# Increased north-migrating Chinook salmon indicator stock coded-wire tagging to improve the quality of Chinook indicator stock analyses

Final Report to the Pacific Salmon Commission's Southern Endowment Fund Committee

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## INTRODUCTION

The United States and Canada have recognized the importance of developing and maintaining a coded-wire tag (CWT) program to estimate exploitation rates of Chinook salmon stocks, and to better define their time-area distributions for the development of management options, at least since the August 13, 1985 Memorandum of Understanding (PSC 2004: March 2004 Annexes, P. 96). In 1999, government-to-government negotiations resulted in the successful renewal of a long-term fishing agreement under the Pacific Salmon Treaty (PST). With this agreement CWTs became one of the key methods to assess harvest rate reduction compliance. Furthermore, in the 2009 agreement, CWT-based individual stock-based management (ISBM) indices are used to monitor relative exploitation rate reductions from the base period (para. 8(b&c), 9(b&c)). CWT data and analyses are also important for developing stock abundance forecasts used in the Pacific Salmon Commission (PSC) Chinook Technical Committee (CTC) Coast wide model calibration. In 2005, the PSC convened an Expert Panel to review the utility of the CWT system for future PST implementation (PSC Tech. Report No. 18). The Panel reported that the CWT program must be relied upon as the primary fishery and stock assessment tool for at least the next 5-10 years (Hankin et al. 2005). No accepted alternative technology currently exists that is capable of providing the data necessary for the implementation of the PST. In 2006, the PSC convened a CWT Work Group to review and recommend a plan to implement the recommendations of the PSC Expert Panel (PSC Tech. Report No. 25). This report states that the principal factors influencing the uncertainty surrounding CWT-based estimates of exploitation rates are those affecting precision and those causing bias. The major factors affecting precision are the number of CWTs released and sample rates for fisheries and escapements. As increased tagging is the most cost effective way to increase precision of CWT-based statistics for these indicator stocks, this project would maintain increased tagging beyond base tagging levels funded by Canadian Department of Fisheries & Oceans (CDFO) to the release group size standards based on expected marine survivals for the 2015 brood.

## PROJECT OBJECTIVES

The objective of this project is the application of CWTs on Adipose Fin-Clipped (AFC) juvenile Chinook salmon incremental to the current tagging levels already funded by CDFO for nine British Columbia (BC) Chinook indicator stocks to meet the CWT release group size standards as outlined in PSC Tech. Report No. 25.

## METHODS

Adult Chinook salmon are captured for brood by CDFO staff upon return to their spawning rivers in the summer or fall. Exact capture methods differ by location, but they include a variety of strategies such as: weir, fish ladder, beach seine, angling and tangle net. Adult Chinook are held at a hatchery either in concrete ponds or in circular fiberglass tubs until they are ready to be spawned. This determination is

made by the fish culturists, who check the females to ensure that the eggs are loose, the belly is soft, and the ovipositor is distended. Eggs are gathered by incising the belly of the female and collecting them in a disinfected container. Milt is then added from one or two males to fertilize the eggs. Water is added to the fertilized eggs, after which they are disinfected in a solution of Ovadine and water for 10 minutes. It is at this stage that fish culturists must conduct bulk fecundity sampling to try to ensure that egg targets are met.

Fertilized eggs are placed into the incubation container, which may be a Heath Tray, Atkins cell, or bulk box. Fungal treatments are conducted on eggs, typically using Parasite-S. Chinook eggs typically require approximately 500-525 accumulated thermal units prior to hatching (Billard & Jensen, 1996). Swim up fry are ponded into rearing containers where they are reared until they are of suitable size for coded-wire-tag application and adipose fin-clipping. Fish health monitoring occurs continuously throughout the early rearing period, with prophylactic and antibiotic treatments used as required. The Salmonid Enhancement Program (SEP) veterinarian is available to diagnose any fish health or well-being issues that may arise and works closely with all hatcheries to ensure that fish are healthy prior to marking and release.

The procedures used to implant the CWTs into juvenile Chinook are documented in detail by Nichols & Hillaby (1990). Marking and tagging of sub-yearling Chinook (fish that have hatched in the spring or winter preceding marking, and that will be released shortly after) occurs when fish begin to reach 3-4 grams (g), with a typical release size of 6 g. The juveniles must not be fed for 48 hours prior to marking and tagging, as this reduces the output of ammonia and excretory by-products associated with stressful fish handling. Juvenile Chinook are transported to the tagging area in small batches into a holding tank prior to being anaesthetized using Tricaine methanesulfonate (TMS). Following anaesthetization, the adipose fin of each juvenile salmon is excised using a set of surgical scissors, after which it is placed nose-first into a Mark IV CWT machine for tag insertion in the nasal tissue. Fish size-grading will occur at fin-clipping to ensure that the appropriate sized head mold is used for fish size. Typically, there are 2 or 3 Mark IVs operating simultaneously, often with different sized head molds. Tagged fish are passed through a quality control device to ensure successful tag implantation.

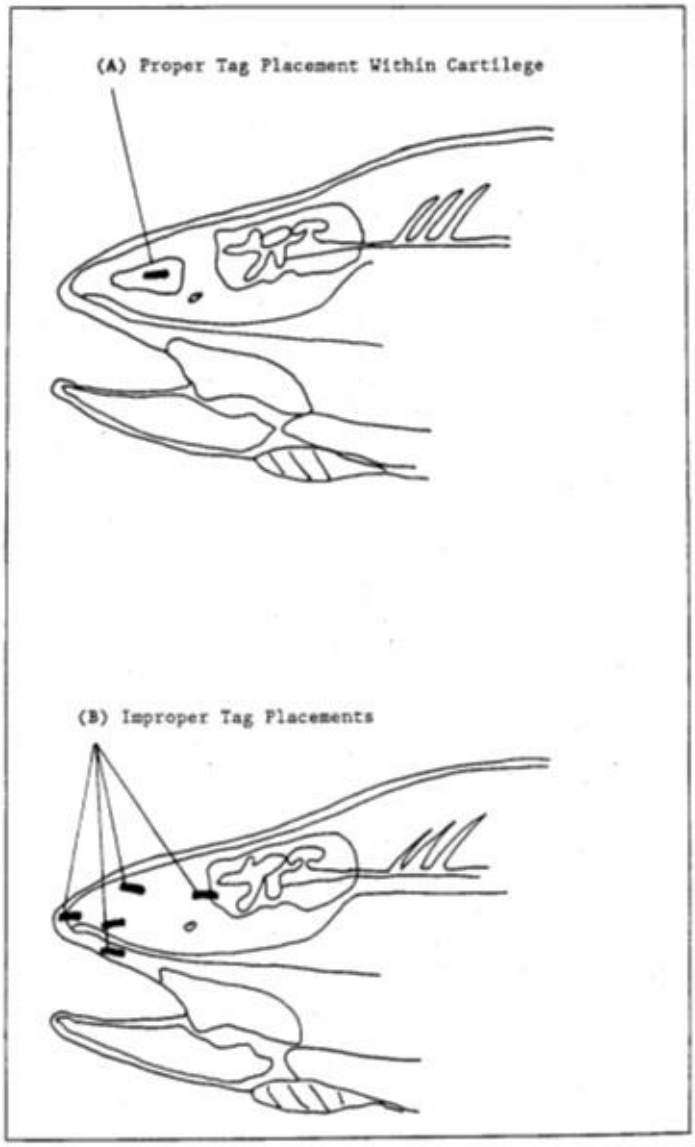
Tag placement and retention is monitored in 3 ways. A small group of tagged fish will be retained at the end of each tagging day for a 24 hour retention check the following day. In many instances, small checks will be conducted on a more immediate basis to ensure quality control. In addition to the 24 hour retention check, a larger group of at least 500 fish is kept for up to 30 days to conduct a longer term retention check (Table 2). Finally, to ensure proper tag placement, one tagged smolt is euthanized and dissected every hour, with the tag placement observed (Figure 1).

Detailed operational procedures may vary slightly by facility, but generally follow the practices as described by Nichols & Hillaby (1990).

Following a holding period of about two weeks after tag application, juvenile Chinook are released from the hatchery back into their river of origin. Yearling juvenile Chinook (fish to be released the following year) are retained at the hatchery for further rearing. Hatcheries that have swim-in infrastructure will

release directly from the hatchery to the river, while stocks from hatcheries without this mechanism will be transported to the river and force released. Juvenile releases typically occur when Chinook are smolting. Some juveniles may stay in the river for a short period of time prior to migrating to saltwater.

**Figure 1** - Proper coded wire tag placement (Nichols & Hillaby, 1990)



## RESULTS

Coded wire tagging began on schedule at all sites in 2017, as water temperatures during the incubation and rearing period were relatively normal. All tagging project operations were completed at or before the expected date, and there were no significant fish health issues during the tagging process.

**Table 1** - Tag application schedule by hatchery.

| Hatchery | Stock | Tagging Period |
|---|---|---|
| Chilliwack | Chilliwack River | April - May |
| Cowichan | Cowichan River | March - April |
| Deep Creek | Kitsumkalum River | May - June |
| Harrison | Harrison River | April – May |
| Quinsam | Quinsam River | March – April |
| Robertson | Robertson River | April – May |
| Shuswap | Lower Shuswap River | April – May |
| Snootli | Atnarko River | April-May |
| Spius | Nicola River | Sept – Oct |

**Table 2** - Estimated tag loss rate by hatchery stock during 2017 tag application. [1]

| Hatchery | Stock | Tag Loss |
|---|---|---|
| Chilliwack | Chilliwack River | 4.5% |
| Cowichan | Cowichan River | 0.1% |
| Deep Creek | Kitsumkalum River | 0.3% |
| Harrison | Harrison River | 0.4% |
| Quinsam | Quinsam River | 0.5% |
| Robertson | Robertson River | 0.5% |
| Shuswap | Lower Shuswap River | 1.0% |
| Snootli | Atnarko River | 0.3% |
| Spius | Nicola River | n/a |

[1]Updated from MRP database - March 2018.

**Table 3** – Tag targets and actuals (base level and incremental) for the 2017 tag application (2016 Brood). [1]

| Stock | Base Level CWT Target | Additional CWT Target | Total CWT Target | Total CWT Applied in 2017 |
|---|---|---|---|---|
| **Atnarko R** | 150,000 | 250,000 | 400,000 | 412,769 |
| **Chilliwack R** | 100,000 | 100,000 | 200,000 | 190,679 |
| **Cowichan R** | 200,000 | 400,000 | 600,000 | 599,671 |
| **Harrison R** | 100,000 | 200,000 | 300,000 | 275,218 |
| **Kitsumkalum** | 60,000 | 200,000 | 260,000 | 208,342 |
| **Nicola R** | 140,000 | 60,000 | 200,000 | 156,997 |
| **Quinsam R** | 200,000 | 300,000 | 500,000 | 698,872 |
| **Robertson Cr** | 200,000 | 250,000 | 450,000 | 591,611 |
| **Shuswap R Low** | 250,000 | 300,000 | 550,000 | 515,594 |
| **Total** | **1,400,000** | **2,060,000** | **3,460,000** | **3,649,753** |

[1]Updated from MRP database - March 2018.

**Table 4** - Base tagging level and percentage increase due to expanded tagging, by brood year and stock.

| Stock | Base Tag Level | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| **Atnarko R** | 150,000 | 239% | 194% | 166% | 163% | 170% | 173% | 175% |
| **Chilliwack R** | 100,000 | 98% | 96% | 100% | 212% | 213% | 99% | 91% |
| **Cowichan R** | 200,000 | 119% | 175% | 199% | 12% | 307% | 254% | 199% |
| **Harrison R** | 100,000 | 95% | 176% | 190% | 172% | 192% | 177% | 175% |
| **Kitsumkalum** | 60,000 | 354% | 249% | 113% | 175% | 186% | 345% | 240% |
| **Nicola R** | 140,000 | 34% | 52% | 36% | 24% | 23% | 23% | 12% |
| **Quinsam R** | 200,000 | 217% | 185% | 224% | 200% | 229% | 264% | 249% |
| **Robertson Cr** | 200,000 | 124% | 122% | 126% | 139% | 161% | 246% | 195% |
| **Shuswap R Low** | 250,000 | 96% | 101% | 104% | 85% | 76% | 98% | 106% |

**Table 5** - Total observed fishery CWTs, by brood year and stock.[1] Brood years 2011-2015 are considered preliminary as there are still cohorts that will likely recruit to catch and escapement in upcoming years. Only the 2009-2010 brood can be considered a complete brood year.

| Stock | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| **Atnarko R** | 690 | 720 | 864 | 505 | 141 | 66 | 1 |
| **Chilliwack R** | 397 | 1289 | 826 | 287 | 142 | 287 | 7 |
| **Cowichan R** | 291 | 418 | 396 | 174 | 68 | 193 | 8 |
| **Harrison R** | 76 | 256 | 203 | 28 | 87 | 108 | 7 |
| **Kitsumkalum** | 53 | 226 | 173 | 44 | 69 | 5 | 0 |
| **Nicola r** | 48 | 9 | 41 | 28 | 21 | 0 | 0 |
| **Quinsam R** | 88 | 60 | 102 | 404 | 318 | 105 | 10 |
| **Robertson Cr** | 56 | 325 | 64 | 1195 | 715 | 305 | 13 |
| **Shuswap R Low** | 325 | 1169 | 458 | 322 | 304 | 64 | 0 |

[1]Updated from MRP database - March 2018.

**Table 6** - Total observed fishery CWTs directly attributable to PSC funded expanded tagging, by brood year and stock. Brood years 2011-2015 are considered preliminary as there are still cohorts that will likely recruit to catch and escapement in upcoming years. Only the 2009-2010 brood can be considered a complete brood year.

| Stock | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| **Atnarko R** | 491 | 508 | 570 | 315 | 87 | 42 | 1 |
| **Chilliwack R** | 186 | 638 | 405 | 144 | 96 | 195 | 3 |
| **Cowichan R** | 152 | 227 | 252 | 116 | 7 | 146 | 6 |
| **Harrison R** | 39 | 125 | 129 | 18 | 55 | 71 | 4 |
| **Kitsumkalum** | 41 | 175 | 123 | 23 | 44 | 3 | 0 |
| **Nicola R** | 13 | 2 | 14 | 7 | 4 | 0 | 0 |
| **Quinsam R** | 61 | 41 | 66 | 279 | 212 | 73 | 7 |
| **Robertson Cr** | 31 | 180 | 35 | 666 | 416 | 188 | 9 |
| **Shuswap R Low** | 157 | 573 | 230 | 164 | 140 | 28 | 0 |

## DISCUSSION

Tag application numbers exceeded targets on 3 of 9 stocks, with 5 of the 9 stocks coming in a little under target. The total project overall goal of 3.46 million CWTs applied was exceeded by 189,753. It is common to exceed CWT targets as the spools of wire that the tags are printed on often have 5-10% more tags than is stated. Increases in tagging numbers help to increase the number of observed and estimated CWTs, which will result in increased precision in the estimated survival and exploitation rate.

Actual tag application numbers are subject to variability for several reasons, including, but not limited to: insufficient broodstock available for egg target, lower than expected in-hatchery survival, or unresolvable tagging equipment malfunctions. Hatcheries that have large production targets to support fisheries will rarely fail to reach their tag target. For example, Robertson Creek hatchery has a production target of 6M smolts, of which only 450K are required for tagging (base level + incremental). Thus, even with a very weak adult return and a fraction of their egg target, the tagging target can still be met. Conversely, stocks that are enhanced purely for stock assessment purposes (Lower Shuswap and Kitsumkalum) have less flexibility in their targets. If there are surplus juveniles available they will typically all be tagged; however, if there is any issue obtaining the release target the tag target will be compromised.

It must be noted that Kitsumkalum tag target is unique compared to all other stocks included in this project in that it is comprised of two different year classes; fed fry that are tagged and released the spring following emergence, and yearling smolts that are tagged at the same time as fed fry but that are held for an additional year prior to release.

Although the direct results of the tagging completed in 2017 (2016 brood) will not be apparent until those fish begin to recruit to the fishery and escapement as jacks in 2018, it can be assumed with certainty that the number of observed tags in catch and escapement will have increased as a function of

the increase in tagging over the base level. Incremental tagging has been occurring at sites since 2009, with some sites starting earlier. This work has been previously funded through the Coded-Wire-Tag Improvement Fund of the PSC, and the results of this earlier work can be used to illustrate the future benefits of this 2017 SEF funded project. Note that at the time of this report, brood years 2011-2015 are considered preliminary as there are still cohorts that will likely recruit to catch and escapement in upcoming years. Table 5 shows the total observed fishery tags, by brood year and stock (data current as of March 2018), while Table 6 shows the observed tags that are directly attributable to the expanded tagging projects. It is important to note that only the 2009-2010 brood can be considered a complete brood year.

It is too early to be able to assess the ultimate success of this project, as well as those that preceded it. This project represents the first step in a complex process that requires fishery and escapement sampling to recover CWTs. Even upon completion of the 2017 spawning and catch year, there are still cohorts that have yet to return from the majority of the years of expanded tagging.

# APPENDIX 1

## Financial Expenditure Summary

Details of expenditures registered in the DFO financial system at fiscal year-end.

| | |
|---|---|
| **Funding Total** | $ **301,293** |

| | |
|---|---|
| DFO Casual Hire Salary (Chilliwack and Quinsam stocks) | $ 45,915 |
| Snootli Hatchery Contracting Costs (Atnarko stock) | $ 25,000 |
| Spius Hatchery Contracting Costs (Nicola and Shuswap stocks) | $ 28,937 |
| Terrace Hatchery (Deep Creek) Contracting Costs (Kitsumkalum stock) | $ 26,250 |
| Cowichan Hatchery Contracting Costs (Cowichan stock) | $ 52,245 |
| Robertson Hatchery Contracting Costs (Robertson stock) | $ 29,475 |
| Chehalis hatchery Contracting Costs (Harrison stock) | $ 22,440 |
| Equipment & Supplies (CWTs, CWT equipment, and site costs) | $ 46,887 |
| **Total Costs** | **$ 277,150** |

| | |
|---|---|
| **Balance** *(refunded to PSC)* | **$ 24,142** |

# REFERENCES

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