

# PIT-Tag Effects on Hatchery Salmonids: Carson National Fish Hatchery Spring Chinook Salmon

## *Annual Report 2011 and Work Plan 2012*

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### Introduction

Coded-wire-tags (CWT) and passive integrated transponder (PIT) tags are used extensively throughout the Columbia River Basin to address a wide variety of management and research questions. A recent study by Knudsen et al. (2009) found that dual-tagged (CWT and PIT-tagged) hatchery spring Chinook salmon smolts released in the Yakima River had lower smolt-to-adult return rates (SARs) compared to CWT smolts, indicating that PIT-tags may impart a survival bias relative to smolts tagged with CWTs. Given the widespread use of CWT and PIT-tags, further evaluations of potential tag effects would be informative for quantifying the level of bias, if present, associated with each of these two tag types. Towards this end, we initiated the PIT-Tag Effects Study (PTES) at Carson National Fish Hatchery (NFH) with the marking of the brood year 2009 release. The objectives are 1) to determine the effects of PIT-tags on spring Chinook salmon SARs and 2) to determine PIT-tag loss rates throughout the complete salmon life-cycle.

### Methods

Spring Chinook salmon from brood year 2009 was the first release from the four-year (brood years 2009-2012) PTES at Carson NFH. The study consist of three tag groups: 75,000 CWT-only fish, 15,000 PIT-tag-only fish, and 15,000 dual-tagged fish (PIT-tag and CWT). Sample sizes were attained by supplementing the current tagging levels at Carson NFH with an additional 50,000 CWT only fish and a dual-tagged group of 15,000 fish. The PTES proposal contains the general study design, including the methods used to select sample sizes (Appendix A).

Historically there have been 4 tag groups at the hatchery: 3 coded-wire-tag groups and a PIT-tag group that are part of ongoing stock assessments. The coded-wire-tag groups consist of 25,000 tags each (75,000 total) and are split between 3 types of rearing vessels (outside raceways, adult ponds, and earthen ponds), with a different tag code for each rearing vessel. The PIT-tag group consists of 15,000 PIT-tagged fish reared in the outside raceways. We chose to

rear all PTES fish in the outside raceways to account for potential confounding factors associated with rearing vessels and to not alter the long term data set provided by the PIT-tag group. Historically, the PIT-tag group at the hatchery may have included some fish with CWTs. For the purposes of the PTES, starting in brood year 2009 we ensured that these fish did not also get a CWT and therefore made up the PIT-tag-only group. The existing 25,000 CWT fish that rear in the outside raceways were supplemented with an additional 50,000 CWTs and make up the CWT-only group. Lastly, we added a group of 15,000 fish which received both a PIT-tag and CWT. These fish were considered the dual-tagged group and were given a unique CWT code to identify these individuals from the other CWT groups. Tags consisted of 12mm full duplex PIT tags and 1.5mm decimal coded-wire-tags.

All spring Chinook salmon at Carson NFH were adipose fin marked from late-April to mid-May 2010 at approximately 120 fish/lb. Fish were then returned to the raceways and reared throughout the summer and fall. In mid-November 2010 the fish were CWT and PIT tagged at a size of approximately 35 fish/lb. After tagging the PTES fish were ponded in the outside raceways. The fish were released from the hatchery (rkm 28) to the Wind River on April 14<sup>th</sup> 2011. The tagging files for the PIT-tagged fish were uploaded to the PTAGIS database on November 9, 2010, and the tagging files for the CWT fish were uploaded to the RMIS database in winter 2011.

A sample of fish from each PTES group was held for 30 days in the hatchery building to assess initial tag retention rates. The dual tagged fish needed to be euthanized to determine both the PIT-tag and CWT retention rates. It was also determined that the CWT-only fish should be euthanized to not impart any bias that may be associated with the 30 day holding period. The PIT-tag-only fish were sampled for tag retention rates and the unique tag codes from these fish were removed from the PTES database which allowed the fish to be returned to the outside raceways and subsequently released. To euthanize as few fish as possible and still collect robust tag retention information, we estimated the expected precision (i.e., coefficient of variation = std. deviation/mean) that would be achieved for various assumed retention rates ranging from 0.90 to 0.99 and sample sizes ranging from 10 to 1000 (Figure 1). At sample sizes greater than ~200 fish, the improvement in precision is relatively small. Therefore, from these data we opted to hold ~300 fish from each PTES tag group for retention sampling to ensure a low coefficient of variation.

A PIT-tag detection array was installed in Tyee Springs between the Hatchery and the Wind River. The array consisted of 6 PIT-tag antennas, a multiplexing transceiver, and computer to log data. We installed this array in order to evaluate mortality that may be occurring between the time of tagging and release, and in order to improve the accuracy of subsequent survival estimates. For the 2009 brood year release, the in-pond mortalities were not scanned for PIT-tags and/or CWT and raceways were not checked for shed tags throughout the rearing period or after the release.

On June 7, 2011 all PIT tag codes were queried from the PTAGIS database and summarized to determine the number and location of detections and average travel time. We

conducted an interrogation detail query using all PTES PIT-tag codes as a registered tag file in PTAGIS.

## Results

Tagging occurred from November 8 to November 17, 2010. Total numbers of tagged fish, number of fish held for tag retention sampling, and percent of fish that retained their tags are reported (Table 1). No mortalities occurred of fish held for tag retention sampling. Overall, 100% of fish retained their PIT-tags and above 99.0% of all Carson NFH fish retained their CWTs.

Fish from PIT-tag-only and dual-tag groups were detected at a number of detection arrays during their out-migration to the Pacific Ocean. The PIT-tag detection array that was installed in the Tyee Springs release channel experienced equipment failures and subsequently detected only 37 unique PIT-tag codes. The Bonneville Dam detection arrays collectively detected 2,892 unique PIT-tag codes and the estuary trawl array at the mouth of the Columbia River detected 129 unique PIT-tag codes. Twenty-two unique PIT-tag codes were detected at both Bonneville Dam and the estuary trawl (Table 2). This equates to about 1% of the total PIT tagged fish being detected on their outward migration in the Columbia River. The PIT-tag-only and dual-tagged groups were detected at similar rates at each of the downstream detection arrays (Table 2). The two groups also displayed similar average travel times to Bonneville Dam and the estuary trawl array (Table 3) as well as similar estimated survival rates from release to Bonneville Dam and similar detection probabilities at Bonneville Dam (Table 4).

## Discussion

In this first year of the PTES, we were successful in achieving the initial study objectives. We successfully tagged and released the target sample sizes for each of the three release groups and conducted tag retention sampling. Estimates of tag retention indicate that tag loss was negligible for all three groups. Following release, the PIT-tag-only and dual-tagged groups displayed similar recovery rates, travel times, survival rates and detection probabilities at downstream arrays. Due to equipment failure, we were unable to estimate survival from tagging until release. However, we have identified measures to reduce the likelihood of similar equipment failures occurring in upcoming study years. During Summer 2011, we will be conducting site visits to Carson NFH during inoculation and spawning periods to refine logistic issues associated with sampling returning adults. Initial adult returns from the 2011 releases will occur in 2012. PTES tasks for 2011-2012 are provided in Appendix B.

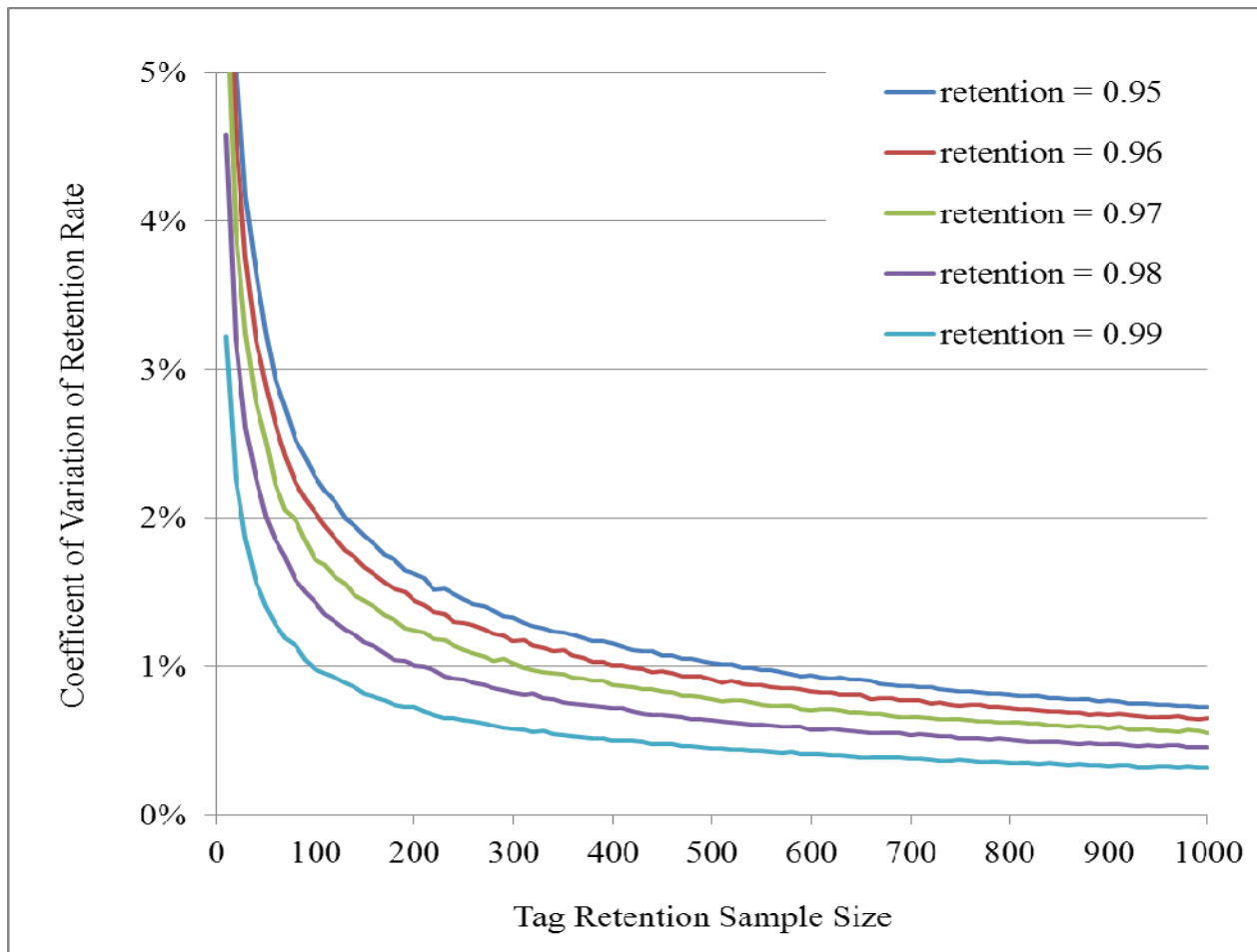


Figure 1. Precision of expected tag retention rates used to determine the sample size of fish held for tag retentions.

**Table 1.** Summary of tag group sizes and tag retention rates of brood year 2009 Carson National Fish Hatchery spring Chinook salmon. Tagging occurred from November 8 to November 17, 2010 and tag retentions were sampled on December 16, 2010.

|                           | PTES tag groups |                          |                              | Other on-station tag groups |                         |
|---------------------------|-----------------|--------------------------|------------------------------|-----------------------------|-------------------------|
|                           | PIT-tag only    | Dual-tagged<br>PIT / CWT | CWT only outside<br>raceways | CWT only earthen<br>ponds   | CWT only adult<br>ponds |
| Unique CWT code           | NA              | 05-53-58                 | 05-45-68                     | 05-48-29                    | 05-48-30                |
| Total tagged fish ponded  | 14,646          | 14,595                   | 74,722                       | 25,121                      | 25,174                  |
| Sampled for tag retention | 306             | 289 / 289                | 305                          | 509                         | 514                     |
| Tags not retained         | 0               | 0 / 1                    | 1                            | 1                           | 1                       |
| Percentage                | 100             | 100 / 99.7               | 99.7                         | 99.8                        | 99.8                    |

**Table 2.** Detection histories of brood year 2009 PIT-tagged juvenile spring Chinook salmon released from Carson National Fish Hatchery. All data was queried from the PTAGIS database on June 7, 2011 except Tyee Springs release channel information which is housed at the Columbia River Fisheries Program Office. Fish were released on April 14, 2011.

|                                  | PIT-tag only |                  | Dual-tagged |                  |
|----------------------------------|--------------|------------------|-------------|------------------|
|                                  | Counts       | Percent of Poned | Counts      | Percent of Poned |
| Tagged fish poned                | 14646        | NA               | 14595       | NA               |
| Tyee Springs release channel     | 17           | 0.001            | 20          | 0.001            |
| Bonneville Dam                   | 1425         | 0.097            | 1467        | 0.101            |
| Estuary trawl                    | 60           | 0.004            | 69          | 0.005            |
| Bonneville Dam and Estuary Trawl | 9            | 0.001            | 13          | 0.001            |

**Table 3.** Average travel time in days ( $\pm$  95% CI) of brood year 2009 PIT-tagged juvenile spring Chinook salmon released from Carson National Fish Hatchery. Fish were released on April 14, 2011.

|                              | PIT-tag only      | Dual-tagged       |
|------------------------------|-------------------|-------------------|
| Carson NFH to Bonneville Dam | 18.1 ( $\pm$ 0.6) | 17.4 ( $\pm$ 0.6) |
| Bonneville Dam to trawl      | 7.4 ( $\pm$ 5.4)  | 14.8 ( $\pm$ 7.5) |
| Carson NFH to trawl          | 31.3 ( $\pm$ 1.2) | 32.2 ( $\pm$ 1.2) |

**Table 4.** Mark-recapture estimates of survival from release to Bonneville Dam (BON) and detection probability at Bonneville Dam of brood year 2009 PIT-tagged juvenile spring Chinook salmon released from Carson National Fish Hatchery. Standard errors are in parentheses.

|                         | PIT-tag-only | Dual-tagged |
|-------------------------|--------------|-------------|
| Release-to-BON survival | 0.65 (0.20)  | 0.53 (0.13) |
| BON                     | 0.15 (0.05)  | 0.19 (0.05) |

Appendix A. Double click on the proposal to open the file.

## PIT-Tag Effects on Hatchery Salmonids: Carson National Fish Hatchery Spring Chinook Salmon

*Study Proposal 3/1/2011*

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### Introduction

Both Coded-Wire Tags (CWT) and Passive Integrated Transponder (PIT) tags are used extensively throughout the Columbia River Basin to address a wide variety of management and research questions. A study by Knudsen et al. (2009) recently found that dual-tagged (CWT and PIT-tagged) hatchery spring Chinook salmon smolts released in the Yakima River had lower smolt-to-adult return rates (SARs) compared to CWT smolts, indicating that PIT-tags may impart a survival bias relative to smolts tagged with CWTs. Given the widespread use of CWT and PIT-tags, further evaluations of potential tag effects would be informative for quantifying the level of bias, if present, associated with each of these two tag types. Towards this end, we conducted sample size calculations to quantify the levels of tagging effort (number of tagged fish released) and study duration (years) that would be required to further evaluate CWT and PIT-tag effects on hatchery spring Chinook salmon released from Carson National Fish Hatchery (NFH). Spring Chinook salmon from Carson NFH have been selected as an initial location for beginning this evaluation, but a more comprehensive evaluation would result from replicating the general experimental design with other hatcheries and species throughout the Columbia River Basin. Towards this end, we illustrate the general experimental design using Carson NFH as an example, recognizing that sample sizes could easily be modified for replicating the experiment with other locations or species.

### General Study Design

The general study design is to release three groups of tagged fish: a number of fish are released with only CWTs, a number of fish are released with only a PIT-tag and a number of fish are dual-tagged, released with both a PIT-tag and a CWT (batch identification numbers for the two groups with CWTs must be different). All fish will be adipose fin marked.

To evaluate short-term tag retention and survival rates for the three groups of tagged fish, a subsample of approximately 300 fish per group is monitored in separate holding facilities. To evaluate mortality that may occur between tagging and hatchery release, a PIT-tag detection array will be installed at the hatchery release channel. Using standard Cormack-Jolly-Seber survival models and downstream detection capabilities at Bonneville Dam, the NOAA PIT-trawl

Appendix B. PIT-tag Effects Study work plan for 2011 – 2012.

| Year                          | Month            | Activity                                                                                                                                                                                                                            | Responsible Party* |
|-------------------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| <b><u>BROOD YEAR 2009</u></b> |                  |                                                                                                                                                                                                                                     |                    |
| 2011                          | late-June        | Complete Annual Report                                                                                                                                                                                                              | HAT/WMT            |
| 2011                          | June - August    | Site visits to incorporate PIT arrays into adult pond entrance/inoculation/spawning/and surplus activities (always on Wednesday; alternating surplus and inoculations until beginning of August then switch to spawning activities. | HAT/FMP            |
| 2011                          | June - August    | Test bio-sample program that incorporates digital PIT info to other bio data                                                                                                                                                        | HAT/FMP            |
| 2011                          | June-November    | Build and test adult and bio-sampling PIT arrays                                                                                                                                                                                    | HAT                |
| 2011                          | June-November    | Install adult and bio-sampling PIT arrays                                                                                                                                                                                           | HAT                |
| <b><u>BROOD YEAR 2010</u></b> |                  |                                                                                                                                                                                                                                     |                    |
| 2011                          | Spring           | Juveniles adipose marked                                                                                                                                                                                                            | FMP                |
| 2011                          | mid-November     | Juveniles CWT and PIT tagged                                                                                                                                                                                                        | FMP/HAT            |
| 2011                          | mid-November     | Ponding numbers and PIT tag data reported to common drive                                                                                                                                                                           | FMP                |
| 2011                          | mid-November     | Juveniles held for tag retention                                                                                                                                                                                                    | FMP/HAT            |
| 2011                          | mid-December     | Juveniles checked for tag retention                                                                                                                                                                                                 | HAT                |
| 2011                          | mid-December     | Remove PIT tag codes of PIT tagged only fish from our database                                                                                                                                                                      | FMP                |
| 2011                          | mid-December     | Remove PIT tag codes of dual tagged fish from our database and PTAGIS. Subtract the number of the sacrificed CWT fish from the dual tagged and CWT only release numbers                                                             | FMP                |
| 2011-2012                     | November - April | Mortalities collected from ponds and checked for PIT tags and CWTs                                                                                                                                                                  | Carson NFH/HAT/FMP |
| 2011-2012                     | November - April | Remove in-pond mortality tag codes from our database and report to PTAGIS                                                                                                                                                           | FMP                |
| 2012                          | April            | Install in-stream Tyee array for release                                                                                                                                                                                            | HAT                |
| 2012                          | mid-April        | Juvenile release                                                                                                                                                                                                                    | Carson NFH         |
| 2012                          | April - June     | Summarize out-migrations                                                                                                                                                                                                            | HAT/WMT            |
| 2011-2012                     | November - April | Raceways scanned for shed PIT tags                                                                                                                                                                                                  | HAT/FMP            |
| 2011-2012                     | November - April | Remove shed tag codes from our database and report to PTAGIS                                                                                                                                                                        | FMP                |
| 2012                          | mid-May          | remove in-stream Tyee array post release                                                                                                                                                                                            | HAT                |
| 2012                          | late-June        | Complete Annual Report                                                                                                                                                                                                              | HAT/WMT            |
| 2012                          | June - November  | Install adult and bio-sampling PIT arrays                                                                                                                                                                                           | HAT                |
| 2012                          | June - August    | Collect bio-data (age, sex, size) and tag codes of returning BY 2009 fish                                                                                                                                                           | HAT/FMP            |

\*Hatchery Assessment Team -HAT, Water Management Team -WMT, and Fish Marking Program -FMP