# Genetic Stock Identification of Chinook Salmon caught in Northern British Columbia Troll Fisheries 2017

Ivan Winther

Fisheries & Oceans Canada
Science Branch, Pacific Region
417-2nd Avenue West
Prince Rupert, British Columbia
V8J-1G8

October, 2017

*A project funded by the Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund 2017. File # NF-2017-VHP-14.*

## CONTENTS



## LIST OF TABLES



## LIST OF FIGURES



## LIST OF APPENDICES

## ABSTRACT

Winther, I. 2017. Genetic Stock Identification of Chinook salmon caught in Northern British Columbia Troll Fisheries 2017. Unpublished report for the Pacific Salmon Commission Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund 2017. File # NF-2017-VHP-14: iv + 23 p.

Fisheries & Oceans Canada has managed the Northern British Columbia (NBC) troll fishery since 1995 to reduce impacts on Chinook salmon (*Oncorhynchus tshawytscha*) stocks from the West Coast of Vancouver Island (WCVI). Microsatellite DNA based stock identification techniques have been used to address stock specific management in this mixed stock fishery since 2002. Chinook salmon stock compositions were estimated for the 2017 NBC troll fishery and the fishery was managed in-season to a harvest rate target for WCVI Chinook salmon. The application of stock specific management allowed the internationally negotiated catch allocation to be attempted while reducing the exploitation of WCVI Chinook. Stock compositions were applied to catch to provide region specific estimates of the impact of the 2017 NBC troll fisheries on all of the Chinook stock groups encountered.

## INTRODUCTION

Funding for 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*) stock compositions in Northern British Columbia (NBC) troll fisheries in 2017. This report presents estimates of the Chinook salmon stock identification based on genetic analyses of samples collected from the fishery. The results are part of a continuing project to examine the genetics of Chinook salmon caught in NBC Troll fisheries. This document fulfills the reporting requirements for the 2017 Northern Fund project. Costs to the Northern Fund consisted of the genetic analyses and a portion of the sampling costs. Other components of the project were funded by Fisheries & Oceans Canada in existing programs.

The primary objective of this study was to estimate stock specific catches by the NBC Troll fishery in 2017. The commercial troll fishery is the largest fishery for Chinook salmon in NBC and is one of two fisheries defined within the Aggregate Abundance Based Management (AABM) regime implemented by the Pacific Salmon Treaty (PST)(2000) for the North Coast. Under the revised international agreement the NBC troll and Haida Gwaii (QCI) sport fisheries are managed in aggregate within the same regime. Current domestic allocation policies within Canada require the NBC troll fishery to be influenced first by any management actions required to protect weak stocks (Winther and Beacham 2006).

The North Coast troll fishery has been defined as Area F consisting of Pacific Fishery Management Areas 1 to 10, 101 to 110, and 130 and 142 (Figure 1.). The AABM portion of the NBC troll fishery makes up the north-western portion of Area F; Areas 1 to 5, 101 to 105, 130 and 142. Historically the size of the troll fleet in Area F was relatively stable from 2002 to 2005, varying between 146 and 168 licensed vessels. Through a series of area selection processes the Area F fleet increased to 284 licensed vessels from 2008 to 2010 and then declined to 238 in 2015. The change in fleet size was initially due to reduced fishing opportunities in southern areas and the introduction of individual transferable quotas (ITQ) in the NBC troll fishery for Chinook salmon in 2005. The number of vessels fishing is considerably less than the licenses available in Area F, for example 143 vessels fished in 2017.

The application of DNA-level markers for stock identification in the NBC troll fishery has continued since 2002. After moderate success in the initial year the experiments essentially met their objective of allowing the Chinook salmon quota negotiated under the PST agreement to be harvested while continuing to reduce impacts on stocks of conservation concern from the West Coast of Vancouver Island (WCVI) (Winther and Beacham 2006 & 2009). Subsequent fisheries were less successful averaging only 72% of the pre-fishery allowance to the troll fishery. These lower catches were the result of forecasting errors and policy changes. A series of under forecasts of WCVI Chinook lead to early closures of the NBC Troll fishery after 2006. The movement of troll licenses to the Pacific Integrated Commercial Fisheries Initiative (PICFI), the Allocation Transfer Program (ATP) and other processes essentially removed licenses from fishing in Area F while leaving their allocation within the ITQ. Consequently a portion of the quota was not available to be fished and Area F could not reach the allowable catch determined under the Treaty.

The 2017 pre-season Aggregate Abundance Based Management (AABM) index was 1.15 with an associated allowable catch of 149,500 Chinook salmon for NBC Troll and QCI sport fisheries. The pre-season estimate of the sport catch was 41,000 fish leaving 108,500 fish as the pre-season troll catch target. The in-season target for the NBC troll fishery was a maximum harvest rate of 3.2% on Chinook salmon of WCVI origin returning to Canadian waters.

A demonstration fishery to examine the application of individual transferable quotas (ITQ) in the troll fishery was first held in 2005 and was continued in 2017. The pre-season troll allocation was divided among 239 licenses for an individual quota of 454 Chinook salmon per licence at the beginning of the season.

Stock identification is a key component in the management of mixed stock salmon fisheries. The application of DNA-level markers for stock identification, particularly microsatellites, has provided much greater resolution among Chinook salmon populations than was possible with previous genetic markers (Beacham et al. 1996; Banks et al. 2000; Beacham et al. 2003). If the baseline used to estimate stock composition is adequate, microsatellites can be applied successfully on a local basis to provide information on stock composition even when there is a complex mixture of populations in the catch (Beacham et al. 2006).

We used microsatellite variation in Chinook salmon as a tool for management of stocks of conservation concern encountered by the NBC troll fishery. Our challenge was to provide advice to managers that would allow the Northern British Columbia (Area F) troll fishery to maximize catch of Chinook salmon while minimizing the exploitation of WCVI Chinook salmon. The biological sampling objectives were to generate stock compositions for the troll catch of Chinook salmon in NBC.

## METHODS

Stock specific catch estimates were generated from the results of genetic samples applied to catch data. Genetic samples were grouped temporally and weighted to the catch for the periods sampled. In cases where the temporal strata for samples overlapped, the daily catch during the overlapping days were weighted to each sample based on the relative number of fish in each sample.

Two programs provided catch accounting of Chinook salmon from the NBC Troll fishery; daily catch records (hails) and landing validation. Vessel operators must provide a record of their daily catch either electronically or by phone to the Fisheries Operating System as a condition of licence. Electronic or phone-in records were required within 24 hours of landing or within 24 hours of the closure of the fishery and consisted of date fished, area fished, number of fish caught and retained by species and number of fish caught and released by species. In addition, all vessel landings of Chinook salmon must be counted and reported (validated) by the third party contractor. The combination of daily records reported by the fishers and validation by the third party provide records that are essentially a census of the Chinook salmon catch. Catch records were treated as a census without variance.

The sample design was approached from the perspective of a binomial problem where Chinook salmon were identified as either from WCVI or not. If the WCVI component was near 5% and the catch approached the ceiling of 108,500 then the level of precision afforded by ~2,600 samples would provide 95% confidence limits plus or minus ~20% of the estimated proportion of WCVI Chinook. Smaller proportions would have respectively broader confidence limits and smaller sample sizes would have respectively broader confidence limits as well.

The program to sample commercial fishery landings was designed with the objective of collecting tissues from approximately 2.7% (~3000 fish) of the Chinook salmon caught in the fishery. Samples were collected by a contractor involved in the existing MRP sampling program. The collection target was designed larger than the target for analysis (2,600 fish) because sample collection was relatively cheap when compared with genetic analyses. The extra samples also allowed for sub-sampling such that the samples submitted for analyses would best represent the commercial fishery landings across the time and area strata in the fishery.

Ultimately 2,471 fish were sampled, 2,089 fish were submitted for analyses and results were received from 2,071 samples.

The NBC Troll fishery was sampled by a third party contractor. The contract description included random selection of troll vessel landings with stratified sampling of fish within the selected landing. The sampling procedure was to select vessel landings at random and sample less than 50 fish from each delivery. Every 5$^{th}$ or 10$^{th}$ fish was sampled from the load depending on the size of the delivery to spread the samples through the load and to reduce autocorrelation. Individual Chinook salmon sampled from commercial fishery landings were sampled for nose-fork length and scales. Fish landed by the commercial fishery were dressed so gender could not be determined. These collections were matched to data on the area fished and date caught. An identification number was included for fish sampled that had coded wire tags (Appendix 1).

Scale samples were collected on to scale books, five scales per fish, as described by MacLellan (1999). Data on the geographic location, date, and sampler accompanied each sample. Samples were forwarded to the Fisheries & Oceans Canada, Molecular Genetics Laboratory at the Pacific Biological Station in Nanaimo.

Chinook salmon collections were compared against genetic baselines from 302 Chinook salmon populations from Southeast Alaska through Canada and the lower United States of America (Appendix 2). 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 provided the sample analysis. A new version of the computer program as outlined by Pella and Masuda (2001) was developed and used for the analyses presented here. The program CBAYES (Neaves et al 2005) can be downloaded from the Molecular Genetics Laboratory website (Fisheries & Oceans Canada, Molecular Genetics Laboratory, Pacific Biological Station, Nanaimo). The model output presented includes the Bayesian probability estimates for the 5 most probable populations for each sample.

## RESULTS

The NBC troll fishery landed 97,730 Chinook salmon in 2017. Chinook salmon fishing was permitted from June 21 to August 4 and from August 25 to September 30. Chinook salmon catches included 88,991 fish in the June to August fishery and 8,739 fish in the August and September fishery. Daily catch was highest on opening day, June 21, when 103 active vessels caught 6,880 Chinook salmon. Catches declined quickly and were below 2,500 fish per day after the first 3 days of the fishery (Figure 2.).

Genetic samples were collected from 172 of the 473 vessel landings that unloaded Chinook salmon from the 2017 Troll fishery. The collection was sub-sampled and 2,089 fish samples from 140 vessel landings were submitted for analyses. The samples were submitted and reported in 6 groups. The first 5 groups were from the June to August fishery and represented catches from periods ranging from 8 to 14 days. Since fishing was continuous from June 21 to August 4, the groups of samples overlapped for periods up to 8 days. The samples from the September fishery were submitted as a single group representing 37 days of fishing. In September catch declined to near zero at the end of the month.

The most prevalent Chinook salmon stock group in the NBC troll catch was the South Thompson (SOTH) stock group making up 31.6% of the catch or 30,868 fish. Other significant components were Upper Columbia Summer & Fall (Up Col-Su/F), North & Central Oregon, and Coastal Washington stock groups (Table 1). This pattern persisted through the samples collected from the June to August fishery but changed in September as the SOTH fish declined significantly and the Columbia and Oregon components increased (Table 2 and Table 3.).

Chinook salmon from WCVI were most prevalent in the August 25 to September 30 samples at 11.8%. They were least prevalent in the June 26th to July 8th sample making up 2.5% of the sample. A total of 4,578 Chinook salmon from WCVI were estimated to be caught by the fishery.

## DISCUSSION

The NBC troll fishery landed 97,730 Chinook salmon in 2017. While there were potentially 108,500 fish available to the troll fishery (149,500 total AABM allowable catch less 41,000 QCI sport catch), catches were limited by the ITQ program. The quota associated with approximately 21 licenses held by PICFI and ATP programs was not fished (~9,500 Chinook). The fishery was managed for concerns for WCVI Chinook salmon but the only management action in this regard was to close the fishery from August 5 to 24.

Catch per unit effort (CPUE) is difficult to interpret for the Chinook troll fishery because of the influence of ITQ's on fishing behavior. CPUE's was high on opening day but declined quickly. CPUE on opening day, June 21, was 67 Chinook salmon per boat day. CPUE dropped to 45 on the second day and then declined to approximately 24 fish per boat day by the end of the week. CPUE increased at the end of June and remained between 30 and 40 fish per boat day for the first week of July.

Recreational fisheries have priority access to Chinook salmon so the shares within the AABM allowable catch are determined pre-season by forecasting the recreational catch. The forecast for the AABM recreational catch of 41,000 underestimated the amount of fish caught. The preliminary sport catch estimate for 2017 was 45,600 Chinook salmon. The recreational catch brings the preliminary estimate for the total AABM catch to 143,330.

Canada's domestic management target for the NBC Troll fishery is to have an exploitation rate (ER) of less than 3.2% on WCVI Chinook salmon. Since Alaskan harvests are unknown in-season this ER is approximated by a harvest rate of 3.2% on the return of WCVI Chinook salmon to Canadian waters. The estimate of WCVI Chinook salmon caught by the troll fishery using genetic samples was 4,578 fish. The actual harvest rate on WCVI Chinook will not be known until the post-season fishery and escapement data have been analyzed.

Summer troll fisheries have been excluded from areas around Langara Island and the north end of Graham Island since 1997 to avoid conflicts with the sport fishery. The ribbon boundary that keeps the troll fishery away from the shore has assisted in the objective of avoiding WCVI Chinook stocks since those fish tend to migrate closer to the shore (Winther and Beacham, 2006 & 2009).

The combination of Chinook salmon abundance and high proportions of WCVI fish makes troll fishery impacts on WCVI stocks most severe in August (Winther and Beacham, 2006 & 2009). The second portion of the 2017 troll fishery was opened August 25 as in 2015 and 2016. A sample collected from catches between August 25 and September 30 also had the highest component of WCVI Chinook salmon of the season at 11.8% (Table 2.). The majority of the fish caught in the second opening were caught during the beginning of the opening. Catches during the first 14 days of the fishery accounted for 8,133 of the 8,739 fish caught over the entire August 25 to September 30 fishery.

The timing differential between WCVI Chinook salmon and abundant stocks in the Fraser River and Upper Columbia provided opportunities to minimize impacts on WCVI stocks by fishing in June and July. The increase in Columbia Summer/Fall stocks doesn't appear to have changed these conditions of higher WCVI proportions in August. The sample collected from catches in late August and September had the highest amount of WCVI Chinook in the

stock mixtures (11.8%). Typically samples from late September have few fish from WCVI but the fishing opportunities in September are hampered by bad weather and the decline of Chinook abundance through the month.

Differences in timing and distribution between stock groups have allowed the fishery to be positioned such the stocks of conservation concern were avoided and more abundant stocks were harvested. Changes in abundance or distribution of either the stock of conservation concern or any of the major components encountered by the fishery could have significant consequences. The ability to have a successful mixed stock fishery while avoiding a stock of conservation concern hinges on identifying such differences.

The application of DNA level markers for stock identification to the management of a particular stock within a mixed stock fishery depends heavily on the ability to identify the stock and detect it with a reasonable level of precision. The management targets and proportions of WCVI Chinook salmon experienced in 2017 are near the edge of the effective range of the technique given the sample sizes that the program could afford (i.e. proportions near 5%). In addition, the relative proportions of component stocks present in the fishery must show some variability across time or space. If the proportion of a stock of conservation concern was static or random across the fishery, fishing periods or areas could not be defined that were any better for avoiding the stock. This could happen if the stock of conservation concern had the same or similar timing and distribution as abundant stocks within the fishery.

## ACKNOWLEDGEMENTS

Funding for this project was provided by the Pacific Salmon Commission's Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund and by Fisheries & Oceans Canada. We thank the staff of the Molecular Genetics Laboratory at the Pacific Biological Station in Nanaimo for analysis of the samples and estimation of stock compositions and J.O. Thomas and Associates for collection of the samples from troll fishery landings.

## REFERENCES

Banks, M.A., Blouin, M.S., Baldwin, B.A., Rashbrook, V.K, Fitzgerald, H.A., Blankenship, S.M., and Hedgecock, D. 1999. Isolation and inheritance of novel microsatellites in Chinook salmon (*Oncorhynchus tshawytscha*). Journal of Heredity 90: 281-288.

Beacham, T.D., Withler, R.E., and Stevens, T.A. 1996. Stock identification of Chinook salmon (*Oncorhynchus tshawytscha*) using minisatellite DNA variation. Canadian Journal of Fisheries and Aquatic Sciences 53: 380-394.

Beacham, T.D., Supernault, K.J., Wetklo, M., Deagle, B., Labaree, K., Irvine, J., Candy, J.R., Miller, K.M., Nelson, R.J., and Withler, R.E. 2003b. The geographic basis of population structure of Fraser River chinook salmon, *Oncorhynchus tshawytscha*. Fishery Bulletin 101: 229-242.

Beacham, T.D., Candy, J.R., Jonsen, K.L., Supernault, J., Wetklo, M., Deng, L., Miller, K.M., Withler, R.E., and Varnavskaya, N.V. 2006. Estimation of stock composition and individual identification of Chinook salmon across the Pacific Rim using microsatellite variation. Transactions of the American Fisheries Society 135: In press.

Candy, J.R., Irvine, J.R., Parken, C.K., Lemke, S.L., Bailey, R.E., Wetklo, M., and Jonsen, K. 2002. A discussion paper on possible new stock grouping (Conservation Units) for Fraser River Chinook salmon. Can. Science Advisory Secretariat Res. Doc. 2002/085. Available from CSAS, 200 Kent St. Ontario, K1A 0E6, Canada or http://www.dfp-mpo.gc.ca/csas/.

MacLellan, S.E. 1999. Guide for sampling structures used in age determination of Pacific salmon. Fisheries & Oceans Canada, Stock Assessment Branch, Pacific Biological Station, Nanaimo, British Columbia.

Pacific Salmon Commission. 2000. Pacific Salmon Treaty, 1999 Revised Annexes, Memorandum of Understanding (1985), Exchanges of Notes.

Pella, J., and Masuda, M. 2001. Bayesian methods for analysis of stock mixtures from genetic characters. Fish. Bull. 99: 151-167.

Winther, I., and Beacham, T.D. 2006. The application of Chinook salmon stock composition data to management of the Queen Charlotte Islands troll fishery, 2002 to 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2665: vii + 88 p.

Winther, I., and T. D. Beacham. 2009. Application of Chinook salmon stock composition data for management of the Northern British Columbia troll fishery, 2006. Pages 977 - 1004 in C. C. Krueger, and C. E. Zimmerman, editors. Pacific Salmon: ecology and management of western Alaska's populations. American Fisheries Society, Symposium 70, Bethesda, Maryland.

## TABLES

Table 1. Chinook salmon catch by stock group for 2017 NBC troll fisheries.
Standard deviations (STD) appear in brackets.

| Code | Region | Proportion (%) | STD (%) | Catch | STD |
|---|---|---|---|---|---|
| 1 | Upper Fraser (UPFR) | 0.2 | (0.1) | 149 | (118) |
| 2 | Middle-Upper Fraser (MUFR) | 0.8 | (0.3) | 756 | (257) |
| 3 | Lower Fraser Fall (LWFR-F) | 0.1 | (0.1) | 138 | (79) |
| 4 | North Thompson (NOTH) | 0.4 | (0.2) | 430 | (171) |
| 5 | South Thompson (SOTH) | 31.6 | (1.1) | 30,868 | (1059) |
| 6 | Lower Thompson (LWTH) | 0.0 | (0.0) | 0 | (22) |
| 7 | East Coast Vancouver Island (ECVI) | 1.4 | (0.4) | 1,371 | (358) |
| 8 | West Coast Vancouver Island (WCVI) | 4.7 | (0.5) | 4,569 | (466) |
| 9 | Southern BC Mainland (SOMN) | 0.6 | (0.2) | 589 | (192) |
| 10 | Northern BC Mainland (NOMN) | 1.6 | (0.4) | 1,555 | (343) |
| 11 | Nass | 0.1 | (0.1) | 49 | (58) |
| 12 | Lower Fraser Spring (LWFR-Sp) | 0.2 | (0.1) | 209 | (111) |
| 13 | Lower Fraser Summer (LWFR-Su) | 0.0 | (0.0) | 40 | (41) |
| 14 | Haida Gwaii (QCI) | 0.0 | (0.1) | 48 | (50) |
| 15 | Alaska | 0.0 | (0.1) | 39 | (78) |
| 17 | Taku | 0.1 | (0.1) | 49 | (85) |
| 18 | Stikine | 0.1 | (0.1) | 68 | (99) |
| 19-23 | Skeena | 1.2 | (0.3) | 1,156 | (306) |
| 24 | Alsek | 0.0 | (0.0) | 31 | (39) |
| 50 | Puget Sound | 1.4 | (0.3) | 1,383 | (295) |
| 51 | Juan de Fuca | 0.3 | (0.1) | 256 | (140) |
| 52 | Coastal Washington | 8.2 | (0.7) | 7,984 | (675) |
| 53 | Lower Columbia | 2.2 | (0.4) | 2,167 | (390) |
| 54 | Upper Columbia Spring | 0.0 | (0.0) | 0 | (16) |
| 55 | Upper Columbia Summer/Fall | 20.6 | (1.1) | 20,173 | (1045) |
| 56 | Snake Spring/Summer | 0.0 | (0.0) | 18 | (40) |
| 57 | Snake Fall | 4.3 | (0.7) | 4,198 | (680) |
| 58 | North & Central Oregon | 14.6 | (0.9) | 14,261 | (907) |
| 59 | South Oregon Coastal | 3.3 | (0.6) | 3,205 | (576) |
| 61 | Klamath/Trinity | 0.0 | (0.0) | 5 | (28) |
| 62 | Middle Columbia Spring | 0.1 | (0.1) | 58 | (98) |
| 63 | Upper Willamette | 1.8 | (0.4) | 1,789 | (396) |
| 64 | Central Valley Fall | 0.1 | (0.1) | 60 | (65) |
| 65 | Central Valley Spring | 0.1 | (0.1) | 57 | (79) |
| 66 | Coastal California | 0.0 | (0.0) | 0 | (8) |
| | TOTAL | 100% | | 97,730 | |

Table 2. Chinook stock proportions observed in samples from 2017 NBC Troll catches.

Composition presented as % of the sample N. Standard deviations appear in brackets.

| | Year | 2017 | | 2017 | | 2017 | | 2017 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | June 21-July 3 | | June 16-July 8 | | July 7-July 14 | | July 12-July 20 | | July 22-Aug 4 | |
| | Catch | 29,398 | | 25,913 | | 11,230 | | 12,052 | | 10,398 | |
| Code | N | 371 | | 544 | | 302 | | 298 | | 247 | |
| | | % | STD | % | STD | % | STD | % | STD | % | STD |
| 1 | Upper Fraser (UPFR) | 0.1 | (0.2) | 0.2 | (0.3) | 0.2 | (0.3) | 0.3 | (0.3) | 0.2 | (0.4) |
| 2 | Middle-Upper Fraser (MUFR) | 1.3 | (0.7) | 1.0 | (0.6) | 0.2 | (0.3) | 0.4 | (0.4) | 0.4 | (0.5) |
| 3 | Lower Fraser Fall (LWFR-F) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.6 | (0.6) |
| 4 | North Thompson (NOTH) | 0.1 | (0.3) | 0.6 | (0.4) | 1.2 | (0.7) | 0.3 | (0.4) | 0.6 | (0.6) |
| 5 | South Thompson (SOTH) | 28.5 | (2.4) | 40.2 | (2.2) | 36.5 | (2.8) | 33.5 | (2.8) | 30.8 | (3.0) |
| 6 | Lower Thompson (LWTH) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.1) |
| 7 | East Coast Vancouver Island (ECVI) | 2.1 | (1.0) | 1.0 | (0.4) | 1.0 | (0.6) | 2.1 | (0.9) | 0.9 | (0.6) |
| 8 | West Coast Vancouver Island (WCVI) | 4.1 | (1.0) | 2.5 | (0.7) | 2.6 | (0.9) | 4.7 | (1.2) | 7.8 | (1.7) |
| 9 | Southern BC Mainland (SOMN) | 0.5 | (0.4) | 0.6 | (0.4) | 2.1 | (0.9) | 0.5 | (0.5) | 0.0 | (0.2) |
| 10 | Northern BC Mainland (NOMN) | 2.0 | (0.8) | 2.4 | (0.8) | 0.7 | (0.6) | 1.4 | (0.7) | 1.0 | (0.7) |
| 11 | Nass | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.2) | 0.4 | (0.4) | 0.0 | (0.1) |
| 12 | Lower Fraser Spring (LWFR-Sp) | 0.3 | (0.3) | 0.2 | (0.2) | 0.3 | (0.3) | 0.0 | (0.1) | 0.4 | (0.4) |
| 13 | Lower Fraser Summer (LWFR-Su) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.3 | (0.3) | 0.0 | (0.0) |
| 14 | Haida Gwaii (QCI) | 0.0 | (0.0) | 0.2 | (0.2) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) |
| 15 | Alaska | 0.0 | (0.1) | 0.1 | (0.3) | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.1) |
| 17 | Taku | 0.0 | (0.2) | 0.0 | (0.2) | 0.0 | (0.1) | 0.1 | (0.2) | 0.1 | (0.4) |
| 18 | Stikine | 0.0 | (0.1) | 0.1 | (0.3) | 0.1 | (0.2) | 0.2 | (0.4) | 0.0 | (0.1) |
| 19-23 | Skeena | 1.1 | (0.7) | 2.0 | (0.7) | 0.7 | (0.8) | 2.0 | (0.9) | 0.0 | (0.2) |
| 24 | Alsek | 0.0 | (0.1) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.1) | 0.0 | (0.1) |
| 50 | Puget Sound | 0.3 | (0.4) | 1.6 | (0.6) | 1.1 | (0.7) | 2.3 | (1.0) | 2.6 | (1.3) |
| 51 | Juan de Fuca | 0.8 | (0.5) | 0.0 | (0.0) | 0.0 | (0.0) | 0.1 | (0.3) | 0.0 | (0.0) |
| 52 | Coastal Washington | 7.0 | (1.5) | 7.4 | (1.2) | 8.6 | (1.8) | 8.8 | (1.8) | 11.5 | (2.2) |
| 53 | Lower Columbia | 2.7 | (0.9) | 2.3 | (0.8) | 0.2 | (0.5) | 2.6 | (1.0) | 1.7 | (0.9) |
| 54 | Upper Columbia Spring | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) |
| 55 | Upper Columbia Summer/Fall | 21.5 | (2.4) | 15.3 | (1.8) | 22.6 | (2.7) | 18.2 | (2.6) | 20.3 | (3.0) |
| 56 | Snake Spring/Summer | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.1) |
| 57 | Snake Fall | 5.8 | (1.7) | 4.1 | (1.2) | 0.8 | (1.3) | 2.4 | (1.5) | 5.5 | (2.0) |
| 58 | North & Central Oregon | 15.6 | (2.1) | 12.6 | (1.6) | 17.7 | (2.5) | 12.0 | (2.4) | 9.7 | (2.1) |
| 59 | South Oregon Coastal | 2.6 | (1.3) | 2.5 | (0.9) | 3.1 | (1.3) | 7.3 | (2.1) | 5.7 | (1.8) |
| 61 | Klamath/Trinity | 0.0 | (0.0) | 0.0 | (0.1) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.1) |
| 62 | Middle Columbia Spring | 0.1 | (0.3) | 0.0 | (0.0) | 0.3 | (0.4) | 0.0 | (0.1) | 0.0 | (0.1) |
| 63 | Upper Willamette | 3.4 | (1.1) | 2.9 | (0.8) | 0.0 | (0.1) | 0.1 | (0.3) | 0.0 | (0.1) |
| 64 | Central Valley Fall | 0.0 | (0.1) | 0.2 | (0.2) | 0.0 | (0.1) | 0.0 | (0.1) | 0.0 | (0.1) |
| 65 | Central Valley Spring | 0.2 | (0.3) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) |
| 66 | Coastal California | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) |

8

Table 2 continued. Chinook stock proportions observed in samples from 2017 NBC Troll catches.

Composition presented as % of the sample N. Standard deviations appear in brackets.

| | Year | 2017 | |
|---|---|---|---|
| | Date | Aug 25-Sep 30 | |
| | Catch | 8,739 | |
| Code | N | 309 | |
| | | % | STD |
| 1 | Upper Fraser (UPFR) | 0.0 | (0.1) |
| 2 | Middle-Upper Fraser (MUFR) | 0.0 | (0.1) |
| 3 | Lower Fraser Fall (LWFR-F) | 0.8 | (0.5) |
| 4 | North Thompson (NOTH) | 0.0 | (0.1) |
| 5 | South Thompson (SOTH) | 8.2 | (1.6) |
| 6 | Lower Thompson (LWTH) | 0.0 | (0.1) |
| 7 | East Coast Vancouver Island (ECVI) | 0.5 | (0.5) |
| 8 | West Coast Vancouver Island (WCVI) | 11.8 | (1.8) |
| 9 | Southern BC Mainland (SOMN) | 0.0 | (0.1) |
| 10 | Northern BC Mainland (NOMN) | 0.1 | (0.2) |
| 11 | Nass | 0.0 | (0.1) |
| 12 | Lower Fraser Spring (LWFR-Sp) | 0.0 | (0.0) |
| 13 | Lower Fraser Summer (LWFR-Su) | 0.0 | (0.0) |
| 14 | Haida Gwaii (QCI) | 0.0 | (0.0) |
| 15 | Alaska | 0.0 | (0.1) |
| 17 | Taku | 0.1 | (0.3) |
| 18 | Stikine | 0.1 | (0.3) |
| 19-23 | Skeena | 0.0 | (0.1) |
| 24 | Alsek | 0.3 | (0.3) |
| 50 | Puget Sound | 2.5 | (1.0) |
| 51 | Juan de Fuca | 0.0 | (0.0) |
| 52 | Coastal Washington | 8.9 | (1.8) |
| 53 | Lower Columbia | 3.1 | (1.1) |
| 54 | Upper Columbia Spring | 0.0 | (0.0) |
| 55 | Upper Columbia Summer/Fall | 34.8 | (3.1) |
| 56 | Snake Spring/Summer | 0.2 | (0.3) |
| 57 | Snake Fall | 5.6 | (1.9) |
| 58 | North & Central Oregon | 22.4 | (2.6) |
| 59 | South Oregon Coastal | 0.1 | (0.3) |
| 61 | Klamath/Trinity | 0.0 | (0.1) |
| 62 | Middle Columbia Spring | 0.0 | (0.1) |
| 63 | Upper Willamette | 0.4 | (0.4) |
| 64 | Central Valley Fall | 0.0 | (0.1) |
| 65 | Central Valley Spring | 0.0 | (0.0) |
| 66 | Coastal California | 0.0 | (0.0) |

9

Table 3. Chinook catch composition from 2017 NBC troll fisheries by sample group.

Catch composition presented in numbers of fish. Standard deviations appear in brackets.

| | Year | 2017 | | 2017 | | 2017 | | 2017 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | June 21-July 3 | | June 16-July 8 | | July 7-July 14 | | July 12-July 20 | | July 22-Aug 4 | |
| | Catch | 29,398 | | 25,913 | | 11,230 | | 12,052 | | 10,398 | |
| Code | N | 371 | | 544 | | 302 | | 298 | | 247 | |
| | | % | STD | % | STD | % | STD | % | STD | % | STD |
| 1 | Upper Fraser (UPFR) | 19 | (60) | 51 | (73) | 18 | (38) | 41 | (42) | 21 | (43) |
| 2 | Middle-Upper Fraser (MUFR) | 386 | (191) | 265 | (152) | 17 | (35) | 46 | (47) | 41 | (54) |
| 3 | Lower Fraser Fall (LWFR-F) | 0 | (10) | 0 | (7) | 0 | (5) | 0 | (5) | 66 | (62) |
| 4 | North Thompson (NOTH) | 30 | (87) | 157 | (95) | 139 | (81) | 41 | (43) | 63 | (66) |
| 5 | South Thompson (SOTH) | 8382 | (692) | 10425 | (559) | 4097 | (316) | 4039 | (336) | 3208 | (314) |
| 6 | Lower Thompson (LWTH) | 0 | (14) | 0 | (10) | 0 | (10) | 0 | (7) | 0 | (7) |
| 7 | East Coast Vancouver Island (ECVI) | 606 | (305) | 264 | (116) | 110 | (65) | 255 | (107) | 90 | (65) |
| 8 | West Coast Vancouver Island (WCVI) | 1216 | (308) | 644 | (179) | 291 | (103) | 571 | (149) | 814 | (177) |
| 9 | Southern BC Mainland (SOMN) | 133 | (121) | 155 | (92) | 240 | (101) | 59 | (57) | 2 | (16) |
| 10 | Northern BC Mainland (NOMN) | 588 | (230) | 609 | (212) | 76 | (71) | 170 | (90) | 105 | (76) |
| 11 | Nass | 0 | (21) | 0 | (14) | 3 | (20) | 45 | (47) | 0 | (9) |
| 12 | Lower Fraser Spring (LWFR-Sp) | 82 | (82) | 48 | (50) | 37 | (37) | 0 | (10) | 42 | (42) |
| 13 | Lower Fraser Summer (LWFR-Su) | 0 | (4) | 0 | (4) | 0 | (2) | 40 | (41) | 0 | (3) |
| 14 | Haida Gwaii (QCI) | 0 | (7) | 48 | (49) | 0 | (4) | 0 | (3) | 0 | (3) |
| 15 | Alaska | 3 | (27) | 36 | (72) | 0 | (6) | 0 | (7) | 0 | (6) |
| 17 | Taku | 10 | (49) | 8 | (39) | 0 | (8) | 7 | (29) | 14 | (40) |
| 18 | Stikine | 1 | (21) | 28 | (76) | 6 | (22) | 24 | (51) | 1 | (11) |
| 19-23 | Skeena | 315 | (206) | 527 | (179) | 74 | (86) | 237 | (107) | 3 | (21) |
| 24 | Alsek | 3 | (23) | 0 | (8) | 0 | (5) | 0 | (6) | 0 | (7) |
| 50 | Puget Sound | 80 | (132) | 406 | (148) | 126 | (80) | 275 | (125) | 275 | (135) |
| 51 | Juan de Fuca | 238 | (136) | 0 | (4) | 0 | (2) | 18 | (33) | 0 | (3) |
| 52 | Coastal Washington | 2055 | (433) | 1929 | (320) | 970 | (203) | 1058 | (217) | 1195 | (227) |
| 53 | Lower Columbia | 794 | (277) | 586 | (201) | 26 | (51) | 308 | (118) | 180 | (97) |
| 54 | Upper Columbia Spring | 0 | (11) | 0 | (7) | 0 | (5) | 0 | (5) | 0 | (5) |
| 55 | Upper Columbia Summer/Fall | 6334 | (711) | 3956 | (478) | 2541 | (302) | 2193 | (314) | 2110 | (308) |
| 56 | Snake Spring/Summer | 0 | (20) | 0 | (14) | 0 | (9) | 0 | (9) | 0 | (10) |
| 57 | Snake Fall | 1696 | (486) | 1054 | (318) | 94 | (141) | 290 | (185) | 575 | (209) |
| 58 | North & Central Oregon | 4595 | (627) | 3273 | (408) | 1983 | (279) | 1445 | (294) | 1005 | (218) |
| 59 | South Oregon Coastal | 751 | (395) | 637 | (231) | 346 | (148) | 877 | (257) | 588 | (185) |
| 61 | Klamath/Trinity | 0 | (11) | 4 | (23) | 0 | (4) | 0 | (4) | 0 | (6) |
| 62 | Middle Columbia Spring | 24 | (87) | 0 | (13) | 34 | (43) | 0 | (7) | 0 | (6) |
| 63 | Upper Willamette | 1000 | (325) | 745 | (219) | 0 | (6) | 10 | (35) | 0 | (6) |
| 64 | Central Valley Fall | 1 | (23) | 58 | (59) | 0 | (7) | 0 | (8) | 0 | (8) |
| 65 | Central Valley Spring | 57 | (78) | 0 | (7) | 0 | (5) | 0 | (5) | 0 | (5) |
| 66 | Coastal California | 0 | (4) | 0 | (4) | 0 | (2) | 0 | (2) | 0 | (3) |

10

Table 3 continued. Chinook catch composition from 2017 NBC troll fisheries by sample group.

Catch composition presented in numbers of fish. Standard deviations appear in brackets.

| | Year | 2017 | |
|---|---|---|---|
| | Date | Aug 25-Sep 30 | |
| | Catch | 8,739 | |
| Code | N | 309 | |
| | | % | STD |
| 1 | Upper Fraser (UPFR) | 0 | (8) |
| 2 | Middle-Upper Fraser (MUFR) | 2 | (13) |
| 3 | Lower Fraser Fall (LWFR-F) | 72 | (48) |
| 4 | North Thompson (NOTH) | 0 | (5) |
| 5 | South Thompson (SOTH) | 718 | (141) |
| 6 | Lower Thompson (LWTH) | 0 | (5) |
| 7 | East Coast Vancouver Island (ECVI) | 46 | (41) |
| 8 | West Coast Vancouver Island (WCVI) | 1032 | (161) |
| 9 | Southern BC Mainland (SOMN) | 0 | (6) |
| 10 | Northern BC Mainland (NOMN) | 6 | (20) |
| 11 | Nass | 0 | (6) |
| 12 | Lower Fraser Spring (LWFR-Sp) | 0 | (4) |
| 13 | Lower Fraser Summer (LWFR-Su) | 0 | (2) |
| 14 | Haida Gwaii (QCI) | 0 | (2) |
| 15 | Alaska | 0 | (5) |
| 17 | Taku | 9 | (26) |
| 18 | Stikine | 7 | (22) |
| 19-23 | Skeena | 0 | (12) |
| 24 | Alsek | 28 | (28) |
| 50 | Puget Sound | 222 | (85) |
| 51 | Juan de Fuca | 0 | (2) |
| 52 | Coastal Washington | 776 | (158) |
| 53 | Lower Columbia | 273 | (94) |
| 54 | Upper Columbia Spring | 0 | (4) |
| 55 | Upper Columbia Summer/Fall | 3038 | (269) |
| 56 | Snake Spring/Summer | 18 | (27) |
| 57 | Snake Fall | 490 | (167) |
| 58 | North & Central Oregon | 1960 | (227) |
| 59 | South Oregon Coastal | 5 | (29) |
| 61 | Klamath/Trinity | 1 | (8) |
| 62 | Middle Columbia Spring | 0 | (5) |
| 63 | Upper Willamette | 34 | (35) |
| 64 | Central Valley Fall | 0 | (6) |
| 65 | Central Valley Spring | 0 | (3) |
| 66 | Coastal California | 0 | (2) |

11

## FIGURES

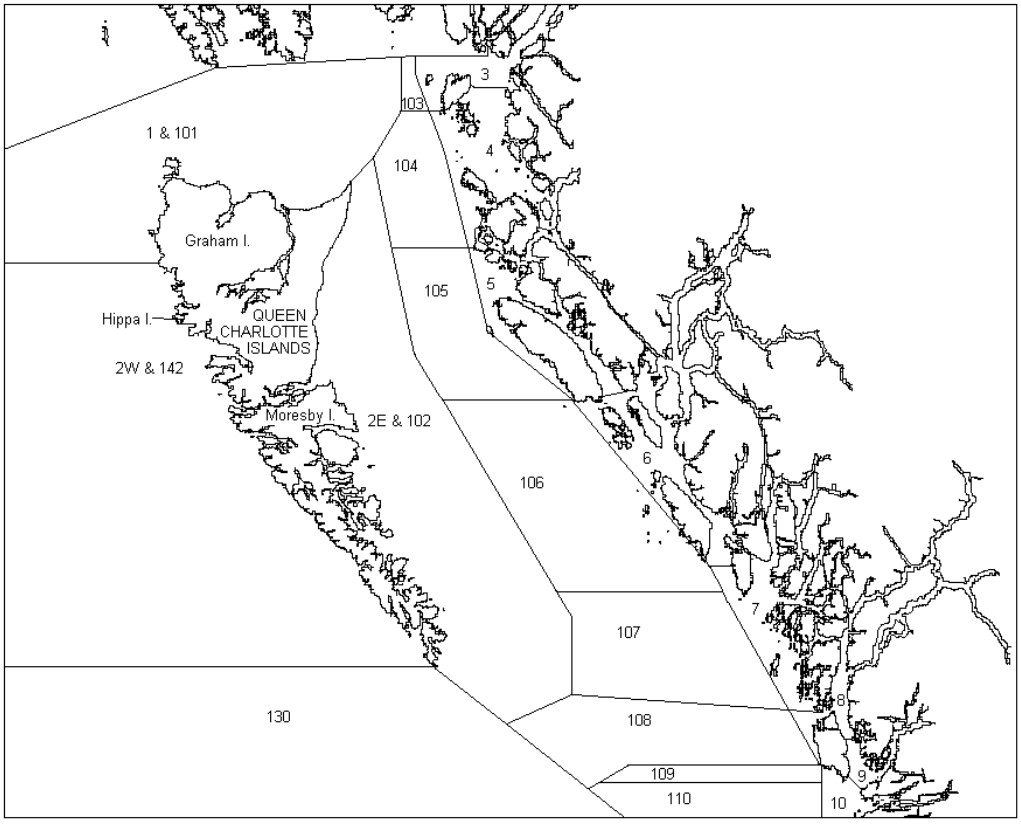



Figure 1. The North Coast of British Columbia showing Pacific Fishery Management Areas 1 to 10, 101 to 110, 130 and 142.

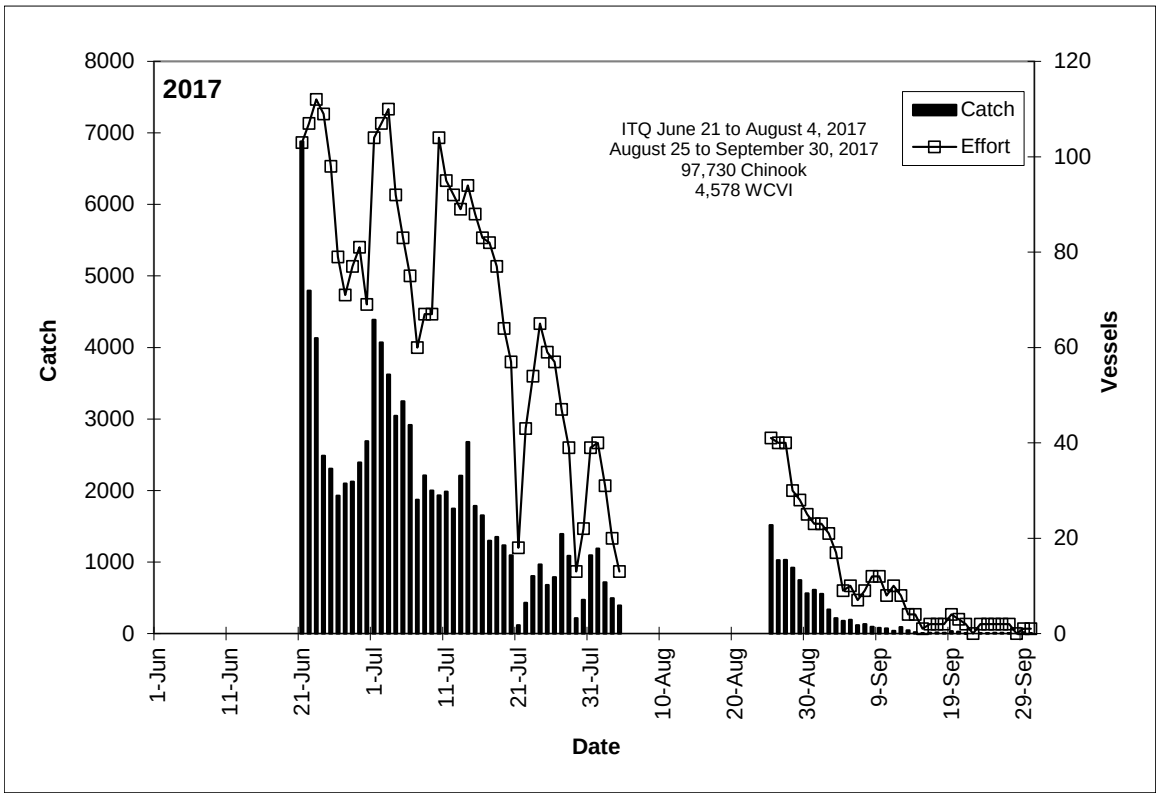



Figure 2. Chinook salmon daily catch and effort in the 2017 NBC Troll fishery.

## APPENDICES

Appendix 1. Contract Statement of work for scale sampling of Chinook Salmon from the 2017 Northern British Columbia Troll fishery.

PERIOD: June 15 to September 30, 2017.

The contractor agrees to collect scale samples from Chinook salmon caught in the Northern British Columbia Troll fishery in conjunction with sampling for coded wire tags (CWTs) as described in this Statement of Work.

### 1. SCOPE

Genetic stock identification of Chinook salmon caught in the Northern British Columbia (NBC) troll fishery is used to establish the origin of fish encountered. The data generated by the program contribute to Canada's domestic management of the fishery. The information has also been used in support of Pacific Salmon Treaty (PST) negotiations. Genetic material and age information are available from scale samples.

The objectives for the genetic program are to provide estimates of the stock composition of Chinook caught in the NBC Troll fishery. These data are essential to the management of the fishery. The management objectives for the NBC Troll fishery are to catch as many of the Chinook salmon allowed within the PST allocation while remaining below a harvest rate of 3.2% of the WCVI Chinook return to Canadian waters. The preliminary estimate of the Chinook available to the NBC Troll fishery is 108,500 fish.

The NBC Troll Fishery is scheduled to open on or after June 21, 2017. The fishery may close near the end of July and reopen in September if the total allowable catch and the WCVI harvest rate objective have not been reached. The dates may change and the fishery will close once either of the targets has been met. A proposed licence condition will require all vessels to land their catch within 5 days of a closure.

The DFO Project Coordinator (Coordinator) for this SOW is Ivan Winther. The coordinator may be contacted by email at Ivan.Winther@dfo-mpo.gc.ca or by telephone at 250-627-3459. The shipping address is:

Ivan Winther
Fisheries & Oceans Canada
417-2nd Avenue West
Prince Rupert, BC
V8J 1G8

### 2. SAMPLE COLLECTION

The NBC Troll genetic sampling objectives are to collect scales and length data from a representative sample of the Chinook salmon catch, supply the samples with the associated capture information to the Coordinator, and provide standardized data to the DFO MRP Unit.

The collection of tissue samples preserved in ethanol has been discontinued as the preferred method for samples of genetic material. For Ice landings, genetic material is available from the

scales, however, it is subject to cross contamination from contact with other fish. In the revised scale sampling procedure the preferred location on each fish sampled will be wiped with a clean paper towel to avoid problems associated with cross contamination. For freezer landings, tissue samples are to be collected into batch vials containing water, transferred to Whatman paper and air-dried at the end of each day.

The sampling objective will be to collect a representative sample of 3000 Chinook salmon from the catch. This strategy is intensive in an attempt to measure the relatively small component of WCVI Chinook anticipated in the fishery. Sampling rate will be dictated by the rate of the fishery. It will be essential to sample heavily from the first landings of Chinook salmon and again once the fishery closes. A random / stratified approach is used to ensure a representative sample. Vessels are selected at random and every $5^{th}$ fish or every $10^{th}$ fish offloaded is sampled to reduce autocorrelation. Fewer than 50 fish are sampled from each vessel landing. Vessel operators are interviewed to determine areas of catch and number of Chinook being delivered. Samples of fresh landings are preferred as they provide the opportunity to sample for size, age and genetic information (as provided by length measurements and scales). The scale samples and data are matched with CWT recoveries when CWTs are encountered. Samples from fish frozen at sea are a second choice as they can only consist of genetic information available from tissue samples. Samples from frozen fish consist of batch collections of tissues into water and preserved on Whatman sheets. Scales and length information are not available from frozen fish.

*2.1 The DFO Mark Recovery Unit shall:*

- Supply the contractor with DFO Mark Recovery Sample Form (MRSF) Form DMP-MRP-FO-F-001 for CWT sampling and with the DFO Salmon Biological Sample Form (SBSF) Form DMP-MRP-FO-F-002 for DNA sampling.
- Supply the contractor with a set of waterproof labels to uniquely label each vial that is used for freezer vessel sampling.
- Provide a central repository for management and access to CWT and Salmon biological data collected for this project.

*2.2 The Coordinator shall:*

- Co-ordinate communication with the DFO Sclerochronology Lab (SCL) as the "DFO Submission Contact".
- Supply single-type scale books (numbered 1-50) from the SCL to the contractor, for sampling fresh catch.
- Supply Whatman sheets to the contractor, for air-drying samples from frozen catch.
- Perform quality inspections to ensure samples meet current SCL or MGL identification and quality requirements and report deficiencies to the contractor.

*2.3 The contractor shall:*

- Communicate with the Coordinator or designate on appropriate sample times, locations and sample amounts.
- Examine scale books and provided by the Coordinator and report deficiencies to the coordinator verbally or by email.
- Collect scale samples from up to 3000 Chinook salmon following the instructions in section 3.

- Provide vials for sampling frozen fish.
- If requested, collect batched samples of tissue into water from frozen landings and transfer specimens onto Whatman paper.
- Ship or deliver the scale books, Whatman paper, and copies of completed SBSF's to the Coordinator within 2 days of sampling.
- Complete data entry of SBSFs and electronically submit data to the MRP Unit according to the following schedule:
    - June/July fishery by September 1, 2017
    - Late August/September fishery by November 1, 2017.
- Discuss modifications to procedures with the coordinator and incorporate modifications if necessary. If additional contract costs will be incurred, discuss modifications to procedures and cost estimate with Scientific Authority.
- Return all of the unused scale books and Whatman sheets to the coordinator at the end of the season.

## 3. SAMPLE INSTRUCTIONS

### 2017 North Coast Chinook Troll Commercial Fishery Samples

Samples of chinook tissue and scales will be collected from the Commercial Troll Fishery on the Queen Charlotte Islands. The sampling target is to collect 3000 scale samples from the Area F troll fishery in 2017.

- The sampling protocol is to collect scale samples with associated length measurements and capture data. The samples will be collected according to a stratified random procedure. Data from Chinook with CWTs will be matched to the scale sample data. Sample 50 or less Chinook from each vessel landing.
- Once a random vessel is selected to be sampled the scales and data are collected in a systematic procedure where every $5^{th}$ or $10^{th}$ Chinook from the load is sampled depending on the total number of fish delivered.
- The selection of Chinook for scale sampling shall be independent of whether a CWT is detected.

COLLECT SCALES AND CAPTURE DATA FROM EACH FISH ACCORDING TO THE FOLLOWING PROTOCOL:

- Use pencil.
- For each vessel, the MRSF (Form DMP-MRP-FO-F-001) will have been completed in full to record information from the vessel master interview and CWT sample data as part of the MRP Program requirements.
    - Complete the (SBSF Form DMP-MRP-FO-F-002) and link it to the MRSF data using the Master Sample # field according to the MRP Program requirements. In addition to MRP program requirements to link forms, copy the Fishing Location, Date Landed, First Day Fished, and Last Day Fished, from the MRSF onto the SBSF.
    - Complete the Sample Type to identify the sample protocols as " 1-Random".
- For scale sampling of ice vessel landings,
    - Record the Fork Length, Species, AD Fin Mark, Scale Book #, and Scale # for each fish sampled.

- Record the CWT Head Label Number for the scale samples of Chinook with a CWT.
- Each page will contain scales from 25 fish. Each vessel will have no more than 2 pages.
- Complete the Sample Status and provide a Sample Comment for incomplete or problem samples.
- Sample each fish in sequence according to the numbers on the scale books.
- WIPE THE SLIME FROM THE PREFERRED SCALE LOCATION ON EACH FISH WITH A CLEAN SHEET OF PAPER TOWEL.
- DO NOT SAMPLE REGENERATE SCALES
- Collect 5 scales from each fish onto standard 5-down format scale books as noted in the following illustration. Each book will contain scales from 10 fish.
- Ensure the numbers on the data sheets match the numbers on the scale books.

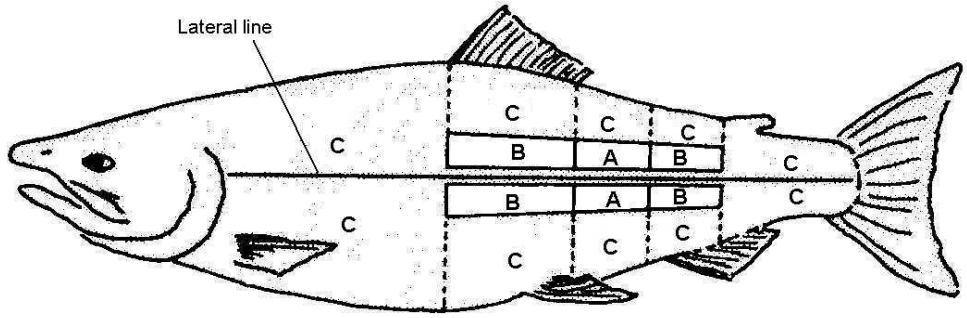
- For batch sampling of freezer vessel landings, Record the Species and vial number for the batch sample on the SBSF in the Sample Comments field.
  - Use a punch to collect a sample from each fish into a batch vial containing water.
  - TAKE A SAMPLE FROM THE THINNEST PART OF THE CAUDAL FIN. If the tissue is too think it will not air dry effectively to stick to the Whatman sheet and can be knocked off.
  - Complete the Sample Status and provide a Sample Comment for incomplete or problem samples.
  - Ensure the vial number on the data sheet matches the number on the vial.
  - At end of day, transfer specimens from the batch vial to individual cells on the Whatman sheets. SHORT-TERM storage in water is OK but the sample will not stick to the Whatman paper if left in water overnight.
  - The sample should be placed in the centre of each of the squares printed on the paper. The paper will absorb all the water in the tissue causing it to adhere to the paper. Keep the sheet as dry as possible and avoid bending which might cause the samples to fall off.
  - Each Whatman page will contain samples from 100 fish. Each vessel will fill no more than ½ a Whatman sheet.
  - Record the date, species, fishing area and fishing gear on the Whatman Sheet.
  - Record the specimen numbers from the Whatman sheets onto the original SBSF. Each vessel will fill no more than 2 pages.
  - Ensure the specimen numbers on the Whatman sheets match the DNA specimen numbers on the data sheets.
  - Once the paper is completely dry it can be gently placed in the provided sleeves with the wax paper covering the samples. This can then be placed in padded or stay-flat envelopes for storage or shipping.
  - Video: DNA sampling using Whatman paper: http://www.youtube.com/watch?v=W9opRMYVVqU

**Copies of the completed SBSF data sheets must be shipped with the samples within two days of sampling.**

SCALE SAMPLES:

- Record the scale book number on the data sheet.

- Scale samples must come from preferred locations on the fish as indicated by an "A" in the diagram below.
- Avoid collecting scales near scars, wounds or net marks. To avoid scars you may have to collect scales from the locations marked "B" in the diagram below.
- Do not collect scales from the lateral line or from the areas marked "C".




- WIPE THE SLIME FROM THE PREFERRED LOCATION WITH A CLEAN SHEET OF PAPER TOWEL.
- Using forceps collect a scale from the preferred location.
- **Please check for REGENERATE SCALES.** Check the scale to ensure the rings extend all the way to the center of the scale. If not, discard the scale and select another. Regenerated scales have a clear spot in the center of the scale which is missing the rings necessary to determine the age of the fish.
- Wipe off the scale and add it to the scale book on the appropriate numbered square, x, in the top row of the 10 X 5 scale book grid.
- Do not turn the scale over; leave the scale with the same side up as it is on the fish.
- Select 4 additional scales and add them to the adjacent squares below the first, bearing the same number series 1x, 2x, 3x, 4x.
- Keep the scale books dry.
- Once the book is full, fill out the information on the back of the page bearing the scales.
- THE SCALES MUST MATCH THE NUMBERS ON THE DATA SHEETS.

## 4. SAMPLE FORM

The following is an example of form DMP-MRP-FO-F-002 to be completed and provided with the sample collections.

**Salmon Biological Sample Form**

Sample #: 000000 Master Sample #

Fishery *(circle one)* A B C D E F G H Other: _____ Fishery Type ☐ Gear ☐☐

Port _____ Sample Type ☐ Sample Status ☐

Offload Site _____

VTP ☐ Vessel Name _____ VRN _____ Sample Site _____

FISHING LOCATION

| | PFMA | PFMA SUB | ZONE |
|---|---|---|---|
| 1 | | - | |
| 2 | | - | |
| 3 | | - | |
| 4 | | - | |

Date Landed d d m m y y y y

First Day Fished d d m m y y y y

Last Day Fished d d m m y y y y

Date Sampled d d m m y y y y

| | CWT Head Label # (Detection Method ☐ Electronic Equipment ☐) | Length (mm) (Length Code ☐) | Species | AD Fin Mark | Sex | Scale Book # (Book Type ☐ Format ☐) | Scale # | DNA Specimen # | DNA Tissue | Otolith Box # | Otolith Specimen (cell # ◯ strap # ◯) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |

Sample Comments *(for example: describe sample method, problems, etc.)*

Sampling Agency _____ Lead Sampler _____

Recorded By _____ Stat Week Sampled _____ Page Number _____

Doc:DMP-MRP-FO-F-002 Rev:2016 DFO–201602

**FISHERY TYPE**
**C** – Commercial
**F** – FN FSC
**N** – FN Economic
**T** – Test

**GEAR**
**7** – Hook & Line
**10** – Gillnet
**15** – Mixed Net
**20** – Seine
**31** – Freezer Troll
**33** – Ice Troll

**VTP**
**1** – Vessel
**2** – Truck
**3** – Packer

**SAMPLE TYPE**
**1** – Random
**2** – Total
**3** – Stratified
**4** – Random Stratified
**5** – Selected
**9** – Other

**SAMPLE STATUS**
**C** – Complete
**I** – Incomplete
**P** – Problem
***(Sample Comment Required for "I" and "P")***

**DETECTION METHOD**
**V** – Visual *(Take AD-OFF/STUBBY)*
**E** – Electronic *(Take BEEP)*
**B** – Both *(Take AD-OFF/STUBBY that BEEP)*

**ELECTRONIC EQUIPMENT**
**T** – Tube
**W** – Wand

**LENGTH CODE**
**1** – Fork Length
**7** – Post Orbital Fork
**8** – Post Orbital Hypural

**SPECIES**
**08** – Pink
**12** – Chum
**15** – Coho
**18** – Sockeye
**24** – Chinook
**28** – Steelhead

**AD FIN MARK**
**0** – AD-ON
**1** – AD-OFF
**2** – Stubby

**SEX**
**F** – Female
**M** – Male

**SCALE BOOK TYPE**
**S** – Single
**D** – Double

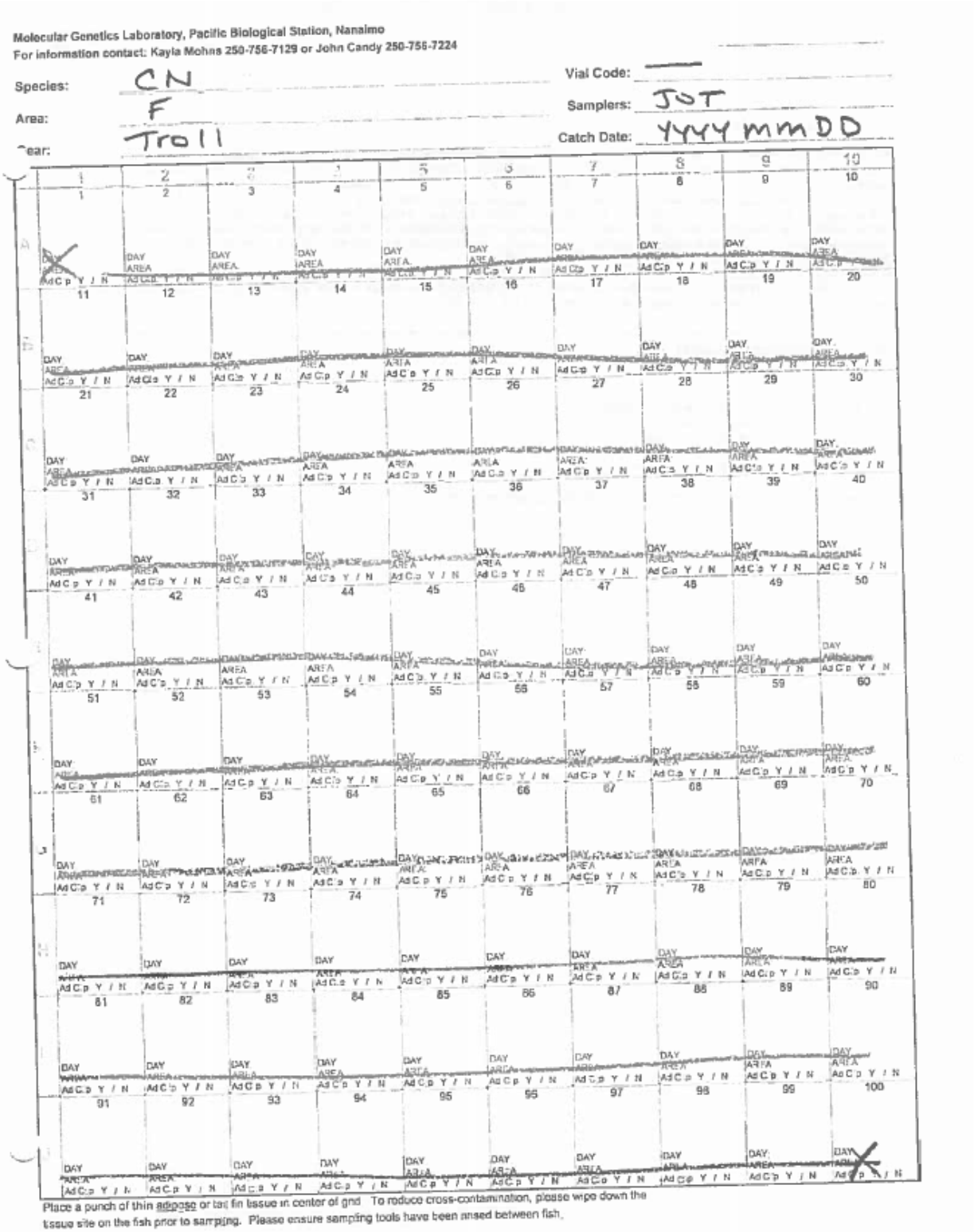
**SCALE FORMAT**
**1** – 2 across
**2** – 5 down
**3** – 10 across
**4** – 2 smears

**DNA TISSUE**
**5** – adipose punch
**6** – caudal or other fin punch
**7** – scales
**8** – operculum punch
**9** – other

19

## 5. WHATMAN SHEET

The fields within each cell are duplicates of fields that are collected on the MRSF and do not need to be filled in. Follow procedures for sampling and shipping that are in this SOW.



Appendix 2. Baseline samples used in the mixture analyses.

| # | Region | Population | N |
|---|---|---|---|
| 1 | UPFR | Bowron | 250 |
| 1 | UPFR | Dome | 382 |
| 1 | UPFR | Fontoniko | 63 |
| 1 | UPFR | Goat | 76 |
| 1 | UPFR | Holliday_Cr | 29 |
| 1 | UPFR | Holmes | 219 |
| 1 | UPFR | Horsey | 47 |
| 1 | UPFR | Indianpoint | 47 |
| 1 | UPFR | James | 58 |
| 1 | UPFR | Kenneth_Cr | 98 |
| 1 | UPFR | McGregor | 125 |
| 1 | UPFR | Morkill | 208 |
| 1 | UPFR | Nevin_Cr | 50 |
| 1 | UPFR | Ptarmigan | 32 |
| 1 | UPFR | Salmon@PG | 263 |
| 1 | UPFR | Slim_C | 240 |
| 1 | UPFR | Swift | 448 |
| 1 | UPFR | Tete_Jaune | 475 |
| 1 | UPFR | Torpy | 174 |
| 1 | UPFR | Walker | 45 |
| 1 | UPFR | Willow_R | 117 |
| 2 | MUFR | Baezaeko | 82 |
| 2 | MUFR | Baker_Cr | 31 |
| 2 | MUFR | Bridge | 424 |
| 2 | MUFR | Chilako | 45 |
| 2 | MUFR | Chilko | 425 |
| 2 | MUFR | Cottonwood | 176 |
| 2 | MUFR | Elkin_R | 248 |
| 2 | MUFR | Endako | 207 |
| 2 | MUFR | Horsefly | 80 |
| 2 | MUFR | Kuzkwa_Cr | 93 |
| 2 | MUFR | L_Cariboo | 104 |
| 2 | MUFR | L_Chilcoti | 236 |
| 2 | MUFR | Nazko | 194 |
| 2 | MUFR | Nechako | 562 |
| 2 | MUFR | Portage_C | 286 |
| 2 | MUFR | Quesnel | 562 |
| 2 | MUFR | Stuart | 545 |
| 2 | MUFR | Taseko | 205 |
| 2 | MUFR | U_Cariboo | 171 |
| 2 | MUFR | U_Chilcotin | 276 |
| 2 | MUFR | Westroad | 104 |
| 3 | LWFR-F | Chilliwac@Stav | 381 |
| 3 | LWFR-F | Chilliwack_F | 696 |
| 3 | LWFR-F | Harrison | 686 |
| 4 | NOTH | Barriere | 55 |
| 4 | NOTH | Blue | 84 |
| 4 | NOTH | Clearwater | 281 |
| 4 | NOTH | Finn | 211 |
| 4 | NOTH | Lemieux_Cr | 153 |
| 4 | NOTH | N_Thom@Main | 116 |
| 4 | NOTH | Raft_R | 457 |
| 5 | SOTH | Bessette | 164 |
| 5 | SOTH | Duteau_Cr | 73 |
| 5 | SOTH | Eagle_R | 331 |
| 5 | SOTH | L_Adams | 340 |
| 5 | SOTH | L_Shus@U_Adams | 46 |
| 5 | SOTH | L_Shuswap | 389 |
| 5 | SOTH | L_Thompson | 229 |
| 5 | SOTH | Little_R | 254 |
| 5 | SOTH | M_Shuswap | 375 |
| 5 | SOTH | Salmon@SA | 215 |
| 5 | SOTH | Seymour@Thomp | 44 |
| 5 | SOTH | South_Thom | 266 |
| 6 | LWTH | Bonaparte | 344 |
| 6 | LWTH | Coldwater | 274 |
| # | Region | Population | N |
| 6 | LWTH | Deadman | 492 |
| 6 | LWTH | Louis | 618 |
| 6 | LWTH | Nicola | 433 |
| 6 | LWTH | Spius | 137 |
| 6 | LWTH | U_Coldwat_SP | 221 |
| 6 | LWTH | U_Spius_SP | 175 |
| 7 | ECVI | Big_Qualicum | 365 |
| 7 | ECVI | Chemainus | 261 |
| 7 | ECVI | Cowichan | 680 |
| 7 | ECVI | L_Qualicum | 305 |
| 7 | ECVI | Nanaimo_F | 523 |
| 7 | ECVI | Nanaimo_SP | 95 |
| 7 | ECVI | Nanaimo_SU | 459 |
| 7 | ECVI | NanaimoSu_BackX | 135 |
| 7 | ECVI | Nimpkish | 316 |
| 7 | ECVI | Puntledge_BackX | 1025 |
| 7 | ECVI | Puntledge_F | 652 |
| 7 | ECVI | Puntledge_Su | 1120 |
| 7 | ECVI | Quatse | 30 |
| 7 | ECVI | Quinsam | 503 |
| 7 | ECVI | Woss_Lake | 31 |
| 8 | WCVI | Burman | 315 |
| 8 | WCVI | Colonial_Cay | 58 |
| 8 | WCVI | Conuma | 455 |
| 8 | WCVI | Gold_R | 227 |
| 8 | WCVI | Kaouk_R | 196 |
| 8 | WCVI | Kennedy | 383 |
| 8 | WCVI | Marble@NVI | 512 |
| 8 | WCVI | Megin_R | 90 |
| 8 | WCVI | Moyeha_R | 57 |
| 8 | WCVI | Nahmint | 411 |
| 8 | WCVI | Nitinat | 346 |
| 8 | WCVI | Robertson | 388 |
| 8 | WCVI | San_Juan | 202 |
| 8 | WCVI | Sarita | 429 |
| 8 | WCVI | Sooke | 58 |
| 8 | WCVI | Stamp | 299 |
| 8 | WCVI | Tahsis | 355 |
| 8 | WCVI | Thornton | 522 |
| 8 | WCVI | Tlupana | 66 |
| 8 | WCVI | Toquart | 87 |
| 8 | WCVI | Tranquil | 395 |
| 8 | WCVI | Zeballos | 199 |
| 9 | SOMN | Bute | 66 |
| 9 | SOMN | Capilano | 126 |
| 9 | SOMN | Cheakamus | 50 |
| 9 | SOMN | Cheakamus_F | 114 |
| 9 | SOMN | Cheakamus_Su | 40 |
| 9 | SOMN | Devereux | 325 |
| 9 | SOMN | Homathko | 51 |
| 9 | SOMN | Klinaklini | 472 |
| 9 | SOMN | Mamquam | 35 |
| 9 | SOMN | Phillips | 641 |
| 9 | SOMN | Squamish_R | 161 |
| 10 | NOMN | Ashlulm | 66 |
| 10 | NOMN | Atnarko | 275 |
| 10 | NOMN | Chuckwalla | 315 |
| 10 | NOMN | Dean | 219 |
| 10 | NOMN | Dean@Main | 25 |
| 10 | NOMN | Docee | 126 |
| 10 | NOMN | Hirsch | 474 |
| 10 | NOMN | Kateen | 244 |
| 10 | NOMN | Kilbella | 196 |
| 10 | NOMN | Kildala | 441 |
| 10 | NOMN | Kitimat | 483 |
| 10 | NOMN | Kitlope | 201 |
| # | Region | Population | N |
| 10 | NOMN | Kwinamass | 362 |
| 10 | NOMN | LowAtnarko | 50 |
| 10 | NOMN | Marble@CC | 41 |
| 10 | NOMN | Neechanze | 57 |

| # | Region | Population | N |
|---|---|---|---|
| 10 | NOMN | Nusatsum | 103 |
| 10 | NOMN | Saloompt | 138 |
| 10 | NOMN | Takia | 63 |
| 10 | NOMN | U_Atnarko | 200 |
| 10 | NOMN | U_Dean | 203 |
| 10 | NOMN | Wannock_R | 506 |
| 11 | NASS | Cranberry | 175 |
| 11 | NASS | Damdochax | 273 |
| 11 | NASS | Ishkheenickh | 199 |
| 11 | NASS | Kincolith | 286 |
| 11 | NASS | Kiteen | 59 |
| 11 | NASS | Kwinageese | 266 |
| 11 | NASS | Meziadin | 194 |
| 11 | NASS | Owegee | 235 |
| 11 | NASS | Seaskinnish | 99 |
| 11 | NASS | Snowbank | 51 |
| 11 | NASS | Teigen | 30 |
| 11 | NASS | Tseax | 244 |
| 12 | LWFR-Sp | Big_Silver | 210 |
| 12 | LWFR-Sp | Birkenhead | 347 |
| 12 | LWFR-Sp | BlueCr_UpPitt | 50 |
| 12 | LWFR-Sp | Sloquet_Cr | 35 |
| 12 | LWFR-Sp | Upper_Pitt | 235 |
| 13 | LWFR-Su | Maria_Slough | 366 |
| 13 | LWFR-Su | Nahatlatch_R | 26 |
| 14 | QCI | Yakoun | 211 |
| 15 | Alaska | Big_Boulder_C | 144 |
| 15 | Alaska | Chickamin | 259 |
| 15 | Alaska | King_Salmon | 266 |
| 15 | Alaska | Situk | 132 |
| 15 | Alaska | Tahini | 142 |
| 15 | Alaska | Unuk | 336 |
| 17 | Taku | Dudidontu | 352 |
| 17 | Taku | Hackett_r | 233 |
| 17 | Taku | Kowatua | 379 |
| 17 | Taku | Little_Tatsam | 698 |
| 17 | Taku | Nahlin | 303 |
| 17 | Taku | Nakina | 480 |
| 17 | Taku | Tatsamenie | 38 |
| 17 | Taku | Tseta | 327 |
| 17 | Taku | Yeth_Cr | 53 |
| 18 | Stikine | Andrew_Cr | 144 |
| 18 | Stikine | Christina | 240 |
| 18 | Stikine | Craig | 114 |
| 18 | Stikine | Johnny_Tashoot | 99 |
| 18 | Stikine | Little_Tahltan | 745 |
| 18 | Stikine | Shakes_Cr | 225 |
| 18 | Stikine | Tahltan_R | 212 |
| 18 | Stikine | Verrett | 854 |
| 19 | Skeena Upper | Bear | 270 |
| 19 | Skeena Upper | Kluatantan | 38 |
| 19 | Skeena Upper | Kluayaz_Cr | 165 |
| 19 | Skeena Upper | Kuldo_C | 171 |
| 19 | Skeena Upper | Otsi_Cr | 276 |
| 19 | Skeena Upper | Sicintine_R | 319 |
| 19 | Skeena Upper | Slamgeesh | 129 |
| 19 | Skeena Upper | Squingula_R | 271 |
| 19 | Skeena Upper | Sustut | 509 |
| 20 | Skeena Babine | Babine | 198 |
| 21 | Skeena Bulkley | Bulkley_Early | 567 |
| 21 | Skeena Bulkley | Morice_R | 243 |
| 21 | Skeena Bulkley | Suskwa | 111 |
| 22 | Skeena Mid | Kispiox | 197 |
| 22 | Skeena Mid | Kitseguecla_R | 260 |
| 22 | Skeena Mid | Kitwanga | 284 |
| 22 | Skeena Mid | Nangeese_R | 32 |
| 22 | Skeena Mid | Shegunia_R | 132 |
| 22 | Skeena Mid | Sweetin | 245 |
| 23 | Skeena Lower | Cedar_Early | 116 |
| 23 | Skeena Lower | Ecstall | 367 |
| 23 | Skeena Lower | Exchamsiks | 116 |
| 23 | Skeena Lower | Exstew_R | 140 |
| 23 | Skeena Lower | Fiddler_Cr | 113 |
| 23 | Skeena Lower | Gitnadoix | 245 |
| 23 | Skeena Lower | Kasiks_R | 63 |
| 23 | Skeena Lower | Khyex_R | 37 |
| 23 | Skeena Lower | Kitsumkalum_R | 810 |
| 23 | Skeena Lower | Thomas_Cr | 117 |
| 23 | Skeena Lower | Zymogotitz_R | 120 |
| 24 | Alsek | Blanchard | 381 |
| 24 | Alsek | Goat_Cr | 134 |
| 24 | Alsek | Klukshu | 433 |
| 24 | Alsek | Kudwat_Cr | 70 |
| 24 | Alsek | Takhanne | 218 |
| 24 | Alsek | Tatshenshi | 24 |
| 50 | Puget Sound | Green@Kendal_F | 50 |
| 50 | Puget Sound | Green_F@Soos | 100 |
| 50 | Puget Sound | Nooksack_SP@Ke | 200 |
| 50 | Puget Sound | Serpentine | 46 |
| 50 | Puget Sound | Skagit_Su | 310 |
| 50 | Puget Sound | Skykomish_Su | 114 |
| 50 | Puget Sound | Snohomish_R | 306 |
| 50 | Puget Sound | Soos_Cr_H | 183 |
| 50 | Puget Sound | StillaguamishS | 87 |
| 50 | Puget Sound | White_F | 252 |
| 51 | Juan de Fuca | Elwha_F | 99 |
| 52 | Coastal Wash | Hoh_River_SP_S | 59 |
| 52 | Coastal Wash | Queets | 138 |
| 52 | Coastal Wash | Quinault_F | 100 |
| 52 | Coastal Wash | Solduc_F | 98 |
| 52 | Coastal Wash | Willapa_Cr | 261 |
| 53 | Low Col | Abernathy_F | 100 |
| 53 | Low Col | Coweeman | 195 |
| 53 | Low Col | Cowlitz_H_Sp | 138 |
| 54 | Up Col-Sp | Chewuch_SP | 100 |
| 54 | Up Col-Sp | Chiwawa_SP | 100 |
| 54 | Up Col-Sp | Entiat_Sp | 142 |
| 54 | Up Col-Sp | Twisp_SP | 227 |
| 55 | Up Col-Su/F | Deschutes-F | 230 |
| 55 | Up Col-Su/F | Hanford_Reach | 617 |
| 55 | Up Col-Su/F | Okanagan | 132 |
| 55 | Up Col-Su/F | Osoyoos_Resid | 35 |
| 55 | Up Col-Su/F | Silmilkameen_S | 370 |
| 55 | Up Col-Su/F | Wenatchee_Su | 235 |
| 56 | Snake-Sp/Su | Frenchman-SP | 61 |
| 56 | Snake-Sp/Su | Imnaha | 239 |
| 56 | Snake-Sp/Su | Johnson_Cr | 240 |
| 56 | Snake-Sp/Su | Marsh_Cr | 220 |
| 56 | Snake-Sp/Su | McCall | 32 |
| 56 | Snake-Sp/Su | McCall_Hat | 41 |
| 56 | Snake-Sp/Su | Minam_Cr | 144 |
| 56 | Snake-Sp/Su | Rapid_Sp | 363 |
| 56 | Snake-Sp/Su | Salmon_E_Fork | 53 |
| 56 | Snake-Sp/Su | Secech | 277 |
| 56 | Snake-Sp/Su | Snake_S | 36 |
| 56 | Snake-Sp/Su | Tucannon_SP | 274 |
| 56 | Snake-Sp/Su | Up_Salmon-SP | 165 |
| 56 | Snake-Sp/Su | Upper_Valley | 77 |
| 56 | Snake-Sp/Su | Valley_Cr | 43 |
| 56 | Snake-Sp/Su | Wenaha | 89 |
| 57 | Snake-F | Lyon's_Ferry_F | 370 |
| 58 | North & Central Oregon | Cle_Elm_Hatch | 95 |
| 58 | North & Central Oregon | Elk | 206 |
| 58 | North & Central Oregon | Euchre_Cr | 57 |
| 58 | North & Central Oregon | Nehalem | 327 |
| 58 | North & Central Oregon | Siuslaw | 258 |
| 58 | North & Central Oregon | Trask_hat_F | 236 |

| | | | |
|---|---|---|---|
| 58 | North & Central Oregon | Trask_hat_SP | 48 |
| 58 | North & Central Oregon | Umpqua_Smith | 229 |
| 59 | South Oregon coastal | Cole | 188 |
| 59 | South Oregon coastal | Hunter_Cr | 96 |
| 59 | South Oregon coastal | Lobster_Cr | 49 |
| 59 | South Oregon coastal | Nestucca_F | 153 |
| 59 | South Oregon coastal | Pistol | 98 |
| 59 | South Oregon coastal | Umpqua_Sp | 136 |
| 59 | South Oregon coastal | Winchuk | 80 |
| 61 | Klamath/Trinity | Blue_Cr | 94 |
| 61 | Klamath/Trinity | Salmon_Cal | 28 |
| 61 | Klamath/Trinity | Trinity_F | 244 |
| 61 | Klamath/Trinity | Trinity_SP | 100 |
| 62 | Mid Col-Sp | Granite | 93 |
| 62 | Mid Col-Sp | John_Day_main | 228 |
| 62 | Mid Col-Sp | John_Day_Mid | 40 |
| 62 | Mid Col-Sp | John_Day_N | 40 |
| 62 | Mid Col-Sp | Naches_Sp | 109 |
| 62 | Mid Col-Sp | Spring_Cr_H | 137 |
| 63 | Up Willamette | Clackamas_N | 79 |
| 63 | Up Willamette | North_Santiam | 236 |
| 63 | Up Willamette | Sandy | 208 |
| 64 | Cent Val-F | American | 69 |
| 64 | Cent Val-F | Battle_Cr | 183 |
| 64 | Cent Val-F | Butte_F | 49 |
| 64 | Cent Val-F | Feather_F | 272 |
| 64 | Cent Val-F | Merced | 200 |
| 64 | Cent Val-F | Mokelumne | 95 |
| 64 | Cent Val-F | Sacr_F | 129 |
| 64 | Cent Val-F | Sacr_LF | 211 |
| 64 | Cent Val-F | Stanislaus | 101 |
| 64 | Cent Val-F | Toulumne | 34 |
| 64 | Cent Val-F | Yuba | 50 |
| 65 | Cent Val-Sp | Butte_Sp | 186 |
| 65 | Cent Val-Sp | Feather_Sp | 226 |
| 65 | Cent Val-Sp | Yuba_Sp | 32 |
| 66 | Coastal California | Eel_F | 279 |