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

Final Report to the Northern 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 and better define time-area distributions to develop management options at least since the August 13, 1985 Memorandum of Understanding (PSC 2004: March 2004 Annexes, P. 96). With the 1999 Agreement, CWTs became one of the key methods to assess harvest rate reduction compliance. Furthermore, in the 2009 agreement CWT-based 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) Coastwide model calibration. In 2005, the PSC convened an Expert Panel to review the utility of the CWT system for future Pacific Salmon Treaty (PST) implementation. They reported (Hankin et al. 2005) that the CWT program must be relied upon as the primary fishery and stock assessment tool for at least the next 5-10 years. No 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. PST Technical Report # 25 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 DFO to the release group size standards based on expected marine survivals for 2014.

PROJECT OBJECTIVES

The primary and sole objective of this project was to purchase and apply CWTs on Adipose Fin Clipped (AFC) juvenile Chinook salmon incremental to the current tagging levels already funded by Canadian Department of Fisheries & Oceans (CDFO) for six BC Chinook indicator stocks to meet the CWT release group size standards as outlined in PSC Tech. Rep. 25.

METHODS

Adult Chinook salmon are captured upon their return to the river in the summer or fall. Exact capture methods differ by location, but they include weir (Big Qualicum, Quinsam), fish ladder (Robertson), beach seine (Lower Shuswap, Kitsumkalum) and tangle net (Atnarko). Adult Chinook are held at the hatchery, either in concrete ponds or in circular fiberglass tubs (3 m in diameter) 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 then 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 (ATUs) prior to hatching (Billard & Jensen, 1996). Swim up fry are ponded into early rearing containers where they are reared until they are of suitable size for coded wire tagging. 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 issues that may arise and works closely with all hatcheries to ensure that fish are healthy prior to marking and release.

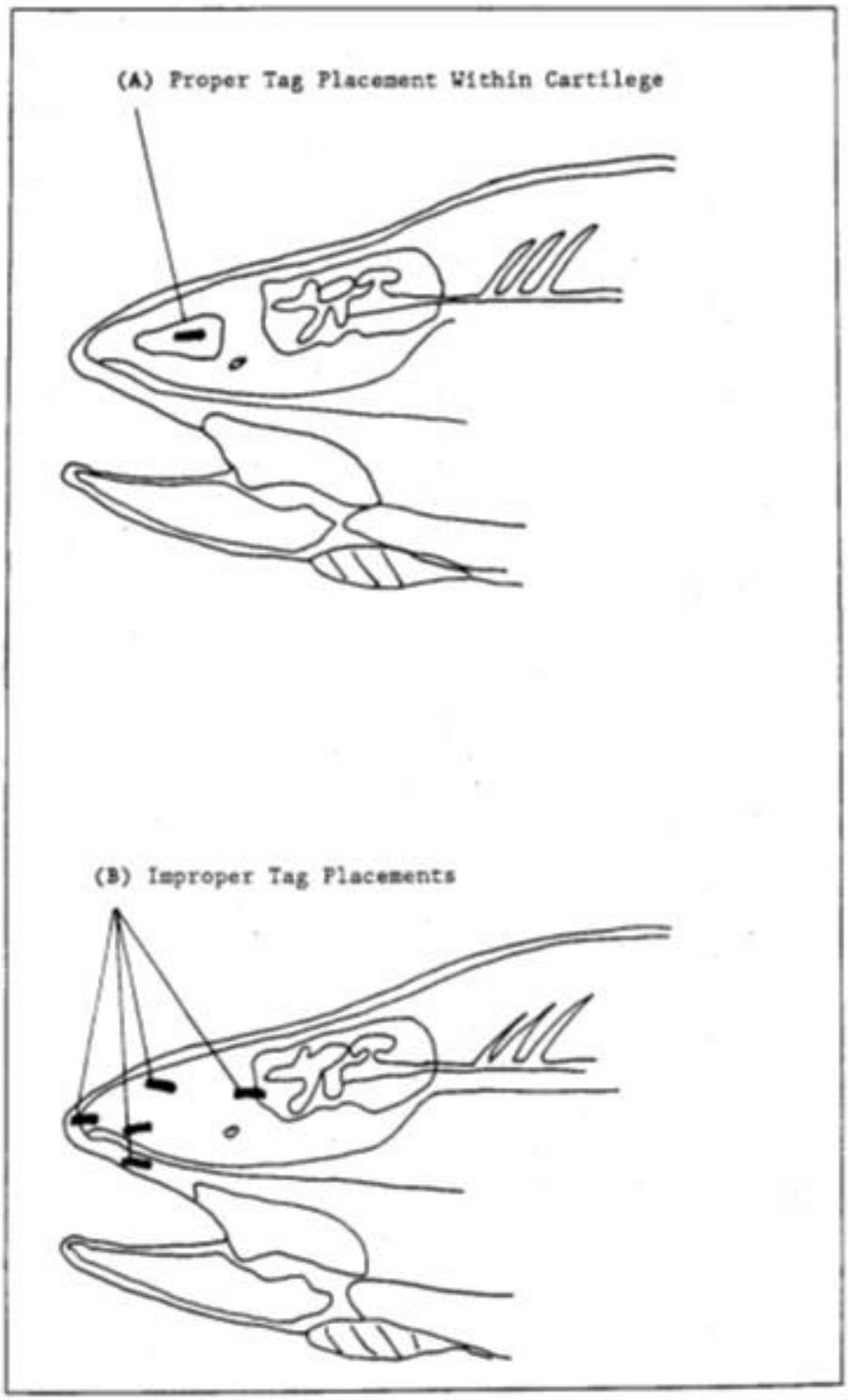
The procedures used to implant the CWTs into juvenile Chinook are documented in detail by Nichols & Hillaby (1990). Marking and tagging of sub-yearling Chinook (fish that have hatched in the spring or winter preceding marking, and that will be released shortly after) occurs when fish begin to reach 3-4 grams (g), with a typical release size of 6 g. Fry must be starved 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 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 (QCD) 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 (at lunch and at end of day) 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 1) . 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 tag application, juvenile Chinook are released from the hatchery back into their river of origin after a short period of holding (~2 week). Hatcheries that have swim-in infrastructure (Robertson, Big Qualicum, Quinsam) will release directly from the hatchery to the river, while Chinook at Shuswap, Snootli and Kitsumkalum will be transported to the river and force released. Juvenile releases typically occur when Chinook are smolting, although 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, 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 - Tagging schedule by hatchery.

Stock	Tagging Period
Robertson Creek	Late April-mid May
Big Qualicum	Early April – early May
Quinsam	Mid March – late April
Lower Shuswap	Early April – mid May
Snootli	Early May – early June
Deep Creek	May - June

Table 2 - Estimated 30 day tag loss rate by hatchery / stock.

Stock/Hatchery	Tag Loss
Big Qualicum	0.37%
Quinsam	0.81%
Robertson	0.00%
Shuswap	3.53%
Atnarko (Snootli Cr)	2.60%
Kitsumkalum (Deep Creek)	4.83%

Table 3 – Tag application targets and actuals (base level and incremental) for the 2013 brood year by stock.

Stock	Base Level CWT Target	Base Level CWT Actual	Incremental CWT Target	Incremental CWT Actual	Total CWT Target	Total CWT Actual
Atnarko	150,000	150,000	250,000	245,064	400,000	395,064
Big Qualicum	200,000	200,000	250,000	153,337	450,000	353,337
Kitsumkalum	60,000	60,000	200,000	105,289	260,000	165,289
Quinsam	250,000	250,000	300,000	350,418	550,000	600,418
Robertson Creek	200,000	200,000	250,000	277,889	450,000	477,889
Lower Shuswap	250,000	250,000	300,000	213,482	550,000	463,482
Total	**1,110,000**	**1,110,000**	**1,550,000**	**1,345,479**	**2,660,000**	**2,455,479**

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

Stock	Base Level	2007	2008	2009	2010	2011	2012	2013
Atnarko	150,000	na	na	177%	168%	169%	166%	163%
Big Qualicum	200,000	na	na	175%	178%	182%	182%	77%
Kitsumkalum	60,000	88%	249%	324%	346%	267%	158%	175%
Quinsam	250,000	113%	na	127%	119%	99%	122%	140%
Robertson	200,000	8%	149%	126%	124%	122%	126%	139%
Lower Shuswap	250,000	8%	na	93%	96%	101%	104%	85%

na = not applicable

Table 5 - Total observed fishery CWTs, by brood year and stock.

Stock	2008	2009	2010	2011	2012
Atnarko	532	683	447	86	4
Big Qualicum	46	67	107	179	3
Kitsumkalum	74	50	65	11	1
Quinsam	142	87	46	23	3
Robertson	237	56	264	12	7
Lower Shuswap	162	325	1161	58	8

Table 6 - Total observed fishery CWTs directly attributable to PSC funded expanded tagging, by brood year and stock.

Stock	2008	2009	2010	2011	2012	2013
Atnarko	na	436	280	54	2	-
Big Qualicum	na	43	69	116	2	-
Kitsumkalum	53	38	50	8	1	-
Quinsam	na	49	25	11	2	-
Robertson	142	31	146	7	4	-
Lower Shuswap	na	157	569	29	4	-

na = not applicable

DISCUSSION

Actual tag application numbers were close to target numbers at 3 of 6 sites, with small overages at 2 sites and 3 other sites not meeting their total CWT targets. The total project overall goal of 2.6 million CWTs applied resulted in 2.45 million being actually applied. It is common to apply up to 10% more tags than planned, as the spools of wire that the tags are printed on can be run out right to the end, which allows some extra tags to be applied. Small increases in tagging numbers help to increase the number of observed and estimated CWTs, which will result in increased precision in estimated of 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 very 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 (such as at Kitsumkalum in 2013) the tag target will be compromised.

The Kitsumkalum tag target is unique 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. In 2013, there were 2 issues at this hatchery that resulted in failure to meet the tag target. Firstly, there was a water flow interruption to one of the rearing containers overnight which resulted in the loss of 31,000 fry. Despite an investigation by the project biologist and DFO engineer, no cause was identified. In addition to this loss, one female that was screened for Bacterial Kidney Disease (BKD) tested medium positive, which necessitated the destruction of her eggs.

Although the direct results of the tagging completed in 2014 will not be apparent until those fish begin to recruit to the fishery and escapement as jacks in 2015, 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 all 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 the 2014 NEF project. Note that at the time of this report, brood years 2009-2012 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 Apr. 2015), while Table 6 shows the observed tags that are directly attributable to the expanded tagging projects. It is important to note that only the 2008 brood can be considered a complete brood year, except for Kitsumkalum which does typically see a return of 6 year old adults.

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 2014 spawning and catch year, there are still cohorts that have yet to return from the majority of the years of expanded tagging.

APPENDIX 1
Budget Summary

As tag application at Quinsam and Lower Shuswap begins in March and continues into April, the tag application costs are spread over two fiscal and project years. The budget showing for these two projects was required for tag application in March 2015. This overlap has been addressed in the PSC proposal for expanded tagging for 2015, and will eliminate this issue.

There was $9,000 of the $216,000 that was not received by the project proponents. This is reflected in the summary below ("funds not received"). A total of $207,000 of funding was received.

Fiscal Year – [2014-2015]	CSA Budget	Final Report Expenditures to Date	Final Balance
Contract Costs			
Shir-Shot Consulting (Robertson)	$ 35,000	$ 27,011.25	$ 7,988.75
Staffing 500 TOTAL	$ 64,000	$ 49,989.74	$ 14,010.26
EH-Fish Consulting (Lower Shuswap)	$ 30,000	$ 29,846.23	$ 153.77
CCFPA Contracting (Atnarko)	$ 22,500	$ 22,500.00	$ -
TSES (Kitsumkalum)	$ 25,000	$ 28,513.95	$ (3,513.95)
JO Thomas (head dissections)	$ 9,000	$ 18,900.00	$ (9,900.00)
Total Contract	**$ 185,500**	**$ 176,761**	**$ 8,739**
Site/Project Costs			
Lab Supplies		*$ 1,063.67*	
Brokerage fees		*$ 735.70*	
Kier Surgical CWT equipment		*$ 6,577.20*	
Northwest Technologies CWT equipment		*$ 14,242.48*	
Misc CWT equipment		*$ 687.77*	
Supplies (CWT machine parts)	**$ 30,500**	**$ 23,306.82**	**$ 7,193.18**
Refunded to PSC + funds not received		$ 15,595.05	
Total Budget	$ 216,000	$ 215,663.04	**$ 336.96**

APPENDIX 2
Authorized Statement of Expenditures

Pacific Salmon Commission
Project Code 57343 2014-2015 Expenditures Breakdown

Row Labels	Sum of AMOUNT
Temporary Help	
EH-FISH	0.00
THE 500 STAFFING SERVICES INC.	37501.04
Misc. Scientific Supplies	
KEIR SURGICAL	6577.20
NORTHWEST MARINE TECHNOLOGY INC	14242.48
Misc. Tagging Equipment	687.77
Funds received from PSC	
PACIFIC SALMON COMMISSION	-207000.00
Return of funds to PSC	
PACIFIC SALMON COMMISSION	6595.05
Brokerage Fees	**735.70**
Salary (THE 500 STAFFING SERVICE INC)	**12488.70**
Lab equipment	**1063.67**
Scientific Services	
CENTRAL COAST FISHERMAN'S PROTECTIVE ASSOCIATION	22500.00
EH-FISH CONSULTING	29846.23
J.O THOMAS & ASSOCIATES LTD	18900.00
SHIRSHOT CONSULTING SERVICES LTD	27011.25
TERRACE SALMONID ENHANCEMENT SOCIETY	28513.95
Office Supplies	**0.00**
Grand Total	**-336.96**

REFERENCES

Nichols, T.L., and J.E. HIllaby. 1990. Manual for Coded-Wire Tagging and Fin Clipping of Juvenile Salmon at Enhancement Operations Facilities. Prepared under contract #90SB.FP501-7-0060/A to Supply and Services Canada by Streamline Consulting Services Limited

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Hankin, D.G. (Chair), J.H. Clark, R.B. Deriso, J.C. Garza, G.S. Morishima, B.F. Riddell, and C. Schwarz. 2005. Report of the expert panel on the future of the coded wire tag recovery program for Pacific salmon. Pacific Salmon Commission Technical Report No. 18. 230 pp