Tracking Station Installation and Spawning Ground Sampling/Tag recovery, 1998. R&E Project 09-98-Part 1. Unpublished report for CRE project 09-98, Yukon River Panel.

Crane, A.B., and R. D. Dunbar. 2011 Sonar estimation of Chinook and fall Chum salmon passage in the Yukon River near Eagle, Alaska, 2009. Alaska Department of Fish and Game, Fishery Data Series No. 11-08, Anchorage.

Crane, A.B., and R. D. Dunbar. 2009 Sonar estimation of Chinook and fall Chum salmon passage in the Yukon River near Eagle, Alaska, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 09-30, Anchorage.

Daum, D.W. and B.G. Flannery. 2009. Canadian origin Chinook salmon rearing in non-natal U.S. tributary streams of the Yukon River, Alaska, 2006-2007. Alaska Fisheries Technical Report No. 102, May 2009.

Department of Fisheries and Oceans, Salmon and Freshwater Ecosystems Division, Science Branch. 2007. Conservation Units for Pacific salmon under the Wild Salmon Policy. Conservation Units for Pacific salmon under the Wild Salmon Policy. CSAS Research Document 2007/070.

Eiler, J.H., T.R. Spencer, J.J. Pella, and M.M. Masuda, and R.R. Holder. 2004. Distribution and movement patterns of Chinook salmon returning to the Yukon River Basin in 2000 – 2002. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-AFSC-148.

Eiler, J.H., T.R. Spencer, J.J. Pella, and M.M. Masuda. 2006. Stock composition, run timing, and movement patterns of Chinook salmon returning to the Yukon River Basin 2004. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-AFSC-165.

Enzenhofer, H.J., Cronkite, G.M.W., and Holmes, J.A. 2010. Application of DIDSON imaging sonar at Qualark Creek on the Fraser River for Enumeration of adult pacific salmon: An operational manual. Can. Tech. Rep. Fish. Aquat. Sci. 2869: iv + 37 p.

FISS database, DFO Yukon/Transboundary Rivers area. *http://habitat.rhq.pac.dfo-mpo.gc.c./fiss/dcf01.cfm*

Galbreath, P.F. and P.E. Barber. Validation of Long-Range Dual Frequency Identification Sonar for Fish Passage Enumeration in the Methow River. Unpublished report for the PSC Southern Fund project. 2005.

Holmes, J. A., Cronkite, G. M. W., Enzenhofer, H. J., and Mulligan, T. J. 2006. Accuracy and precision of fish-count data from a ‘‘dual-frequency identification sonar’’ (DIDSON) imaging system. ICES Journal of Marine Science, 63: 543e555.

Joint Technical Committee (JTC) of the Yukon River US/Canada Panel. 2010. Yukon River Salmon 2010 Season Summary and 2011 Season Outlook. Fisheries and Oceans Canada, Stock Assessment and Fisheries Management Section, Yukon and Transboundary Area. Whitehorse, Yukon Territory.

Maxwell, S., D. Burwen, and C. Pfisterer. Testing the Range Limitations of the Long Range and Standard Versions of the Dual Frequency Identification Sonar (DIDSON). Draft report. Regional Information Report No. 2A04-XX April 2004.

Mercer, B. 2005. Distribution and Abundance of Radio Tagged Chinook Salmon in the Canadian Portion of the Yukon River Watershed as Determined by 2004 Aerial Telemetry Surveys. CRE project 77-04, Yukon River Panel.

Mercer, B. and J Eiler, 2004. Distribution and Abundance of Radio Tagged Chinook Salmon in the Canadian Portion of the Yukon River Watershed as Determined by 2003 Aerial Telemetry Surveys. Unpublished report for CRE project 77-03, Yukon River Panel.

Mercer, B. 2013. 2012 Teslin River Chinook Sonar Project. Unpublished report for Yukon River Panel, CRE-01N-12.

Mercer, B. 2012. 2011 Teslin River DIDSON Sonar Feasibility Study. Unpublished report for the Yukon River Panel, CRE-01N-11.

Mercer, B. 2009 through 2011. Klondike River DIDSON Sonar Feasibility Study Unpublished report for Yukon River Panel, CRE projects 16-08 through 16-11.

Mercer, B. and J. Wilson, 2005 through 2012. Chinook salmon Sonar Enumeration on the Big Salmon River. Unpublished reports for Yukon River Panel CRE project 41.

Water Survey of Canada. Archived hydrometric data. *http://www.wsc.ec.gc.ca/applications/H2O/ reporteng.cfm?station=09AF001 from December 1955 through January 1973.*

Osborne, C.T., B. Mercer, and J.H. Eiler, 2003. Radio Telemetry Tracking of Chinook Salmon in the Canadian Portion of the Yukon River Watershed – 2002. CRE project 78-02, Yukon River Panel.

7. ACKNOWLEDGEMENTS

Several individuals contributed to the success of the 2013 Teslin River sonar project. David Macdonald, assisted with the camp setup, ably conducted the sonar operations and was involved in the carcass pitch. Robert gransden, Matthew Fry, and Jesse McEwen all worked on the sonar operation and assisted with the carcass pitch. Jane Wilson assisted with logistics and expediting and provided editorial support for this report. Elizabeth Macdonald of DFO Whitehorse coordinated the provision of GSI and ASL data as well as other technical input. Funding for this project was provided by the Yukon River Panel Restoration and Enhancement Fund.

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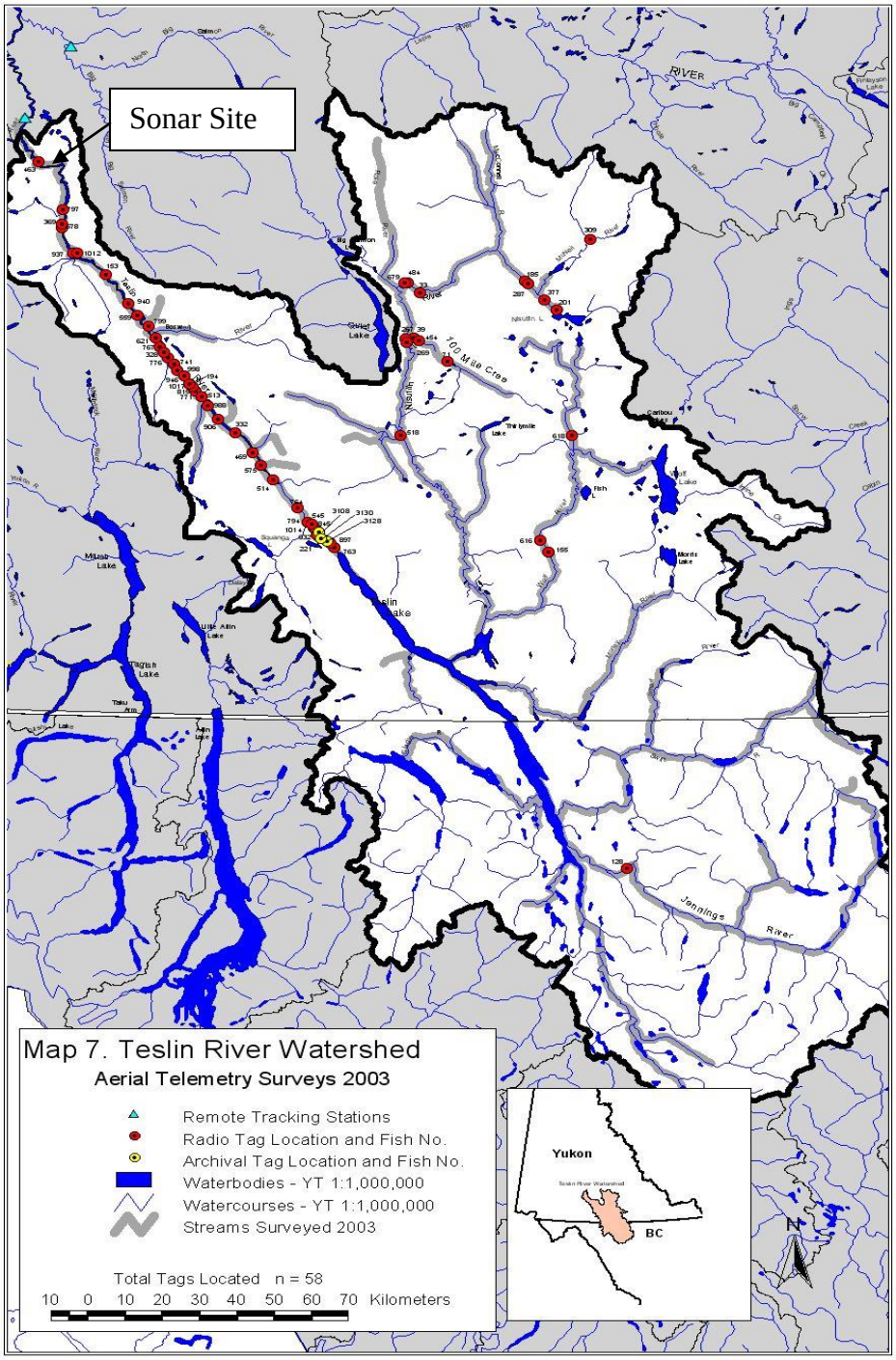
Appendix 1. Location of radio tagged Chinook during peak spawning in the Teslin River drainage in 2003.
Source: Mercer and Eiler, 2004.



Appendix 2. 2013 Mainstem Teslin River carcass pitch data.

Date	Sex	MEF	POHL	DNA	Age	Scale Bk
31-Aug	F	90.0	79.0	Y	14	95570
6-Sep	F	88.0	77.0	Y	14	95570
6-Sep	F	87.0	75.0	Y	1F	95570
6-Sep	M	74.5	64.5	Y	12	95570
6-Sep	M	61.0	53.0	Y	12	95570
6-Sep	M	78.0	68.0	Y	23	95570
6-Sep	F	91.0	80.0	Y	14	95570
6-Sep	F	79.5	69.5	N	14	95570
6-Sep	M	71.0	61.0	Y	13	95570
6-Sep	F	88.5	79.0	Y	13	95570
6-Sep	F	82.0	71.5	Y	14	95571
6-Sep	F	88.0	76.5	Y	14	95571
6-Sep	F	83.0	72.5	Y	14	95571
6-Sep	F	76.0	66.5	Y	13	95571
6-Sep	F	75.0	64.0	N	13	95571
6-Sep	M	67.0	58.5	Y	13	95571
7-Sep	F	85.0	74.0	Y	M4	95571
7-Sep	M	92.0	80.0	Y	14	95571
7-Sep	F	79.0	68.0	Y	13	95571
7-Sep	M	90.5	78.0	Y	14	95571
7-Sep	F	80.0	69.5	N	13	95572
7-Sep	F	83.0	73.0	Y	14	95572
7-Sep	F	90.0	79.0	N	M4	95572
7-Sep	M	86.0	74.5	Y	13	95572
7-Sep	F	78.5	69.0	N	M4	95572
7-Sep	F	77.5	68.0	N	13	95572
7-Sep	F	86.0	77.0	Y	14	95572
7-Sep	M	70.0	61.0	Y	13	95572
7-Sep	F	87.0	78.0	Y	14	95572
7-Sep	F	77.5	66.5	N	13	95572
7-Sep	F	83.0	74.0	Y	14	95573
7-Sep	M	70.0	61.0	Y	13	95573
7-Sep	F	93.0	82.0	Y	14	95573
7-Sep	M	75.0	64.5	Y		95573
7-Sep	F	90.0	81.0	N	15	95573
7-Sep	F	85.5	75.0	Y	14	95573
7-Sep	M	63.0	55.0	Y	13	95573
7-Sep	F	85.0	74.0	N	14	95573
7-Sep	M	60.0	51.5	N	13	95573
7-Sep	F	75.0	65.0	N	M3	95573
7-Sep	M	74.0	63.0	N	13	95574
7-Sep	M	67.0	58.5	N	13	95574
7-Sep	M	66.0	57.0	Y	1F	95574
7-Sep	F	88.0	77.5	Y	14	95574
7-Sep	F	78.5	69.0	Y	13	95574
7-Sep	F	83.0	74.0	N	14	95574
7-Sep	F	78.0	68.5	Y	13	95574
7-Sep	F	82.0	73.0	Y	14	95574
7-Sep	F	81.0	70.0	Y	13	95574

Date	Sex	MEF	POHL	DNA	Age	Scale Bk
7-Sep	F	90.0	79.5	Y	14	95574
7-Sep	F	79.5	70.0	Y	14	95575
7-Sep	F	81.0	72.0	Y	14	95575
7-Sep	F	78.0	68.0	N	14	95575
7-Sep	F	83.5	74.0	N	13	95575
7-Sep	M	97.0	84.0	Y	14	95575
7-Sep	M	66.0	58.0	Y	13	95575
7-Sep	M	95.0	81.0	Y	14	95575
7-Sep	M	85.0	74.0	N	13	95575
7-Sep	F	83.5	74.5	Y	14	95575
7-Sep	F	86.0	77.0	N	14	95575
7-Sep	F	81.5	70.0	Y	14	95576
7-Sep	F	93.0	82.0	Y	M4	95576
7-Sep	F	85.5	76.0	Y	14	95576
7-Sep	F	95.0	84.0	Y	M5	95576
7-Sep	F	86.5	77.0	Y	14	95576
7-Sep	F	87.0	76.0	Y	14	95576
7-Sep	M	86.0	75.0	Y	14	95576
7-Sep	F	87.0	77.0	Y	14	95576
7-Sep	M	71.0	61.5	Y	13	95576
7-Sep	F	79.5	68.0	N	15	95576
7-Sep	F	92.0	80.5	N	14	95577
7-Sep	F	84.0	73.5	Y	14	95577
7-Sep	F	83.0	73.0	Y	14	95577
7-Sep	F	91.5	81.0	Y	14	95577
7-Sep	F	89.0	80.0	N	14	95577
7-Sep	M	64.0	56.5	Y	13	95577
7-Sep	F	76.5	67.0	N	13	95577
7-Sep	F	88.0	78.0	N	15	95577
7-Sep	F	83.5	72.5	Y	14	95577
7-Sep	F	83.0	74.0	Y	14	95577
7-Sep	M	80.0	70.0	Y	14	95578
7-Sep	F	90.0	80.0	N	14	95578
7-Sep	M	59.0	50.0	Y	12	95578
7-Sep	M	75.0	65.0	N	13	95578
7-Sep	M	65.0	56.0	Y	13	95578
7-Sep	F	87.0	77.0	Y	14	95578
7-Sep	F	81.0	72.0	Y	14	95578
7-Sep	M	100.0	89.0	Y	15	95578
7-Sep	M	100.0	87.0	N	15	95578
7-Sep	F	78.0	69.0	Y	13	95578
7-Sep	M	102.0	89.0	Y	15	95579
7-Sep	F	85.0	75.0	Y	14	95579
7-Sep	F	81.0	71.0	N	13	95579
7-Sep	F	89.0	78.0	Y	14	95579
7-Sep	M	61.0	53.0	Y	12	95579
7-Sep	M	68.0	58.5	Y	13	95579
7-Sep	M	73.0	64.5	Y	13	95579
7-Sep	F	92.0	81.0	N	15	95579
7-Sep	F	81.0	70.0	Y	13	95579
7-Sep	M	65.0	58.0	Y	14	95579

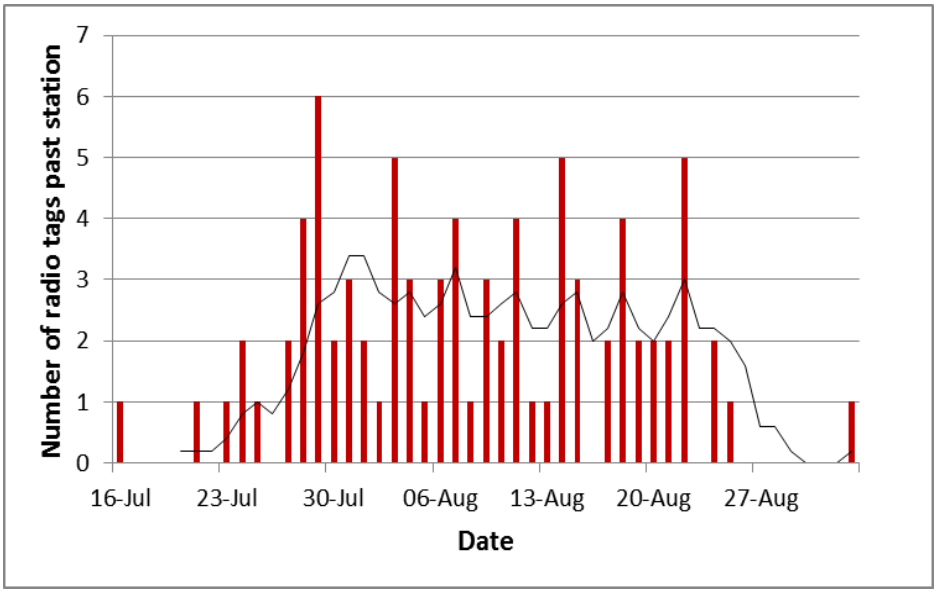
Date	Sex	MEF	POHL	DNA	Age	Scale Bk
08-Sep	M	72.0	63.0	Y	13	10901
08-Sep	M	60.0	52.0	Y	13	10901
08-Sep	F	87.0	76.0	Y	14	10901
08-Sep	M	63.0	56.0	Y	13	10901
08-Sep	F	84.0	73.5	N	15	10901
08-Sep	F	90.0	79.0	Y	14	10901
08-Sep	M	67.0	57.5	Y	13	10901
08-Sep	M	73.5	63.5	Y	13	10901
08-Sep	M	72.5	61.5	Y	13	10901
08-Sep	F	89.0	77.0	Y	13	10901
08-Sep	M	73.0	62.0	Y	13	10902
08-Sep	M	93.0	80.0	Y	M4	10902
08-Sep	M	66.0	56.5	N	13	10902
08-Sep	M	68.0	59.0	N	M3	10902
08-Sep	M	73.0	63.5	Y	13	10902
08-Sep	M	63.0	54.0	Y	13	10902
08-Sep	F	91.0	79.5	Y	14	10902
08-Sep	M	73.0	63.0	N	13	10902
08-Sep	F	85.5	76.0	N	15	10902
08-Sep	M	69.5	60.0	Y	13	10902
08-Sep	M	69.0	59.5	N	13	10903
08-Sep	M	68.0	58.5	Y	13	10903
08-Sep	M	66.5	58.0	Y	13	10903
08-Sep	M	71.0	62.0	Y	13	10903
08-Sep	M	70.0	61.0	N	13	10903
08-Sep	M	60.0	52.5	N	13	10903
08-Sep	M	74.0	65.0	Y	13	10903
08-Sep	M	74.0	64.0	Y	13	10903
08-Sep	M	60.5	50.5	Y	12	10903
08-Sep	M	63.0	54.0	N	13	10903
08-Sep	M	73.5	63.0	Y	13	10904
08-Sep	M	92.0	79.0	Y	13	10904
08-Sep	F	92.0	79.0	Y	15	10904
08-Sep	M	70.0	61.0	Y	13	10904
08-Sep	M	68.0	59.0	Y	13	10904
08-Sep	M	80.0	70.0	Y	13	10904
08-Sep	M	90.0	78.0	Y	14	10904
08-Sep	M	81.0	72.0	Y	14	10904
08-Sep	M	70.0	62.0	Y	13	10904
08-Sep	M	67.0	59.0	Y	M3	10904
08-Sep	M	61.0	55.0	N	13	10905
08-Sep	M	53.0	46.0	N	12	10905
08-Sep	M	65.5	57.0	Y	13	10905
08-Sep	M	71.0	62.0	Y	13	10905
08-Sep	F	89.0	78.0	N	14	10905
08-Sep	F	82.0	73.0	N	13	10905
08-Sep	M	90.0	78.0	Y	14	10905
08-Sep	F	91.5	80.5	Y	14	10905
08-Sep	M	81.0	70.0	Y	14	10905
08-Sep	F	83.5	74.0	Y	13	10905
08-Sep	F	87.0	77.5	Y	14	10906

Date	Sex	MEF	POHL	DNA	Age	Scale Bk
08-Sep	M	69.0	60.0	Y	13	10906
08-Sep	F	88.0	77.0	Y	M4	10906
08-Sep	M	79.0	68.0	N	13	10906
08-Sep	M	94.0	81.5	N	14	10906
08-Sep	M	65.5	58.0	Y	13	10906
08-Sep	M	91.0	78.0	Y	14	10906
08-Sep	M	75.0	67.0	Y	13	10906
08-Sep	F	92.0	82.0	Y	14	10906
09-Sep	M	76.0	66.0	Y	13	10906
09-Sep	F	84.0	74.0	Y	14	10907
09-Sep	F	84.0	75.0	Y	14	10907
09-Sep	M	49.0	42.0	N	12	10907
09-Sep	M	64.0	56.0	Y	13	10907
09-Sep	F	82.0	73.0	N	14	10907
09-Sep	M	65.0	56.0	Y	13	10907
09-Sep	F	82.0	72.0	N	14	10907
09-Sep	M	87.5	75.0	Y	M4	10907
09-Sep	F	77.5	68.5	Y	13	10907
09-Sep	M	69.0	60.0	Y	13	10907
09-Sep	M	79.0	68.0	Y	14	10908
09-Sep	M	75.0	66.0	Y	13	10908
09-Sep	M	64.0	56.0	Y	12	10908
09-Sep	F	90.0	78.0	Y		10908
09-Sep	M	72.5	62.0	Y	23	10908
09-Sep	M	67.0	58.5	Y	13	10908
09-Sep	M	76.0	65.0	Y	13	10908
09-Sep	F	82.0	72.0	Y	14	10908
09-Sep	M	71.0	62.0	Y	13	10908
09-Sep	M	76.0	67.0	Y	M3	10908
09-Sep	F	93.0	82.5	Y	14	10909
09-Sep	M	79.0	69.0	Y	14	10909
09-Sep	M	65.0	57.0	Y	1F	10909
09-Sep	F	86.0	76.0	N	14	10909
09-Sep	F	88.0	79.0	Y	13	10909
09-Sep	F	85.0	75.0	Y	14	10909
09-Sep	F	80.0	79.0	N		10909
09-Sep	M	59.0	52.0	Y	13	10909
09-Sep	M	72.0	62.0	N	13	10909
09-Sep	M	78.0	67.0	Y	M4	10909
09-Sep	M	74.5	65.0	N	M3	10910
09-Sep	M	75.0	66.0	Y	13	10910
09-Sep	M	92.0	81.0	Y	14	10910
09-Sep	M	84.0	73.5	N	M3	10910
09-Sep	F	89.0	79.0	N	14	10910
09-Sep	F	86.0	78.0	Y	M4	10910
09-Sep	F	87.0	78.0	Y	14	10910
09-Sep	M	87.0	76.0	Y	14	10910
09-Sep	M	76.0	66.0	Y	13	10910
09-Sep	M	65.0	55.5	N	M3	10910
09-Sep	F	86.0	75.5	Y	14	10911
09-Sep	F	84.0	75.0	Y	14	10911

Date	Sex	MEF	POHL	DNA	Age	Scale Bk
09-Sep	F	92.0	80.0	Y	14	10911
09-Sep	F	90.5	80.0	Y	14	10911
09-Sep	M	71.0	62.0	Y	13	10911
09-Sep	M	68.0	58.0	Y	13	10911
09-Sep	F	88.0	78.0	Y	14	10911
09-Sep	M	103.0	91.0	Y		10911
09-Sep	F	80.0	71.0	Y	13	10911
09-Sep	F	78.0	69.0	Y	13	10911
09-Sep	M	68.0	60.0	Y	13	10912
09-Sep	F	88.0	78.0	Y	14	10912
09-Sep	F	80.0	71.0	Y	M4	10912
09-Sep	F	86.0	76.0	N	14	10912
09-Sep	M	76.0	65.0	Y	12	10912
09-Sep	F	75.5	67.0	Y	13	10912
09-Sep	F	84.0	75.5	Y	14	10912
09-Sep	M	71.0	63.0	Y	13	10912
09-Sep	F	89.0	79.0	Y	14	10912
09-Sep	M	72.0	63.0	Y	14	10912

Appendix 3. Daily count of radio tagged Chinook (n=86) passing the Teslin telemetry station in 2003.

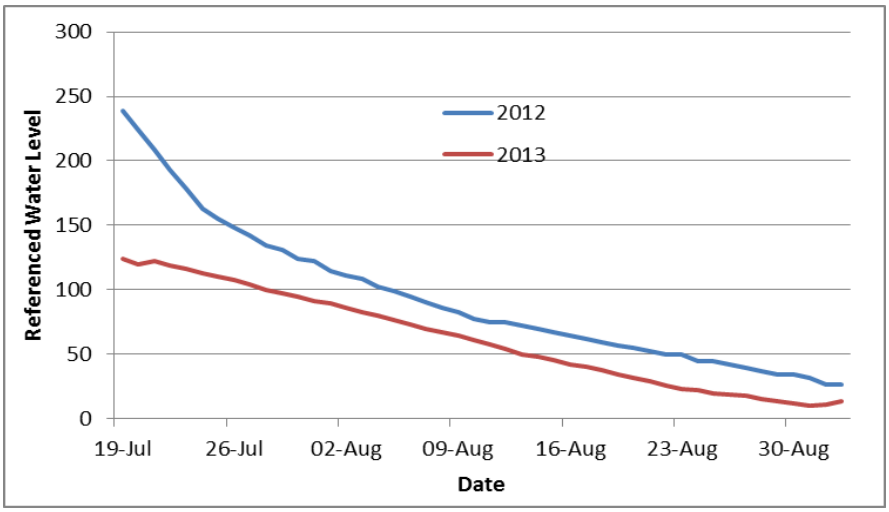
Note: Black line is a 5 day moving average; Source: Mercer and Eiler , 2003



Appendix 4. Hydrometric data and weather observations, Teslin sonar site 2013.

Date	Time	Air Temp. C	Water Temp. C	Water Level cm
19-Jul	1510h		13.5	124.5
20-Jul	1500h		14.0	120.0
21-Jul	0900h	11.5	12.0	121.9
22-Jul	0900h	12.0	14.0	118.7
23-Jul	0800h	11.5	11.5	116.2
24-Jul	0915h	15.0	11.5	112.4
25-Jul	0900h	13.0	13.0	109.9
26-Jul	1025h	18.0	12.5	107.3
27-Jul	0800h	13.0	13.0	104.1
28-Jul	0700h	9.0	13.0	99.7
29-Jul	0835h	19.0	15.0	97.2
30-Jul	0625h	10.5	14.5	94.6
31-Jul	0730h	12.5	14.5	91.4
01-Aug	0730h	12.5	14.0	89.5
02-Aug	0645h	8.0	13.5	85.7
03-Aug				
04-Aug	1045h	20.0	12.0	80.0
05-Aug	0845h	19.0	12.0	76.8
06-Aug	0822h	15.0	14.0	73.0
07-Aug	1230h	25.0	16.0	69.9
08-Aug	0830h	18.0	15.0	67.3
09-Aug	0940h	20.0	16.0	64.1
10-Aug	0740h	14.0	15.5	61.0
11-Aug	0800h	14.5	16.0	57.8
12-Aug	0645h	10.0	16.0	54.0
13-Aug	1030h	24.0	17.0	50.2
14-Aug	0736h	11.0	15.5	48.3
15-Aug	0915h	19.0	17.0	45.1
16-Aug	0715h	12.5	16.5	41.9
17-Aug	0915h	16.0	14.5	40.0
18-Aug	0830h	13.0	16.0	37.5
19-Aug	0800h	9.0	14.5	34.3
20-Aug	0830h	10.0	14.5	31.8
21-Aug	0845h	13.0	14.0	29.2
22-Aug	0815h	8.0	13.5	26.0
23-Aug	0900h	14.0	13.0	23.5
24-Aug	0830h	12.0	13.0	22.2
25-Aug	0815h	9.0	13.0	19.7
26-Aug				
27-Aug	1030h	10.0	13.0	17.8
28-Aug	0900h	8.0	12.0	15.2
29-Aug	0740h	5.0	12.0	14.0
30-Aug	1000h	13.0	13.5	12.1
31-Aug	0630h	8.0	12.0	10.2
01-Sep				
02-Sep	0615h	12.0	12.0	13.3

Appendix 5. Referenced water levels at Teslin sonar site 212 and 2013.



Appendix 6. Age, sex, and length summary of sampled and aged 2013 mainstem Teslin Chinook.

SEX	Age	Data	Total	%
Female	13	Average of MEF	80.2	
		Count of age	23	11.8%
	14	Average of MEF	86.2	
		Count of age	66	33.8%
	15	Average of MEF	87.3	
		Count of age	7	3.6%
Female Average of MEF			84.8	
Female Count			96	49.2%
Male	12	Average of MEF	62.0	
		Count of age	9	4.6%
	13	Average of MEF	70.1	
		Count of age	67	34.4%
	14	Average of MEF	85.6	
		Count of age	18	9.2%
	15	Average of MEF	100.7	
		Count of age	3	1.5%
	23	Average of MEF	75.3	
		Count of age	2	1.0%
Male Average of MEF			73.2	
Male Count			99	50.8%
Total Average of MEF			79.0	
Total Count			195	

Note: European age classification. A total of 220 chinook was sampled (112 male, 108 female) but only 195 were fully aged. 25 fish were not aged due to scale regeneration and poor annuli resolution.

Appendix 7. Estimated proportions of Big Salmon River and Teslin River Chinook in upper Yukon River Chinook escapements, 2002 through 2012.

Year	**Method**	**Big Salmon River Estimated % proportion of border escapement based on telemetry or GSI sampling ( )= sd**	**Teslin River Estimated % proportion of border escapement based on telemetry or GSI sampling ( )= sd**
2002	Telemetry	9.2	19.8
2003	Telemetry	15.1	18.1
2004	Telemetry	10.0	20.8
2006	Fishwheel GSI Sampling	10.7 (3.2)	14.2 (2.4)
2007	Fishwheel GSI Sampling	10.6 (2.5)	9.6 (1.6)
2008	Fishwheel GSI Sampling	9.3 (6.0)	16.4(3.4)
2009	Eagle Gillnet GSI Sampling	16.9 (3.6)	25.6(3.3)
2010	Eagle Gillnet GSI Sampling	11.7 (2.4)	33.0(4.6)
2011	Eagle Gillnet GSI Sampling	8.0 (2.4)	25.3(3.3)
2012	Eagle Gillnet GSI Sampling	6.7 (2.8)	37.8 (4.6)
2013	Eagle Gillnet GSI Sampling	6.6 (2.7)	25.6 (5.2)
Mean 2002-2012		10.4	22.4
Std. Dev.		3.2	8.2

Data source: DFO unpublished data, Osborne et al. 2003, Mercer and Eiler 2004, Mercer 2005.

Appendix 8(a). 2013 above border escapement estimates based on Eagle sonar counts, and expansion of sonar counts based on GSI stock proportions.

Method	Above Border Escapement Estimate
Eagle Sonar Count	28,669
Teslin sonar/Unweighted Teslin GSI stock proportion	38,648 (95% CI = 27,636 – 64,246
Teslin Plus Big Salmon Sonar/Unweighted Aggregate GSI	40,486 (95% CI = 30,540 – 60,038)
Teslin Plus Big Salmon Sonar/Weighted and Stratified GSI	41,997 (95% CI = 33,141 – 50,853)

Appendix 8(b). Table of stratified GSI stock proportions and expanded escapement estimate based on aggregate Teslin/Big Salmon sonar counts.

	Run	Teslin/Big	Run	Escapement	"Actual"	Effective	SD	SD	SD
Strata/Stat Week	Weight	Salmon Prop.	Standard		Sample	Sample	Prop	wp	Escape
1 (28 & 29)	**0.276**	**0.374**	0.276	11,605	92	55.2	0.065	0.018	1,249
2 (30)	**0.337**	**0.347**	0.337	14,154	69	41.4	0.074	0.025	1,523
3 (31)	**0.243**	**0.027**	0.243	10,193	78	46.8	0.024	0.006	1,097
4 (32 - 35)	**0.144**	**0.597**	0.144	6,046	54	32.4	0.086	0.012	650
Total	1.000		1.000	**41,997**	293			0.034	4,518
Aggregate of Big Salmon and Teslin sonar Counts 2013		**13,136**						**Confidence Interval**	
Desired Confidence		**95%**			% Sample =	0.7%		**Low**	**High**
Desired Precision		**25%**			Precision =	21.1%			
Effect. Sample Coeff.		**0.6**	**0.000**					33,141	50,853