Chinook Salmon Escapement Estimation to the Skeena River Using Genetic Techniques 2015.

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The 2015 return of Chinook salmon (*Oncorhynchus tshawytscha*) to the Skeena River was estimated using genetic stock identification techniques. Genetic analyses of 663 Chinook salmon caught at the Tyee Test Fishery identified 24.4% of the sample as Kitsumkalum Chinook salmon (standard deviation = 1.8%). The preliminary escapement of large Chinook salmon to the Kitsumkalum River was estimated at 14,500 fish (standard deviation = 1,239 fish) from an independent mark-recapture estimate. The preliminary estimate of large Chinook salmon returning to the Skeena River as measured at Tyee was 59,476 fish with a standard deviation of 6,700 fish (coefficient of variation = 11.3%). Escapement was estimated at 53,770 Chinook salmon accounting for catch above the Kitsumkalum River.

These results are preliminary as additions and modifications are scheduled for the information used in the analyses of Skeena River Chinook salmon populations.

INTRODUCTION

Funding for the genetic analyses presented in this project was provided by the Pacific Salmon Commission's Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund (Northern Fund) to estimate Chinook salmon (*Oncorhynchus tshawytscha*) abundance in the Skeena River in 2015. The Tyee Test Fishery and the Kitsumkalum mark-recapture program that provide the basis for the study are funded by Fisheries and Oceans Canada. This report presents preliminary estimates of the Chinook salmon return to the Skeena River for 2015 based on genetic analyses of samples collected at the Tyee Test fishery. The results are part of a larger project to examine the genetics of Chinook salmon caught at Tyee over a 35 year time series. Several programs on the Skeena River have contributed to this project including the Tyee Test Fishery, the Kitsumkalum mark-recapture program and genetic baseline collections by First Nations groups and Fisheries & Oceans. Our findings are preliminary as improvements are anticipated to the Skeena Chinook salmon databases used to generate Chinook escapement estimates. This document fulfills the reporting requirement for the 2015 Northern Fund project and represents another step in an iterative process to improve Chinook escapement estimates for the Skeena River. Costs to the SSP consisted of the genetic analyses and a portion of the sampling costs at the Tyee Test fishery.

The primary objective of this study was to generate a watershed-wide estimate of Chinook salmon returning to the Skeena River. The Skeena River has the second largest aggregate of Chinook salmon in British Columbia. Total escapements of Chinook salmon to the Skeena River estimated using the genetic approach have been significantly larger than the indices in most years. Escapements measured using the genetic approach have averaged over 80,000 fish since 1984 while the escapement index for the Skeena River aggregate has averaged 50,000 over the same period. The index is comprised of the mark-recapture estimates for the Kitsumkalum, visual estimates for the Bear, Morice and other systems and fence counts for the Sustut, Kitwanga and part of the Babine populations. The Kitsumkalum indicator stock represents approximately 30% of the spawners in the escapement index but contributes approximately 18% of the aggregate measured using the genetic approach on average. The Bear and Morice populations have comprised 20% and 26% of the escapement index respectively on average since 1985. Comparison of the annual indices is problematic because the methods used to generate estimates for visual portions of the indices have changed through time. Further, measures of uncertainty are not available for the indices.

Skeena Chinook salmon are encountered in the PST Aggregate Abundance Based Management (AABM) fisheries in Southeast Alaska (SEAK all gear) and Northern British Columbia (NBC Troll and Haida Gwaii (QCI) Sport). They also contribute to the Individual Stock Based Management (ISBM) fisheries in Northern British Columbia including gillnet, tidal sport, non-tidal sport, tidal First Nations' (FN) and non-tidal FN fisheries. Skeena Chinook are north migrating so they do not contribute to the West Coast Vancouver Island (WCVI) AABM fisheries nor do they contribute appreciably to ISBM fisheries south of the Skeena River.

Preliminary estimates of the Chinook return to the Skeena River in 2000, 2001 and 2003 generated using the genetic approach produced coefficients of variation (CV) between 15% and 17%. Improvements were expected after 2009 as the genetic baselines were improved, and four additional genetic markers used by Genetic Analysis of Pacific Salmonids (GAPS) consortium (Seeb et al. 2007) were added. Also, sample sizes were expected to increase at Tyee. However, the expected improvements were not realized. Starting the Tyee Test Fishery on 25 May rather than 10 June resulted in only small increases to the Chinook sample size. The historic start date of 10 June proved to sample more of the front tail of the summer run than initially thought. The smaller than expected sample sizes combined with broader variance around the mark-recapture estimates of Kitsumkalum River Chinook escapements have resulted in larger CV's than expected. The genetic based estimates remain a significant improvement over the historic indices of abundance as the method is constant across the time series and the variance is estimated.

The Kitsumkalum River Chinook project produces Chinook salmon marked with coded wire tags (cwt's) for annual release as fry and yearlings. A mark-recapture program is conducted annually to estimate the escapement of the marked and unmarked fractions of the Kitsumkalum Chinook return. The data generated by the program contribute internationally as one of the stocks in the PSC Chinook model. Domestically the data contribute to Canada's Key Stream Program and provide the only exploitation rate indicator stock for Chinook salmon in the North Coast. These data are essential to the Chinook run reconstruction calculations.

The Kitsumkalum River hosts the second largest spawning population of Chinook salmon in the Skeena River watershed (second to the Morice River). The Kitsumkalum River summer run Chinook population forms a single conservation unit within the Skeena watershed. The Kitsumkalum River indicator stock probably represents the ocean distribution of other spawning populations in the Skeena River however their age at maturity differs. Kitsumkalum River Chinook salmon have stream type life histories with the predominant portions of the stock returning at age 5_2 and 6_2 for males and at age 6_2 for females. Other Skeena Chinook salmon also have stream type life histories but age at return is predominantly composed of age 4_2 and 5_2 males and age 5_2 females. Other age components observed in Skeena Chinook salmon include males returning from 3 to 7 years from brood and females returning from 4 to 7 years from brood. Fish returning 7 years from brood are more common in the Kitsumkalum River than in the rest of the Skeena watershed. The spawning migration occurs in the summer with peak passage through the Skeena River estuary in early July. Spawning takes place in late August and early September. Skeena River Chinook life histories are consistent with those observed in most northern Chinook salmon populations with the exception of Kitsumkalum River returns which tend to be a year older.

The Kitsumkalum River Chinook population is of sufficient magnitude and the mark-recapture program provides escapement estimates with a reasonable level of accuracy such that the total return of Chinook to the Skeena River may be estimated from an unbiased sample of the Skeena return. The Tyee Test fishery provides the samples of the Chinook return to the Skeena River. Expansion of the Kitsumkalum component to a Skeena wide population estimate requires that Chinook salmon from Kitsumkalum be equally vulnerable to the sample collection procedure as other components. Differences in timing and/or size of the returning sub-populations within the Skeena watershed could confound these analyses. We assume the Tyee Test fishery is an unbiased sampler of the Chinook salmon population entering the Skeena River.

Hatchery production of Chinook salmon in the Skeena watershed has been limited to small scale assessment projects and small scale production projects for community development. The hatchery production for the purposes of the exploitation rate indicator contributes an average of 2.6% to returns of Chinook salmon to the Kitsumkalum River (range from near zero to 1000 fish annually). Community production projects have been carried out and tag groups have been released from Chinook stocks in the Babine, Kispiox, Morice, Bulkley, Cedar, and Erlandsen tributaries of the Skeena River. Most releases were smaller than those to the Kitsumkalum River and success rates are unknown. The Bulkley River releases were of an early spring timed stock, and complete estimates of the Bulkley stock are not provided by this project because of the difference in migration timing.

Evidence of Chinook salmon straying from other rivers to the Skeena River is rare. No stray coded wire tags have been recovered at the Tyee Test Fishery. The Kitsumkalum River is sampled extensively and only one Chinook tagged in the Unuk River system has been recovered since the beginning of the program in 1984. However, the recovery of cwt's is a relatively weak measure of straying as few populations in northern British Columbia are tagged. The nearest populations to the Skeena that have been marked with cwt's are in the Kincolith River the north and the Kitimat River to the south. Neither stock is currently marked and the nearest marked stocks now are the Unuk River to the north and the Atnarko River to the south. Examinations of genetic markers provide more robust measures of the incidences of straying to the Skeena watershed. Genetic results from 2009 and 2010 samples supported the assumption that all of the Chinook salmon caught at the Tyee Test fishery were from the Skeena watershed and that any straying was extremely limited (<<1%).

METHODS

A Skeena wide Chinook salmon escapement estimate and stock specific estimates of escapement were produced using the genetic results from samples collected at Tyee. The component of the Tyee sample identified as originating in the Kitsumkalum River was the basis for the expansions.

Tyee is located on the tidal estuary of the Skeena River, on the north side, upstream of the confluence with the Ecstall River (Figure 1). The Tyee Test Fishery is a standardized fishery that has been conducted in the Skeena River estuary since 1955. Its' primary purpose has been to provide an in-season indication of sockeye salmon (*Oncorhynchus nerka*) abundance but is also used to monitor the relative abundance of other salmon species including Chinook (Cox-Rogers and Jantz, 1993). A gill net is deployed (set) in standard locations relative to tidal flow. Sets are made at high and low water slack tides during daylight hours. Usually three (3) sets are made per day except for some days late in the season when there are only two (2) tidal changes during daylight. An index consisting of standardized catch per effort is calculated daily. Typically more fish are caught during low water sets so the standardized catch consists of the mean of averaged high water and averaged low water catch measured per hour the net is fished.

The net used at the Tyee Test fishery is a multi-panel gill net 366 meters (200 fathoms) in length and 7.6 meters (25 feet) deep constructed of six strand monofilament nylon (Alaska twist). The net includes ten panels with web sizes ranging from 8.9 cm to 20.3 cm (3.5 inches to 8 inches) increasing in size by 1.3 cm (0.5 inch) increments. (Imperial units are included to match the web size designation by the manufacturer.) The different mesh sizes are arranged at random across the length of the net. The web is hung in a 2:1 ratio of webbing to fishing net length. A full description of the test fishery is provided by Jantz et. al. (1990).

Prior to 2009 the test fishery usually began around June 10 and continued until September. The Chinook run appeared to begin before 10 June and peak migration past Tyee occurred at the end of June and early in July. Historically the last Chinook are caught at Tyee around the middle of August (Figure 2.). Beginning in 2009 the test fishery was designed to begin around 25 May to capture more of the front tail of the Chinook salmon summer run. The test fishery began on 25 May in 2015 and the first Chinook salmon were caught on 26 May.

Chinook salmon caught in the Tyee Test fishery were sampled for nose-fork length, eye orbit to hypural plate length, and were incised to determine sex. Scale samples were collected from each fish on to scale books as described by MacLellan (1999) and forwarded to the Fisheries & Oceans Canada, Sclerochronology Laboratory at the Pacific Biological Station for ageing. Scale samples were also used as the tissue collections for genetic analyses.

Chinook salmon collections were compared with baselines collected from 30 Skeena River populations (Appendix 1). The criteria for selecting a spawning population or site as baseline were that they had to have genetic material from over 30 individuals. Samples were analyzed for 15 microsatellite loci using methods of DNA extraction, PCR reaction, electrophoresis, and allele scoring described by Candy et al. (2002) and Beacham et al. (2006). The Molecular Genetics Laboratory at the Pacific Biological Station provided the sample analysis. A new version of the computer program as described by Pella and Masuda (2001) was used for the analyses. The program CBAYES (Neaves et al 2005) can be downloaded from the Molecular Genetics Laboratory website. The model output included individual assignments to baseline populations where the posterior distribution gives probabilities for the five most likely populations for each sample.

To examine changes in stock composition through time the 663 Chinook salmon samples collected in 2015 were separated temporally by week and genetic results were compared for fish caught during different weeks. Weekly stock proportions were weighted to the catch to produce final estimates.

A key stream program on the Kitsumkalum River estimates the escapement of large Chinook salmon to the system. In addition to the escapement estimate, biological samples are collected from live fish during the tagging event and from dead fish during the recovery event. The samples include data on size and gender and scale samples to determine age.

The mark re-capture estimate of Chinook salmon to the Kitsumkalum River consisted of simple Petersen estimates of the form:

$$N_{sr} = \frac{(M_{sr}+1)(C_{sr}+1)}{(R_{sr}+1)}$$

Where N is the estimate of large Chinook salmon, M is the number of large Chinook salmon marked, C is the total number of large Chinook salmon carcasses encountered in the dead pitch and R is the number of marked large Chinook salmon carcasses recovered in the dead pitch by sex (subscript s) and river reach (subscript r) (Ricker, 1975). Separate estimates were calculated for males and females. Variance was computed using:

$$v(N_{sr}) = N_{sr}^2(C_{sr}-R_{sr})/(C_{sr}+1)(R_{sr}+2)$$

Variance (v) for the estimate of the Chinook salmon return to the Skeena River (z) was computed using Calculations from TCChinook (99)-3 where:

$$v(z) \sim= z^2((v(y)/y^2)+(v(x)/x^2))$$

or

$$v(z) \sim= z^2 (cv^2 (y)+cv^2 (x))$$

Where y was the estimate of the Kitsumkalum escapement and x was the estimate of the Kitsumkalum component measured at Tyee. The abbreviation cv refers to the coefficient of variation.

RESULTS

The Tyee Test fishery was operated from 25 May to 15 September 2015. Chinook salmon were caught from 26 May through 8 September (Figure 4.). A total of 852 Chinook salmon encountered by the net were classed as 750 large and 102 jacks from initial visual inspection. Upon examination of the scale ages the catches were revised to 809 large and 43 jacks. A total of 672 Chinook salmon were sampled for size, gender and scales and genetic analyses were completed for 663 of them. Depredation by seals accounted for most of the fish that could not be sampled. Often these fish were so badly mutilated that size and gender could not be determined. Typically the seals would chew or tear off the rear half of the fish leaving the head in the net. Mutilated fish were not sampled as the preferred areas for the scale collections were often missing.

The Skeena River baseline used for the analyses of the samples collected at Tyee included genetic material from 30 populations (Appendix 1) (Erhardt and Rabnett, 2009; Gottesfeld, 2009). When the samples collected at Tyee in 2015 were compared against the baseline results were produced for 663 of the 672 fish sampled. The proportion of the sample assigned to the Kitsumkalum River was estimated at 24.4% with a standard deviation of 1.8% (Table 1). The Morice River component in the sample was equivalent to the Kitsumkalum component at 24.4%, followed by the Babine River at 14.6% and Bear River at 8%.

The 2015 escapement of Chinook salmon to the Kitsumkalum River was estimated at 14,500 large fish (jacks excluded) with a standard deviation of 1,239 fish. The preliminary total return to the Skeena River was estimated at 59,476 (standard deviation = 6,700) using the Kitsumkalum escapement estimate and the proportion of Kitsumkalum estimated at Tyee as the basis for expansion. The coefficient of variation for the estimated number of large Chinook returning to the Skeena River was 11.3%. Escapement was estimated at 53,919 after the removal of 5,706 Chinook catch above the confluence of the Kitsumkalum River and the Skeena River.

The largest weekly catch of Chinook salmon at Tyee in 2015 was 105 fish in statistical week 075 (July 26 to August 1). Significant catches were also made in statistical week 064 (June 21 to 27) at 103 fish and week 073 (July 12 to 18) at 100 fish (Figure 4).

The Morice stock was the most prevalent in June and early July whereas the Kitsumkalum, Babine and Bear stocks tended to be more prevalent later in the run (Figure 5 and Table 2).

DISCUSSION

The findings reported represent preliminary estimates. Additional analyses are required to develop final estimates for the aggregate of Skeena River Chinook salmon as well as for the major component stocks. These analyses are proposed in combination with the results of the Sentinel Stocks retrospective projects that examined the stock compositions of Chinook salmon samples collected at Tyee prior to 2009.

The results from 2015 were developed using a genetic baseline from 30 Chinook salmon spawning populations in the Skeena watershed. Data from historic projects were reanalyzed with this common baseline. Initially, problems were identified in 2009 with the baseline genetic material collected for the Morice and Babine populations. No fish were assigned to the Babine River even though the fence counts and visual estimates indicated that the Babine represented a significant portion of the stock mixes tested. New baseline samples were collected in 2010 and 2011 from Morice and Babine which resulted in assignments to the Babine population. Samples collected in 2010 to 2012 have been incorporated in the baseline for the data analyses presented here as well as more recent collections from the Zymoetz River (Thomas Creek) and the Bear River.

This project assumes that components of the Chinook salmon return to the Skeena River are equally vulnerable to the Tyee Test fishery. Starting the test fishery on 10 June appeared to truncate the front tail of the Chinook salmon migration pattern (Figure 2). Sampling the front tail of the Chinook salmon migration has been attempted by starting the test fishery on 25 May or earlier since 2009 (Figure 3 and Figure 4). The portion of the migration pattern observed in the 25 May to 9 June time period in years 2009 through 2015 are not as large as might have been predicted when the historic average run timing curve is considered. The proportion of the Chinook salmon runs sampled in the 25 May to June 9 period averaged 6.7% of the total catch from 2009 to 2015 and only made up 3.8% of the catch in 2015.

The 2015 Chinook salmon migration past Tyee was later than normal with significant catches in late July and even in August. The pattern of Chinook salmon catches at Tyee was not appreciably different from 2009 to 2014 (Figure 3). The average date of capture at Tyee from 2009 to 2014 was 8 July (Julian day 189) and ranged from 3 July to 11 July within each year (Julian days 184 to 192). While the front tail of the 2015 run was similar to recent years, the peak was prolonged and the last fish were caught 8 September. Average date of capture in 2015 was 17 July (Julian day 198). When the historic data set is examined the average day of capture from 1979 to 2008 was 7 July (Julian day 188), essentially no different than the results from 2009 to 2014. Late runs were rare in the 1979 to 2014 data set but not unprecedented as the average day of capture at Tyee in 1980 was 16 July (Julian day 197) and in 1982 was 15 July (Julian day 196). The 2015 Chinook migration past Tyee was 9 to 10 days later than average.

The late run in 2015 did not appear to be a change in the ability of the test net to capture fish as late run fish were also observed in upstream sport and First Nation's fisheries. A common comment from the test fishery as well as anecdotally from upstream fisheries was the silver bright condition of the fish caught in August. Typically fish encountered in August are darker and exhibit morphometric changes associated with spawning. The later run timing into the Skeena watershed did not appear to change the timing of spawning. Observations of spawning Chinook salmon were normal timed in the Kitsumkalum, Bear, Morice, Babine, Kitwanga and Sustut.

The similarity in water levels between 2010, 2014 and 2015 suggest that water levels were not responsible for the difference in run timing in 2015. Water levels may influence fish migration or could influence their vulnerability to the test net. The 2009 to 2015 samples represented recent extremes in the range of water levels on the Skeena River. Extreme high water and flooding was experienced in 2009. This was followed by small winter snow packs and a warm, dry summer which resulted in very low water conditions in 2010. Very high water and prolonged freshet conditions were evident in 2011 and 2012 as the result of heavy winter snow packs and a cool, wet spring and summer. Low water conditions were evident again in 2014 and 2015 on the Skeena River when a small snow pack made for a relatively small freshet and minimal precipitation kept water levels were low and clear through the summer. There was no evidence of delay in the 2009, 2011 and 2012 migrations due to high water but this could be masked if high water levels make the fish passing Tyee less vulnerable to the fishery.

Initiating the Tyee Test fishery near 25 May instead of the historic start near 10 June was done to ensure that the front tail of summer run of Chinook salmon was vulnerable to the fishery. The earlier start has caught few fish (Figures 3 and 4) and made little difference to the estimates of average date of capture.

The 2009 and 2010 Chinook salmon samples collected at Tyee were compared with the coast-wide stock baseline to test for closure in the system. The results supported the assumption that all of the Chinook salmon caught at the Tyee Test fishery were essentially from the Skeena watershed and that any straying or nose-ins[1] were extremely limited (<1%) if they occurred at all. The 2011 through 2015 Tyee samples were not compared with the coast-wide stock mix since virtually all of the Chinook salmon caught at Tyee were assigned to the Skeena region aggregate in 2009 and 2010. The only coded wire tag evidence of straying was a single recovery of a fish marked in the Unuk River recovered in the Kitsumkalum in 2013. No stray coded wire tags have been recovered at Tyee.

This project assesses the Skeena Chinook abundance with removals accounted for the Chinook return as far upstream as the Kitsumkalum River. Fishery removals upstream of the Kitsumkalum must be considered in order to reach an escapement estimate. The First Nations'

[1] Nose-ins refer to fish that enter a non-natal stream then leave.

fisheries on the Skeena River in 2015 were modest due to the relatively small run size. Sport catches in the lower Skeena River were larger than expected in 2015 due to low, clear water conditions that began early and persisted through the duration of the Chinook migration. Catch estimates are preliminary as final estimates were not available at the time of writing. Assessing whether removal rates differ among stocks encountered by in-river fisheries has yet to be measured.

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This project was the result of a large number of people dedicated to assessments of Skeena River Chinook salmon. The Molecular Genetics Laboratory at the Pacific Biological Station (PBS), Nanaimo, provided the genetic analyses. The Sclerochronology Laboratory at PBS provided the age analyses of the scale collections. Richard Kristmanson was Captain of the test fishing boat "*Skeena Dawn*" which was operated at Tyee for the duration of the 2009 through 2015 programs. Improvements to the genetic baseline were realized from collections made by staff from Fisheries & Oceans, First Nations' Fisheries programs and local hatcheries.

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TABLES

Table 1. Results of the genetic mixture model analysis of Chinook salmon caught at the Tyee Test fishery in 2015 using the 30 stock Skeena baseline and 15 loci.

Data are presented as percent of the sample by stock. N= 663.

Stock	2015 Estimate (% of sample)	2015 Standard Deviation
Babine River	14.6	(1.8)
Bear River	8.0	(1.5)
Bulkley River	1.1	(0.4)
Cedar River	0.0	(0.1)
Ecstall River	2.4	(0.6)
Exchamsiks River	0.5	(0.4)
Exstew River	1.1	(0.5)
Fiddler Creek	0.0	(0.2)
Gitnadoix River	2.0	(0.6)
Kasiks River	0.5	(0.4)
Khyex River	0.3	(0.3)
Kispiox River	5.8	(1.3)
Kitseguecla River	0.1	(0.2)
Kitsumkalum River	24.4	(1.8)
Kitwanga River	1.0	(0.8)
Kluatantan River	0.5	(0.5)
Kluayaz Creek	0.5	(0.5)
Kuldo Creek	0.8	(0.6)
Morice River	24.4	(1.8)
Nangeese River	1.4	(0.6)
Otsi Creek	0.5	(0.5)
Shegunia River	0.1	(0.2)
Sicintine River	0.0	(0.2)
Slamgeesh River	3.5	(1.0)
Squingula River	1.6	(0.8)
Suskwa River	0.6	(0.4)
Sustut River	0.6	(0.3)
Sweetin River	0.5	(0.5)
Thomas Creek (Zymoetz River)	2.9	(0.7)
Zymagotitz River	0.4	(0.4)

Table 2. Mixture model analyses of large Chinook salmon caught at the 2015 Tyee Test fishery using the 30 stock Skeena baseline by week. Data are presented as percent of the sample by stock.

Stat. week	054		061		062		063		064		071		072		073		074	
Time period	May 25 - 30		May 31 - Jun 6		Jun 7 - 13		Jun 14 - 20		Jun 21 - 27		Jun 28 – Jul 04		Jun 5 – Jul 11		Jul 12 – Jul 18		Jul 19 - 25	
Sample size	2(0)		3(0)		33(0)		31(0)		76(0)		56(0)		82(0)		84(0)		82(0)	
Stock	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Babine R	0.0	(4.3)	0.1	(4.4)	0.1	(1.0)	0.0	(0.7)	11.7	(5.6)	0.1	(0.8)	10.8	(5.0)	17.2	(5.5)	7.9	(4.6)
Bear R	0.0	(5.1)	1.2	(7.6)	0.2	(1.3)	0.2	(1.5)	0.1	(1.0)	2.3	(4.0)	3.2	(3.0)	2.2	(3.7)	23.7	(6.1)
Bulkley R	50.0	(23.6)	0.0	(4.2)	0.0	(0.6)	6.5	(4.4)	0.0	(0.3)	1.8	(1.8)	0.0	(0.2)	0.0	(0.3)	0.0	(0.2)
Cedar R	0.0	(5.6)	0.0	(4.3)	0.0	(0.5)	0.1	(0.7)	0.0	(0.3)	0.0	(0.4)	0.0	(0.3)	0.0	(0.2)	0.0	(0.2)
Ecstall R	0.0	(4.6)	0.0	(4.1)	0.0	(0.6)	0.0	(0.6)	0.0	(0.2)	0.0	(0.5)	4.9	(2.4)	2.4	(1.7)	8.5	(3.0)
Exchamsiks R	0.0	(4.3)	1.1	(6.1)	5.6	(4.7)	0.3	(1.7)	0.1	(0.6)	0.3	(1.2)	0.1	(0.5)	0.0	(0.4)	0.0	(0.2)
Exstew R	47.0	(24.5)	0.3	(3.3)	0.0	(0.4)	0.3	(1.9)	1.6	(2.5)	0.3	(1.2)	2.3	(2.3)	0.0	(0.4)	0.0	(0.2)
Fiddler Cr	0.0	(5.1)	0.0	(3.4)	0.0	(0.6)	0.0	(0.5)	0.0	(0.3)	0.0	(0.5)	0.0	(0.3)	0.0	(0.3)	0.0	(0.4)
Gitnadoix R	0.8	(6.7)	3.9	(13.5)	0.0	(0.6)	19.2	(7.5)	2.2	(2.7)	5.7	(3.7)	0.5	(1.1)	2.0	(1.8)	0.0	(0.3)
Kasiks R	2.3	(9.4)	23.6	(20.5)	0.0	(0.6)	0.4	(2.0)	0.0	(0.4)	0.1	(0.6)	0.0	(0.3)	0.3	(0.8)	0.0	(0.3)
Khyex R	0.0	(5.8)	0.4	(5.8)	0.0	(0.6)	3.2	(3.1)	0.0	(0.4)	0.0	(0.4)	0.4	(0.8)	0.1	(0.4)	1.1	(1.3)
Kispiox R	0.0	(5.9)	10.4	(20.7)	45.0	(10.7)	1.8	(4.5)	12.8	(6.9)	7.7	(5.8)	6.6	(4.5)	0.1	(0.8)	0.2	(0.8)
Kitseguecla R	0.0	(5.3)	0.9	(6.5)	0.0	(0.5)	0.1	(1.0)	0.1	(0.5)	0.0	(0.4)	0.0	(0.3)	0.0	(0.2)	0.0	(0.2)
Kitsumkalum	**0.0**	**(4.7)**	**0.0**	**(4.8)**	**1.7**	**(4.0)**	**2.3**	**(4.7)**	**1.6**	**(2.8)**	**7.0**	**(4.4)**	**27.4**	**(5.8)**	**37.3**	**(6.1)**	**38.4**	**(6.2)**
Kitwanga R	0.0	(4.7)	8.1	(16.8)	0.4	(2.2)	7.4	(9.2)	1.4	(3.7)	1.0	(2.9)	0.4	(1.6)	0.2	(0.8)	0.3	(1.2)
Kluatantan R	0.0	(4.9)	0.0	(3.8)	0.1	(0.6)	0.0	(0.6)	0.1	(0.8)	2.7	(4.9)	0.0	(0.4)	0.1	(0.5)	0.3	(1.2)
Kluayaz Cr	0.0	(5.6)	0.0	(4.1)	0.5	(1.9)	2.2	(4.8)	0.8	(2.0)	1.9	(3.3)	0.0	(0.3)	0.1	(0.5)	0.0	(0.4)
Kuldo Cr	0.0	(4.8)	1.3	(7.3)	2.9	(4.7)	4.0	(6.7)	0.2	(0.9)	4.9	(5.6)	0.0	(0.3)	0.1	(0.5)	0.0	(0.4)
Morice R	0.0	(4.9)	0.5	(5.2)	13.4	(6.3)	12.0	(6.4)	31.3	(5.8)	48.6	(6.8)	36.8	(5.8)	34.2	(5.8)	19.3	(4.8)
Nangeese R	0.0	(4.3)	15.7	(23.2)	0.5	(2.1)	13.2	(7.1)	0.1	(0.5)	2.2	(3.6)	0.0	(0.3)	2.4	(2.3)	0.0	(0.2)
Otsi Cr	0.0	(5.2)	0.0	(4.0)	0.0	(0.5)	3.5	(6.5)	0.0	(0.4)	2.5	(3.8)	0.1	(0.6)	0.1	(0.5)	0.0	(0.3)
Shegunia R	0.0	(5.6)	1.9	(7.7)	0.0	(0.6)	0.1	(1.1)	0.1	(0.5)	0.0	(0.4)	0.1	(0.5)	0.0	(0.4)	0.0	(0.2)
Sicintine River	0.0	(5.3)	0.0	(4.7)	0.0	(0.7)	0.0	(0.7)	0.0	(0.3)	0.1	(0.7)	0.0	(0.2)	0.0	(0.4)	0.0	(0.4)
Slamgeesh R	0.0	(5.4)	1.5	(8.2)	0.1	(1.0)	1.2	(4.1)	20.8	(6.2)	0.2	(1.1)	3.4	(3.4)	0.1	(0.7)	0.0	(0.3)
Squingula R	0.0	(6.0)	0.0	(3.2)	4.2	(4.9)	0.2	(1.4)	8.2	(5.5)	2.7	(3.9)	0.0	(0.3)	0.2	(0.9)	0.0	(0.2)
Suskwa R	0.0	(6.0)	0.7	(6.6)	4.0	(4.0)	6.3	(4.9)	0.0	(0.3)	0.5	(1.4)	0.0	(0.3)	0.1	(0.5)	0.0	(0.3)
Sustut R	0.0	(4.5)	0.0	(3.0)	0.0	(0.5)	3.2	(3.2)	0.0	(0.2)	2.0	(2.0)	2.4	(1.7)	0.0	(0.2)	0.0	(0.4)
Sweetin R	0.0	(5.4)	22.6	(27.0)	0.6	(2.4)	0.9	(3.3)	0.3	(1.3)	0.2	(1.2)	0.2	(0.9)	0.1	(0.6)	0.0	(0.3)
Thomas Cr (Zymoetz R)	0.0	(4.9)	0.0	(3.3)	20.7	(7.5)	11.3	(5.9)	4.1	(2.9)	5.1	(3.1)	0.4	(1.1)	0.7	(1.2)	0.0	(0.2)
Zymagotitz R	0.0	(4.8)	5.7	(14.4)	0.0	(0.7)	0.1	(0.9)	2.5	(2.2)	0.1	(0.6)	0.1	(0.5)	0.0	(0.2)	0.0	(0.2)

SD = standard deviation
Stat. week = Statistical week
R = River
Cr = Creek

Table 2 continued.

Data are presented as percent of the sample by stock.

Stat. week	075		081		082		083		084		091	
Time period	Jul 26 - Aug 1		Aug 2 - 8		Aug 9 - 15		Aug 16 - 22		Aug 23 - 29		Aug 30 – Sep 5	
Sample size	103(0)		52(0)		39(0)		14(0)		5(0)		1(0)	
Stock	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Babine R	21.8	(5.7)	29.2	(7.7)	24.1	(9.7)	48.9	(14.3)	7.3	(16.3)	1.3	(9.2)
Bear R	11.0	(4.7)	2.8	(4.8)	35.3	(11.4)	0.6	(3.0)	11.2	(17.1)	19.2	(23.7)
Bulkley R	0.0	(0.1)	0.0	(0.4)	2.8	(2.6)	0.0	(1.7)	0.0	(3.0)	0.0	(6.0)
Cedar R	0.0	(0.2)	0.0	(0.3)	0.0	(0.4)	0.0	(1.2)	0.0	(2.5)	0.0	(7.8)
Ecstall R	0.0	(0.2)	3.9	(2.6)	0.0	(0.6)	7.1	(6.7)	0.0	(3.0)	0.0	(5.7)
Exchamsiks R	0.1	(0.5)	0.2	(1.0)	1.0	(1.9)	0.0	(1.1)	0.1	(2.7)	0.0	(7.8)
Exstew R	0.0	(0.2)	0.0	(0.3)	0.3	(1.1)	4.7	(5.6)	0.1	(2.9)	0.0	(7.3)
Fiddler Cr	0.0	(0.4)	0.0	(0.3)	0.3	(1.2)	0.0	(1.1)	0.0	(2.9)	0.0	(7.8)
Gitnadoix R	0.0	(0.3)	0.0	(0.4)	0.2	(1.0)	0.0	(1.2)	0.1	(3.5)	0.0	(7.3)
Kasiks R	0.0	(0.2)	0.0	(0.5)	0.8	(2.0)	0.0	(1.0)	0.1	(2.7)	16.6	(24.2)
Khyex R	0.0	(0.1)	0.0	(0.3)	0.0	(0.4)	0.0	(0.8)	0.0	(3.0)	0.0	(7.1)
Kispiox R	0.1	(0.5)	0.6	(1.9)	0.4	(1.9)	0.8	(3.0)	1.2	(6.1)	1.0	(9.9)
Kitseguecla R	0.1	(0.6)	0.0	(0.3)	0.0	(0.7)	0.0	(1.5)	0.0	(2.8)	0.9	(9.2)
Kitsumkalum	**37.3**	**(5.6)**	**46.7**	**(7.8)**	**23.9**	**(7.4)**	**37.0**	**(13.2)**	**0.6**	**(3.8)**	**16.6**	**(22.6)**
Kitwanga R	0.1	(0.5)	0.1	(0.9)	0.1	(1.1)	0.1	(1.1)	9.6	(17.8)	0.0	(7.1)
Kluatantan R	0.1	(0.6)	0.1	(0.7)	1.8	(3.5)	0.0	(1.5)	2.5	(11.3)	0.7	(8.2)
Kluayaz Cr	0.1	(0.8)	0.0	(0.3)	0.1	(0.9)	0.0	(1.4)	4.5	(11.7)	0.0	(6.7)
Kuldo Cr	0.1	(0.6)	0.0	(0.6)	0.1	(1.0)	0.0	(1.4)	1.4	(7.3)	0.2	(7.9)
Morice R	27.7	(5.4)	14.9	(5.7)	2.7	(4.6)	0.0	(1.5)	41.7	(21.9)	0.0	(9.0)
Nangeese R	0.0	(0.3)	0.0	(0.6)	0.0	(0.4)	0.0	(0.9)	3.4	(11.0)	0.0	(8.0)
Otsi Cr	0.1	(0.4)	0.0	(0.5)	0.0	(0.5)	0.1	(1.9)	2.9	(9.3)	1.0	(10.4)
Shegunia R	0.1	(0.5)	0.0	(0.3)	0.0	(0.4)	0.0	(0.9)	0.0	(3.1)	0.0	(7.4)
Sicintine River	0.0	(0.2)	0.1	(0.5)	0.0	(0.4)	0.0	(1.0)	0.2	(3.4)	0.3	(7.9)
Slamgeesh R	0.8	(1.8)	0.1	(0.6)	3.0	(5.6)	0.1	(1.2)	3.4	(10.5)	38.3	(30.2)
Squingula R	0.1	(0.6)	0.1	(0.6)	0.1	(0.7)	0.0	(0.9)	5.5	(12.9)	3.9	(13.3)
Suskwa R	0.1	(0.4)	0.0	(0.4)	0.0	(0.5)	0.1	(1.3)	0.0	(3.1)	0.0	(7.8)
Sustut R	0.0	(0.2)	1.0	(1.6)	0.0	(0.5)	0.0	(1.5)	0.1	(3.0)	0.0	(6.9)
Sweetin R	0.0	(0.3)	0.0	(0.4)	0.1	(0.6)	0.2	(1.8)	3.8	(11.3)	0.0	(7.2)
Thomas Cr (Zymoetz R)	0.0	(0.2)	0.1	(0.9)	2.4	(2.6)	0.2	(2.2)	0.1	(2.5)	0.0	(6.8)
Zymagotitz R	0.0	(0.2)	0.0	(0.4)	0.3	(1.4)	0.0	(1.6)	0.0	(3.0)	0.0	(7.4)

SD = standard deviation
Stat. week = Statistical week
R = River
Cr = Creek

FIGURES

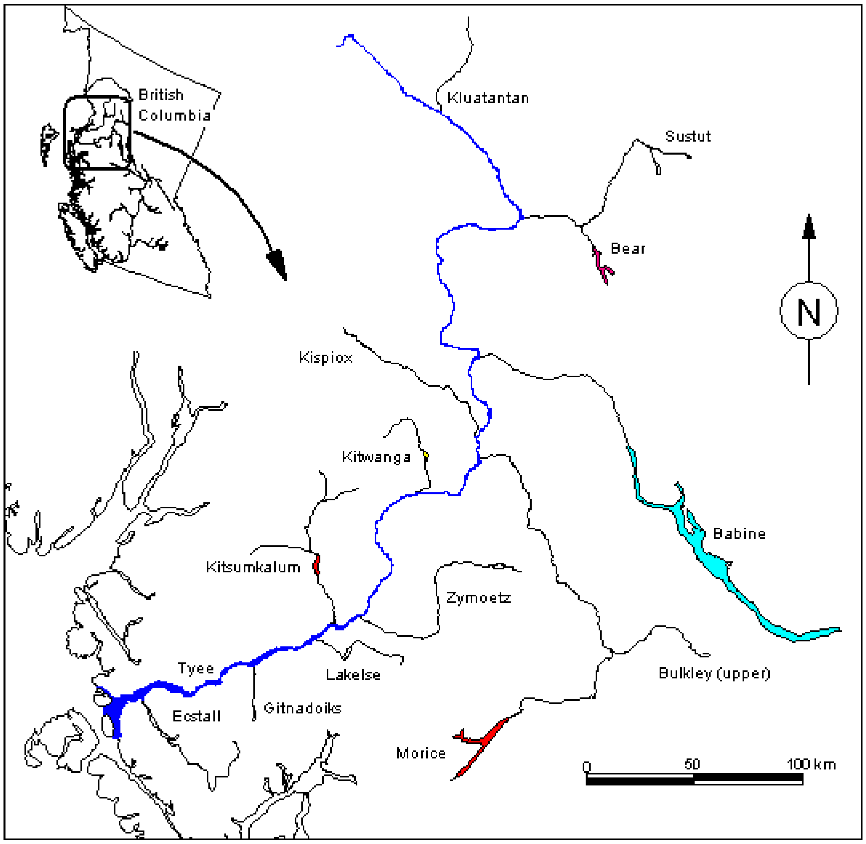

Figure 1. The Skeena River watershed in northern British Columbia showing the largest tributaries and the location of Tyee.

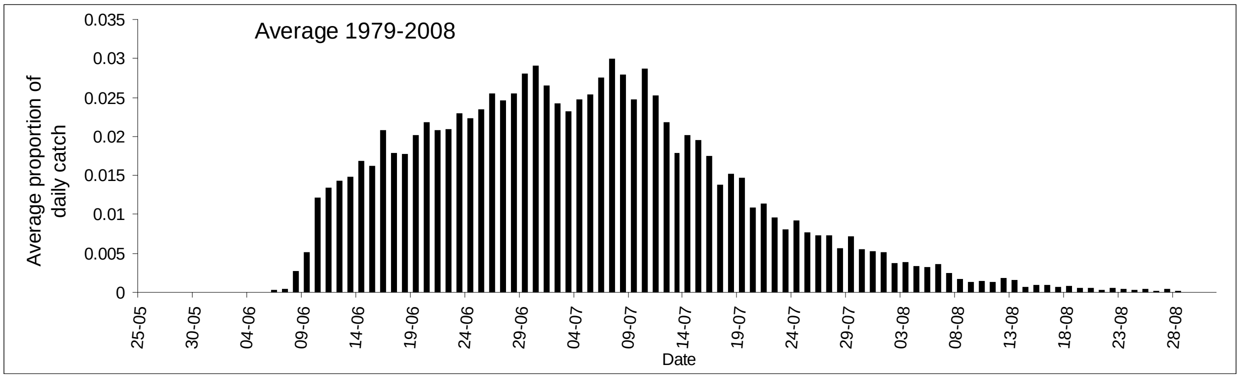

Figure 2. Skeena River Chinook salmon run timing past Tyee as measured by the average proportion of daily catch at the Tyee Test Fishery from 1979 to 2008.

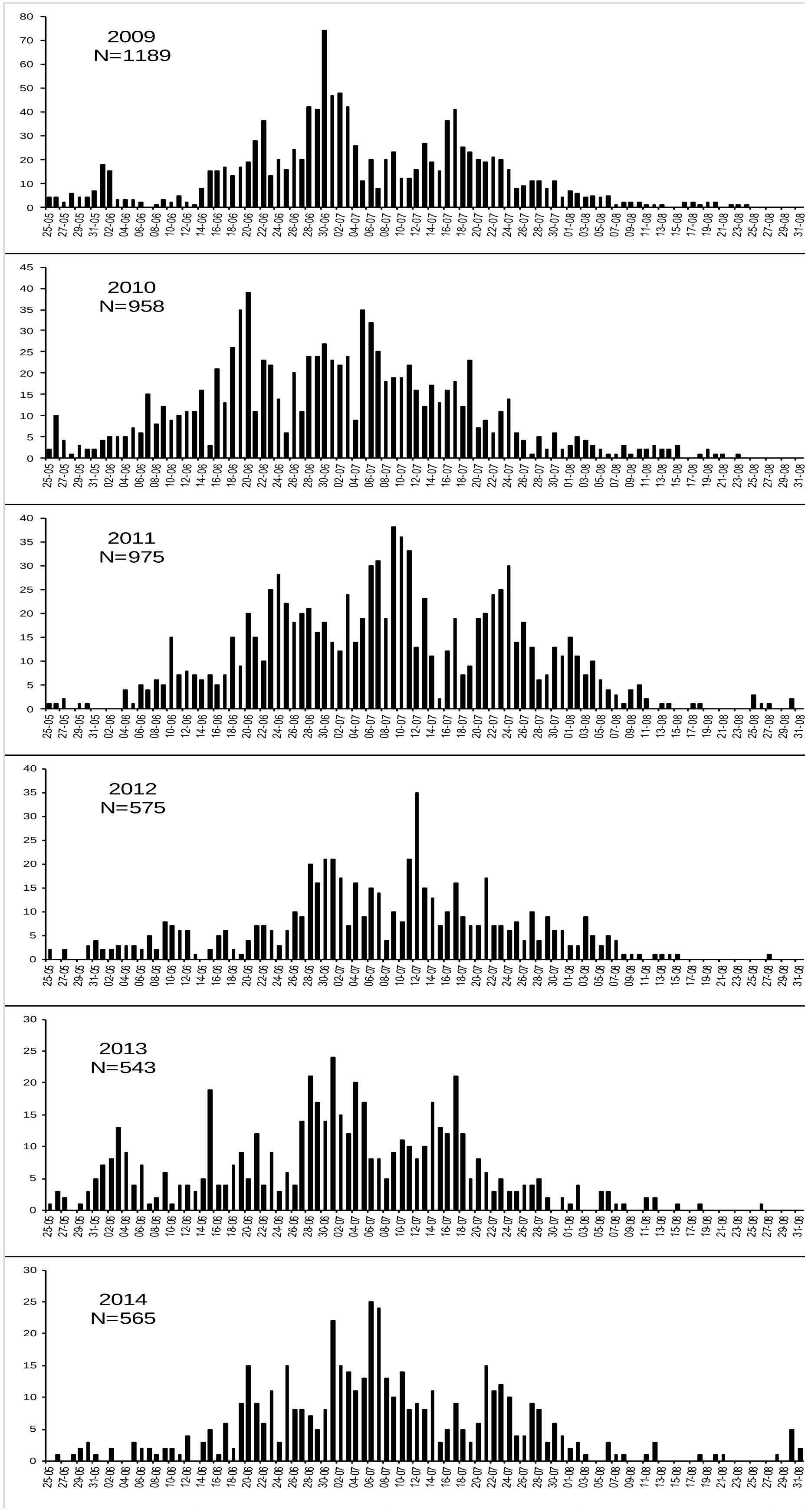

Figure 3. Skeena River Chinook salmon daily catch at the Tyee Test fishery from 2009 to 2014.

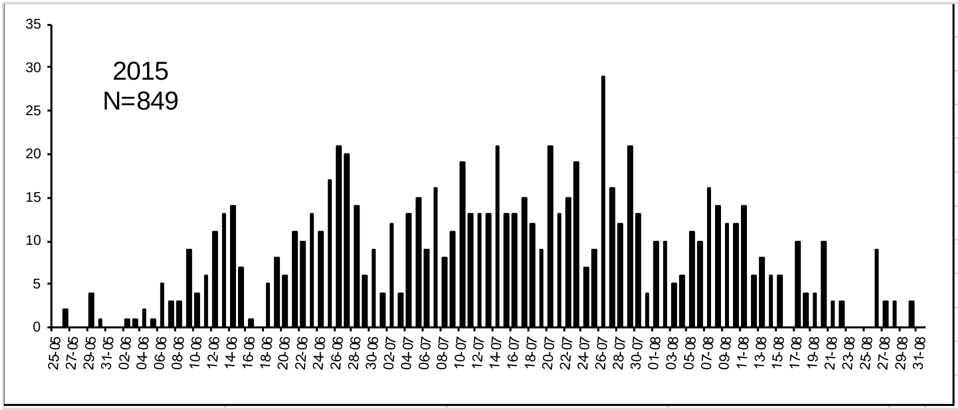

Figure 4. Skeena River Chinook salmon daily catch at the Tyee Test Fishery 2015.

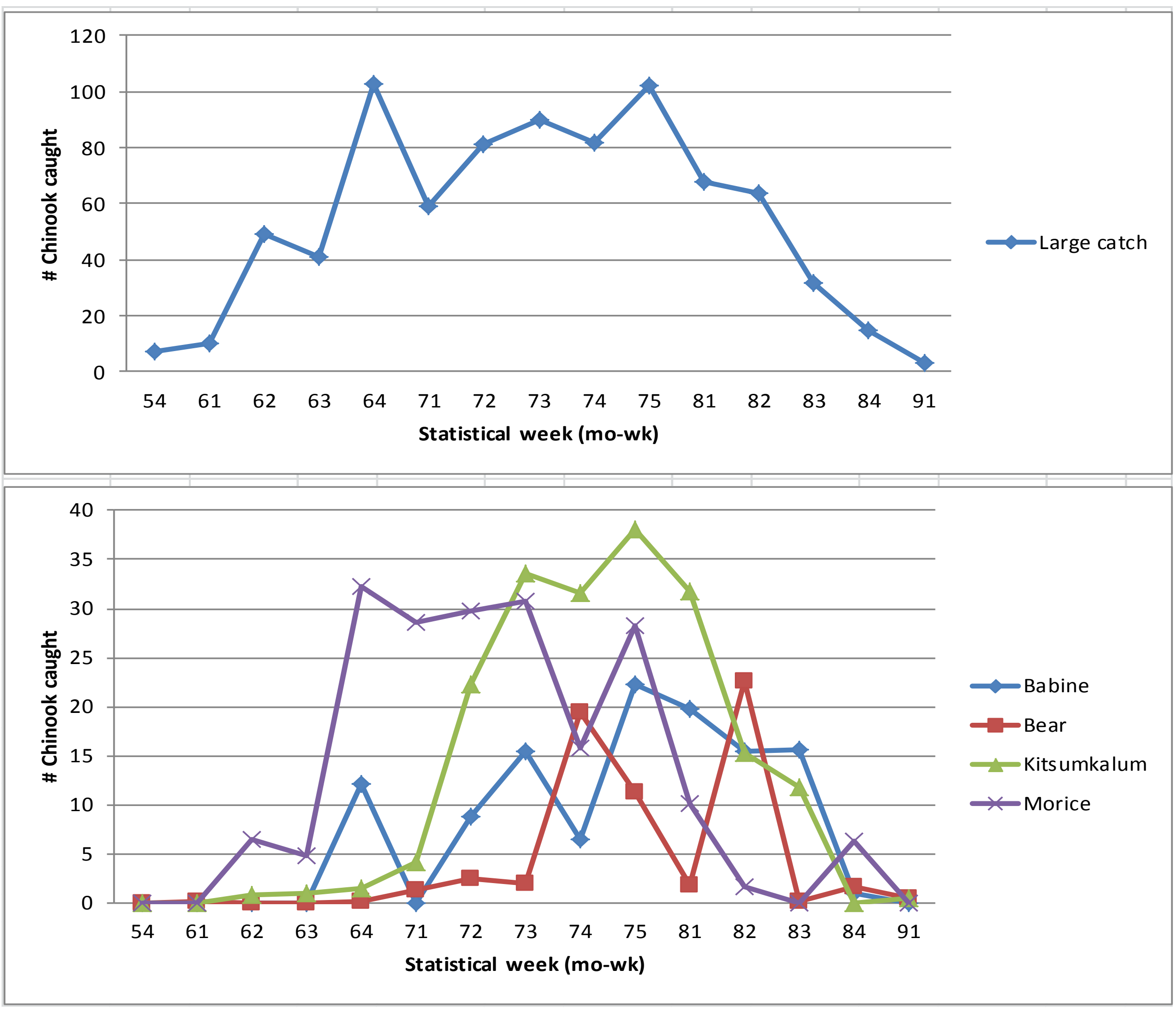

Figure 5. Total catch of Chinook salmon and catch of Chinook salmon from large component stocks at the 2015 Tyee Test Fishery by week.

APPENDICES

Appendix 1. Skeena Chinook baseline used in the 2015 genetic analyses.

Stock name	Year	Locus specific N															Maximum
		1b	i1	3g	a1	go2	go4	oke	oki	omy	ots2	ots 201b	ots 211	ots 213	ots9	sa	
Babine	2010	179	179	179	178	178	178	178	177	179	179	178	178	179	179	178	179
Babine	2011	19	19	19	19	19	19	19	18	19	18	19	18	19		18	19
Bear	1991	88	91	86	92	90	99	99	96	90	90	22	28	15	94	95	99
Bear	1995	13	17	10	11	15	19	18	20	15	19	22	20	23	21	23	23
Bear	1996	50	50	47	50	51	53	52	52	45	51	50	49	50	51	52	53
Bear	2005	5	5	5	4	5	5	5	5	5	5	5	5	4	5	5	5
Bear	2012	91	91	91	89	91	91	91	91	91	89	91	91	92	90	92	92
Bulkley_Early	1991	92	93	87	92	91	109	110	111	81	91	93	91	93	94	111	111
Bulkley_Early	1996	11	20	28	11	68	1	23	28		65				88	4	88
Bulkley_Early	1998	197	197	181	189	208	206	206	204	204	198	6	6	6	204	208	208
Bulkley_Early	1999	135	136	121	141	142	131	131	129	139	121	269	271	250	139	124	271
Cedar_Early	1996	114	111	110	109	112	114	116	116	106	114	108	115	111	115	116	116
Ecstall	1995	10	11	10	9	13	7	15	14	9	11				10	16	16
Ecstall	2000	39	41	36	34	40	35	23	36	35	39	63	58	62	42	29	63
Ecstall	2001	64	66	66	65	64	62	63	61	62	64	60	61	60	66	64	66
Ecstall	2002	60	58	59	60	58	60	59	58	59	57	74	79	68	57	56	79
Ecstall	2003	103	104	102	98	101	104	102	99	105	103				104	106	106
Exchamsiks	1995	4		6	7		8	9	9	9	4	8	7	7	9	11	11
Exchamsiks	2009	105	103	105	105	103	103	103	105	102	101	102	103	101	99	104	105
Exstew_R	2009	138	138	138	134	138	138	135	137	136	136	138	138	139	136	138	139
Fiddler_Cr	2010	109	109	109	109	109	109	108	106	109	109	111	110	113	109	109	113
Gitnadoix	1995	13		12	14		12	19	17	18	15	11	8	11	24	22	24
Gitnadoix	2002	22	22	22	22	22	22	18	22	22	22	9	13	13	22	21	22
Gitnadoix	2003	19	19	19	19	18	18	19	20	19	19				19	20	20
Gitnadoix	2009	168	170	171	171	172	166	170	173	163	170	163	168	172	170	172	173
Kasiks_R	2009	62	61	62	61	59	59	62	61	61	61	62	62	62	63	62	63
Khyex_R	2010	35	37	35	37	37	37	37	37	37	37	36	36	37	36	37	37
Kispiox	1979	1	3			3	3	2	3	3	3				3	3	3
Kispiox	1985	21	24	9	19	23	24	24	19	12	26				26	20	26
Kispiox	1989	15	21	6	18	16	19	20	20	9	21				21	17	21
Kispiox	1991	13	17	3	9	16	17	19	11	15	17				17	17	19
Kispiox	1995	18		17	18		24	21	22	22	18	15	16	14	14	25	25
Kispiox	2004	61	60	61	59	61	57	61	59	61	61	61	62	62	61	62	62
Kispiox	2006	28	28	28	28	27	28	25	26	28	28	28	26	28	28	28	28
Kispiox	2008	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Kispiox	2010	8	8	8	8	7	8	8	8	8	8	8	8	8	8	8	8
Kitseguecla_R	2009	258	255	258	253	256	258	254	246	257	260	259	255	258	259	258	260

Appendix 1. continued.

Stock name	Year	Locus specific N															Maximum
		1b	i1	3g	a1	go2	go4	oke	oki	omy	ots2	ots 201b	ots 211	ots 213	ots9	sa	
Kitsumkalum_R	1991	153	152	139	143	142	177	176	177	143	153				151	180	180
Kitsumkalum_R	1995	17	18	13	19	16	13	22	21	21	19				18	22	22
Kitsumkalum_R	1996	41	42	41	41	41	41	41	42	39	42	42	42	42	40	42	42
Kitsumkalum_R	1998	172	171	86	170	166	167	167	151	169	165	84	49	85	172	173	173
Kitsumkalum_R	2001	219	219	217	217	218	213	215	192	214	211	282	318	283	218	214	318
Kitsumkalum_R	2009	200	195	199	198	194	197	197	197	198	197	193	199	198	199	200	200
Kitwanga	1991	88	91	85	87	93	92	95	95	78	87				88	93	95
Kitwanga	1996	14	18	13	18	18	19	19	19	16	17	17	19	17	17	19	19
Kitwanga	2002	68	51	64	62	49	69	68	67	68	56	69	70	66	58	68	70
Kitwanga	2003	88	84	78	78	84	80	88	64	64	69	100	97	96	85	83	100
Kluatantan	2006	7	7	7	7	6	7	7	7	7	7	7	7	7	7	7	7
Kluatantan	2008	8	9	6	9	9	9	9	9	4	9	2	6		9	9	9
Kluatantan	2009	14	14	14	14	14	14	14	14	14	14	14	14	14	14	13	14
Kluatantan	2010	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Kluayaz_Cr	2007	85	86	85	86	86	85	85	86	86	84	86	85	86	83	86	86
Kluayaz_Cr	2008	19	18	18	21	21	20	18	22	19	20	19	21	20	20	19	22
Kluayaz_Cr	2009	50	50	50	50	49	50	50	50	49	50	49	48	50	50	49	50
Kluayaz_Cr	2010	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Kuldo_C	2008	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Kuldo_C	2009	166	162	165	166	164	167	168	168	168	167	168	158	168	166	168	168
Kuldo_C	2010	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1
Morice_R	2010	82	82	82	82	82	81	82	81	82	81	82	82	82	81	82	82
Morice_R	2011	158	156	160	155	157	160	154	156	157	154	160	160	155	152	155	160
Nangeese_R	2010	29	31	30	32	32	32	32	32	29	30	28	30	29	30	31	32
Otsi_Cr	2007	30	30	30	30	30	30	30	30	30	29	30	30	30	29	28	30
Otsi_Cr	2008	48	56	50	53	58	52	53	53	52	52	55	54	53	56	54	58
Otsi_Cr	2009	107	106	107	106	106	105	107	105	107	107	107	107	107	107	103	107
Otsi_Cr	2010	69	69	69	69	69	69	68	69	69	68	49	69	69	68	69	69
Otsi_Cr	2011	6	5	6	5	5	6	6	6	6	5	5	5	6		6	6
Shegunia_R	2009	79	79	79	78	79	77	78	79	79	79	78	77	79	78	75	79
Shegunia_R	2010	51	52	51	53	53	51	53	53	51	52	50	52	50	53	52	53
Sicintine_R	2009	110	110	111	108	110	109	109	106	107	111	109	108	108	111	111	111
Sicintine_R	2010	202	202	204	205	203	202	203	203	202	206	206	203	204	205	205	206
Slamgeesh	2004	34	32	34	34	34	32	34	31	34	34	33	33	34	34	34	34
Slamgeesh	2005	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4
Slamgeesh	2006	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Slamgeesh	2007	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Slamgeesh	2008	18	18	18	18	18	18	18	18	17	18	17	18	18	18	18	18
Slamgeesh	2009	49	49	49	49	49	49	49	47	49	49	48	49	48	49	49	49
Squingula_R	2008	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Squingula_R	2009	266	264	267	262	263	263	268	263	265	259	261	256	263	261	260	268

Appendix 1. continued.

Stock name	Year	Locus specific N															Maximum
		1b	i1	3g	a1	go2	go4	oke	oki	omy	ots2	ots 201b	ots 211	ots 213	ots9	sa	
Suskwa	2004	20	20	19	20	19	16	21	21	20	20	13	19	14	20	20	21
Suskwa	2005	3	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3
Suskwa	2009	81	79	79	83	76	77	77	76	74	78	74	77	76	75	77	83
Suskwa	2010	1	2	1	2	2	2	2	2	1	2	1	2	2	2	2	2
Sustut	1995	28		28	28		28	34	36	25	28	26	28	26	30	37	37
Sustut	1996	36	36	20	32	35	35	37	23	36	35	18	18	18	33	34	37
Sustut	1999	78	85	73	85	83	84	83	83	88	83	87	63	87	90	87	90
Sustut	2001	177	175	181	183	181	190	182	174	187	168	152	148	149	177	197	197
Sustut	2002	42	44	43	43	43	46	36	43	42	39	46	45	47	38	40	47
Sustut	2003					3					4				5		5
Sustut	2005	47	47	47	46	47	46	44	46	47	46	47	40	44	46	46	47
Sustut	2006	48	48	48	48	48	47	44	46	48	48	48	42	45	48	48	48
Sweetin	2004	43	42	42	41	41	40	41	38	43	43	42	44	42	44	43	44
Sweetin	2005	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Sweetin	2008	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Sweetin	2010	180	181	180	181	181	181	181	180	179	180	180	180	180	179	180	181
Thomas_Cr	2003	2	2	2	2	2	2	2	2	2	2				2	2	2
Thomas_Cr	2004	19	19	21	20	21	19	21	20	16	20	21	21	21	19	21	21
Thomas_Cr	2009	32	32	31	31	32	30	32	31	32	32	31	31	31	32	31	32
Thomas_Cr	2010	62	62	61	62	62	60	62	61	62	62	60	61	61	61	61	62
Zymogotitz_R	2006	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Zymogotitz_R	2009	116	119	116	116	119	118	117	116	118	117	115	116	115	116	119	119

Appendix 2. Comparison of 2015 project results with the objectives identified in the proposal to the Pacific Salmon Commission's Northern Fund Program.

1. Estimate the 2015 Chinook salmon escapement to the Skeena River with an estimated coefficient of variation (CV) of 15% or less.

   The 2015 escapement of Chinook salmon to the Skeena River was estimated and the program met the data standard of a CV of less than 15%. The CV for the 2015 estimate was 11.3%. Success of the program was related to the relatively high component of Kitsumkalum Chinook salmon in the Skeena River. Although the small sample size (663 fish) at Tyee resulted in higher than normal standard deviations around catch components the high proportion of the Kitsumkalum stock made up for the small sample size. Results from the Kitsumkalum mark-recapture program were excellent with a CV of only 8.5%. Good weather conditions through the tag application and dead pitch recovery programs allowed the contractor to handle enough fish to reduce the CV to near the ~10% value necessary to allow the Skeena estimate to be within the 15% data standard.

2. Sample all Chinook salmon captured at the Tyee Test Fishery for the biological attributes of length, sex and age and determine the age and sex composition for large components of the Chinook return to the Skeena River.

   All of the Chinook salmon captured at the Tyee Test Fishery were sampled and probabilities of belonging to the component stocks were developed for 663 of the 672 fish submitted for genetic analyses.

3. Meet the objectives above in subsequent years - 2016.

   This project has been proposed to the PSC Northern Fund for 2016.