Forecasting Leavenworth National Fish Hatchery returns using PIT expansion.

## Jakub Bednarek, Fish Technician Mid-Columbia Fish and Wildlife Conservation Office March 1, 2018

## In-season salmon run forecasting is used in supplement with pre-season forecasts to make fisheries management decisions at the Leavenworth National Fisheries Complex. At Leavenworth National Fish Hatchery (LNFH), forecasting adult Spring Chinook returns to Icicle Creek allows for managing harvest fisheries as well as operating the Leavenworth National Fish Hatchery (LNFH). The tool helped secure brood stock for the LNFH in 2017 when low number of adult returns was forecasted and harvest fisheries were reduced. We used PIT tag interrogation data as our method of inferring the total expected adult returns to from a proportion of tagged fish.

PIT tag detection data was obtained for LNFH origin Spring Chinook salmon at Bonneville Dam and Icicle Creek using the PIT Tag Information System (PTAGIS). We join the release year data read from unique PIT tags detected at Bonneville dam to their respective tagging ratios for that release cohort. Table 1 shows the rate at which juvenile Spring Chinook salmon were PIT tagged between 2009 and 2016. We then calculate the survival of adults between Bonneville Dam and the lower Icicle River array. The forecast LNFH returns to Icicle River can be summarized by where the ratio (R) expands the number of fish (F) detected at Bonneville dam from each release group and then multiplied by the average conversion rate (C).

**Table 1 PIT tagging ratios at LNFH**

|  |  |  |  |
| --- | --- | --- | --- |
| *Release Year* | *Total Released* | *# PIT tagged* | *PIT Ratio* |
| 2017 | 1,131,913 | 20,158 | 56 |
| 2016 | 945,277 | 19,957 | 47 |
| 2015 | 1,139,567 | 14,994 | 76 |
| 2014 | 1,239,025 | 13,380 | 93 |
| 2013 | 1,289,293 | 14,951 | 86 |
| 2012 | 1,186,622 | 14,901 | 80 |
| 2011 | 1,189,442 | 14,875 | 80 |
| 2010 | 1,284,653 | 14,948 | 86 |
| 2009 | 1,685,038 | 14,931 | 113 |

Table 2 shows the average conversion rates as well as the average 0.647. No data is available prior to the installation of the lower Icicle River PIT antenna array (ICL) in 2012. We use the trend observed between 2012 until the present to forecast the next years’ return.

**Table 2 Age Weighted Conversion rates between 2012 and 2017**

|  |  |  |
| --- | --- | --- |
| *BON* | *ICL* | *Conversion* |
| 98 | 63 | 0.739 |
| 40 | 30 | 0.862 |
| 121 | 56 | 0.532 |
| 80 | 60 | 0.862 |
| 68 | 36 | 0.609 |
| 17 | 8 | 0.541 |
|  | Average: | 0.691 |

We further adjust the in-season forecast based on the migration timing characteristics of adult Spring Chinook. PIT tag data shows that the first LNFH origin adults begin passing over Bonneville Dam in early April and on average 50% passage occurs May 3nd (Table 3.) Run timing allows us to make and adjust the in-season forecast in real time as returns are detected over Bonneville Dam. Forecasting can be used to make management decisions as far as 30 days before fish begin returning to the Icicle with regards to fish ladder operation or harvest season dates and limits.

**Table 3. Migration Timing Characteristics adult PIT tag Hatchery Spring Chinook Released in Icicle Creek, Bonneville Dam 2007 – 2017 (Columbia River DART 2018)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | |
| *Year* | *First Passage Date* | *5% Passage Date* | *10% Passage Date* | *25% Passage Date* | *50% Passage Date* | *75% Passage Date* | *90% Passage Date* | *95% Passage Date* | *Last Passage Date* |
| *Average* | 03/29 | 04/13 | 04/21 | 04/25 | 05/02 | 05/19 | 06/12 | 06/21 | 07/15 |
| *Median* | 04/05 | 04/17 | 04/22 | 04/26 | 05/02 | 05/10 | 06/26 | 07/06 | 07/19 |
| 2017 | 02/27 | 02/27 | 05/01 | 05/05 | 05/17 | 05/23 | 07/01 | 07/05 | 07/05 |
| 2016 | 04/02 | 04/16 | 04/21 | 04/27 | 04/30 | 05/07 | 05/15 | 05/24 | 07/10 |
| 2015 | 04/09 | 04/12 | 04/16 | 04/20 | 04/28 | 05/09 | 05/25 | 06/27 | 08/27 |
| 2014 | 04/07 | 04/18 | 04/20 | 04/25 | 04/30 | 05/07 | 06/25 | 07/10 | 08/08 |
| 2013 | 03/05 | 04/23 | 04/25 | 04/29 | 05/06 | 06/24 | 07/07 | 07/18 | 08/04 |
| 2012 | 04/07 | 04/20 | 04/23 | 05/02 | 05/08 | 05/14 | 07/04 | 07/06 | 07/17 |
| 2011 | 04/20 | 04/26 | 04/28 | 05/03 | 05/09 | 05/18 | 07/06 | 07/15 | 07/27 |
| 2010 | 03/29 | 04/13 | 04/15 | 04/21 | 04/28 | 05/06 | 07/03 | 07/11 | 07/19 |
| 2009 | 04/22 | 04/24 | 04/26 | 05/02 | 05/08 | 05/16 | 06/28 | 07/09 | 07/17 |
| 2008 | 03/02 | 04/15 | 04/19 | 04/27 | 05/11 | 07/05 | 07/14 | 07/17 | 08/01 |
| 2007 | 04/12 | 04/13 | 04/15 | 04/19 | 04/26 | 05/09 | 06/21 | 06/29 | 07/19 |

Our forecast was compared to historical returns. Historical returns are were reconstructed using the sum of fish that returned to LNFH, the sport and tribal harvest estimates, and the number that are observed during spawning ground surveys. Our PIT expansion ranges within 35% to 104% of the run reconstruction estimate but on average is within 72% of the actual run (Table 4.) Figure 1 shows a graphical visualization of Table 4.

**Table 4 Comparison of PIT expansion and run reconstruction, Icicle Cr.**

|  |  |  |  |
| --- | --- | --- | --- |
| *Year* | *Total Run* | *Forecast* | *% of Total Run* |
| 2006 | 3147 | 1,579 | 50.2 |
| 2007 | 2,622 | 908 | 34.6 |
| 2008 | 4,692 | 3,560 | 75.9 |
| 2009 | 4,977 | 4,198 | 84.3 |
| 2010 | 13,862 | 11,948 | 86.2 |
| 2011 | 6,990 | 6,634 | 94.9 |
| 2012 | 7,074 | 5,595 | 79.1 |
| 2013 | 3,309 | 2,098 | 63.4 |
| 2014 | 6,005 | 6,294 | 104.8 |
| 2015 | 8,149 | 4,508 | 55.3 |
| 2016 | 5,224 | 3,996 | 76.5 |
| 2017 | 1,417 | 791 | 55.8 |

**Figure 1PIT tag expansion plotted with Actual Adult Returns base on Run Reconstruction**